

Pt. Ravishankar Shukla University, Raipur**M. Sc. Microbiology****Scheme and Syllabi of Examination for SESSION 2020-2022**

July 2020 – December 2020

Paper	Title of Paper	Marks		Credit
		(External)	(Internal)*	
I	Cell Biology	80	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	20

January 2021-June 2021

Paper	Title of Paper	Marks		Credit
		(External)	(Internal)*	
I	Genetics and Molecular Biology	80	20	4
II	Bioenergetics & Metabolism	80	20	4
III	Instrumentation and 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)	80	20	2
		Total	600	20

July 2021-December 2021

Paper	Title of Paper	Marks		Credit
		(External)	(Internal)*	
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	20

January 2022-June 2022

Paper	Title of Paper	Marks		Credit
		(External)	(Internal)*	
I	Microbial Biotechnology	80	20	4
II	Advanced Immunology, Prophylaxis and Diagnostics	80	20	4
III ^a	Food Microbiology/ Microbial Ecology	80	20	4
IV ^a	Agricultural Microbiology/ Industrial Microbiology	80	20	4
LC-I	Lab Course I (Based on paper I & II)	80	20	2

^a = Only one paper will be active.J. Ravishankar
17.1.20S. D. Singh
17/01/2020M. D. Singh
17/01/2020R. D. Singh
17/01/20A. D. Singh
17.1.20B. D. Singh
17/1/20C. D. Singh
17.1.20

Syllabi of M. Sc. Microbiology: 2020-2022

LC-II	Lab Course I (Based on paper III & IV)	80	20	2
		Total	600	20
		Grand Total	2400	Credit:80

Important Note:

Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.

Continuous evaluation of Performance*

Each student will be evaluated continuously throughout the semester. Each student will be required to submit a brief write-up (not more than 15-20 pages) on his/her poster/oral presentation.

Out of 20 marks allocated for internal Assessment for each paper

- 10 marks are to be assigned for class test.
- 5 marks are to be assigned for assignment/seminar presentation.
- 5 marks are to be assigned for attendance.

The marks for attendance shall be as follows:

(i)	More than 65% but less than 70%	1 Marks
(ii)	70% or more but less than 75%	2 Marks
(iii)	75% or more but less than 80%	3 Marks
(iv)	80% or more but less than 85%	4 Marks
(v)	85% and above	5 Marks

Scheme for Lab Course (for each Semester) Maximum Marks 100

External/Internal

1- Major exercise based on paper I	20
2- Minor exercise based on paper I	10
3- Major exercise based on paper II	20
4- Minor exercise based on paper II	10
5- Spotting/ Interpretation•	10
6- Viva-voce	10

Internal

1- Sessional	20
Total	100

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

Dr. 17/1/20

Dr. Nithamr 17.1.20

Dr. 17/1/20

Dr. 17/01/2020

Dr. 17/1/20

Dr. 17/1/2020

Dr. 17/01/2020

Dr. 17.1.20

Dr. 17/1/20

UNIT-I	Molecular organization of membranes - Asymmetrical organization of lipids, proteins and carbohydrates. Membrane transport: Passive transport, Osmosis, ion channels, membrane pumps and, Active transport: ATP-powered pumps-types, properties and mechanisms. electrical properties of membranes.
UNIT-II	Protein trafficking: Transport of proteins into mitochondria, chloroplast, endoplasmic reticulum and nucleus [in and out]. Transport by vesicle formation: exocytosis, endocytosis and its molecular mechanism.
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. Oncogenes: retinoblastoma, E2F and p53 proteins. Apoptosis: regulation by CASPases and formation of apoptosome. Pro- and anti-apoptotic factors.
UNIT-IV	States of chromosomes during cell cycle. Mitotic chromosome. Organization of genes in chromosomes. Banding pattern of chromosomes. Lampbrush and Polytene chromosomes. DNA packaging: Chromatin, nucleosomes, heterochromatin and euchromatin.

1. Study of chromosome behaviour during Mitosis and meiosis (Onion / Garlic root tips, Onion buds, human lymphocytes, rat or bird testis /grass hopper testis or any other materials).
2. Calculation of mitotic index in growing Onion / Garlic root tips
3. Squash preparation: Polytene chromosome (in chironomus / Drosophila or other insect salivary gland) and Barr body (in buccal epithelial cells).
4. Demonstration of secretory granules in the salivary gland cells of insect.
5. Demonstration of mitochondria by vital staining.
6. Study of permanent slides.
7. Estimation of DNA
8. Estimation of RNA
9. Sub-cellular fractionation and marker enzymes
10. Identification of biomolecules in different tissues by histochemical techniques
11. Preparation of mitotic plate by carmine squashing method and phase identification.
12. Demonstration of the nuclear matrix networks in onion cells.
13. Study of the effect of chemical agents on chromosomes plant cells.
14. Isolation of protoplast, measurement of cell density plating efficiency.
15. Preparation of Karyotype of metaphase plate.
16. Preparation of Meiotic plate and determination of phases.
17. Computation of Chiasma frequency and Terminalization of phases.
18. Micrometry and Camera Lucida drawings.

~~Aspley~~
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~~Dunham~~
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~~Inailham~~
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~~S. Howard~~
17/01/2020
~~P. Paul~~
17/01/2020
~~ASH~~
17/1/2020
~~M Dewno~~
17/01/2020
~~Shree~~
17.1.20
~~Rajm~~
17/1/20

Syllabi of M. Sc. Microbiology: 2020-2022

Books Recommended:

H. Lodish, A. Berk, S L Zipursky, P. Matsudaira
D. Baltimore, and James Darnell.
B. Alberts, D. Bray, K. Hopkin, A. Johnson
H. Lodish, A. Berk, C. A. Kaiser & M. Krieger
B. Alberts, A. Johnson, J. Lewis and M. Raff
G. Karp

Molecular Cell Biology

Essential of Cell Biology

Molecular cell Biology

Molecular Biology of the Cell

Cell and Molecular Biology

Concepts and experiments

M. Sc. Microbiology

FIRST SEMESTER (July 2020 – December 2020)

PAPER – II: Biomolecules

[Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

UNIT-I Classification, structure and function of Carbohydrates, Lipid:

Carbohydrate: Monosaccharides, homo and hetero-polysaccharides, Peptidoglycan glycoproteins and liposaccharide.

Lipids: Simple; cholesterol and complex; phospholipids and TAG

UNIT-II Classification, structure and functions of amino acids, Synthesis of peptides, Proteins-properties, secondary, tertiary and quaternary structure of proteins, Ramchandran plot. Nucleic Acid: Structure and functions of Purine and pyrimidine, DNA-types, linking number, RNA-types.

UNIT-III Enzyme: apoenzymes, cofactors, coenzymes, active site, factors contributing to the catalytic efficiency of enzyme; enzyme kinetics- Michaelis-Menten equation, determination of K_m , enzyme inhibition, allosteric enzymes, isoenzymes, multienzyme complexes

UNIT-IV Structure and biological role of:

Porphyrins in biology, structure of hemoglobin and chlorophyll

Animal hormones: protein, peptide and steroid hormones.

Vitamins: fat and water soluble.

Lab Course:

1. Specific tests for sugars, amino acids and lipids
2. Formal titration of amino acids
3. Estimation of proteins using ninhydrin and biuret method
4. Estimation of sugar by anthrone and Folin-Wu method.
5. Saponification value and iodine number of fat.
6. Estimation of ascorbic acid.
7. Achromic point determination using salivary amylase
8. Effect of ions on salivary amylase activity.
9. Enzyme assay and kinetics (ex. Amylase, Protease)

Syllabi of M. Sc. Microbiology: 2020-2022

Books Recommended:

Nelson, Cox and Lehninger
G. Zubay
Stryer
Garrett and Grosham
West, Tood, Mason & Bbruglen
White, Handler & Smith
D. Voet and J C Voet

Principles of Biochemistry
Biochemistry
Biochemistry
Biochemistry
Text book of biochemistry
Biochemistry-clinical application
Biochemistry

M. Sc. Microbiology

FIRST SEMESTER (July 2020 – December 2020)

PAPER – III: Microbiology

[Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

- UNIT-I** General characteristics of fungi, classification of fungi, life cycle of selected fungal genus (Aspergillus, Pencillium, Fusarium and Mucor). Economic importance of fungi. Microbial association, parasitism, mutualism and symbiosis with plants and animals. Mycorrhiza, VAM. Algae: Distribution, classification, reproduction, ecology and importance.
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- UNIT-II** Morphology and ultra-structure of bacteria: Morphological types, cell wall of archaeobacteria, gram negative, gram positive eubacteria. Bacterial 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 and cosmid 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, Basis of microbial classification, classification and salient feature of bacteria according to Bergey's manual of determinative bacteriology.
- UNIT-IV** Viruses: Structure and classification; General concepts: Viral genome, capsids, envelopes, viroids and prions). Virus reproductions: Lysogeny and Lytic phase, Bacteriophages and their types. Introduction to Plant and animal viruses (TMV, HIV, Hepatitis virus, H1N1 virus, Small Pox virus and Ebola virus), Route of transmission of viruses, Laboratory diagnosis and treatment, Antiviral therapy

Lab Course:

1. Glassware preparation and sterilization techniques- wet heat- dry heat- filter types- laminar flow chamber types- CDC- safety levels.
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 plate methods
4. Identification and Microscopic examination of the microorganisms.
5. Motility of bacteria by hanging drop technique.

Syllabi of M. Sc. Microbiology: 2020-2022

6. Bacterial DNA isolation from *E-coli* culture.
7. Grams' staining for Gram positive and Gram's negative Bacteria.
8. Study of bacterial growth by turbidimetry/ spectrophotometry
9. Isolation and enumeration of microorganisms from soil by serial dilution agar plating method.
10. Enumeration of viruses by plaque assay technique.

Books Recommended:

Microbiology	L.M. Prescott, J.P. Harley and D.A. Klein
General Microbiology	RY Stanier, J L Ingrahamana, ML Wheelis & P. R. Painter
Principles of Microbiology	R.M. Atlas
Microbiology	Peleczar, Chan & Krieg.
General Virology	Luria, Darnell, Baltimore and Campell.
Introduction to Mycology	CJ Alexopoulos and CW Mims
Principles of Virology: Molecular	S. J. Flint, V. R. Racaniello, L. W. Enquist,
Biology, Pathogenesis, and	V. R. Rancaniello, A. M. Skalka
Control of Animal Viruses	

M. Sc. Microbiology

FIRST SEMESTER (July 2020 – December 2020)

PAPER – IV: Biology of Immune System

[Credit: 4 and Maximum Marks: 80]

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- UNIT-I** Innate immune mechanism and characteristics of adaptive immune response. Cells of immune system: Hematopoiesis 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. Complement system.
- 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 and autoimmune disorder. Immunological tolerance.

Lab Course:

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Handwritten signatures and dates:
Rundh... 17/11/2020
S. Aravind 17/10/2020
Ash 17/11/2020
M. Desai 17/11/2020
D. Desai 17.1.20
M. Desai 17/10/2020
D. Desai 17/11/20
M. Desai 17.1.20
D. Desai 17/11/20

Syllabi of M. Sc. Microbiology: 2020-2022

1. Identification of cells of immune system
2. Separation of mononuclear cells by Ficoll-Hypaque
3. Identification of Lymphocytes and their subsets
4. Lymphoid organs and their microscopic organization
5. Isolation and purification of Antigens
6. Purification of IgG from serum
7. Estimation of Levels of gamma globulins and A/G ratio in blood
8. Antigen antibody interaction

Books Recommended:

Kuby's Immunology	R.A. Goldsby, T. J Kindt and B. A. Osborne
Immunology- A short Course	E. Benjamini, R. Coico and G. Sunshine
Immunology	Roitt, Brostoff and Male
Fundamentals of Immunology	William Paul
Immunology	Tizard
Immunology	Abbas et al

M. Sc. Microbiology

SECOND SEMESTER (January 2021 – June 2021)

PAPER – I: Genetics and Molecular Biology

[Credit: 4 and Maximum Marks: 80]

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- UNIT-I** Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants, complementation analysis.
Mutation: Types, mutagens and detection.
Mutant types – lethal, conditional, biochemical, loss of function, gain-of-function, germinal verses somatic mutants, insertional mutagenesis.
- UNIT-II** DNA replication in eukaryotes and prokaryotes : 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. p_{53} and p_{21} .
- UNIT-III** RNA synthesis and processing: enzymes involved, formation of initiation complex, transcription activator and repressor, elongation, and termination, RNA processing, capping, RNA editing, splicing, and polyadenylation, RNA transport.
- UNIT-IV** Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors, elongation and elongation factors and their regulation, termination.
Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors.
Post Translational modification of proteins.

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Lab Course:

1. Isolation, purification and estimation of RNA
2. Isolation, purification and estimation of DNA
3. Determination of T_m of nucleic acid
4. Fraction of poly (A) RNA
5. Restriction Mapping
6. Restriction Digestion
7. Ligation
8. DNA molecular size determination

Books Recommended:

Molecular Cell Biology	H. Lodish, A. Berk, SL Zipursky, P. Matsudaira, D.
Essential Cell Biology	B. Alberts, D. Bray, K. Hopkin and A. Johnson
Molecular Biology of the Cell	Baltimore, and James Darnell
Molecular Biology of the Cell	B. Alberts, A. Johnson, J. Lewis and M. Raff
Cell and Molecular Biology	G. Karp
: Concepts and experiments	
Molecular Biology of the Gene	JD Watson et al.
Molecular Biology of the Cell	John Wilson, Tim Hunt
The Problems	
Molecular Biology of the Cell	Bruce Albert's, Alexander Johnson, Julian Lewis,
	Martin Raff, Keith Roberts, Peter Walter
Genes VIII	Benjamin Lewin

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SECOND SEMESTER (January 2021 – June 2021)

PAPER – II: Bioenergetics & Metabolism

[Credit: 4 and Maximum Marks: 80]

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- UNIT-I** First and second laws of thermodynamics. Gibbs free energy G , free energy change ΔG , endergonic & exergonic reactions. Standard state free energy changes- ΔG , ΔG° and $\Delta G'^\circ$, Relationship between equilibrium constant and $\Delta G'^\circ$, Feasibility of reactions. ATP-Structure, properties and energy currency of the cell, Importance of Coupled reactions, other high energy compounds.
- UNIT-II** Carbohydrate metabolism: Glycolysis, Kreb's cycle, glycogenolysis, glycogenesis, pentose phosphate pathway, gluconeogenesis, and glyoxylate pathway. 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

Syllabi of M. Sc. Microbiology: 2020-2022

UNIT-IV Nitrogen Assimilation: Overview of Nitrogen in biosphere and uptake by organism. Biosynthesis and 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 Spectrophotometric method
2. Estimation blood cholesterol
3. Estimation of sugar by Nelson- Somagy and Benedict's reagent
4. Isolation and estimation of lipid from seeds and egg.
5. Estimation of inorganic and total phosphorus by Fiske-Subba Rao method
6. Assay of phosphatases in blood and seeds
7. Urease estimation in plant tissues

Books Recommended:

Principles of Biochemistry	Nelson, Cox and Lehninger
Biochemistry	G. Zubay
Biochemistry	Stryer
Biochemistry	Garrett and Grosham
Text book of biochemistry	West, Tood, Mason & Bbruglen
Biochemistry	White,Handler & Smith
Biochemistry with clinical application	D. Voet and J C Voet
Enzymes	Dixon and Webb
Fundamentals of Enzymology	Price and Steven
Practical biochemistry	Plummer
Enzyme biotechnology	G. Tripathi
Enzyme Reaction Mechanism	Walsh
Enzyme catalysis and regulation	Hammes

M. Sc. Microbiology

SECOND SEMESTER (January 2021 – June 2021)

PAPER- III: Instrumentation and Techniques

[Credit: 4 and Maximum Marks: 80]

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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

Syllabi of M. Sc. Microbiology: 2020-2022

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| UNIT-II | Microscopic techniques: light microscopy, phase-contrast microscopy, scanning and transmission electron microscopy, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy. |
| UNIT-III | Chromatography: Paper and Thin Layer Chromatography. Gel filtration, Ion exchange and Affinity chromatography. GLC and HPLC.
Histochemical and immunohistotechniques: Detection of molecules using immunoprecipitation, EIA, RIA and FIA. |
| UNIT-IV | Electrophoresis: Agarose, PAGE, 2D-E.
Radioactivity: GM counter, liquid Scintillation counter, solid Scintillation counter, gamma counters.
<i>Lyophilization</i> : Principle, instrumentation and applications.
Microtomy: types, principle and applications |

Lab Course:

1. Verification of Beers Law
2. Determination of absorption maxima
3. Quantitative determination, Enzyme kinetics
4. Amino acid and carbohydrate separation by paper and TLC
5. Ion exchange and gel filtration chromatography
6. SDS Polyacralamide Gel Electrophoresis
7. Isoenzymes
8. Separation of sub-cellular organelles by differential centrifugation.
9. Isolation of DNA and Agarose gel Electrophoresis

Books Recommended:

K Wilson and John Walker RF Boyer	Practical Biochemistry: Principles & Techniques 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
TA Jennings	Lyophilization: Introduction and Basic Principles
James M. Miller	Chromatography: Concepts and Contrasts
LR Synder, JJ Kirkland and JL Glajch	Practical HPLC Method Development, 2nd Edition
Anna Pratima Nikalje & D. Bhosale	A Handbook of Chromatography
Mark F. Vitha	Chromatography: Principles and Instrumentation
AGE Pearse	Histology and Histochemical methods
PA Midgley	The principles of microscopy
DB Murphy & MW Davidson	Fundamentals of Light Microscopy and Electronic Imaging, Second Edition
IW Watt	The Principles and Practice of Electron Microscopy
RF Egerton	Physical Principles of Electron Microscopy
P Haselet, G-W Oetjen	An Introduction to TEM, SEM, and AEM
EC Clayden	Freeze-Drying, 3rd Edition
T Chandak, M Chaudhary & V	Practical Section Cutting and Staining
	Microtomy: Microtome and its applications

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Mutham
17-1-20
Ash
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S. Suresh
17/1/2020

R. P. S.
17/1/20

Ash
17/1/20

D. S.
17-1-20

M. S.
17/1/2020

L. S.
17/1/20

Syllabi of M. Sc. Microbiology: 2020-2022

Chandak

Simon Renshaw

IB Buchwalow & W Bocker

JB Birks

Immunohistochemistry and Immunocytochemistry:
Essential Methods, Second Edition
Immunohistochemistry: Basics and Methods
The Theory and Practice of Scintillation Counting

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SECOND SEMESTER (January 2021 – June 2021)

PAPER- IV: BIOMETRY, COMPUTER AND SCIENTOMETRY

[Credit: 4 and Maximum Marks: 80]

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- 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 & binomial. Probability: Basic laws of probability, addition law, multiplication law. Probability and frequency.
- 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. Multiple comparisons: Duncan's multiple-range tests. 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 formulas and functions, Features for Statistical data analysis, Excel ToolPak for data analysis, Generating charts/ graph. Presentation software; Working in PowerPoint, Creating new presentation, working with slides.
- Unit-IV** Introduction to Internet and Applications. Basics of internet, e-mailing, Search engine – Google and Yahoo; Pub med, 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.

Syllabi of M. Sc. Microbiology: 2020-2022

Lab Course:

1. Exercises for data distribution
2. Exercises for computation of measures of central tendency
3. Exercises for computation of measures of variability
4. Computation of correlation coefficient, r , and regression constants
5. Data analysis by ANOVA and multiple-range tests
6. Hypothesis testing by t-test, F-test, and Chi-square test
7. Graphical presentation of data using a suitable package
8. Statistical analysis of a data using a suitable package
9. Preparation of document using a suitable package
10. Preparation of slides using a suitable package
11. Hands-on-practice for finding indices [SCI, h-index, i-10 index] of articles using relevant database

Books Recommended:

Campbell RC	Statistics for biologists
Zar JH	Biostatistical Analysis
Wardlaw AC	Practical Statistics for Experimental Biologists
Snedecor GW & Cochran WG	Statistical Methods
Sokal RR & Rohlf FJ	Introduction to Biostatistics
Sumner M	Computers: Concepts & Uses
White R	How Computers Work
Cassel P et al.	Inside Microsoft Office Professional
Coleman P and Dyson P	Mastering Internets
Gralla P	How the Internet Works
Shelly GB, Vermaat ME, Cashman TJ	Microsoft 2007: Introductory Concepts & Techniques
Habraken J	Microsoft Office 2003 All in One
Gilmore B	Microsoft Office 2010 In Depth
Buranen L & Roy AM	Plagiarism: Why it happens, How to prevent it? Perspectives on Plagiarism & Intellectual Property in a Post-Modern World
Kumar Anupa P	Cyber Law
Sood V	Cyber Law Simplified

M. Sc. Microbiology	
THIRD SEMESTER (July 2021 – December 2021)	
PAPER I: MICROBIAL PHYSIOLOGY	
[Credit: 4 and Maximum Marks: 80]	
<p>Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice. of 5 marks each. The question has to be answered in about 150 words.</p>	

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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 of hydrogen.

UNIT – III

Microbial photosynthesis: Historical account, structure of photosynthetic pigments i.e., chlorophylls and bacterio-chlorophylls, carotenoids, phycobilins, primary photochemistry and 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-cellular enzymes
2. Quantitative assay of alkaline and acid phosphatases from microorganisms.
3. Determination of K_m value of beta- fructofuranosidase from yeast
4. Antibiotic sensitivity test
5. Measurement of CM-cellulase by viscometric and reducing sugar method.
6. Experiment on production of enzymes and optimizing parameters for enzyme production in shake flask culture using *Aspergillus niger*, *Saccharomyces cerevisiae* for production of amylase, invertase respectively.
Experiment on production of citric acid and optimizing parameters for citric acid production in shake flask culture using *Aspergillus niger*.

Books Recommended:

1. Brown TA (1999) Genome. John Wiley & Sons (Asia) PTE. LTD.
2. Goeddel DV (1990) Methods in Enzymology, vol 185, Gene Expression Technology. Academic Press, San Diago.
3. Kaufman PB, Wu W, Kim D and Cseke LJ (1995) Molecular and Cellular Methods in Biology and 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 2021 – December 2021)

PAPER-II: FERMENTATION TECHNOLOGY

[Credit: 4 and Maximum Marks: 80]

Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.

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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 shake flask culture using *Saccharomyces cerevisiae*.
2. Experiment on production and optimizing parameters for SCP in shake flask culture.
3. Experiment on production of enzymes and optimizing parameters for enzyme production in solid-state fermentation using wheat bran and other agricultural solid waste.
4. Protein purification methods: affinity chromatography, ion exchange and gel filtration.
5. Recovery of products from solid state cultures -Recovery of intracellular products: Cell disruption procedures by sonication,
6. Carbohydrate catabolism by microorganisms (oxidation and fermentation of glucose)
7. Fermentation of carbohydrates.

Books Recommended:

- EL-Mansi E.M.T. and Bryce C.F.A. Fermentation Microbiology and Biotechnology.
- Alberghina Lilia. Protein Engineering in Industrial Biotechnology..
- Jogdand S. N. Gene Biotechnology. .
- O. J. Eugenia, S. G. & Hernandez Elizabeth. Environmental Biotechnology and Cleaner Bioprocesses.
- Prescott & Dunn's. Industrial Microbiology. 4th ed,.
- Bullock John and Kristiansen Bjorn. Basic Biotechnology.
- A.H. Patel. Industrial Microbiology

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THIRD SEMESTER (July 2021 – December 2021)

PAPER III: ENVIRONMENTAL MICROBIOLOGY

[Credit: 4 and Maximum Marks: 80]

Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.

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UNIT - I

Distribution and ecology of microorganism, 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, O₂ and CO₂. Microorganisms of extreme environments: psychrophiles, mesophiles, thermophiles, acidophiles, alkalophiles, halophiles and specific habitats.

UNIT - II

Microbiology of water: aquatic and marine ecosystems, Zonation of water ecosystems: eutrophication, ecology of polluted water, microbiological treatment processes. Waste water disposal and reclamation. Brief account of major water borne diseases and their control measures.

UNIT – III

Soil microbiology: Micro flora of various soil types (bacteria and nematodes): rhizosphere and phyllosphere, Microbial interactions: symbiosis, mutualism, commensalism, competition, amensalism, synergism, parasitism and predation, Phosphate solubilizing organisms, Biogeochemical cycles and Microbes, Biological N₂ fixing organisms, extracellular enzymes, Ecology of litter decomposition.

UNIT-IV

Biodegradation of lingo-cellulose and hydrocarbons, oil spills and superbug. Composting, treatment of solid and liquid wastes. Bioaccumulation of metals and detoxification-biopesticides; biodeterioration of materials, GMO and their impact.	
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Lab Course:

1. BOD & COD estimation in water sample
2. Study of microbial contaminants from water and wastewater.
3. Study of air borne microorganisms using various methods.
4. Assay of anti-fungal and antibacterial properties of agro-chemicals and fungicides.
5. Assessment of quality of oils using saponification value, iodine number, and free fatty acid composition.
6. Study of thermophilic microorganisms.
7. Bacteriological examination of water by multiple-tube fermentation test.
8. Determination of coliforms to determine water purity using membrane filter method.
9. Lipase production test.
10. Isolation of Rhizobium from root nodule.
11. Measurement of spore size using micrometry
12. Isolation of microorganisms from rhizosphere and phylloplane.

Books Recommended:

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

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THIRD SEMESTER (July 2021 – December 2021)

PAPER-IV: MEDICAL MICROBIOLOGY

Syllabi of M. Sc. Microbiology: 2020-2022

[Credit: 4 and Maximum Marks: 80]

Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.

UNIT – I

Normal microbial flora of human body, role of resident flora, host microbe interactions. Classification of medically important microorganisms. Nosocomial infection, common type of hospital infections. 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 Enterobacteriaceae, vibrios, Non fermenting gram negative bacilli *Yersinia*; *haemophilus*; *Bordetelia*; *Brucella*; *Mycobacteria*, *Spirochaetes*, *Actinomycetes*; *Rickettsiae*, *Chlamdiae*. Principles of antimicrobial action and resistance of antibiotics. Antimicrobial susceptibility testing.

UNIT- III

General properties of Viruses; Viruses Host Interactions, Pox viruses, Herpes viruses, Adeno viruses; Picarno viruses; Orthomyxo viruses; Paramyxo viruses (Nipah Virus); Arboviruses, Rhabdo viruses, Oncogenic viruses; Filoviridae (Ebola Viruses), Human Immuno deficiency viruses. Anti viral therapy and anticancer compounds.

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. Anti fungal compounds
Parasitology - Medical importance of Entamoeba, Giardia, Plasmodium, Taenia, Ascaris, Wucherhiria. Laboratory diagnosis of parasitic diseases

Lab Course:

1. Identification of micro flora of mouth, skin and wounds
2. Identification of enteric pathogens by TSIA medium
3. Identification of dermatophytic fungi
4. Identification of important human parasites
5. IMVIC test/other specific tests
6. Identification of Microorganisms from Cell Phone/ contaminated objects.

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 Saunders Co.
- Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications
- Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology, Mosby

Syllabi of M. Sc. Microbiology: 2020-2022

M. Sc. Microbiology
FOURTH SEMESTER (January 2022 – June 2022)
PAPER-I: MICROBIAL BIOTECHNOLOGY [Credit: 4 and Maximum Marks: 80]
Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.
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 electrodes, enzyme in pulp and paper industry, Bioremediation. Bioleaching.
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: <ol style="list-style-type: none">1. Bacterial culture and antibiotic selection media. Preparation of competent cells.2. Isolation of plasmid DNA.3. Isolation of Lambda phage DNA.4. Estimation of nucleic acids.5. Agarose gel electrophoresis and restriction mapping of DNA.6. Construction of restriction map of plasmid DNA.7. Cloning in plasmid/phagemid vectors.8. Preparation of single stranded DNA template.9. Gene expression in <i>E. coli</i> and analysis of gene product10. PCR
Books Recommended: <ul style="list-style-type: none">• Bruce A White (1997) PCR Cloning Protocols.• Bruce Birren, Eric D Green, Sue Klapholz, Trichard M Myers, Horald Riethman, & Jane Roskenus (1999) Genome Analysis: A Lab Manual vol.1, vol.2, vol.3, Daniel L Hartl, Elizabeth & Jones W (1998) Genetics: Principles and Analysis.

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- Davies JA & Rez WS (1992) Milestones in Biotechnology Classic papers on Genetic Engineering. Glick Molecular Biotechnology.
- Glover DM and Hames BD (1995) DNA Cloning: A practical approach, IRL Press, Oxford.
- Kaufman PB, Wu W, Kim D and Cseke LJ (1995) Molecular and Cellular Methods in Biology and Medicine. C. Press, Florida.
- Kingsman SM & Kingsman AJ (1998) Genetic Engineering. An Introduction to gene analysis and exploitation in eukaryotes. Blackwell Scientific Publishers, Oxford.
- Mickloss DA & Freyer GA (1990) DNA Science. A First Course in Recombinant Technology. Cold Spring Laboratory Press, New York
- Primrose SB (1994) Molecular Biotechnology (2nd Edition). Blackwell Scientific Publishers, Oxford.
- Sambrook, Fritsch EF and Maniatis (2000). Molecular Cloning: A Laboratory Manual. Cold Spring Laboratory Press, New York
- Sambrook & Russell (2001) Molecular Cloning: A lab Manual (3rd Edition). Cold Spring Harbor Lab Press.
- Strickberger MW (2000) Genetics (3rd Edition), Prentice Hall of India Pvt. Ltd.
- Walker MR & Rapley R (1997) Route Maps in Gene Technology. Blackwell Scientific Publishers, Oxford.
- Watson JD, Gilman N, Witkowski, Mark, Zoller . Recombinant DNA , Scientific American Books.
- John Bulock and Bjorn Kristiansen. Basic Biotechnology Academic Press

M. Sc. Microbiology	
FOURTH SEMESTER (January 2022 – June 2022)	
PAPER-II: ADVANCED IMMUNOLOGY, PROPHYLAXIS AND DIAGNOSTICS	
[Credit: 4 and Maximum Marks: 80]	
<p>Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.</p>	
UNIT – I	
<p>Generation of diversity in BCR. Light and heavy chain gene recombination. Recombination Signal sequences. Class switching. Membrane and secreted immunoglobulins. Organization, arrangement of T-cell receptor genes and recombination.</p> <p>Regulation of immune response by antigen, antibody, immune complex, MHC and cytokines.</p>	
UNIT – II	
<p>Immunoprophylaxis: Principles of Vaccination. Immunization practices. Vaccines against important bacterial and parasitic diseases. DNA vaccines; passive prophylactic measures. Viral vaccines and antiviral agents. Vaccination schedules and safety. Production of vaccines.</p>	
UNIT – III	
<p>Diagnosis of microbial diseases - Collection, transport and preliminary processing of Clinical pathogens. Clinical, microbiological, immunological and molecular diagnosis of diseases.</p> <p>Principles of immunodiagnosics. Antigen-antibody based diagnosis and the techniques involved – Enzyme, Radio and Fluorescence Immuno assays, Immunoblotting, Flow cytometry. Effector cell assays, Cytotoxic assays. Isolation of pure antibody. Monoclonal & Designer antibody and their application in immunodiagnosics.</p>	
UNIT – IV	

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Modern methods of microbial diagnosis. Use of nanotechnology in diagnosis. Synthesis of Nanomaterials, Nanoparticle based drug delivery, Toxicity and environmental risks of nanomaterials. Biosensors: Biosensor-development, types and characteristics, DNA biosensors, application of biosensors in clinical diagnostics: detection of infectious diseases, food pathogen and environmental monitoring.

Lab Course:

1. Preparation of Parasite/ microbe Antigen and analysis by PAGE
2. Immunizations and Production of Antibody
3. Antigen antibody reaction by Double Diffusion, Counter Current and IEP, RID and ELISA
4. Western Blot Analysis
5. Immunodiagnosis using commercial kits (VDRL, RPR, Widal etc.)
6. Identifications of nanomaterials using physical and chemical properties.
7. Green and chemical route for synthesis of nanomaterials.
8. Nanomaterial characterizations using UV-Vis and FT-IR spectroscopy.
9. Assessment of antibacterial properties of nanomaterials.
10. Identification of different analyte/ biomolecules for biosensing system.

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 Saunders Co.
- Chapel and Haeney: Essentials of Clinical Immunology, Blackwell Scientific Publications
- 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 and Male
- Forbes BA, Sahm DF and Weissfeld AS: Bailey & Scott's Diagnostic Microbiology, Mosby
- Nanotechnology: Basic science and Emerging technologies, M. Wilson, K. Kannangara, G Smith, M. Simmons, B. Raguse, Overseas Press India Pvt. Ltd, New Delhi, First Edition, 2005.
- Nanostructures and Nanomaterials: Synthesis, G. Cao, properties and applications, Imperial College Press, 2004.
- Nanomaterials for medical diagnosis and therapy, Challa S.S.R. Kumar, Wiley-VCH, 2007.
- Introduction to Nanotechnology - Charles P. Poole Jr. and Franks. J. Qwens, Publisher: Wiley.
- Nanobiotechnology: Concepts, Applications and Perspectives- Christof M. Niemeyer (Editor), Chad A. Mirkin (Editor), 2004, WILEY-VCH, Verlag Gmb H & Co.

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FOURTH SEMESTER (January 2022 – June 2022)	
PAPER-III: FOOD MICROBIOLOGY	
[Credit: 4 and Maximum Marks: 80]	
Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.	
UNIT- I	
Microbial flora of fresh food, grains, fruits, vegetables, milk, meat, eggs and fish.	Microbiological

Handwritten signatures and dates:

- Dr. J. H. Hani* 17.1.20
- SK Singh* 17/01/2020
- ASR* 17/1/20
- Pranav* 17/01/20
- Abhishek* 17.1.20
- Labym* 17/1/20
- 400* 17.1.20

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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: <i>Bacillus</i> , <i>Clostridium</i> , <i>Escherichia</i> , <i>Salmonella</i> , <i>Shigella</i> , <i>Staphylococcus</i> , <i>Vibrio</i> , nematodes, protozoa, algae, fungi and viruses. Food borne outbreak- laboratory testing procedures; Sources and transmission of bacteria in foods: human, animal, and environmental reservoirs.
UNIT- IV
Food preservation and quality control. Government Agency and Food Safety Policy: Government Branches (FDA, CDC, USDA and how they work to control food safety), HACCP, Risk Assessment. Biosensor for the detection of food pathogens.
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 reductase test.
Books Recommended:
<ul style="list-style-type: none">• M.R. Adams and M.O. Moss: Food Microbiology, Royal Society, Cambridge• William, C. Frazier and Dennis C. Westhoff: Food Microbiology, Tata McGraw Hill• Banwart GJ: Food Microbiology CBS Publishers & Distributors, New Delhi.• Hobbs BC and Roberts D: Food Poisoning and Food Hygiene, Edward Arnold, London

M. Sc. Microbiology
FOURTH SEMESTER (January 2022 – June 2022)
PAPER-III: MICROBIAL ECOLOGY [Credit: 4 and Maximum Marks: 80]
Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.
UNIT- I
History, significance and developments in the field of microbial ecology Contributions of Beijerinck, Winogradsky, Kluver, Van Niel, Martin Alexander, Selman A. Waksman,

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S. Singh: 17/10/2020
Rudra: 17/10/20
Arun: 17.1.20
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Environmental chemistry, Atmospheric 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, Soil microflora
- B. Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats.
- Atmosphere: Stratification of the Atmosphere, Aeromicroflora, Dispersal of Microbes
- 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 nutrient levels.

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, Biocontrol agents.
- B. Microbe–Plant Interactions: Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/nonsymbiotic - biofertilizers)
- C. Microbe–Animal Interactions: Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont.

UNIT- IV

Biogeochemical cycles an introduction.

Carbon cycle: Microbial degradation of polysaccharide (cellulose, hemicellulose, lignin, chitin)

Nitrogen cycle: Ammonification, nitrification, denitrification & nitrate reduction. Nitrate pollution.

Phosphorous cycle: Phosphate immobilization and phosphate solubilization.

Sulphur Cycle: Microbes involved in sulphur cycle.

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, New York.
- Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/ Benjamin Cummings.
- Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
- Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
- 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, Academic Press.
- 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,

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Cambridge, England.

- Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

M. Sc. Microbiology
FOURTH SEMESTER (January 2022 – June 2022)
PAPER-IV: AGRICULTURE MICROBIOLOGY [Credit: 4 and Maximum Marks: 80]
Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.
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- ectendo mycorrhizae and their importance in agriculture.
UNIT- III
Major biogeochemical cycles and the organisms: carbon – nitrogen - phosphorous and sulphur. Biopesticides: toxin from <i>Bacillus thuringiensis</i> , <i>Psuedomonas syringae</i> . Biological control - use of Baculovirus, protozoa and fungi.
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:
<ol style="list-style-type: none"> 1. Isolation and enumeration of bacteria from different soil type. 2. Isolation and enumeration of fungi from different soil type 3. Preparation of Winogradsky Column to study the various soil microflora. 4. Isolation of Rhizobium from root nodules. 5. Isolation of Azotobacter from soil. 6. Isolation of Cyanobacteria from paddy field. 7. Measurement of pH of soil sample.
Books Recommended:
<ul style="list-style-type: none"> • Bagyraj and Rangasamy: Agricultural Microbiology

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M. Sc. Microbiology	
FOURTH SEMESTER (January 2022 – June 2022)	
PAPER-IV: INDUSTRIAL MICROBIOLOGY	
[Credit: 4 and Maximum Marks: 80]	
<p>Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.</p>	
UNIT- I	
<p>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</p>	
UNIT- II	
<p>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-lift fermenter.</p>	
UNIT- III	
<p>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.</p>	
UNIT- IV	
<p>Down-stream Processing Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying</p>	
Lab Course:	
<p>1. Microbial fermentations for the production and estimation (qualitative and quantitative) of: (a) Enzyme: Amylase (b) Amino acid: Glutamic acid (c) Organic acid: Citric acid (d) Alcohol: Ethanol (e) Antibiotic: Penicillin</p> <p>2. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations.</p>	

Syllabi of M. Sc. Microbiology: 2020-2022

Books Recommended:

- Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
- Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
- Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
- Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

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