Shri Sanjiv Kumar
OSD University
Raj Bhawan, Patna.

Sub:- Revision of MSc Biotechnology syllabus under CBCS Program for all the Universities of Bihar from session 2018-20.

A meeting was held in the conference hall at Raj Bhawan on 14.06.2018 for the final approval of MSc Biotechnology curriculum for its implementation in all the Universities of Bihar from session 2018-20 as per admission ordinance and examination regulation. Following experts were present.

(1) Prof. Dr. Awadh Kishor Roy (Convener)

(2) Dr. Birendra Prasad

(3) Dr. Narendra Srivastava

The curriculum of MSc Biotechnology was thoroughly discussed and approved in the light of the Ordinance and Regulations of Master in Biotechnology in the Faculty of Science. The curriculum of MSc in Industrial Microbiology is under preparation as it is not running in any Universities of Bihar. The Committee member feels that the curriculum of Industrial Microbiology is to be revised as per rules and regulation. The said curriculum will be finalized within fifteen days.

14.6.18 14/6/18 14/6

Revise Final Curriculum for M.Sc. Biotechnology (Choice Based Credit System) From Session 2018-20

Implementation in the State Universities of Bihar

1. Prof. A. K. Roy — Convenor
   Vice-Chancellor
   B.N. Mandal University, Madhepura

2. Dr. Birendra Prasad — Member
   Coordinator, PG Biotechnology
   Patna University

3. Dr. Narendra Srivastava — Member
   Associate Professor
   Deptt. of Zoology
   Presently Registrar
   B.N. Mandal University, Madhepura

14/06/2018

14/06

OUTLINE OF THE CHOICE BASED CREDIT SYSTEM (CBCS) for PG degree courses:

It consists of a number of courses i.e. **Core Course (CC), Elective Course (EC), Discipline Specific Elective Course (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.

1.1 Core Course (CC):

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.

1.2. Elective Course (EC):

Generally a course which can be chosen from a pool of courses (Basket) and which may be very specific or specialized or advanced or supportive to the subject/ discipline of study or which provides an extended scope or which enables an exposure to some other subject/discipline/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

1.3 Discipline Specific Elective Course (DSE):

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).

1.4 Generic Elective (GE) Course:

An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a **Generic Elective**.

1.5 Ability Enhancement Courses (AEC/SEC):

The Ability Enhancement Courses (AEC) / Skill Enhancement Courses (SEC). "AEC/SEC" is the courses based upon the content that leads to life skill enhancement.

1.6 Ability Enhancement Compulsory Courses (AECC):

University will run a number of **Ability Enhancement Compulsory Courses (AECC)** which is qualifying in nature and student from all faculties have to qualify in all such courses.

1.7 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 his/her own with mentoring support by a teacher / faculty member called the guide/ supervisor. In case of internship/ industrial training the student will work under the joint guidance of one teacher-supervisor from the parent department to be termed as Supervisor-1 and one suitably qualified personnel at the research institute/ research laboratory/ industrial organization, to be termed as Supervisor-2. A student may join any recognized research institute/ research laboratory/ the industrial organization with the approval of parent department. The student has to work for a minimum number of days/ hour 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 both supervisors to the parent department. Supervisor-2 will issue a letter certifying that the candidate has successfully completed the project and also award marks/ grade to him/ her. The certificate will be submitted to the parent department confidentially. The Board of Courses of Studies (BOCS) of the concerned subject/ department will draft and design the certificate and other documents as per requirement. 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.

2.0 CREDIT

The total minimum credits, required for completing a PG program is 100.

The details of credits for individual components and individual courses are given in Table.1.

14/6

Table 1: Structure of the 2 Yrs (Four Semesters) Post Graduate Degree course under CBCS:

Semester	No of COURSE / Papers	Credit per COURSE/ paper	Total credit	Minimum No of Learning Hours#	No of CORE COURSE/ PAPER	No of ELECTIVE Course/ PAPER	Code & Nature of Elective Course/ paper
I	05	05	25	250	4	1	AECC-1
SEMESTER BREAK							
II	06	05	30	300	5	1	AEC-1
SEMESTER BREAK							
III	06	05	30	300	5	1	AECC-2
SEMESTER BREAK							
IV	03	05	15	150	0	3	EC -1* EC -2* DSE-1 or GE-1
Total	**20**		**100**	**1000**	**14**	**6**	

#For Tutorial (T)/ Practical (P)/ Field Work (FW)/ Internship etc. extra working hour to be added as per requirement and will be decided by the BOCS of the respective subject.

* The two **Elective Courses (EC)** to be studied in semester IV may be

One Theory paper and One Practical paper

/One Theory paper and One Project work

/ Both Project work/ Internship

IMP : It is desirable that all students of all courses be given adequate exposure over and above the class room teaching to enhance the scope of skill development/ entrepreneurship and employability.

2.1. There shall be six elective courses - two EC, one DSE or one GE, two AECC, one AEC/SEC. Students may opt for any elective course out of a list of elective papers **(Basket)** offered

by the parent department or any other department/s as per his/her choice with the prior permission of the parent department. The list of elective papers, syllabus and prerequisite of the elective course will be as decided by the Board of Courses of Studies (BOCS) of the concerned subject/ department. All elective course listed may not be available in all semesters. Based on the availability of resource persons and infrastructure the parent department will assist the students to select elective courses of their choice.

2.2. The final CGPA/ class will be decided on the performance of the student in the 16 courses / papers including the 14 Core Courses (CC) / papers and two Elective Courses (EC)/ papers.

2.3. The one DSE or one GE, two AECC, one AEC/SEC papers will be qualifying in nature and a student has to score at least 45% marks in these papers. Grade will be awarded separately for these courses, however, performance in these elective courses/ papers will not be considered for awarding the final CGPA/ class.

2.4. **Ability Enhancement Compulsory Courses (AECC):**

University will run two **Ability Enhancement Compulsory Courses (AECC)** which are qualifying in nature and a student has to qualify in both these courses. The courses are:

AECC-1
Environmental Sustainability (3 Credit) & Swachchha Bharat Abhiyan Activities (2 Credit)
AECC-2
Human Values & Professional Ethics (3 credits) and Gender sensitization (2 credits)

Students will do assignments/project work related to institutional social responsibilities including Swachchha Bharat Abhiyan activities during SEMESTER BREAK.

2.5. University will run a number of **Ability Enhancement Courses** (AEC)/ **Skill Enhancement Courses** (SEC); a student can choose one from these. For example:

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

- Computers and IT Skill
- 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

etc.

14.6

2.6 Discipline Specific Elective (DSE):

In each subject the **CC-5** being taught in the **second semester** will be open to be selected as a DSE paper. In the first phase a student will be allowed to choose a paper from any subject other than his/ her Core Course (CC) from the same faculty in the same university.

2.7 Generic Elective (GE) Course:

University will run a number of **Generic Elective Courses** (GE); a student can choose one from these. For example:

Basket of Generic Elective (GE) courses

- Music
- Dramatics
- Fine Arts
- Graphic Design
- Inclusive Policies
- Human Rights
- Any such course run by any department

Name of the Programme: M.Sc. Biotechnology (CBCS

(Code-MBT)
(Four Semesters Programme)

PROGRAM OBJECTIVES:

1. To promote interest, participation and commitment in the field of Biotechnology.
2. To acquire competencies in theoretical as well as experimental Biotechnology in order to enhance knowledge in the applied aspect of the subjected related to the welfare/development of society.
3. To strengthen aptitude for research in bio-science at molecular level and its interdisciplinary areas.
4. To prepare the students to successfully compete for employment in academia, agriculture, horticulture and need based industry.
5. To help students to develop integrity and objectivity and disseminate the knowledge for scientific, economic and social benefit, hence contributing towards national and global development.

Course Structure for M.Sc. Biotechnology (Choice Based Credit System) for Session 2018-20

emester	Course/ Paper Code	Nature of Course/ Paper	Credit	Marks	Marks of CIA	Marks of ESE	Passing criterion	Qualifying Criterion
SEMESTER I	MBTCC-1	Cell & Molecular Biology and Genetics	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-2	Microbiology	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-3	Biomolecule and Basic Enzymology	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-4	Practical (Based on BIOCC 1, 2 & 3)	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTAECC-1	One Ability Enhancing Elective course selected from Basket	5	100	50	50	45% in CIA 45% in ESE	Qualifying
SEMESTER II	MBTCC-5	Biofertilizer and Mushroom Technology	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-6	Biophysics and Instrumentation	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-7	Biology of Immune System	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-8	Bioprocess Technology	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-9	Practical (Based on BIOCC 5, 6, 7 & 8)	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTAEC-1 /SEC-1	One selected from basket	5	100	50	50	45% in CIA 45% in ESE	Qualifying
SEMESTER III	MBTCC-10	Biostatistics and Bioinformatics	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-11	Recombinant DNA Technology	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-12	Plant and Animal Biotechnology	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-13	Environmental Biotechnology	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTCC-14	Practical (Based on BIOCC 10, 11, 12 & 13)	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTAECC-2	Human Values & Professional Ethics and Gender sensitization	5	100	50	50	45% in CIA 45% in ESE	Qualifying
SEMESTER IV	MBTEC-1	Subject specific elective	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTEC-2	Subject specific elective	5	100	30	70	45% in CIA 45% in ESE	Marks decide class/ CGPA
	MBTDSE-1	Opt a Course from other Department	5	100	30	70	45% in CIA 45% in ESE	Qualifying

M.Sc. Biotechnology
(Semester-I)

MBTCC -1: Cell & Molecular Biology and Genetics (5 Credits)

Time: 3hrs Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Cell & Molecular Biology and Genetics (5 Credits)	
Unit I	**Cell Biology:** Diversity of cell; Cell organization, sub-cellular structure of prokaryotic and eukaryotic cells; Organelle biogenesis; Synthesis and sorting of plasma membrane, Transport of nutrient ions and macromolecule across cell membranes; Signal transduction and regulation 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
Unit II	**DNA replication in prokaryotes and eukaryotes:**DNA replication models; DNA polymerases- mode of action; RNA polymerases and reverse transcriptase; Enzymes and proteins involved in DNA replication (methylases, demethylases, DNases, DNA gyrase, Topoisomerase) **DNAdamage and repair mechanism:** Different types of DNA damage and repair mechanisms; Diseases caused due to impairment in repair mechanism **Gene transfer mechanisms in prokaryotes**: Transformation, conjugation, transduction and transfection
Unit III	**Transcription:** Concept of template surfaces, Transcriptions, Post-transcriptional processing and transport of RNA, Regulation of transcription, Transcription factors; Structures and function of ribonucleoproteins, SiRNA, MiRNA **Translation:** Genetic code; Prokaryotic and eukaryotic translation, regulation of translation, co- and post translational modifications of proteins **Gene expression and regulation:** Operons and regulons, repression and activation of *Lac* and *Trp* operons, feed back inhibition; Regulation of eukaryotic gene expression
Unit IV	**Antisense technology:** Molecular mechanism of antisense molecules, application of antisense technologies. **Mutation and Mutagenesis:** Molecular basis of mutations; mutagens; Spontaneous and induced mutation; Ames test for mutagenesis; Biochemical mutation; One gene-one enzyme hypothesis. **Transposons:** Structure and types of transposons (Prokaryotic and Eukaryotic); Mechanism of transposition (replicative and non-replicative); Application of transposon
Unit V	**Extrachromosomal inheritance:**Cytoplasmic inheritance in plants and animals; Genome organization of Mitochondria and Chloroplast **Sex determination:**Sex determination in dioecious plant (*Melandrium, Coccinia*) and animals (*Drosophila*, human beings); Sex link, Sex limited and Sex influenced inheritance; Sex differentiation **Population Genetics:** Hardy-Weinberg equilibrium; Gene and genotypic frequencies

14/6

M.Sc. Biotechnology
(Semester-I)

MBTCC -2: Microbiology (5 Credits)

Time: 3hrs

Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Microbiology (5 Credits)	
Unit I	General introduction; History and scope of microbiology; theory of spontaneous generation. **Methods of microbiology**: Sterilization-Different types of sterilization (moist heat, dry heat, filtration, radiation and chemicals); Microbiological Media: types and significance; techniques of 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; Whittaker's five kingdoms and Woese *et al* 's three domains; morphological, physiological, biochemical and molecular criteria for the classification of bacteria (scheme not required); Nutritional classification of microorganisms
Unit II	**Diversity of microorganisms:** Bacteria- purple and green bacteria, cyanobacteria, homoacetogenic bacteria, gliding and sheathed bacteria, lactic acid bacteria, endospore forming rods and cocci, chlamydias and mycoplasma Archea- Concept of Archea, halophiles, acidophiles, thermophiles, methanogenes **Structure of bacteria:** Ultra structure of Gram positive and Gram negative bacteria with special reference to cell membrane, cell wall, flagella, capsule and slime layer, genome, ribosome, plasmid and endospores; Biosynthesis of peptidoglycan
Unit III	**Eukarya**- Fungi, slime mold and protozoa **Viruses**- A general idea of structure of different kinds of viruses; Plant viruses: tobacco mosaic virus; structure of bacteriophages belonging to 'T' series; Lytic cycle and its regulation; lysogeny and its regulation in lambda phage Prions and viroids: Recent development in research
Unit IV	**Host-parasite relationships:** Entry of pathogens into the host, colonization and factors predisposed to infections; types of toxins (Exo-, endo- and entero-) and their structure, mode of action, virulence and pathogenesis **Microbial diseases:** Overview of microbial diseases; diseases caused by Gram positive cocci - pneumonia; diseases caused by Gram negative cocci - gonorrhea; diseases caused by Gram positive bacilli - tuberculosis, tetanus; diseases caused by Gram negative bacteria of family Enterobacteriaceae - enteric fever; diseases caused by other Gram negative bacilli - cholera; sexually transmitted diseases; AIDS
Unit 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

1416

M.Sc. Biotechnology
(Semester-I)

MBTCC-3: Biomolecule and Basic Enzymology (5 Credits)

Time: 3hrs

Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Biomolecule and Basic Enzymology (5 Credits)	
Unit 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)
Unit 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
Unit 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.
Unit 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
Unit 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

M.Sc. Biotechnology
(Semester-I)

MBTCC-4: Practical based on MBTCC 1, 2 & 3 (5 Credits)

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

M.Sc. Biotechnology
(Semester-II)

MBTCC-5: Biofertilizer and Mushroom Technology) [5 Credits]

Time: 3hrs Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Biofertilizer and Mushroom Technology [5 Credits]	
Unit 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
Unit 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 endomycorrhizae and their importance in agriculture. Isolation of AM fungi - Wet sieving method and sucrose gradient method. Mass production of AM inoculants and field applications.
Unit 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
Unit IV	Mushroom Technology - Introduction, History and Scope - Edible and Poisonous Mushrooms. Life cycle of mushroom: Vegetative and reproductive phase (Formation and development of Basidiocarp, structure of basidiocarp), Importance and nutritive value of edible mushrooms
Unit 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

M.Sc. Biotechnology
(Semester-II)

MBTCC-6: Biophysics and Instrumentation (5 Credits)

Time: 3hrs Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Biophysics and Instrumentation (5 Credits)	
Unit 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
Unit II	**Chromatography:** Principles, types (Paper, TLC, Affinity, Ion-exchange, Gel filtration, GLC, HPLC) and their applications
Unit III	**Centrifugation:** Principles, types; Differential and density gradient centrifugation; Applications of centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods
Unit IV	**Microscopy**: Simple Microscope; Compound Microscope; Stereomicroscope; Phase-contrast and Fluorescence microscopes; Electron Microscope-TEM and SEM; Confocal Microscope Autoradiography; Flow cytometry
Unit 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

M.Sc. Biotechnology
(Semester-II)

MBTCC-7: Biology of Immune system (5 Credits)

Time: 3hrs Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Biology of Immune system (5 Credits)	
Unit 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
Unit II	**Antigens**: Properties of antigens; superantigens; haptens, adjuvants **Antibody**: Classes, structure and function; Immunoglobulin superfamily; Generation of antibody diversity
Unit 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
Unit 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
Unit 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

14/6

M.Sc. Biotechnology
(Semester-II)

MBTCC-8: Bioprocess Technology (5 Credits)

Time: 3hrs Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Bioprocess Technology (5 Credits)	
Unit I	Industrially important microbes and their application; Chronological development of fermentation industry. Isolation andpreservation 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
Unit 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
Unit 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.
Unit IV	**Downstream processing**: Removal of microbial cells and solid matter, foam separation, precipitation, filtration, centrifugation, liquid-liquid extraction, chromatography, drying and crystallization
Unit 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 **Production of secondary metabolites**: Penicillin

14/6

M.Sc. Biotechnology
(Semester-II)

MBTCC-9: Practical based on MBTCC 5, 6, 7 & 8 (5 Credits)

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, Purity determination and quantification of DNA by UV method
8. The ultraviolet absorption of proteins and amino acids.
9. Estimation of protein by E280/E260 method.
10. Blood smear identification of leucocytes by Giemsa stain
11. Separation of leucocytes by dextran method
12. Demonstration of Phagocytosis of latex beads
13. Separation of mononuclear cells by Ficoll-Hypaque
14. Blood grouping test
15. Ouchterlony immuno diffusion,
16. Radial Immuno diffusion
17. Immuno-electrophoresis
18. Antibody titre by ELISA method.
19. Isolation and purification of IgG from serum or IgY from chicken egg.
20. Immunodiagnostics using commercial kits
21. Isolation and screening of industrially important microorganisms.
22. Determination of oxygen transfer rate and volumetric oxygen mass transfer coefficient (KLa) under variety of operating conditions in shake flask and bioreactor.
23. Production of microbial products in bioreactors.
24. Production and purification of various enzymes from microbes.
25. Comparative studies of Ethanol production using different substrates.
26. Microbial production and downstream processing of an enzyme, e.g. amylase
27. Microbial production of citric acid and its estimation
28. Production and assay of antibiotics by disc diffusion method

M.Sc. Biotechnology
(Semester-III)

MBTCC-10: Biostatistics and Bioinformatics (5 Credits)

Time: 3hrs Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Biostatistics and Bioinformatics (5 Credits)	
Unit 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
Unit II	Concept of Probability, Addition and Multiplication theorem **Probability distribution**: Binomial, Poisson and Normal distribution
Unit 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
Unit IV	**Introduction:** definition & scope of bioinformatics.terminologies, types of format, 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
Unit V	Pair wise sequence comparison, Multiple sequence alignments sequence queries., multifunctional tools for sequence analysis; Phylogenetic analysis

14/6

MBTCC-11: Recombinant DNA Technology (5 Credits)

Time: 3hrs

Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Recombinant DNA Technology (5 Credits)	
Unit 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
Unit 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
Unit 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)
Unit 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 Microarray and its applications
Unit 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

14/6

M.Sc. Biotechnology
(Semester-III)

MBTCC-12: Plant and Animal Biotechnology (5 Credits)

Time: 3hrs Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Plant and Animal Biotechnology (5 Credits)	
Unit 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
Unit II	Micropropagation techniques, its application and limitations; Production of virus free plants Production and exploitation of haploids and triploids Somaclonal variations: applications and limitations
Unit III	Protoplast isolation and culture techniques; testing of viability of isolated protoplasts; Osmotimum 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
Unit 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
Unit 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 Transgenic animals, Methods for generating knockout mice Cell culture based vaccines **Hybridoma technology**: Hybridoma technology and production of Monoclonal antibody and its applications

14/6

M.Sc. Biotechnology
(Semester-III)

MBTCC-13: Environmental Biotechnology [5 Credits]

Time: 3hrs Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Environmental Biotechnology [5 Credits]	
Unit I	**Biogeochemical cycling:** carbon, nitrogen and sulfur cycle **Environmental problems**- Ozone depletion, green house 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
Unit 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
Unit 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)
Unit 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)
Unit 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

1416

MBTCC-14: Practical based on MBTCC 10, 11, 12 & 13 (5 Credits)

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
12. Agarose gel electrophoresis and restriction digestion of DNA
13. Demonstration of technique of PCR
14. Endonuclease digestion of DNA and analysis of DNA fragments by agarose electrophoresis
15. Ligation process
16. Preparation of plant tissue culture media.
17. Surface sterilization.
18. Organ culture.
19. Protoplast isolation and culture.
20. Anther culture: production of haploids
21. Artificial seed preparation
22. 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
33. Preparation of proposal for patenting.

1416

M.Sc. Biotechnology
(Semester-IV)

In M.Sc. Biotechnology following two patterns may be adopted

1. **Option 1**

MBTEC-1: Microbial Biotechnology or Advanced Plant and Agriculture Biotechnology

MBTEC-2: Practical based on MBTEC-1

2. **Option 2**

MBTEC-1 and MBTEC-2 act as a Project dissertation and Viva-voce having 200 marks (10 Credits)

M.Sc. Biotechnology
(Semester-IV)

MBTEC-1:Microbial Biotechnology [5 Credits]

Time: 3hrs Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Microbial Biotechnology [5 Credits]	
Unit I	Scope of Microbial biotechnology; Microbial products as primary and secondary metabolites; Trophophase-Ideophase 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
Unit II	**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)
Unit 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
Unit 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
Unit 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)

M.Sc. Biotechnology
(Semester-IV)

MBTEC-1: Advanced Plant and Agriculture Biotechnology
[5 Credits]

Time: 3hrs

Marks: 70

The question paper will consist of 7 questions divided into 3 sections.
Section A: Question No.1 will be compulsory comprising ten objective types questions (two from each Unit) each carrying two marks (10x2=20 marks).
Section B: Question No. 2 will also be compulsory and comprise five short answer types questions (one from each Unit) and students will have to attempt only four questions (4 x 5=20marks).
Section C: Five long answer types questions are to be set (one from each Unit) of which any three questions are to be answered (3 x 10=30 marks).

Advanced Plant and Agriculture Biotechnology (5 Credits)	
Unit I	Biotechnology for Crop Improvement. Conventional methods for crop improvement (Pedegree breeding, Heterosis breeding, Mutation breeding) Tissue culture in crop improvement, Micropropagation for virus-free plants, Somaclonal variation, Somatic hybridization, Haploids in plant breeding
Unit II	**Protoplast technology**: isolation, culture and fusion, viability testing; Selection of hybrid cells and regeneration of somatic hybrid plants; Symmetric and asymmetric hybrids; cybrids
Unit 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
Unit 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**: Flavanoid, Terpenoid, Polyketoid
Unit V	**Plant tissue culture as source of medicines**: Plant tissue culture for enhancing secondary metabolite production (*Withania somnifera*, *Rauwolfia serpentina*, *Catheranthus roseus*, *Andrographis paniculata*); Anticancer, Anti-inflammatory, Antidiabetic, Analgesic drugs **Transgenics**: possible risks and benefits; Current global status of transgenic crops

MBTEC-2: Practical based on MBTEC-1

1416