DEPARTMENT OF BIOTECHNOLOGY
MATA GUJRI MAHILA MAHAVIDYALAYA (AUTONOMOUS), JABALPUR
SYLLABUS PRESCRIBED FOR THE DEGREE OF MASTER OF SCIENCE IN BIOTECHNOLOGY
PROGRAMME UNDER CHOICE BASED CREDIT SYSTEM ORDINANCE- 222
(Academic Session 2023 – 2024 & Onwards)

This brochure of the programme for the M.Sc. degree in Biotechnology consists of six parts, viz., (A) Information from the relevant Ordinance(s) / Statute(s), (B) Programme Objective (C) Programme Outcomes (D) Programme Specific Outcomes (PSOS)and (E) Courses of study.

1. INFORMATION FROM THE RELEVANT ORDINANCE(S)/STATUTES

1.1. DURATION OF THE COURSE

M.Sc. Biotechnology will be a full time two-year programme to be covered in four semesters, each of six months duration. TheI year of the programme will complete the I and II semesters, and the second year will complete the third and fourth semesters. The maximum duration of the programme shall be twice of the minimum duration of the programme i.e. four years.

1.2. PROGRAM OF THE STUDY

The semester will consist of 16-18 weeks of academic work. One credit is equivalent to one hour (60 minutes) of teaching (lecture or tutorial) or two hours (120 minutes) of practical work/field work per week throughout a semester. The credits associated with the courses will be valid credits, while credits associated with comprehensive viva voce will be virtual credits. In the end term examination there will be **three components, namely Core Courses, Elective Courses and Skill Development Course,** except for the 4th semester where every student will carry out and submit a **dissertation**.
The syllabus for the theory and practical examination will be prescribed by the Board of Studies in Biotechnology.

1.3. CONTINUOUS EVALUATION

During the semester, a teacher offering the course will do the continuous evaluation of the student at three points of time by conducting three tests of 20 marks each. Of these, two must be written tests and the third may be written test/quiz/seminar/assignment for theoretical courses. Marks obtained in two best tests out of three will be awarded to the student.

1.4. ATTENDANCE

The student, whose attendance is less than 75 %, will not be allowed to appear in the end semester examination and he/she will be declared fail in that semester.

1.5. END SEMESTER EXAMINATION:

There shall be an end semester examination at the end of first, second & third semester. The semester examination will be held every year normally in December and June or on the dates declared by the college. Every student will appear in four respective theory papers and two combined practical examinations in first, second, & third semesters except for the fourth semester. Each student has to appear in the end semester examination, otherwise he/she shall

be awarded “Ab” grade in that course. In the fourth semester, every student will be allotted dissertation work in lieu of four theory papers.

The dissertation will be evaluated by the external examiner who has expertise in the concerned subject. For the purpose of holding a viva-voce, the supervisor will be the internal examiner along with the external examiner who has evaluated the dissertation. The scheme of marks for evaluating the various components of the dissertation will be followed as given in the syllabus.

1.6. CONDITION FOR A PASS:

For each course, each student has to appear in at least two tests and end semester examinations, otherwise the student will be awarded “Ab” grade. The total marks obtained in the end-semester examination, and the best of two tests under continuous evaluation will decide the grade in that course. The grading will be made on 10 –point scale as follows:

Letter Grade	Grade Points	Description	Range of Marks (%)
O	10	Outstanding	90-100
A+	9	Excellent	80-89
A	8	Very Good	70-79
B+	7	Good	60-69
B	6	Above Average	50-59
C	5	Average	40-49
P	4	Pass	35-39
F	0	Fail	0-34
Ab	0	Absent	Absent

For passing the examination in each semester, a candidate must have secured a minimum of 35% marks (“P” Grade: 4 Grade Points) in the course. If the marks obtained by the student in a course are less than the minimum cut-off percentage of marks, then “F” Grade will be awarded. If a student obtains “F” or “Ab” Grade in any course, he/she will be treated to have failed in the course. He/she has to reappear in the examination of the course as and when conducted or arranged by the college. Marks obtained earlier in continuous assessment may be carried forward and added to the marks obtained in repeat end semester examination to decide the grade in the repeat course.

The theoretical and practical courses can be repeated whenever offered or arranged by the college but within maximum duration of the programme. He/she can avail multiple repeat attempts to pass the course. The student will be promoted to the next semester if he/she secures at least 12 valid credits in a semester. In case the student secures less than 12 valid credits in any semester, then the student will be asked to repeat the entire semester and that semester will be treated as zero semester.

The decision of the teacher regarding the evaluation and the grade shall be final. However, a student submits in writing for review of his Marks/Grade to the Head/Director who will place the case before the board of comprehensive viva voce. The decision of the board will be final. Result of the review will be declared by the concerned Head/Director. Review is effective only when grade improve. Review will be allowed only if –

1. The prescribed fee is paid.
2. The candidate applies within 7 days of the declaration of the grade in that course.

There will be no provision for revaluation. However the candidates can apply for Re-totaling in one course per semester.

1.7. In matters not covered under this Ordinance, general rules of the college shall be applicable.

2. PROGRAMME OBJECTIVES

2.1. The objective of the Master's Program in Biotechnology is to equip the students to gain conceptual and analytical skills about biological materials, biotechnological tools and techniques.

2.2. The program emphasizes applied knowledge acquired about prokaryotic and eukaryotic cellular processes, structural and genetic manipulation of cellular material and processes, and data processing and interpretation techniques.

2.3 The imparting of laboratory training for bioassay protocols of biological materials, their manipulative treatments, emerging tissue culture and genetic recombinant techniques, and bioinformatics databases and tools.

2.4. Students will be able to address application skills of biotechnological techniques and tools in fields of biomolecules including enzymes, environment, animals, microbes and plants.

3. PROGRAMME OUTCOMES

The Masters in Biotechnology Program will cater to the expanding demand for skilled manpower, which is equipped with an understanding of modern research protocols and ethics involving both cellular and molecular materials from biological entities in alleviation and remediation of energy demands, environmental conservation and management, plant health and yield management, human health including emerging epidemic and pandemic disease loads, and synthesis of multi-functional enzymes, organisms and their survival in nature to maintain natural biodiversity and ecological balance.

A M.Sc. Biotechnology student should be able to independent study and researches related to

3.1. Isolation of novel biological material, its assay and multiplication, and manipulation.

3.2. Application of modern emerging methodological and analytical tools and techniques in qualitative and quantitative assessment of biological materials and processes.

3.3. Extraction of biological molecules and sub-molecules and their biochemical, genetic and molecular characteristics and dynamics.

3.4. Designing of bioassay experiments, assessment of their outcomes, their modeling and simulation.

3.5. Efficient retrieval of information from national and international biological databases, analysis of retrieved information and contribution to new knowledge.

3.6. Integration of up- and down-stream processing of bioassay experiments and their analytical and application assessment.

3.7. Undertaking of research involving genomics, metabolomics, and protemics.

3.8. Competition at national and international level to pursue career in advanced studies in research and industrial establishments.

3.9. Independent documentation and communication of scientific results in the public domain as well as peer-reviewed scientific magazines and journals.

3.10. Filing of intellectual property rights to national and international registries

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4. PROGRAMME SPECIFIC OUTCOMES (PSOS)

A successful graduate student will understand and assess a variety of biological entities including structure, metabolism and dynamics. The student will be able to design and execute experiments related to Immunology, Molecular Biology, Recombinant DNA Technology, and bioinformatics. He/ She will be able to pursue independent research in industrial and research establishment by utilizing his/ her analytical and creative biotechnological skills.

Core Course Code BTC101: Cell Biology
(Course Credits= 03)

Course Objectives:
The course aims to facilitate the learners an in-depth understanding of structure and function of the cell, its components and transport across various organelles. Empowering the learners with different tool and techniques of cell biology, it will provide a deep understanding of the cellular aspect of the mechanism of signal transduction, cell cycle and cancer.

Course Learning Outcomes:
CO1: Understanding of structure of prokaryotic and eukaryotic cell, and application of knowledge of microscopic techniques for cell study.
CO2: Knowledge of functional integrity and structure of different cell organelles and transport of ions, nutrients and macromolecules across membranes.
CO3: Knowledge about signal transduction pathway with understanding of different type of receptors and signaling molecules.
CO4: Conceptualization of cell cycle, cell division and cell death. Deep understanding of events of mitosis, apoptosis, embryonic stem cells and therapeutic cloning.
CO5: Knowledge about biology of cancer and its causes. Understanding of oncogenes, tumor suppressor gene, tumor viruses and molecular approach of cancer treatment.

COURSE CONTENTS

UNIT I
Diversity of cell size and shape, Cell Theory, Structure of Prokaryotic and Eukaryotic cells; Isolation of cells, Microscopic techniques for study of cells. Cell motility: cilia and flagella of eukaryotes and prokaryotes.

UNIT II
Cellular Organelles: structural organization and functions of Plasma Membrane, Mitochondria, Chloroplast, Nucleus, lysosomes, golgi bodies, ribosomes; Transport of nutrients, ions and macromolecules across membranes: Active and passive diffusion, Symport, Antiport and uniport, Na+ K+ pumps and their metabolic significance.

UNIT III
Cell Signaling: Signaling Molecules and their Receptors, functions of Cell Surface Receptors, Intracellular Signal Transduction pathway, and signaling networks. ECM and its proteins

UNIT IV
The Cell Cycle and Cell Death and Cell Renewal; Eukaryotic Cell Cycle, Events of Mitotic Phase, Meiosis and Fertilization. Programmed Cell death, Stem Cells and Embryonic Stem Cells and Therapeutic Cloning

UNIT V
Cancer: Development and causes of Cancer, Tumor Viruses, Oncogenes, Tumor suppressor

genes, Cancer Treatment- Molecular approach.

Recommended Books

1. Molecular Biology of Cell, Alberts, B. et al.
2. Molecular Cell Biology, Lodish et al.
3. Reproduction in Eukaryotic cells, DM Prescott, Academic Press.
4. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
5. Cell in Development and Inheritance, EB Wilson, MacMilanNewYork.
6. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press.
7. Fertilization, FT Longo, Chapman and Hall.
8. Molecular Biology of Steroid and Nuclear Hormone Receptors, LP Freedman, Birkhuse

Core Course Code BTC102: Animal Cell Science and Techniques
(Course Credits=03)

Course Objectives:
The course aims to empower the learners with knowledge and techniques of Animal cell science for in vitro cell culture and its application in formation of various cell culture products for research laboratory to industrial uses.

Course Learning Outcomes:
CO1: Understanding the basic structure and organization of animal cell; equipment's and materials for animal cell culture technology; primary and established cell lines cultures; introduction and function of the balanced salt solutions and simple growth medium, serum and supplements; role of carbon dioxide in to the culture.
CO2: Learning the different parameters, i.e. viability and cytotoxicity; biology and characterization of the cultured cells and basic techniques of cultured cells like disaggregation of tissue and primary culture; maintenance of cell culture.
CO3: Knowledge about various techniques like Scaling up of animal cell culture, cell synchronization, cell cloning and micro-manipulation, cell transformation.
CO4: Understanding the application of animal cell cultures, stem cell cultures, cell culture based vaccines, somatic cell genetics.
CO5: Conceptualize the application of Organ and histotypic culture, measurement of cell death, apoptosis, three dimensional culture and tissue engineering.

COURSE CONTENTS
UNIT-I
Structure and Organization of Animal cell; Equipments and Materials for Animal cell culture technology; Primary and established Cell lines cultures; Introduction to the Balanced Salt Solutions and simple Growth Medium; Brief account of chemical, physical and metabolic functions of different constituents of culture medium; role of carbon dioxide, Serum and Supplements.

UNIT-II
Serum and protein free defined media and their application, measurement of viability and cytotoxicity; biology and characterization of the cultured cells, measuring parameters of growth; basic techniques of mammalian cell culture in vitro; disaggregation of tissue and primary culture; maintenance of cell culture; cell separation.

UNIT-III
Scaling up of animal cell culture, cell synchronization, cell cloning and micro-manipulation, cell transformation.

UNIT-IV

Application of animal cell cultures, stem cell cultures, embryonic stem cells and their applications, cell culture based vaccines, somatic cell genetics. Culture collection centres for animal cell lines

UNIT-V

Organ and histotypic culture, measurement of cell death, apoptosis, three dimensional culture and tissue engineering and its application, Basic concept of organ printing

Recommended Books:

1. Culture of Animal Cells (3rd Edition), R. lanFreshmney. Wiley-Liss.
2. Animal Cell Culture-Practical Approach, (Ed) John R.W. Masters, Oxford.
3. Cell Growth and Division' A Practical Approach. (Ed.) R. Basega, IRL Press.
4. Cell Culture Lab Fax. (Eds). M. Buller& M. Dawson, Bios Scientific Publication Ltd. Oxford.
5. Animal Cell Culture Techniques. (Ed.) Martin Clynes, Springer.
6. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods, (Ed.) Jenni P. Mather and David Barnes

Core Course Code BTC103: Microbial Physiology and Genetics
(Course Credits=03)

Course Objectives:
The course aims to study microbial physiological and biochemical processes within the microbial cell for profiling of metabolic pathways and metabolites along with their genetic controls for possible applications in Biotechnology

Course Learning Outcomes:
CO1: Gains insight about growth dynamics, mathematical expression, growth curves and yields, types of growth; effect of environmental factors storage and maintenance of cultures.

CO2: Understanding of concepts of metabolic diversity, including photosynthetic, chemolithotrophic and CO2 and nitrogen fixation, nitrate and sulfate reduction, fermentation, decomposition, methanogenesis and acetogenesis, hydrocarbon transformation.

CO3: Gains insight knowledge about structural and metabolic diversity of bacteria, viruses, viroids and prions. Prokaryotic cells structure.

CO4: Insight into host-parasite relationship, colonization, types of toxins, and their structures, mode of action, Chemotherapy/antibiotics: antimicrobial agent antibiotics, mode of action, antibiotics resistance.

CO5: Sound knowledge of genes, mutation and mutagenesis; types of mutagens and mutation; Ames test, complementation test, Bacterial genetic recombination, plasmids and transposons; bacterial genetics mapping.

COURSE CONTENTS
UNIT-I
The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; synchronous growth; growth as affected by environmental factors like temperature, acidity, water availability and oxygen; storage and maintenance of cultures, continuous culture, Culture Collection Centre in India

UNIT-II
Metabolic diversity among microorganisms, photosynthesis in microorganisms; role of chlorophylls, carotenoids and phycobilins: Calvin cycle; chemolithotrophy; hydrogen-ion nitrite oxidizing bacteria; nitrate and sulfate reduction; Methane fermentation-diversity, syntrophy, role of anoxic decomposition, methanogenesis and acetogenesis; nitrogen fixation; hydrocarbon transformation

UNIT-III
Structural diversity of bacteria: purple and green bacteria, cyanobacteria, homoacotogenic bacteria, acetic acid bacteria, budding and appendaged bacteria, spirilla, spriochaetes, gliding

and sheathed bacteria, pseudomonads, lactic and propionic acid bacteria, endospore forming rods and cocci, mycobacteria, rickettsias, chlamydias and mycoplasma methanogens;
Structural diversity of viruses: bacterial, plant, animal and tumor viruses examples of herpes, pox, adenoviruses, retroviruses, viroids and prions. Prokaryotic cells structure and functions: cell walls of eubacteria; peptidoglycan and related molecules; outer-membrane of gram negative bacteria; cell membrane synthesis; cell inclusions like endospores, gas vesicles etc.

UNIT-IV

Host-parasite relationship: entry of pathogens into the host; colonization types of toxins: exoendo- and entero-toxins and their structures, mode of action, Chemotherapy/antibiotics: antimicrobial agents, sulfa drugs, antibiotics, penicillins and cephalosporins, broad spectrum antibiotics, mode of action, resistance to antibiotics.

UNIT-V

Genes, mutation and mutagenesis; UV and chemical mutagens; types of mutation; Ames test for mutagenesis, complementation test, Bacterial genetic system: transformation, conjugation, transduction, recombination, plasmids and transposons; bacterial genetics map with reference to E. coli.

Recommended Books

1. General Microbiology, Stanier, R.Y. Ingraham, J.L. Wheelis, M.L. and Painter, P.R. The Macmillan press Ltd.
2. Brock Biology of Microogranisms, Madigan M.T. Martinko, J.M. and Parker, J. Prentice-Hall.
3. Microbiology, Pelczar, M.J. Jr. Chan E.C.S. and Kreig , N.R. Tata McGraw Hill.
4. Microbial Genetics Maloy, S.R.C Cronan ,J.E.Jr. andFrelfelder ,D. Johnos Bartlett Publishers.
5. Microbiology- A Laboratory Manual, Cappuccino, J.G. and Sherman N. Addison Wesley.
6. Microbiological Application: A Laboratory Manual in General Microbiology Benson, H.J, and WCB: Wm C. Brown publishers.

Core Course Code BTC104: Practical based on Course Code BTC101 & Course Code BTC 102
(Course Credits= 04)

Suggested list of Practical (Course **BTC101**)

1 To study working and principle of compound microscope.

2. To study working of different instruments in cell biology.

3. To study different stages of mitosis.

4. To measure cell number of microbial culture by turbidity method.

5. To study isolation of chlorophyll pigment from spinach leaves.

Suggested list of Practical (Course **BTC102**)

1. To study demonstration and working of instruments in Animal Biotechnology.

2. To study preparation of animal cell culture media

3. To prepare balanced salt solutions

4. To count the number of RBCs and WBCs from blood samples.

5. To study isolation of DNA from a given blood sample.

Core Course BTC105: Practical Based onCourse Code BTC103 & Course Code BTE101 / BTE102
(Course Credits =04)

Suggested List of Practicals (Course **BTC103**)

1. To prepare liquid and solid media for the growth of microorganisms.
2. To isolate bacteria and fungi by pour plate, streak plate, spread plate and serial dilution agar plating method.
3. To isolate bacteria from water and soil sample on selective agar medium.
4. To examine bacteria microscopically by Gram staining.
5. To determine MPN of different water sample.
6. To confirm the presence of coliforms in water samples by using 24 hrs old positive lactose broth culture.
7. Microscopic identification of Fungi by lactophenol cotton.
8. To study the growth curve of bacteria by using a spectrophotometer.
9. To study maintenance and preservation of pure culture by slants, parafilms and glycerol method.

Elective Course Code BTE101: Biomolecules
(Course Credits =03)

Course Objective:
Develop a deep understanding about the structure and various principles dealing with the working of biomolecules and their mutual interactions to support the life system.

Course Learning Outcomes:
CO1: Enabling students to understand the importance of water in maintaining the various biochemical reactions such as buffering, phosphorylation, oxidation-reduction, etc.

CO2: The students learn the principle of working of enzyme and the process of enzymology, i.e. how the enzymes work and where the active sites play a key role.

CO3: The students also learn the basic and functional structures of all the biomolecules in detail.

CO4: The inter-relationships and communication between the biomolecules is a major part of signal transduction. The students become well versed with this mode of biological process.

CO5: The students learn various techniques such as chromatography, spectroscopy and electrophoresis to understand the purity of biomolecules and their analytical properties for further application.

COURSE CONTENTS

UNIT I

Structure of water and its solvent properties, Acid- bases, pH and buffer, Bi and polyprotic buffer. Free energy and spontaneity of reactions, ATP and other phosphorylated compound with their free energy of hydrolysis, Phosphoryl group transfer, Biological oxidation reductions reaction, Coupled reaction and oxidative phosphorylation, Inhibitors and uncouplers. Types of bonds.

UNIT II

Enzyme classification and functions, Specificity, Active site, Transition state hypothesis Enzyme kinetics, Michealis Menton equation, Holoenzyme, apoenzyme, coenzyme, cofactors, prosthetic group and their examples. Ribozymes and abzymes. Allosteric enzyme

UNIT III

Structure and classification of macromolecules: Proteins, Carbohydrates, Nucleic acid and Lipids, Protein folding, Ramachandran Plot, Structure and chemistry of biomolecules such as antibiotics, Pigments, Vitamins as coenzymes.

UNIT IV

Biosignaling molecular mechanism of signal transduction, Gated ion channels, Nicotinic acetylcholine receptor, Receptor enzyme, The insulin receptor, G- proteins and cyclic AMP membrane transport.

UNIT V

Chromatographic technique, Paper and TLC , Gel filtration, Ion exchange, Affinity, HPLC, SDS, PAGE, Isoelectric focusing, Western blotting, Protein sequencing, Mass spectrometry, MALDI , TOF, MS.

Books Recommended

J. L., Jain, Sanjay, and Jain Nitin, (1979) Fundamentals of Biochemistry (6th revised Edition). S. Chand & Co. Ltd. New Delhi.

Buchanan . B.B. Gruissem, W. and Jones .R.L. (2000) Biochemistry and Molecular Biology of Plants , American Society of Plant Physiologists, Maryland ,USA.

Albert L. Lehninger, Davis L. Nelson, Michael M. Cox.(2004) Lehninger Principles of Biochemistry.

Lea P.J. and Leegood ,R.C. (1999) Plant Biochemistry and Molecular Biology (2 nd Edition) John Wiley and Sons. Chichester, England

Berg Jeremy, Tymoczko John, StryerLubert (2001) Biochemistry 4th Ed, W. H. Freeman, New York.

Conn Eric, Stumpf Paul K., Bruuening George, Doi Roy H., (1987) Outlines of Biochemistry 5th Ed , John Wiley and Sons, New Delhi.

Dawes Edwin A. (1972) Quantitative Problems in Biochemistry, Churchill Livingston, Edinburgh.

Hall D. D. and Rao K. K. (1996) Photosynthesis 5th Ed., Cambridge University Press. 5. Mandelstam Joel and McQuillen Kenneth (1976) Biochemistry of Bacterial Growth, Blackwell Scientific Publication London.

Metzler David E. (2001) Biochemistry: The chemical Reactions of Living Cells, Volume 1&2, Academic Press California.

Moat Albert G. and Foster John W. (1988) Microbial Physiology 2nd Ed. John Wiley and Sons New York.

Nelson D. L. and Cox M. M. (2005) Lehninger's Principles of Biochemistry, Fourth edition, W. H. Freeman & Co. New York.

Palmer Trevor (2001) Enzymes: Biochemistry, Biotechnology and Clinical chemistry, Horwood Pub. Co. Chinchester, England.

Segel Irvin H. (1997) Biochemical Calculations 2nd Ed., John Wiley and Sons, New York.

Voet Donald and Voet Judith G. (1995) Biochemistry, 2nd Ed..John Wiley and sons New York.

White Abraham, Handler Philip, Smith Emil, Hill Rober, Lehman J. (1983) Principles of Biochemistry, Edition 6, Tata Mc-Graw Hill Companies, Inc.

White David (2000) Physiology and Biochemistry of Prokaryotes. 2nd Ed. Oxford University Press, New York.

Zubay Geoffrey (1998) Biochemistry, 4th Ed., W. C. Brown, New York.

Suggested list of Practicals (Course Code BTE101)

1. To perform qualitative analysis of carbohydrates.
2. To perform qualitative analysis of lipids.
3. To perform qualitative analysis of proteins.
4. Chromatographic separation of given sample by paper and thin layer chromatography.
5. Estimation of protein by Lowry method.
6. To study the titration curve of amino acids.
7. To study preparation of buffer solutions (acetate buffer pH5, phosphate buffer pH 8)

Elective Course Code BTE102: Bioenergetics and Intermediary Metabolism (Course Credits = 03)

Course Objective:
It explains the potential role of biomembranes and their extraordinary use in maintaining and regulating all the metabolic cycles taking place inside the cell and outside the cell. These membranes are playing a very crucial role in maintaining the energy dynamics of the cell.

Learning Outcomes:
CO1: Enabling students to understand finely detailed energy dynamics of a biomembrane, the components involved therein and various physiological attributes driven by aforementioned energy transformation.

CO2: The students learn the principle of working of mitochondria as a model of energy transducer with special reference to its membrane associated respiratory processes leading to formation of ATP.

CO3: The students also learn the anabolic and catabolic processes involving carbohydrates in marinating the energy balance of the cell.

CO4: The biosysnthesis of lipids that constitute the biomenbranes is understood at the level of enzymes and pathways.

CO5: The catabolic role of amino acids in the formation of urea and abnormalities due to metabolic errors in these cycles is learnt by students. The synthesis of nucleic acids, the hereditary material, involving purines and pyrimidines is made acquainted to the learners.

COURSE CONTENTS

UNIT I

Bioenergetics: energy transformation, biological oxidations, oxygenases, hydroxylases, dehydrogenases and energy transducing membranes; free energy changes and redox potentials, phosphate potential, ion and proton electrochemical potentials, membrane potentials, chemo-osmotic theory; ion transport across energy transducing membranes, influx and efflux mechanisms, transport and distribution of cations, anions and ionophores. Uniport, antiport and symport mechanisms, shuttle systems.

UNIT- II

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization; the Q cycle and the stoichiometry of proton extrusion and uptake. Oxidative phosphorylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes.ATP synthetase complex, microsomal electron transport.

UNIT- III

Carbohydrates: glycolysis, citric acid cycle- its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway, alternate pathways of carbohydrate metabolism, gluconeogensis, inter-conversions of sugars, biosynthesis of glycogen, starch and oligosaccharides.

UNIT-IV

Lipids: fatty acid biosynthesis: acetyl CoA carboxylase, fatty acid synthase; fatty acid oxidation: α, β, oxidation and lipoxidation; lipid biosynthesis: of triacylglycerols, phosphoglycerides and sphingolipids, biosynthetic pathways for terpenes and steroids.

UNIT- V

Amino acids and nucleic acids: biosynthesis and degradation of amino acids and their regulation, specific aspects of amino acid metabolism, urea cycle and its regulation, in-born errors of amino acid metabolism; Nucleic acids: degradation of purines and pyrimidines, regulation of purine and pyrimidine biosynthesis, structure and regulation of ribonucleotide biosynthesis, biosynthesis of ribonucleotides, deoxyribonucleotides and polynucleotides, inhibitors of nucleic acid biosynthesis.

Books recommended

1. M.M. Cox and D.L. Nelson (2008) Lehninger Principals of Biochemistry W.H. Freeman & Company
2. Otto Hoffmann-Ostenhof (2008) Intermediary metabolism; *Van Nostrand Reinhold (USA)*.
3. P.H. Clarke (1978) Intermediary metabolism; *John Wiley & Sons Ltd Hoboken, New Jersey (United States)*.
4. Alexander Lowen (1994) Bioenergetics; *Penguin/Arkana Books USA*.
5. David G. Nicholls and Stuart Ferguson (2013) Bioenergetics; *Academic Press Elsevier United States*.

Suggested list of Practical (Course Code BTE102)

1. To perform qualitative analysis of carbohydrates.
2. To perform qualitative analysis of lipids.
3. To perform qualitative analysis of proteins.
4. Chromatographic separation of given sample by paper and thin layer chromatography.
5. Estimation of protein by Lowry method.
6. To study the titration curve of amino acids.
7. To study preparation of buffer solutions.

Core Course Code BTS101: Skill Development Modules 1
(Course Credits = 02)
Personality Development Module - 1 (Semester-1) Hrs.

Core Course Code BTS101: Skill Development Modules 1
(Course Credits = 02)
Personality Development Module - 1 (Semester-1)

S. No.	Subject	Classroom Activity	Hrs.
1	Orientation , Personality Development	Worksheet	1
2	Role and Impact of Personality	Group Activity	1
3	Different level of Effective Communication	Worksheet	1
4	Rules of Professional Communication	Group Activity	1 + 1
5	Body Language - 1	Worksheet	1 + 2
6	Interpersonal Skills	Worksheet	1
7	Extempore - 1	Group activity	1 + 1
8	Extempore - 2	Group Activity	1 + 1
9	Presentation Skills	Worksheet	2 + 2
10	How to Draw the Attention of Audience	Worksheet	1
11	Steps of Effective Presentation	Worksheet	1
12	Leadership Quality	Group activity	1
13	Interview Skills	Lecture	2 + 1
14	Group Discussion	Group Activity	2 + 2
15	Resume Preparation	Group Activity	1 + 2

SECOND – SEMESTER

Core Course Code BTC201: Molecular Biology

(Course Credits =03)

Course Objectives:
Enables students to understand basic properties and application of nucleic acids and functionally associated proteins both in prokaryotic and eukaryotic systems.

Course Learning Outcomes:
CO1: The students learn about different models and biochemical processes associated with nucleic acid replication in diverse model organisms.

CO2: The learners get a deep acquaintance with the process of DNA recombination and repair in model organisms.

CO3: The pupils become well versed with the process of DNA-dependent RNA synthesis (transcription) and post-transcriptional modifications thereby generating transfer, messenger and ribosomal RNA. Channeling of specialized proteins to their correct positions is also made aware of.

CO4: Students learn the function of cancer-associated and cancer-preventing genes as well as techniques and applications related to ribozymes and antisense RNA.

CO5: Sophisticated techniques related to genome mapping, DNA fingerprinting, genome cloning and recognition of desired genes are elaborated along their applications.

COURSE CONTENTS

UNIT-I

DNA replication: prokaryotic and eukaryotic DNA replication, mechanics of DNA replication enzymes and accessory proteins involved in DNA replication.

UNIT-II

DNA repair and recombination – methyl directed mismatch repair, very short patch repair nucleotide and base excision repair, SOS system. Holliday junction, gene targeting and gene knock-outs, FLP/ FRT Cre/Lox recombination, RecA and other recombinases.

UNIT-III

Transcription and modification in RNA/protein; prokaryotic and eukaryotic transcription, RNA polymerases, general and specific transcription factors, regulatory elements and mechanisms of transcription regulation, 5'- Cap formation transcription termination, 3' – end processing and polyadenylation, splicing and nuclear export of mRNA; post- transcriptional gene silencing, Protein localization; synthesis of secretory and membrane proteins.

UNIT-IV

Oncogenes and tumor suppressor genes: viral and cellular oncogenes, tumor suppressor genes from humans; structure function and mechanism of action of pRB and p53 tumor suppressor proteins. Antisense and ribozyme technology, molecular mechanism of anti- sense molecules, disruption of RNA structure.Biochemistry of ribozyme; hammerhead, hairpin and other ribozymes, applications of antisense and ribozyme technologies.

UNIT-V

Molecular mapping of genome: genetic and physical maps, physical mapping and map- based cloning. Southern and fluorescence in situ hybridization for genome analysis; molecular markers in genome analysis: RFLP and RAPD analysis, application of RFLP in forensic, disease prognosis, genetic counseling,

Recommended Books:

1. Molecular cloning: A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000.
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. N York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ CummlngsPubl Co. Inc. California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American
Books, Inc., USA, 1994.
6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.) VCH Publishers, Inc, New York, 1995
9. Genomes, T.S. Brown

Core Course Code BTC202: Macromolecules & Basic Enzymology (Course Credits =03)

Course Objective: Students learn about various properties and applications of enzymes and functional proteins both in prokaryotic and eukaryotic systems.

Course Learning Outcomes:

CO1: The students learn the unitary model of functioning of the enzymes and the environmental factors affecting the efficiency of working of the enzyme

CO2: The kinetics of the enzyme leading to catalysis in polar and non-polar environments, and the contribution of metal ions, water, pH, cofactor and coenzyme in overall efficiency of the enzyme is made understood in detail.

CO3: The students become well versed with the selected model enzymes with their regulatory pattern in overall control of anabolic and catabolic pathways.

CO4: The learners get acquainted with the physiological role of the appropriate conformation of macromolecules and assemblies, contributing to the efficiency of catalytic proteins.

CO5: Various biochemical techniques related in elucidating the overall structure of the different biomolecules and their specific role in specific conformations is learnt by the students.

COURSE CONTENTS

UNIT- I

Review of uni-substrate enzyme kinetics and factors affecting the rate of enzyme catalyzed reactions. Michaelis pH function and their significance. Kinetics of Bisubstrate reactions.

UNIT- II

Enzyme catalysis in solutions- Kinetics and thermodynamic analysis, activation energy and binding energy. General acid-base catalysis, Covalent catalysis, Metal ion catalysis. Effect of organic solvents on enzyme catalysis and structure consequence

UNIT- III

Detailed mechanism of catalysis of serine proteases, Ribronuclease, Triose phosphate isomerase, lysozyme. General mechanism of enzyme regulation, Enzyme inhibition and kinetics, feedback inhibition and feed forward stimulation. Allosteric regulation of phosphofructokinase

UNIT- IV

Macromolecule and supramolecular assemblies, Glyco-lipid proteins, membrane.Conformational properties of polynucleotide and polysaccharide.Protein denaturation and denaturants.

UNIT- V

Physical techniques in Proteins, Nucleic acid and Polysaccharides: UV-Vis, IR, NMR, Fluorescence Spectroscopy, Ultracentrifugation, Electron Microscopy. Methods for preparing

samples and producing contrast replica formation, freeze fracture, Shadow-casting positive staining.

Core Course Code BTC203: Biostatistics and Computational Biology (COURSE CREDITS: 3)

Course Objectives:
The course aims to empower the learners with tools and techniques in collection, collation, summarization and interpretation of data along with various experimental designs and bioinformatics.

Course Learning Outcomes:
CO1: Proficiency of students in various techniques of collection, collation, summarization and presentation of data. They could learn basic concepts of probability and probability distribution functions along with applications.
CO2: Understanding and applications of descriptive and inferential statistics enabling students to use tests of significance in biological data.
CO3: Can apply Analysis of Variance tools and different experimental designs to biological experiments, enabling them to minimize experimental and sampling errors.
CO4: Understands concepts of correlation and regression tools and techniques, attempts extrapolation and simulation of biological processes.
CO5: Empowers students to utilize software packages in digital analysis and processing of biological data. Integrate informatics with biology through data submission protocols, sequence alignment and searches, annotations and possible applications in human health and welfare.

COURSE CONTENTS
UNIT-I
Importance and scope of statistics in biochemical experimentation; Elements of Probability-Mathematical and Statistical definitions, sample space and events; Addition and Multiplication theorems; Probability Distribution Functions – Binomial, Poisson and Normal

UNIT-II
Measures of central tendency: Arithmetic, geometric & harmonic means, median, mode and Percentile; Measures of dispersion: range, mean deviation, quartile deviation, variance, standard deviation, coefficient of variation, confidence limits of population mean. Tests of significance: Hypotheses and errors; student t statistics, P-Value of the statistic, Preparation of graphs; histograms; charts and diagrams, SPSS Statistics.

UNIT-III
Analysis of variance: one-way analysis (sample sizes equal and unequal), two-way analysis (one observation per cell), Linear regression, correlation coefficient, relationship between regression and correlation coefficients; Chi-square statistics, test of goodness of fit, test of independence of attributes; standard line interpolation. Research ethics: Introduction, importance and its principles.

UNIT-IV
Introduction to Computers: Basic architecture, hardware and software; operating systems-WINDOWS and UNIX;
Concept of Bioinformatics**,** Database: Database concept; Database management system; Database browsing and Data retrieval; Sequence and Genome Databases, NCBI, GenBank; EMBL; DDBJ; Swissprot; PIR; Human Genome Project.

UNIT-V

Pair-wise Sequence Alignment: BLAST and its variants; FASTA. Multiple sequence alignment: introduction

Alignments of Protein Database, Designing of Probe, Determination of conservative sequences.

Phylogenetic Analysis: Introduction; Molecular Evolution; Cluster Analysis; Phylogenetic clustering by simple matching coefficients; Sequence comparison; Sequence pattern Tools

List of Recommended Books

1. Statistics in biology, Vol. 1 by Bliss, C.I.K. (1967) McGraw Hill, NewYork.

2. Practical Statistics for experimental biologist by Wardlaw, A.C. (1985).

3. Programming in C by E. Ballaguruswamy

4. How Computers Work - 2000. By Ron White. Tech. Media

5. How the Internet Works 2000 by Preston Gralla Tech. Media.

6. Statistical Methods in Biology - 2000 by Bailey, N.T. J. English Univ. Press.

7. Biostatistics - 7th Edition by Daniel

8. Fundamental of Biostatistics by Khan

9. Biostatistical Methods by Lachin

10. Statistics for Biologists by CampbellR.C. (1974) Cambridge University Press, UK.

11. INTERNET – CDC publication, India.

Core Course BTC204: Practical based on Course Code BTC201 & Course Code BTC202
(Course Credits =04)

Suggested list of practical (Course Code BTC201)

1. Isolation of Plasmid DNA from E. coli.
2. Isolation of genomic DNA from microbes
3. Isolation of genomic DNA from higher plants.
4. To perform Agarose gel electrophoresis for isolated DNA samples.
5. To perform PCR

Suggested list of practical (Course Code BTC202)

1. To estimate glucose or fructose concentration by DNS method.
2. To study the effect of temperature on enzyme activity.
3. To study the effect of pH on enzyme activity
4. To study cell immobilisation using alginate method
5. To study demonstration of SDS PAGE Assembly

Core Course BTC205: Practical Based on Course Code BTC203 & BTE201 / BTE202 / BTE203

(Course Credits =04)

Suggested list of Practical's (Course Code BTC203: Biostatistics and Computational Biology)

1. Representation of Statistical data by a) Histograms b) Pie diagrams

2. Testing statistical definition of probability.

3. Testing of the binomial distribution becoming normal distribution at small n, if p=q.

4. Determination of Statistical averages/ central tendencies. a) Arithmetic mean b) Median c) Mode

5. Determination of measures of Dispersion a) Mean deviation b) Standard deviation and coefficient of variation c) Quartile deviation

6. Tests of Significance-Application of following a) Chi- Square test b) t- test c) Standard error

7. To study different software used in Bioinformatics.

8. To access gene, protein databases through the internet.

Elective Course Code BTE201: Biology of the Immune System
(Course Credits =03)

Course Objectives:
Develops deep understanding about the various components of the host immune system, their structure and organization, and functions to serve as the defense system of the body, including operational mechanisms underlying the host defense system, allergy and organ transplantation.

Course Learning Outcomes:
CO1: Students will be able to understand the fundamental bases of immune system and immune response.

CO2: Information about the structure and organization of various components of the immune system.

CO3: Students learn the genetic organization of the genes meant for expression of immune cell receptors and the bases of the generation of their diversity.

CO4: Will be able to understand the operation and the mechanisms which underlie the immune response.

CO5: Application of the knowledge gained to understand the phenomena like host defense, hypersensitivity (allergy), organ transplantation and certain immunological diseases

COURSE CONTENTS

UNIT-I

Introduction: phylogeny of immune system, innate and acquired immunity, clonal nature of immune response; organization and structure of lymphoid organs,

UNIT-II

Antibody structure and function; nature and biology of antigens and superantigens.
antigen-antibody interactions, serological reactions, major histocompatibility complex, BCR & TCR, generation of diversity, complement system.

UNIT-III

Cells of the immune system; hematopoiesis and differentiation, lymphocyte trafficking. Blymphocytes, T-lymphocytes, macrophages, dendritic cells, natural killer and lymphokine activated killer cells, eosinophils, neutrophils and mast cells. Regulation of immune response: antigen processing and presentation, generation of humoral and cell mediated immune responses, Maturation and activation of B-and T-lymphocytes, cytokines and their role in immune regulation; T-cell regulation, MHC restriction, immunological tolerance.

UNIT-IV

Cell- mediated cytotoxicity; mechanism of T cell and NK cell mediated lysis; antibody dependent cell mediated cytotoxicity, macrophage mediated cytotoxicity; hypersensitivity autoimmunity, transplantation.

UNIT- V

Immunity to infectious agents (intracellular parasites, helminthes & viruses); tumor immunology; AIDS and other immunodeficiencies, hybridoma technology and monoclonal antibodies.

Recommended Books:

1. Kuby immunology, 4th Edition, R.A. Goldsby, Thomas J.Kindt, Barbara, A.Osbarne. (Freedom)
2. Immunology-A short Course, 4th Edition- Ell Benjamin, Richard Coico, Geoffrey Sunshine (Wiley-Liss).
3. Fundamentals of immunology, William Paul.
4. Immunology, Roitt and others.

Suggested list of Practicals (Course Code BTE201)

1. To perform Widal test
2. To study radial immuno-diffusion assay
3. Preparation of blood smears.
4. To isolate serum from blood plasma.
5. To perform an agglutination reaction to identify a blood group.
6. To perform ELISA test for given sample.

Elective Course Code BTE202: Resource Utilization and Conservation
(Course Credits = 03)

Course Objectives:
The course aims to empower the learners with knowledge pertaining to world biomes, resources, conservation, sustainable development, pollution and its management, and remote sensing in management of earth resources.

Course Learning Outcomes:
CO1: Deep understanding of distribution, structure and function of various aquatic and terrestrial biomes.

CO2: Learn definitions, types and utilities of biodiversity along with threats along their applications in management and sustainable development of resources from various biomes.

CO3: Empowers students to apply in-situ and in-vitro techniques in conservation of aquatic and terrestrial resources in real time.

CO4: Understands concepts of pollution of different environments and can monitor and treat pollution loads in artificial and natural ecosystems; and appreciate nuances of industrial, societal and urban pollution.

CO5: Gains insight knowledge about remote sensing of earth resources along with platforms, sensors and scanners, visual and digital interpretation of remotely sensed data.

COURSE CONTENTS
UNIT – I
Major Biomes of the world, Tropical rain & Seasonal Forests, Temperate rain & Seasonal forests, Boreal forests, Grasslands, Deserts, Aquatic Ecosystems wetlands, Lakes & Ponds Streams & Rivers, Marine & Estuarine habitats.

UNIT – II
Resource utilization**,** Status & Utilization of Biodiversity, Sustainable development resources from forest, Grassland and aquatic habitats, Food forage, Fodder, Timber & Non-wood forest products, Threats to quality & quantity of Resources due to overexploitation.

UNIT –III
Strategies for conservation of resources: Classifications of resources, Principles of conservation, *In-situ* conservation sanctuaries, National parks, Biosphere reserves for wildlife conservation, Habitat conservation practices of conservation for forests ranges, Soil and water.

UNIT – IV
Air, Water and Soil pollution**,** Kinds, Sources, Quality parameters, Effects on structure & function of ecosystems, Management of pollution, Bioremediation, Climate changes sources,

Trends & role of greenhouse gases, Effect of global warming on climate, Ecosystem processes & Biodiversity, Ozone layer & Ozone hole.

UNIT – V

Resource monitoring, Remote sensing concepts & Tools, Satellite remote sensing basics sensors, Visual & digital interpretation, EMR bands and their applications, Indian remote sensing programme, Thematic mapping of resources, Application of remote sensing in Ecology &Forestry.

Books recommended

Chopra R. N. (1933) Indigenous Drugs of India.

Hayes W. B. (1953) Fruit Growing in India.

Atkinson E. T. (1980) Economic Botany of Himalayan Regions.

Chapman, J.L. and Reiss, M.J. (1999) Ecology: Principles and Applications.

Singhal, P.K. and Shrivastava, P. (2004) Challenges in Sustainable Development.

Odum, E.P. (1971) Fundamentals of Ecology.

Begon, M., Harper, J.L. and Townsend, C.R. (1986) Ecology: Individuals, Populations and Communities.

Wetzel, R.G. (1983) Limnology.

Suggested list of Practical's: Course Code BTE202 (Resource Utilization and Conservation)

1. To find the pH of the various samples of soil by pH meter.

2. To determine ground flora in forest ecosystems.

3. To determine IVI of species in forest ecosystmes.

4. To determine the presence of carbonate in different soil mixtures.

5. To determine the presence of phosphate in soil and water sample.

6. To determine the presence of nitrate in mixture sample.

7. To determine the presence of nitrite in mixture sample.

8. To determine frequency, density and abundance of herbaceous species from local garden.

9. To determine the biomass of plant vegetation.

10. To determine leaf area, dry weight and moisture content of few species of plant from grassland.

Elective Course Code BTE203: Microbial Metabolism
(Course Credits: 3)

Course Objectives:
The major objective of this paper is to develop clear understanding of various aspects of microbial physiology along with diverse metabolic pathways existing in bacteria in relation to its survival and propagation, and to enable students to better understand courses taught later.

Course Learning Outcomes:
CO1: Students become acquainted with methods of measuring microbial growth, calculating growth kinetic parameters with understanding of steady state and continuous growth.

CO2: They gain an in-depth knowledge of primary, secondary and group translocation transport systems existing in bacteria, simultaneously learning membrane transport proteins and kinetics of solute transport.

CO3: They learn central metabolic pathways for carbon metabolism in bacteria enlisting differences with eukaryotic systems and their regulation in diverse physiological conditions. This allows students to apply the acquired knowledge in engineering metabolic pathways for developing industrially useful strains.

CO4: Will have gathered understanding of inorganic and organic nitrogen assimilation and its regulation. Also knows role of glutathione in cellular redox regulation and biochemistry of glutamate overproducing strains.

CO5: They learn basic concepts of enzyme biochemistry, its kinetics and regulation, details of lipid and nucleotide metabolism in *E. coli* and its regulation along with biochemical basis of lipid accumulation in yeasts, and intracellular signaling in bacteria in response to various nutritional and physiological stresses.

COURSE CONTENTS

UNIT-I

Microbial growth: mathematical expression of growth, growth measurement, efficient growth curve, synchronous growth and continuous culture, effect of environmental factors on microbial growth, nutrients diffusion, active transport, group translocation, solutes, temperature, oxygen relations.

UNIT-II

Chaemolithotrophy: Sulphur, iron, hydrogen, carbon monoxide, nitrogen oxidations. Methanogenesis, luminescence. Brief account of photosynthetic and accessory pigments chlorophyll, bacteriochlorophyll, carotenoids, oxygenic, anoxygenic photosynthesis.Electron transport- photoautotrophic generation of ATP, fixation of CO2- Calvin cycle, reverse TCA, carbohydrate anabolism.

UNIT-III

Respiratory metabolism: Embden Mayer Hoff pathway, EntnerDoudroff pathway, glyoxalate pathway, Krebs cycle, oxidative and substrate level phosphorylation, Pasteur effect, fermentation of carbohydrates-homo and heterolactic fermentations. Synthesis of polysaccharides- gluconeogenesis and other pathways.

UNIT-IV

Assimilation of nitrogen: Dinitrogen - nitrate nitrogen-ammonia- denitrification, synthesis of major amino-acids, polyamines; peptidoglycan-biopolymers as cell components.

UNIT-V

Microbial development, sporulation and morphogenesis, hyphae vs. yeast forms and their significance.Multicellular organization of selected microbes.Dormancy.Endospore-structure, properties and germination.

List of Recommended Books

1. Doelle H.W. 1969. Bacterial Metabolism.Academic Press.

2. Gottschalk G. 1979. Bacterial Metabolism. Springer Verlag. Moat AG. 1979. Microbial Physiology. John Wiley & Sons.

3. Sokatch JR. 1969. Bacterial Physiology and Metabolism.Academic Press.

4. Moat A G., Foster J W., Spector M P. Microbial Physiology, 4th Ed: Wiley India Pvt Ltd 2009.

Suggested list of Practicals (Course Code BTE203: Microbial Metabolism)

1. Determination of Bacterial growth by turbidity measurements (spectrophotometric method).

2. Study of effect of temperature on growth of bacteria.

3. Study of effect of pH on growth of Bacteria.

4. Isolation of rhizobia from root nodules.
5. Slide culture technique for studying morphology and molds.

Core Course Code BTS201: Soft Skill Development Modules 2
(Course Credits = 02)

S. No.	Subject	Classroom Activity	Hrs.
01	Orientation , Personality Development	Worksheet/ lecture	02
02	Role and Impact of Personality	Group Activity/ lecture	01
03	Pre Self-Assessment (Psychometric Analysis)	PDP Assessment Sheet	02
04	Importance of characteristics and Traits	lecture/Group Activity	02
05	Empowerment of Internal and external traits	lecture	02
06	Definition of Personality	Lecture	02
07	Power of Self	Lecture	03
08	Path to Improve Personality	lecture/Group Activity	03
09	Body Language - 1	Worksheet	02
10	Grooming Yourself	Lecture	02
11	IQ / EQ / MQ / SQ	lecture	02
12	Disposition of Body in various aspects	Group Activity	03
13	Getting desired output	Group Activity	02
14	Post Assessment of Personality	Group Activity	02

THIRD SEMESTER

CORE COURSE CODE BTC301: ENVIRONMENTAL BIOTECHNOLOGY (COURSE CREDITS: 3)

Course Objectives:

The course aims to empower the learners with the basic concepts of the global environmental issues, biodiversity in India, water pollution and its control, waste water treatment (physical, chemical and biological) and microbial remediation of xenobiotics in the environment.

Course Learning Outcomes:

CO1: Deep understanding of existing and emerging technologies that are important in the area of environment and the principles and techniques which underline the environmental issues including air and water pollution.

CO2: Empowers the students with the knowledge of Domestic waste water treatment, Classification of wastewater treatment (physical, chemical and biological)

CO3: Students learn about concepts of Biodegradation, Biodegradation of hydrocarbon, and Measurement of biodegradation. Bioremediation-Concept, Methods of Bioremediation (In-situ and Ex-situ Bioremediation), and Xenobiotic biodegradation.

CO4: Learners will understand the concept of biodiversity: conservation and management, rules and acts.

CO5: Deep understanding of global environmental problems-ozone depletion, UV-B greenhouse effect and acid rain, their impact and biotechnology approaches for management.

UNIT-I

Environment: Basic concepts and issues; environmental pollution: types and methods for the measurement; methodology of environmental management-problem solving approach, its limitations; air pollution and its control through biotechnology, air sampling techniques; biodiversity: conservation and management. Biodiversity in India: Status, Threats, Utility & Conservation; Indian Biodiversity ACT 2002 and Biodiversity Rules 2004.

UNIT-II

Water pollution and its control: Water as a scarce natural resource, need for water management, sources and measurement of water pollution, waste water treatment-physical, chemical and biological treatment processes; algal blooms and human health.

UNIT-III

Microbiology of waste water treatment: Aerobic process-activated sludge, oxidation ditches, trickling filter, towers, rotating discs, rotating drums, oxidation ponds; anaerobic processesanaerobic digestion, anaerobic filters, upflow anaerobic sludge blanket reactors; treatment schemes for waste waters of dairy, distillery, tannery industries; biotechnological application of microbes form extreme environment.

UNIT-IV

Microbial degradation of xenobiotics in the environment- ecological considerations, decay behaviour & degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides; bioaccumulation of metals and radio-nucleids and detoxification; bioremediation.

UNIT-V

Biological N_2 fixation, H_2 production, biofertilizers and biopesticides; solid wastes; sources and management (composting, vermiculture and methane production). Single cell protein (Spirulina, yeast, mushroom); global environmental problems-ozone depletion, UV-B green house effect and acid rain, their impact and biotechnology approaches for management.

List of Recommended Books

1. Wastewater Engineering- Treatment, disposal and Reuse. Metcalf and Eddy, Inc,.Tata McGraw Hill, New Delhi.
2. Comprehensive Biotechnology. Vol. 4, M. Moo-young (Ed-in-chief), Pergamon Press, Oxford.
3. Environmental Chemistry, A.K. De. Wiley Eastern Ltd. New Delhi.
4. Introduction to Biodeterioration. D. Allsopp and K.J. Seal, ELBS/Edward Arnold

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CORE COURSE CODE BTC302: GENETIC ENGINEERING (COURSE CREDITS =03)

Course Objectives:

Inculcates deeper insights about genetic engineering concepts, techniques and tools, and its applications in strain improvement, enzyme engineering, metagenomics and transgenic technology.

Course Learning Outcomes:

CO1: Students will understand the core concepts and fundamentals of genetic engineering.

CO2: Develop their competency on different types of strain improvements.

CO3: Analyses of the enzymes and vectors for genetic modification for required productivity.

CO4: Examination of gene cloning and evaluate different methods of gene transfer like metagenomics

CO5: They are able to critically analyze the major concerns and applications of transgenic technology.

COURSE CONTENTS

UNIT-I: Scope of genetic engineering, milestones in genetic engineering; isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separations, cloning, gene expression; cloning and patenting of life forms; genetic engineering guidelines; molecular tools and their applications; restriction enzymes, modification enzymes, DNA and RNA markers; nucleic acid purification, yield analysis. The manufacture, use, import, export and storage of hazardous micro-organisms genetically engineered organisms or cells rules, 1989.

UNIT-II: Nucleic acid amplification and its applications, gene cloning vectors-plasmids, bacteriophages, phagemids, cosmids, artificial chromosomes; restriction mapping of DNA fragments and map construction; nucleic acid sequencing; cDNA synthesis and cloning; mRNA enrichment, reverse transcription, DNA primers, linkers, adaptors and their chemical synthesis; library construction and screening.

UNIT-III: Alternative strategies of gene cloning; cloning interacting genes-two-and three hybrid systems, cloning differentially expressed genes, nucleic acid micro array; site-directed mutagenesis and protein engineering; gene regulation-DNA transfection, Northern blot, primer extension, S1 mapping, RNAse protection assay, reporter assays.

UNIT-IV: Expression strategies for heterologous genes; vector engineering and codon optimization, host engineering; in vitro transcription and translation, expression in bacteria, yeast, insects and insect cells, mammalian cells, plants; processing of recombinant proteins-purification and refolding, characterization of recombinant proteins, stabilization of proteins; phage display.

UNIT-V: T-DNA and transposon tagging; role of gene tagging in gene analysis, identification and isolation of genes through T-DNA or transposon; transgenic and gene knockout technologies targeted gene replacement, chromosome engineering; gene therapy-vector engineering, strategies of gene delivery, gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing.

Recommended Books:

1. Molecular cloning: A Laboratory Manual, J. Sambrook , E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.

2. DNA Cloning: A practical Approach, D.M. Glover and B.D. Hames, IRL Press, Oxford, 1995.

3. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J. Cseke, CRC Press, Florida, 1995.

4. Methods in Enzymology Vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego,1998.

5. Methods in Enzymology Vol.185 Gene Expression Technology, D.V. Goeddel, Academic Press, Inc. San Diego, 1990.

6. DNA Science. A First Course In Recombinant Technology, D.A. Mickloss and G.A. Freyer, Cold Spring Harbor Laboratory Press, New York,1990.

7. Molecular Biotechnology (2nd Edn.) S.B. Primrose, Blackwell Scientific Publishers, Oxford, 1994.

8. Milestones in Biotechnology, Classic Papers in Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.

9. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd. Oxford, 1997.

10. Genetic Engineering; An Introduction to gene analysis and exploitation in eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998.

11. Molecular Biotechnology-Glick

12. Pollution control law series; PCLS/02/2010(Sixth Edition)

COURSE CODE BTC303: PLANT BIOTECHNOLOGY

(COURSE CREDITS =03)

Course Objectives:

It aims to enable the learners with the knowledge of the qualitative and quantitative improvements in higher plants through emerging biotechnological tools.

Course Learning Outcomes:

CO1: Understanding of different techniques of *in vitro* culture and media preparation. Concept of totipotency, morphogenesis, organogenesis and somatic embryogenesis.

CO2: Knowledge of protoplast isolation, culture, fusion, somatic hybridization and cybridization.

CO3: Concepts of transgenic plant production through Ri and Ti plasmids and direct methods.

CO4: Concept of chloroplast transformation and its advantages, post harvest technology, and cryopreservation.

CO5: Role of biotechnology in qualitative improvement in plants through herbicide resistance, insect resistance, disease resistance and N2 fixation. Knowledge of molecular markers: RFLP, PCR, QTL and MAS.

COURSE CONTENTS

UNIT-I: Introduction to plant cell and tissue culture: tissue culture media (composition and preparation), initiation and maintenance of callus and suspension culture. Regeneration through organogenesis and somatic embryo genesis; transfer and establishment of whole plant in soil; embryo culture and embryo rescue; anther, pollen and ovary culture for production of haploid plants and homozygous diploid lines; cryopreservation for germplasm conservation; protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plant; symmetric and asymmetric cybrids; germplasm conservation, virus free plants.

UNIT-II Cloning vector for higher plant transformation: *Agrobacterium tumefaciens* Ti and Ri plasmids, basis of tumor formation, hairy root, mechanisms of DNA transfer, role of virulence genes. Viral vectors and their application: direct gene transfer: particle bombardment, electro oration, microinjection: transformation of monocots; transgene stability and gene silencing, selection of clones.

Expression of cloned genes: genetic markers, reporter genes, Gus assay.

UNIT-III Application of plant transformation for productivity and performance: herbicide resistance (phosphnoinothricin, glyphosate, sulfonylurea, atrazine), insect resistance (Bt. Endotoxin genes, Non- Bt like proteinase inhibitors alpha amylase inhibitor), virus resistance (Coat protein mediated protection (CPMP), nucleocapsid gene), disease resistance (anti fungal proteins chitinase, 1-3 beta glucanase, ribosome inactivating proteins (RIP), thionins, pathogenesis related (PR) proteins, nematode resistance, abiotic stress (salt tolerance); post harvest losses, long shelf life of fruits and flowers, use of ACC synthase. polygalacturanase. ACC oxidase, carbohydrate composition and concentration during storage. ADP glucose pyrophosphatase.

UNIT-IV Chloroplast transformation: advantages, vectors, success with tobacco and potato; metabolic engineering and industrial products; plant secondary metabolites, control mechanism and manipulation of phenyl propanoid pathway, Shikimate pathway, alkaloids, industrial enzymes; biodegradable plastics. Polyhydroxybutyrate, therapeutic proteins; lysosomal enzymes, antibodies, edible vaccines purification strategies, oleosin partitioning technology.

UNIT-V Molecular marker- aided breeding RFLP maps. Linkage analysis. RAPD markers. STS, microsatellites, SCAR (sequence characterized amplified region), AFLP, QTL. Molecular assisted selection; arid and semi- arid plant biotechnology, green house and green- home technology.

Recomonded Books:

1. J. Hammond, P. McGarvey and V. Yusibov (Eds.): Plant Biotechnology. Springer

Verlag, 2000. COURSES OF STUDY IN M. Sc. BIOTECHNOLOGY

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2. T, J. Fu, G. Singh and W.R. Curtis (Eds): Plant Cell and Tissue Culture for the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999.

3. H.S. Chawla: Biotechnology in Group Improvement, International Book Distributing Company. 1998.

4. R.J. Henry: Practical Application of Plant Molecular Biotechnology. Chapman and Hall. 1997.

5. P.K. Gupta Elements of Biotechnology. Rastogi and Co. Meerut. 1996.

CORE COURSE CODE BTC304: PRACTICAL BASED ON COURSE CODE BTC301 & COURSE CODE BTC302

(COURSE CREDITS =04)

Suggested list of practical (Course Code BTC301)

1. To isolate aromatic hydrocarbons on degrading bacteria/fungi.
2. To estimate nitrate in drinking water.
3. To estimate nitrite in drinking water.
4. To estimate ammonia on drinking water.
5. Determination of biological oxygen demand (BOD) of water sample.
6. Determination of chemical oxygen demand (COD) of water sample.
7. To study airborne microbes by agar plate technique.
8. To study pollution stress by chlorophyll and carotenoid ratio from plant sample.
9. To study the effect of heavy metal on growth of bacteria.
10. To study the effect of heavy metal on growth of bacteria.
11. To determine dissolved oxygen concentration of water samples.
12. To study the impact of salt and osmotic stress on the growth and survival of microbes.
13. To study the impact of pesticides on the growth and survival of microbes.

Suggested list of practical (Course Code BTC302)

1. Isolation of bacterial DNA by quick preparation.
2. To isolate fungal DNA.
3. To perform Agarose gel electrophoresis of isolated DNA.
4. Comments on Electrophoresis.
5. Comments on Gel documentation system.
6. Comments on PCR.

CORE COURSE CODE BTC305: PRACTICAL BASED ON COURSE CODE BTC303 & BTE301 / BTE302 / BTE303 /BTE 304

(COURSE CREDITS =04)

Suggested list of Practicals (Course Code BTC303)

1.To perform surface sterilization of explant.

2.Preparation of media of plant tissue culture.

3.To isolate embryos from Arachis hypogaea (ground nut) and perform in vitro culture.

4.To study Regeneration of the whole plant through callus culture.

5.To isolate and culture protoplast from a given plant cell.

6. To perform Anther culture from production of haploid plants.

7.To isolate genomic DNA from plant leaves.

8.To confirm the presence of genomic DNA in the sample by agarose gel electrophoresis.

ELECTIVE COURSE CODE BTE301: ADVANCED MOLECULAR BIOLOGY

(COURSE CREDITS = 03)

Course Objectives:

This course combines special set of tutorials centered on research activities in molecular biology with practical exercises and/or laboratory placements. The content is designed to provide students with a perspective of how cutting edge molecular biology principles and techniques are applied to major research questions. This course will illustrate that cross disciplinary approaches are essential in modern research.

Course Learning Outcomes:

CO1: To understand key principles of how cells work, including gene regulation, protein synthesis and signal transduction.

CO2: To locate, analyse, evaluate and synthesise information from a wide variety of sources to understand the key principles of Molecular Biology

CO3: To read, interpret and discuss major contributions to Molecular Biology research published in scientific research literature.

CO4: To develop effective, creative and innovative solutions, both independently and cooperatively, to current and future research problems in Molecular Biology.

COURSE

CONTENTS UNIT

I

Recombinant DNA technology I: methods of creating recombinant DNA molecule, properties of restriction endonucleases and their mode of action, selection screening construction of DNA library.

UNIT II

Recombinant DNA Technology II: Use of cloned gene, sub-cloning; recombinant proteins production in bacteria, site-directed mutagenesis, RFLP, PCR, DNA-fingerprinting, antisense-RNA technology, chromosomal walking.

UNIT III

Hybridoma technology: monoclonal antibodies mycelium cell infusion selection of hybridomas, protoplast fusion and HAT-medium screening assay purification and application of monoclonal antibodies.

UNIT IV

Cell and tissue culture: micropropagation, somatic cell culture, somoclonal variations, somatic cell hybridization, protoplast isolation, protoplast fusion, protoplast culture, genetic transformation, various methods of gene transfer (all vector and methods), production of transgenic plant and animal; production of secondary metabolites, primary and transferred cell culture, differentiated cells in culture application.

UNIT V

Fermentation technology: continuous and batch type culture techniques, principle types of Fermenters, general design of fementors. Fermentation processes, brewing manufacture of antibiotics, production of single cell protein. Application of genetic and molecular biology procedures in strain improvement.

Books recommended

1. Molecular cloning : A Laboratory Manual , J. Sambrook ; Fritsch and T. Maniatis Cold Spring Harbor Laboratory Press, New York, 2000.
2. Introduction to practical molecular biology P.D. Dabre, John Wiley & sons Ltd. N York 1988
3. Molecular Biology LabFax, T.A. Brown (Ed) Bios Scientific Publishers Ltd. Oxford, 1991
4. Molecular Biology of the Gene (4th edition), J.D. Watson N.H. Hopkins, J.W. Roberts J.A. Steitz and A.M. Weiner, The Benjamin/ Cummlngs Publ Co. Inc. California, 1987.
5. Molecular Cell Biology (2nd Edition) J. Darnell, H. Lodish and D. Baltimore, Scientist American Books, Inc., USA, 1994.

VCH Publishers, Inc, New York, 1995

6. Molecular Biology of the Cell (2nd Edition) B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J. D. Watson, Garland Publishing, Inc., New York, 1994.
7. Gene VI (6th Edition) Benjamin Lewin, Oxford University press, U.K., 1998.
8. Molecular Biology and biotechnology; a comprehensive desk reference, R.A. Meyers (Ed.)

9. Genomes, T.S. Brown

Suggested list of Practicals (Course Code BTE301)

1. To isolate genomic DNA from fungi by LETS methods.
2. To determine the quantity and quality of the isolated fungal DNA.
3. To determine the agarose gel electrophoresis of the isolated fungal DNA.
4. To isolate plasmid DNA from bacteria by quick method.
5. To purify the DNA from agarose gel.
6. To study the Thermal cycler.
7. To study the gel documentation system.

ELECTIVE COURSE CODE BTE302: AGRICULTURAL MICROBIOLOGY (COURSE CREDIT: 3)

Course Objectives:

To make students aware about agricultural technique, crop diseases, soil health, composting, agriculture losses, pest management, green revolution and agricultural biotechnology.

Course Learning Outcomes

CO1: Describe role of microorganism in recycling soil nutrients, biodegradation of complex plant polymers, sustaining and improving plant growth through improving nutrient availability, production of plant growth promoting substances and inhibiting pathogens.

CO2: Critically discuss the need for agricultural microbiology and explain their limitations.

CO3: Applications of microorganisms in varied fields of agricultural microbiology like bioremediation, biofertilizers and waste water treatment.

CO4: Analyses of various aspects of N2 fixation, Phosphate solubilization, PGPR etc. Pre and post harvesting agricultural losses, management, formulation, mass production and applications.

CO5: Green revolution, transgenic plant, gene protection technology, resistant verities, management of agricultural waste as food, feed and fuel.

COURSE CONTENTS

UNIT – I

History, scope and development of agricultural microbiology, rhizosphere and phyllosphere: concept, importance, factors affecting microbial diversity.

UNIT – II

Soil health: crop residues, humus, mineralization, immobilization, soil-sickness, composting, vermicomposting, green manure. Effect of crop residues on plant growth; biodegradation of pesticides and pollutants; biodegradation fate, bioavailability, acceleration, bioremediation. Biofertilizers: types, production, formulation and constraints.

UNIT – III

General idea about major agricultural pests: Plant diseases- late blight potato. downy mildew of pea, stem gall of coriander, powdery mildew / rust / smut, rust of linseed, Ergot of bajara, Anthracnose of soybean, Tikka disease of groundnut, wilt of arhar, bacterial blight of paddy, citrus canker, leaf curl of papaya, little left of brinjal. Insects: gram, soybean. Weeds: parthenium, xanthium, waterhyacinth, cyperus, phalaris

UNIT – IV

Post harvest losses of agricultural products: causes, problems and management recent trends in pest management: strategies, mass production, formulation and application technology, achievements,

constraints

UNIT – V

Biotechnology in agriculture: the new green revolution, transgenic crops, gene protection technology, frost control technology, resistant varieties. Bioconversion futurology: exploitation of agricultural wastes for food / feed and fuel.

List of Recommended Books

1. Soil microbiology by Subba Rao
2. Soil and microbes by Waksman and Starkey.
3. Plant pathology by Mehrotra.
4. Alexander, M. Introduction to Soil Microbiology, 3rd Edition. Wiley Eastern Ltd., New Delhi
5. Microbiology by S.S. Purohit.

Suggested list of Practicals (Course Code BTE302: Agricultural Microbiology)

1. Isolation and Enumeration of the microorganism from soil by serial dilution agar plate method.
2. Isolation of fungi from soil by warcup's method.
3. Isolation of azotobacter species from soil.
4. Isolation of microorganism from rhizosphere.
5. Isolation of microorganism from phyllosphere (phyloplane) by serial dilution, agar plate method or leaf impression method.
6. Plant diseases – leaf curl of papaya, rust of wheat, citrus canker, red rot of sugarcane. Study of weeds- *Parthenium*, water hyacinth.

ELECTIVE COURSE CODE BTE303: BIOPROCESS ENGINEERING AND TECHNOLOGY (COURSE CREDITS =03)

Course Objectives:

The course will enable students to apply biotechnological concepts in the exploitation of biological organisms for industrial and human benefits. The strategies for development of microbial strains, process optimization, large scale production and product recovery will be covered for industrially relevant biotechnological products and therapeutic proteins.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: Insights on industrially important organisms, recent developments in fermentation processes and various optimization strategies at fermenter level. Learns about the design, types of fermenters and various critical components of bioreactors.

CO2: Is able to describe control parameters, fluid rheology and process constraints in large scale bioreactors. Strategies of product recovery from a fermentation broth.

CO3: Understand the significance and activities of microorganisms in food. Recognize the characteristics of food-borne, waterborne and spoilage microorganisms, and methods for their isolation, detection and identification.

CO4: Analyze the importance of microbiological quality control programme's in food production.

CO5: Discuss the microbiology of different types of food commodities. Describe the rationale for the use of standard methods and procedures for the microbiological analysis of food

COURSE

CONTENTS

UNIT-I

Biofermentation: designing and application, principles of biofermentation, monitoring and control of parameters (pH, oxygen, agitation, temperature, foam etc.), batch & continuous; production medium, raw materials, isolations; maintenance, preservation & improvement of industrial strains, computer control of fermentation processes.

UNIT-II

Downstream processing: Filtration of fermentation broths, ultra-centrifugation, recovery of biological products by distillation, superficial fluid extraction. Comparison of Upstream & Downstream processing methods

UNIT-III

Industrial production of solvents: Ethyl alcohol, citric and acetic acids; enzymes; amylases, proteases, cellulases; vitamins: vitamin B12, vitamin C, antibiotics (penicillin, streptomycin, tetracycline and griseofulvin) Microbes in petroleum industry (oil

recovery); immobilized cells & enzymes.

UNIT-IV

Microbiology of food: sources and types of microorganisms in food, food borne pathogens, microbiological examination of food, spoilage of food, food preservation, fermented foods, microbial proteins.

UNIT-V

Dairy microbiology: microbial examination of milk, pasteurization and phosphatase test, sterilization of milk, grades of milk, dairy products, fermented milk, butter & cheese

Packaging Technology: Definition, function of packaging. Package design, Tests for flexible packaging materials

Recommended Books:

1. Biochemical Engineering, Aiba, S., Humphrey, A.E. and Millis, N.F. Univ of Tokyo Press, Tokyo.

2. Biochemical Reactors, Atkinson, B: Pion Ltd. London.

3. Biochemical Engineering Fundamentals, Baily, J.E. and Ollis, D.F. McGraw-Hill Book Co. New York.

4. Bioprocess Technology: Fundamental and Application, KTH, Stockholm.

5. Process Engineering in Biotechnology, Jackson, A.T., Prentice Hall, Engelwood Cliffs.

6. Bioprocess Engineering: Basic Concepts, Shuler, M.L. and Kargi, F., Prentice Hall, Engelwood Cliffs.

7. Principles of Fermentation Technology, Stanbury, P.F. and Whitaker, A. Pergamon Press, Oxford.

8. Bioreaction Engineering principles, Nielson, J. and Billadsen, J. Plenum Press.

9. Chemical Engineering Problems is Biotechnology, Shuler, M.L. (Ed.) AICHE.

10. Biochemical Engineering, Lee, J.M. Prentice Hall Inc.

11. Bioprocess Engineering-kinetics, Mass Transport, Reactors and Gene Expression, Viet; W.F., John Wiley & Sons, Inc.

Suggested list of Practical (Course Code BTE303)

1. To isolate industrially important microorganisms for microbial processes.
2. To study cell immobilization using alginate method.
3. Isolation of fungi from spoiled bread.
4. Quantitative test of milk by resazurin test and MBRT.
5. Estimation of antibiotic producing microbes.
6. Quantitative estimation of Amylase production.

COURSE CODE BTE304: BIOTECHNOLOGY (COURSE CREDITS = 03)

Course Objectives:

The course will help students to understand various applications of microbes for the development of various products of agriculture, industrial and clinical application. The knowledge of recombinant technology, bioreactors and optimization strategies will be beneficial in development of production processes.

Course Learning Outcomes: Upon successful completion of the course, the student:

CO1: **Will learn about industrially relevant microbial products and their production process, role of biotechnology in environment management.**

CO2: Acquires knowledge about strains development, selection of hyper producers, microbial products, metabolic engineering and various industrial relevant microbial products and their production process Learns about the designing of recombinant heterologous expression systems such as *E. coli*, yeast, mammalian and insect cells.

CO3: Learns about sterilization at reactor scale and different types of sterilization strategies.

CO4: Attains knowledge about designing large scale industrial processes and types of cultivation strategies Understands the concept of recombinant biomolecules, therapeutic proteins, vaccines, antibodies, bio-pesticides, bio-fertilizers, and probiotics .

CO5: Understands different types of regulatory approvals required for drug development and difference between biologics, biosimilars and biobetters.

COURSE CONTENTS UNIT I

Biotechnology an Overview, Definition, Perspective and scope of biotechnological processes and products, Biotechnology and Ethics, Introduction, Medical and chemical Biotechnology, Agriculture and Food, Energy and environment and human, Bioethics, Facing problem and finding solutions, Regulating the use of biotechnology, Patenting biotechnology inventions.

UNIT II

Genetic Engineering and gene cloning, Introduction of genetic engineering procedure, restriction endonuclease, cloning vehicle, Vectors for animals and plants, Insertion of DNA molecule in to a vector, Direct transformation, Isolation and cloning, Transformation and growth of cells, Selection and screening of particular recombinants, Genomic library, sequencing of DNA, Gene identification and mapping, Analysis of expression of cloned genes, Polymerase chain reaction, Monoclonal Antibodies

UNIT III

Plant cell and tissue cultures, Culture techniques, Protoplast fusion, Direct gene transfer, Microinjections,

Nuclear transplantation, Plastid and mitochondrial genes, production of secondary metabolites by immobilized plant cell, Development of disease resistant, herbicide resistant, Salt & drought resistant plant varieties, Microbial Toxins, Introduction, Toxins gene isolation, Genetic engineering of *B. thuringiensis* strains, *Baculovirus* as biocontrol agents.

UNIT IV

Culturing microorganisms for the production of biomass, Production of microbial (Bacterial, Cyanobacterial and Fungal) products, Batch culture, Continuous culture, Fed-batch culture, Mass culture, Use of culture system for the production of microbial products, Production of cyanobacterial biomass for food, Feed and health care products, Improvement of microbial strains for industry, Agriculture, Immobilization of microbial cells and enzyme and its applications.

UNIT V

Strain improvement, bioreactor design, Reactor types, Application of immobilized cells and enzyme, improvement in bioreactor to control environment of process organism. use of microorganisms in pollution control, Waste treatment, Bioremediation, Biological removal of eutrophic nutrients, Heavy metals, Toxic chemicals (Herbicide, Insecticide and Fungicide and Other Toxicants) from waste water and industrial effluents, Utilization of waste water for the production of food and feed, Biodegradation, Bioleaching of metals, Application of microorganisms from environment

Books recommended

- Haekett P. B., Fuchs J. A. and Mesing J. W. (1988) An Introduction to Recombinant DNA techniques – basic experiments in gene manipulation.
- Glck B. R. and Thompson J. E. (1993) Methods in Plant Molecular Biology and Biotechnology.
- Bjorn Kristiansen, (2012) Basic Biotechnology third Edition.

Suggested list of practical's (Course Code BTE304)

1. Demonstration:-
   - PCR
   - Spectrophotom
   - eter pH meter
   - Centrifuge
   - Photomicrographic Camera
2. To prepare the media for plant tissue culture.
3. Isolation of pathogenic fungi from infected plants/Disease plants (Leaf/ Stem/ root)
4. Identification of unknown microorganism from given plates.
5. Preparation of tissue culture media.

CORE COURSE CODE BTS301: SKILL DEVELOPMENT MODULES 3

(COURSE CREDITS = 02)

Communicative & Conversational English

TIME - 30 Hrs

Unit	Content
Unit-1	**Grammar:** 1. Use of the Definite Article, Omission of the Article and Repetition of the Article 2. Words followed by Preposition 3. The Use of Tense 4. Subject-Verb Agreement 5. (The Error of Proximity) 6. Modals and Auxiliaries 7. Common Errors in the Use of Parts of Speech
Unit-2	**Basic Language Skills:** 1. Reading Skills 2. Writing Skills 3. Listening Skills **4.** Presentation Skills
Unit-3	**Comprehension Skills(i):** 1. Resume Writing 2. Letter Writing 3. Report Writing 4. Notices, Circulars and Orders
Unit-4	**Comprehension Skills(ii):** 1. Summarizing 2. Paraphrasing 3. Expansion Ideas
Unit-5	**Comprehension Skills:** 1. English in Situations 2. Group Discussion 3. The Art Of Interview

M.Sc. FOURTH SEMESTER Biotechnology
(COURSE CREDITS 18)

(A) DISSERTATION	Credits	Maximum Marks
A. Valuation (i) Language & Presentation (ii) Review of Literature (iii) Methodology (iv) Analysis & interpretation of Result	**18**	**300**
B. Viva-Voce EXTERNAL		**50**
C. Viva-Voce INTERNAL		**50**
Total		**400**

(B) Comprehensive viva voce (virtual credits)	**4**	**50**

Course Objectives:

The primary object is to expose the students to research culture and technology. They learn how to choose a research problem, plan and perform experiments, collect data, and analyze the data qualitatively and quantitatively. The student gets trained in presenting the results in the form of an oral presentation as well as a thesis. The student presents his/ her research orally at the end of the semester, and this is coupled to a viva-voce. This not only equips the student for a career in research/ industry, but also fosters self-confidence and self-reliance in the student as he/she learns to work and think independently.

Course Learning Outcomes:

CO1: Student is able to conceive a research problem based on current published researches through comprehensive survey of literature on the topic of research.

CO2: Student is able to plan and design bioassay protocols, to isolate microbes and macrobes from different sources, to identify the isolated organisms using morphological, structural, biochemical and molecular methods.

CO3: Student becomes well-versed in enzymatic, growth and toxicological assay systems through handling, use of instruments, reagents and chemicals, and in execution of experiments independently.

CO4: They learn to summarize and present research data by tables and graphs, and statistically analyze and interpret data.

CO5: They are trained to write dissertation (research reports) and present their important findings for peer evaluation. They also learn to publish their research output in peer reviewed journals and magazines.