Khandesh Education Society's

Pratap College, Autonomous) Amalner

Structure of syllabus for

M. Sc.I

[Microbiology]

As per NEP 2020

[2023-24]

M. Sc. Microbiology

Prelude

The need for trained and skilled human resource is a prerequisite in the higher education. This coerces the necessity to acquire thorough knowledge of theoretical concepts and hands-on laboratory methods of the subject. On this streak, the present syllabus of M.Sc. part I in the subject Microbiology has been prepared as per the guidelines of UGC and cultivate a theoretical and practical know how of different fields of Microbiology. The contents of syllabus have been prepared to accommodate the fundamental aspects as well as advanced developments in various disciplines of Microbiology and to complement the needs of various applied sectors of Microbiology.

Beside this, the graduate students will be enlightened with knowledge in the newer areas of Microbial Systematic, Bioinstrumentations, Biomolecules, Microbial Genetics, Immune response, etc. Post graduate students will surely have an urge to endure research studies in Microbiology and contribute significantly in the development.

The present syllabus is restructured to cater the present and future needs of Microbiology in research field, Industrial Sector, Environmental Sector, etc., with more emphasis on imparting hands-on skills. Hence, the curriculum is endowed with more experiments that shall run hand-in-hand with theory. The extensive appendix is furnished for each course to support know how and suffice the inquisitive of the students. The detailed syllabus of each paper is appended with a list of suggested readings.

Learning objectives

To acquaint students with:

- Basic concepts, principles and methods of Microbial Diversity, microbial Systematics and
- Bioinstruments used in isolation and identification of microbes and structural determination of biomolecules.
- Basic and applied aspects of Genetic makeup of bacteria, algae, fungi and viruses. Causes, mechanisms and consequences of defect in gene/genome of microorganisms. Basic concepts of microbial enzymes, enzyme kinetics, regulation of enzyme activity, industrial applications of enzymes.
- Biotechnological significance of enzymes of extremophiles in agriculture, environment, medicine and industry.
- Concepts and significance of enzymes in non-aqueous environment.

Learning outcome: After completion of this course, students are expected to learn/understand the:

- Basic and applied aspects of microbial diversity and systematic.
- Physiology, biochemistry and applications of basic and applied aspects of microbial diversity and systematic.
- Principles, working and application of bioinstruments used in isolation and identification of microbes and structural determination of biomolecules.
- Characteristics and significance of Extremophiles, Algae, Fungi, Viruses.
- Impact of various groups of microbes on earth atmosphere, human, plant and animal health and technology development.
- Structure, properties, pathways and significance of biomolecules.
- Applications of microbial biomolecules in various fields.
- Basic and applied aspects of Genetic makeup of bacteria, algae, fungi and viruses. Causes, mechanisms and consequences of defect in gene/genome of microorganisms.
- Basic concepts of microbial enzymes, enzyme kinetics, regulation of enzyme activity, industrial applications of enzymes.
- Biotechnological significance of enzymes from extremophiles in agriculture, environment, medicine and industry
- Enzyme function in non-aqueous environment

Structure of Syllabus for M.Sc. (Part- I) Microbiology

Year	Level	Semester	Major Core Courses		RM	OJT	Cumulative Credit
1st	6.0	Sem I	Mandatory	Elective	RM (4T)	-----	22
			DSC 25 (4)T	DSE 5 (4)T			
			DSC 26 (2)T				
			DSC 27 (4)T				
			DSC 28 (2)P				
			DSC 29 (2)P				
		Sem II	DSC 30 (4)T	DSE 6 (4)T	------	OJT (4)	22
			DSC 31 (2)T				
			DSC 32 (4)T				
			DSC 33 (2)P				
			DSC 34 (2)P				

Structure of Syllabus for M.Sc. (Part- I) Microbiology

Semester I

Course	Subject Code	Credit	Title of the Paper	Duration in hours/ Weak	Max Marks	Exam Time
DSC 25 (4)T	MB-MJ-501	4	Microbial Taxonomy and Diversity	04	100	3 hrs
DSC 26 (2)T	MB-MJ-502	2	Cell Biology -I	02	50	2 hrs
DSC 27 (4)T	MB-MJ-503	4	Microbial Biochemistry	04	100	3 hrs
DSC 28 (2)P	MB-MJP-504	2	Methods in Microbiology	04	50	3 hrs
DSC 29 (2)P	MB-MJP-505	2	Methods in Biochemistry	04	50	3 hrs
DSE 5 (4)T	MB-EC-521	4	Bioanalytical Techniques	04	100	3 hrs
RM (4)T	MB-RM-541	4	Research Methodology	04	100	3 hrs
	Total	22		Total	550	
Semester II						
DSC 30 (4)T	MB-MJ-551	4	Microbial Genetics	04	100	3 hrs
DSC 31 (2)T	MB-MJ-552	2	Cell Biology -II	02	50	2 hrs
DSC 32 (4)T	MB-MJ-553	4	Microbial Enzymology	04	100	3 hrs
DSC 33 (2)P	MB-MJP-554	2	Methods in Enzymology	04	50	3 hrs
DSC 34 (2)P	MB-MJP-555	2	Methods in Molecular Biology and Immunology	04	50	3 hrs
DSE 6 (4)T	MB-EC-571	4	Immunology	04	100	3 hrs
OJT	MB-OJT-591	4	On Job Training/Internship	60	100	3 hrs
	Total	22		Total	550	

- Each theory and practical course has to complete in 60 lectures, respectively of 60 min duration or 30 lectures, respectively of 60 min duration as per credit of the course.
- Each theory course will be of 100 marks comprising of 40 marks internal (20 marks of 3 internal examinations) and 60 marks external examination. OR 50 marks comprising of 20 marks internal (10 marks of 3 internal examinations) and 30 marks external examination.
- Theory examination (60 marks) will be of three hours duration for each theory course. There shall be 5 questions each carrying equal marks (12 marks each). The pattern of question papers shall be:
- Question 1 (12 marks): 6 sub-questions, each of 3 marks; answerable in brief and based on entire syllabus, attempt any 4 out of 6 questions.
- Question 2, 3 and 4 (12 marks each): based from Unit I, II, and III, respectively, each question has 3 sub-questions of 6 marks each and answer only 2 sub-questions from each Q2, Q3, and Q4.
- Question 5 (12 marks): answer only 3 out of 5 in brief, based from all 3 units, Each 4 marks.

Note: The pattern of examination may be change as per instructions and guidelines from Exam Dept. of the college.

Internal examination (40 marks each semester): Internal assessment of the student by respective teacher will be comprehensive and continuous, based on written test. The written test shall comprise of both objective and subjective type questions.

Practical Examination: Practical examination shall be conducted by the college at the end of the semester. Practical examination will be of minimum 3 hours duration and shall be conducted as per schedule (10 am to 1 pm on schedule date or can be scheduled 10 am -1pm/ 2 – 5 pm for 2 consecutive days) in case of microbiology practical's where incubation condition, allied aspect are essential. There shall be 5 marks for laboratory log book and well written journal, 5 marks for vivavoce and minimum 2 experiments (major and minor). Certified journal is compulsory to appear for practical examination. There shall be two expert and two examiners (external and internal) per batch for the practical examination

Note: It may change as per guideline from Examination Department
Separate sheet is attached.

Semester I
DSC-25
PAPER CODE: MB-MJ-501
Microbial Taxonomy and Diversity

Course Objectives:
1. To understand the ubiquitous nature of microbes to build basic concept
2. To give basic knowledge on extremophiles
3. To provide knowledge on characteristics of various microbes

Credit 4 Lectures 60

Unit	Title	Topic Particular	Lectures
Unit I	Microbial Systematics	• Introduction to Bergey's Manual of Systematic Bacteriology 9th Edition. • Polyphasic identification approaches: 16S rRNA Ribotyping, Cell wall Fatty Acid Methyl Ester Analysis (FAME), BIOLOG, DNA fingerprinting, Randomly Amplified Polymorphic DNA (RAPD), Metagenomics concept • Culturable and Non-culturable biodiversity • Microbial metabolic diversity and Conservation of microbial diversity • Culture collection centers in India	12
Unit II	Extremophile bacteria (Archaea)	• Types and properties of Archaea: Thermophile, Psychrophile, Barophile, Halophile, Acidophile, Alkalophile, radiation resistant bacteria, Metanogens • Methods/Techniques for cultivation of Thermophile, Psychrophile, Barophile, Halophile, Acidophile, Alkalophile, Xerophiles, Endoliths. • Applications of extremophiles in Agricultural, • Pharmaceutical and Environment	12
Unit III	Algae	• Nutrition: Physical and chemical requirements, Types based on nutrition • Significance of algae in biogeochemical Cycle, food, Animal feed, fertilizers, cosmetics, therapeutic supplements, extracts (Agar, Alginate, Carrageenan), Biopigments. • Algal farming for biodiesel • BGA : General characteristics, cultivation and significance • Prochlorons and cyanelles	12
Unit IV	Fungi	• Characteristics: Fungi (Yeast, moulds and dimorphic fungi), mycorrhizal fungi • Endophytic fungi: General characteristics, Growth, Cultivation and Significance. • Ecological significance and applications of fungi: Biogeochemical role, Medical significance (Mycoses), Industrial and Biotechnological applications	12

Unit V	Virus	• Structure and classification of virus on the basis of genome • Structure of virus - Virus proteins, Capsids, Virion membranes, Ultrastructure of Animal Virus (Corona), Plant virus (TMV) and Bacterial virus (T4 phage). • Cultivation of viruses –Basic and advance methods. • Detection/Enumeration of viruses - Plaque formation, cytopathic effect. • Emerging viruses: Corona Virus, • Viruses in Oncogenesis : Oncogenic viruses, Source and causes of viral induced oncogenesis,	12

On completion of this course, the student will be able to:

1.1 Differentiate various groups of microbes and microbial taxonomy

1.2 Acquire knowledge on adaptability of extremophiles and microbial diversity

1.3 Acquaint with the scope of microbiology in different diversified areas.

Suggested readings:

1. Carter, John B and Saunders, Venetia A. (2007) Virology : Principles and applications, John Wiley & Sons Ltd., London
2. Wagner, E. K. and Hewlett, M. J (2004) Basic Virology, 2nd Edn., Blackwell Publications, Oxford, UK.
3. Conrat, H.F. KiMB-Nall, P.C. and Levy, J. A (1994) Virology, 3rd Edn., Prentice Hall, Eaglewood Cliff, New Jersey, USA
4. Hull, R. (2002) Matthew's Plant Virology, 4th Edn., Academic Press, London Dimmock, N. J. Easton, A. J. and Leppard, K. N. (2001) Introduction to Modern Virology, 5th Edn., Blackwell Science, London
5. Laura Barsanti, and Paolo Gualtieri (2006) Algae: Anatomy, Biochemistry and Biotechnology, Taylor & Francis Group, UK
6. Becker, E. W. (1994) Microalgae- Biotechnology and Microbiology, CaMB-Nridge University Press, UK.Burnett, J. H.
7. Kevin Kavanagh (2005) Fungi: Biology and Applications, John Wiley & Sons Ltd., West Sussex,
8. Jim Deacon (2006) Fungal Biology, 4th Ed. Blackwell Publishing Ltd., West Sussex
9. Alexopoulous, C. J. and Mims, C. W. (1979) Introduction to Mycology, Wiley Eastern Ltd., New Delhi
10. Griffin, D. H. (1994) Fungal Physiology, Wiley-Liss, New York
11. Kathy Talaro and Barry Chess (2012) Foundations in Microbiology, 8th Edn., The McGraw-HillCompanies, Inc., New Delhi
12. Tortora, Funke and Case (2010) Microbiology, 10th Edn., Brenjamin Cummings Inc. California
13. Moselio Schaechter (2009) 2nd Ed, Desk encyclopaedia of Microbiology, Elsevier
14. Prescott, Harley and Klein's (2002) Microbiology, 5th Ed. The McGraw-Hill Companies, Inc.,
15. Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2011) Foundations in Microbiology, 7thEdn., Nirali Prakashan, Pune
16. Fred A. Rainey and Aharon Oren (2006) Extremophiles, Methods in Microbiology, Volume 35 Elsevier and Academic Press,
17. Martin Dworkin (Editor) (2006) The Prokaryotes A Handbook on the Biology of Bacteria Volume 2,Ecophysiology and Biochemistry, Springer-Verlag New York.
18. Michael T. Madigan, John M. Martinko, Paul V. Dunlap, David P. Clark, (2009) Brock Biology of Microorganism, Benjamin Cummings, California, USA.
19. Bergey's Manual of Systematic Bacteriology (2001) Editor-in-chief: Garrity, George M. Boone,
20. David R.; Castenholz, Richard W. (Eds.), (4 Volumes) Springer/ Williams and Wilkins, USA

21. Kushner, D.J. eds. (1978) Microbial life in extreme environments. Academic Press, London.
22. Horikoshi, K., Grant, W.D. eds. (1998) Extremophiles, Microbial life in extreme environments. Wiley- Liss Publishers, New York.

DSC-26

PAPER CODE: MB-MJ-502

Cell Biology -I

Course Objectives:

1. To introduce the basics of cell biology
2. To understand the cellular organization and transport
3. To learn cell division and human genetics

Credit 2 Lectures 30

Unit	Title	Topic Particular	Lectures
Unit-I	**Introduction to cell biology**	• Cell theory and its implications in modern biology • Protoplasm theory • Cell types- Bacteria, Archaea (prokaryotic) and eukaryotic cells and evolutionary perspectives • Cytoskeleton dynamics and its role in cellular architecture • Tools and techniques used in cell biology- CRISPR-Cas9 Gene Editing and live cell imaging (fluorescent probes and time-lapse microscopy).	10
Unit-II	**Prokaryotic Cell Biology**	• Ultra-structure of bacterial cell, Structure, Function and Chemical Composition of: Glycocalyx/capsule, • Flagella, endoflagella, Pilli, Cell wall, sphaeroplasts, protoplasts, and L-forms • Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell • Nucleolus, Nucleoid Mesosomes, Plasmid, phasmid, Ribosome, • Cytoplasmic inclusions (volutin granules, PHB granule, glycogen, carbohydrates, • Magnetosomes, gas vesicles, carboxysomes, chlorosome and sulphur granules) and Endospore structure • Structure, Function and Chemical Composition of : Flagella, Cell wall, Cell Membrane, , Ribosome •	10
Unit-III	**Cell Organelles and Subcellular Structures**	• Nucleus: organization, chromatin structure • Endoplasmic reticulum: protein synthesis(brief overview), protein folding and quality control • Golgi apparatus: processing, sorting, and trafficking of proteins • Mitochondria: structure and functions • Lysosomes: function, autophagy, and cellular waste disposal • Peroxisomes: roles in metabolism and reactive	10

		oxygen species detoxification • Cytoskeleton: microtubules, microfilaments, and intermediate filaments	

Learning Outcomes : On completion of this course, the student will be able to:
1. Acquire basic understanding of cell biology
2. Get knowledge cell organelles and transport
3. Learn the steps in cell cycle and human genetics

Suggested readings:

1. De Roberties E. D. P. and De Roberties E. M. F. (2005) Cell and molecular biology (8th Ed), Lippincott Williams and Wilkins, Philadelphia
2. Lodisch H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H and Matsudaire P (2008) Molecular Cell Biology. WH Freeman & Co., NewYork.
3. Madigan M.T. and Martinko J.M., (2005) Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA,
4. Pawar C. B. (2007) Cell biology, Himalaya Publishing House, Mumbai
5. Rasoti S. C. (2005) Cell biology, New Age Int., New Delhi.
6. Verma P. S. and Agrawal V. K. (2018) Cell biology, genetics, molecular biology, evolution and ecology, S. Chand, New Delhi.

DSC-27

PAPER CODE: MB-MJ-503

Microbial Biochemistry

Course Objectives:
1. To know the structural organization, characteristics and metabolism of biomolecules
2. To learn microbial metabolic pathways and its enzymatic regulation
3. To acquire knowledge on transport of solute and energy metabolism

Credit 4 Lectures 60

Unit	Title	Topic Particular	Lectures
Unit I	Biomolecules	• Classification, Structure and Significance of carbohydrates, lipids, proteins • and nucleic acids. • Chemical bond formation in carbohydrates, lipids, proteins and nucleic acids • Structural organization of proteins: Primary, secondary, Tertiary and • Quaternary structure; Ramachandran plot, cot value • Vitamins of microbial origin: Structure, properties and Functions.	12
Unit II	Transport and energy metabolism	• Ultrastructure of cell membrane and structural features • Transport of molecules: Types of transport – (a) Active, (b) Passive, (c) Facilitated, (d) Translocation. Na/K+ ATPase.,(e) Ionophores and siderophores • Energy metabolism : Free energy, bacterial and mitochondrial ETC, ATP Synthase complex, inhibitors of oxidative phosphorylation, Energetics of ETC.	12
Unit III	Metabolism	• Metabolic pathway, EMP, HMP, TCA, Glyoxylate	12

	of carbohydrates	• pathway, C3 and C4 pathway, bioenergetics and regulation. • Alternative glycolytic pathways	
Unit IV	Metabolism of Lipids	• Metabolic pathway, Bioenergetics and regulation of: Fatty acid synthesis, • Catabolism of lipids FAS Complex	12
Unit V	Amino acid and Nucleotide metabolism	• Metabolic pathway, Bioenergetics and regulation of: amino acid degradation and biosynthesis • Transamination, Deamination, Stickland Reaction. • Metabolic pathway, Bioenergetics and regulation : Purines and Pyrimidine biosynthesis: De novo pathway and Salvage pathway, Ribonucleotide reductase and inhibitors of nucleic acid biosynthesis	12

Course Outcomes
2.1 Acquire knowledge on metabolism of biomolecules
2.2 Familiarise with amino acids, proteins, lipids, nucleic acids and enzymes
2.3 Understand biochemical reactions in microbial cells and metabolic pathway diversity

Suggested readings:

1. White, D. (2000) The Physiology and Biochemistry of Prokaryotes, Oxford University Press, New York, USA
2. Gottschalle, G (2004) Bacterial Metabolism, Springer, Weinheim
3. Moat, A. G. and Foster, J. (1988) Microbial Physiology, Wiley Interscience Publ., New York
4. Nelson, D.L. and Cox, M.M. (2000) Lehninger's Principles of Biochemistry, CBS Publications, New Delhi
5. Stryer, L. (1992) Biochemistry, 4th Edn., W.H. Freeman and Co., New York, USA
6. Price, N.C. and Stevens, L. (2000) Fundamentals of Enzymology, 3rd edn., Oxford University, Press, NY, USA.
7. Voet, D., Voet, J.G. and Pratt C.W. (1999) Fundamentals of Biochemistry. John Wiley & Sons, Inc., Chicheter, UK
8. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2003) Harper's Biochemistry. Appleton and Lange, Stamford, Connecticut.
9. Jain, J.L., Jain, S. and Jain, N. (2009) Fundamentals of Biochemistry, S Chand, New Delhi
10. Das, H. K. (2005) Text book of Biotechnology, 2nd Edn. Wiley Deramlech India Pvt. Ltd., New, Delhi.
11. Doelle, H.W. (1975) Microbial Metabolism, 2nd Edn, Academic Press, London

DSC-28

PAPER CODE: MB-MJP-504

Methods in Microbiology

Course Objectives:
1. To familiarize the student in biochemical techniques and learn basic microbial biochemistry
2. To utilize bioinformatics software tool to understand the biomolecule

Credit 2 Lectures 60

Sr. No.	Title of the practical
1	Biosafety: Safe Laboratory techniques (GLP), Equipment related hazards, Biosafety cabinets, Transport of infectious material/cultures, Waste disposals, Fire and

	electricity hazards, Immunization of staff.
2	Growth Curve of yeast by Turbidity (Spectrophotometer/ Nephelometer) and Dry mass (Centrifugation) measurement
3	Isolation and cultivation of cyanobacteria/ Algae.
4	Isolation and cultural characterization of Actinomycetes.
5	Isolation and enumeration of Bacteriophages by plaque Titer Method
6	Cultivation of algae/ Endophytic fungi
7	Isolation of Acidophile/ Alkalophile/ Halophile/ Thermophile/ Psychrophile bacteria from extreme environments.
8	SDS PAGE of protein
9	Agarose gel electrophoresis of DNA
10	Column chromatography – Sepharose/Agarose/XAD/Octyl/CM Cellulose/DEAE Cellulose

On completion of this course, the student will be able to:
4.1 Acquire expertise in basic biochemical techniques
4.2 Get knowledge in the analysis and estimation of biomolecules
4.3 Carry out biochemical analysis

Suggested readings:

1. Norris, J. R. and Ribbons, D. W. (Ed) (1969) Methods in Microbiology, Vol 1, Academic Press Inc. Ltd., London
2. Harley, J. P., Lansing, M. Prescott, (2002) Laboratory Exercises in Microbiology, 5th Edn., The McGraw−Hill Companies, New York
3. Benson, H. (2001) Microbiological Applications Lab Manual, 8th Edn. The McGraw Hill Co., New York
4. Aneja, K.R. (1996) Experiments in Microbiology, 3rd Edn., Wishwa Prakashan, New Delhi.
5. Parija, S.C. (2005) Text Book of Practical Microbiology, Ahuja Publishing House, New Delhi.
6. Patil, Ulhas and Muskan, Kalyani (2009) Essential of Biotechnology, IK International, New Delhi
7. Dubey, R.C. and Maheshwari, D.K. (2004) Practical Microbiology, S. Chand and Co. New Delhi.

DSC-29

PAPER CODE: MB-MJP-505

Methods in Biochemistry

Course Objectives:
1. To introduce the student to the variety of biophysical and biochemical techniques
2. To make them familiar with various approaches of analytical techniques

Credit 2 Lectures 60

Sr. No.	Title of the practical
1	Basic biochemical techniques: Use of hand glove, Use of pipette aid, Preparation of standard solutions and buffers, Dilution approaches and Calibration of glass wares (pipet, volumetric flask)
2	Preparation of buffers of various pH and determination of pKa of a buffer system
3	Quantitative analysis reducing sugar by DNSA method.
4	Quantitative estimation of Total carbohydrate - Phenol sulphuric acid method.
5	Quantitative estimation of - Folin-Ciocalteu method/Biuret Method.
6	Quantitative estimation of amino acids by ninhydrin method.
7	Quantitative estimation of DNA by Diphenyl amine method.
8	Quantitative estimation of RNA by Orcinol method.
9	Quantitative estimation of lipids - Determination of Iodine and acid number.
10	Qualitative analysis of biomolecules by Thin Layer Chromatography: Sugars and amino acids

Course Outcomes (COts): On completion of this course, the student will be able to:
5.1 Acquire knowledge on basic biophysical and biochemical aspects
5.2 Learn purification of molecules, analytical tools, electrophoretic separation
5.3 Learn how to interpret protein mobility on page under native and SDS

Suggested readings:

1. Thomas, G.M. and Shalkhammer, (2004) Analytical Biotechnology, Springer, New Delhi
2. Thimmaiah, S.R. (2006) Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.
3. Plummer, D.T. (2001) An Introduction to Practical Biochemistry, 3rd edn., McGraw Hill Ltd. New Delhi
4. Sawhey, S.K. and Singh, R. (2002) Introductory Practical Biochemistry, Narosa Publication House, New Delhi.
5. Jayramann, J. (2008) Laboratory Manual in Biochemistry, New Age International, New Delhi.
6. Schmauder, H.P, Schweizer, M. and Schewizer, L.M. (2003) Methods in Biotechnology, Taylor and Francis Ltd., London

DSE-5

PAPER CODE: MB-EC-521

Bioanalytical Techniques

Course Objectives:
1. To familiarize in General Microbiology techniques
2. To learn the basic microbial techniques used for characterization of microbial system
3. To know about effect of environmental condition on microbes

Credit 4 Lectures 60

Unit	Title	Topic Particular	Lectures
Unit I	Separation Techniques	• Chromatography: Principle, design and applications of HPTLC, GC, HPLC, Gel filtration, Affinity chromatography. • Electrophoresis and electrofocusing: Principle, design and applications of Agarose gel, PAGE and Iso-electric focusing. Centrifugation and Ultracentrifugation	12
Unit II	Biophysical methods of analysis of biomolecules	• Spectrophotometry: UV-visible spectrophotometer, fluorescence, Circular dichroism, • Spectroscopy: IR, NMR and ESR spectroscopy, • Structure determination: X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry.	12
Unit III	Radiolabeling techniques	• Properties of different types of radioisotopes used in biology, detection and measurement of radioactivity using GM scintillation counters, tracer techniques. • Radiolabelling of biological tissues and cells. Safety guidelines for use and disposal of radioisotopes.	12
Unit IV	Microscopic techniques	• Electron microscopes (Scanning and Transmission) – Principle, Working and Construction and application in microbiology • Smear preparation for electron microscope. • Staining techniques for electron microscope, freeze-etch and freeze-fracture methods for electron microscope. • Image processing for electron microscope.	12
Unit V	Biosensors	• Biosensors – Principle, Working, Types and	12

		Applications • Nano-biosensors ,Biomarkers and Bioreporter	

On completion of this course, the student will be able to
3.1 Develop expertise in basic analytical techniques of microbiology.
3.2 Get knowledge in the analysis of biomolecules
3.3 Carry out microbial techniques related to isolation, identification of algae, fungi, archea

Suggested readings:

1. Upadhyay, A., Upadhyay, K. and Nath, N. (2000) Biophysical Chemistry, Himalaya Publisher, Nagpur.
2. Friefelder A, D. (1993) Physical Biochemistry, 2nd Edn. W. H. Freeman & Co., USA.
3. Van Holde, K. E. (1985) Physical Biochemistry, 2nd Edn., Prentice Hall Inc. New Jersey.
4. Skoog, D.A., Hollier, F.J. and Nieman, I.A. (1998) Principles of Instrumental Analysis, Harcourt Brace College Publishers, Orlando.
5. Wilson, K. and Walker, J. (2000) Practical Biochemistry: Principles and techniques, 5th Edn., ambridge University Press, Cambridge.
6. Willard, H.H. and Merrit, Jr. L.L. (1986) Instrumental Methods of Chemical Analysis, CBS Publishers, New Delhi.
7. Wilson, K. and Goulding, K.H. Biologists Guide to Principle and Techniques of Practical Biochemistry, ELBS Publications, London.
8. Mikkelsen, S.R. and Corton, E. (2004) Bioanalytical Chemistry,Wiley Interscience, New York, USA,
9. Sivasankar, B. (2005) Bioseparations Principles and Techniques, Printice Hall of India Pvt. Ltd., New Delhi.
10. Bengt Nölting (2009) Methods in Modern Biophysics, 3rd Edn., Springer, Berlin.

RM

PAPER CODE: MB-RM-541

Research Methodology

Credit 4 Lectures 60

Course objective

- To understand some basic concepts of research and its methodologies.
- To select and define appropriate research problem and parameters.
- Understand the various techniques of Data Collection- Observation, Questionnaire, Interview Schedule; CaseStudy, Social Survey, Content Analysis.
- Describing various types of Sampling
- Elaborate on Data Processing and Data Analysis
- Writing of dissertations, project proposals, project reports, research papers.

Unit	Topics	Lectures
Unit I	Foundations of Research Meaning of research Objectives of research Motivation in research Research methods versus methodology Types of research a) Analytical *vs* Descriptive b) Quantitative *vs* Qualitative c) Basic *vs* Applied d) Conceptual *vs* Empirical	**12**
Unit II	Research Design Meaning of research design Need of research design Features of good design Importance concepts of research design a) Observation and Facts b) Prediction and Explanation c) Development of Models Developing a research plan by using a) Problem identification b) Experimentation c) Determining experimental and sample designs	**12**
Unit III	Data Collection, Analysis and Presentation Observation and Collection of Data Methods of data collection - Sampling Methods Data Processing and Analysis Strategies a) Tabulation of data: i. Variables(Definition, types with example); Frequency distribution(Definition, types and example); ii. Measurement of central tendency(Definition, types of average – mean, median, mode with example); iii. Standard deviation(SD) and iv. Standard error(SE) b) Data Analysis Strategies i. Testing hypothesis ii. Chi-square test iii. Student 't' test Data presentation using MS Excel application of MS office. a) Charts: Types of Charts i) Column charts, ii) Line charts iii) Pie charts iv) Bar charts v) Area charts vi) Scatter charts vii) Stock charts viii) Surface charts ix) Radar charts x) Tree charts xi) Sunburst charts xii) Histogram xiii) Box and whisker charts xiv) Water fall charts xv) Funnel charts	**16**

	b) Elements of Bar charts c) Creation of Bar Charts using MS Excel application d) Creation of Spark line Charts using MS Excel.	
Unit IV	Technical Reports and Thesis writing Prepare Title, Author and Addresses, key words and Abstract (summary and synopsis) Writing of technical report and thesis - IMMRAD system (Introduction, Material methods, Result and Discussion), Acknowledgement, Summary, Conclusion and references. Concept of scientific writing Meaning of scientific paper Write a letter to Editor of scientific journal for publishing a research paper.	**12**
Unit V	Ethical Issues Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Impact factor h-index	**8**

Learning outcomes

After successful completion of this course, students are expected to:

- understand some basic concepts of research and its methodologies.
- differentiate between the Quantitative and Qualitative Research and understand different types of Research Design
- select and define appropriate research problem and parameters.
- organize and conduct research project in a moreappropriate manner.
- writing of dissertations, project proposals, project reports, research papers.
- understand intellectual Property Rights – Biopiracy, copyrights, patent and traditional knowledge and plagiarism.

Suggested Readings

1) Anthony,M,Graziano,A.M.andRaulin,M.L.200
9. Research Methods: A Process of Inquiry, Allyn and Bacon.
2) Coley,S. M. and Scheinberg, C. A.1990,"Proposalwriting".StagePublications.
3) Gurumani, N. Research methodology for biological science, MJP publisher, Chennai.
4) Kothari C. R. Research Methodology, New Age International,2009
5) Robert A. Day, How to write and publish a Scientific papers (4th edition).
6) Tejinder Singh and N. G. Madhav, Better Thesis Writing
7) Wadhera, B. L. Law Relating to Patents, Trade Marks, Copyright Designsand Geographical Indications, 2002, Universal Law publishing
8) Walliman,N.2011.ResearchMethods - The Basics. Taylor and Francis, London, New York.

Semester II
DSC-30
PAPER CODE: MB-MJ-551
Microbial Genetics

Credit 4 Lectures 60

Unit	Title	Topic Particular	Lectures
Unit I	Genome organization	• General features of genome: Bacteria, Viruses, • Prokaryotic Chromosome • Genome: E. coli, Phage (T4, T7, φX174), • Genome vocabulary: Operon, interrupted genes, gene families, chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, allele, transposons. • Eukaryotic chromosome structure and function • Principles of Mendelian inheritance, • Extra-chromosomal inheritance (episomes, mitochondria and chloroplasts) • Transposons	12
Unit II	Virus Genome replication	• General aspects of viral genome replication: Gapped, Segmented, Positive, strands of DNA, Negative strands of DNA, Positive strands of RNA, Negative strands of RNA. • Replication: DNA replication (Initiation, elongation and termination), Double stranded RNA replication, Single-stranded RNA replication. • Mechanism of reverse transcription and viral interference	12
Unit III	DNA Damage and Repair	• Mutation: Spontaneous and induced (Physical and Chemical mutagens), • Effects of mutation on the gene product: loss of the function of mutants (null,leaky mutations), gain of function of mutants, random or adaptive mutations, • Significance of mutants: Uses of bacterial and fungal mutants in strain improvement, Bacteriophage mutants in viral genetics, Plasmids in emergence of Multiple Drug Resistance. • DNA protection and repair: Role of restriction-modification system in DNA protection and repair.	12
Unit IV	Plasmid biology	• Characteristics and Features of bacterial plasmid: Size, Conformation, origin of replication, replication proteins, regulation of plasmid copy number, amplification, segregation and compatibility. Curing of plasmids and plasmid incompatibility. • Types of plasmid in: Bacteria (R, F, Ti, Vi, Ri, Deg, Col) and Saccharomyces (Snapfast). • Plasmid segregation: Random diffusion, par regions, post-segregational killing. • Plasmid isolation: Isolation and purification techniques for bacterial plasmids	12

Unit V	Gene regulations	• Gene regulation in bacteria and Viruses: His and Lac operon, Quorum sensing, Riboswitch, gene regulation by repressor in Lysogenic cycle of bacteriophage • Gene regulation in eukaryotes: DNA Rearrangements, Chromatin Modification, Cis-acting site, RNA Silencing.	12

Suggested readings:

1. Streips, U. N. and Yasbin, R. E. (2002) Modern Microbial Genetics, 2nd Edn., Wiley-Liss, New York
2. Maloy, S. and Freifelder, D. (1994) Microbial Genetics, Jones and Barlett Publishers, London
3. Dale, J. W. (1994) Molecular Genetics, John Wiley and Sons, Hoboken, NJ, USA
4. Upadhyay, A., and Upadhyay, K. (2005) Molbio: Fundamentals of Molecular Biology, Himalya Publication House, Mumbai
5. Trun, Nancy Jo and Trempy, J. E.(2006) Fundamental Bacterial Genetics, Blackwell Publishers, New York
6. Verma, P.S. and Agrawal, V.K. (2005) Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, S Chand and Co., New Delhi
6. Gupta, P.K. (2008) Cell and Molecular Biology, Rastogi Publications, Meertut
7. Rastogi, V. B. (2008) Fundamentals of Molecular Biology, Ane Books, New Delhi
7. Larry, Snyder and Wendy, Champness (2007) Molecular Genetics of Bacteria, 3rd Edn, ASM Press, Washington, USA.
8. Malacinski, G.M. (2005) Freifelder's Essentials of Molecular Biology, 4th Edn., Narosa Publishing House, New Delhi

DSC-31

PAPER CODE: MB-MJ-552

Cell Biology -II

Credit 2 Lectures 30

Unit	Title	Topic Particular	Lectures
Unit-I	**Cell Membrane Dynamics and Transport**	• Structure and organization of cell membranes • Membrane lipid composition and its impact on function • Protein-lipid interactions and membrane fluidity • Membrane transport mechanisms: diffusion, facilitated transport, active transport • Membrane receptors (GPCRs, RTKs, ion channel and nuclear) • Endocytosis and exocytosis: mechanisms and regulation	10

		• Intracellular membrane trafficking and vesicular transport	
Unit-II	**Cell Division and Systems Biology**	• Cell cycle control: checkpoints, cyclin-cdk complexes, and regulatory proteins • Mitosis and cytokinesis: spindle assembly, chromosome segregation, and cleavage furrow formation • Meiosis and sexual reproduction: gametogenesis, recombination, and genetic variation • Systems biology: Brief overview and applications	10
Unit-III	**Human Genetics**	• Pedigree analysis; amniocentesis • Twins: monozygotic and dizygotic • Human traits • Disorders due to mutant genes: Huntington's chorea, tongue rolling, phenylketonuria, alkaptonuria, albinism, sickle cell anaemia • Human cytogenetics: Banding techniques; sex determination; sex linkage; chromosomal aberrations	10

Suggested readings:

1. De Roberties E. D. P. and De Roberties E. M. F. (2005) Cell and molecular biology (8th Ed), Lippincott Williams and Wilkins, Philadelphia
2. Lodisch H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H and Matsudaire P (2008) Molecular Cell Biology. WH Freeman & Co., NewYork.
3. Madigan M.T. and Martinko J.M., (2005) Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA,
4. Pawar C. B. (2007) Cell biology, Himalaya Publishing House, Mumbai
5. Rasoti S. C. (2005) Cell biology, New Age Int., New Delhi.
6. Verma P. S. and Agrawal V. K. (2018) Cell biology, genetics, molecular biology, evolution and ecology, S. Chand, New Delhi.

DSC-32

PAPER CODE: MB-MJ-553

Microbial Enzymology

Credit 4 Lectures 60

Unit	Title	Topic Particular	Lectures
Unit I	Concepts in Enzymology	• General characteristics of enzyme, Ribozyme, Abzyme and Coenzymes • Enzyme Nomenclature, classes of enzymes, enzyme activity, Specific activity, catal, Substrate specificity, turn over number. • Enzyme active site • Effect of pH, temperature, substrate concentration, activator on enzyme activity • Enzyme turnover: Concept and significance. • Isoenzyme: Concept, properties e.g. LDH • Multienzyme complexes- pyruvate dehydrogenase (PDH) and fatty acid synthetase, advantages of multienzyme complex	12
Unit II	Enzyme Kinetics	• Elementary reactions, Reversible reactions, Rates of reactions, Transition state theory • The Michaelis–Menten Equation, Concept of Km and Vmax, Double reciprocal plot and Brigg's Haldane plot, Analysis of Kinetic Data. • Enzyme Inhibition : Competitive Inhibition, Non-competitive, Uncompetitive Inhibition and Mixed Inhibition, • Bi-substrate kinetics and Oligomeric enzymes	12
Unit III	Mechanism and regulation of enzyme catalysis	• Acid–Base Catalysis: Covalent Catalysis, Metal Ion Catalysis, Electrostatic Catalysis, Catalysis through Proximity and Orientation Effects, Catalysis by Preferential Transition State Binding • Serine Proteases : Kinetics and Catalytic Groups, X-Ray Structures, Catalytic mechanism, Testing Catalytic Mechanism, Zymogens • Enzyme regulation: Feedback inhibition, enzyme repression, induction and degradation, enzyme regulation by cAMP, covalent modification, allosteric regulation of enzymes (ATCase)	12
Unit IV	Industrial applications of enzymes	• Perspective of use of enzyme in industry • Source, Significance and biotechnological applications of Cellulases (Cellulose hydrolysis), Proteases (protein hydrolysate), Amylases • (maltodextrin preparation), Lipases (oil industry), Pectinases (clarification of fruit juices), Laccases (delignification), Asperaginase	12
Unit V	Extremozymes	• Microbial source, characteristics and biotechnological significance of extremozymes from thermophiles, psychrophiles, acidophiles, alkalophiles,halophiles. Solvent resistant enzymes. • Non aqueous enzymology and Biosurfactants	12

Suggested readings:

1. Stryer, L. (2004) Biochemistry, 5th Edn., W. H. Freeman and Co., New York
2. Palmer, T. (2004) Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Affiliated East-West Press Pvt. Ltd., New Delhi
3. Price, N. C. and Stevens, L. (2000) Fundamentals of Enzymology, Oxford University Press, New York.
4. Dixon, M. Webb, E. C., Throne, C.J.R. and Tipton, K. F., Enzymes, Academic Press, New York
5. Pandey, A., Webb, C., Soccol, C.R, and Larroche, C. (2005). Enzyme Technology, Asiatech Publishers Inc., New Delhi
6. Cook, Paul, F. and Cleland, W.W. (2007) Enzyme Kinetics and Mechanism, Garland Science, New York.
7. Nooralabettu, K. P. (2011) Enzyme Technology Pacemakar of Biotechnology, PHI Learning Pvt. Ltd., New Dehli
8. Shanmugam, S. and Sathishkumar, T. (2009) Enzyme Technology, I K International, New Delhi
9. Satyanaryana, T. (1999) Biochemistry, Books and Allied Pvt. Ltd., Calcutta
10. Jain, J.L, Jain, S, and Jain, N (2005) Fundamental Biochemistry, S. Chand and Co., New Delhi
11. Nelson, D.L. and Cox, M.M. (2000) Lehninger's Principles of Biochemistry, CBS Publications, New Delhi.

DSC-33

PAPER CODE: MB-MJP-554

Methods in Enzymology

Credit 2 Lectures 60

Sr. No.	Title of the practical
1	Screening and Detection of enzyme from microbial source
2	Quantitative estimation of enzyme (Enzyme activity, specific activity, IU)
3	Effect of pH and temperature on enzyme activity
4	Effect of activator on enzyme activity and determination of kinetic parameters
5	Screening and evaluation of inhibitor on enzyme and determination of Km and Vmax
6	Purification of enzyme by salting out and dialysis/gel permeation and determination of purification fold and yield parameters
7	Detection of enzyme by zymography: Substrate gel electrophoresis
8	Enzyme stabilization by immobilization technique (Gel entrapment/ Crosslinking)
9	Production of maltodextrin using amylase (% conversion method/Degree of hydrolysis method)
10	Determination of enzyme activity in organic solvent media

NB: Use any ONE enzyme from the following:

1) Amylase 2) Protease 3) Phytase 4) Laccase 5) Lipase 6) β-Galactosidase 7) Xylanase 8) Cellulase

Suggested readings:

1. Thimmaiah, S.R. (2006) Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.
2. Bisswanger, Hans (2011) Practical Enzymology, Wiley-VCH, Germany.
3. Robert Eisenthal and Michael Danson (2002) Enzyme Assays: A Practical Approach, 2nd Edn. Oxford University Press, USA.
4. Plummer D.T. (2001) In introduction to Practical Biochemistry, 3rd edn., McGraw Hill Ltd. N. Delhi.
5. Sawhey, S.K. and Singh, R. (2002) Introductory Practical Biochemistry, Narosa Publication House, New Delhi.
6. Jayramann, J. (2008) Laboratory Manual in Biochemistry, New Age International, New Delhi.

DSC-34

PAPER CODE: MB-MJP-555

Methods in Molecular Biology and Immunology

Credit 2 Lectures 60

Sr. No.	Title of the practical
1	Bacterial transformation
2	Detection of transformants
3	Bacterial conjugation.
4	Isolation and detection of bacterial/ Fungal DNA.
5	Isolation and curing of plasmid.
6	Restriction digestion by endonucleases.
7	PCR amplification of DNA.
8	Effect of physical/Chemical mutagen on growth of bacteria
9	Immuno-diffusion by Ouchterlony double diffusion
10	Immuno-electrophoresis
11	Bacterial gene expression using IPTG /X-gal
12	ELISA (Sandwitch method)

Suggested readings:

1. Schmauder, H. P., Schweizer, M. and Schweizer, L. M. (2003) Methods in Biotechnology, Taylor and Francis, London
2. Joe Sambrook (2001) Molecular Cloning: A Laboratory Manual, 3rd Edn., (3 volume set) Cold
3. Spring Harbor Laboratory Press,
4. Sawhey, S.K. and Singh, R. (2002) Introductory Practical Biochemistry, Narosa Publication House, New Delhi.
5. Thimmaiah, S.R. (2006) Standard Methods of Biochemical Analysis, Kalyani Publishers, New Delhi.
6. Davis, L.G., Dibner, M.D. and Battey, J.F. (1986) Basic Methods in Molecular Biology, Appleton and Lange, Norwalk.

DSE-6

PAPER CODE: MB-EC-571

Immunology

Credit 4 Lectures 60

Unit	Title	Topic Particular	Lectures
Unit I	Overview of the Immune System	• Morphology and functions of organs of the immune system. • Morphology, formation and functions of cells of immune system. • Antibody diversity - Somatic gene recombination, Genesis of light and heavy chain • diversity. • Major Histocompatibility Complex: Structure, Properties and distribution. • Graft rejection: • Mechanisms, HLA typing.	12
Unit II	Mechanisms of immune response	• Cell mediated Immune response : T-cell, Types of T cells, T cell activation • Humoral Immune response: B cell, Plasma cell, B cell activation (T dependent and Tindependent pathway)	12

		• Complement system – Pathway and Role, Complement deficiency. • Inflammatory response – Functions, Types and Mechanisms. • Immunotolerance : General features of immunologic tolerance , T and B lymphocyte • tolerance , Tolerance induced by foreign protein antigens	
Unit III	Hyper immune response	• Hypersensitivity: Types (I-IV) and mechanism of each type. • Autoimmune diseases: Mechanisms for induction of autoimmunity, Organspecific and systemic, Treatment of autoimmune diseases.	12
Unit IV	Immune response to infections and diseases	• Immunity against bacterial, viral, Fungal and protozonal infections. • Tumor immunology: Types of tumors, oncogenesis and tumor antigens (TATAs, TSTA), Immune response to tumors. • Immunodeficiency diseases (e.g. SCID, CVI, AIDS)	12
Unit V	Histochemical and immunotechniques	• Production and applications of monoclonal antibodies • Detection of Ag/Ab - ELISA, RIA, Western blot, Immunoprecipitation, immunofluorescence and Flow Cytometry. • in situ localization by FISH and GISH	12

Suggested readings:

1. Goldsby, R.A., Kindt, T.J. and Osborne, B. and Kuby, A. (2003) Immunology, 5th edn., W. H. Freeman and Company, New York.
2. Roitt, I. (2000) Essentials of Immunology, 5th edn., Blackwell ELBS Science Publication, Oxford.
3. Paul, W. E (2003) Fundamental Immunology, 5th edn., Lippincott Williams and Wikins Publishers, USA
4. Tizard, I. R. (1995) Immunology: An Introduction, Saunders College Publishing, Philaldelphia
5. Banerjee, A. K. and Banerjee, N. (2006) Fundamentals of Microbiology and Immunology, New Central Book Agency (Pvt.) Ltd., Kolkata
6. Coleman, R.M., Lombard, M.F. and Sicard, R.E. (2000) Fundamental Immunology, 4th edn., WmC Publications, London
7. Rao, C. V. (2007) Immunology, Narosa Publishing House, New Delhi
8. Shastri, N.V. (2005) Principal of Immunology, Himalya Publication House, Mumbai
9. Barrett, James T. (1998) Microbiology and Immunology Concepts, Lippincott Williams & Wilkins, Philadelphia, PA
10. Janeway, Charles, Travers, Paul, Walport, Mark and Shlomchik, Mark (2004) Immunobiology, Garland Science.

RM

PAPER CODE: MB-OJT-591

On Job Training/ Internship

Credit 4 Lectures 60