



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
(With effect from Academic Year: 2019-20)

M.Sc. (Microbiology)

Faculty: Science

Semester: I

Sr. No.	Paper No.	Course Title	Eligibility	Remarks
1	I	Cytology and Molecular Biology	B.Sc. Microbiology	
2	II	Biochemistry		
3	III	Analytical Techniques in Microbiology		
4	IV	Practicals		

Name of the Subject: M.Sc. (Microbiology)

Sr. No.	Paper No.	Course Title	Total Marks (Ext+Int=Total)	Passing Standard (Ext+Int=Total)	Total Teaching Hours	Exam Hours	Credits
1	I	Cytology and Molecular Biology	70+30=100	28+12=40	15x4=60	2.30 H	04
2	II	Biochemistry	70+30=100	28+12=40	15x4=60	2.30 H	04
3	III	Analytical Techniques in Microbiology	70+30=100	28+12=40	15x4=60	2.30 H	04
4	IV	Practicals	100	40	15x15=225	06x2=12	15

Internal	Marks
• Internal Test	15
• Assignments/Presentation	10
• Seminars/Attendance	05
Total	30



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
(With effect from Academic Year: 2019-20)

M.Sc. (Microbiology)

SEMESTER – I

MIC-I: Cytology and Molecular Biology

Credits: 04

Marks:	Semester end Exam	70
	Continuous Internal Evaluation	30

Unit	Detailed Syllabus	Teaching Hours	Marks/ Weight
1	Cell Structure and Cellular Organization <ul style="list-style-type: none">Cell ConceptUltrastructure of plasma membrane, microbial and plant cell wall, nucleus and nucleolus, pore complex of nuclear envelopeUltrastructure of chromosomes, chromosomal models and special types of chromosomesMitochondria: Membrane Organization, Biogenesis and role in cellular energeticsChloroplasts: Ultrastructure, biogenesis, Photosynthetic units and reaction centresUltrastructure and functions of Lysosome, Peroxisomes & GlyoxysomesVacuoles and their role in cell structure and functionCytoskeleton: Organization and functions of microtubules, microfilaments and intermediate filaments, actin and myosin	16	18
2	Molecular Biology – I <ul style="list-style-type: none">Resume of DNA structure and DNA topologySuperhelical density, C value paradox, Cot curvesCentral dogma of molecular biologyDNA replicationDNA repair mechanisms	16	18
3	Molecular Biology – II <ul style="list-style-type: none">Structural features of rRNAs, tRNAs and mRNATranscriptionBacterial promotersRNA processing in Bacteria and EukaryotesRibozymes and Reverse transcriptaseRNA foot printing DNA sequencing: Sanger's method and Next Generation Sequencing (NGS)	14	17
4	Molecular Biology – III <ul style="list-style-type: none">Basic feature of the genetic code and its decipheringTranslation (Initiation, elongation and termination in prokaryotes and eukaryotes)Processing of proteome: Post translational modificationAntiterminationRegulation of transcription: Operon model, Positive and negative control	14	17



Reference Books:

- ❖ Genes IX by Benjamin Lewin, Jones and Bartlett Publishers, Inc; 9th Revised edition, 2007.
- ❖ Molecular Biology by David Friefelder, Narosa Publications, 2004.
- ❖ Molecular Cell Biology by Lodish, W. H. Freeman; 6th edition, 2007.
- ❖ Cell by Carl Swanson and Peter Webster, Prentice Hall College Div, 1985.



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
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M.Sc. (Microbiology)

SEMESTER – I

MIC-II: Biochemistry

Credits: 04

Marks:	Semester end Exam	70
	Continuous Internal Evaluation	30

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Proteins <ul style="list-style-type: none">• Structure, classification, properties and function• Amino acids and peptides• Titration curves and functions• Methods of protein purification• Sequencing of proteins• Biosynthesis and degradation	16	18
2	Glycobiology and Lipids <ul style="list-style-type: none">• Structure, classification, properties and functions of carbohydrates• Glycoconjugates: Glycolipids, Proteoglycans and Glycoproteins• Glycolysis (EMP, ED & HMP), TCA cycle, Gluconeogenesis• Structure, classification, properties and functions• Biological membranes• Biosynthesis and degradation	16	18
3	Vitamins and Hormones <ul style="list-style-type: none">• Classification, biochemistry and functions of vitamins• Biochemistry, mode of action and functions of plant, animal and microbial hormones	14	17
4	Enzymology <ul style="list-style-type: none">• Structure of enzymes• Properties, classification, functions and mode of action of enzymes and coenzymes• Protein folding and denaturation• Mechanism of enzyme action• Regulation and inhibition• Isozymes, abzymes and ribozymes• Kinetics of enzyme catalyzed reactions Clinical, analytical and industrial applications	14	17

Reference Books:

- ❖ Lehninger Principles of Biochemistry by Nelson and Cox, W. H. Freeman & Co (Sd); 6th edition, 2012.
- ❖ Principles and Techniques of Biochemistry and Molecular Biology by Keith Wilson and John Walker, Cambridge University Press; 7th edition, 2010.
- ❖ Biochemistry by Lubert Stryer, W. H. Freeman & Co Ltd; 5th Revised edition, 2002.
- ❖ Principles of Biochemistry by Voet and Voet, John Wiley & Sons Inc., 2012.
- ❖ An Introduction to Practical Biochemistry by David Plummer, Mcgraw Hill Education, 3rd edition, 2004.
- ❖ Biochemistry by N P Sharma, Kalpaz Publications, 2008.



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M.Sc. (Microbiology)

SEMESTER – I

MIC-III: Analytical Techniques in Microbiology

Credits: 04

Marks: Semester end Exam **70**
Continuous Internal Evaluation **30**

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Microtechniques – I <ul style="list-style-type: none">• Measurement of pH, construction and working of pH meter• Principles of centrifugation, its types and applications• Microscopy – Bright field, Stereomicroscopy, Fluorescence microscopy, Phase contrast microscopy, Atomic Force microscopy, Confocal Microscopy, SEM and TEM	16	18
2	Microtechniques – II <ul style="list-style-type: none">• Principle, working and applications of: Colorimeter UV and Visible Spectrophotometer Flame photometer Atomic Adsorption Spectrophotometer IR and MALDI-TOF	16	18
3	Microtechniques – III <ul style="list-style-type: none">• Basic principles and types of chromatography PC, TLC, GC, GC-MS and LC-MS Ion exchange, Gel permeation, Affinity and Reverse phase chromatography• Basic principles of Electrophoresis Agarose gel, Native and SDS-PAGE Isoelectric focusing Fractionation and Blotting techniques	14	17
4	Nano-Biotechnology <ul style="list-style-type: none">• Introduction• Concept and principles of Nanotechnology• Properties of nanomaterials, carbon nanotubes• Techniques and methodology used to study nanoparticles• Applications of nanoparticles in Molecular Biology, Industries, Agriculture and Environment	14	17

Reference Books:

- ❖ Instrumental Methods of Chemical Analysis by BK Sharma, Krishna Prakashan Media Pvt Ltd; 1/e edition, (2011).
- ❖ Microscopy for Students by JD Casartelli, McGraw-Hill Inc., USA; 2nd Revised edition, 1969.
- ❖ Comprehensive Biotechnology (Vol 1 to 4) by Conney and Humphrey, 1st edition.
- ❖ Molecular Biotechnology by S B Primrose, Blackwell Scientific Publications, London, UK, 2nd edition, 1991.
- ❖ Principles of Instrumental analysis by DA Skoog and JJ Leary, 4th edition, 1992.
- ❖ Instrumentation by Chatwal and Anand.

M.Sc. (Microbiology)

SEMESTER – I

MIC-IV: Practicals

Credits: 15

Marks: 100

Practicals exercises based on Paper 1 to 3.



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M.Sc. Microbiology

Faculty: Science

Semester: II

Sr. No.	Paper No.	Course Title	Eligibility	Remarks
1	V	Bioinformatics and Biostatistics	B.Sc. Microbiology	
2	VI	Microbial Biotechnology		
3	VII	Immunology, Drug Development and Biopharmaceuticals		
4	VIII	Practicals		

Name of the Subject: M.Sc. (Microbiology)

Sr. No.	Paper No.	Course Title	Total Marks (Ext+Int= Total)	Passing Standard (Ext+Int= Total)	Total Teaching Hours	Exam Hours	Credits
1	V	Bioinformatics and Biostatistics	70+30=100	28+12=40	15x4=60	2.30 H	04
2	VI	Microbial Biotechnology	70+30=100	28+12=40	15x4=60	2.30 H	04
3	VII	Immunology, Drug Development and Biopharmaceuticals	70+30=100	28+12=40	15x4=60	2.30 H	04
4	VIII	Practicals	100	40	15x15=225	06x2=12	15

Internal

Marks

- Internal Test
- Assignments/Presentation
- Seminars/Attendance

15

10

05

Total

30



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M.Sc. (Microbiology)

SEMESTER – II

MIC-V: Bioinformatics and Biostatistics

Credits: 04

Marks:	Semester end Exam	70
	Continuous Internal Evaluation	30

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Bioinformatics <ul style="list-style-type: none">• Introduction to Bioinformatics• Basic terminologies• Computer basics, Computer codes and programme languages• Biological Databases• Applications of Bioinformatics• Sequence comparison• Pair-wise and Multiple sequence alignment• Profiles, motifs and feature identification• Phylogenetic analysis	16	18
2	Biostatistics – II <ul style="list-style-type: none">• Application of computers in statistics• MS Excel and statistical functions• ANOVA, Correlation, Regression, Chi-square test Biostatistics in process optimization: Response Surface Methodology (RSM) and Overview of Artificial Neural Network (ANN)	16	18
3	Biostatistics – II <ul style="list-style-type: none">• Population and Samples: Sampling, sampling size, sampling distribution, finite and infinite population, necessity of sampling, methods of sampling• Variables: Variable in Biology, Collection, Classification and tabulation of data• Meaning of data and their representation: Diagrams and Graphs – Need, usefulness, types of diagram• Frequency distribution: Definition, relative and percent relative frequencies, discrete and continuous frequency distribution, cumulative frequency distribution, frequency graphs	14	17
4	Biostatistics – III <ul style="list-style-type: none">• Descriptive Statistics, Average: Definition, objectives, types of averages• Deviation: Mean deviation, standard deviation and its interpretation, standard error, coefficient of variation• Probability: Scale, definitions, types and rules of probability, applications of probability, Venn Diagrams• Hypothesis Testing: Null Hypothesis, sampling distribution, Level of significance	14	17



Reference Books:

- ❖ Bioinformatics Databases, Tools and Algorithms by Orpita Bosu and Simminder Kaur Thukral, Oxford University Press, USA, 2007.
- ❖ Biostatistics by A Lewis, Watkins Natural History Books, Reinhold Publishing Corp., USA, 1966.
- ❖ Introduction to Biostatistics: A Guide to Design, Analysis and Discovery, RN Forthofer, Ronald N., Lee, Eun Sul, Academic Press, 1995.
- ❖ Statistical Methods in Biology by NTJ Bailey, The English Universities Press Ltd., 1999.
- ❖ Biostatistics by P K Sen,
- ❖ An introduction to Biostatistics by N Gurumani, MJP Publishers, 2011.
- ❖ Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins by AD Baxevanis and BF Francis Ouellette, Wiley-Blackwell; 3rd Revised edition, 2004.
- ❖ Bioinformatics: Concepts, Skills and Applications by SC Rastogi, CBS; 2nd edition, 2009.
- ❖ Bioinformatics: A Beginner's Guide by JM Clavarie and C Notredame, Wiley India Private Limited, 2003.
- ❖ Bioinformatics: Principles and Applications by Z Ghosh and B Mallick, OUP India, 2008.



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M.Sc. (Microbiology)
SEMESTER – II

MIC-VI: Biotechnology

Credits: 04

Marks:	Semester end Exam	70
	Continuous Internal Evaluation	30

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Biotechnology – I <ul style="list-style-type: none">• Concept and scope of recombinant DNA technology (RDT)• General strategies and steps involved in gene cloning• Extraction and purification of DNA from bacteria, plant and animal cells• Restriction enzymes, DNA ligase and other enzymes involved in gene cloning• cDNA synthesis	16	18
2	Biotechnology - II <ul style="list-style-type: none">• Cloning vectors: Plasmids, Cosmids, Phagemids, Bacteriophages, BAC, YAC, HAC/MAC• Expression of cloned gene in heterologous host• Production of Insulin, Human Growth Hormone• Vaccines by RDT• Site directed and oligonucleotide directed mutagenesis• Recombinant selection• Hybridization techniques: Southern, Northern and Western blotting• Pulse Field Gel Electrophoresis (PFGE), Rotating Gel Electrophoresis (RGE), 2D Electrophoresis, Capillary Electrophoresis• Mobility Gel Shift Assay, Protein Activity Assay• Phage display, Subtractive hybridization and cloning, HRT/HART DNA microarray	16	18
3	Biotechnology – III <ul style="list-style-type: none">• Transgenic plants (insect resistance, viruses, herbicides, bacterial and fungal pathogens, increased photosynthesis, Nitrogen fixation, nutritional benefits, stress tolerance, etc.)• Transgenic animals and their applications• Biotechnological applications of animal cell and tissue culture	14	17
4	Biotechnology – IV <ul style="list-style-type: none">• Polymerase Chain Reaction• Molecular markers• Linkage mapping• Biosafety guidelines in RDT	14	17



Reference Books:

- ❖ Analysis of Genes and Genomes by R Reece, Wiley, 2004.
- ❖ Biotechnology by P K Gupta, Rastogi Publications, New Delhi, India, 2010.
- ❖ Principles of Gene Manipulation by SB Primrose AND RM Twyman, Wiley India; 7th edition, 2014.
- ❖ Recombinant DNA Techniques by Rodriguez and Tait, Addison-Wesley, 2010.
- ❖ Genomes 3 by TA Brown, Garland Science, 3rd edition, 2006.
- ❖ Molecular Biotechnology: Principles and Applications of Recombinant DNA by BJ Glick, JJ Pasternak and CL Patten, American Society for Microbiology, 4th edition, 2010.
- ❖ Textbook of Biotechnology by HK Das, Wiley, 2010.



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(With effect from Academic Year: 2019-20)

M.Sc. (Microbiology)

SEMESTER – II

MIC-VII: Immunology, Drug Development and Biopharmaceuticals

Credits: 04

Marks:	Semester end Exam	70
	Continuous Internal Evaluation	30

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Immunology <ul style="list-style-type: none">Antigens: Definition, types and propertiesAntibodies: Definition, classes, cellular mechanism of production, Antigen-Antibody reactionsMonoclonal antibodies: Definition, production and applicationsImmunity: Definition and types of immunity; AutoimmunityHypersensitivity: Definition and classesAutoimmunity: Definition and autoimmune diseasesVaccines: Types, DNA vaccines, Malaria vaccines, Edible vaccinesInterferons: Types, properties and mode of action	16	18
2	Biosafety and Bioethics <ul style="list-style-type: none">Biosafety guidelinesRisk and risk assessmentBiosafety levels and laboratory biosecurity conceptsIntroduction to Drug DesignPre-clinical and clinical trialsBasics of Bioethics principles, international codes and guidelines in IndiaEthics in post-genomic era	16	18
3	Bioprocess Economics and IPR <ul style="list-style-type: none">IPR and patent processBenefits, problems and management of IPRInternational harmonization of patent lawPatents of Biotechnological process and their protectionIndian scenario	14	17
4	Regulatory Affairs <ul style="list-style-type: none">Introduction to Pharmacopoeia, good Microbiological techniques and good laboratory practice (GLP)Basic principles of Quality Control (QC) and Quality Assurance (QA)Guidelines for QA and QCValidation study and toxicity testingRole of Public Health Laboratories and Regulatory Agencies	14	17



Reference Books:

- ❖ Textbook of Microbiology by Ananthanarayan and CKJ Paniker, Universities Press, 2013.
- ❖ Immunology by Glynn and Steward, John Wiley and Sons, Chichester and London, 1977.
- ❖ Kuby Immunology: International Edition by J Owen, J Punt, S Stranford, W. H. Freeman, 7th edition, 2013.
- ❖ Roitt's Essential Immunology by PJ Delves, SJ Martin, DR Burton, IM Roitt, Wiley-Blackwell Publications, 2016.
- ❖ Biotechnology, Biosafety and Biodiversity: Scientific and Ethical Issues for Sustainable Development by S Shantharam and JF Montgomery, Science Pub Inc., 1999.
- ❖ Microbiological Quality Assurance: A Guide towards Relevance and Reproducibility of Inocula by Michael RW Brown, P Gilbert, CRC Press, 1995.

M.Sc. (Microbiology)
SEMESTER – II

MIC-VIII:Practicals

Credits: 15

Marks: 100

Practicals exercises based on Paper V to VII.



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(With effect from Academic Year: 2019-20)

M.Sc. Microbiology

Faculty: Science

Semester: III

Sr. No.	Paper No.	Course Title	Eligibility	Remarks
1	IX	Microbial Taxonomy	As per MKBU norms	
2	X	Environmental Microbiology		
3	XI	Microbial Genetics		
4	XII	Practicals		

Name of the Subject: M.Sc. (Microbiology)

Sr. No.	Paper No.	Course Title	Total Marks (Ext+Int= Total)	Passing Standard (Ext+Int= Total)	Total Teaching Hours	Exam Hours	Credits
1	IX	Microbial Taxonomy	70+30=100	28+12=40	15x4=60	2.30 H	04
2	X	Environmental Microbiology	70+30=100	28+12=40	15x4=60	2.30 H	04
3	XI	Microbial Genetics	70+30=100	28+12=40	15x4=60	2.30 H	04
4	XII	Practicals	100	40	15x15=225	06x2=12	15

Internal Marks	
• Internal Test	15
• Assignments/Presentation	10
• Seminars/Attendance	05
Total	30



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(With effect from Academic Year: 2019-20)

M.Sc. (Microbiology)
SEMESTER – III

MIC-IX: Microbial Taxonomy

Credits: 04

Marks:	Semester end Exam	70
	Continuous Internal Evaluation	30

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Classification of Microorganisms <ul style="list-style-type: none">Haeckel's 3 kingdom conceptFour kingdom classification by Margulis and CopelandWhittaker's 5 kingdom classificationThree domain concept by Carl WoeseDifferences between the three domainsClassification and salient features of bacteria according to Bergey's Manual of Systematic Bacteriology, 2nd EditionTaxonomic RanksMolecular taxonomy, biochemistry and serology in bacterial classificationNumerical taxonomy, phylogeny, molecular chronometer, evolutionary distance	16	18
2	Bacterial Diversity <ul style="list-style-type: none">Bacterial diversity: Mycoplasmas, Rickettsias, Chlamydias, anoxygenic and oxygenic photosynthetic microbesUnculturable and culturable bacterial diversityMetagenomicsConventional and molecular methods of studying bacterial diversityDiversity indices, Polyphasic approach for analysis of microbial diversityMulticellular behaviour of selected microbes	16	18
3	Mycology <ul style="list-style-type: none">General features of fungiClassification, structure and reproduction of fungiCharacteristics of genera important in industry, biodegradation and diseases of animals and humans	14	17
4	Virology <ul style="list-style-type: none">Classification and ultrastructure of virusesViral genome types and virus related agents (viroids, prions, satellite viruses etc.)Description of some bacterial, plant and animal viruses	14	17



Reference Books:

- ❖ Brock, T.D., Madigan, M.T. Biology of microorganisms Prentice Hall Int.Inc.
- ❖ The Prokaryotes (1991). A. Balows, A. G. Thuper, M. Dworkin, W. Harder, K. Schleifer. Springer verlag.
- ❖ Bridge, E. A. (1992). Modern Microbiology. W. M. C. Brown, publishers, Oxford, England.
- ❖ Stainer R. Y., Ingraham. J. L., Wheelis M. J., Painter P. R. (1999). General microbiology. MacMillan Educational Ltd. London.
- ❖ Bergey's manual of systematic bacteriology.
- ❖ Colwd , D. (1999). Microbial Diversity . Academic Press.
- ❖ Dube, H. C. Introduction to fungi. Vikas Publishers.
- ❖ Fundamentals of Mycology. J. H. Burnett. Edward, Arnold crane Russak Publishers.
- ❖ Dimmock, N. J., Primrose S. B. (1994). Introduction to Modern virology IV Ed, Blackwell Scientific Publications. Oxford.
- ❖ Topley and Wilson's (1995). Text book on principles of Bacteriology, Virology and Immunology. Edward Arnold, London.



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
(With effect from Academic Year: 2019-20)

M.Sc. (Microbiology)
SEMESTER – III

MIC-X: Environmental Microbiology

Credits: 04

Marks:	Semester end Exam	70
	Continuous Internal Evaluation	30

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Concept and Dynamics of Ecosystem <ul style="list-style-type: none">• Environment: Basic concept, global environmental problems, components, food chain and energy flow• Types and complexity of ecosystem• Biogeochemical cycles• Microbial leaching of metal ores• Environmental pollution, Eutrophication and its control, Siderophores	16	18
2	Waste Treatment <ul style="list-style-type: none">• Types and characteristic of waste, waste water characterization• Principles and aims of biological waste treatment• Waste treatment processes• Anaerobic waste water treatment	16	18
3	Biodegradation and Bioremediation <ul style="list-style-type: none">• Principles and mechanism• Factors influencing biodegradation, Biodegradation of hydrocarbons, lignin, dyes, pesticides, recalcitrant compounds• Biopulping and biobleaching• PHB biosynthesis and its degradation• Biosurfactants and their applications• Principles of bioremediation• Biosorption and bio accumulation• Bioremediation of oil spills and MEOR• Co-metabolism, Recalcitrance• <i>In situ</i> and <i>ex situ</i> techniques of bioremediation• Use of GMOs in bioremediation	14	17
4	Extreme Environment <ul style="list-style-type: none">• Temperature, pH, high solute concentration, low nutrients, hydrostatic pressure• Microorganisms and their molecular adaptations to extreme environments• Polyextremophiles• Biotechnological applications of extremophiles	14	17



Reference Books:

- ❖ Alexander, M. (1971). Microbial ecology. John Wiley & Sons, Inc, New York.
- ❖ Alexander, M. (1971). Introduction to soil microbiology. John Wiley & Sons, Inc, New York
- ❖ Ec Eldowney, S. Hardman, D. J. and waite, S. (1993). Pollution: Ecology and biotreatment. Longman Scientific Technical.
- ❖ Baker, K. H. and Herson, D. S. (1994). Bioremediation. McGraw Hill Inc., New York.
- ❖ K. C. Marshall (1985). Advances in microbial ecology Vol – 8. Plenum Press.
- ❖ Burns R. G. and Slater H. (1982). Experimental Microbial ecology. Blackwell Scientific Publications, Oxford, London.
- ❖ Vanghan, D. and Malcolm, R. E. C. (1985). Soil organic matter and biological activity. Martinus Nighoff W. Junk Publishers.
- ❖ Brock, T. D., Madigan, M. T. Biology of Microorganisms. Prentice Hall Int. Inc.
- ❖ R. M. Maier, I. L. Pepper and G. P. Gerba. Environmental Microbiology.
- ❖ Waste water treatment for pollution control, 2nd Edition by Arceivala.
- ❖ Biodegradation and Bioremediation by M Alexander, Academic Press, 1999.



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
(With effect from Academic Year: 2019-20)

M.Sc. (Microbiology)
SEMESTER – III

MIC-XI: Microbial Genetics

Credits: 04

Marks:	Semester end Exam	70
	Continuous Internal Evaluation	30

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Mutation <ul style="list-style-type: none">• Gene as unit of mutation and recombination• Types, mechanisms, molecular nature of mutations• Mutagens, genetic analysis and its uses	16	18
2	Genetic Exchange in Bacteria and Regulation of Genes <ul style="list-style-type: none">• Transformation, transduction, conjugation, lysogeny• Recombination: molecular basis of recombination• Process and control of transcription and translation• Operon concept: <i>lac</i>, <i>ara</i>, <i>trp</i>, <i>his</i> operons• Genetic basis of cancer: Oncogenes• Tumor viruses and cancer• Control of cell proliferation and programmed cell death	16	18
3	Transposable Elements <ul style="list-style-type: none">• Insertion sequences, transposons, retrotransposons, integrons• Plasmid: Properties, types, detection, transfer, replication, compatibility, control of copy number etc.	14	17
4	Genetics of Eukaryotes and Virus <ul style="list-style-type: none">• Yeast-one hybrid, Yeast-two hybrid and Yeast-three hybrid system• Fungal Genetics: Tetrad analysis and mitotic recombination of <i>Neurospora</i>• Bacteriophage genetics: T4, T7, ΦX174 and MS2	14	17

Reference Books:

- ❖ Short Course in bacterial genetics. J. H. Miller. (1992). CSH. Laboratory
- ❖ Microbial genetics. Maloy et al. (1994). Jones and Bartlett Publishers.
- ❖ Molecular genetics of bacteria: J. W. Dale. (1994). John Wiley and Sons.
- ❖ Modern Microbial genetics. Streips and Yasbin (1991). Niley Ltd.
- ❖ Microbial genetics. D. Freifelder. (2002). Jones and Bartlett Publishers, Inc.
- ❖ Genes III. (2004). Benjamin Lewin.

M.Sc. (Microbiology)
SEMESTER – III

MIC-XII: Practicals

Credits: 15

Marks: 100
Practicals exercises based on Paper IX to XI.



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(With effect from Academic Year: 2019-20)

M.Sc. Microbiology

Faculty: Science

Semester: IV

Sr. No.	Paper No.	Course Title	Eligibility	Remarks
1	XIII	Microbial Physiology	As per MKBU norms	
2	XIV	Industrial Microbiology		
3	XV	Marine Microbiology		
4	XVI	Practicals		

Name of the Subject: M.Sc. (Microbiology)

Sr. No.	Paper No.	Course Title	Total Marks (Ext+Int=Total)	Passing Standard (Ext+Int=Total)	Total Teaching Hours	Exam Hours	Credits
1	XIII	Microbial Physiology	70+30=100	28+12=40	15x4=60	2.30 H	04
2	XIV	Industrial Microbiology	70+30=100	28+12=40	15x4=60	2.30 H	04
3	XV	Marine Microbiology	70+30=100	28+12=40	15x4=60	2.30 H	04
4	XVI	Practicals	100	40	15x15=225	06x2=12	15

Internal	Marks
• Internal Test	15
• Assignments/Presentation	10
• Seminars/Attendance	05
Total	30



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M.Sc. (Microbiology)
SEMESTER – IV

MIC-XIII: Microbial Physiology

Credits: 04

Marks:	Semester end Exam	70
	Continuous Internal Evaluation	30

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Growth of Bacteria <ul style="list-style-type: none">• Growth curve, growth kinetics, measurement of growth• Synchronous and asynchronous growth, batch and continuous culture of bacteria• Cell division cycle: Cell division cycle in yeasts, cdks and cyclins as regulators• Bacterial sporulation and its genetics, dormancy• Specific transport mechanisms• Chemotaxis	16	18
2	Bioenergetics <ul style="list-style-type: none">• Entropy, enthalpy, laws of thermodynamics, free energy change, standard free energy change, equilibrium constant• Relationship between free energy change, equilibrium constant and spontaneity of a reaction• Microbial photosynthesis : Oxygenic and anoxygenic photosynthesis• Microbial oxidation of sulphur, iron, hydrogen and nitrogen	16	18
3	Respiratory Metabolism and its control <ul style="list-style-type: none">• Aerobic and anaerobic• Fermentation of carbohydrates and proteins• Electron transport system in bacteria and eukaryotes; ATP synthesis and release• Cell signaling mechanisms• Control of enzyme synthesis and activity• <i>lac</i> operon, <i>ara</i> operon, Transcription attenuation (<i>trp</i> operon)• Binding efficiency of RNA polymerase, antitermination, sigma factors. RNAi (RNA interference)• Global regulation: Two component signal transduction system• Stringent response, <i>ntr</i> and <i>pho</i> system in response to N and P starvation• <i>ArcAB</i> and <i>fnr</i> system• Bioluminescence and its control	14	17
4	Secondary Metabolism <ul style="list-style-type: none">• Secondary metabolites and secondary metabolism: Antibiotics• Multiple drug resistance, biochemical mechanisms of drug resistance• Plasmids and transposons mediated drug resistance• Bacteriocins• Microbial toxins	14	17



Reference Books:

- ❖ Principles of Biochemistry, Lehninger. (2000). 3rd ed. Nelson and Cox (worth) publisher.
- ❖ Biochemistry, Stryer. (2001). 5th ed. W. H. Freeman.
- ❖ Caldwell, D. R. 1995. Microbial Physiology and Metabolism Brown Publishers.
- ❖ Moat and Foster, J. W. (1999). Microbial physiology. Wiley.
- ❖ Brun, Y. N. and Shimkets, L. J. (2000). Prokaryotic development. ASM press.
- ❖ Stainer, R. Y., Ingraham, J. L., Wheelis, M. L., Painter, P. R. (1986). General Microbiology, MacMillan Education Ltd. London.



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
(With effect from Academic Year: 2019-20)

M.Sc. (Microbiology)
SEMESTER – IV

MIC-XIV: Industrial Microbiology

Credits: 04

Marks: **Semester end Exam** **70**
 Continuous Internal Evaluation **30**

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Microorganisms in fermentation Industries <ul style="list-style-type: none">• Methods for isolation: Sources, strategies and methods, enrichment methods• Screening selection: types and screening artifacts• Genetics improvement of strains: production variants by mutation, gene manipulation, cloning and over production of native protein• Yeast strain improvement for ethanol production• Preservation of industrial microorganisms	16	18
2	Bioreactors <ul style="list-style-type: none">• Concept, design, types factors affecting selection of bioreactor• Immobilization of cells and enzymes: Physical and chemical methods, applications of various immobilized cells and enzymes• Sterilization by various approaches• Aeration and agitation, mass transfer of oxygen• Determination and factors affecting KLa• Fluid rheology	16	18
3	Upstream and Downstream Processing <ul style="list-style-type: none">• Product recovery (downstream processing): separation, disintegration, enrichment by various methods• Purification: crystallization, chromatography methods. Drying• Process control: Measuring and set up of various physical, chemical and biological parameters• Antifoam agents: Sterilization, types, devices for the addition of antifoam agents, antifoam detection device• Scale up of microbial processes	14	17
4	Fermentative Productions, Transformation and Biomass Production <ul style="list-style-type: none">• Fermentative production of solvent (ethyl alcohol), organic acids (citric acid), amino acids (glutamic acid), exopolysaccharides (xanthan, dextran) , antibiotics (penicillin, streptomycin), enzymes (amylase, protease) and vitamins (cobamide) by microorganisms• Microbial flavours: Diacetyl, Methyl Ketones, Terpenes, Vanillin• Biochemical mechanisms, fermentative processes, recovery, bioprocess economics• Steroid transformation: introduction, various applications, biotransformation of steroids and sterols, biotransformation pathways, biotransformation technology• SCP: selection of microorganisms, substrates and processes, optimization of conditions and recovery• Edible mushrooms	14	17



Reference Books:

- ❖ Industrial microbiology. G. Reed (Editor), CBS Publishers, (AVI publishing Company)
- ❖ Biology of industrial microorganisms. A. L. Demain.
- ❖ Genetics and biotechnology of industrial microorganisms. C. L. Hershnergev, S. W. Queeners, Q. Hegeman. American Society of Microbiology.
- ❖ Stanbory P. F. A. Whitakar Hall. (1995). Principles of fermentation Technology. Porgaman, Mc Neul and Harvey.
- ❖ Fermentation – A practical approach, IRL.
- ❖ Material and methods in fermentation. G. L. Solomons. (1969). AP.
- ❖ Microbial technology. Vol. I and II. Pappler H. J. Jovanovich Publishers.
- ❖ Microbial technology. Casida. L. E. John Wiley and Sons.
- ❖ Progress in Industrial Microbiolgy Vol. 9. D. J. D. Hockenhull. Cambridge University Press.



MAHARAJA KRISHNAKUMARSINHJI BHAVNAGAR UNIVERSITY
(With effect from Academic Year: 2019-20)

M.Sc. (Microbiology)
SEMESTER – IV

MIC-XV: Marine Microbiology

Credits: 04

Marks:	Semester end Exam	70
	Continuous Internal Evaluation	30

Unit	Detailed Syllabus	Teaching Hours	Marks/Weight
1	Marine Environment <ul style="list-style-type: none">History of oceanography; oceans of the worldContinental drift; sea as a biological environment, main division and zones of marine environmentPhysical factors: temperature , light, pressure, sound velocity, sedimentation , dynamic factors, waves , tides, currents, their effects on marine flora , fauna, and microorganisms	16	18
2	Chemistry of Seawater <ul style="list-style-type: none">Chemical composition, chlorinity, salinity, pH, dissolved gases, minerals, nutrients and organic matterPollution: major pollutants (sewage, agricultural discharges, industrial wastes, dredging, oils, radioactive elements) and their effects on marine biota	16	18
3	Marine Bacterial Diversity <ul style="list-style-type: none">Types and characteristics of marine bacteria with emphasis on structural and behavioral adaptations to marine environmentBiofilms – Various stages and significance in marine habitatFactors influencing cultivation and enumeration of marine microbesUnculturable marine bacterial diversityMarine extremophilesMarine fungiMarine virusesThe microbial loop and its componentsCarbon cycling – solubility pump and biological pumpMarine microbes: Applications of their enzymes, secondary metabolites and bioactive compounds	14	17
4	Pollution <ul style="list-style-type: none">Microbial indicators of marine pollutionOil pollution and microbes used in biodegradation of oilFate of oil and enhancement of degradation by the use of nutrients and emulsifiersHeavy metal removal by marine microbesBiofouling and Biodeterioration – Microbially induced corrosionBiodeterioration of marine wooden structures and timber	14	17



Reference Books:

- ❖ Marine microbiology by B Austin, Cambridge University Press, 1988.
- ❖ Microbiology: Ecology and application by CB Munn, Garland Science, Taylor and Francis Group, 2nd edition, 2011.
- ❖ Biodegradation and Bioremediation by M Alexander, Academic Press, 1999.
- ❖ Principles of Microbiology by R Atlas, The University of Michigan, 2008.
- ❖ Marine Microbiology: Ecology and Applications by CB Munn, Garland Science/BIOS Publishers, 2004.

M.Sc. (Microbiology)
SEMESTER – IV

MIC-XVI: Practicals

Credits: 15

Marks: 100

Practicals exercises based on Paper XIII to XV.