SYLLABUS

for

Choice Based Credit System (CBCS)

On the basis of

Outcome Based Education (OBE)

Two Year M.Sc. Programme in Biotechnology

PATNA WOMEN'S COLLEGE
Autonomous
PATNA UNIVERSITY
3rd Cycle Accredited at 'A' Grade with CGPA 3.58/4
"College with Potential for Excellence" Status Accorded by UGC

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VISION

Rooted in the life, vision, and teachings of Jesus Christ and inspired by Mother Veronica, the foundress of the Apostolic Carmel, Patna Women's College strives to become a centre of academic excellence in higher education, social responsibility, and empowerment of women.

MISSION STATEMENT

Patna Women's College, the first college for women in Bihar, is committed to the holistic development of women so as to make an effective contribution to the creation of a better society.

To this end, we strive

- To become a centre of excellence in higher education for women in an atmosphere of autonomy.
- To excel in teaching-learning, research, and consultancy.
- To provide education that promotes capacity building and holistic development of a person.
- To offer subjects for competency building and motivate/animate a workforce imbued with human values.
- To promote patriotism, communal harmony and cultural integration to maintain a free and peaceful atmosphere on the campus.
- To train the students in creative arts, social service, critical thinking, and leadership in order to make an effective contribution to the creation of a new and value-based society.
- To create women leaders and to make them agents of social change.
- To develop skill oriented and value-based courses, for the all-round development of individuals.
- To promote academic exchange and academia-industry interface.
- To form young women who are 'always wise' and who will dare to 'go ahead and conquer knowledge' through, competence, commitment, delicate conscience, and compassion.

M.Sc. BIOTECHNOLOGY

PROGRAMME OUTCOMES (POs)

Upon completion of the M.Sc. Biotechnology programme, the candidate should be able to:

PO1: Acquire knowledge for in-depth analytical and critical thinking to identify, formulate and solve the issues related to Biotechnology Industry, Pharma industry, Medical or hospital related organizations, Regulatory Agencies, & Academia.

PO2: Develop an ability to solve, analyze and interpret data generated from experiments done in project work or practical courses.

PO3: Demonstrate skills to use modern analytical tools/ software/ equipment and analyze and solve problems in various courses of biotechnology.

PO4: Appreciate and execute their professional roles in society as biotechnology professionals, employers and employees in various industries, regulators, researchers, educators and managers.

PO5: Adopt code of ethics in professional and social context and demonstrate exemplary professional, ethical and legal behaviours in decision making.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Upon completion of the programme, the students will attain the ability to:

PSO1: Acquire competencies in theoretical as well as experimental Biotechnology in order to enhance knowledge in the applied aspect of the subject related to the welfare/development of society.

PSO2: Apply written and oral communication skills to communicate effectively in healthcare, industry, academia and research

PSO3: Develop aptitude for research in bio-science at molecular level and its interdisciplinary areas.

PSO4: Compete for employment in academia, agriculture, horticulture and need based industry with the biotechnological skills.

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PSO5: Produce entrepreneurs who can develop sustainable solutions in mushroom cultivation and small scale biofertilizer production.

PSO6: Apply responsibilities to promote societal health and safety, upholding the trust given to the profession by the society and develop skills, attitude and values required for self-directed, lifelong learning and professional development.

SUMMARY OF THE SYLLABUS

M.Sc. Biotechnology (CBCS) – Four Semester Programme

Note: 1 credit = 15 hours

1. **Theory Paper - 5 credit each**
2. **Practical paper - 5 credit each**
3. **Tutorial group of each theory paper should have a group size of 8 students.**
4. **Practical paper will not have tutorials.**

It consists of a number of courses i.e., Core course (CC), Elective Course (EC), Discipline Specific Elective Courses (DSE), Ability/ Skill Enhancement Courses (AEC/SEC), and ability Enhancement Compulsory Courses (AECC). Each course is equivalent to a paper. The nature of these courses is defined below.

Core Courses (5 credit each)

Core Course: A course, which should compulsorily be studied by a candidate as a core requirement on the basis of subject of M.Sc. studies and is termed as a Core course.

Skill Enhancement Course (SEC) (5 credits)

Skill Enhancement Courses (Sec): These courses may be chosen from a pool of courses designed to provide **value- based and /or skill- based knowledge**.

Discipline Specific Elective (DSE) (5 Credit each)

Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/ subject of study is referred to as Discipline Specific Elective. The University/ Institute may also offer discipline related elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

Generic Elective Papers (GE) (5 Credits each)

Generic Elective (GE) Courses: An elective course chosen generally from an unrelated discipline/ subject, with an intension to seek exposure is called a Generic Elective.

P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred as Generic Elective.

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Details of Credits for Courses under M.Sc.

Semester	Course Opted	Course/ Paper Code	Nature of Course/ Paper	Credit
SEMESTER I	CC-1(Core Course)	MBTCC 101	Cell & Molecular Biology and Genetics	5
	CC-2(Core Course)	MBTCC 102	Microbiology	5
	CC-3(Core Course)	MBTCC 103	Biomolecule and Basic Enzymology	5
	CC-4 (Core Course)	MBTCC 104	Practical (Based on MBT CC 101, 102, 103)	5
	AECC-1(Ability Enhancement Compulsory Courses)	MAECC 101	Environmental sustainability and Swachh Bharat Abhiyan Activities	5
SEMESTER II	CC-5 (Core Course)	MBTCC 205	Biofertilizer and Mushroom Technology	5
	CC-6 (Core Course)	MBTCC 206	Biophysics and Instrumentation	5
	CC-7 (Core Course)	MBTCC 207	Biology of Immune System	5
	CC-8 (Core Course)	MBTCC 208	Bioprocess Technology	5
	CC-9 (Core Course)	MBTCC 209	Practical (Based on MBTCC 205, 206, 207, 208)	5
	SEC-1(Skill enhancement Course)	MBTSEC 201	One selected from basket	5
SEMESTER III	CC-10(Core Course)	MBTCC 310	Biostatistics and Bioinformatics	5
	CC-11(Core Course)	MBTCC 311	Recombinant DNA Technology	5
	CC-12(Core Course)	MBTCC 312	Plant and Animal Biotechnology	5
	CC-13(Core Course)	MBTCC 313	Environmental Biotechnology	5
	CC-14(Core Course)	MBTCC 314	Practical (Based on MBTCC 310, 311, 312, 313)	5
	AECC-2(Ability Enhancement Compulsory Courses)	MAECC 302	Human Values & Professional Ethics and Gender sensitization	5
SEMESTER IV	DSE-1 (Discipline Specific Elective Courses)	MBTDSE 401	Dissertation and Viva voce	5
	DSE 2	MBT DSE 402	Literature Review & presentation	5
	or			
	DSE 1	MBTDSE 401	Microbial Biotechnology	5
	DSE 2	MBTDSE 402	Practical Based on MBTDSE 401(Microbial Biotechnology)	5
	or			
	DSE 1	MBTDSE 401	Advanced Plant and Agriculture Biotechnology	5
	DSE 2	MBTDSE 402	Practical Based on MBTDSE 401(Advanced Plant and Agriculture Biotechnology)	5
	or			
	DSE 1	MBTDSE 401	Food Biotechnology	5
	DSE 2	MBTDSE 402	Practical Based on MBTDSE 401(Food Biotechnology)	5
	GE-1(Generic Elective Courses)	MBTGE 401	Selected from SWAYAM PG Courses	5
			Total Credit	100

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Course Structure for M.Sc. Biotechnology (Choice Based Credit System)

Note: 1 Credit = 15 Hours

Semester 1: M.Sc. Biotechnology

Paper Code	Paper	Credit
MBTCC 101	Cell & Molecular Biology and Genetics	05
MBTCC 102	Microbiology	05
MBTCC 103	Biomolecule and Basic Enzymology	05
MBTCC 104	Practical (Based on MBT CC 101, 102, 103)	05
MAECC 101	Environmental sustainability and Swachh Bharat Abhiyan Activities	03 02
	Total Credit	**25**

`Semester II: M.Sc. Biotechnology

Paper Code	Paper	Credit
MBTCC 205	Biofertilizer and Mushroom technology	05
MBTCC 206	Biophysics and instrumentation	05
MBTCC207	Biology of Immune System	05
MBTCC 208	Bioprocess Technology	05
MBTCC 209	Practical (Based on MBT CC 205, 206, 207,208)	05
MBTSEC 201	One Selected from basket	05
	Total credit	**30**

Semester III: M.Sc. Biotechnology

Paper Code	Paper	Credit
MBTCC 310	Biostatistics and Bioinformatics	05
MBTCC 311	Recombinant DNA Technology	05
MBTCC 312	Plant and Animal Biotechnology	05
MBTCC 313	Environmental Biotechnology	05
MBTCC 314	Practical (Based on MBT CC310, 311, 312, 313)	05
MAECC 302	Human Values & Professional Ethics Gender Sensitization	03 02
	Total Credit	**30**

Semester IV: M.Sc. Biotechnology

Paper Code	Paper	Credit
MBTDSE 401	Dissertation and Viva voce	5
MBT DSE 402	Literature Review & presentation	5
	or	
MBT DSE 401	Microbial Biotechnology	5
MBT DSE 402	Practical Based on MBTDSE 401	5
	or	
MBT DSE 401	Food Biotechnology	5
MBT DSE 402	Practical Based on MBTDSE 401(Food Biotechnology)	5
	or	
MBTGE 401	Selected from SWAYAM Portal PG Courses	05
	Total Credit	**15**

Total credit for the course - 100

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BIOTECHNOLOGY (M.Sc.) DETAILS OF THE CBCS SYLLABUS

Semester I Core Course (5 Credit each)

MBT CC101 : Cell & Moleccular Biology and Genetics (5 credits)

Course outcomes:

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

CO1: To describe the concept of cell organisation, concept of biological membrane system and transport across different cells.

CO2: To describe the cell cycle and its control mechanism. To understand the basics of cancer oncgenes and suppressor genes.

CO3: To understand the concept of DNA replication in Prokaryotes and Eukaryotes, DNA damage and repair mechanism; Transcription in Prokaryotes and Eukaryotes; Regulatory elements and DNA binding domains of transcription apparatus; Processing of primary transcript and RNA editing in eukaryotes.

CO4: To describe the mechanism of Gene Regulation in Prokaryotes and Eukaryotes.

CO5: to describe the Antisense technology and its application. Mutation and its application and extra chromosomal inheritance.

Units	Topics	No of Hours
I	**Cell Biology:** Diversity of cell; Cell organisation, Sub-cellular structure of prokaryotic and eukaryotic cells; Organelle biogenesis; Synthesis and sorting of plasma membrane, Transport of nutrient ions and macromolecules across cell membranes; Signal traansduction and reglation. **Cell Cycle:** Molecular events and model system **, control mechanism** Biology of cancer: Hallmarks of cancer, Oncogenes and tumour suppressor genes; viral and cellular oncogenes; Apoptosis	15
II	• **DNA Replication in prokaryotes and eukaryotes:** DNA replication Models; DNA polymerase mode of action; RNA polymerase and reverse transcriptase; Enzyme and protein involved in DNA replication (methylases, demethylases, DNases, DNA gyrase, Topoisomerase) • DNA damage and repair mechanism: Different types of DNA damage and repair mechanism; Diseases caused due to impairment in repair mechanism • Gene transfer mechanism in prokaryotes: Transformation, conjugation, Transduction and transfection	20
III	• **Transription:** Concept of Template surfaes, Transcriptions, Post-transrcriptional processing and transport of RNA, Regulation of transcription, Transcription factors; Structures and fuction of ribonucleoproteins, Si RNA, MiRNA • **Translation: Genetic code;** Prokaryotic aand eukaryotic translation, regulation of translation, co-and post translational modifications of proteins	20

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	regulation of translation, co-and post translational modifications of proteins	
IV	• **Gene expression and regulation:** Operons and Regulators, repression aand activation of Lac and Trp operons, feedback inhibition; regulation of eukaryotic gene expression • **Antisense Technology:** Molecular mechanism of antisense molecules, aapplication of antisense technologies. • **Mutation and Mutagenesis**: Molecular basis of mutation ; mutagens; Spontaneous and induced mutation; Ames Test for mutagenesis; Biochemiaal mutation; One gene -one enzyme hypothesis. • Transposons: Structrure and types of transposons (Prokaryotic aand Eukaryotic); Mechanism of transposition (replicative and non replicative); Application of transposons	**15**
V	**Extrachromosomal inheritance:** Cytoplasmic inheritance in plants and animals ; Sex differentiation Population Genetics: Hardy-Weinberg equilibrium; Gene and genotyping frequencies	**05**
	Total	**75**

Recommended Textbooks and References:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th Ed.). New York: Garland Science.
2. Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman.
3. Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning.
4. Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th Ed.). Washington: ASM; Sunderland.
5. Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). *Becker's World of the Cell*. Boston (8th Ed.). Benjamin Cummings.
6. Watson, J. D. (2008). *Molecular Biology of the Gene* (5th ed.). Menlo Park, CA: Benjamin/Cummings.

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M.Sc. Biotechnology (Semester I)

MBT CC102 : Microbiology (5 credits)

Course outcomes:

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

CO1: to describe the history and scope of microbiology, Sterilizaton and its type, preservation methods, staining methods, microbial growth kinetics and classification of microbes.

CO2: To describe diversity of bacteria, Archea and detailed structure of bacteria.

CO3: To describe general features of Fungi, protozoa, slime mold, viruses, viroids and prions.

CO4: To describe host pathogen relationship and different microbial diseases and its causative agent, and its pathogenesis

CO5: To describe types of antibiotics and its mode of action, nitrogen metabolism and symbiotic nitrogen fixation mechanism.

Units	Topics	No of Hours
I	General interoduction; History and scope of mirobiology; theory of spontaneous generation. **Methods of microbology**: Sterilization – Different types of sterilization (moist heat, dry heat, filtration, radiation and chemicals); Microbiological media: types and significance; techniqueof pure culture; maintenance and preservation of microorganisms; Staining: types of microbial staining techniques **Microbial growth:** Mathematical expression of growth, Growth curve, Measurement of growth, Various factors affecting growth **Microbial systematics:** A general idea of classification of microbes	**15**
II	**Diversity of microorganisms:** **Bacteria-** Puple and green bacteria, cyanobaccteria, homoacetogenic bacteria, gliding and sheated bacteria, lactic acid bacteria, endospore forming rods and cooci, chlamydias and mycoplasma **Archea-** Concept of Archea, halophiles, acidophiles, thermophiles, methanogens **Structure of bacteria:** Ultra structure of Gram positive and Gram negative bacteria with special refrence to cell membrane, cell wall, flagella, capsule and slime layer, genome, ribosome, plasmid and endospores; Biosynthesis of peptidoglycan	**15**
III	**Eukarya-** Fungi, slime mold and protozoa **Viruses-** a general idea of structure of different kinds of viruses; Plant viruse: tobacco mosaic virus; structure of bacteriphage belonging to 'T' series; Lytic cycle and its regulation; lysogeny and its regulation in lambda phage **Prions and viroids :** Recent development in research	**10**
IV	**Host – Parasite relationship:** Entry of pathogens into the host,	**20**

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	colonization and factors predisposed toinfections; types of toxins (Exo-, endo- and entero-) and their structure, mode of action, virulence and pathogenesis **Microbial Disease:** Overview of microbial diseases; diseases caused by Gram positive cocci- pneumonia; disease caused by Gram negative cocci-gonorrhea; diseases caused by Gram positive bacilli- tuberculosis, tetanus; diseases caused by Gram negative bacteriaof family Enterobacteriaceae- enteric fever; diseases caused by other Gram negative bacilli- cholera; sexually transmitted disease; AIDS	
V	**Antibiotics:** Different types of antimicrobial agents, mode of action; resistance to antibiotics, Biological nitrogen fixation: - Free living and symbiotic nitrogen fixing organisms; Mechanism of nitrogen fixation	**15**
	Total	**75**

Recommended Textbooks and References:

1. Pelczar, M. J., Reid, R. D., & Chan, E. C. (1977). Microbiology (5th ed.). New York: McGraw-Hill.
2. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011). Prescott's microbiology. New York: McGraw-Hill.
3. Matthai, W., Berg, C. Y., & Black, J. G. (1999). Microbiology, principles and explorations. Boston, MA: John Wiley & Sons
4. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition
6. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan

M.Sc. Biotechnology (Semester I)

MBT CC103 : Biomolecules and Basic Enzymology (5 credits)

Course outcomes:

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

CO1: Understand the concept of pH, pK , acid bases and carbohydrates structure and function

CO2: Develop knowledge of Amino acids Structure, function and classification and types of protein structure

CO3: to describe the classification, structure, properties and function of lipids and nucleic acid.

CO4: Understand Ribozyme technology and its application, Immobilization of enzymes, methods and its industrial application.

CO5: Develop knowledge of Enzyme kinetics, allosteric regulations

Units	Topics	No of Hours
I	**Chemical foundation of Biology:** pH, pK, acid, bases, weak bonds, covalent bonds; Buffers **Carbohydrates:** Classification, types, Optical isomerism, Mutarotation, Basic structure and functions of monosaccharides, Oligosaccharides (with special reference to some disaccharide: maltose, cellobiose, lactose, sucrose), polysaccharides (cellulose, starch, glycogen)	**15**
II	**Amino Acids:** Structure, properties (acid-base, chemical, optical isomerism, isoelectric points), classification and functions; non-protein amino acid; Biosynthesis of major amino acids (Glycin, Proline, Serine, Glutamic acid) **Structure of Proteins:** Primary, Secondary (α-helix, β-sheet), Tertiary and Quaternary structures of proteins; Conjugated and metal binding proteins	**20**
III	**Lipids**: Classification, structure, properties and function of fatty acids; Phospholipids; Glycolipid; Lipoprotein **Nucleic acids:** Structure and chemistry of DNA and RNA; Melting of DNA, Denaturation and Renaturation kinetics.	**20**
IV	**Ribozyme technology:** Types of ribozymes, application of ribozyme technologies **Immobilization of enzyme:** Physical and chemical methods of immobilization of enzymes and cells; immobilization supports; kinetics of immobilized enzymes; Advantages and industrial applications of immobilize enzymes and cells	**10**
V	**Enzymes:** Characteristics, Co-enzymes, kinetics, determination of Km and Vmax using different plots; mechanism of action - binding of substrate and lowering of activation energy, covalent catalysis, acid-base catalysis; regulation- general concepts, allosteric regulation	**10**
	Total	**75**

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Recommended Textbooks and References:

1. Stryer, L. (1988). Biochemistry. New York: Freeman.
2. Lehninger, A. L. (1982). Principles of biochemistry (4th ed.). New York, NY: Worth.
3. Voet, D., &Voet, J. G. (2004). Biochemistry (4th ed.). Hoboken, NJ: J. Wiley & Sons.
4. Dobson, C. M. (2003). Protein folding and misfolding. Nature, 426(6968), 884-890. doi:10.1038/nature02261.
5. Richards, F. M. (1991). The Protein Folding Problem. Scientific American, 264(1), 54-63. doi:10.1038/scientificamerican0191-54.

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M.Sc. Biotechnology (Semester I)

MBT CC104 : Practical (Based on MBT CC101, 102, 103) (5 credits)

Course outcomes:

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

CO1: Understand the different stages of cell cylce and working knowledge of cell counting by haemocytometer

CO2: Hands on understanding to wok with microbial culture, media preparation, sterilization, staining techniques & identification of microbes by different biochemical tests

CO3: Gain knowledge of growth curve of bacteria and effects of different parameters on its growth

CO4: Acquire knowledge of standard graph preparation by measuring optical density, working with protein and its purification

CO5: hands on experience with instruments such as spectrophotometer, SDS PAGE gel electrophoresis, column chromatography

Experiment No	Name of the Experiment
1.	Mitotic and meiotic slide preparation of plant.
2.	Counting of cell by haemocytometer.
3.	Assay of antibiotic resistance by disc diffusion method.
4.	Isolation of auxotrophs by replica plate technique.
5.	Transformation of *E. coli* with standard plasmids, Calculation of transformation efficiency
6.	Sterilization, disinfection, safety in microbiological laboratory.
7.	Preparation of media for growth of various microorganisms.
8.	Isolation and Identification of various microorganisms.
9.	Biochemical tests for identification of Bacteria – Oxidase, catalase, IMViC test, etc.
10.	Staining and enumeration of microorganisms.
11.	Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen.
12.	To prepare an Acetic-Na Acetate Buffer system and validate the Henderson-Hasselbach equation.
13.	To determine an unknown protein concentration by plotting a standard graph of BSA using UV-VIS Spectrophotometer.
14.	To determine an unknown carbohydrate concentration by plotting a standard graph of glucose using UV-VIS Spectrophotometer.
15.	Separation of aliphatic, aromatic and polar amino acids by TLC.
16.	AN ENZYME PURIFICATION THEME (such as *E. coli* any enzyme of the institutions choice).
	(i) Preparation of cell-free lysates
	(ii) Ammonium Sulphate precipitation
	(iii) Ion-exchange Chromatography
	(iv) Gel Filtration

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	(v) Affinity Chromatography
17.	Separation of protein by SDS-PAGE
18.	Separation of DNA by Agarose electrophoresis
19.	Determination of enzyme activity (any)
20.	Enzyme Kinetic Parameters: Km, Vmax.
21.	Immobilization of enzymes by Na alginate method (any)
22.	Whole cell immobilization (Yeast) by Na Alginate and the estimation of alcohol produced.
23.	Effect of NaCl on any enzyme activity
24.	Effect of Temperature on activity of and determination of optimum temperature.
25.	Effect of pH on activity of and determination of optimum pH

M.Sc. Biotechnology (Semester I)

ABILITY ENHANCEMENT CUMPULSORY COURSE (5 CREDIT)

MAECC 101: Environmental Sustainability and Swachha Bharat Abhiyan Activities

Course Outcome: On completion of the course students will be able:

CO1- To understand the sustainable development and ecosystem and discuss the environmental pollution, climate change, ozone layer depletion, threats of encroachment on habit and habitat of flora and fauna.

CO2- To understand biodiversity and its conservation, three 'R', environmental education, awareness programme and ecological economics.

CO3- To understand the importance of swachhata, sanitation and hygiene. Describe the Gandhiyan approach towards social and environmental moral values.

CO4- To study the case of sanitation and effect of cleanliness.

Units	Topics	No of Hours
I	Environmental ethics & ecosystem: Concept of sustainable development with reference to human values in western and Indian perspective, sustainable development & conservation of natural resources (Nature, factors, structure, development and people participation) development, environment- rural and urban, concept of Ecosystem	15
II	Development and its effect on environment: Environment pollution- water, air, noise etc. due to Urbanization, Industrial civilization, Concept of Global Warming, Climate change, Green House Effect, Acid rain, Ozone layer depletion, Menace of encroachment to impact on habit & habitat on indigenous flora & fauna	15
III	Concept of Biodiversity and its conservation: environment; degradation and conservation Govt Policies, Social effects and role of social reforms in this direction. Role of scientific conservation of environmental concept of Three 'R' (reduce, reuse, recycle). Need of environmental education and awareness programme and ecological economics.	15
IV	Swachha Bharat Abhiyan: The concept of Swachhata as personal, Gandhiyan approach towards social and environmental moral values & concept of swachhata and its relation to moral Upgradation of society and freedom struggle, Awareness programme related to Swachhata. Role of 'Swachchagrahis' in Swachha Bharat Abhiyan. Sanitation and hygiene, why sanitation is needed, sanitation and human rights, plantation, values of nature, concept of community participation and role of state agencies. Case study of Sanitation, effects of cleanliness, diseases- infectious and vector- born ideas of spread of diseases through body and other biological fluids and excreta.	20
V	Assignment/ Practical/ field work based on Unit- 4 or **Alternative to unit – 4 and unit- 5**, a student can also enrol for Swachha Bharat Internship programme of MHRD	10
	Total	75

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BIOTECHNOLOGY (M.SC.) DETAILS OF THE CBCS SYLLABUS

Semester II

Core Course (5 Credit each)

MBT CC205 : Biofertilizer and Mushroom Technology (5 credits)

Course outcomes:

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

CO1: Understand N_2 fixation, phosphate solubilization, & mycorrhizal interaction in maintaining soil fertility

CO2: Understand mass cultivation of cyanobacteria and its application in rice field

CO3: Developed skill on potent microorganism to be used as biopesticides

CO4: Understand Mushroom types and its cultivation mechanism

CO5: Develop depth knowledge on Bioinsecticides

Units	Topics	No of Hours
I	**Introduction to biofertilizers**-Structure and characteristic features of the following biofertilizer organisms: • Bacteria: *Azospirillum, Azotobacter, Rhizobium* and *Frankia.* • *Cyanobacteria: Anabaena, Nostoc* • Fungi: *Glomus, Gigaspora* **Nitrogenous Biofertilizers:** Bacteria – • Isolation and purification of *Azospirillum* and *Azotobacter*, mass multiplication of *Azospirillum* and *Azotob*acter, formulation of inoculum of *Azospirillum* and *Azotobacter*, application of inoculants of *Azospirillum* and *Azotobacter*. • Isolation and purification of *Rhizobium*, mass multiplication and inoculum production of *Rhizobium*, Methods of application of *Rhizobium* inoculants	15
II	• **Isolation and purification of Cyanobacteria-** Mass multiplication of cyanobacterial bioinoculants - Trough or Tank method, Pit method, Field method; Methods of application of cyanobacterial inoculum. *Azolla* - mass cultivation and application in rice fields. • **Mycorrhizae** - Ecto and endo mycorrhizae and their importance in agriculture. Isolation of AM fungi - Wet sieving method and sucrose gradient method. Mass production of AM inoculants and field applications.	20
III	• **Isolation and Purification of phosphate solubilizers**. Mass multiplication and field applications of phosphate solubilizer • **Biofertilization processes** -Decomposition of organic matter and soil fertility and vermicomposting • **Biofertilizers** - Storage, shelf life, quality control and marketing	10
IV	• **Mushroom Technology** - Introduction, History and Scope - Edible and Poisonous Mushrooms. Life cycle of mushroom: Vegetative and	10

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	reproductive phase (Formation and development of Basidiocarp, structure of basidiocarp), Importance and nutritive value of edible mushrooms	
V	• **Cultivation of button mushroom** (*Agaricus bisporus*), milky white mushroom (*Calocybe indica*), oyster mushroom (*Pleurotus sajorcaju*) and paddy straw mushroom (*Volvariella volvacea*). • Isolation and culture of spores, culture media preparation. Production of mother culture, mother spawn, commercial spawn. • Production of medicinal mushroom (*Ganoderma lucidum*) and its medical application. • Storage of mushroom (Drying and Canning); Diseases on mushrooms (Bacteria, Fungal and Viral) and its remedial measure	**15**
	Total	**75**

Recommended Textbooks and References:

Reading List:

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.

2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.

3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.

4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.

5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

M.Sc. Biotechnology (Semester II)

MBT CC206 : Biophysics and Instrumentation (5 Credits) (5 credits)

Course outcomes:

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

CO1: Analyse the different biomolecules through different spectroscopic techniques

CO2: Understand the instruments and its techniques to study microbes and its biomolecules

CO3: Develop depth knowledge of observing microbial world through microscopy technique

CO4: Analyse the biomolecule separation techniques: chromatography, gel electrophoresis

CO5: Understand column packing in any form of column chromatography

Units	Topics	No of Hours
I	**Bioenergetics:** Principles of thermodynamics, redox potential and free energy change of the reaction; Biological energy transducers **Spectroscopy:** Beer Lambert's Law • UV-VIS spectroscopy • Infrared (IR) spectroscopy • Fluorescence spectroscopy • Atomic absorption spectroscopy • Nuclear magnetic resonance (NMR) • Mass spectroscopy • X-ray diffraction	**20**
II	**Chromatography:** Principles, types (Paper, TLC, Affinity, Ion-exchange, Gel filtration, GLC, HPLC) and their applications	**10**
III	**Centrifugation:** Principles, types; Differential and density gradient centrifugation; Applications of centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods	**15**
IV	**Microscopy**: Simple Microscope; Compound Microscope; Stereomicroscope; Phase-contrast and Fluorescence microscopes; Electron Microscope-TEM and SEM; Confocal Microscope Autoradiography; Flow cytometry	**10**
V	**Electrophoresis:** Principles and types [Polyacrylamide gel electrophoresis (PAGE), SDS-PAGE, agarose gel electrophoresis, 2D electrophoresis and their applications; Gradient Gel Electrophoresis (DGGE); Temperature Gradient Gel Electrophoresis (TGGE); Pulsed field gel electrophoresis **Immunoelectrophoresis:** Types (crossed, rocket) and their applications **Isoelectric focusing (IEF):** Principles and applications	**20**
	Total	**75**

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Recommended Textbooks and References:

1. Wilson, K.& Walker, J., Practical Biochemistry, Cambridge University Press, (1992).
2. Lehninger, A. L. (1982). Principles of biochemistry (4th ed.). New York, NY: Worth.
3. Willey, J. M., Sherwood, L., Woolverton, C. J., Prescott, L. M., & Willey, J. M. (2011). Prescott's microbiology. New York: McGraw-Hill.
4. Mark F. Vitha. Spectroscopy: Principles and Instrumentation. Wiley
5. Dinesh Kumar Chatanla, Prahlad Singh Mehra. Instrumental Methods of Analysis in Biotechnology. I.K. International Publishing House Pvt. Ltd.
6. Prakash S. Bisen, Anjana Sharma. Introduction to Instrumentation in Life Sciences. CRC Press. Taylor and Francis Group.
7. Prakash S. Bisen, Anjana Sharma. Laboratory Protocols in Applied Life Sciences. CRC Press. Taylor and Francis Group

M.Sc. Biotechnology (Semester II)

MBT CC207 : Biology of Immune System (5 Credits)

Course outcomes:

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

CO1: Gain Knowledge of cells and organ system of immune system

CO2: Understand Immune system and its response to pathogenic microorganisms

CO3: Develop Understanding of various immunological disorders

CO4: Apply Knowledge of various immunological techniques

CO5: Understand the effect of different foreign molecules on immune system and its defense mechanism

Units	Topics	No of Hours
I	**Immune responses**: Innate and adaptive immune responses **Cells and organs of the immune system**: hematopoiesis, cells of the immune system; Primary and secondary lymphoid organs	**10**
II	**Antigens**: Properties of antigens; superantigens; haptens, adjuvants **Antibody**: Classes, structure and function; Immunoglobulin superfamily; Generation of antibody diversity	**10**
III	**T-cell receptors**: Structure; organization of T-cell receptor genes and generation of its diversity **Major histocompatibility complex**: Different classes of MHC and its role in antigen processing and presentation **Transplantation immunology:** Types of grafts, grafts rejection, GVH reactions, mechanism of graft rejection, and prevention of graft rejection	**15**
IV	**Immune responses**: Generation of humoral and cell-mediated immune responses and effector mechanisms; Complement system- different pathways and biological function of complement proteins **Antigen-antibody interactions**: Antigen-antibody interactions and its *in vivo* and *in vitro* applications	**20**
V	**Hypersensitivity**: Type I, Type II, Type III and Type IV and their significance Autoimmunity; Immunological tolerance; Immunosuppression; Immunodeficiency; Immunotherapy **Interferon**: recent development in research, role in therapy **Vaccines**: Different types of vaccines and its merits and demerits	**20**
	Total	**75**

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Recommended Textbooks and References:

1. Kindt, T. J., Goldsby, R. A., Osborne, B. A., &Kuby, J. (2006). *Kuby Immunology*. New York: W.H. Freeman.
2. Brostoff, J., Seaddin, J. K., Male, D., &Roitt, I. M. (2002). *Clinical Immunology*. London: Gower Medical Pub.
3. Murphy, K., Travers, P., Walport, M., &Janeway, C. (2012). *Janeway's Immunobiology*. New York: Garland Science.
4. Paul, W. E. (2012). *Fundamental Immunology*. New York: Raven Press.
5. Goding, J. W. (1996). *Monoclonal Antibodies: Principles and Practice: Production and Application of Monoclonal Antibodies in Cell Biology, Biochemistry, and Immunology*. London: Academic Press.
6. Parham, P. (2005). *The Immune System*. New York: Garland Science.

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M.Sc. Biotechnology (Semester II)

MBT CC208 : Bioprocess Technology (5 Credits)

Course outcomes:

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

CO1: Understand the Methods of isolation of microorganisms from different sources

CO2: Analysis the Methods of preservation of industrially important microbes, industrial fermentation media and growth kinetics of industrially important microorganism

CO3: Apply Knowledge of different types of fermentation process and bioreactors

CO4: Demonstrate the Knowledge of downstream processes and enzyme mobilization techniques

CO5: Understand the process technology for the production of industrially important products

Units	Topics	No of Hours
I	Industrially important microbes and their application; Chronological development of fermentation industry. Isolation and preservation of industrially important microorganisms Screening methods for industrial microbes; detection and assay of fermentation products Strain selection and improvement (Mutation, protoplast fusion and recombinant DNA techniques); classification of fermentation types	15
II	**Microbial growth kinetics**: Batch culture, continuous culture, industrial applications of continuous culture processes, fed-batch culture **Media for industrial fermentation**: Typical media, media formulation, water, energy sources, carbon sources, nitrogen sources, minerals, vitamin sources, nutrient recycle, buffers, precursors and metabolic regulators, oxygen requirement; Sterilization of air and media; Inoculum development and aseptic transfers	15
III	**Design of fermenter**: Construction, aeration and agitation, baffles, achievement and maintenance of aseptic conditions, valves **Instrumentation and control**: Control systems, manual, automatic, methods of measurements of process variables, flow, temperature, pressure, agitator shaft power, foam sensing and control, measurement and control of dissolved oxygen, on-line analysis of process parameters, computer control of fermenters.	15
IV	**Downstream processing**: Removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, liquid-liquid extraction, chromatography, drying and crystallization	10
V	**Process technology for the production of primary metabolites**: Baker's yeast, ethanol, beer, wine, distilled spirits, acetone-butanol, citric acid, amino acids (Glutamic acid) **Microbial production of industrial enzymes**: Cellulase and amylase	20

	Production of secondary metabolites: Penicillin	
	Total	**75**

Recommended Textbooks and References:

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

M.Sc. Biotechnology (Semester II)

MBT CC209 : Practical (Based on MBT CC205, 206, 207, 208) (5 credits)

Course outcomes:

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

CO1: Learn how to produce biofertilizers, mushroom spawn for its commercial production

CO2: Understand the method of quantification of DNA concentration and its purity by Spectrophotometer.

CO3: Learn how to perform WBC count in blood samples and learn other immunological processes like pahgocytosis

CO4: Understand the basic concepts of Immunological techniques

CO5: Understand the concept of production and estimation of various industrially important Enzymes, antibiotics, ethanols and acids.

Experiment No	Name of the Experiment
1.	Production of microbial fertilizers (*Rhizobium*, *Azotobacter*, Nostoc, *Azolla*).
2.	Identification of mushroom by spore print method
3.	Spore culture for development of primary mycelium
4.	Production of mother culture by tissue culture method
5.	Production of mother spawn
6.	Commercial production of different varieties of mushroom (Oyster, Button and Paddy straw)
7.	Isolation of DNA from different sources (plant /animal/ microbes)
8.	Purity determination and quantification of DNA by UV method
9.	The ultraviolet absorption of proteins and amino acids.
10.	Estimation of protein by E280/E260 method.
11.	Blood smear identification of leucocytes by Giemsa stain
12.	Separation of leucocytes by dextran method
13.	Demonstration of Phagocytosis of latex beads
14.	Separation of mononuclear cells by Ficoll-Hypaque
15.	Blood grouping test
16.	Ouchterlony immuno diffusion,
17.	Radial Immuno diffusion
18.	Immuno-electrophoresis
19.	Antibody titre by ELISA method.
20.	Isolation and purification of IgG from serum or IgY from chicken egg.
21.	Immunodiagnostics using commercial kits
23.	Isolation and screening of industrially important microorganisms.
24.	To study the determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask
25.	To study the production of microbial products in bioreactors.
26.	Production and purification of various enzymes from microbes.
27	Comparative studies of Ethanol production using different substrates.
28.	Microbial production and downstream processing of an enzyme, e.g., amylase
29.	Microbial production of citric acid and its estimation
30.	Production and assay of antibiotics by disc diffusion method

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M.Sc. Biotechnology (Semester II)

MBT SEC201 : Skill Enhancement Courses (One selected from basket)

Project/Dissertation

(5 credits)

Basket of Ability Enhancement or Skilled Enhancement Courses (AEC/SEC)

- Business Communication and Employability Skills
- Web Designing
- Financial Risk Management/
- Solid waste Management/
- Mushroom Culture /
- Bio-fertilizer production/
- Environmental Law/
- Tourism and Hospitality Management/
- Life-skill and skill development /
- Yoga Studies
- Any other Courses decided by B.O.C.S. and duly approved by Academic Council
- Any PG Courses Selected from SWAYAM related to Skill Enhancement

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BIOTECHNOLOGY (M.SC.) DETAILS OF THE CBCS SYLLABUS

Semester III

Core Course (5 Credit each)

MBT CC310 : Biostatistics and Bioinformatics (5 credits)

Course outcomes:

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

CO1: Develop basic knowledge of mathematics as applied to biological phenomenon

CO2: Understand the basic concepts of statistics and their importance

CO3: Apply Various statistical techniques to prove the significance of biological experiment

CO4: Understand Biological databases and its tools to use them for bioinformatic studies

CO5: Gain the ability to apply the sequence analysis knowledge to understand the phylogenetic distance between different organisms.

Units	Topic to be covered	No of Hours
I	Scope and limitations of biostatistics, collection, classification and tabulation of data, graphical and diagrammatic representation, scale diagrams, histograms, frequency polygon, frequency curves, ogives **Measures of central tendency**: arithmetic mean, median and mode; Measure of dispersion, Moments, Skewness and Kurtosis	**15**
II	Concept of Probability, Addition and Multiplication theorem **Probability distribution**: Binomial, Poisson and Normal distribution	**15**
III	**Correlation and regression**: Simple correlation, correlation coefficient, regression simple linear regression; Basic ideas of significance test, Hypothesis testing level of significance, Student 't' test, goodness of fit and 'chi' square test; 'F' test – ANOVA	**15**
IV	**Introduction:** definition & scope of bioinformatics. terminologies, types of formats, motifs, patterns. **Databases**: types of databases; sequence databases, structural databases) Protein data bank, Swiss-prot, NCBI, examples and applications. **Sequence analysis: nucleic acid sequence, protein sequence** Similarity search Tools: BLAST and FASTA	**15**
V	Pair wise sequence comparison, Multiple sequence alignments sequence queries., multifunctional tools for sequence analysis; Phylogenetic analysis	**15**
	Total	**75**

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Recommended Textbooks and References:

1. Whitlock and Schluter (2008). The Analysis of Biological Data. Roberts and Company Publishers
2. Zar JH (2010). Biostatistical Analysis. Pearson publication.
3. Lesk, A. M. (2002). *Introduction to Bioinformatics*. Oxford: Oxford University Press.
4. Mount, D. W. (2001). *Bioinformatics: Sequence and Genome Analysis.* Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
5. Baxevanis, A. D., & Ouellette, B. F. (2001). *Bioinformatics: a Practical Guide to the Analysis of Genes and Proteins*. New York: Wiley-Interscience.
6. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*. Hoboken, NJ.: Wiley-Blackwell.
7. Bourne, P. E., & Gu, J. (2009). *Structural Bioinformatics*. Hoboken, NJ: Wiley-Liss.
8. Lesk, A. M. (2004). *Introduction to Protein Science: Architecture, Function, and Genomics.* Oxford: Oxford University Press.

M.Sc. Biotechnology (Semester III)

MBTCC 311 : Recombinant DNA Technology (5 credits)

Course outcomes:

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

CO1: Analyse the Genetic engineering tools for manipulation of DNA

CO2: Understand the concept of cDNA libraries, rDNA and methods of DNA transfer in suitable host

CO3: Develop knowledge advanced Recombinant DNA techniques like, DNA isolation, PCR, blotting, DNA sequencing and gel electrophoresis

CO4: Perform Demonstration of Bacterial Transformation and calculation of transformation efficiency.

CO5: Understand the Concept of RDT & its application in the production of therapeutic products

Units	Topic to be covered	No of Hours
I	**rDNA technology**: Core techniques and essential enzymes; Restriction enzymes-types and cleavage pattern; DNA ligase- types and ligation of DNA molecule *in vitro*; Isolation of genomic and plasmid DNA **Cloning vectors**: Plasmids (natural, pBR322, pUC, Ti plasmid vectors), phages, cosmid, animal virus vectors, artificial chromosome vector; Shuttle vectors; Expression vector	**15**
II	**Passenger DNA**: Different strategies used for isolation/synthesis of gene; Organ chemical synthesis of gene; Construction of genomic and cDNA libraries **Construction of rDNA**: Different strategies for construction of rDNA (Use of restriction enzymes, Linkers, Adaptors, Homopolymer tailing) **Methods of DNA transfer in suitable host**: electroporation, electrofusion, microinjection, particle gun method, direct uptake of DNA ($CaCl_2$ method), *Agrobacterium* mediated transformation, liposomes as transforming vehicle	**15**
III	**Selection strategies**: Different methods for selection of clone (antibiotic resistant markers, colony hybridization, plaque hybridization, immuno screening) **Probe construction**: different methodologies used to prepare radioactive (Nick translation, end filling and random priming) and non-radioactive (biotinylated and horseradish peroxidase) labelled probes **Mapping of Genome**: Molecular markers as tool for mapping, Restriction Fragment Length Polymorphism (RFLPs), Randomly Amplified Polymorphic DNA (RAPD)	**15**
IV	**Blotting**: Principles, types of blotting- Southern, Northern, Western and Dot blots **Amplification of DNA**: Polymerase Chain Reaction (PCR) and its application **DNA sequencing**: Various methods of DNA sequencing	**10**

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	Microarray and its applications	
V	**Application of rDNA technology**: In medicine, agriculture and environment protection **DNA finger printing**: Methodology and its application **Intellectual property rights, bioethics and patenting**: IPR, sovereignty rights, CBD, bioethics and patenting; General agreement on trade and tariffs; Indian sui-generis system for plant variety and farmer's rights protection act **Safety of recombinant DNA technology**: Restriction and regulation for the release of GMOs; Social and ethical issue	**20**
	Total	**75**

Recommended Textbooks and References:

1. Old, R. W., Primrose, S. B., &Twyman, R. M. (2001). *Principles of Gene Manipulation: an Introduction to Genetic Engineering*. Oxford: Blackwell Scientific Publications.
2. Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
3. Brown, T. A. (2006). *Genomes* (3rd ed.). New York: Garland Science Pub.
4. Selected papers from scientific journals, particularly Nature & Science.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab *etc.*

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M.Sc. Biotechnology (Semester III)

MBT CC312: Plant and Animal Biotechnology (5 credits)

Course outcomes:

After the completion of the course the students will be able to :
CO1: Learn regeneration ability of plant cells through various culture techniques
CO2: Understand the application of tissue culture methods for generation of vrus free plants, haploid plants
CO3: Understand the importans of micropropagation techniques to obtain hybrids through protoplast fusion, somatic hybridization
CO4: Acquire the concepts of trangenic plants and commercial application of plant tissue culture for propagation of transgenics.
CO5: Acquire the concept of Animal cell culture and its application

Units	Topic to be covered	No of Hours
I	History of plant cell, tissue and organ culture; laboratory organization; aseptic techniques; nutritional components of growth medium Basic techniques involved in culture of various explants Single cell suspension culture and their applications Embryo culture, factors and applications Process of somatic embryogenesis and organogenesis; synthetic seeds; *In vitro* pollination	**10**
II	Micropropagation techniques, its application and limitations; Production of virus free plants Production and exploitation of haploids and triploids Somaclonal variations: applications and limitations	**10**
III	Protoplast isolation and culture techniques; testing of viability of isolated protoplasts; Osmoticum Somatic hybridization (parasexual hybridization technique) and production of somatic hybrids and its applications *Agrobacterium* mediated gene transfer method in plant; Ti plasmid Production of secondary metabolites using *in vitro* techniques Practical applications of tissue and organ culture; Commercial applications of plant tissue culture; Transgenic plants and its products, Cryopreservation and *ex situ* conservation of germplasm	**20**
IV	**Animal Cell and Tissue Culture:** Principles of cell and tissue culture techniques; equipment and materials for animal cell culture technology Culture media: Chemical, physical and metabolic functions of different constituents of culture medium; role of carbon dioxide, serum and other supplements; Serum and protein free defined media and their applications **Animal cell culture methods**: Different methods **Cell lines**: primary and established cell lines Measurement of viability and cytotoxicity	**20**
V	Applications of animal tissue cultures **Stem cell cultures technology**: Different types of stem cells; embryonic stem cells and their applications, Induced pluripotent stem cells	**15**

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	Transgenic animals, Methods for generating knockout mice Cell culture-based vaccines **Hybridoma technology**: Hybridoma technology and production of Monoclonal antibody and its applications	
	Total	**75**

Recommended Textbooks and References:

1. Chawla, H. S. (2000). *Introduction to Plant Biotechnology*. Enfield, NH: Science.
2. Razdan, M. K. (2003). *Introduction to Plant Tissue Culture*. Enfield, NH: Science.
3. Slater, A., Scott, N. W., & Fowler, M. R. (2008). *Plant Biotechnology: an Introduction to Genetic Engineering*. Oxford: Oxford University Press.
4. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). *Biochemistry & Molecular Biology of Plants*. Chichester, West Sussex: John Wiley & Sons.
5. Umesha, S. (2013). *Plant Biotechnology.* The Energy And Resources.
6. Glick, B. R., & Pasternak, J. J. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. Washington, D.C.: ASM Press.
7. Brown, T. A. (2006). *Gene Cloning and DNA Analysis: an Introduction*. Oxford: Blackwell Pub.
8. Primrose, S. B., &Twyman, R. M. (2006). *Principles of Gene Manipulation and Genomics*. Malden, MA: Blackwell Pub.
9. Slater, A., Scott, N. W., & Fowler, M. R. (2003). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford: Oxford University Press.
10. Gordon, I. (2005). *Reproductive Techniques in Farm Animals*. Oxford: CAB International.
11. Levine, M. M. (2004). *New Generation Vaccines.* New York: M. Dekker.
12. Pörtner, R. (2007). *Animal Cell Biotechnology: Methods and Protocols*. Totowa, NJ: Humana Press.

M.Sc. Biotechnology (Semester III)

MBT CC313: Environmental Biotechnology (5 credits)

Course outcomes:

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

CO1: Analysis on idea of nutrient cycling with reference to C- cycle, N- cycle and Sulfur

CO2: Understand the basic idea of environmental problems and Biomonitoring of water pollution

CO3: Understand the Role of microorganisms in degradation of solid/liquid wastes

CO4: Develop better understanding of bioremediation by exploiting the degradation abilities of microorganisms

CO5: Develop a better understanding of Biopesticides and Microbial role in mining

Units	Topics to be covered	No of Hours
I	**Biogeochemical cycling:** carbon, nitrogen and sulfur cycle **Environmental problems**- Ozone depletion, greenhouse effect and acid rain, their impact and biotechnological approaches for management. **Biomonitoring:** Biomonitoring of water pollution (physical, chemical and biological), Role of microbes in biomonitoring of water quality; indicator organisms; biosensors for ecotoxicity measurement	20
II	**Treatment of wastes:** Treatment of solid wastes: Composting, Land filling, Incineration Wastewater treatment methods: Oxidation Pond, Trickling filter–design, operation; Activated sludge–design, operation; Anaerobic treatment of wastewater and sludge Waste water treatments by plants and vermiculture	15
III	**Bioremediation:** Microorganisms in removal of organic and metal pollutants; Bioremediation of contaminated ground water and phytoremediation of soil; biodegradation and bioaugmentation; Oil spillage and degradation of hydrocarbons; Degradation of xenobiotics (Pesticides and Plastics)	15
IV	**Biofuels:** Brief idea about renewable and non-renewable energy resources Production of ethanol fuel from domestic and agro-wastes Methanogenesis and biogas production Plant based fuel (biodiesel) Hydrogen as fuel and its microbial production (biohydrogen)	15
V	**Biopesticides:** Bacterial, viral and fungal biopesticides and their and applications, Integrated pest management **Microbial mining:** Microbial enhanced recovery of mineral resources; Use of microbes in oil recovery	10
	Total	75

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Recommended Textbooks and References:

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

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M.Sc. Biotechnology (Semester III)

MBT CC314 : Practical (Based on MBT CC301, 302, 303, 304) (5 credits)

Course outcomes:

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

CO1: Learn how to interpret & analyse mean, mode, median, standard error and standard deviation manually and with software programs

CO2: Aquire the working knowledge of softwares and online databses for retrieving sequences, 3D structures, metabolic pathways.

CO3: Perform the DNA, Plasmid isoaltion and its visualuzation by agarose gel electrophoresis.

CO4: Gain knowledge of advance molecular biology techniques like PCR, restriction digestion, ligation, transformation

CO5: Gain the ability to apply knowledge to establish organ culture, protoplast culture, haploid production and also use of microbiological techniques to isolate and stdy indicator organisms.

Experiment No	Name of the Experiment
1.	Calculation of mean, mode, and median.
2.	Calculation of standard deviation and standard error.
3.	Computer aided statistical analysis.
4.	Computer presentation of statistical data, charts and diagrams.
5.	Computer aided visualization of amino acid sequence of protein and its 3D structure.
6.	Retrieving metabolic pathway using internet.
7.	Homology searching using BLAST.
8.	Base sequence analysis of gene / protein sequence.
9.	Computer aided survey of scientific literature.
10.	Isolation of plasmid DNA (miniprep and alkaline bulk method)
11.	Isolation of genomic DNA and Agarose gel electrophoresis
12.	Restriction digestion of DNA
13.	Demonstration of technique of PCR
14.	Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis
15.	Study of Ligation process
16.	Preparation of plant tissue culture media.
17.	Surface sterilization.
18.	To study Organ culture (embryo culture)
19.	To study Protoplast isolation and culture.
20.	To study Anther culture: production of haploids
21.	To study Artificial seed preparation
22.	To study Cytological examination of regenerated plants.
23.	Preparation of animal cell culture media

24.	Cell counting and cell viability
25.	Detection of coliforms for determination of the purity of potable water
26.	Determination of total dissolved solids of water
27	Determination of Hardness and alkalinity of water sample.
28.	Determination of dissolved oxygen concentration of water sample
29.	Determination of biological oxygen demand of sewage sample
30.	Preparation and formulation of microbial biopesticide (bacteria, fungi)
31.	*In vitro* evaluation of medicinal plants against pathogenic microbes.
32.	Study of patenting procedure

PAPER – MAECC-302 (Ability Enhancement Compulsory Course)

A. Human values and professional Ethics (3 credits)

B. Gender Sensitization (2 credits)

COURSE OUTCOME

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

CO1. Understand the importance of human values and professional ethics for their overall personality development

CO2. Infer the sociological, psychological and constitutional perspectives of gender

CO3. Apply the values of peace, harmony, morality, ethics, empathy, integrity and courage in their lives

CO4. Develop the understanding of human and gender specific rights

Unit I **Variety of Moral Issues, principals of Ethics and Morality:** Understanding the harmony in the society (society being an extension of family), Integrity, Work ethics, Courage, Empathy, Self Confidence, Professional Ideas and Virtues, Ethics as a Subset of Morality, ethics and Organizations, Duties and Rights of employees and employers.

Unit II **Holistic approach to corporate ethics:** Vendantic ethics- Tagore, Vivekananda, Gandhi and Aurobondo on ethics, Ethics in Finance, Business and Environment, Professional Rights, Intellectual property rights, Corporate responsibility, Social Audit and Ethic Investing, Computer and Ethics.

Unit III **Professional Ethics:** Augmenting Universal Human Order, Characteristics of people- friendly and eco-friendly production, Strategy for Transition from the Present state to Universal Human Order, At the level of Individual- as Socially and Ecologically Responsible Technologists and managers, at the Level of Society- as Mutually Enriching Institutions and organizations. case studies of typical holistic technologies and management patterns.

Unit IV **Gender- An overview:** Gender: Definition, nature and evolution, culture, tradition, histocrity, Gender spectrum: biological sociological , psychological conditioning, Gender based division of labour- domestic work and use value.

Unit V **Gender- Contemporary perspectives:** Gender justice and human rights: international perspectives, Gender: constitutional and legal perspectives, media and gender, Gender: emerging issues and challenges.

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BIOTECHNOLOGY (M.SC.) DETAILS OF THE CBCS SYLLABUS

Semester IV

MBT DSE 401: Dissertation and Viva voce (5 credits)

COURSE OUTCOME

After completion of the course, the students will:

CO1: Apply Experimental approach of various scientific phenomena

CO2: Enhance knowledge on research aptitude and designing experiments independently

CO3: Develop knowledge on Augmented reading habit of research/review articles

CO4: Skilled knowledge on project work within a bound time period

CO5: Gaining abilities to analyse the experimental results to compile Project report

Units	Topics to be covered	No of Hours
	Dissertation or project work in place of one Discipline Specific Elective paper (5 credits) in 4th Semester. **Dissertation/Project**: An elective course designed to acquire special/advanced knowledge, such as to supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.	

Dissertation/Project/ Internship/ Industrial Training/ Field Work:

Elective courses are designed to acquire advanced knowledge to supplement /support the main subject through project work/ internship/ industrial training/ field work. A student studies such a course on her own A student may join any recognized research institute/ research laboratory/ the industrial organization with the approval of parent department at their own cost. The student has to work for a minimum number of months as decided by the parent department. On completion of the project work/ training at the research institute/ research laboratory/ industrial organization, student will submit a written project report certified by the authorised person where she has worked for that period to his/her satisfaction. The certificate will be submitted to the parent department dully signed by the authorised person. The parent department will also assist the students to choose proper organizations for their project work/ industrial training/ field work etc. The student can also do Project dissertation work in parent department on selected topic under the supervision of teacher of the department.

MBTDSE 402: Literature Review & Presentation (5 Credit)

BIOTECHNOLOGY (M.SC.) DETAILS OF THE CBCS SYLLABUS

Semester IV

MBT DSE401 : Microbial Biotechnology (5 credits)

COURSE OUTCOME

After completion of the course, the students will:

CO1: Understand the concept of Microbial biotechnology

CO2: Develop the concept of industrial production of organic acids and amino acids.

CO3: Develop knowledge on commercial production of enzymes

CO4: Develop knowledge on commercial production of fermented beverages and dairy products

CO5: To understand the concept of production of single cell protein and Mushroom cultivation.

I	Scope of Microbial biotechnology; Microbial products as primary and secondary metabolites; Trophophase - Idiophase relationships in production of secondary metabolite; Role of primary and secondary metabolites in physiology of organisms; Pathways for the synthesis of primary and secondary metabolites of commercial importance **Metabolic control mechanisms:** substrate induction; catabolic regulation; feedback regulation; amino acid regulation of RNA synthesis
sII	**Organic acids**: Citric acid; Acetic acid, Lactic acid, Gluconic acid, Kojic acid and itaconic acid **Amino acids**: Use of amino acids in industry; methods of production; Production of some amino acids (L-Glutamic acid; L-Lysin; L-Tryptophan)
III	**Enzymes production and commercial applications**: Amylases; Glucose Isomerase; L-Asparaginase, Proteases Renin; Lactases; Pectinases; Lipases Vitamins production: Vitamin B_{12}, Riboflavin Antibiotics production: Streptomycin, Rifampicin
IV	**Fermented beverages**: Production of wine, beer and sake **Fermented foods**: soya sauce, koji, tempeh, sauerkraut **Fermented dairy products**: Buttermilk, yogurt, acidophilus milk, bulgarian milk, cheeses
V	**Single cell protein**: Microorganisms used; raw material used as substrate; condition for growth and production; nutritive value and uses of SCP **Mushroom production**: Cultivation of different types of edible mushroom and their nutritional values (*Agaricus, Pleuoratus; Calocybe* and *Volveriella*) Cultivation of medicinal mushroom (*Ganoderma*)and its therapeutic uses Diseases of mushrooms and storage methods of mushroom (drying and canning) Properties, beneficial effects and production of probiotic and prebiotic Bioplastics (PHB; PHA)

MBT DSE402: Practical based on MBT DSE 401 (Microbial Biotechnology)

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BIOTECHNOLOGY (M.SC.) DETAILS OF THE CBCS SYLLABUS

Semester IV

MBT DSE401 : Advanced Plant and Agriculture Biotechnology (5 credits)

COURSE OUTCOME

After completion of the course, the students will:

CO1: Understand the concept of biotechnology for crop improvement

CO2: Develop the concept of protoplast technology

CO3: Understand the application of genetic engineering in crop improvement

CO4: Understand the concept of metabolic engineering

CO5: Understand the application of plant tissue culture as a source of medicine

I	Biotechnology for Crop Improvement. Conventional methods for crop improvement (Pedigree breeding, Heterosis breeding, Mutation breeding) Tissue culture in crop improvement, Micropropagation for virus-free plants, Somaclonal variation, Somatic hybridization, Haploids in plant breeding
II	**Protoplast technology**: isolation, culture and fusion, viability testing; Selection of hybrid cells and regeneration of somatic hybrid plants; Symmetric and asymmetric hybrids; cybrids
III	**Application of transgenic plants for productivity and performance**: tolerance to herbicides, drought, salt and diseases Genetic engineering for increasing crop productivity by manipulation of Photosynthesis, Nitrogen fixation **Anti-sense RNA technology**: Mechanism and applications Golden rice technology
IV	Genetic engineering for quality improvement of Protein, lipids, carbohydrates, vitamins **Secondary metabolites**: Historical and current views; importance in agriculture **Metabolic engineering and industrial products**: Flavonoid, Terpenoid, Polyketoid
V	**Plant tissue culture as source of medicines**: Plant tissue culture for enhancing secondary metabolite production (*Withania somnifera*, *Rauwolfia serpentina*, *Catheranthus roseus*); Anticancer, Anti-inflammatory, Antidiabetic **Transgenics**: possible risks and benefits; Current global status of transgenic crops

MBTDSE 402: Practical based on MBT DSE 401 (Advanced Plant and Agriculture Biotechnology)

BIOTECHNOLOGY (M.SC.) DETAILS OF THE CBCS SYLLABUS

Semester IV

MBT DSE401 : Food Biotechnology (5 credits)

COURSE OUTCOME

After completion of the course, the students will:

CO 1: Understanding the fundamental aspects of food and nutrition
CO 2: Critically understanding the principles, techniques of food processing
CO 3: Understanding the scope, technology and importance of functional foods
CO 4: Critically understanding the importance of evaluation of food quality and food safety management
CO 5: Understand the fermented foods and their spoilage mechanism

Units	Topics to be covered	No of Hours
I	**Fundamentals of Food and Nutrition** Introduction to food, nutrition, nutrient, malnutrition and balanced diet Nutrient requirement and recommended dietary allowances (RDA) Carbohydrates- classification, properties, functions and food sources of carbohydrates (sugar, starch, cellulose, glucans, hemicelluloses, gums, peptic substances & polysaccharides); recommended dietary allowances Lipids- classification, properties, functions and food sources of lipids; recommended dietary allowances Proteins- classification, properties, functions and food sources of proteins; recommended dietary allowances Vitamins and Minerals- functions, food sources; recommended dietary allowances	20
II	**Food processing and preservation** Scope and importance of food processing, Processing of cereals, pulses and oilseeds, Technology for improved process- baking, milk products, cheesemaking and alcohol production, Food preservation by heating (drying, osmotic dehydration, blanching, canning, Pasteurization & sterilization), freezing (refrigeration & freeze-drying), non-thermal preservation (ultra- filtration, microwave processing & irradiation), Chemical methods of preservation of foods- uses of sugar, salt, chemicals and antibiotics	15
III	**Functional foods** Nutraceuticals- types, processing of nutraceutical products, therapeutic applications, Pharma foods- diabetic foods (sugar free), confectionaries, sodium free, lactose free, phenylalanine free and fibre rich foods - nutritional implications, Dietary supplements- fortification of nutrients in the processed foods & other dietary supplements, hyper nutritious foods (protein powders), Fat free foods- PUFA oils n3, n6 fatty acids, fat free milk powder, low cholesterol oils and cholesterol free foods, Functional nano foods- benefits of nanotechnology for functional foods, Probiotics and prebiotics- sources and their health benefits	15
IV	**Food quality and safety management** Introduction, scope of food quality and food safety, food adulteration-	15

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	adulteration in different foods Evaluation of food quality- appearance, colour texture, viscosity, consistency, flavour defects and foreign matter Methods of identification of microbial contamination (bacteria, fungi & virus) of food, Methods of identification of toxic chemicals (food additives, food preservatives, pesticides, dyes, etc.) of food. Food standards and laws- national food safety and food standards regulations, prevention of food adulteration act, safety regulations of genetically modified foods	
V	**Microbial spoilage of various foods:** Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods. Cultural and rapid detection methods of food borne pathogens in foods. **Fermented foods** Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.	**10**
	Total	**75**

MBTDSE 402 Practical based on MBTDSE 401 (Food Biotechnology)

REFERENCE BOOKS

1. Swaminathan M.S. Dr. Hand Book of Food and Nutrition
2. Sumati R. Mudambi and M.V, Rajgopal. Fundamentals of Food and Nutrition
3. Nutrient Requirements and Recommended Dietary Allowances for Indians. National Institute of Nutrition, Indian Council of Medical Research, 2010
4. Aurand, L.W. and Woods, A.E. 1973. Food Chemistry. AVI, Westport
5. Birch, G.G., Cameron, A.G. and Spencer, M. 1986. Food Science, 3rd Ed. Pergamon Press, New York.
6. Fennema, O.R. Ed. 1976. Principles of Food Science: Part-I Food Chemistry. Marcel Dekker, New York
7. Meyer, L.H. 1973. Food Chemistry. East-West Press Pvt Ltd., New Delhi
8. Potter, N.N. 1978. Food Science. 3rd Ed. AVI, Westport
9. Fellows, P. and Ellis H. 1990. Food Processing Technology: Principles and Practice, New York
10. Jelen, P. 1985. Introduction to Food Processing. Prentice Hall, Reston Virginia, USA
11. Lewis, M.J. 1990. Physical Properties of Food and Food Processing Systems. Woodhead
12. Stanburry P.P. and Whitaker, A. 1984. Principles of Fermentation Technology Pergamon Press, Oxford UK
13. Rosenthal, I. 1991. Milk and Milk Products. VCH, New York
14. Warner, J.M. 1976. Principles of Dairy Processing. Wiley Eastern Ltd. New Delhi

15. Krammer, A. and Twigg, B.A. 1970. Quality Control for the Food Industry.3rd Edn. AVI, Westport

16. Pattee, H.E. Ed. 1985. Evaluation of Quality of Fruits and Vegetables. AVI, Westport

17. Ranganna, S. 1986. Handbook of Analysis and Quality Control for Fruits and Vegetable Products. Tata McGraw Hill, New Delhi

18. Joshi, V.K. and Pandey, A. Ed. 1999. Biotechnology. Food Fermentation, (2 Vol. set). Education Publ. New Delhi

19. Knorr, D. 1982. Food Biotechnology. Marcel Dekker, New York 20. Inteas Alli: Food Quality Assurance: Principles and practices, CRC Press LLC 21. Knechtes P.L.: Food Safety: Theory and Practice, Jones and Bartlett Learning, USA 22. R.A Garg: The Food Safety and Standard Act, 2006 along with Rules and regulation, (2011) Commercial Law Publisher (India) Pvt Ltd

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M.Sc. Biotechnology

Semester IV

MBT GE401 : Selected PG Courses from Swayam (05 credits)

Selected From SWAYAM PG Courses
• **The student can select any course from the available courses on SWAYAM portal * recommended by the Department.**

* Students will select SWAYAM course available at https://swayam.gov.in/explorer in consultation with Department.

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