NEW

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SCHEME OF EXAMINATION
&
SYLLABUS
of
M.Sc. (Microbiology) Semester Exam

UNDER

FACULTY OF LIFE SCIENCE

Session 2018-20

(Approved by Board of Studies)
Effective from July 2018

M. SC. MICROBIOLOGY
Scheme of Examination and Syllabus

July 2017 – December 2017

	Paper No.	Title of Paper	Marks (External)	Marks (Internal)**	Credit
FIRST Semester	I*	Cell Biology		20	4
	II	Biomolecules	80	20	4
	III	Microbiology	80	20	4
	IV	Biology of Immune System	80	20	4
	LC-I	Lab Course I (Based on paper I & II)	80	20	2
	LC-II	Lab Course II (Based on paper III & IV)	80	20	2
		Total		600	

January 2018 – June 2018

	Paper No.	Title of Paper	Marks (External)	Marks (Internal)	
SECOND Semester	I	Genetics and Molecular Biology	80	20	4
	II	Bioenergetics & Metabolism	80	20	4
	III	Instrumentation and Molecular Techniques	80	20	4
	IV	Biometry, Computer and Scientometry	80	20	4
	LC-I	Lab Course I (Based on paper I & II)	80	20	2
	LC-II	Lab Course II (Based on paper III & IV)		20	2
		Total		600	

July 2018 – December 2018

	Paper No.	Title of Paper	Marks (External)	Marks (Internal)	
THIRD Semester	I	Microbial Physiology	80	20	4
	II	Fermentation Technology	80	20	4
	III	Environmental Microbiology	80	20	4
	IV	Medical Microbiology	80	20	4
	LC-I	Lab Course I (Based on paper I & II)	80	20	2
	LC-II	Lab Course II (Based on paper III & IV)	80	20	2
		Total		600	

January 2019 – June 2019

	Paper No.	Title of Paper	(External)	(Internal)	
FOURTH Semester	I	Microbial Biotechnology	80	20	4
	II	Advanced Immunology, diagnostics and prophylaxis	80	20	4
	III	**Special Paper-A:** Food Microbiology **Special Paper-B:** Microbial Ecology	80	20	4
	IV	**Special Paper-A:** Agricultural Microbiology **Special Paper-B:** Industrial Microbiology	80	20	4
	LC-I	Lab Course I (Based on paper I & II)	80	20	2
	LC-II	Lab Course II (Based on paper III & IV)	80	20	2
		Total		600	
	OR				
		Project Work* **			
		Dissertation	240	60	11
		Seminar based on project	160	40	06
		Viva-voce	80	20	03
		Total		600	
		Grand Total		**2400**	

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* Each theory paper will have 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.

** Each student will be evaluated continuously throughout the semester. There will be a class test based on each theory paper. The full marks will be 10 for each paper. There will be a poster/oral presentation based on each theory paper. The full marks will be 10 for each presentation. Each student will be required to submit a brief write-up (not more than 10 pages) on his/her poster/oral presentation.

***A student of IV semester will have the choice to opt for project work in lieu of four theory papers and two lab courses provided he/she secures at least **65%** or more marks in aggregate in semester I and II. The project has to be carried out in recognized national laboratories or UGC recognized universities. No student will be allowed to carry out project work in private laboratories/ college/ institutions, excluding the colleges recognized as research centers by the RDC of Hemchand Yadav Vishwavidyalaya; Durg. The valuation of all the projects will be carried out by an external examiner and HoD of UTD or its nominee at the UTDCentre.

Scheme for Lab Course (foreachSemester)	**Maximum Mark100**	
1	Major Exercise based on paper 1	20
2	Minor Exercise based on paper 1	10
3	Major Exercise based on paper 2	20
4	Minor Exercise based on paper 2	10
5	Spotting/ Interpretation****	10
6	*Viva- voce*	10
	Sub Total	80
	Sessional (Internal)	20
	Total	100

****A student will be required to interpret on the displayed item/material

M. Sc. Microbiology

FIRST SEMESTER

(July 2018 – December 2018)

PAPER I: CELL BIOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

Molecular organization of membranes- asymmetrical organization of lipids, proteins and carbohydrates. Osmosis, ion channels, membrane pumps and electrical properties of membranes. Active transport by ATP-powered pumps: types, properties and mechanisms.

UNIT II

Transport of proteins into mitochondria, chloroplast and endoplasmic reticulum. Transport of proteins into and out of nucleus. Transport by vesicle formation: exocytosis, endocytosis and its molecular mechanism.

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UNIT III

Cell signaling: Signaling via G-protein linked and enzyme linked cell surface receptors, MAP kinase pathways. Eukaryotic cell division cycle: different phases and molecular events, regulation and control of cell cycle. Apoptosis. Oncogenes and tumor suppressor genes: viral and cellular Oncogenes, retinoblastoma, E2F and p53proteins.

UNIT IV

Organization of chromosomes: Structure of chromosomes, centromere and telomere. States of chromosomes during cell cycle. Mitotic chromosome. Organization of genes in chromosomes Banding. Pattern of chromosomes. Lampbrush and Polytene chromosomes. Chromatin, nucleosomes, DNA packaging, heterochromatin and euchromatin.

Lab Course:

1. Study of chromosome behaviour during Mitosis and meiosis (Onion / Garlic root tips, Onionbuds, human lymphocytes, rat or bird testis /grass hopper testis or any othermaterials).
2. Calculation of mitotic index in growing Onion / Garlic roottips
3. Squash preparation: Polytene chromosome (in chironomus / Drosophila or other insect salivarygland) and Barr body (in buccal epithelialcells).
4. Demonstration of secretory granules in the salivary gland cells ofinsect.
5. Demonstration of mitochondria by vitalstaining.
6. Study of permanentslides.
7. Estimation ofDNA
8. Estimation ofRNA
9. Sub-cellular fractionation and markerenzymes
10. Identification of biomolecules in different tissues by histochemicaltechniques
11. Preparation of mitotic plate by carmine squashing method and phaseidentification.
12. Demonstration of the nuclear matrix networks in onioncells.
13. Study of the effect of chemical agents on chromosomes plantcells.
14. Isolation of protoplast, measurement of cell density platingefficiency.
15. Preparation of Karyotype of metaphaseplate.
16. Preparation of Meiotic plate and determination ofphases.
17. Computation of Chaisma frequency and Terminalization ofphases.
18. Micrometry and Camera Lucidadrawings.

Books Recommended:

H Lodish*etal.*	MolecularCellBiologyB
Alberts*etal.*	EssentialCellBiologyH
Lodish*etal.*	MolecularCellBiology
B Alberts*etal.*	MolecularBiologyoftheCell
GKarp	CellandMolecularBiology:ConceptsandExperiments

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FIRST SEMESTER

(July 2018 – December 2018)

PAPER II: BIOMOLECULES

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

Carbohydrates: structure, classification, properties and function; derivatives of monosaccharides, homo and hetero-polysaccharides, Peptidoglycan, glycoproteins and liposaccharide. Lipids: Classification, structure and function. Nucleic Acid: Structure of purine and pyrimidine bases, nucleoside and nucleotide; DNA-structure and conformation; RNA - Structure, types and functions.

UNIT II

Amino acids: structure, classification and functions; Synthesis of peptides and protein sequencing. Proteins- properties, covalent structure; secondary, tertiary and quaternary structure of proteins, Ramchandran plot

UNIT III

Enzyme classification, coenzymes, active site of enzyme, factors contributing to the catalytic efficiency of enzyme; enzyme kinetics- Michaelis-Menten equation, determination of Km, enzyme inhibition, allosteric enzymes, isoenzymes, ribozyme, multienzyme complexes

UNIT IV

Chemistry of porphyrins: Importance of porphyrins in biology; structure of hemoglobin and chlorophyll porphyrins, structure and biological role of animal hormones, structure and biological role of water soluble and fat soluble vitamins.

Lab Course:

1. Specific tests for sugars, amino acids andlipids
2. Formal titration of aminoacids
3. Estimation of proteins using ninhydrin and biuretmethod
4. Estimation of sugar by anthrone and Folin-Wumethod.
5. Saponification value and iodine number offat.
6. Estimation of ascorbicacid.
7. Achromic point determination using salivaryamylase
8. Effect of ions on salivary amylaseactivity.
9. Enzyme assay and kinetics (ex. Amylase,Protease)

Books Recommended:

- Principles of Biochemistry by Nelson, Cox andLehninger
- Biochemistry by G.Zubay
- Biochemistry byStryer
- Biochemistry by Garrett andGrosham
- Text book of Biochemistry by West, Tood, Mason &Bruglen
- Biochemistry by White, Handler &Smith
- Biochemistry by D. Voet and J CVoet

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FIRST SEMESTER

(July 2018 – December 2018)

PAPER III: MICROBIOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

General characteristics of fungi, classification of fungi, life cycle of selected fungal genus (*Aspergillus, Pencillium, Fusarium*and *Mucor*). Economic importance of fungi. Fungi and bioremediation, parasitism, mutualism and symbiosis with plants and animals. Heterothallism, sex hormone in fungi, Mycorrhiza, VAM. Algae: Distribution, classification, reproduction, ecology and imp ance.

UNIT II

Morphology and ultra structure of bacteria, morphological types, cell wall of archaebacteria, gram negative, gram positive eubacteria, eukaryotes.

Cell membranes – structure, composition and properties. Structure and function of flagella, cilia, pili, gas vesicles. Cyanobacteria, protozoa, mycoplasma and Rickettsia.

Gene transfer mechanisms, transformation, transduction, conjugation and transfection. Plasmids F: factors colicins and col factors, plasmids as a vector for gene cloning.

UNIT III

Nutritional types (autotrophs, heterotrophs, phototrophs, chemotrophs), growth curves, measurement of growth, factors affecting growth, generation time, growth kinetics. Batch and continuous culture, asynchronous and synchronous culture.

Basis of microbial classification, classification and salient feature of bacteria according to Bergey's manual of determinative bacteriology, cyanobacteria, prochlorons and cyanelles.

UNIT IV

Viruses: Structure and classification of viruses; morphology and ultra structure; capsids and their arrangements, types of envelopes, viral genome, their types and structure, virus related agents (viroids, prions). General feature of virus reproductions, early events in virus multiplication, virus restriction and modification of host, virus mRNA. General overview of bacterial viruses, RNA and DNA bacteriophages (MS2, ϕX174, M13, T3, T4). Lysogeny and Lytic phase. General account of plant and animal viruses (TMV, HIV and other oncogenic virus, Hepatitis virus).

Lab Course:

1. Glassware preparation and sterilization techniques- wet heat- dry heat- filter types- laminar flow chamber types- CDC- safetylevels.
2. Preparation of liquid & solid media, plating, pouring, inoculation and incubation for growth of microorganism
3. Methods of obtaining pure culture of microorganisms (a) streak plate (b) Pour plate, and (c) spread platemethods
4. Microscopic examination of the microorganisms, identificationand staining methods
5. Micrometry and camera lucidadrawings
6. Study of bacterial growth by turbiditimetry/spectrophotometry
7. Biomass measurement forfungi
8. Isolation and enumeration of microorganisms from soil by serial dilution agar platingmethod.
9. Enumeration of viruses by plaque assaytechnique.
10. Motility of bacteria by hanging droptechnique.

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Books Recommended:
• Microbiology: L.M. Prescott, J.P. Harley and D.A. Klein, McGraw HillPublication. • General Microbiology: Stanier, Ingrahamana, Wheelis and Painter, Mac MillianPress • Principles of Microbiology: R.M.Atlas • Microbiology: Peleczar, Chan &Krieg • General Virology: Luria, Darnell, Baltimore andCampell • Introduction to Mycology: CJ Alexopoulos and CW Mims, Wiley Eastern Ltd, NewDelhi

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FIRST SEMESTER

(July 2018 – December 2018)

PAPER IV: BIOLOGY OF IMMUNE SYSTEM

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

Innate immune mechanism and characteristics of adaptive immune response. Cells of immune system: Hematopoisis and differentiation, mononuclear cells and granulocytes. Antigen presenting cells. Primary and Secondary lymphoid organs and tissues. Ontogeny and phylogeny of lymphocytes. Lymphocyte traffic.

UNIT II

Antigen receptor molecules: B-cell receptor complex, Immunoglobulin- structure, types and function. T-cell receptor complex. Major Histocompatibility Complex- types, structural organization, function and distribution. Transplantation and Rejection. Complements in immune function.

UNIT III

Antigens: nature of antigens, factor affecting immunogenicity, Haptens and super antigens. Antigenic determinants. Recognition of antigens by T and B cell. Antigen processing. Role of MHC molecules in antigen presentation and co-stimulatory signals. Antigen and antibody interaction.

UNIT IV

Cell mediated immune response. Cytokines and interleukins- structure and function. Immunity to infections. Hypersensitive reactions and their types. Immunodeficiency disorders.Autoimmunity

Lab Course:

1. Identification of cells of immunesystem
2. Separation of mononuclear cells byFicoll-Hypaque
3. Identification of Lymphocytes and theirsubsets
4. Lymphoid organs and their microscopicorganization
5. Isolation and purification ofAntigens
6. Purification of IgG fromserum
7. Estimation of Levels of gamma globulins and A/G ratio inblood
8. Antigen antibodyinteraction

Books Recommended:

- Kuby's Immunology: R.A. Goldsby, Thomas J Kindt and Barbara A.Osborne
- Immunology- A short Course: E. Benjamini, R. Coico and G.Sunshine
- Immunology: Roitt, Brostoff andMale
- Fundamentals of Immunology: WilliamPaul
- Immunology:Tizard
- Immunology: Abbas *etal*

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SECOND SEMESTER

(January 2019 – June 2019)

PAPER I: GENETICS AND MOLECULAR BIOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT – I:

Mendelian principles: Dominance, segregation, independent assortment.
Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests
Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions.
Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

UNIT – II:

DNA replication, repair and recombination: Mechanism of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms; Repair of Base-excision, Nucleotide excisions, Mismatch and Double Strand. Guardian of DNA; p_{53} and p_{21}. Homologous and site-specific recombination.

UNIT – III:

RNA synthesis and processing: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, elongation, and termination, RNA processing, capping, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNAtransport.

UNIT – IV:

Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl t-RNA synthetase, and translational proof-reading, translational inhibitors, Post Translational modification of proteins. Protein targeting.

Lab Course:

1. Isolation, purification and estimation ofRNA
2. Isolation, purification and estimation ofDNA
3. Determination of Tm of nucleicacid
4. Fraction of poly (A)RNA
5. RestrictionDigestion
6. Ligation
7. DNA molecular sizedetermination

Books Recommended:

H Lodish*et al.*: Molecular Cell Biology
B Alberts*et al.* : Essential Cell Biology
B Alberts*et al.*: Molecular Biology of the Cell
G Karp : Cell and Molecular Biology: Concepts and experiments
JD Watson *et al.* : Molecular Biology of the Gene
J Wilson and T Hunt : Molecular Biology of the Cell: The Problems

B Lewin : Genes VIII
JE Krebs *et al.* (Ed.) : Genes X (Lewin's), Jones and Bartlett Publishers, Sudbury, Massachusetts, (2011)

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SECOND SEMESTER

(January 2019 – June 2019)

PAPER II: BIOENERGETICS AND METABOLISM

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

First and second laws of thermodynamics. Concept of free energy, High – energy compounds, ATP cycle, structural basis of free energy change during hydrolysis of ATP. Other hi[illegible] – energy biological compounds

UNIT II

Basic concepts of intermediary metabolism. Carbohydrate metabolism: Glycolysis, Kreb's cycle, glycogenolysis, glycogenesis, pentose phosphate pathway, gluconeogenesis, and glyoxylate pathway, inborn errors of carbohydrate metabolism. Regulation of carbohydrate metabolism.

UNIT III

Electron transport and oxidation phosphorylation: electron carriers, Complexes I to IV, substrate level phosphorylation, mechanism of oxidative phosphorylation, Shuttle system for entry of electron, Biosynthesis and degradation of Lipids, Regulation of lipid metabolism.

UNIT IV

Nitrogen Assimilation. Biosynthesis of amino acids. Degradation of amino acids. Regulation of amino acid metabolism. Biosynthesis and degradation of purine and pyrimidine nucleotides.

Lab Course:

1. Protein estimation by Lowry, Bradford and Spectrophotometricmeth[illegible]
2. Estimation bloodcholesterol
3. Estimation of sugar by Nelson- Somogyi and Benedict'sreagent
4. Isolation and estimation of lipid from seeds andegg.
5. Estimation of inorganic and total phosphorus by Fiske-SubbaRaomethod
6. Assay of phosphatases in blood andseeds
7. Urease estimation in planttissues

Books Recommended:

- Principles of Biochemistry by Nelson, Cox andLehninger
- Biochemistry by G.Zubay
- Biochemistry byStryer
- Biochemistry by Garrett andGrosham
- Text book of Biochemistry by West, Tood, Mason &Bbruglen
- Biochemistry by White, Handler &Smith
- Biochemistry by with clinicalapplication
- Biochemistry by D Voet and J CVoet
- Enzymes by Dixon andWebb
- Fundamentals of Enzymology by Price andSteven
- Practical Biochemistry byPlummer
- Enzyme Biotechnology by G.Tripathi
- Enzyme Reaction Mechanism byWalsh.
- Enzyme Catalysis and Regulation by Hammes

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SECOND SEMESTER

(January 2019 – June 2019)

PAPER III: INSTRUMENTATION AND MOLECULAR TECHNIQUES

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

Centrifugation: Principle, techniques. Preparative, analytical and ultracentrifuges, sedimentation coefficient and factors affecting sedimentation coefficient. Application of centrifugation.
Photometry: Basic principles of colorimetry, UV- visible spectrophotometry & IR- spectrophotometry. Spectroflurometry
Atomic absorption spectroscopy: Principle, Instrumentation and applications
Electrophoresis: Paper electrophoresis, Starch gel, agarose, PAGE-type, 2D-E.

UNIT II

Microscopic techniques: light microscopy, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy
Microtomy: types, principle and applications
Lyophilization: Principle, instrumentation and applications

UNIT III

Chromatography: Paper and Thin Layer Chromatography. Gel filtration, Ion exchange chromatography and Affinity chromatography. Gas-liquid chromatography and HPLC.
Histochemical and immunotechniques: Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, *In situ* localization; FISH and GISH.

UNIT IV

Molecular techniques: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, separation methods; RNA, DNA and proteins; 1-D and 2-D, isoelectric focussing gels; Molecular cloning of DNA and RNA fragments in bacterial systems; Expression of recombinant DNA; DNA sequencing. Gene expression; mRNA, cDNA using PCR and qRT-PCR. Micro array based techniques.
Molecular Markers for diversity analysis: RFLP, RAPD, AFLP, VNTR, SSR, ISSR, SNP, DArT.

Lab Course:

- Verification of BeersLaw
- Determination of absorptionmaxima
- Quantitative determination, Enzymekinetics
- Amino acid and carbohydrate separation by paper andTLC
- Ion exchange and gel filtrationchromatography
- SDS Polyacralamide GelElectrophoresis
- DNAelectrophoresis
- Separation of sub-cellular organelles by differentialcentrifugation.
- Isolation of DNA and Agarose gelElectrophoresis
- Amplification of RAPD and AFLPmarkers.
- Isolation of RNA and Electrophoresis of RNA on denaturinggels.
- cDNA synthesis andcloning
- Isolation of Protein andSDS-PAGE
- In vitro DNA ligation, transformation of E.coli
- Characterization of transformants: DNA gel electrophoresis, Restriction mapanalysis.

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Books Recommended:	
• K Wilson and John Walker	Practical Biochemistry: Principles & Techniques
• RF Boyer	Biochemistry Laboratory: Modern Theory & Techniques
• S Carson, H Miller and D Scott	Molecular Biology Techniques: A Classroom Laboratory Manual
• TC Ford and J. M. Graham	An Introduction to Centrifugation
• R Baserga and D Malamud	Autoradiography: techniques and application
• T Chard	An Introduction to Radioimmunoassay and Related Techniques , Volume 6
• MD Bruch	NMR Spectroscopy Techniques
• BA Wallace and R William	Modern Techniques for Circular Dichroism and Synchrotron Radiation, Volume 1
• J Sambrook, EF Rritsch and I Maniatis	Molecular cloning: A Laboratory Manual
• PD Dabre	Introduction to Practical Molecular Biology
• JD Watson, NH Hopkins, JW Roberts, JA Steitz and AM Weiner	Molecular Biology of Gene (4thEdition)
• J Darnell, H Lodish and D Baltimore	Molecular Cell Biology (2ndEdition)
• B Alberts, D Bray, J Lewis, M Raff, K Roberts and JD Watson	Molecular Biology of the Cell (2ndEdition)
• Benjamin Lewin	Gene VII
• JM Walker and R Rapley	Molecular Biology and Biotechnology
• SB Primrose	Molecular Biotechnology

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SECOND SEMESTER

(January 2019 – June 2019)

PAPER IV: BIOMETRY, COMPUTER AND SCIENTOMETRY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT I

Introduction to biostatistics. Types of biological data: data on different scales. Frequency distributions. Cumulative frequency distributions. Random sampling. Parameters and statistics. Measures of central tendency and dispersion: Mean, Median, Mode, Range, Variance and Standard deviation. Coefficient of variation. The effects of coding data. Data transformations: Log-transformation, Square-root transformation and Arcsine transformation. Distribution: normal and binomial.

UNIT II

Statistical errors in hypothesis testing. Testing goodness of fit: Chi-square goodness of fit. Heterogeneity Chi-square. The 2 x 2 contingency table. One sample hypothesis. Two- sample hypothesis. Testing for difference between two means (*t*-test). Testing for difference between two variances (*F*-test). The paired sample *t*-test. Multiple-sample hypothesis (ANOVA): Single factor and two factors ANOVA. Simple linear regression. Regression *vs.* Correlation. Regression equation. Interpretations of regression functions. Simple linear correlation. The correlation coefficient.

UNIT III

Introduction to MS-Office software: Word processing; Creating new document, Editing documents, Adding graphics to documents, Word tables. Management of Workbook &Worksheets; Applications, Features, Using formulasandfunctions,FeaturesforStatisticaldataanalysis, Generatingcharts/graph.Presentationsoftware; WorkinginPowerPoint,Creatingnewpresentation,Workingwithslides.

UNIT IV

Introduction to Internet and Applications. Basics of internet, e-mailing, Search engine – Google and Yahoo; PubMed, Scopus, Web of Science, Google Scholar, Indian Citation Index, Science Citation Index (SCI), h-index, i-10-index. Journal Impact Factor (JIF). Introduction to Plagiarism and Cyber laws.

Lab Course:

1. Exercisesfordatadistribution
2. Exercisesforcomputationofmeasuresofcentraltendency
3. Exercisesforcomputationofmeasuresofvariability
4. Computationofcorrelationcoefficient,r,andregressionconstants
5. DataanalysisbyANOVAandmultiple-rangetests
6. Hypothesistestingby*t*-test,F-test,andChi-squaretest
7. Graphicalpresentationofdatausingasuitablepackage
8. Statisticalanalysisofadatausingasuitablepackage
9. Preparationofdocumentusingasuitablepackage
10. Preparationofslidesusingasuitablepackage

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Books Recommended:	
Campbell RC	Statistics forbiologists
ZarJH	BiostatisticalAnalysis
WardlawAC	PracticalStatisticsforExperimentalBiologists
Snedecor GW &CochranWG	StatisticalMethods
Sokal RR &RohlfFJ	IntroductiontoBiostatisticsS
umnerM	Computers:Concepts&Uses
WhiteR	HowComputersWork
Cassel P*etal.*	InsideMicrosoftOfficeProfessional
Coleman P andDysonP	MasteringInternets
GrallaP	HowtheInternetWorks
Shelly GB,VermaatME, ashmanTJ	Microsoft2007:IntroductoryConceptsandTechniquesC
HabrakenJ	Microsoft Office 2003 AllinOneMicrosoft Office 2010 InDepth
GilmoreB	Plagiarism: Why it happens, How to preventit?
Buranen L andRoyAM	Perspectives on Plagiarism and Intellectual Property in aPost-Modern World
KumarAnupaP	CyberLaw
SoodV	CyberLawSimplified

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THIRD SEMESTER

(July 2019 – December 2019)

PAPER I: MICROBIAL PHYSIOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

Aerobic metabolism of methane and methanol: Methane and methanol users, Oxidation of methane, Formaldehyde and formic acid, assimilation of C-1 compounds.
Anaerobic respiration: Sulphur compounds and nitrate as electron acceptors, electron transport in SO_4 and NO_3 reducers. Anaerobic metabolism of glucose, Fermentation process, modes of glucose fermentation (lactic acid, ethanol, acetic acid, butyric acid, acetone and butanol, formate and propionate). Transport of nutrients across membrane.

UNIT - II

Biosynthesis of peptidoglycan, teichoic acid, lipopolysaccharide, biosynthesis and degradation of essential amino acids, microbial degradation of aromatic, polycyclic and halogenated aromatic compounds. Microbial metabolism ofhydrogen.

UNIT - III

Microbial photosynthesis: Historical account, structure of photosynthetic pigments i.e., chlorophylls and bacterio-chlorophylls, carotenoids, phycobilins, primary photochemistry nd electron transport (light harvesting, charge-separation and electron transport in anoxygenic photosynthesis), ATP synthesis.
Eubacterial photosynthetic microbes, development of photosynthetic apparatus, carbon metabolism.
Cynobacterial organization of photosynthetic apparatus. Halobacterial photo-phosphorylation.

UNIT - IV

Nitrogen metabolism: Biological nitrogen fixation, Mechanism of nitrogen fixation, ammonia assimilation, properties and regulation of glutamine synthetase, glutamate synthetase, glutamate dehydrogenase. Biochemistry of methanogenesis; bio-transformation of steroid and non-steroid compounds.

Lab Course:

1. Qualitative of assay of different extra-cellularenzymes
2. Quantitative assay of alkaline and acid phosphatases frommicroorganisms.
3. Determination of Km value of beta- fructofuranosidase fromyeast
4. Antibiotic sensitivitytest
5. Measurement of CM-cellulase by viscometric and reducing sugarmethod.
6. Experiment on production of enzymes and optimizing parameters for zyme production in shake flask culture using *Aspergillusniger, Saccharomyces cerevisiae*for production of amylase, invertase respectively.
7. Experiment on production of citric acid and optimizing parameters for citric acid production in shake flask culture using *Aspergillusniger*.

Books Recommended:

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1. Brown TA (1999) Genome. John Wiley & Sons (Asia) PTE.LTD.
2. Goeddel DV (1990) Methods in Enzymology, vol 185, Gene Expression Technology. AcademicPress, SanDiago.
3. Kaufman PB, Wu W, Kim D and Cseke LJ (1995) Molecular and Cellular Methods in Biologyand Medicine. C. Press,Florida.
4. EL-Mansi E.M.T. and Bryce C.F.A. Fermentation Microbiology and Biotechnology. Taylor &Francis.

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THIRD SEMESTER

(July 2019 – December 2019)

PAPER-II: FERMENTATION TECHNOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

General Considerations: Fermentation biotechnology – An historical perspective, metabolic pathways and metabolic control mechanisms, primary and secondary metabolites, genetic regulation and catabolite repression, Fermentation kinetics, kinetics of substrate utilization, product formation.

UNIT - II

Types of bio-reactors, their design and instrumentation: Fed batch bio-reactors, continuous stirred tank bio-reactors, plug flow tubular reactors; multiphase reactors, packed bed, bubble column , fluidized bed and trickle bed bio-reactors, animal and plant cell bio-reactors, non-ideal mixing, batch and continuous sterilization, immobilized bio-catalysts, sensors for medium and gases.

UNIT - III

Industrial production of microbial biomass (SCP, and mushrooms), alcohol, organic acid (citric acid, gluconic acid, itaconic acid), amino acids (L- glutamic acid, L- lysine and L-aspartic acid), enzymes and antibiotics (Penicillin), microbial polysaccharides and polyesters.

UNIT - IV

Scale up, instrumentation control, Bio-sensors in bio-process monitoring and control. Downstream processing: Removal of microbial cells and solid matter, precipitation, filtration, centrifugation, disintegration of cells, extraction methods, concentration methods, purification and resolution of mixtures, drying and crystallization.

Lab Course:

1. Experiment on production of alcohol and optimizing parameters for alcohol production in shakeflask culture using *Saccharomycescerevisiae.*
2. Experiment on production and optimizing parameters for SCP in shake flaskculture.
3. Experiment on production of enzymes and optimizing parameters for enzyme production in solid-state fermentation using wheat bran and other agricultural solidwaste.
4. Protein purification methods: affinity chromatography, ion exchange and gelfiltration.
5. Recovery of products from solid state cultures -Recovery of intracellular products: Celldisruption procedures bysonication,
6. Carbohydrate catabolism by microorganisms (oxidation and fermentation ofglucose)
7. Fermentation ofcarbohydrates.

Books Recommended:

- EL-Mansi E.M.T. and Bryce C.F.A. Fermentation Microbiology and Biotechnology. Taylor & Francis.
- Alberghina Lilia. Protein Engineering in Industrial Biotechnology. Harwood AcademicPublishers.
- Jogdand S. N. Gene Biotechnology. Himalaya PublishingHouse.
- Olguin J. Eugenia, Sanchez Gloria & Hernandez Elizabeth. Environmental Biotechnology and Cleaner Bioprocesses. Taylor &Francis.
- Prescott & Dunn's. Industrial Microbiology. 4thed, CBS publishers &Distributors.
- Bullock John and Kristiansen Bjorn. Basic Biotechnology. AcademicPress.
- A.H. Patel. IndustrialMicrobiology

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THIRD SEMESTER

(July 2019 – December 2019)

PAPER III: ENVIRONMENTAL MICROBIOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

Distribution and ecology of microorganism: airspora- concepts and components, indoor and outdoor air spora, aeroallergens, Ecosystem- concept, components, food chains, food webs, and trophic levels. Energy transfer efficiencies between trophic levels. Environmental factors influencing the growth and survival of microorganism. Physical factors- temperature, light, osmotic pressure and hydrostatic pressure. Chemical factors- pH, O_2 and CO_2. Microorganisms of extreme environments: Psychrophiles, Mesophiles, thermophiles, acidophiles, alkalophiles, halophiles and specific habitats.

UNIT - II

Microbiology of water: aquatic ecosystems-types- fresh water (ponds, lakes, streams) - marine (estuaries, mangroves, deep sea, hydrothermal vent, saltpans, coral reefs). Zonation of water ecosystems– upwelling-eutrophication- food chain. Drinking and potable water, ecology of polluted water, microbiological treatment processes. Waste water disposal and reclamation. Brief account of major water borne diseases and their controlmeasures.

UNIT – III

Soil microbiology: Micro flora of various soil types (bacteria and nematodes): rhizosphere- phyllosphere – brief account of microbial interactions symbiosis, mutualism, commensalism, competition, amensalism, synergism, parasitism, predation, biological N_2 fixing organisms, symbiotic fungi, Phosphate solubilizing organisms, Ecology of litter decomposition; extracellular enzymes (hydrolases), heterotrophic potential decomposers and utilizers relationship.

UNIT -IV

Biodegradation of Cellulose ,Lignins and hydrocarbons (superbug). Composting, treatment of solid wastes. Bioaccumulation of metals.Biodeterioration: classification of Biodeterioration of materials (monuments, paints, rubbers, plastics, fuels, lubricants, metals, stone, cosmetics, toiletries). GMO and their impact.

Lab Course:

1. BOD & COD estimation in watersample
2. Study of microbial contaminants from water andwastewater.
3. Study of air borne microorganisms using variousmethods.
4. Assay of anti-fungal and antibacterial properties of agro-chemicals andfungicides.
5. Assessment of quality of oils using saponification value, iodine number, and free fattyacid composition.
6. Study of thermophilicmicroorganisms.
7. Bacteriological examination of water by multiple-tube fermentationtest.
8. Determination of coliforms to determine water purity using membrane filtermethod.
9. Lipase productiontest.
10. Isolation of Rhizobium from rootnodule.
11. Measurement of spore size usingmicrometry
12. Isolation of microorganisms from rhizosphere andphylloplane.

Books Recommended:

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- Michael, T. Madican; John. M. Mmmartinko and Jack Parker. Brock. Biology ofMicroorganisms.
- Microbiology of Extreme Environments edited by CliveEdwards
- Olguin J. Eugenia, Sanchez Gloria & Hernandez Elizabeth. Environmental Biotechnologyand Cleaner Bioprocesses. Taylor &Francis.
- Michel. R. Introduction to Environmental Microbiology.1999

M. Sc. Microbiology

THIRD SEMESTER

(July 2019 – December 2019)

PAPER-IV: MEDICAL MICROBIOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

Normal microbial flora of human body, role of resident flora, host microbe interactions. Classification of medically important microorganisms. Infection and infectious process - routes of transmission of microbes in the body. Source of infection for man; vehicles or reservoirs of infection. Mode of spread of infection. Pathogenesis: Infectivity and virulence.

UNIT –II

Classification of pathogenic bacteria. *Staphylococcus, Streptococcus, Pneumococcus, Neisseria, Corynebacterium, Bacillus, Clostridium*, Non sporing Anaerobes, Organism belonging to Enterobacteriacea, vibrios, Non fermenting gram negative bacilli *Yersinia; haemophilus; Bordetelia; Brucella*; *Mycobacteria, Spirochaetes, Actinomycetes; Rikettsiae,Chlamdiae.*

UNIT- III

General properties of Viruses; Viruses Host Interactions, Pox viruses, Herpes viruses, Adeno viruses; Picarno viruses; Orthomyxo viruses; Paramyxo viruses; Arboviruses, Rhabdo viruses, Hepatitis viruses; Oncogenic viruses; Human Immuno deficiency viruses.

UNIT- IV

Mycology - Human mycotic infections caused by Dermatophytes, Histoplasma,
Cryptococcus, Candida, opportunistic mycoses. Mycotoxins. Description and classification of pathogenic fungi and their laboratory diagnosis.
Parasitology - Medical importance of Entamoeba, Giardia, Plasmodium, Taenia,
Ascaris, Wucherhiria. Laboratory techniques in parasitology.

Lab Course:

1. Identification of micro flora of mouth, skin andwounds
2. Identification of enteric pathogens by TSIAmedium
3. Identification of dermatophyticfungi
4. Identification of important humanparasites
5. IMVIC test/other specifictests

Books Recommended:

- Prescott & Dunn's. Microbiology. CBS Publishers &Distributors.
- Anantnarayan R and Panikar CKJ: Text book of Microbiology, Orient Blackswan Pvt.Ltd.
- Broude AI: Medical Microbiology and Infectious Diseases, WB SaundersCo.
- ChapelandHaeney:EssentialsofClinicalImmunology,BlackwellScientificPublications
- Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology,Mosby

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M. Sc. Microbiology

FOURTH SEMESTER

(January 2020 – June 2020)

PAPER-I: MICROBIAL BIOTECHNOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

Techniques of Microbial technology: Scope of genetic engineering, restriction and modification enzymes, ligation and transformation, agarose and polyacrylamide gel electrophoresis, Southern, northern, western blotting, polymerase chain reaction, DNA sequencing, cloning vectors- plasmids, bacteriophages, phagemids, cosmids. YAC, BAC.

UNIT - II

Basics of Genomics, RNA interference, Cloning strategies, cDNA synthesis and cloning, mRNA enrichment, DNA primers, linkers, adaptors and their synthesis, library construction and screening; Cloning interacting genes, two and three hybrid systems, cloning differentially expressed genes, nucleic acid microarrays; Site directed mutagenesis and protein engineering, immobilization techniques.

UNIT - III

Microbial screening, selection and strain improvement, bacterial enterotoxins, peptide hormone, interferons.

Biofertilizers, Biopesticides, , Enzyme in pulp and paper industry, Bioremediation.

UNIT - IV

Role of national and international organization in biotechnology, cooperative efforts, government programs for biotechnology development and applications, patenting biotechnological process and products in different fields, regulation for bio-hazardous products.

Lab Course:

1. Bacterial culture and antibiotic selection media. Preparation of competentcells.
2. Isolation of plasmidDNA.
3. Isolation of Lambda phageDNA.
4. Estimation of nucleicacids.
5. Agarose gel electrophoresis and restriction mapping ofDNA.
6. Construction of restriction map of plasmidDNA.
7. Cloning in plasmid/phagemidvectors.
8. Preparation of single stranded DNAtemplate.
9. Gene expression in *E. coli* and analysis of geneproduct
10. PCR

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Books Recommended:

1. Bruce A White (1997) PCR Cloning Protocols. Hanuman Press Totowa, NewJersey.
2. Bruce Birren, Eric D Green, Sue Klapholz, Trichard M Myers, HoraldRiethman, & JaneRoskenus (1999) Genome Analysis: A Lab Manual vol.1,vol.2,vol.3, Cold Spring Harbor Lab.Press.
3. Daniel L Hartl, Elizabeth & Jones W (1998) Genetics: Principles and Analysis. Jones & Bartlett Publishers.
4. Davies JA &Rez WS (1992) Milestones in Biotechnology Classic papers on GeneticEngineering. Butterworth-Heinemann,Boston.
5. Glick MolecularBiotechnology.
6. Glover DM and Hames BD (1995) DNA Cloning: A practical approach, IRL Press,Oxford.
7. Kaufman PB, Wu W, Kim D and Cseke LJ (1995) Molecular and Cellular Methods in Biologyand Medicine. C. Press,Florida.
8. Kingsman SM &Kingsman AJ (1998) Genetic Engineering. An Introduction to gene analysisand exploitation in eukaryotes. Blackwell Scientific Publishers,Oxford.
9. Mickloss DA &Freyer GA (1990) DNA Science. A First Course in Recombinant Technology. Cold Spring Laboratory Press, NewYork
10. Primrose SB (1994) Molecular Biotechnology (2nd Edition). Blackwell Scientific Publishers,Oxford.
11. Sambrook, Fritsch EF and Maniatis (2000). Molecular Cloning: A Laboratory Manual. ColdSpring Laboratory Press, NewYork
12. Sambrook& Russell (2001) Molecular Cloning: A lab Manual (3rd Edition). Cold Spring Harbor LabPress.
13. Strickberger MW (2000) Genetics (3rd Edition), Prentice Hall of India Pvt.Ltd.
14. Walker MR &Rapley R (1997) Route Maps in Gene Technology. Blackwell ScientificPublishers, Oxford.
15. Watson JD, Gilman N, Witkowski, Mark, Zoller . Recombinant DNA , Scientific AmericanBooks.
16. John Bulock and Bjorn Kristiansen. Basic Biotechnology AcademicPress

M. Sc. Microbiology

FOURTH SEMESTER

(January 2020 – June 2020)

PAPER-II: ADVANCED IMMUNOLOGY, DIAGNOSTICS AND PROPHYLAXIS

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT - I

Generation of diversity in BCR and TCR. Light and heavy chain gene recombination. Recombination Signal sequences. Heavy chain constant region genes. Class switching. Membrane and secreted immunoglobulins. Organization and arrangement of T-cell receptorgenes.

UNIT - II

Synthesis and production of immunoglobulins. Monoclonal antibody. Designer antibody.

Regulation of immune response by antigen, antibody, immune complex, MHC and cytokines. Autoimmunity and autoimmune disorders. Immunological tolerance. Immunity to microbial and parasitic infections. Immunodeficiency diseases.

UNIT - III

Principles of antimicrobial action and resistance of antibiotics. Antimicrobial susceptibility testing Anti fungal and anti cancer compounds. Nosocomial infection, common type of hospital infections and their diagnosis and control.

Immunoprophylaxis: Principles of Vaccination. Immunization practices. Vaccines against important bacterial and parasitic diseases. DNA vaccines; passive prophylactic measures. Viral vaccines and antiviral agents

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UNIT - IV

Diagnosis of microbial diseases - Collection, transport and preliminary processing of Clinical pathogens. Clinical, microbiological, immunological and molecular diagnosis of microbial diseases. Modern methods of microbial diagnosis.

Principles of immunodiagnostics. Antigen-antibody based immunodiagnosis and the techniques involved – Enzyme, Radio and Fluorescence Immunoassays, Immunoblotting, Flow cytometry. Effector cell assays, Cytotoxic assays. Isolation of pure antibody. Application of monoclonal antibodies in immunodiagnostics.

Lab Course:

- Preparation of Parasite/ microbe Antigen and analysis byPAGE
- Immunizations and Production ofAntibody
- Antigen antibody reaction by Double Diffusion, Counter Current and Immunoelectrophoresis,RID andELISA
- Western BlotAnalysis
- Immunodiagnosis using commercialkits
- VDRL and RPRTest.
- Widaltest

Books Recommended:

- Prescott and Dunn's. Microbiology. CBS Publishers &Distributors
- Anantnarayan R and Panikar CKJ: Text book of Microbiology, Orient Blackswan Pvt.Ltd.
- Broude AI: Medical Microbiology and Infectious Diseases, WB SaundersCo.
- ChapelandHaeney:EssentialsofClinicalImmunology,BlackwellScientificPublications
- Kuby's Immunology: R.A. Goldsby, Thomas J Kindt and Barbara A.Osborne
- Immunology- A short Course: E. Benjamini, R. Coico and G.Sunshine
- Immunology: Roitt, Brostoff andMale
- Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology,Mosby

M. Sc. Microbiology

FOURTH SEMESTER

(January 2020 – June 2020)

Special Paper - PAPER-III (A): FOOD MICROBIOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT- I

Microbial flora of fresh food, grains, fruits, vegetables, milk, meat, eggs and fish. Microbiological examination of foods for their infestation by bacteria, fungi & viruses. Chemical preservatives and food additives. Factors influencing microbial growth in food- Extrinsic and intrinsic factors. Food as a substrate for micro-organism.

UNIT- II

Canning, processing for heat treatment - D, Z and F values and working out treatment parameters; microbial spoilage of canned foods, detection of spoilage and characterization. Mold and mycotoxin contamination of food, aflatoxins, ochratoxins, trichothenes, zearalenone, ergot mycotoxins. Role of microorganisms in beverages– beer, wine and vinegar fermentation.

UNIT- III

The roles of microorganisms in the food industry, positive and negative perspectives. Food-borne infections and intoxications: Bacteria and nonbacterial-with examples of infective and toxic types- *Brucella, Bacillus, Clostridium, Escherichia, Salmonella, Shigella, Staphylococcus, Vibrio, Yersinia*; nematodes, protozoa, algae, fungi and viruses. Food borne outbreak- laboratory testing procedures; Sources and transmission of bacteria in foods: human, animal, and environmental reservoirs; cross-contamination.

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UNIT- IV

Prevention Measures-Food sanitation in manufacture and retail trade; Plant sanitation- Employee's Health standards-waste treatment-disposal- quality control. Government Agency and Food Safety Policy: Government Branches (FDA, CDC, USDA and how they work to control food safety), HACCP, Risk Assessment.

Lab Course:

1. Isolation and identification of microorganisms from fermented food, fruits, cereal grains and oil seeds.
2. Determination of quality of milk sample by methylene blue reductasetest.

Books Recommended:

- M.R. Adams and M.O. Moss: Food Microbiology, Royal Society,Cambridge
- William, C. Frazier and Dennis C. Westhoff: Food Microbiology, Tata McGrawHill
- Banwart GJ: Food Microbiology CBS Publishers & Distributors, NewDelhi.
- Hobbs BC and Roberts D: Food Poisoning and Food Hygiene, Edward Arnold,London

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FOURTH SEMESTER

(January 2020 – June 2020)

Special Paper - PAPER-III (B): MICROBIAL ECOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT- I

History, significance and developments in the field of microbial ecology
ContributionsofBeijerinck,Winogradsky,Kluyver,VanNiel,MartinAlexander,SelmanA.Waksman,
Environmental chemistry, Atmosphereic pollutants, Types of wastes, The Atmosphere, Organization of life,Ecosystems.

UNIT- II

Microorganisms & their natural habitats
A. Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soilmicroflora
B. Aquatic Environment: Stratification &Microflora of Freshwater & Marinehabitats.
Atmosphere: Stratification of the Atmosphere, Aeromicroflora, Dispersal ofMicrobes
D. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants)body.
E. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic& osmotic pressures, salinity, & low nutrientlevels.

UNIT- III

Succession of microbial communities in the decomposition of plant organic matter
Biological Interactions
A. Microbe–Microbe Interactions: Mutualism, Synergism, Commensalism, Competition,Amensalism, Parasitism, Predation, Biocontrolagents
B. Microbe–Plant Interactions: Roots, Aerial Plant surfaces, Biological Nitrogenfixation (symbiotic/nonsymbiotic -biofertilizers)
C. Microbe–Animal Interactions: Role of Microbes in Ruminants, Nematophagus fungi,Luminescent bacteria assymbiont

UNIT- IV

Biogeochemical cycles an introduction
Carbon cycle: Microbial degradation of polysaccharide (cellulose, hemicellulose, lignin, chitin)
Nitrogencycle:Ammonification,nitrification,denitrification&nitratereduction.Nitratepollution.
Phosphorous cycle: Phosphate immobilization and phosphatesolubilization
Sulphur Cycle: Microbes involved in sulphur cycle

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Lab Course:

Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action
Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C) Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.

Detection (qualitative) of the presence of enzymes (dehydrogenase, amylase, urease) in soil.

Isolation of Rhizobium from root nodules of legumes

Isolation of Azotobacter/Azospirillum from soil

Isolation of phosphate solubilizers from soil

Books Recommended:

- Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing,USA.
- Atlas RM. (1989). Microbiology: Fundamentals and Applications. 2nd Edition, MacMillan Publishing Company, NewYork.
- Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/ BenjaminCummings.
- Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford,England.
- Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar ThomsonLearning.
- Lynch JM &Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication,U.K.
- Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, AcademicPress.
- Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York &London.
- Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge,England.
- SubbaRaoNS.(1999).SoilMicrobiology.4thedition.Oxford&IBHPublishingCo.NewDelhi.

M. Sc. Microbiology

FOURTH SEMESTER

(January 2020 – June 2020)

Special Paper - PAPER-IV (A): AGRICULTURE MICROBIOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT- I

Structure and characteristic features of the following Biofertilizer organisms: Bacteria: Azospirillum, Azotobacter, Bacillus, Pseudomonas, Rhizobium and Frankia. Cyanobacteria: Anabaena, Nostoc, Fungi: Glomus, Gigaspora, Sclerocystis, Amanita, Laccaria.
Biofertilization processes - Decomposition of organic matter and soil fertility and vermicomposting. Mechanism of Phosphate Solubilization and phosphate Mobilization.

UNIT- II

Biofertilizers – biological nitrogen fixation – Nitrogenase enzyme - symbiotic nitrogen fixation- (Rhizobium, Frankia) – non symbiotic nitrogen fixation (Azotobacter - Azospirillum), VAM- ecto- endo-ectendomycorrhizae and their importance in agriculture.

UNIT- III

Major Biogeochemical Cycles and the organisms: carbon – nitrogen - phosphorous and sulphur. Biopesticides: toxin from *Bacillus thuringiensis, Psuedomonassyringae.* Biological control - use of Baculovirus, protozoa and fungi.

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UNIT- IV

Microbial diseases of crop plants: symptoms, causal organisms and control.
Fungal diseases (Late blight of potato, Tikka disease of groundnut, red rot of sugarcane).
Bacterial diseases (bacterial blight of rice, citrus canker, Tundu disease of wheat) and
Viral diseases (Tobacco mosaic, leaf curl of papaya, yellow vein mosaic of bhindi).

Lab Course:

1. Isolation and enumeration of bacteria from different soiltype.
2. Isolation and enumeration of fungi from different soiltype
3. Preparation of Winogradsky Column to study the various soilmicro ra.
4. Isolation of Rhizobium from rootnodules.
5. Isolation of Azotobacter fromsoil.
6. Isolation of Cyanobacteria from paddyfield.
7. Measurement of pH of soilsample.

Books Recommended:

- Bagyraj and Rangasamy: AgriculturalMicrobiology

M. Sc. Microbiology

FOURTH SEMESTER

(January 2020 – June 2020)

Special Paper - PAPER-IV (B): INDUSTRIAL MICROBIOLOGY

Max. Mark 80

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT- I

Introduction to industrial microbiology
Brief history and developments in industrial microbiology
Fermentation processes
Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatch and continuous fermentations

UNIT- II

Bioreactors/fermenters
Components of a typical bioreactor, types of bioreactors-Laboratory, pilot- scale and production fermenters; constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-liftfermenter.

UNIT- III

Control parameters, industrially important strains, media ingredients
Measurement and control of fermentation parameters
Control and monitoring of different parameters in a bioreactor; pH, temperature, dissolved oxygen, foaming and aeration
Isolation of industrially important microbial strains
Primary and secondary screening, strain development, preservation and maintenance of industrial strains
Media and ingredients for industrial fermentations
Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.

UNIT- IV

Down-stream Processing
Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying

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Lab Course:
1. Microbial fermentations for the production and estimation (qualitative and quantitative) of: (a) Enzyme:Amylase (b) Amino acid: Glutamicacid (c) Organic acid: Citricacid (d) Alcohol:Ethanol (e) Antibiotic:Penicillin 2. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.
Books Recommended:
• Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley EasternLimited. • Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. NewDelhi. • Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan IndiaLimited. • Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier ScienceLtd.

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