Department of Microbiology
Mohanlal Sukhadia University
Udaipur, Rajasthan

M.Sc. (CBCS) Microbiology
Syllabus as per the National Education Policy

M.Sc. (CBCS) Microbiology: Course structure

Level	Sem	Course Type	Course Code	Course Title	Delivery Type			Total Hours	Credit	Total Credit	Internal Assessment	EoS Exam	M.M.	Remarks
					L	T	P							
8	I	DCC	MBY8000T	IMMUNOLOGY AND ENZYMOLOGY	L	T	-	60	4	24	20	80	100	
			MBY8001T	CELL BIOLOGY AND MOLECULAR GENETICS	L	T	-	60	4		20	80	100	
			MBY8002T	FUNDAMENTALS OF MICROBIOLOGY	L	T	-	60	4		20	80	100	
			MBY8003T	BIOMOLECULES AND METABOLISM	L	T	-	60	4		20	80	100	
			MBY8004P	IMMUNOLOGY AND CELL BIOLOGY LAB	-	-	P	120	4		20	80	100	
			MBY8005P	MICROBIOLOGY AND BIOMOLECULES LAB	-	-	P	120	4		20	80	100	
	II	DCC	MBY8006T	MOLECULAR BIOLOGY	L	T	-	60	4	24	20	80	100	

		MBY8007T	RECOMBINANT DNA TECHNOLOGY AND ITS APPLICATIONS	L	T	-	60	4		20	80	100	
		MBY8008T	AGRICULTURAL MICROBIOLOGY AND MICROBIAL ECOLOGY	L	T	-	60	4		20	80	100	
		MBY8009P	MOLECULAR BIOLOGY AND RDT LAB	-	-	P	120	4		20	80	100	
		MBY8010P	AGRICULTURAL AND MICROBIAL PHYSIOLOGY LAB	-	-	P	120	4		20	80	100	
	GEC	MBY810XP	0. INSTRUMENTATION AND ANALYTICAL TECHNIQUES LAB 1. APPLICATION OF BIOINFORMATICS IN BIOLOGICAL SCIENCES LAB 2. 3.	-	-	P	120	4		20	80	100	
Exit with PG Diploma in Microbiology													
9	III	DCC	MBY9011T	INDUSTRIAL MICROBIOLOGY	L	T	-	60	4	24	20	80	100	
			MBY9012T	MICROBIAL PHYSIOLOGY AND METABOLISM	L	T	-	60	4		20	80	100	
		DSE	MBY910YT	4. FOOD AND DAIRY MICROBIOLOGY 5. MICROBIAL GENETICS 6. 7.	L	T	-	60	4		20	80	100	

			MBY911ZT	8. ENVIRONMENTAL MICROBIOLOGY 9. MEDICAL MICROBIOLOGY 10. 11.	L	T	-	60	4		20	80	100	
			MBY912UP	12. INDUSTRIAL TECHNIQUES, FOOD AND ENVIRONMENTAL LAB 13. MICROBIAL GENETICS AND MEDICAL MICROBIOLOGY LAB 14. 15.	-	-	P	60	4		20	80	100	
		GEC	MBY913VT	16. BIOINFORMATICS & BIOSTATISTICS 17. BIOSAFETY, BIOETHICS AND IPR 18. 19.	L	T	-	60	4		20	80	100	
	IV		MBY914XS	MAJOR RESEARCH PROJECT/INDUSTRIAL TRAINING	-	-	-	600	24	24	120	480	600	Minimum 30hrs /week

Exit with PG Degree in Microbiology

M. Sc. (CBCS) Microbiology

Total Seats: 20
(All Self Finance Seats)

Eligibility: B.Sc. with a minimum of 48% marks. Candidates from outside the state of Rajasthan should possess a minimum of 60% marks to seek admission.

(A). Candidate should have studied any two of the following subjects for at least two years at the under graduate level: Botany, Zoology, Chemistry, Microbiology, Biochemistry and Biotechnology.

or

(B). Candidates with B.Sc. in Life Sciences disciplines (Biotechnology, Genetics, Microbiology, Biochemistry, Biomedical Science, Genetic engineering, Genetics, Agriculture, Biosciences, Food Science, Food Technology, Forensic Science, B. Pharma, BDS, B.Sc. Nursing, BMLT and other relevant subjects) are also eligible for admission.

SYLLABUS

M. Sc. MICROBIOLOGY SEMESTER –I (2023-24)
DCC Course (MBY8000T)

Code of the course: MBY8000T

Title of the course: IMMUNOLOGY AND ENZYMOLOGY

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge basic immunology and enzymology learn at School level and lay foundation for further learning of the subject through first course on Immunology and Enzymology which is a prerequisite for higher courses in Microbiology.

Course Outcome:

Upon completion of this course, the students will able to:

- Understand the role of the immune system, its organization and function.
- Develop immunological concepts and methods to diagnose immune disorders.
- Learn the mechanism of action and kinetics of enzyme.

Syllabus:

DCC Course (MBY8000T)

IMMUNOLOGY AND ENZYMOLOGY (THEORY)
(Credits:4, Hours: 60)

UNIT I **Credit hours: 12**

Innate and acquired immunity, clonal nature of the immune response. Immune system: primary lymphoid organs, secondary lymphoid organs. Cells of the immune system: B-lymphocytes, T-lymphocytes, Macrophages, Natural killer, Lymphokine activated killer cells. Haptens and adjuants. Nature of antigens, Antibody: types structure and function, Abzymes, Antigen-antibody reactions.

UNIT II **Credit hours: 12**

Antigen processing and presentation. Major histocompatibility Complex, complement system. Regulation of the immune response, activation of B and T-lymphocytes, cytokines, T-cell regulation, MHC restriction, Immunological tolerance. Hybridoma technology and monoclonal and polyclonal antibodies. Autoimmunity, Hypersensitivity reactions and Organ transplantation.

UNIT III **Credit hours: 12**

Classification of Enzymes, Mechanism of Enzyme Action; Concept of active site and energetics of enzyme substrate complex formation; Specifically of enzyme action; Kinetics of single substrate reactions; turnover number; estimation of Michaelis-Menten parameters, multi-substrate reactions-mechanism and kinetics; Types of inhibition-kinetic models; Substrate and Product Inhibition; Allosteric regulation of enzyme; Deactivation kinetics.

UNIT IV **Credit hours: 12**

Physical and Chemical methods used for cell disintegration. Enzyme fractionation by precipitation (using temperature, salt, solvent, pH, chemicals), Liquid-liquid extraction, ionic exchange, Gel Chromatography, Affinity chromatography and other special purification methods. Isozymes, Coenzymes, Ribozymes.

UNIT V **Credit hours: 12**

Physical and Chemical techniques for enzyme immobilization-adsorption, matrix entrapment, encapsulation, cross linking, covalent binding. Advantages and disadvantages of different immobilization techniques, overview of application of immobilized enzyme systems. Enzyme crystallization techniques. Commercial applications of enzymes in food, pharmaceutical and other industries.

Recommended Books:

1. Harvey W. Blanch, Douglas S. Clark, “Biochemical Engineering”, marcel Dekker, Inc.
2. James M. Lee, “Biochemical Engineering”, PHI, USA.
3. James, E. Bailey & David F. Ollis, “Biochemical Engineering fundamentals”, McGraw-Hill.
4. Wiseman, “Enzyme Biotechnology”’ Ellis Horwood Pub.
5. Kuby, J. “Immunology”. W. H. Freeman and Company.
6. Roitt, Brostoff, Male and Mosby, Immunology.
7. Palmer, T. Understanding Enzymes.
8. Coleman, R.M. Fundamental Immunology. McGraw Hill.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

M. Sc. MICROBIOLOGY SEMESTER –I (2023-24)

DCC Course (MBY8001T)

Title of the course: CELL BIOLOGY AND MOLECULAR GENETICS

Level of the Course: NHEQF Level 6

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of cell biology and molecular biology learn at School level and lay foundation for further learning of the subject through the course on cell biology and molecular genetics which is a prerequisite for higher courses in Microbiology.

Course Outcome:

Upon completion of this course, the students will able to:

- Get a strong foundation on the basic unit of life and functions of cell
- Understand genetics and relate modern DNA technology for disease diagnostics and therapy.

Syllabus:

DCC Course (MBY8001T)

CELL BIOLOGY AND MOLECULAR GENETICS (THEORY)

(Credits:4, hours: 60)

Unit I **Credit hours: 12**

Comparison of prokaryotic and eukaryotic cells, cell wall, ultrastructure of plasma membrane, Nucleus: nuclear membrane, nucleolus and nuclear pore complex, Cytoskeletal elements, Mitochondria and chloroplast- structure and evolution, Mitochondria and male sterility, Lysosomes, Peroxisomes, glyoxysomes, Sub cellular organisms: Viruses and Prions.

Unit II **Credit hours: 12**

Cell-Cell Interactions: General principles of cell to cell communication, Cell Signaling: Signaling via G- Protein- linked cell surface receptors and via enzyme- linked cell surface receptors; Cell cycle events, regulation of cell division: cyclins, cyclin-dependent kinases, control of cell division in multicellular organisms; Transport across biomembrane, endocytosis and exocytosis.

Unit III **Credit hours: 12**

Mendelian genetics – Laws of inheritance; Gene interaction: modification of mendelian ratios; Linkage and crossing over, linkage map; Tetrad analysis; Chromatin; structure, types organization and chemistry of the chromosome. C-value paradox, Nuclear dyes and their application in staining of chromosomes. Polytene, Lambrush and B-chromosomes.

Unit IV **Credit hours: 12**

Genetic recombination at molecular level (Holliday model). Role of RecA protein in recombination, Mutation: spontaneous and induced mutations, Physical and chemical mutagenesis. Numerical and structural changes in chromosomes, Karyotyping, Pedigree analysis; Sex-linked inheritance: sex limited and sex influenced inheritance, Conceptual basis: Mechanism of sex determination in plants and animals.

Unit V **Credit hours: 12**

Transposons: Types, structure, properties and their significance. Mechanism of transposition, transposon mutagenesis. Integrons, Insertion sequences (IS), Composite transposons. Replicative and non-replicative transpositions. Role of transposase and resolvase. Examples of Transposable elements, Retrotransposon.

Recommended Books:

1. Alberts, B., Bray, D. Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell. Garland Publishing Co. New York, USA.

2 Gasque, E. Manual of Laboratory experiments in cell Biology. W.C. Wilson Public.

3. Robertis, E.D.P., Robertis, E.M.F. Cell and Molelcular Biology. Sauder College Publication.

4. Beeker, W.M. The world of the cell. Pearson Education.

5. Karp, G. Cell and Molecular Biology. John Willey and sons.

6. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.

7. Snustad, D.P. and Simmons, M.J. 2000. Principles of genetics. John Wiley and Sons.

8. Russel, P.J. 1998. Genetics. The Benjamin/Cumming Publishing Co.

9.Gardner et al. Principles of Genetics. John Wiley

10. Griffiths et al. An Introduction to Genetic Analysis Freeman.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

M. Sc. MICROBIOLOGY SEMESTER –I (2023-24)

DCC Course (MBY8002T)

Code of the course: MBY8002T

Title of the course: FUNDAMENTALS OF MICROBIOLOGY

Level of the Course: NHEQF Level 6

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Forty Lecture plus Twenty Tutorial

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of microbiology learn at School level and lay foundation for further learning of the subject through the course on fundamentals of microbiology which is a prerequisite for higher courses in Microbiology.

Course Outcome:

Upon completion of this course, the students will able to:

- Throws light on types of microorganisms in and around humans
- Understanding on the concept of culturing microbes, sterilization techniques andestimating number of microbes in given sample

Syllabus:

DCC Course (MBY8002T)

FUNDAMENTALS OF MICROBIOLOGY (THEORY)

(Credit: 4, Hours: 60)

Unit-I **Credit hours: 12**

History, introduction and scope of Microbiology. Types of microorganisms, their general characteristics and significance. Kingdom and domain system of classification, Bacterial nomenclature and taxonomy. Bergey's manual of systematic bacteriology.

Unit-II **Credit hours: 12**

Archaea: General characters, classification, economic and ecological significance: differences and similarities with bacteria. Virus: Structural organization, classification, multiplication and transmission. Mycoplasma, General characters, reproduction and transmission. Some important diseases caused by viruses and mycoplasma.

Unit-III **Credit hours: 12**

Bacteria: Ultrastructure, Morphological types, arrangement, Structure and function of Capsule, Cell membrane, flagella and pili. Cell wall: types, structural organization, Significance of LPS and role in pathogenicity. Nucleoid, Plasmids and Bacterial endospores. Applications of bacteria as probiotics and in bioremediation. Some important diseases caused by the bacteria.

Unit-IV **Credit hours: 12**

Physical and chemical methods of sterilization. Isolation and development of pure culture. Techniques of microbial culture, Anaerobic culture. Nutritional requirement for growth, Physical requirements for growth. Culture media; types, composition, preparation. Enumeration of microbes.

Unit V **Credit hours: 12**

Principles of Staining, Nature of dyes and types of staining; Maintaining and preservation of cultures, Selective culture methods, Characterization and identification of microbes based on morphology, cultural physiological and biochemical characteristics, serology and molecular methods of identification.

Recommended Books:

1. Tortora GJ, Funke BR, and Case C.L. (2004). *Microbiology*: *An Introduction.* 4th edition. Pearson Education.
2. Atlas RM. (1997). *Principles of Microbiology*. 2nd edition. WM.T. Brown Publishers.
3. Cappucino J and Sherman N. (2010). *Microbiology: A Laboratory Manual*. 9th edition. Pearson Education limited.
4. Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th edition. Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). *Microbiology*. 5th edition. McGraw Hill Book Company.
6. Dubey, R.C. and Maheshwari, D.K. A Text Book of Microbiology. S. Chand and Company.
7. Prescott, H. and Klein. 2000. Microbiology. McGraw Hill.

E-Resources

1. https://www.khanacademy.org/
2. https://unacademy.com/
3. https://swayam.gov.in/
4. https://hstalks.com/
5. https://nptel.ac.in/courses

M. Sc. MICROBIOLOGY SEMESTER –I (2023-24)

DCC Course (MBY8003T)

Code of the course: MBY8003T

Title of the course: BIOMOLECULES AND METABOLISM

Level of the Course: NHEQF Level 6

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of biochemistry learn at School level and lay foundation for further learning of the subject through the course biomolecules and metabolism which is a prerequisite for higher courses in Microbiology.

Course Outcome:

Upon completion of this course, the students will able to:

- Understand salient features of biomolecules in the organization of life.
- Helps the students in appreciating the integrated approach of interrelatedpathways of catabolism and anabolism.

Syllabus:

DCC Course (MBY8003T)

BIOMOLECULES AND METABOLISM (THEORY)

(Credit: 4, Hours: 60)

Unit –I **Credit hours: 12**

Bioenergetics: entropy, enthalpy, Gibbs free energy concept, Laws of thermodynamics. Acids and Bases, redox potential, Ioninzation of water, weak acids, and weak bases, pH and Buffers, Henderson and Hasselbach equation, pKa, pKb.

Unit- II **Credit hours: 12**

Carbohydrates: classification, structure, properties and functions. Glycolysis, TCA, HMP, and PPP; Gluconeogenesis, Glycogenesis, Glycogenolysis. Electron transport mechanism (chemi-osmotic theroy), Mechanism of ATP synthesis, Energy rich molecules.

Unit -III **Credit hours: 12**

Lipids: classification, structure, properties and functions of fatty acids, triacylglycerols, phospholipids, sterols and terpenes, Conjugated lipids - lipoproteins. ketone bodies, Lipids with specific biological functions, micelles and liposomes. Biosynthesis of saturated and unsaturated fatty acids, β-oxidation.

Unit -IV **Credit hours: 12**

Amino acids: general properties and biosynthesis, Transamination, Deamination, Decarboxylation; glutamine and glutamic acid pathway, urea cycle, uric acid biosynthesis. pI of amino acids, Protein structure (primary, secondary, tertiary and quaternary). Ramachandran plot. Protein turnover, Vitamins and Co- enzyme (biological and biochemical functions).

Unit -V **Credit hours: 12E**

Experimental evidence for nucleic acids as genetic material. Secondary structure of DNA, Watson and Crick model of DNA. A, B and Z forms of DNA, Tm and its relation to GC content Chemical and enzymatic degradation of nucleic acids. Nucleic Acids: Structure of nucleoside, nucleotide. De novo and salvage pathways of nucleotide synthesis

Recommended Books:

1. Voet and Voet. 2000. Biochemistry. John Wiley.

2. Lehninger. 2000. Principles of Biochemistry. CBS Publishers.

3. Stryer, L. 2002. Biochemistry. W.H. Freeman.

4. Harper. 2003. Biochemistry. McGraw-Hill.

5. Zubay. 1995. Biochemistry. Brown Publishers

6. Trehan, K. Biochemistry. Wiley Eastern Publications.

7. Jain, J.L. Fundamentals of Biochemistry. S. Chand and Company.

8. Deb, A.C. Fundamental of Biochemistry.

E-Resources

1. https://www.khanacademy.org/
2. https://unacademy.com/
3. https://swayam.gov.in/
4. https://hstalks.com/
5. https://nptel.ac.in/courses

M.Sc. Microbiology Semester-I (2023-24)

DCC Course-Immunology and Cell Biology Lab (MBY8004P)

Code of the course: MBY8004P

Title of the course: IMMUNOLOGY AND CELL BIOLOGY LAB

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving

Prerequisites:

1. Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic immunology and cell biology learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Microbiology.

Learning Outcome:

Upon completion of this course, the students will able to:

1. Develop the skills to think independently

2. Collect data and update the experimental process repetitively

2. Assess the procedure and outcomes of an experiment quantitatively and qualitatively

3. Perform an experiment collaboratively and ethically

Syllabus:

Students are required to complete at least eight experiments.

1. To perform the sandwich Dot ELISA test for antigen.
2. Perform the ouchterlony double diffusion procedure to determine the time value of the test antiserum.

3. To determine the concentration of unknown antigen in the given sample using radial immunodiffusion (RID)
4. To prepare blood film and observe various type of blood cells.
5. To determine the blood group and Rh factor
6. To study the formation of haemin crystals.
7. Determination of alpha amylase activity by DNS method.
8. Indirect estimation of lactate dehydrogenase using yeast.
9. Prepare a temporary mount of given flower bud of onion and observe any one stage of meiosis.
10. Prepare a temporary mount of given onion root tip sample and observe any one stage of mitosis.
11. Prepare a karyotype from the given mitotic complement and derive the chromosome formula.
12. Demonstrate the presence of Barr body in your own buccal smear.
13. Prepare a temporary mount of buccal epithelium and localize the mitochondria using vital stain.
14. Prepare a temporary mount of buccal epithelium and localize the golgi body using vital stain.
15. Isolate the chloroplast from the give plant material.
16. Exercises based on genetics.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

Spots:

1. Blood groups
2. Haemoglobinometer
3. Haemocytometer
4. Water bath
5. Photographs of abnormal karyotyping
   (a) Turner syndrome
   (b) Klienfelter syndrome
   (c) Down syndrome
   (d) Patau syndrome
6. Sides of mitosis and meiosis
7. **Photographs of cell organelles**: Chloroplast, RER, Golgi complex, Secondary lysosomes, Mitochondria, Nucleus

Recommended Books:

1. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.
2. R.C. Dubey and D.K. Maheshwari (2012) Practical Microbiology, 3rd Edition, S. Chand and Company Ltd.

Scheme of Examination:

1. Major Exercise 1	15 Marks
2. Major Exercise 2	15Marks
3. Minor Exercise 1	10 Marks
4. Minor Exercise 2	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

M. Sc. MICROBIOLOGY SEMESTER –II (2023-24)

DCC Course-MICROBIOLOGY AND BIOMOLECULES LAB (MBY8005P)

Code of the course: MBY8005P

Title of the course: MICROBIOLOGY AND BIOMOLECULES LAB

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving

Prerequisites:

1. Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of basic microbiology and biomolecules learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Microbiology.

Learning Outcome:

Upon completion of this course, the students will able to:

1. Develop the skills to think independently

2. Collect data and update the experimental process repetitively

2. Assess the procedure and outcomes of an experiment quantitatively and qualitatively

3. Perform an experiment collaboratively and ethically

Syllabus:

Students are required to complete at least eight experiments.

1. Determine quantitatively the number of cells in the given yeast suspension using Neubauer'schamber.
2. Calibrate the ocular micrometer and determine the size of given microscopic structure

3. Perform the Gram staining procedure for the given bacterial sample.
4. Perform the negative staining procedure to study the morphology and arrangement of bacterialcells.
5. Perform the spore staining procedure for the given bacterial sample to observe the bacterialspores.
6. Determine the carbohydrate fermentation pattern of given bacterial sample (*Bacillus subtilis)*
7. Determine the ability of given bacterial cultures (*Bacillus subtilis)* to reduce nitrate to nitrite bynitrate reduction method.
8. Determine the ability of given bacterial cultures (*Bacillus subtilis* and *E.coli)* to excretehydrolytic extracellular enzyme capable of degrading starch.
9. Isolation and identification of *E. coli* on EMB agar.
10. Enumerate the bacteria in the given food sample by standard plate count.
11. Determination of protein content by Bradford assay in the given sample using spectrophotometer.
12. Extract and quantify the total phenol content in given plant sample using the Folin-Ciocalteu method.
13. Determination of chlorophyll a and b in the given plant sample spectrophotometrically.
14. Determination of ABTS radical scavenging activity using spectrophotometer.
15. Qualitative determination of lipids in the given sample using Sudan test.
16. Qualitative estimation of carbohydrates in the given sample using different methods.
17. Qualitative estimation of protein content in the given sample using Biuret and Xanthoproteic test.
18. Determine the saponification value of given fat sample.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

Spots:

1. Slides (Negative staining, Gram staining and spore staining)
2. Biochemical tests (Catalase test, Oxidase test)
3. Cultural characteristics
4. Photomicrographs (TMV, bacteriophage)
5. Specimen of diseased plants (Citrus canker, Yellow vein mosaic of bhindi
6. Glycolysis
7. Kreb's cycle
8. Urea cycle
9. Calculation of the solutions (Molar, Molal, Normal and ppm)
10. Bradford's reagent
11. Folin-Ciocalteu
12. Henderson–Hasselbalch equation
13. Chemiosmotic hypothesis

Recommended Books:

1. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.
2. Rajendiran, S., & Dhiman, P. (2019). Biochemistry Practical Manual-E-Book. Elsevier Health Sciences.

Scheme of Examination:

1. Major Exercise 1	15 Marks
2. Major Exercise 2	15Marks
3. Minor Exercise 1	10 Marks
4. Minor Exercise 2	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

M. Sc. MICROBIOLOGY SEMESTER –II (2023-24)

DCC Course (MBY8006T)

Code of the course: MBY8006T

Title of the course: MOLECULAR BIOLOGY

Level of the Course: NHEQF Level 6

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of Molecular biology learn at School level and lay foundation for further learning of the subject through the course on Molecular biology which is a prerequisite for higher courses in Microbiology.

Course Outcome

Upon completion of this course, the students will able to:

- Learn fundamental molecular principles of genetics.
- Understand relationship between phenotype and genotype in human genetic traits.
- Describe the basics of genetic mapping and understand how gene expression is regulated.

Syllabus:

DCC Course (MBY8006T)
MOLECULAR BIOLOGY (THEORY)

(Credit: 4, Hours: 60)

Unit –I **Credit hours: 12**

Eukaryotic and prokaryotic genetic materials: Structure, chemical composition, organization; Molecular mechanism of DNA synthesis, RNA primer for DNA synthesis, Enzymes and proteins associated with DNA replication, repetitive DNA. DNA repair: photo reactivation, excision repair, post replication repair, SOS repair.

Unit -II **Credit hours: 12**

RNA: types, structure and synthesis. Transcription: Prokaryotic transcription and RNA polymerase. Eukaryotic transcription and RNA polymerases. Transcription factors and their role. Modification in RNA: 5'-CAP formation, 3'-end processing, Polyadenylation, Splicing, Editing, Nuclear export of mRNA and mRNA stability. Processing of other RNAs. Reverse transcription. Inhibitors of RNA synthesis.

Unit -III **Credit hours: 12**

Translation: Prokaryotic and Eukaryotic translation, mechanism of initiation, elongation & termination, Amino acid activation, Inhibitors, Regulation of translation, Co- & Post- translational modification of proteins such as phosphorylation, adenylation, acylation and glycosylation. Protein sorting: synthesis of secretory and membrane proteins, import into nucleus, mitochondria, chloroplast and peroxisomes.

Unit –IV **Credit hours: 12**

Regulation of gene expression in prokaryotes and eukaryotes: Transcriptional control; enzyme induction and repression, constitutive synthesis of enzymes. The operon hypothesis: genes involved in regulation- regulatory gene, promoter gene, operator gene and structural gene, role of cAMP and cAMP receptor protein (CRP) in the expression of e.g. Lac operon, Tryptophan operon. Catabolite repression. *Cis* control elements, promoters, enhancers, DNA binding motifs of transcription factors.

Unit- V **Credit hours: 12**

Principles and applications of blotting techniques: Southern, Northern, Western and Eastern blotting. Polymerase chain reaction: Types and applications. Radioactive and Non-radioactive probes. Autoradiography. DNA fingerprinting, DNA foot printing and DNA sequencing, Antisense and siRNA technology. Chromosome walking.

Recommended Books

1. Watson, J.D. Molecular Biology of Gene. Pearson Education.

2. Friefelder, D. Molecular Biology. Narosa Publishing House, New Delhi.

3. Weaver, R. Molecular Biology. McGraw Hill.

4. Lewin, B. Gene VIII. Pearson Education.

5. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.

6. Cooper, M. The Cell – A molecular approach. Sinauer.

7. Daniel. Molecular Cell Biology. Scientific American Books.

8. Smith. Molecular Biology. Faber and Faber Publications.

9. Dabre, P.D. Introduction to (Practical) Molecular Biology. John Wiley and Sons,

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

M. Sc. MICROBIOLOGY SEMESTER –II (2023-24)

DCC Course (MBY8007T)

Code of the course: MBY8007T

Title of the course: RECOMBINANT DNA TECHNOLOGY AND ITS APPLICATIONS

Level of the Course: NHEQF Level 6

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of Biotech learn at School level and lay foundation for further learning of the subject through the course on recombinant DNA technology and its applications which is a prerequisite for higher courses in Microbiology.

Course Outcome:

Upon completion of this course, the students will able to:

- Know about implementation of genetic engineering for different purposes.
- Understand the principles of genetic engineering and the vectors used in cloning, methods of introduction of gene and expression.
- Investigate the different strategies of recombinant DNA technology and resolve the problems encountered.

Syllabus:

DCC Course (MBY8007T)

RECOMBINANT DNA TECHNOLOGY AND ITS APPLICATIONS (THEORY)

(Credit: 4, Hours: 60)

Unit I **Credit hours: 12**

Recombinant DNA Technology: History, Milestones and basic steps in Genetic Engineering. Applications of genetic enzymes in recombinant DNA technology- Exo and endonucleases, restriction endonucleases; discovery, nomenclature, types and applications, DNA ligases, polymerases, DNA modifying enzymes.

Unit II **Credit hours: 12**

General concept and principle of cloning: Cloning vectors, classification, plasmids: pBR 322, pBR327, pUC8. Phage vectors: M13 and λ. Phagemids and cosmids. Animal virus derived vectors: SV 40 and baculoviral vectors. Yeast cloning vectors: 2µm plasmid, Yep, Yip and YAC. Shuttle and expression vectors.

Unit III **Credit hours: 12**

Methods for constructing rDNA and cloning: ligation; Use of linkers, adaptors and homo-polymer tailing. Insertion of DNA into living cell- physical; electroporation, ultrasonication, biolistic, laser mediated transfer and chemical methods. Methods for screening and selection of recombinant clones; genetic, immunochemical and hybridization methods.

Unit-IV **Credit hours: 12**

Polymerase chain reaction: Concept, optimization, Types (Simple, Nested, Muliplex, Real time and reverse transcriptase PCR) and applications. Nucleic Acid sequencing: Sanger's, Maxam Gillbert's method, Next generation sequencing; pyrosequencing and Illumina sequencing. Construction and screening of Genomic and c- DNA libraries.

Unit V **Credit hours: 12**

DNA fingerprinting, Foot printing, Site directed mutagenesis, DNA microarrays and Chromosome walking. Products of rDNA technology in humulin and hGH production, herbicide resistance, BT transgenic, golden rice. Antisense, siRNA and CRISPR technology and their applications.

Recommended Books:

1. Watson, J.D. Molecular Biology of Gene. Pearson Education.
2. Friefelder, D. Molecular Biology. Narosa Publishing House, New Delhi.
3. Weaver, R. Molecular Biology. McGraw Hill.
4. Lewin, B. Gene VIII. Pearson Education.
5. Lodish and Baltimore. Molecular Cell Biology. W.H. Freeman and Co.
6. Cooper, M. The Cell – A molecular approach. Sinauer.
7. Daniel. Molecular Cell Biology. Scientific American Books.
8. Smith. Molecular Biology. Faber and Faber Publications.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

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M. Sc. MICROBIOLOGY SEMESTER –II (2023-24)

DCC Course (MBY8008T)

Code of the course: MBY8008T

Title of the course: AGRICULTURAL MICROBIOLOGY AND MICROBIAL ECOLOGY

Level of the Course: NHEQF Level 6

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of Microbiology learn at School level and lay foundation for further learning of the subject through this course on agricultural microbiology which is a prerequisite for higher courses in Microbiology.

Course Outcome:

Upon completion of this course, the students will able to:

- Acquire skills for addressing agricultural problems using microbes like biofertilizers, biopesticides etc.
- Gain knowledge about the importance of microbes for a sustainable environment.
- Comprehend the concept of ecology and its importance for existence of various microbes on the planet.

Syllabus:

DCC Course (MBY8008T)

AGRICULTURAL MICROBIOLOGY AND MICROBIAL ECOLOGY (THEORY)

(Credit: 4, hours: 60)

Unit – I **Credit hours: 12**

Soil microbiology: Soil as a habitat for microorganisms, distribution of microorganisms in soil and its significance, microbial density in soil- zymogenous and autochthonous flora in soil. Interaction between microbes and plants: rhizosphere and rhizoplane microbes, R:S ratio, phyllosphere microorganisms, their importance in plant growth. Interaction among microorganisms: mutualisms, commensalism, competition, amensalism, parasitism and predation.

Unit – II **Credit hours: 12**

Biopesticides: Types, production and its significance, Biofertilizers: Types, production and its application. Microbial waste recycling: organic compost, vermicomposting. Nitrogen fixation: symbiotic (root nodule bacteria-Rhizobium) and non-symbiotic, Importance of leghemoglobin and nitrogenase enzyme, Nitrogen fixing genes. Phosphate solubilizing bacteria, Mycotoxins: side effects and advanced method of detection (Biosensors)

Unit - III **Credit hours: 12**

Air microbiology: microbial population and its significance. Aerosol, droplet nuclei, air pollution-sources. Air quality analysis: air sampling devices, Isolation and enumeration methods of air flora analysis. Water microbiology: microbial population and its significance, Isolation and enumeration methods of studying water microflora. Eutrophication, algal blooms and red tides: definition, causes and effects. Water treatment: Primary, secondary and tertiary treatment. Drinking water potability: MPN technique. Microbial corrosion.

Unit – IV **Credit hours: 12**

Microbes in extreme environments: Habitat, biodiversity, physiological adaptations, evolutionary, ecological, commercial and biotechnological significance. Thermophiles; Classification and properties, Hyperthermophiles and extreme thermophilic habitats. Alkalophiles: classification and properties, Soda lakes and deserts, calcium alkalophily, Acidophiles: classification, life at low pH, acidotolerence, applications. Halophiles: classification and properties, Evolutionary, ecological and commercial significance.

Unit V **Credit hours: 12**

Barophiles: Classification and properties, Evolutionary, ecological and commercial significance. Psycrophiles and psychrotrophs: Classification and properties, Evolutionary, ecological and commercial significance, Role of microorganisms in the biogeochemical cycling of carbon, nitrogen, phosphorus, sulphur, iron, manganese, silicon etc. Methanogens, Methylotrophs. Microbial Biofilms: Nature, properties and significance, Mechanism of microbial adherence.

Recommended Books:

1. Atlas RM and Bartha R. (2000). *Microbial Ecology: Fundamentals & Applications*. 4th edition. Benjamin/Cummings Science Publishing, USA.
2. Atlas RM. (1989). *Microbiology: Fundamentals and Applications*. 2nd Edition, MacMillan Publishing Company, New York.
3. Madigan MT, Martinko JM and Parker J. (2009). *Brock Biology of Microorganisms*. 12th edition Pearson/ Benjamin Cummings.
4. Campbell RE. (1983). *Microbial Ecology*. Blackwell Scientific Publication, Oxford, England.
5. Coyne MS. (2001). *Soil Microbiology: An Exploratory Approach*. Delmar Thomson Learning.
6. Lynch JM & Hobbie JE. (1988). *Microorganisms in Action: Concepts & Application in Microbial Ecology*. Blackwell Scientific Publication, U.K.
7. Maier RM, Pepper IL and Gerba CP. (2009). *Environmental Microbiology*. 2nd edition, Academic Press.
8. Subba Rao NS. (1999). *Soil Microbiology*. 4th edition. Oxford & IBH Publishing Co. New Delhi.

E-Resources

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4. https://hstalks.com/
5. https://nptel.ac.in/courses

M. Sc. MICROBIOLOGY SEMESTER –II (2023-24)

DCC Course- MOLECULAR BIOLOGY AND RDT LAB (MBY8009P)

Code of the course: MBY8009P

Title of the course: MOLECULAR BIOLOGY AND RDT LAB

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving

Prerequisites:

1. Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of molecular biology and RDT learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Microbiology.

Learning Outcome:

Upon completion of this course, the students will able to:

1. Develop the skills to think independently

2. Collect data and update the experimental process repetitively

2. Assess the procedure and outcomes of an experiment quantitatively and qualitatively

3. Perform an experiment collaboratively and ethically

Syllabus:

Students are required to complete at least eight experiments.

1. Demonstrate the agarose gelelectrophoresis to visualize the given DNA sample.
2. Perform agarose gel electrophoresis to study the effect of varying concentration of DNA sample.

3. Perform agarose gel electrophoresis to study the effect of varying voltage on the mobility of the DNA.
4. Perform agarose gel electrophoresis to study the effect of varying agarose concentration on the mobility of the DNA.
5. To determine the protein anti-aggregation activity of the given sample.
6. Determine the extent of polymorphism in given DNA profile using Jaccard'sCoefficient.
7. Quantify the size of unknown DNA comparing with known DNA by semi- logarithmic graph.
8. Estimate the quantity of DNA present in each band by comparing the known quantity of DNA to an unknown quantity of DNA using percent (%) method.
9. Isolate plasmid DNA from the given bacterial sample by alkaline lysis method and test it on agarose gel by electrophoresis.
10. Isolate the genomic DNA from the given bacterial culture by Pospiech and Neumann's method.
11. Perform the polymerase chain reaction to amplify the given DNA sample using universal primers.
12. Perform restriction digestion of the given bacterial DNA sample, run on Agarose gel.
13. Purify the isolated genomic DNA by RNase treatment and test its purity on agarose gel by electrophoresis.
14. Prepare competent cells from given microbial culture using calcium chloride method
15. Identify the bacteria on basis of biochemical tests using PIB software.
16. Construct phylogeny tree from the given table (dendrogram preparation)

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. Semi-discontinuous replication
2. OriC
3. UV-transilluminator
4. Gel electrophoresis apparatus
5. Ethidium bromide dye
6. Bromophenol blue dye
7. Gel Doc System
8. PCR machine
9. SDS-PAGE
10. Questions based on solution preparations.
11. Role of chemicals
12. SDS
13. Chloroform
14. Isopropanol
15. NaCl
16. Lysozyme

Recommended Books

1. Green, M. R., & Sambrook, J. (2012). Molecular cloning. *A Laboratory Manual 4th*.

2. Schleif, R. F., & Wensink, P. C. (2012). *Practical methods in molecular biology*. Springer Science & Business Media.

E Resources: Online Virtual labs

Scheme of Examination:

1. Major Exercise 1	15 Marks
2. Major Exercise 2	15Marks
3. Minor Exercise 1	10 Marks
4. Minor Exercise 2	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

M. Sc. MICROBIOLOGY SEMESTER –II (2023-24)

DCC Course- AGRICULTURAL AND MICROBIAL PHYSIOLOGY LAB

Code of the course: MBY8010P

Title of the course: AGRICULTURAL AND MICROBIAL PHYSIOLOGY LAB

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving

Prerequisites:

1. Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of agricultural and microbiology learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Microbiology.

Learning Outcome:

Upon completion of this course, the students will able to:

1. Develop the skills to think independently

2. Collect data and update the experimental process repetitively

2. Assess the procedure and outcomes of an experiment quantitatively and qualitatively

3. Perform an experiment collaboratively and ethically

Syllabus:

Students are required to complete at least eight experiments.

1. To calculate the R:S ratio by isolating bacteria from rhizospheric and non-rhizospheric soil.
2. To isolate the *Azotobacter* species from soil sample by serial dilution method.
3. To isolate the *Rhizobia* from root nodules using YEMA medium.
4. To isolate antibiotic producing bacteria from soil.

5. To isolate the microorganisms from air by solid impingement method.
6. To isolate the microorganisms from phyllosphere using leaf impression method.
7. To perform gram staining of *Rhizobium* bacteria isolated from root nodules
8. Isolate the fungi from soil sample using pour plate method.
9. Isolate the vesicular arbuscular mycorrhizal (VAM) spores from the soil sample using sieving method.
10. Prepare the Growth curve of bacteria using spectrophotometric analysis.
11. Demonstrate the lethal effect of temperature on microorganisms and determine TDP.
12. Demonstrate the lethal effect of temperature on microorganisms and determine TDT.
13. Perform Triple Sugar Iron (TSI) test for given sample.
14. Demonstrate the effect of pH on growth of bacteria.
15. Demonstrate the effect of salt concentration on growth of bacteria.
16. Demonstrate the effect of osmotic pressure on growth of bacteria.
17. Demonstrate the effect of dyes on growth of bacteria.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

1. Spectrophotometer
2. pH meter
3. Autoclave
4. Bromocresol purple
5. *Rhizobium* root nodules
6. MPN test
7. *Nostoc* Slide

Recommended Books

1. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.
2. D. Amin, N. Amaresan, P. Patel (2022) 1st edition Practical Handbook on Agricultural Microbiology (Springer Protocols Handbooks)

E Resources: Online Virtual labs

Scheme of Examination:

1. Major Exercise 1	15 Marks
2. Major Exercise 2	15Marks
3. Minor Exercise 1	10 Marks
4. Minor Exercise 2	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

M. Sc. MICROBIOLOGY SEMESTER –II (2023-24)

GEC: MBY8100P

INSTRUMENTATION AND ANALYTICAL TECHNIQUES LAB

Code of the course: MBY8100P

Title of the course: INSTRUMENTATION AND ANALYTICAL TECHNIQUES LAB

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Generic Elective (GEC) Course for Life Science

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving

Prerequisites:

(1) Life science of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of instrumentation and analytical techniques learn at college level and lay foundation for further learning of the subject.

Learning Outcome:

Upon completion of this course, the students will able to:

1. Develop the skills to think independently
2. Collect data and update the experimental process repetitively
2. Assess the procedure and outcomes of an experiment quantitatively and qualitatively
3. Perform an experiment collaboratively and ethically

Syllabus:

Students are required to complete at least eight experiments.

1. Extract and separate pigments from *Curcuma longa* using thin layer chromatography and calculate their Rf values
2. Evaluate the effectiveness of moist heat sterilization using linear streak method.
3. Evaluate the effectiveness of dry heat sterilization using linear streak method.
4. To evaluate the effectiveness of ultra violet radiations using linear streak method.

5. Evaluate the effectiveness of alcohol as a skin antiseptic using thumb impression method.
6. Evaluate the antiseptics (30% hydrogen peroxide and 70% Isopropyl alcohol) by filter paper disk method.
7. Extract and separate photosynthetic pigments by paper chromatography and calculate their Rf values.
8. Demonstration of lyophilizer

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

Spots:

1. Instruments:

a) Autoclave
b) Incubator
c) Laminar air flow
d) Spectrophotometer
e) Centrifuge
g) pH meter

2. Microscopy (principle and applications of Light, phase contrast, SEM, TEM)

Recommended Books

1. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.

Scheme of Examination:

1. Major Exercise 1	20 Marks
2. Minor Exercise 1	15 Marks
3. Minor Exercise 2	15 Marks
4. Spots	2X5=10 Marks
5. Viva-voce	10 Marks
6. Record	10 Marks

M. Sc. MICROBIOLOGY SEMESTER –II (2023-24)

GEC: MBY8101P

APPLICATION OF BIOINFORMATICS IN BIOLOGICAL SCIENCES LAB

Code of the course: MBY8101P

Title of the course: **APPLICATION OF BIOINFORMATICS IN BIOLOGICAL SCIENCES LAB**

Level of the Course: NHEQF Level 6.0

Credit of the Course: 4

Type of the Course: Generic Elective (GEC) Course Life Science/ Mathematical/Computer Science Subject

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving

Prerequisites:

(1) Life science/ Mathematical/ Computer Sciences courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of instrumentation and analytical techniques learn at college level and lay foundation for further learning of the subject.

Learning Outcome:

Upon completion of this course, the students will able to:

1. Develop the skills to think independently

2. Collect data and update the experimental process repetitively

2. Assess the procedure and outcomes of an experiment quantitatively and qualitatively

3. Perform an experiment collaboratively and ethically

Syllabus:

Students are required to complete at least eight experiments.

1. To give an introduction to the National Center for Biotechnology Information (NCBI) and its popular resources.
2. Retrieve a nucleotide sequence from the NCBI database, perform its BLAST search analysis, study the obtained results and generate the phylogenetic tree.
3. Find the Open Reading Frames and the Conserved Domains of the given genome sequence through NCBI available ORF Finder and CD Search Tool.
4. To quickly identify segments / contamination of a nucleic acid sequence that may be of vector origin with the help of NCBI available VecScreen software.
5. To perform the reverse translation of a give protein sequence with the help of Sequence Manipulation Suite online server.
6. To construct the restriction map of the given sequence using NEBcutter from New England BioLabs online server.
7. Retrieving structural data of a SARS Coronavirus Main Protease 2VJ1 using PDB database
8. To calculate the Impact Factor of a Journal for the current year.

Spots:

1. C^{++} Language
2. Perl Language
3. Chemical Database
4. Functional Genomics
5. Microarray Technology
6. Human Genome Project
7. Software for Phylogenetic Analysis
8. European Molecular Biology Laboratory (EMBL)

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

Recommended Books:

1. Uesaka, K., Oka, H., Kato, R., Kanie, K., Kojima, T., Tsugawa, H., ... & Horinouchi, T. (2022). Bioinformatics in bioscience and bioengineering: recent advances, applications, and perspectives. Journal of bioscience and bioengineering.

Scheme of Examination:

1. Major Exercise **1**	20 Marks
2. Minor Exercise 1	15Marks
3. Minor Exercise 2	15 Marks
4. Spots	2X5=10 Marks
5. Viva-voce	10 Marks
6. Record	10 Mark

M. Sc. MICROBIOLOGY SEMESTER –III (2023-24)

DCC Course (MBY9011T)

Code of the course: MBY9011T

Title of the course: INDUSTRIAL MICROBIOLOGY

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of microbiology learned at college level and lay foundation for further learning of the subject through this course on Industrial Microbiology which is a prerequisite for higher courses in Microbiology.

Course Outcome:

Upon completion of this course, the students will able to:

- Comprehend fermentation techniques, fermentation processes and designing of fermentors
- Learn to isolate and preserve industrially important microorganisms.
- Understand the industrial production of various products using microbes.

Syllabus:

DCC Course (MBY9011T)

INDUSTRIAL MICROBIOLOGY (THEORY)

(Credits: 4, Hours: 60)

Unit I **Credit hours: 12**

Brief history and developments in industrial microbiology, Types of fermentation: Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations. Growth rate, generation time, Scale up and scale down of fermentation process.

Unit II **Credit hours: 12**

Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot-scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration.

Unit III **Credit hours: 12**

Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media, Utilization of waste as a substrate: molasses, cornsteep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates

Unit IV **Credit hours: 12**

Downstream Processing: Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying. Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 & Riboflavin, Enzymes (amylase, protease, lipase), Wine, beer, Microbial production of bioplastics (PHB and PHA), Single cell protein.

Unit V **Credit hours: 12**

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase**)** Food plant

sanitation, Microbial exopolysaccharides (EPS): classification and applications of cyclodextrin, alginate, chitosan.

Recommended Books:

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.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

M. Sc. MICROBIOLOGY SEMESTER –III (2023-24)

DCC Course (MBY9012T)

Code of the course: MBY9012T

Title of the course: MICROBIAL PHYSIOLOGY AND METABOLISM

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Centric Compulsory (DCC) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of microbiology learn at college level and lay foundation for further learning of the subject through the course on microbial physiology which is a prerequisite for higher courses in Microbiology.

Course Outcome:

Upon completion of this course, the students will able to:

- Understand the regulation of biochemical pathway and possible process modifications for improved control over microorganisms for microbial product synthesis.
- Gain knowledge of energy transfers and biomolecular transformations.
- Comprehend metabolic pathways unique to microorganisms.

Syllabus:

DCC Course (MBY9012T)

MICROBIAL PHYSIOLOGY AND METABOLISM
(Credits: 4, Hours: 60)

Unit-I **Credit hours: 12**

Chemical composition and structure of bacterial and archaebacterial and cyanobacterial membranes. Lipid bilayer, membrane proteins, Spectrins, Glycophorin, Multipass membrane proteins Bacteriorhodopsin. Membrane Transport: Principles of membrane transport, ion channels and electrical properties of membranes. Uptake of nutrients. Cellular movement; types of locomotion, structures involved in locomotion, structure and arrangement of flagella, Movement in response to external stimuli, mechanism of chemotaxis. Cell signaling, two component system.

Unit-II **Credit hours: 12**

Bacterial nutrition; types and modes of nutrition in bacteria, Nutrient requirements of microbes. Nutritional classification. Bacterial growth; events in cellular growth, growth rate and generation time. Bacterial Growth curve, Growth kinetics, factors effecting growth; temperature, pH, osmotic pressure, salinity, oxygen tension, water, nutrient availability etc. Measurement of growth. Measurement of cell mass and number. Pattern of death. Methods used to study, microbial metabolism – nutrient balance, metabolically blocked microbes; radiolabelled compounds

***U*nit-III** **Credit hours: 12**

Autotrophic metabolism: Photoautotrophy; Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power Absorption spectrum, pigments involved in absorption of light energy, site of absorption in bacteria and cyanobacteria, oxygenic and anoxygenic photosynthesis. Purple sulphur bacteria and the green sulphur bacteria. Chemoautotrophy; sources of energy, Energy yielding processes: oxidation of inorganic compounds. Sulphur bacteria, iron bacteria, nitrifying bacteria, hydrogen bacteria. Photoheterotrophs: purple nonsulphur bacteria.

Unit-IV **Credit hours: 12**

Heterotrophic metabolism: Metabolism of two carbon compounds: EMP pathway, citric acid cycle, EDP, PPP and other alternate pathways. Fermentation and anaerobic respiration. Anaerobic fermentation – alcoholic fermentation, propionic acid fermentation, formic acid fermentation. Metabolism of one carbon compounds: methylotrophs; Oxidation of methane, methanol, methylamines and carbon assimilation in methylotrophic bacteria and yeasts, Metahnogens: Methanogenesis form H_2,CO_2, CH_3OH, HCOOH, methylamines, energy coupling and biosynthesis in methanogenic bacteria. Significance of methanogenesis, Acetogens: autotrophic pathway of acetate synthesis and CO_2 fixation.

Unit-V **Credit hours: 12**

Nitrogen fixation by rhizobia; formation and structure of root nodule, Physiology of nitrogen fixation, Importance of leghemoglobin and nitrogenase enzyme. Nitrogen fixing genes. Non leguminous nitrogen fixers, Physiology of heterocyst and actinorhizal nodules. Factors affecting nitrogen transformation, nitrogen assimilation, incorporation of ammonia into organic compounds (GOGAT pathway), transporting of fixed nitrogen in symbiotic systems. PGPR. Phosphate solubilizing bacteria, Mechanism of Phosphate solubilization.

Recommended Books:

1. Ananthanarayan R and Paniker CKJ. (2005). *Textbook of Microbiology*. 7th edition (edited byPaniker CKJ). University Press Publication.
2. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). *Jawetz, Melnick and Adelberg'sMedical Microbiology*. 24th edition. McGraw Hill Publication.
3. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). *Mims' Medical Microbiology*.4th edition. Elsevier. Crofts publication.
4. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein'sMicrobiology*. 7th edition. McGraw Hill Higher Education.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

M. Sc. MICROBIOLOGY SEMESTER –III (2023-24)

DSE Course (MBY9104T)

Code of the course: MBY9104T

Title of the course: FOOD AND DAIRY MICROBIOLOGY

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of Food science learned at School level and lay foundation for further learning of the subject through the course on food and dairy microbiology which is a prerequisite for higher courses in Microbiology.

Course Outcome

Upon completion of this course, the students will able to:

- Acquaint students with various industrial and food products, their production techniques, and prevention of spoilage.
- Apply the knowledge about food preservation, food fermentation, food safety and quality control
- Work in food and industries dealing with fermentation.

Syllabus:

DSE Course (MBY9104T)

FOOD AND DAIRY MICROBIOLOGY

(Credit: 4, Hours: 60)

Unit I **Credit hours: 12**

Intrinsic and extrinsic factors that affect growth of microbes in food. Source of contamination of various foods. Microbial spoilage of various foods: vegetables, fruits, meat, eggs, milk and butter, bread, canned foods

Unit II **Credit hours: 12**

Physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins

Unit III **Credit hours: 12**

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.

Unit IV **Credit hours: 12**

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, Salmonellosis, Shigellosis, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni***.** Food adulteration

Unit V **Credit hours: 12**

Quality assurance: Microbiological quality standards of food, Government regulatory policies: FDA, EPA, HACCP, FSSAI. Introduction to Intellectual Property rights: definition, types: patents, trademarks, copyright, industrial design, traditional knowledge, geographical indications and concept of patents**.**

Recommended Books:

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). Antimicrobials in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural Antimicrobial Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The Microbiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

E-Resources

1. https://www.khanacademy.org/

2. https://unacademy.com/

3. https://swayam.gov.in/

4. https://hstalks.com/

5. https://nptel.ac.in/courses

M. Sc. MICROBIOLOGY SEMESTER –III (2023-24)
DSE Course (MBY9105T)

Code of the course: **MBY9105T**

Title of the course: MICROBIAL GENETICS

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of cell biology, and genetics learn at college level and lay foundation for further learning of the subject through the course on microbial genetics which is a prerequisite for higher courses in Microbiology.

Course outcome:

Upon completion of this course, the students will able to:

- Understand the properties, structure and function of genes in living organisms at the molecular level
- Understand the molecular mechanisms involved in transcription and translation
- Gain knowledge of prokaryotic gene transfer mechanisms and recombination.

Syllabus:

DSE Course (MBY9105T)
MICROBIAL GENETICS (THEORY)
(Credit: 4, Hours: 60)

Unit-I **Credit hours:12**

Prokaryotic Genomes - Structure of the bacterial nucleoid, DNA supercoiling and associated proteins: writhing number, twisting number. Replication and partitioning of the bacterial genome and Genome of Archaea.

Unit-II **Credit hours:12**

Bacterial conjugation: discovery, effective contact and pilli in conjugation, F-factor, the conjugal transfer process; high frequency recombination and Hfr strains, cointegrate formation; the order of chromosome transfer; formation of F prime (F'), Time–of–Entry, Mapping of bacterial genes. Plasmid: F Plasmid, Conjugate plasmid', Non-conjugative plasmid, R plasmid, Col plasmid (copy number and incompatibility) and sex pili. Episomes.: mechanism and significance. Site specific recombination, replicative recombination.

U**nit –III** **Credit hours:12**

Bacterial Transformation: discovery, mechanism and significance, detection of transformation, development of competence, mechanism of transformation, transfection, Transduction: discovery, mechanism (Generalized and specialized transduction), significance. Sex duction Mutant phenotype. Metagenomics and its applications. Expression of foreign gene in bacteria.

Unit-IV **Credit hours:12**

Conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Microbial genomics: identification of unculturable prokaryotes, safer food production, improved biosensing, genomic islands, pathogenicity islands. Genetically engineered microbes: development, commercial and practical applications

Unit-V **Credit hours:12**

Gene regulation – Post-transcriptional processing of RNAs – methylation, polyadenylation and splicing of mRNA; cutting and modification of tRNA degradation system; Catalytic RNA, Group I and Group II intron splicing; Gene regulation – negative regulation – E. coli lac operon (structural, operator, promoter and repressor genes), Positive regulation – E. coli trp operon;

Regulation by small molecules e.g. ppGpp and cAMP Post-translational processing (removal of fmet from polypeptide; ribosome editing: protein folding); Gene silencing (RNAi):An introduction and its application.

Recommended Books:

1. Gardner, E. J,Simmons, M J& D P Snustard ,1991 , Principles of Genetics, 8 edition.John Wiley & Sons.NY.
2. Freifelder .S ,1987 Microbial Genetics, Jones & Bartlett, Boston.
3. Robert H .Tamarin. Principles of Genetics, 5th edition, Cm Brown Publishers.
4. Lewin.B, 1990. Genes, 6 th edition, Oxford University Press.
5. Klug .W.S. & Cummings, MR, 1996, Essentials of Genetics, Mentics Hail. NewJersey.
6. Stanier, R.Y. General Microbiology. Macmillan Publishers.

E-Resources

1. https://www.khanacademy.org/
2. https://unacademy.com/
3. https://swayam.gov.in/
4. https://hstalks.com/
5. https://nptel.ac.in/courses

M. Sc. MICROBIOLOGY SEMESTER –III (2023-24)
DSE Course (MBY9118T)

Code of the course: MBY9118T

Title of the course: ENVIRONMENTAL MICROBIOLOGY

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of environmental science learn at College level and lay foundation for further learning of the subject through the course on environmental microbiology which is a prerequisite for higher courses in Microbiology.

Course Outcome:

Upon completion of this course, the students will able to:

- Understanding the significance of microorganisms in the bioremediation of pollutants for developing environmental conservation and remediation strategies.
- Comprehend the various methods to determine the quality of water and sewage treatment methods employed in wastewater treatment
- Acquaints with the basic principles of environmental microbiology and will be able to apply these principles to solve environmental problems viz. wastewater treatment, bioremediation, biodegradation etc.

Syllabus:

DSE Course (MBY9118T)

ENVIRONMENTAL MICROBIOLOGY (THEORY)

(Credit: 4, Hours: 60)

Unit I **Credit hours: 12**

Applications of microbes in biodegradation and bioremediation: Microbial degradation of cellulose, hemi cellulose, lignin, pectin, chitin, pesticides, xenobiotics and other recalcitrant chemicals, petroleum and hydrocarbons and its ecological significance. Bioaccumulation of heavy metals ions from industrial effluents. Biomining, Microbial leaching: recovery of metals from solutions; Microbes in petroleum extraction.

Unit II **Credit hours: 12**

Biomagnification and degradative plasmids, biotransformation. Biodeterioration and its control. Biological control and biopesticides: definition, significance, types, production, application and mode of action. Entomopathogenic fungi, viral insecticides. Significance of *Bacillus thuringiensis* in biocontrol.

Unit III **Credit hours: 12**

Microbes and pollution: waste water; types, sources and microbiology. Methods of waste water treatment. Solid waste: Source, types and characterization. Microorganisms as an indicator of water quality. Application of genetically engineered microorganisms for controlling pollution.

Unit IV **Credit hours: 12**

Bioconversion of Solid Waste: Composting, vermicomposting and vermiculture. Microbial biofertilizers: types, sources, manufacture and significance. Green manuring, Mycorrhizae as fertilizers: Rhizhobia and other symbiotic and non-symbiotic nitrogen fixing microbes as biofertilizer. Significance and application of phosphate solubilizing bacteria and plant growth promoting rhizobacteria (PGPR).

Unit V **Credit hours: 12**

Microbes as biological weapons, Role of microbes in production of Biofuels. Biogas production and factors affecting methane formation. Biosensors: Principle, types and applications in environmental monitoring.

Recommended Books:

1. Mooray Moo-Young. (Eds). Comprehensive Biotechnology (Vol. I, II, III) Pergamon Press, England.
2. Metcalf and Eddy. Waste water engineering treatment and uses. McGraw Hill.
3. Jogdand, S.N. Environmental Biotechnology. Himalaya Publication House.
4. De, A.K. Environmental Chemistry. Wiley Eastern Ltd.
5. Abbasi and Abbasi. Renewable Energy Sources and their environmental impact. Prentice Hall of India, Pvt. Ltd.
6. Chatterji, A.K. Introduction to Environmental Biotechnology. Prentice Hall of India.
7. Thakur, I. S. Text Book of Environmental Biotechnology. I. K. International Publisher, New Delhi.
8. Mohapatra, P. K. Text Book of Environmental Biotechnology. I. K. International Publisher, New Delhi.

E-Resources

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M. Sc. MICROBIOLOGY SEMESTER –III (2023-24)

DSE Course (MBY9119T)

Code of the course: MBY9119T

Title of the course: MEDICAL MICROBIOLOGY

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(2) Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of medical science learn at School level and lay foundation for further learning of the subject through the course on medical microbiology which is a prerequisite for higher courses in Microbiology.

Course Outcome:

Upon completion of this course, the students will able to:

- Understand various pathological events during the progression of infectious diseases and interpretation of laboratory tests in the diagnosis of infectious diseases.
- Apply the principle of epidemiological sciences in studying the underlying mechanisms of the spread of disease and controls required thereof to combat the spread of pathogens.
- Gain knowledge of the mechanism of action of antimicrobial drugs and antimicrobial resistance.

Syllabus:

DSE Course (MBY9119T)
MEDICAL MICROBIOLOGY (THEORY)

Credit: 4, Hours: 60

Unit-I: **Credit hours: 12**

Brief idea of pathogenicity, invasiveness, toxins (bacterial, fungal, algal), and virulence; Quantitative measures of virulence: minimal lethal dose (MLD), LD50, ID50, TCID50. Epidemiology-definition, diseases outbreak, sources, reservoirs of pathogens, epidemics. Normal microflora of human body. Disease transmission- portals of entry, Mode of transmission, Prevention of medically important microbes.

Unit II **Credit hours: 12**

Nosocomial infections, Diagnosis of infectious disease- blood count, hypersensitivity reactions, isolation and identification of pathogens by culture methods (Respiratory tract, CSF, urine, blood, vaginal smear and skin lesion culture). Production of Biopharmaceuticals- Insulin, Interferon. Vaccines- Recombinant vaccines, subunit vaccines, DNA vaccines, Vaccinia, BCG and HIV– vector-based vaccines

Unit-III **Credit hours: 12**

Antibiotics and their mode of action, Antibiotic susceptibility testing. Antimicrobial resistance: Mechanism, extended spectrum β-lactamases (ESBL), MDR *M. tuberculosis*, Methicillin-resistant *S. aureus* (MRSA). Epidemiology, causal organism, life cycle, mode of action, transmission, detection, control, therapeutic measures of following fungal diseases: Mycoses, Mycotoxicoses, Candidiasis, Actinomycosis, Dermatophytosis, Aspergillosis, and Pencillinosis.

Unit-IV **Credit hours: 12**

Epidemiology, causal organism, life cycle, mode of action, transmission, detection, control, therapeutic measures of following viral diseases: Influenza, Measles, Mumps, Rubella and Small pox, Yellow fever, Polio, Viral hepatitis, Rabies, Cold sores, AIDS, genital herpes, warts. Emerging and reemerging viral diseases: SARS virus - Swine flu and Dengue virus

Unit-V **Credit hours: 12**

Epidemiology, causal organism, life cycle, mode of action, transmission, detection, control, therapeutic measures of following bacterial and protozoan diseases: Tuberculosis, Diptheria, Meningitis, Streptococcal Pneumonia, Cholera, Botulism, Typhoid, Tetanus, Gonorrhoea, Syphilis, Leprosy, Malaria, Leishmaniasis, Toxoplasmosis, Meningitis, Vaginitis, Giardiasis, Trypanosomiasis, Amoebiasis.

Recommended Books:

1. Ananthanarayan. R. And Paniker C.K. Text Book of Microbiology, Orient Longman, 2009.
2. Gottschalk G. (1986). *Bacterial Metabolism*. 2nd edition. Springer Verlag
3. Jawetz, Melnick, & Adelberg's Medical Microbiology by Brooks GF, Butel JS, Morse SA, Melnick JL,
   Jawetz E, Adelberg EA . 23rd edition. Lange Publication. 2004.
4. Madigan MT, Martinko JM and Parker J. (2003). *Brock Biology of Microorganisms*. 10th edition.Pearson/ Benjamin Cummings.
5. Moat AG and Foster JW. (2002). *Microbial Physiology*. 4th edition. John Wiley & Sons.
6. Reddy SR and Reddy SM. (2005). *Microbial Physiology*. Scientific Publishers India.
7. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). *General Microbiology*. 5th edition,McMillan Press.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). *Prescott, Harley and Klein's Microbiology*. 7th edition. McGraw Hill Higher Education.

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4. https://hstalks.com/
5. https://nptel.ac.in/courses

M. Sc. Microbiology Semester III (2023-24)

DSE -Industrial techniques, Food and Environmental lab (MBY91212P)

Code of the course: MBY91212P

Title of the course: Industrial techniques, Food and Environmental lab

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving

Prerequisites:

1. Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of agricultural and microbiology learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Microbiology.

Learning Outcome:

Upon completion of this course, the students will able to:

1. Develop the skills to think independently

2. Collect data and update the experimental process repetitively

2. Assess the procedure and outcomes of an experiment quantitatively and qualitatively

3. Perform an experiment collaboratively and ethically

Syllabus:

Students are required to complete at least eight experiments.

1) Production of sauerkraut by microorganisms and acidity calculation of fermented juice.
2) Isolation of yeast on Sabouraud agar from fermented sugarcane juice.
3) To examine *Leuconostoc* bacteria from fermented juice of sauerkraut
4) Demonstration of citric acid production by *Aspergillus niger/Penicillium citrianum*
5) Isolation of total bacteria present in butter
6) To determine the quality of milk sample by methylene blue reductase test.
7) To detect mastitis through milk test
8) To determine the phosphatase activity in milk powder
9) To detect the pathogenic bacteria from food sample
10) To isolate bacteria from probiotic product i.e. Yakult
11) To study adulteration of starch in milk.
12) To study adulteration of detergents in milk.
13) To determine the adulteration of sugar solution in honey
14) Isolation of *E. coli* from sewage water on EMB agar by broth dilution method.
15) Detection of coliforms from given water sample using MPN method.
16) To perform Methyl Red Voges-Proskauer (MRVP) test for differentiation between Enterobacteriaceae group.
17) To perform indole test for checking the ability of microorganism to convert tryptophan.

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

Spots:

1. Air lift Fermentor
2. Stirred tank fermentor
3. Lyophilizer
4. Sauerkraut
5. Sonicator
6. Yakult
7. MBRT
8. Canned food

9. Starch adulteration

Recommended Books:

1. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.

2. P. Papademas (2015) Dairy Microbiology A Practical Approach, 1st Edition

Scheme of Examination:

1. Major Exercise 1	15 Marks
2. Major Exercise 2	15Marks
3. Minor Exercise 2	10 Marks
4. Minor Exercise 2	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

M. Sc. Microbiology Semester III (2023-24)
DSE- Microbial Genetics and Medical Microbiology Lab (MBY91213P)

Code of the course: MBY91213P

Title of the course: AGRICULTURAL AND MICROBIAL PHYSIOLOGY LAB

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Discipline Specific Elective (DSE) Course for Microbiology Discipline/ Subject

Delivery Type of the Course: Lecture and practical 80+40=120. The 80 lectures for the hands on experiments, observations and record of the data, 20 hours for the experiment, instruments demonstration, lab practices and 20 hours on diagnostic assessment, formative assessment, subject/class activity, problem solving

Prerequisites:

1. Life science courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the practical knowledge of agricultural and microbiology learn at college level and lay foundation for further learning of the subject which is a prerequisite for higher courses in Microbiology.

Learning Outcome:

Upon completion of this course, the students will able to:

1. Develop the skills to think independently

2. Collect data and update the experimental process repetitively

2. Assess the procedure and outcomes of an experiment quantitatively and qualitatively

3. Perform an experiment collaboratively and ethically

Syllabus:

Students are required to complete at least eight experiments.

1. To study the effect of UV exposure on the growth of bacterial cells.
2. Isolation of antibiotic resistant bacteria population by gradient plate method.
3. To prepare the glycerol stock of given bacterial culture for long term storage.
4. To perform the double digestion of the given DNA sample using restriction endonuclease.
5. Isolate nutritional mutant from given bacterial sample using replica plating method.
6. Demonstration of blue-white screening of bacterial colonies
7. To study resident microflora of skin.
8. To study resident microflora of oral cavity.
9. To study cultural characteristics of pathogenic bacteria on following selective/differential media: TCBS agar; XLD agar
10. Determine the antibiotic resistance activity of *Bacillus subtilis* using multiple antibiotic discs.
11. Differentiation of Streptococci by bacitracin test.
12. Candle jar method for the cultivation and identification of anaerobic bacteria
13. To perform sugar fermentation of enteric bacteria using disc method

Any other experiment can be designed to demonstrate the concepts and phenomenon related to the paper.

SPOTS:

a) pBR322
b) pUC18
c) Diauxic growth curve
d) Electroporation
e) Calcium phosphate transfection
f) Transduction
g) Conjugation
h) Candle Jar
i) Antibiotic disc
j) Sugar discs

Recommended Books

1. K.R. Aneja (2007) Experiments in Microbiology, Plant pathology and Biotechnology, 4th Edition, New Age International (P) Limited Publishers.

Scheme of Examination:

1. Major Exercise 1	15 Marks
2. Major Exercise 2	15Marks
3. Minor Exercise 1	10 Marks
4. Minor Exercise 2	10 Marks
5. Spots	2X5=10 Marks
6. Viva-voce	10 Marks
7. Record	10 Marks

M. Sc. MICROBIOLOGY SEMESTER –III (2023-24)

GEC Course (MBY91316T)

Code of the course: MBY91316T

Title of the course: BIOINFORMATICS AND BIOSTATISTICS

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Generic Elective (GEC) Course for all Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

(1) Life science/ Mathematical/ Computer Sciences courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of biotechnology learn at School level and lay foundation for further learning of the subject through course on Bioinformatics and Biostatistics which is a prerequisite for higher courses in Microbiology and life sciences.

Course Outcome:

Upon completion of this course, the students will able to:

- Understand the basic concepts of biostatistics.
- Learn the formula and principles used in biology.
- Explore methods and software tools for understanding biological data.

Syllabus:

GEC Course (MBY91316T)

BIOINFORMATICS AND BIOSTATISTICS (THEORY)

(Credits: 4, Hours: 60)

Unit I **Credit hours: 12**

Computer Architecture, Internal and External devices, Computer Networking – Topology and Advantages of Networking, Types of Networking (LAN, MAN, WAN). Network Protocol – Internet Protocol (TCP, IP) and File Transfer Protocol. Introduction to Programming languages, C^{++}, Perl.

Unit II **Credit hours: 12**

Introduction and brief history of Bioinformatics, Applications of Bioinformatics in different fields of Sciences. Biological Databases – Nucleotide sequence Databases (GenBank, EMBYL, DDBJ), Protein sequence Databases (Swiss Prot, PIR, PROSITE), Structural Databases (PDB, SCOP).

Unit III **Credit hours: 12**

Sequence Alignment – Pairwise Sequence Alignment: Sequence Homology, Sequence Similarity, Sequence Identity, Gaps, Gap penalties, G scoring schemes, DOT PLOT, DOT MATRIX, Database similarity searching – BLAST, FASTA. Multiple sequence alignment.

Unit IV **Credit hours: 12**

Introduction and brief history of Biostatistics, Applications of Biostatistics. Collection of Data – Types of Sampling methods. Brief description of Classification of data, Tabulation of data and their Graphical representation – Class Intervals, Tally marks, Frequency, Frequency distribution.

Unit V **Credit hours: 12**

Measures of Central Tendency and Dispersion: Mean, Median, Mode, Range, Standard deviation, Variance, Standard error, Degree of freedom. Brief idea of statistical softwares and their applications. Analysis of Variance (ANOVA), Elementary idea of Test of Hypothesis, Test of Significance, Student T test, Chi square test.

Recommended Books:

1. Xinong J. Essential Bioinformatics, Cambridge University Press.
2. Mount D.W. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbor Laboratory Press.
3. Sharma V., Munjal A., Shanker A. A Text Book of Bioinformatics. Rastogi Publications.
4. Rastogi V.B. Biostatistics, Third Revised Edition, Medtech.
5. Gupta S. C. Fundamentals of Statistics. Himalaya Publishing House.
6. Sinha K P., Sinha P. Computer Fundamentals. BPB Publications.
7. Swardlaw, A.C. (Practical) statistics for experimental Biology. John Wiley and Sons.

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2. https://unacademy.com/
3. https://swayam.gov.in/
4. https://hstalks.com/
5. https://nptel.ac.in/courses

M. Sc. MICROBIOLOGY SEMESTER –III (2023-24)

GEC Course (MBY91317T)

Code of the course: MBY91317T

Title of the course: BIOSAFETY, BIOETHICS AND IPR

Level of the Course: NHEQF Level 6.5

Credit of the Course: 4

Type of the Course: Generic Elective (GEC) Course for all Discipline/ Subject

Delivery Type of the Course: Sixty (40 Lectures + 20 tutorial and diagnostic assessment)

Prerequisites:

Life science/ Computer Sciences courses of Undergraduate level or equivalent.

Objectives of the Course:

The course aims to strengthen the conceptual knowledge of copyright, good laboratory practices learn at School level and lay foundation for further learning of the subject through this course on Biosafety, Bioethics and IPR which is a prerequisite for higher courses in Microbiology and life sciences.

Course Outcome:

Upon completion of this course, the students will able to:

- Understand the basic concepts of intellectual property and intellectual property rights.
- Learn about the ethical implications of cloning and biosafety.

Syllabus:

GEC Course (MBY91317T)

BIOSAFETY, BIOETHICS AND IPR (THEORY)

(Credits:4, Hours: 60)

UNIT I **Credit hours: 12**

Introduction to ethics and bioethics: Personal ethics: profession and professionalism – Moral Reasoning – Ethical theories – person as an experimenter – Moral leadership (integrity and ingenuity) - framework for ethical decision making.

UNIT II **Credit hours: 12**

Biotechnology and ethics: Biotechnology in agriculture and environment: benefits and risks – benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare.

UNIT III **Credit hours: 12**

Ethical implications of cloning: Reproductive cloning , therapeutic cloning ; Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research- GM crops and GMO's – biotechnology and biopiracy – ELSI of human genome project.

UNIT IV **Credit hours: 12**

Introduction to biosafety: Biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International), types of biosafety containment. Ethical issues for animal cell culture.

UNIT V **Credit hours: 12**

Introduction to intellectual property and intellectual property rights: Types, patents, copy rights, trade secrets and trademarks, design rights, geographical indications – importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO)

Recommended Books:

1. Principles of cloning, Jose Cibelli, Robert P. lanza, Keith H. S . Campbell, Michael D.West, Academic Press,2002Glimpses of Biodiversity – B.Bltosetti
2. Ethics in engineering, Martin. M.W. and Schinzinger.R. III Edition, Tata McGraw-Hill, New Delhi. 2003.

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2. https://hstalks.com/
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M. Sc. MICROBIOLOGY SEMESTER –IV (2023-24)

Industrial Training: Major Research Project at research laboratory or institute of repute (600 hrs)

Code of Course**: MBY914XS**

Level of the Course: NHEQF Level 6.5

Credit of the Course: 24

Course Outcome:

Upon completion of this course, students will be able to:

- Develop the skills to think independently, identification of a research topic, research planning, and its execution in 600 hrs.
- Undertake research on their area of interest in different fields of Microbiology.
- Demonstrate capacity to lead and manage change through collaboration with others.

NOTE:

1. In the IV semester student shall undertake a Project work. After completion the student shall submit a dissertation. The work shall be typically carried out in an industrial/Research organization/Institute individually by the students admitted in the IV semester. Each student shall complete the dissertation under a mentor/ supervisor. Just after joining a mentor, the student will inform to the Head of the Department/Course Director. It will be mandatory to submit the progress report in the middle of the semester to the Department. It has to be duly signed by the mentor/Supervisor giving number of hour the students has worked for the project. During the project period, a student is expected to work at least 30 hrs/week. Thus a candidate who successfully completes the project work can earn 24 credit points. At the end of the semester, the student has to submit work carried out in the project as Dissertation in a prescribed format. He is required to attach a certificate of successful completion of the project from his mentor/supervisor giving total number of hours worked to carry out the project work and staining his conduct in the entire period of project work. Evaluation of the project will be carried out by a committee consisting of external

examiner, internal examiner and a professor by examining the Dissertation, presentation of the project and demonstration of the work carried out with sufficient supporting data to check the work carried out in the project.

2. The students will have to take prior permission from the HOD at least 3 months in advance to join for MRP and submit their acceptance letter from the institute where he/she is going to do the training one month in advance. Failing this the student will not be permitted to go for training.
3. The student will have submit a duly signed and sealed certificate from the mentor and competent authority in the prescribed format (Annexure 1)
4. Student will be required to submit a hard copy of the grades prepared by the mentor as per the prescribed format filled in a sealed envelope. The mentor will also have to send a soft copy of the same to the HOD (Annexure 2).
5. Such students will also have to submit a dissertation report as per the prescribed format for the training (Annexure 3).

Internal Examination

In the paper entitled "Dissertation", student will submit a report on the progress of the work done in the middle of the semester to the head/Course Director. The report will be routed through the Mentor with his grading. A three member committee constituted by the Course Director shall finally award the internal marks of the "Dissertation".

Dissertation Evaluation

On completion of the dissertation the student has to submit the project report in the Department. The dissertation is to be written in a specified format (Annexure 1). It should be duly signed and certified by the mentor. On the day of examination student will give presentation of 25 minutes before the panel of examiners. The panel of examiner will consists of (i) One Professor (ii) External Expert (iii) Internal Examiner. One professor and the internal examiner will be picked up by the head of the Department/course Director. The Dissertation shall be examined and marks will be awarded following the marks distribution scheme given in table (Annexure 4).

ANNEXURE 1

DEPARTMENT OF MICROBIOLOGY
Vigyan Bhawan- Block 'B': New Campus
MOHANLAL SUKHADIA UNIVERSITY
UDAIPUR
2023-24

INSTITUTE NAME AND LOGO

Ref no.-…….. Date……

CERTIFICATE

This is to certify that the dissertation/project report entitled "**……**" submitted towards the partial fulfillment for the award of the degree of Master of Science in Microbiology, from Mohanlal Sukhadia University, Udaipur (Rajasthan) India is the result of bonafide work compiled by **Mr./Ms. …….** carried out under the guidance of **Dr. …….** at **……..** in the academic year of ……... During the dissertation period, the candidate has worked for at least 30 hrs/week with total of 600 hrs. It has no part the dissertation has been submitted for the award of any degree, diploma, fellowship or other similar titles or prizes and that the work has not been published in part or full in any scientific or popular journals or magazines.

Date

Name & Signature of the supervisor

Seal of the supervisor

ANNEXURE 2

M. Sc. MICROBIOLOGY Semester IV

ASSESSMENT SHEET

(To by submitted by Mentor)

Major Research Project

Name of Student:

S.No.	Assessment	Grade
	Technical Competence and instrument handling	
	Experimental Skills	
	Data Interpretation/ Result Analysis	
	Regularity	
	Communication Skills (Written and oral)	

Grade: Indicative Marks

A: (91-100)

B: (81-90)

C: (71-80)

D: (61-70)

E: (51-60)

F: (50 and Below)

Remark on professional competence (or deficiency) of the trainee and overall performance.

Name of the Mentor:

Designation : E-mail…….

Ph. No.

Organization:

Date: Signature with seal

ANNEXURE 3

General Guidelines for Preparation of Project Report

(For specific details the students are advised to consult their respective supervisors)

1. Strictly follow the format given to write the manuscript of the project.
2. On the front page include title of the project (font size 21, centered). The title should not contain abbreviation and scientific names of organisms should be in *italics.* This page should not be numbered.
3. Starting from second page, the pages must be numbered consecutively, including figures and table.
4. Text should be 1.5 point spaced type written using Times New Roman Font, Font Size 12, on one side of A 4 Size paper, with 1.5 inch margins throughout. Scientific names of the organisms should be in *italics.* Main headings (Summary, Introduction, Chapter details, Conclusions and References) should be bold type, justified and separated from the text.
5. The full text of project should not exceed 20-25 one side typed pages.
6. Literature citation in the text should be cited in alphabetic order. The form and style of references should be as indicated below.

(a) Journal article

Carvalho, L.C., Goulao, L., Oliveira, C., Goncalves, C.J. and Amancio, S. 2004. Rapid assessment for identification of clonal identity and genetic stability of *in vitro* propagated chestnut hybrids. Plant Cell Tiss. Org. Cult. 77:23-27.

Chae, W.B., Choi, G.W. and Chung, I.S. 2004. Plant regeneration depending on explant type in *Chrysanthemum coronarium* L. J. Plant Biotech. 6:253-258.

(b) Book reference

Salisbury, F. B., Ross, C. W. 1992. Plant Physiology. 4th edn. Wadsworth Publishing Company. Belmount.

(c) Edited books

Constantine, D.R. 1986. Micropropagation in the commercial environment. In : "Plant Tissue Culture and its Agricultural Applications". L.A. Withers and P.G. Alderson (Eds.) pp. 175-186. Butterworths, London, UK.

(d) Paper presented at a conference

Chaturvedi, H.C. 1992. Hardening of *in vitro* raised plants for transplant success. A state of art report. Paper presented in DBT Project Monitoring Committee Meeting held on 6th-7th July, 1992 in DBT, New Delhi, India.

(e) Proceeding of a symposium

Rajsekharan, P. E., Ganeshan, S. 2005. Designing *exsitu* conservation strategies for threatened medicinal plant species of South India. In: " Proc. Natl. Symp. and 27th Annual Meeting of PTCA(I)." A.K. Kukreja *et al* (Eds). Pp.159-164. CIMAP, Lucknow, India.

(f) Thesis/ Dissertation

Dave, N. 2004. Factors influencing micropropagation of two varieties of *Achras sapota* and their rootstock *Mimusops hexandra*. Ph.D. Thesis, Mohanlal Sukhadia University, Udaipur, India.

(g) Patent

Trepaginer, J.H. 2000. New surface finishings and coatings. US Pat 1276323 (to DuPont Inc, USA). 27 June, 2000. Chem Abstr, 49 (2000) 27689.

(h) Reports

Anonymous, 1976. The Wealth of India. Raw Meterials. Vo. X. pp. 44-48. CSIR, New Delhi, India.

TITLE MUST BE IN CAPITAL LETTERS, SIZE 21 AND CENTERED, WITH *Scientific names* IN ITALICS

A Project Report submitted

for the partial fulfillment of the Degree of Master of Science

By

(**Name of student**)

[M.Sc. (Microbiology), IV Semester]

Declaration

I, **……** Roll No. _____student of M. Sc. IV Semester Microbiology (Session 2023-24) hereby declare that the project entitled "……." is my own compilation. I have strictly adhered to the guidelines provided by the department for the preparation of the project report.

Date: Signature of the Student

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ANNEXURE 4

Marks Distribution and Examination Scheme for Major Research Project

M. Sc. Microbiology Semester IV

Duration: 35 min		**Maximum Marks 600**	**Min Marks 216**
S. No.	**Sections**	**Marks**	
1	Continuous assessment (30 each) Technical Competence Professional Qualities Ability to understand Research Communication Skills	120	
2	Dissertation write-up	300	
3	Presentation	100	
4	Viva-voce	80	
	TOTAL MARKS	**600**	