South Konkan Education Society's

GOVIDRAM SEKSARIA SCIENCE COLLEGE, BELAGAVI

(AUTONOMOUS)

PG Dept. of Microbiology

The Course structure of M.Sc. degree in Microbiology

Subjects	**Paper**	Instruction hrs/week	**Duration of Exam (hrs)**	Marks			Credits
				IA	Exam	Total	
a) I Semester of the PG Program							
Core Subject	4T	4x4	4x3	4x20	4x80	4x100	4x4=16
	3P	3x4	3x4	3x10	3x40	3x50	3x2=6
Soft Core/ Specializatio n/ Optional	1T	1x2	1x2	1x10	1x40	1x50	1x2=2
Per Semester Total of Credits							24
b) II/III Semester of the PG Program							
Core Subject	3T	3x4	3x3	3x20	3x80	3x100	3x4=12
	3P	3x4	3x4	3x10	3x40	3x50	3x2=6
Soft Core/ Specialization/ Optional	1T	1x2	1x2	1x10	1x40	1x50	1x2=2
Open Elective	1T	1x4	1x3	1x20	1x80	1x100	1x4=4
Semester Total of Credits (II and III Sem.)							24+24= 48
c) IV Semester of the PG Program							
Core Subject	3T	3x4	3x3	3x20	3x80	3x100	3x4=12
	3P	3x4	3x4	3x10	3x40	3x50	3x2=6
Soft Core/ Specialization / Optional	1T	1x2	1x2	1x10	1x40	1x50	1x2=2
Project Work	1P	4	Report Evaluati on	1x20	1x80	1x100	1x4=4
Semester Total of Credits							**24**
Program Grand Total of Credits							**96**

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GOVIDRAM SEKSARIA SCIENCE COLLEGE, BELAGAVI

(AUTONOMOUS)

PG Dept. of Microbiology

Choice Based Credit System (CBCS)

Details of Course structure of M.Sc. degree in Microbiology

Papers details		Teaching hrs/ week	Duration of Exam hrs	Marks			Credits
				Exam	IA	Total	
I Semester							
Hard Core	MBH -1.1: General Microbiology	4	3	80	20	100	4
	MBH -1.2: Microbial Diversity and Taxonomy	4	3	80	20	100	4
	MBH -1.3: Microbial and Biochemical Techniques	4	3	80	20	100	4
	MBH -1.4: Microbial Physiology & Biochemistry	4	3	80	20	100	4
Soft Core	MBS-1.5: Biostatistics	2	2	40	10	50	2
Practical	MBHP -1.6: Based on MBH 1.1 and 1.2	4	4	40	10	50	2
	MBHP -1.7: Based on MBH 1.3	4	4	40	10	50	2
	MBHP –1.8 Based on MBH 1.4	4	4	40	10	50	2
Total		30	26	480	120	600	24
II Semester							
Hard Core	MBH -2.1 Immunology and Immunotechnology	4	3	80	20	100	4
	MBH -2.2: Microbial Genetics	4	3	80	20	100	4
	MBH - 2.3: Molecular Biology	4	3	80	20	100	4
Softcore	MBS- 2.4: Bioinformatics	2	2	40	10	50	2
OEC	MOE-2.5: Applied Microbiology	4	3	80	20	100	4
Practical	MBHP -2.6: Based on MBH 2.1	4	4	40	10	50	2
	MBHP -2.7: Based on MBH 2.2	4	4	40	10	50	2
	MBHP – 2.8 Based on MBH 2.3	4	4	40	10	50	2
Total		30	26	480	120	600	24

Papers details		Teaching h/ week	Duration of Exam,h	Marks			Credits
				Exam	IA	Total	
III Semester							
Hard Core	MBH - 3.1: Food Microbiology	4	3	80	20	100	4
	MBH - 3.2: Medical Microbiology	4	3	80	20	100	4
	MBH - 3.3: Recombinant DNA Technology	4	3	80	20	100	4
Soft core	MBS - 3.4: Fermentation Technology	2	2	40	10	50	2
OEC	MOE - 3.5: Microbial Water analysis	4	3	80	20	100	4
Practical	MBHP -3.6: Based on MBH 3.1	4	4	40	10	50	2
	MBHP -3.7: Based on MBH 3.2	4	4	40	10	50	2
	MBHP – 3.8 Based on MBH 3.3	4	4	40	10	50	2
Total		30	26	480	120	600	24
IV Semester							
Hard Core	MBH- 4.1: Agriculture Microbiology	4	3	80	20	100	4
	MBH - 4.2: Industrial Microbiology	4	3	80	20	100	4
	MBH - 4.3: Environmental Microbiology	4	3	80	20	100	4
Soft core	MBS- 4.4: Microbial Biotechnology	2	2	40	10	50	2
Project	MBP 4.5: Project /Dissertation	4		80	20	100	4
Practical	MBHP -4.6: Based on MBH 4.1	4	4	40	10	50	2
	MBHP -4.7: Based on MBH 4.2	4	4	40	10	50	2
	MBHP – 4.8 Based on MBH 4.3	4	4	40	10	50	2
Total		30	23	480	120	600	24
Grand Total		120	101	1920	480	2400	96

Question paper Pattern of 4 Credit Paper

Semester (Regular/ Repeater) M.Sc. Degree (CBCS) Examination
MICROBIOLOGY
Paper Code: MBH

Time:3 Hours Max. Marks:80

*Instructions: Answer **all** questions*

I. Answer **any Ten** of the following questions. (10x2 = 20)

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II. Write a short note on **any Five** of the following. (5x6 = 30)

13.
14.
15.
16.
17.
18.
19.

III. Answer **any Three** of the following. (3x10 = 30)

20.
21.
22.
23.
24.

Question paper Pattern of 4 Credit Paper

Semester (Regular/ Repeater) M.Sc. Degree (CBCS) Examination
MICROBIOLOGY
Paper Code: MOE

Time:3 Hours Max. Marks:80

*Instructions: Answer **all** questions*

I. Answer **any Ten** of the following questions. (10x2 = 20)

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

II. Write a short note on **any Five** of the following. (5x6 = 30)

13.
14.
15.
16.
17.
18.
19.

III. Answer **any Three** of the following. (3x10 = 30)

20.
21.
22.
23.
24.

Question paper Pattern of 2 Credit Paper

_ Semester (Regular/ Repeater) M.Sc. Degree (CBCS) Examination
MICROBIOLOGY
Paper MBS: GENERAL

Time: 2 Hours Max. Marks: 40

*Instructions: Answer **all** questions*

I) Answer **any four** of the following questions. (4x2 = 8)

1)
2)
3)
4)
5)
6)

II)

7)
8)
9)

OR

10) (5+5+6)

III)

11)
12)
13)

OR

14) (5+5+6)

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Question paper Pattern of 4 Credit Practical

_ Semester (Regular/ Repeater) M.Sc. Degree (CBCS) Examination
MICROBIOLOGY
Practical Code:
(Semester: I/II/III/IV)

Time: 04 Hrs. Max Marks: 40

Q I (Major) 14 Marks
1.

Q II (Minor) 10 Marks
2.

Q III Spotters 2*3=6 Marks
3. A
4. B
5. C

Q IV 5 Marks
6. Record

Q V
7. **Viva Voce** 5 Marks

ELIGIBILITY FORADMISSION:

Candidates who have passed the three-year Bachelor's degree examination of Rani Channamma University or any other University considered as equivalent thereto, with the respective subject**(B,Sc., in Microbiology/Biotechnology/B.Sc(CBZ) or B.Sc., Agricultural sciences cognate subject or MBBS Medical sciences cognate subject or B.Sc., Cognate subject in any biological science)** as optional/major / special/main subject, are eligible for admission to the program provided they have secured a minimum of 40% marks in the aggregate of all the subjects and 50% (45% for SC/ST/Category I candidates) marks in the cognate subject.

Project Work

1. Proposed to carry out the project work individually or in group to a maximum of 4 or 5 Students.
2. Project shall be allotted at the beginning of the III semester to facilitate students to carry out project work during semester break and in house projects are encouraged.
3. Students may also be allowed to carry out the project work in other research institutes.
4. Evaluation of dissertation has to be done by two external examiners appointed by the University for 80 Marks.

Open Elective: Open Elective Subject is open for all faculty students.

M.Sc. Microbiology FIRST SEMESTER
MBH 1.1: General Microbiology

Teaching: 4 hours/Week **Total 60 hours**
Credits: 4

Unit-1: History and Scope of Microbiology: Introduction to Microbiology, Spontaneous generation theory, Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Edward Jenner, and Alexander Fleming. Beneficial and harmful microorganisms, Introduction to branches of Microbiology: a) Air, b) Water, c) Sewage, d) Soil, e) Dairy, f) Food, g) Medical, h) Industrial, i) Biotechnology j) Geo-microbiology. **Prokaryotic and Eukaryotic cells:** Introduction and evolution of Prokaryotic and Eukaryotic cells, Structural organization of Prokaryotic and Eukaryotic cells

15 Hrs

Unit-2: Bacteria: Morphology of Bacteria size, shape, arrangements, Structure, and functions of Cell wall, Cell membrane, Capsule and slime layer, Flagella, Pilli, Nuclear material, Mesosome, Ribosome; General Characteristics of bacteria Spirochetes, *Rickettsia, Chlamydia, Mycoplasma, Cyanobacteria, Actinomycetes, Archaebacteria***;** Growth and reproduction of bacteria- effect of nutritional and environmental factors on bacterial growth.

15Hrs

Unit-3: Viruses: History and development of virology; Types and classification of viruses; Structural organization of viruses with examples: Capsids, Nucleic acids, Envelope; Structure of T4 bacteriophage, TMV, HIV. Brief introduction about Viroid, Virions, and Prions.

Protozoa: History of Protozoa**;** Classification, Growth, and reproduction of Protozoa. General Characteristics of Protozoa: *Paramecium, Amoeba, Euglena, Trypanosoma,* and *plasmodium*

15 Hrs

Unit-4: Fungi and Algae: History and scope of Mycology; General Characteristics of Fungi; Classification and Identification of fungi- Basidiomycetes, Ascomycetes, Deuteromycetes, Oomycetes, Hypochytriomycetes and Symbiotic fungi (Lichens).

Algae: History and development of Algae**;** General Characteristics of Algae: Classification, Growth, and reproduction of Algae; Cultivation of algae, media, photo-bioreactors, Economic importance of Algae: *Spirulina, chlorella, Nostoc,* ana*baena.*

1**5 Hrs**

REFERENCES:

1. Lodish, H.T. Baltimore, A. Berk, B. L, Zipursky, PMastudaira, and J. Darnell, (2004). Molecular cell biology, scientific American Books, Inc. New York
2. Textbook of Microbiology by Stanley
3. Microbiology Pelczar, Chan and Krieg. (Indian edition)
4. Microbiology Vol II Power and Daginawala.

5. Outlines of Biochemistry Cohn and Stumpf.
6. Microbiology by Dubey &Maheswari
7. Microbiology by Purohit.
8. Tobin and Morel (1997). Asking about CELLS. Saunders college publishing. N.Y
9. Cooper, G. M (1997): THE CELL: A molecular approach ASM Press, USA.
10. De Robertis and De Robertis (1998) – Cell and Molecular Biology, 8th edn Saunders, New York.
11. Prescott. D.M (1998) Cells, Principles of molecular structure and functions. Jones Bartlett Publishers, Boston.
12. Garret R.H and Gresham, C.M. (1995) Molecular aspects of cell Biology, International Edition Saunders College Publishing, New York

MBH 1.2: Microbial Diversity and Taxonomy

Teaching: 4hours/Week **Credits:4**
Total 60 hours

Unit-1: Microbial Taxonomy and Classical taxonomy: Taxonomic ranks, nomenclature rules, identification, Classification systems, microbial diversity, and evolution. **Classical taxonomy**: Haeckle's three kingdom concepts, Whittaker's five-kingdom concept, the three-domain concept of Carl Woose criteria used for classification of microorganisms, and Classification according to Bergey's manual of systematic bacteriology.

15Hrs

Unit- 2: Recent trends in microbial taxonomy:

a) Chemo-taxonomy – Cell wall components, lipid composition, isoprenoid sequences,
b) Cytochrome composition, amino acids, sequences of proteins, protein profile, DNA
c) DNA homology, RNA homology, G+C ratio, RNA sequencing.
d) Numerical taxonomy.
e) Serological Methods.
f) Molecular methods in taxonomy.

15Hrs

Unit-3: Microbial Diversity: Concepts and scope, methods used in the study of microbial taxonomy and diversity. Diversity of microorganisms at different levels of Assessment and measure of microbial diversity, Factors influencing microbial diversity. **Extremophiles:** Diversity of microorganisms in arctic, antarctic and hydrothermal vents; thermophiles, barophiles, acidophiles, alkaliphiles, Psychrophiles, osmophiles

15 Hrs

Unit-4: Microbial interaction- Basic principles and types, intra and inter-specific illustrations. Ecology of microbial cells and population ecology, Microbial Interactions. Distribution and significance of Viruses, Bacteria, Fungi, Algae, and Protozoa.

Microbial diversity as a source of innovations in biotechnology, Biotechnological approaches to improve microbial diversity and bio-productivity.

15 Hrs

REFERENCE

1. Magurran A.E, (1998) – Ecological diversity and its measure. Princeton University Press, Priceton, N.J.
2. Cowld, D (1999) – Microbial Diversity, Academic Press.
3. Wilkinson, J.F, (1997)- Basic Microbiology. Panima Book Distributors. New Delhi.
4. Sneath P.H.A, Mair. N.S, Elizabeth, M. Bergey's Manual of Systemic Bacteriology.
5. Flesentein J. (1983)– Numerical Taxonomy. Nato ASI Series, Springer-Verlag N.Y.
6. Biswas, S.B and Anitha Biswas (1997) – An Introduction to viruses. 4th Revised Edition, Vikas Publishing house Pvt. Ltd. New Delhi.
7. Breiman, L, Friedman, J.H, Olsen, R.A. and Stone, C.J (1984) – Classification and regression Trees. Wadsworth and Brooks/ Cole, Pacific Grav, CA.
8. Alexopoulos C.J and Mims (1979)- Introductory Mycology, Wiley Eastern Limited. New Delhi.
9. Atlas R. M (1998)- Microbiology, Fundamentals and Applications 2ndEdn. Mac Millan Publishing Company.

2. Brock T.D, Madigan M T, Prentice Hall Int. Inc.- Biology of Microorganisms.

MBH-1.3: Microbial and Biochemical Techniques

Teaching: 4hours/Week
Credits:4Total 60 hours

Unit 1: Isolation techniques of microorganisms: Isolation of pure cultures (Viruses, Fungi, Protozoa); dilution, spread plate, streak plate, pour plate, micromanipulator method, colony morphology and other characteristics of cultures. Staining techniques. Maintenance and preservation of pure cultures, culture collection center-national and international.

Microscopy: Working principle of Simple, Bright field and Dark field microscopy, phase contrast microscopy, fluorescent microscopy, electron microscopy (TEM and SEM), confocal microscopy, fluorescent microscope, scanning probe microscopy and their staining techniques: image processing methods in microscopy. Micrometry.

15 Hrs

Unit 2: Measurement of microbial growth: Direct microscopic count, standard plate count, membrane filtration, MPN, Indirect method: turbidity, metabolic activity and dry weight. Automated microbial identification system. Growth curve analysis

Analysis of metagenomes: Metagenomics, Culture independent analysis of microbes, phospholipids. Fatty acids analysis, Fluorescent *in situ* hybridization (FISH), Genomic *in situ* hybridization (GISH). NGS **15 Hrs**

Unit 3: Spectrophotometry and Electrophoresis: Principle and applications of spectrophotometer- UV/visible, fluorescence.

Spectroscopy: Principle and applications of circular dichroism, NMR and ESR spectroscopy, X-ray diffraction. Mass spectroscopy.

Electrophoresis: Definition, principles and applications; different types of Electrophoresis- PAGE, SDS-PAGE, IEF, 2D-PAGE, Agarose gel electrophoresis, PFGE

15Hrs

Unit 4: Chromatography and Isotope techniques: Principles and applications of Chromatography: Thin layer chromatography (TLC), Gel filtration chromatography, Ion exchange chromatography, Affinity chromatography, Gas chromatography (GC) and High-performance liquid chromatography[(HPLC).

Isotope techniques: Stable and radioactive isotopes, radio isotopic labelling, autoradiography, scintillation counters, non-radioactive labelling, safety guidelines.

15 Hrs

REFERENCES:

1. G. Tripathi. (2009). Cellular and Biochemical Science. I.K. International Publishing House Ltd. New Delhi.
2. R.K. Sharma. (2009). Basic Techniques in Biochemistry and Molecular Biology. I.K. International Publishing House Ltd. New Delhi.
3. Ashok K. Chauhan. (2007). Microbes for Human Life. I.K. International Publishing House.
4. B.B. Buchanan. (2007). Biochemistry and Molecular Biology of Plants. I.K. International Publishing House Ltd. New Delhi.
5. David White and George D. Hegeman. **(**2006). The Physiology and Biochemistry of Prokaryotes, Third Edition. Oxford University Press.
6. P C Trivedi. (2006). Advances in Physiology. I.K. International Publishing House Ltd. New Delhi.
7. David Greenwood, Richard C.B. Slack, John F. Peutherer (2003). Medical Microbiology. Churchill Livingstone.
8. Prescott, Harley, Klein (2002). Microbiology, Mc Graw Hill.
9. Purohit, S.S. (2002). Microbiology fundamentals and applications. Agrobios (India).
10. Samuel Singer (2001). Experiments in Applied Microbiology. Academic Press.
11. Collins, C.H., Tatrica M. Lyne& Grange, J.M. (1999). Microbiological methods. Arnold publishers.
12. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, & Gary Sayler. (1998). Techniques in Microbial Ecology. Oxford University Press. NY.
13. Alexander N. Glazer, Hiroshi Nikaido (1994). Microbial Biotechnology, Freeman.

MBH-1.4: Microbial Physiology and Biochemistry

Teaching: 4hours/Week **Credits:4**
Total 60 hours

Unit1: Bioenergetics and Photosynthesis: The laws of thermodynamics and concept of entropy; First and Second law of thermodynamics, Gibb's Free energy, free energy changes in chemical reactions, free energy changes in metabolic reactions, coupling endergonic and Exergonic reactions.

Microbial Photosynthesis: Anaerobic way of life, Overview of Photosynthetic metabolism. Absorption of light, Photosynthetic pigments, light reactions; cyclic and non-cyclic photophosphorylation in eukaryotes, cyanobacteria, green and purple bacteria, Carbon dioxide fixation and synthesis of carbohydrates.

15Hrs

Unit 2: Metabolism of carbohydrates and lipids: Overview of metabolism, Pasture effect, Glycolysis and ATP formation, gluconeogenesis, Glyoxylate cycle, Tricarboxylic acid cycle, Pentose phosphate pathway, Hexose monophosphate pathway, Entner-Doudor off pathway, electron transport chain and oxidative phosphorylation, substrate level phosphorylation. Anaerobic oxidation of pyruvate: the process of fermentation.

Metabolism of lipids: Biosynthesis of lipids, Catabolism oflipids by beta-oxidation, yield of ATP for Stearic acid and Linoleic acid, Biosynthesis of cholesterol and ergosterol.

Metabolism of Proteins: General biosynthetic pathways of amino acids, biosynthesis of purines and pyrimidines and their regulation.

15Hrs

Unit 3: Fungal and bacterial secondary metabolism: Secondary metabolites and regulation of secondary metabolism. Antibiotics: Definition, Discovery, classification, structure and mode of action. Biosynthesis of secondary metabolites -beta-lactum antibiotics, patulin, Aflatoxin, ergot alkaloids. Fungal and Bacterial toxins. Pigments: Melanin, carotenoids. Fungal hormones: Sirenin(Allomyces) Sterols(Achlya). Trisporicacid(Ascomycetes), peptidehormones(Basidiomycetes).Bioluminescence in microorganisms: Mechanism and significance.

10Hrs

Unit4: Biochemistry

Water: Properties of water, weak interaction in aqueous systems, ionization of water, pH, weak acids and weak bases, buffers, types of buffers and their importance. **Carbohydrates:** Definition, classification, structural properties and importance of sucrose, lactose, maltose, starch, cellulose, agar. **Amino acids, peptides and proteins:** Definition, classification, structure, general properties, assay methods of proteins. **Lipids and fats:** Definition, classification, structure and importance of lipids and fats.

10Hrs

Unit 5: Nucleotides: Structure and properties of nucleotides and nucleosides. Vitamins: Definition, classification, structure and importance. Porphyrins: Definition, structure, properties and importance of chlorophyll, cytochrome and hemoglobin. Enzymes: Classification, nomenclature, general properties, activation energy, Transition state, binding energy, turn over number, enzyme kinetics and Michaelis-Menten Equation, Importance of Km and Vmax, coenzymes, activators, inhibitors, isoenzymes, multi-enzyme complex, allosteric enzymes, mechanism of enzyme action.

10Hrs

REFERENCES:

1. Batzing, B.L.2002.Microbiology(An Introduction), Brooks/Cole Thamson Learning, Canada.
2. Cooper, G. Mand Hausman, R.2009. The Cell a Molecular Approach, 5thedition, ASM Press, Washington, D.C.
3. Moat, A.G., Foster, J. Wand Spector, M.P. Microbial Physiology, 4thedition, A John Wiley & Sons, Inc., Publication.
4. Ratledge, Cand Kristiansen, B.2001. Basic Biotechnology, 2ndedition, Cambridge University Press, USA.

5. Willey, J.M., Sherwood, L. Mand Woolverton, C.J.2008. Prescott, Harley, and Klein's Microbiology, McGraw-Hill, New York.
6. Rastogi, S.C., Menndiratta, N. and Rastogi, P.2007. Bioinformatics
7. methods and applications, 2nd edition, Printice-hall of India. Pvt. Ltd. New Delhi.
8. Rajan, S. Sand Balaji, R. 2002. Introduction to bioinformatics, Himalaya Publishing house, Mumbai.
9. Cazes, J.2005.Ewing'sAnalytical Instrumentation Handbook, 3rd edition, Marcel Dekker. Inc., USA
10. Miller, J.M.2005. Chromatography concepts and contrasts, 2ndedition, John Wiley &Sons. Inc Publication, Canada
11. Mohan, J. 2003. Organic Analytical Chemistry (Theory and Practice), Narosa Publishing House, New Delhi.
12. Williard, Merritt, Dealand Settle. 1986. Instrumental methods of Analysis, 7th edition, CBS Publishers, New Delhi.
13. Wilson, K and Walker, J. 2000. Practical Biochemistry (Principles in Techniques), 5th edition, Cambridge University Press, UK.
14. Devlin, J.M.2011. Textbook of Biochemistry with clinical correlations, 7th edition, John wiley and sons, Inc. USA.
15. Voet, D. J., Voet, J. G. and Pratt, C. W. 2008. Principles of Biochemistry, 3rd edition, John wiley and sons.
16. Elliott, W. Hand Elliott, D. C. 2009. Biochemistry and molecular biology, 4thedition, Oxford university press, New York.

MBS- 1.5 BIOSTATISTICS

Teaching: 2hours/Week
Credits:2 Total 30 hours

Unit 1: Introduction to Bio-statistics, basic concepts, and data types. Need for statistical techniques for biological applications, replicable data, Tabulation of data, construction of graph and graphical representations of data. Different models of data presentations. Frequency distribution, Arithmetic mean, mode, median, and percentiles. Measures of variability: Range, mean deviation. Standard deviation and coefficient of variation.

Properties of the data- Organization of data, Central tendency, dispersion, linear regression and correlation-test of significance, skewness, and kurtosis and their various measures, percentiles Simple linear correlation, and regression analysis. Analysis of variance.

Sampling Techniques-Population and sample: Random sample, use of a table of random numbers, parameters and statistics, sampling distribution of sample means Standard error; confidence intervals.

15Hrs

Unit 2: Probability: types of events, sample space, definition, conditional probability, addition and multiplication rules of probability, and some simple problems. Probability distributions-Binomial, Poisson, and Normal distributions and a few simple problems. Statistical Inference-Estimation, standard error, the confidence interval for means and

proportion. Testing of hypothesis: basic concepts and definitions, types of errors. Tests based on Normal, student's t, chi-square, and F distributions, interpretation of' `p' value. Statistical package- Features of statistical software, SPSS for various applications in the Biostatistical program. **15 Hrs**

References:

1. Daniel (1999). Biostatistics (3rd edition) Panima Publishing Corporation.
2. Khan (1999). Fundamentals of Biostatistics, Panima Publishing Corporation
3. Swardlaw, A.C. (1985). Practical Statistics for Experimental Biologists, Joh
4. Bazin, M.J. (1983). Mathematics in microbiology Academic press
5. Green, R.H. (1979). Sampling design & Statistical methods for environmental Biologists, Wiley Int. N.Y.
6. Campbell, R.C. (1974). Statistics for Biologists, Cambridge Univ. Press, Cambridge
7. Bliss, C.I.K. (1967). Statistics in Biology, Vol.1 Mc Graw Hill, New York.
8.Research Methodology by C.R.Kothari

PRACTICALS

MBHP-1.6: Based on Theory MBH 1.1: General Microbiology and MBH 1.2 Microbial Diversity and Taxonomy

Teaching: 4hours/Week **Credits:2**

1. Safety Measures in the Microbiology laboratory.
2. Calibration of Microscope and Micrometry.
3. Effect of antibiotics on bacterial growth – paper disc and cup plate method.
4. Isolation and Enumeration of Bacteria, Actinomycetes& Fungi from soil Samples using selective media.
5. Isolation and Enumeration of Bacteria, Actinomycetes &Fungi from Water Samples using selective media.
6. Isolation and Enumeration of Bacteria, Actinomycetes & Fungi from air Samples using selective media.
7. Isolation and Enumeration of Microorganisms in polluted environments.
8. Isolation and Enumeration of Microorganisms in Extreme environments.
9. Observation of permanent slides;
   a) Algae: *Cyanobacteria Spirulina, Anabaena Chlorella, Scenedesmus, Spirogyra, Diatoms and Gracillaria.*
   b) Fungi: *Pythium, Rhizopus, Saccharomyces, Penicillum, Aspergillus, Fusarium, Agaricus.*
   c) Virus infected Plant materials TMV/Bean mosaic.
   d) Protozoa: *Euglena, Paramaecium, Entamoeba histolytica*
10. Study tour for collection of marine water sample for isolation and enumeration of microorganisms from ocean samples.

MBHP-1.7: Based on Theory MBH-1.3: Microbial and Biochemical Techniques

Teaching: 4hours/Week **Credits:2**

1. Study of Instruments – Autoclave, Hot air Oven, Incubator, Laminar airflow, Centrifuge, pH meter, Colorimeter, Spectrophotometer.
2. Study of motility of cells by hanging drop technique.
3. Study and staining of different groups of microorganisms
4. Sterilization methods and sterilization indicators
5. Pure culture techniques and aseptic transfer
6. Study of cultural characteristics of bacteria
7. Measurement of microbial cell 'number / Spore number using a hemocytometer
8. Study of microbial culture preservation methods
9. Evaluation of antiseptic: the filter paper disc method
10. Estimation of protein by Bradford method
11. Effect Temperature and pH on growth curve of bacteria (*E. coli*).
12. Estimation of reducing sugar.
13. Isolation of lipolytic microbes from soil-plate method

MBHP-1.8: based on MBH-1.4 Microbial Physiology & Biochemistry

Teaching: 4hours/Week **Credits:2**

1. Preparation of solutions
2. Preparation of buffers
3. Study of Biochemical tests
    a. IMVIC test,
    b. Urease test,
    c. Citrate utilization test,
    d. Gelatin Hydrolysis test,
    e. Starch hydrolysis test,
    f. Cellulose degradation test,
    g. Catalase test,
    h. Oxidase test,
    i. Coagulase test,
    j. H_2S Production test,
    k. Nitrate Reduction,
    l. Optochin Sensitivity test,
    m. Esculin Hydrolysis test)
4. KOH Solubility test
5. Identification of unknown bacteria using different physiological tests
6. Qualitative analysis of carbohydrate
7. Qualitative estimation of proteins
8. Quantitative estimation of total carbohydrate by Anthrone method
9. Saponification Value of Fats
10. Circular Paper Chromatogram

M.Sc., Microbiology SECOND SEMESTER

MBH-2.1: Immunology and Immunotechnology

Teaching: 4hours/Week
Credits:4 **Total 60 hours**

Unit 1: Introduction: Origin, concept and historical development of immunology. **Biology of immune cells:** B Cells-Origin, development, maturation and surface molecules. T cells- Origin, development, maturation and surface molecules; Subsets of T cells. Structure and function of T Cell receptors **15 Hrs**

Unit 2 : MHC molecules-Types, structure, genetics and functions. Complement system-Components and pathways of component activation**.**
Antigens and Antibodies: Antigens - Physical and chemical properties of antigens, Epitopes, Antigenicity and Immunogenicity; Types of antigens. Antibodies- Physical and chemical structures of antibodies, Types and biological functions of immunoglobulins. Monoclonal and Polyclonal antibodies- Production and applications **15 Hrs**

Unit 3: Antigen-Antibody reactions: Mechanism and principles of antigen antibody reactions. Types and determination of antigen antibody reactions – Radio immune assay, Ouctherlony double diffusion technique, complement fixation test, Enzyme linked immunosorbent assay and Immuno blotting
Immune response: Antigen processing and presentation; Activation of T and B cells; Differentiation and formation of functional T cells; Differentiation of B cells and formation of plasma and memory cells. Immune response-Primary and secondary. Effector mechanism of HMI and CMI. Cell mediated cytotoxicity, ADCC and Inflammation. Cytokines- Types, functions and applications. Hypersensitivity- Mechanism and types of hypersensitivity **15 Hrs**

Unit 4: Autoimmunity and Immuno deficiency syndrome: Autoimmunity and autoimmune disorders. **Immuno deficiency syndrome:** IDS due to deficient T and B cells, phagocytes, complement. Severe combined immunodeficiency syndrome.
Tumor and Transplantation immunology: Tumor antigens and immunology to tumor cells. **Transplantation immunology**-Blood transfusion, Tissue transplantation and HLA typing. Immuno tolerance and Immuno modulators
Vaccines- Types, production and immunization schedules. Recent advances in vaccines and their developments: Recombinant vaccine development (covishield) attenuated vaccine (covaxin) **15 Hrs**

Reference Books:

1. Bradley and Mecharty. Clinical Immunology. Oxford University Press, New York.
2. Abbas AK, Lichtman and Pobes. Cellular and Molecular Immunology. W.B. Saunders Co.,

3. Coleman. Fundamental Immunology. Brown Publishers. Bubuone Zowa.
4. Catty. Maintenance of Laboratory Animals and Production of antibodies.
5. Janis Kubey. Immunology. Freeman & Co., New York.
6. Janeway and Travers et al. Immunology. Churchill Publishers.
7. Stities, Tesss and Parslow. Medical Immunology. 9th Ed. Appleton & Lange, Connecticut.
8. Benjamin E, Coice R and Sunshine G. Immunology – A Short course. 4th Ed. Willey-Liss
9. Topley and Wilson. Principles of bacteriology, Virology and Immunity. Edward Arnold
10. Roitt I.M., 1994, Essential of Immunology, Raven Press, New York.

MBH-2.2: Microbial Genetics

Teaching: 4hours/Week
Credits:4 **Total 60 hours**

Unit 1: Classical Genetics: Historical Preview of Genetics: Development of microbial genetics, contributions of various scientists, time line of the development of microbial genetics, Chemical basis of heredity; early concepts of genes; discovery of the chemical basis of heredity - experimental evidences, Mendelian principles and classical genetics, Genetic concepts, use of microorganisms in genetic studies
15Hrs

Unit 2: Prokaryotic Genome: *E. coli* chromosome- coiled, supercoiled (plectonemic, solenoid), folded fiber model. *Mycoplasma genitalium* and *E. coli* genome.
Eukaryotic Genome: Structure of chromatin, chromosome, centromere, telomere, nucleosome, genome organization, split gene, overlapping genes and Cot curves, chromatin remodeling; types of histones, histone modifications- methylation, acetylation, phosphorylation and their effects on structure and function of chromatin, DNA methylation, repetitive and non-repetitive DNA sequence. Law of DNA constancy, C value paradox and genome size, karyotype and ideogram, chromosome banding pattern, types of chromosomes.
15Hrs

Unit 3: Gene and Mutation: Gene as unit of mutation, molecular basis of spontaneous and induced mutations and their role in evolution; mutagens, types of mutations, transposon mutagenesis, site directed mutagenesis; environmental mutagenesis; Ame's and other toxicity testing. Genetics of fungi-alteration of generation, induction of mutation in *Neurospora crassa* and yeast, cytoplasmic inheritance and biochemical mutants. 15**Hrs**

Unit 4 Genetic recombination: Genetic recombination in bacteriophages and *E. coli,* synopsis of homologous duplexes, breakages and re-union role of RecA and other recombinases, generalized & specialized transduction, transformation and conjugation, legitimate & illegitimate recombination, gene conversion, overview of bacterial genetic map. Homologous and non-homologous recombination.
Plasmids and Bacteriophages: Plasmids, F-factors - description and their uses in genetic analysis, Colicins and Col Factors, R plasmids. Lysogeny and lytic cycle in bacteriophages, Life cycle and their uses in microbial genetics. Lytic phages-T7 and

T4, Lysogenic phages Lamda, M13 and ΦX174. **15Hrs**

References:

1. Jeremy W Dale and Simon F Park. (2010). Molecular Genetics of Bacteria. Fifth Edition. Wiley-blackw.
2. Dale. J.W. (1994). Molecular Genetics of bacteria, John Wiley & Sons.
3. Robert J. Brooker. **(**2009). Genetics: Analysis and Principles, 3rd Edition.McGraw-Hill.
4. George Lipps. (2008). Plasmids: Current Research and Future Trends. Acedemic Press.
5. Madhusudan W Pandit. (2007). Scientoonic Tell-Tale of Genome and DNA. I. K. International Publishing.
6. Oladele Ogun seitan. (2004). Microbial Diversity: Form and Function in Prokaryotes. Wiley- Blackwell.
7. Lewin, B. (2002). Genes VIII. Oxford.
8. Streips & Yasbin (2001). Modern microbial Genetics. Wiley Ltd.
9. Bloom, Freyer, Micklos. (1996). Laboratory DNA Science. The Benjamin/Cummings Pub.
10. Silhavy, T. (1994). Experiments with Gene Fusions, Cold Spring Harbour Lab. Press.
11. Miller, J.H. (1992). Short course in bacterial genetics, CSH Laboratories.
12. Roger L.P. Adams, Johm, T., Knowler and David P. Leader. (1992). The
13. Biochemistry of the Nucleic Acids. 11th edition. Chapman and Hall.

MBH-2.3: Molecular Biology

Teaching: 4 hours/Week **Total 60 hours**
Credits:4

Unit 1: Concepts of molecular biology and Replication: Introduction, flow of information, central dogma of molecular biology. Structure of DNA, DNA polymorphism (A, B, Z DNA). Structure and function of different types of RNA.

DNA Replication: DNA replication in prokaryotes and viruses (Rolling circle and M13 bacteriophages replication), asymmetric replication, looped rolling circle, semi conservative replication, primer or template, coniotomy formation –P1. Origin of replication, replication fork- leading and lagging strands, enzymes involved at different steps of replication. Fidelity of replication. Extra chromosomal replicons.

15hrs

Unit 2: Transcription and Translation: Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases. Initiation, elongation and termination. Heat shock response, stringent response. Inhibitors of RNA synthesis and their mechanism. Polycistronic and monocistronic mRNA. Control of elongation and termination. Alternate sigma factors. Post transcriptional modifications of mRNA- capping, editing, splicing, polyadenylation, modifications of tRNA and rRNA.

Translation: Genetic code- Features and character, wobble hypothesis**.** Ribosome assembly, initiation factors and their regulation, formation of initiation complex, Initiation, elongation and termination of polypeptide chain, elongation factors and releasing factors, translational proof-reading, inhibitors of translation and their mechanism, post-translational modification of proteins-glycosylation. Control of

translation in eukaryotes. Differences between prokaryotic eukaryotic translation.

15Hrs

Unit 3: Regulation of gene expression: Transcriptional control. Operon concept, catabolite repression. Inducible and repressible systems. Negative gene regulation – *E. coli* lac operon; Positive regulation – *E. coli ara*operon; Regulation by attenuation – his and trp operons, anti-termination – N protein and nut sites, DNA binding protein, enhancer sequences, identification of protein binding site on DNA. Maturation and processing of RNA– methylation, cutting and modification of tRNA degradation system. **15Hrs**

Unit 4: DNA Damage Control of gene expression at transcription and translation evel:

DNA damage and repair: Types of DNA damage – deamination, oxidative damage, alkylation, pyrimidine dimers; Repair pathways – photo-reactivation, excision repair, post replication repair, SOS repair, methyl directed mismatched repair, very short patch repair

Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression.

Gene silencing: Transcriptional and post transcriptional gene silencing-RNA pathway (siRNA and miRNA).

15Hrs

REFERENCES:

1. Robert F. Weaver. (2009). Molecular Biology, 4th Edition. McGraw-Hill.
2. B.B. Buchanan. (2007). Biochemistry and Molecular Biology of Plants. I.K. International Publishing House Ltd. New Delhi.
3. Chris. R. Callbine., Hallace. R. Bin. F. Leus. and Andrew, A. Travers. (2006)
4. Understanding DNA (3rd Ed.). Academic Press.
5. Raymond F Gesteland. (2006). The RNA World, Third Edition. I.K. International Publishing House.
6. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter
7. Walter, (2002). Molecular Biology of the Cell. Garland Pub. 4th Ed.
8. Twyman R.M., (1998). Advanced Molecular Biology. 1st Ed. Viva Books PvtLtd.,New Delhi.
9. Joset F., Michel G, (1993). Prokaryotic Genetics, Genome Organization, Transfer appliedand Plasticity, Boston. Blackwell.
10. Adams R.L.P, (1992). DNA Replication. IPL Oxford, England.
11. Streips and Yasbin, (1991). Modern Microbial Genetics. Wiley Ltd.
12. Thomas D. Brock, (1990). The Emergence of Bacterial Genetics, CSH lab Press.
13. Mark Ptashne, (1986). A Genetic Switch. Gene Control and Phage λ. Cell Press and Blackwell Scientific Publications.

MBS-2.4: Bioinformatics

Teaching: 2hours/Week **Credits:2**
Total 30 hours

Unit 1: Introduction to Bioinformatics: Introduction to Biological Databases - Types of databases (Primary, secondary and complex databases), Bioinformatics platforms: NCBI, DDBJ EMBL, PUBMED**,** Nucleic Acid Sequence databases, Protein sequence database; Genomics, Transcriptomics, Proteomics and Metabolomics, PDB retrieval, Database visualization, Accessing bibliographic database,
Bioinformatics software: Schrodinger**,** Perl and Bio Perl, Rosetta/ Remoneblod.

Sequence alignment and phylogenetics:
Pairwise sequence alignment: Eg. BLAST, FASTA, CONTIG sequence
Multiple Sequence Alignment: Eg. Clustal W, Clustal X,
Phylogenetic analysis with reference to nucleic acids – PHYLIP, MEGA, NTYSIS (3D and 2D)
Primer designing: Primer 3, applied biosystems. **15 Hrs**

Unit 2
Structural biology: Modeling: Protein secondary structure prediction – Chou Fasman rules– neural networks discriminant analysis. Protein 3D structure prediction homology - identification of active sites/pockets, threading potential energy functions – energy minimization molecular dynamics simulated annealing.
Drug Design and discovery: steps in drug discovery, ADME, Lead identification, QSAR.
Commercial application of bioinformatics: Definition, genome technology, High throughput sequencing and assembly. Genomics in medicine, Disease monitoring, profiles for therapeutic molecular targeting. Diagnostics, drug discovery and genomics, Gene evolution, Comparative proteomics and its applications, Bioinformatics patents.

15 Hrs

REFERENCES

1. Attwood, T.K., and Parry-Smith, D. J. (2007). Introduction to Bioinformatics, Pearson Education Asia.
2. B. D. Singh. (2017). Biotechnology, Kalyani Publishers.
3. Baxevanis, A.D., and Francis Ouellette, B.F. (2004). Bioinformatics – A Practical Guide to the Analysis of Genes and Proteins, 3rd edition, Wiley – Interscience.
4. Bergeron, B. (2002). Bioinformatics Computing. 1st edition, Prentice Hall Publishres
5. Blum R and LeBlanc Dee-Ann. (2014). Linux for Dummies, 2nd edition, WILEY.
6. Campbell AM and Heyer LJ. (2007). Discovering Genomics, Proteomics and Bioinformatics, 2nd edition, Benjamin Cummings.
7. Dhananjaya (2002). Introduction to Bioinformatics, www.sd-bio.com series
8. Elmasr R and Navathe SB. (2017). Fundamentals of Database Systems, 7th edition, Pearson Education
9. Higginns, D., and Taylor, W., (2000). Bioinformatics. Sequence, Structure and databanks – A Practical Approach, Oxford University Press.
10. Kothekar, V (2004) Introduction to Bioinformatics 1st edition Dhruv publication

11. Krane D.E.,Raymen, M. L. (2003) Fundamental Concepts of Bioinformatics, Benjamin Cummings
12. Krawetz, S.A., David, D., Womble, S.A., Krawetz, D.D., Womble, D., (2003). Introduction to Bioinformatics: A theoretical and Practical approach. Humana Press, USA
13. M. Barnes, Glaxo SmithKline, U.K. Bioinformatics for Geneticists.
14. Misener, S., and Krawetz, S.A., (2000). Methods in Molecular Biology – Bioinformatics. Methods and Protocols, Humana Press.
15. MountD. W. (2001). Bioinformatics. Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press.
16. Rajaraman V. (2009) Fundamentals of Computers, Prentice-Hill India.
17. Rashidi, H., and Buehler, L.K. (2005). Bioinformatics Basics: Applications in Biological Science and Medicine. CRC Press/Taylor & Francis Group.
18. S C Rastogi, N Mendiratta, P. Rastogi. (2013). Bioinformatics: Methods and Applications Genomics Proteomics and Drug Discovery, 4th edition, Prentice Hall of India Private Ltd
19. S.C.Rastogi, NamithaMendinatta. (2009). Bioinformatics Concepts, Skills and Applications, 2nd edition, CBC Publication.
20. Singer, S.(2001). Experiments in Applied Microbiology. Academic Press.
21. Sullia, S.B. and Shantaram, S. (2006). General microbiology, 2nd edition, Oxford IBH, New Delhi.
22. Upadhyay, Upadhyay&Nath. (2016). Biophysical chemistry: principles and techniques, 4thedition, Himalaya Publishing House Pvt. Ltd.
23. Woolverton, J.C.,Sherwood, L. (2017).Prescott's Microbiology, 10thedition,McGraw Hill.

MOE-2.5: APPLIED MICROBIOLOGY

Teaching: 4 hours/Week **Total 60 hours**
Credits:4

Unit-1 Microbiology of Air: Air spora of indoor and outdoor environment, factors affecting airspora, Techniques of trapping airborne microorganisms.

2hrs

Unit-2 Soil Microbiology: Historical accounts and the "Golden Age" of soil microbiology and significant contributions of pioneer soil microbiologists. Diversity and abundance of dominant soil microorganisms, Methods of isolation of soil microflora, soil organic matter decomposition.

8hrs

Unit-3 Contamination, Preservation and Spoilage of Food: Definition, concepts and scope. Food as substrate for microbes. Factors influencing microbial growth in food-Extrinsic and intrinsic factors. **Principles of food preservation**-Chemical preservatives and Food additives, Asepsis-Removal of microorganisms, (anaerobic conditions, high temperatures, low temperatures, drying). Canning, processing for Heat treatment. Contamination and food spoilage: Cereals, sugar products, vegetables, fruits, meat and meat products, Fish and sea foods- poultry-spoilage of canned foods.

12 hrs

Unit-4 Dairy Microbiology: Microbiology of raw milk, Milk as a vehicle of pathogens, Prevention of contamination of raw milk, Microbiology of processed milk, Spoilage and defects fermented milk and milk products, Microbiological standards for milk and milk products. Ceram and butter bacteriology.

12hrs

Unit-5 Clinical Microbiology: Role of Microbiologist in Diagnostic laboratory, General concepts for specimen collection, handling, transportation, processing, specimen workup, Laboratory safety and infection control. Scientific and Laboratory basis for Clinical/Diagnostic Microbiology: Microscopic examination of infectious diseases, Growth and biochemical characteristics, Rapid methods of identification.

10hrs

Unit-6 Agricultural Microbiology: Introduction to agricultural microbiology, concepts and scope of agricultural microbiology, Agronomy and production of important crop plants, green revolution.

6hrs

References:

1. Microbiology by MJ Pelczar Jr, ECS Chan, NRK rig 5th Edition, Pub: Tata McGraw-Hill Publishing Co Ltd.
2. Introductory Microbiology by Heritage Pub Heritage
3. General Microbiology by Stainer Pub; Ingrahamand Wheeler (McMillan)
4. Alexander M (1977) Introduction to soil microbiology, John Wiley and Sons Inc. N. Y.
5. Atlas R. M. (1998) Microbiology, Fundamentals and applications 2nd Edition, Milan Publishing Co.
6. Brock T. D. and Madigan M. T (1992) Biology of Microorganisms 6th Edn. Prentice Hall, Eaglewood cliffs N. j.
7. Prescott L. M, Harley T. Pand Klein D. A. (1996) Microbiology WMC. Brown publishers Connie RMahon. (2010). Textbook of Diagnostic Microbiology. 3rd edition.
8. Fritz H. Kayser. (2005). Medical microbiology. Thieme Verlag.
9. Wadher, and Bhoos reddy. (2005). Manual of Diagnostic Microbiology. Himalaya Publisher.
10. Credric, A. Mims. (2004) Medical microbiology. (3rd Ed.). Moshy Inc.

PRACTICALS

MBHP-2.6: based on MBH-2.1: Immunology and Immunotechnology

Teaching: 4hours/Week **Credits:2**

1. Determination of Bleeding time and clotting time of blood
2. Estimation of Hemoglobin
3. Determination of Blood grouping
4. Determination of differential count of leucocytes
5. Estimation of total count of red blood cells (RBC)

6. Estimation of total count of white blood cells (WBC)
7. Widal test
8. Rapid plasma regain (RPR) Test
9. Immunoelectrophoresis
10. ELISA
11. Ouchterlony Double Diffusion

MBHP-2.7: based on MBH-2.2: Microbial Genetics

Teaching: 4hours/Week **Credits:2**

1. Quantitative estimation of RNA by Orcinol method
2. Estimation of protein by Lowry's Method
3. Estimation of DNA
4. Isolation and electrophoretic analysis of plasmid DNA from bacteria
5. Transformation in *E. Coli*
6. *Conjugation in E. coli*
7. Ampicillin selection for enrichment of auxotroph
8. Genetic mapping in Bacteria
9. Identification of lytic and lysogenic cycles in bacteriophage
10. Demonstration of SDS PAGE
11. Genetic problems

MBHP-2.8: Based on MBH-2.3: Molecular Biology

Teaching: 4hours/Week **Credits:2**

1. Isolation and electrophoretic analysis of genomic DNA (from bacteria, fungi and algae)
2. Quantitative estimation of DNA by Diphenyl amine method
3. Mutagenesis: Identification and isolation of fungal mutants [physical (UV) and chemical (EMS)]
4. Isolation of antibiotic-resistant mutant by gradient plate method
5. Induction of mutation in yeast and bacteria by chemicals / radiation
6. Replica plating technique
7. Bacterial plasmid isolation
8. Ame's test for detecting chemical carcinogens
9. Visit to Pharmaceutical industry

M.Sc., Microbiology Third SEMESTER

MBH - 3.1: Food Microbiology

Teaching: 4hours/Week **Credits:4**

Total 60 hours

Unit 1: Introduction Origin, Concept, Scope and historical developments. Food as substrate for microorganisms: Hydrogen ion concentration (pH), Moisture requirement, Water activity, Oxidation-Reduction potential, Nutrient content, Inhibitory substances and biological structure. ***Food Preservation:*** General principles, Physical methods of food preservation (High temperature, Low temperature and drying), Chemical methods of food preservation (Food additives) and biological methods of food preservation. Intrinsic and extrinsic growth factor

15hrs

Unit 2: Food contamination: Contamination of foods from green plants, animals, sewage, soil, water, air and handling. **Food spoilage**: General principles of food spoilage, causes of food spoilage, Factors affecting kind and number of microorganisms. Chemical changes caused by microorganisms. Spoilage of Meat and Meat products, Egg and Egg products, Fish and Marine products, Cereal and Cereal products, Fruits and Vegetables. **15 hrs**

Unit 3: Food *borne diseases and their control*: Food Infection and Intoxication. Detection of food borne pathogens and their toxins by various methods.

Fermented foods (Bread, Sauerkraut and tempeh), Probiotics and Prebiotics. Concept and importance of Nutraceuticals and Nutraceutical products.

Testing of milk quality. Contamination, spoilage and preservation of milk and milk products.

15hrs

Unit 4: Fermented milk products: Milk: Definition, Composition, Nutritive value and Properties. Microbiology of milk. Production, Quality control and Significance of Cheese, Yogurt, Shrikhand and Acidophilus milk.

Food sanitation and food safety: Concept, Importance and Safety laws, GMP and LP.

Quality control and food standards: Bureau of Indian Standard (BIS). PFAA, FPO, MPO, CSO, Agmark Standards, International standards – HACCP, ISO 9000 Series. Food testing laboratories.

15hrs

Reference Books:

1. Doyte MP, Loory RB & Thomas JM; Food Microbiology, ASM Pres, Washington DC.
2. Jay JM, Modern; Food Microbiology, Chapman & Hall, New York.
3. Joshi VK & Pandey Ashok; Biotechnology of Food Fermentation, Asia tech Publ. Delhi, India.
4. Frazier WC & Westh of DC; Food Microbiology, 3rd Ed., Tata McGraw Hill.
5. Doyle PM et al; Food Microbiology – Fundamentals & Frontiers, 2nd Ed., ASM Press.
6. Danwart GJ; Basic Food Microbiology, CBS Publ. Delhi.

7. Pitt J & Hocking. (1985); Fungi & Food spoilage, Academic Press.
8. Sandeep Sareeen; Food Preservation, Sarops&Soni, New Delhi.
9. Ananthakrishnan CP. Et al. (1994); Dairy Microbiology, Sreelakshmi Publ. Chennai.
Rabinson RK. (1990); Dairy Microbiology, Elsevier Applied Science, London.

MBH - 3.2: Medical Microbiology

Teaching: 4hours/Week **Credits:4**
Total 60 hours

Unit 1: Introduction: Historical developments - Major milestones and significant contributions. Human Anatomy and physiology: An overview of human anatomy and physiology. Important terms/concepts of human anatomy and physiology with special reference to microbial infections.

.**Microbial pathogenicity and pathogenesis:** Attributes of pathogenicity and pathogenesis. Mechanism of disease process and prognosis. Host and microbial factors influencing susceptibility. Microbial infections: Concept and types of microbial infections; Modes of transmission of pathogens, Portal of entry and exit; Types of infections; Nosocomial infections.

Diagnostics: Collection and transport of clinical samples; Processing of clinical samples for direct and indirect diagnostics tests. Conventional, Serological and Molecular methods and techniques for the diagnosis of Urinary tract infections, sexually transmitted diseases

15Hrs

Unit 2: Chemotherapy: Antimicrobial agents and antibiotics; Classification of antibiotics based on chemical structure, mode of action and range of effectiveness; Drug resistance - recent trends and its consequences; Antibiogram and Antibiotic policy; NCCLS (CLSI) guidelines and standards; WHO Guidelines and CDC guidelines

Systematic study of important pathogenic bacteria with reference to etiology, symptoms, diagnosis, treatment and epidemiology; Enterobacteriaceae (Salmonella, Shigella, *E. coli, Klebsiella*); *Mycobacterium tuberculosis*, *M .leprae,* Staphylococci, Streptococci, *Vibrio cholerae*, *Brucella pertusis*, *Clostridium welchi*, *C. tetani* and *Treponema palladium*

15Hrs

Unit 3: Etiology, epidemiology, symptoms, diagnosis and treatment of diseases caused by Chlamydia, Mycoplasma and Rickettsia. Pathogenicity, symptoms, diagnosis, treatment and preventive measures of viral diseases caused by important viruses - Pox, Herpes, Adeno, Papovo Picarno, myxo, retro, arbo, hepatitis, Rabies, SARS, Chikungunya, Ebola and H_1N_1 viruses.

Advances in Molecular Diagnosis of infections: RT-PCR (HCV, Corona, Mycobacteria), RAT (Rapid Antigen Test), True Nat (TB and Covid-19), Feluda test Based on CRISPR (Clustered Regularly Interspaced Short Palindromic), Cartridge Based Nucleic Acid Amplification Test (CBNAAT), for TB, MDR-TB.

15Hrs

Unit 4:Microbial diseases: Diseases caused by microorganisms: Concept and illustrations; Communicable diseases; normal flora of human body; opportunistic pathogens Types of diseases - superficial and deep mycosis; Causative agents; Diagnosis and Treatment diseases. **Protozoan & Helminthic diseases**: Causative agents, symptoms, diagnosis and treatment of Amoebiasis, Giardiasis, Filariasis, Leishmaniasis, Toxoplasmosis and Malaria.
Acute diarrheal and gastrointestinal infections, Cholera, Dysentery, Tuberculosis, Leprosy, Pyogenic infections, Dental caries and Central nervous system infections.

15Hrs

Reference Books:

1. Topley and Wilson. Principles of bacteriology, Virology and Immunity. Edward Arnold.
2. David Greenwood, Richard C and Slack B. Medical Microbiology. ELBS Churchill Livingstone.
3. Rajesh Bhatia R. Essentials of Medical Microbiology. Jaypee Brothers.
4. Kenneth j R. Medical Microbiology – Introduction to Infectious Disease. Prentice Hall Int.
5. Joan stokes, Ride waywren and Sir ashleymiles. Clinica Microbiology. Edward Arnold.
6. Dougias J and Slekh. Medical Bacteriology. Churchill Livingstone.
7. Bailey and Scotts. Diagnositc Microbiology. C.V. Mosry Company
8. Hoghl and Moffet. Clinical Microbiology. JB Lippincott Company

MBH - 3.3: Recombinant DNA Technology

Teaching: 4hours/Week **Credits:4**
Total 60 hours

Unit 1: Methods of studying DNA – Density gradient sedimentation, zonal centrifugation, isopycnic separation, electrophoretic separation, agarose, polyacrylamide, pulse field electrophoreses, southern blotting, northern blotting, labeling – radioactive and non-radioactive labeling. Isoelectric Focusing
DNA sequencing - direct sequencing, indirect sequencing, Maxam and Gilbert method, Sangers method, RNA sequencing. Nucleic acid hybridization – Design and construction of probes, nick translation, hybridization, liquid hybridization, solid hybridization, determination of stringency conditions. Applications of nucleic acid hybridization. **15Hrs**

Unit 2: Enzymes used in recombinant DNA technology, Restriction endonucleases – Type, I, II & III, Nucleotide kinas, reverse transcriptase, T4 DNA ligase, kleno polymerase and others, alkaline phosphatase restriction mapping, RFLP and RAPD.

Plasmid vectors - Use of natural plasmids as vectors, artificial plasmid vectors, pSC 101, pBR 322, pUC 18, Ti and Ri plasmid vectors. Bacteriophage vectors – Insertion

vectors, replacement vectors, cosmid vectors, phagemid vectors, shuttle vectors and M13 based vectors. BACs, YACs and HAC

15Hrs

Unit 3: Hosts for recombinant DNA technology; Prokaryotes –Bacteriophages, *E. coli, B. subtilis, Streptomyces*, Eukaryotic – Yeasts and Fungi. Construction of recombinant DNA, selection of DNA fragments for cloning, chemical synthesis, gene synthesizers, ligation with RES, homopolymer tailing, blunt end ligation, linkers, monitoring restriction and ligation.

Insertion of recombinant DNA – Host selection, transformation, transfection, electroporation, lipofection, Screening of recombinant, Applications of rDNA technology

Gene transfer mechanisms: Bacterial transformation; Host cell restriction; Transduction; complementation; conjugation and transfection, mechanisms and applications, genetic analysis of virus, bacteria and yeast genomes

15Hrs

Unit 4: Genome libraries – construction and screening of genome libraries, chromosome walking, cDNA libraries. PCR – principles, types and applications, primer design and applications. DNA micro array – principle, types, construction and applications, *in vitro* approach for studding DNA- Protein interactions.

15Hrs

Reference Books:

1. Brown TA. Ed. Homes BD & Richwood D, 1998; Molecular Biology – LABFAX, Academic Press.
2. Biotechnology book by B.D Singh
3. Gerard Karp, 1999; Cell and Molecular Biology, John Wiley & Sons Inc., New York.
4. Miller G et al, 1996; An introduction to Genetic analysis, Freeman & Co., New York.
5. Watson JD et al, 1992; Recombinant DNA, Scientific American Books.
6. Desmond ST & Nicoll, 1994; An introduction to Genetic Engineering, Cambridge Uni. Press.
7. Nicholl DST, 1994, An introduction to Genetic Engineering, Cambridge Univ. Press.
8. Trapp BE & Freifelder D, 2007; Molecular Biology – Genes to proteins, Jones &Bartlet Publ. Inc. Learning.
9. David P Clark, 2005; Molecular Biology, Academic Press
10. Harvey F Lodish, 2008; Molecular Cell Biology, W.H. Freeman
11. Cornell Mechardt, 2007; Molecular Biology & Genomics, Academic press

MBS - 3.4: Fermentation Technology

Teaching: 2hours/Week **Credits:2**
Total 30 Hours

Unit 1: Basics of fermentation processes, definition, scope, history, chronological development of the fermentation industry. Component parts of fermentation process. Types of fermentation Microbial growth kinetics, batch and continuous, direct, dual or multiple fermentations; scale-up of fermentation, comparison of batch and continuous culture as investigative tools, examples of the use of fed batch culture .Isolation preservation and strain improvement to find Industrially important microorganism. Use of recombination system (Para sexual cycle, protoplast fusion techniques), application of recombinant strains, the development of new fermentation products.

15Hrs

Unit 2: Screening (primary and secondary screening); detection and assay of fermentation products (Physico-chemical assay, biological assays). Inoculum development , criteria for transfer of inoculum, development of inoculum for yeast processes, bacterial fermentation and mycelial processes.

Fermentation equipment and its use; (design of a fermentor, types of fermentor, agitation, aeration, antifoam, pH and temperature. Instrumentation and process variables control use of on-line, offline, on and offline control. Media formulation–raw materials, fermentation media, solid state, surface and submerged fermentation.

15Hrs

References;

1. Casida, L.E.2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
2. Clark, D.P and Pazdernik, N.J.2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
3. Glazer, A and Nikaido.1995. Microbial biotechnology fundamentals of applied microbiology, W. H. Freemn and company, USA.
4. Glick, B.R and Pasternak, J.J.2003. Molecular Biotechnology Principles and Applications of Recombinant DNA, 3rd edition, ASM Press, USA.
5. Harider, S.I. and Ashok, A. 2009. Biotechnology, A Comprehensive Training Guide for the Biotechnology Industry, CRC Press, New York.
6. Sridhar, S.2010. Industrial Microbiology, Dominant Publishers, New Delhi.
7. Tanuja. S and Purohit, S.S. 2008. Fermentation Technology, Agrobios Publication, Jodhpur, India.

MOE - 3.5: Microbial Water analysis

Teaching: 4 hours/Week **Total 60 hours**
Credits:4

Unit 1: Sources of Microbial contamination of water. Factors influencing microbial Contamination of water. Sampling of water for microbiological analyses. Types of water samples. Collection, transport and processing of samples. Detection of microbial populations in water – Phenotypic detection. Determination of microbial members: Direct count and viable count procedures **15 hrs**

Unit 2: Detection methods for water-borne pathogens-multiple tube fermentation method, membrane filter method-A technique, rapid detection of coliforms. Detection of indicators of pathogenic bacteria-enterococci, bacteriophages. Water disinfection methods. Safe limits for drinking water. Water Quality standards.

15hrs

Unit 4: Microorganisms in storm water, purpose and scope. Introduction indicator organisms, ratios of fecal coliforms to fecal streptococci, bacterial load of stormwater, sources of bacteria in storm water, variation in number of micro-organisms in stormwater, pathogens in stormwater, fate of micro-organisms in storm water, methods and procedures, sample collection, storage of stormwater samples.

15hrs

References.

1. Alcamo, I.E. 1997. Fundamentals of Microbiology, 5th edition, An imprint of Addison Wesley Longman, New York.
2. Batzing, B.L. 2002. Microbiology (An Introduction), Brooks/Cole ThamsonLearining, Canada.
3. Bauman, R. 2007. Microbiology (With diseases by Taxonomy), 2nd edition, Pearson Benjamin Cummings Publishers, San francisco.
4. Cappucino, J.G. and Sherman, N. 2005. Microbiology, A Laboratory Manual, 7th edition, Pearson Education INC. Delhi, India
5. Patnail, P. 1997. Hand Book of Environmental Analysis. CRC Press,
6. Inc., USA.
7. Willey, J.M., Sherwood, L.M and Woolverton, C.J.2008. Prescott, Harley, and Klein's Microbiology, McGraw-Hill, New York.

PRACTICALS

MBHP-3.6: based on MBH-3.1: Food Microbiology

Teaching: 4hours/Week **Credits:2**

1. Microbiological examination of food utensils
2. Microbiological examination of vegetables
3. Microbiological examination of spices
4. Microbiological examination of fruits
5. Microbiological examination of cereals
6. Dye reduction test
    i. Methylene blue reduction test
    ii. Resazurin dye reduction test
7. Standard plate count of milk
8. Estimation of Ascorbic acid from Tomato, Chills and Lemon.
9. Estimation of Lactic acid from fermented milk products.
10. Detection of Palmolein in oil
11. Production Curd, Yoghurt, Paneer, Tempeh.
12. Production of Sauerkraut.
13. Mandatory visit to Food industry/National food Laboratory/ Brewerage industry

MBHP-3.7: based on MBH - 3.2: Medical Microbiology

Teaching: 4hours/Week **Credits:2**

1. Preparation of culture media for the culture of different pathogenic microorganisms.
2. Aerobic and Anaerobic culture method for clinical importance.
3. Presumptive identification of pathogenic microorganisms using colony morphology on selective/differential/selective-differential/enrichment media and Staining
4. Study of clinical significant species: *Staphylococcus, Streptococcus, Candida, Cryptococcus, Cornybacterium, Bacillus, Nocordia, Neisseria, Enterobacteriaceae, Vibrio, Pseudomonas, Aeromonas.*
5. Study of commensal microbial flora of human body (mouth/skin/hands/nose/ear).
6. Isolation, characterization and identification of bacterial pathogen from clinical specimen (Urine sample/Pus sample/Blood sample).
7. Demonstration of the diagnosis of HBV.
8. Identification of pathogenic fungi (Germ tube test/Slide culture technique).
9. Determination of MIC value for selected antibiotics by Kirby-Bauer method.
10. Study of *Mycobacterium tuberculosis* by AFB method using sputum (Bacterial infection).

MBHP-3.8: based on MBH - 3.3: Recombinant DNA Technology

Teaching: 4hours/Week **Credits:2**

1. Isolation of Bacterial genomic DNA
2. Restriction digestion
3. Ligation of DNA fragment with cloning vector
4. Preparation of Competent cells
5. Transformation in E. coli with recombinant vector
6. Polymerase Chain Reaction
7. Southern Hybridization
8. DNA Finger printing
9. Western blotting
10. Restriction Mapping by kit Method

M.Sc., Microbiology Fourth SEMESTER

MBH- 4.1: Agriculture Microbiology

Teaching: 4hours/Week **Credits:4**

Total 60 hours

Unit 1: Concepts and scope of agricultural microbiology, importance of microorganisms in agriculture, influence of microorganisms in plant growth, modern concepts of microbial inoculants in agriculture. Interaction of soil microorganisms with plants: Rhizosphere and phylloplane microorganisms. Symbiotic and non-symbiotic nitrogen Fixation, mechanisms of nitrogen fixation and importance. Brief account of production and application of *Rhizobium* inoculant; strain selection and mass culturing. Brief account of production and utility of *Azotobacter, Azospirillum*, cyanobacteria, *Azolla*, *Frankia*. Salient features and significance of strains and application of these microorganisms. Phosphate-solubilizing microorganisms-importance, culturing and applications of these microorganisms in agriculture. Mycorrhizae: types, Mass production and application of mycorrhizae. Plant and Microbial Interaction.

15Hrs

Unit 2: Role of pathogen enzymes in pathogenesis- production of different enzymes and action of pathogen enzymes on host tissues and significance of these enzymes in disease development**.** Role of phytotoxins in plant pathogenesis-types of toxins produced by plant pathogens, effect of toxins on disease development. Role of plant growth regulators in plant pathogenesis.

Defense mechanisms in plants: Structural and biochemical defense mechanism's role of elicitors, receptors and suppressors in disease development, molecular mechanisms in expression of plant disease resistance**.**

Epidemiology of plant diseases: Effect of environmental factors on disease development; Dissemination of plant pathogens; Disease forecasting and its Significance. **Seed Pathology:** Importance of seed-borne diseases and seed health testing methods. **15Hrs**

Unit 3: Phytopathology: Introduction and historical milestones, significance of plant diseases, types of plant diseases, basic procedure of plant disease diagnosis, parasitism, pathogenicity and plant disease development, disease cycle, infection cycle and plant disease triangle.

Levels of plant-pathogen interaction: Pre penetration, host-recognition, role of host exudates, entry by plant pathogens through natural openings and wounds, direct penetration, process of pathogenesis, infection and establishment of pathogens in the host tissues**.**

Brief account on some locally available plant diseases.

15Hrs

Unit 4: Plant Disease Management: Cultural methods-exclusion, eradication, crop rotation and sanitation. Inspection and certification, quarantine regulations. **Biological control of plant disease-**selection, testing and use of antagonistic microorganisms and their metabolites, application methodology and significance. Breeding for disease resistance, systemic acquired resistance; protoplast, cell, tissue culture and somaclonal variation for disease resistance, biotechnological approaches in obtaining disease resistance plants, induced resistance, transgenic plants for plant disease management. Integrated disease management practices, Brief account on control of Physical and chemical methods.

15Hrs

References;

1. Agrios, G.2005. Plant Pathology, 5th edition, Reed Elsevier India Private Limited, New Delhi, India.
2. Ayres, P.G. 1992. Pests and Pathogens (Plant Responses to foliar Attack), Bioscientific Publishers.
3. Carlile, M. G., Watkinson, S. Cand Gooday, G. W. 1994. The Fungi, Academic Press, UK.
4. Gow, N. A. Rand Gadd, G.M. 1996. The growing fungus, Chapman and Hall Publishers, London.
5. Mehrotra, R. S. 1980. Plant Pathology, Tata McGraw-Hill publishing Company Limited, New Delhi.
6. Purohit, S.S.2003. Agricultural Biotechnology, 2ndedition, Agrobios Publisher, Jodhpur, India.
7. Rangaswami, Gand Bagyarai, D.J.2005. Agricultural Microbiology, 2nd edition, Prentice-Hall of India Private Limited, New Delhi.
8. Agarwal, V. Kand Sinclair, J. B. 1987. Principles of Seed Pathology, CBS Publishers, Delhi.
9. Srivastava, H. N.2001.Plant Pathology, Pradeep Publications, Jalandhar.
10. Rao, N.S.S.1993. Biofertilizers In Agriculture and Forestry, 3rdedition, Oxford & IBH Publishing Pvt. Ltd, New Delhi.
11. Dhingra, O. Dand Sinclair, J.B.1985. Basic Plant Pathology Methods, CBS Publishers, Delhi.

MBH - 4.2: Industrial Microbiology

Teaching: 4hours/Week **Credits:4**
Total 60 hours

Unit 1: Concepts and scope of Industrial microbiology. Screening and strain improvement in industrial microbiology: Industrial important species and strains, strain development for improved yields, strain maintenance and preservation. Sterilization of fermentor, sterilization of air supply, inoculation methods, sampling methods, a brief account of monitoring and control devices. Different types of fermentors: Chemostat, turbidostat, gradostat, tabular fermentors, tower fermentors, membrane bioreactors, scale up of fermentation process-parameter and problems associated with scaleup. Microbial growth kinetics. Fermentation media**:** Desired qualities, sources of carbon, nitrogen, vitamins and minerals; role of buffers, precursors, inhibitors, inducers and antifoams**.**

15Hrs

Unit2: Fermentor: Basic features, design and components of advanced bioreactor (Stirred tank bioreactor), submerged Fermentor. Specialized bioreactors- design and their functions of airlift bioreactor, tubular bioreactors, fluidized bed reactor, packed bed reactors, membrane bioreactors, tower bioreactors and Photo-bioreactors; Sterilization of fermentor, medium and air supply; Aseptic inoculation and sampling methods.

Solid state fermentation (SSF): Introduction, characteristics and application of SSF; advantages of SSF compared with submerged fermentation; Solid Matrix in SSF; Inert support materials; Factors influencing SSF, design of Koji fermentor; Production

of commercially important products by SSF- Cellulases, penicillin, gibberillic acid and clavulanic acid.

15Hrs

Unit 3: Downstream processing: objectives and criteria, foam separation, precipitation methods, filtration devices, filter aids, industrial scale centrifugation and cell disruption methods, liquid-liquid extraction, solvent recovery, chromatography, microfiltration, ultrafiltration, drying devices, crystallization and whole broth processing. Industrial fermentation of penicillin, lactic acid, glutamic acid, vitamin A and alcoholic beverages-wine, beer and whisky.

Industrial enzymes: production and applications of amylases, proteases, pectinases, cellulases and lipases. Immobilization of enzymes or cells: methods, substrates, advantages and applications. Modern approaches to industrial waste treatments.

15Hrs

Unit4: Intellectual Property Rights (IPR): Introduction and implications, WTO, WIPO, GATT, TRIPS; Patenting procedures and granting, compulsory licenses, patent search, Patent Cooperation Treaty (PCT); Patents in microbiology-National and international status; Legal implications; Traditional knowledge in commercial exploitation and protection; GI tags and significance;

Entrepreneurship– Potential activities in microbial biotechnology, product development, marketing, research and training units. Industrial licensing and venture capital. Microbial Biotechnology industries in India and potential job opportunities.

15Hrs

References;

8. Casida, L.E.2007. Industrial microbiology, New age international (P) Ltd., New Delhi.
9. Clark, D.P and Pazdernik, N.J.2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
10. Glazer, A and Nikaido.1995. Microbial biotechnology fundamentals of applied microbiology, W.H.Freemn and company, USA.
11. Glick, B.R and Pasternak, J.J.2003. Molecular Biotechnology Principles and Applications of Recombinant DNA, 3rd edition, ASM Press, USA.
12. Harider, S.I. and Ashok, A. 2009. Biotechnology, A Comprehensive Training Guide for the Biotechnology Industry, CRC Press, New York.
13. Sridhar, S.2010. Industrial Microbiology, Dominant Publishers, New Delhi.
14. Tanuja.S and Purohit, S.S. 2008. Fermentation Technology, Agrobios Publication, Jodhpur, India.

MBH - 4.3: Environmental Microbiology

Teaching: 4hours/Week **Credits:4**
Total 60 hours

Unit1: Environment and Ecosystem: Physical, chemical and biological aspects of environment, natural habitats of microorganisms, microorganisms in ecosystem as producers and decomposers. Bio geochemical cycles-role of microorganism in transformation and maintenance of carbon, nitrogen, phosphorus and Sulphur in nature.
Soil Microbiology Historical development of soil microbiology. Physical characteristics and nutrient status of soil. Distribution of microorganisms in soil, their importance in maintaining soil fertility, organic matter and composting. Influence of environmental factors on soil microorganisms. Role of microorganisms in formation of different soils. Enumeration and isolation of soil microorganisms. Brief account of interactions among soil microorganisms-mutualism, commensalism, antagonism, competition, synergism, parasitism and predation. Bioremediation of pollutants in soil, biodegradation of pesticides in soil.

15 Hrs

Unit 2: Aquatic microbiology: Aquatic environment: Temperature, hydrostatic pressure, light, salinity, turbidity, pH, nutrients. Distribution of microorganism s in the aquatic environment. Methods in the study of fresh and marine water microorganisms. Role of aquatic microorganisms in food chain of aquatic environment. Eutrophication-role of nitrogen and phosphorus in eutrophication, process and control of eutrophication. Microorganisms and water Pollution-Microflora of natural and polluted water, sources and characteristics of water pollutants; health hazards due to water pollution; microorganisms as indicators of water pollution; water quality criteria and assessment; bacteriological examination of water for potability. The role of microorganisms in the purification of waste water: waste water treatment process, aerobic-anaerobic-design and functioning of treatment plant; microbial ecology and application of trickling filters; activated sludge process, microbial treatment of sludges. Water-borne diseases and their prevention. **15Hrs**

Unit 3: Microbiology of the atmosphere: Microorganisms in air, sources of air-borne microorganisms. Intramural and Extramural aero microbiology. Techniques for microbiological sampling of air, impactors and impingers-Gravity slide, Plate exposure, vertical cylinder, Anderson's sampler, Hirst's trap, Burkard's 7-day volumetric sampler, rotarod sampler. Brief account of air-borne diseases of humans and plants. Brief account of air-borne allergens and their significance.
Microorganisms in extreme environments: Extreme environments of temperature, salinity, pressure, pH. Extreme thermopiles, psychrophiles, extreme halophiles, barophiles and other microorganisms in extreme environments. Radiosensitivity of microorganisms, effect of radiation on microorganisms, mechanisms of radio-tolerance in microorganisms.

15 Hrs

Unit 4: Biodeterioration and Bioremediation: Microorganisms as biodeteriogens and their role in cycling of matter. Microbial degradation of cellulose, lignin, pectin, chitin, synthetic polymers, xenobiotic compounds, petroleum and other hydrocarbons.

Solid wastes, chemical wastes, utilization of microorganisms in industrial effluent treatment technologies. Bioremediation of xenobiotic pollutants. Factors influencing bioremediation. Metal toxicity to microorganisms, importance of microorganisms in ore-leaching, use of microorganisms in metal extraction.

15 Hrs

References;

1. Atlas, Rand Bartha, R. 2005. Microbial Ecology Fundamental and Applications, 4th edition, Pearson Education (P) Ltd. Delhi, India
2. Bhatia, S. C. 2008. Hand Book of Environmental Microbiology, Atlantic Publishers Pvt. Ltd. New Delhi.
3. Gilman, J. 2001. A Manual of Soil Fungi, Biotech Books, Delhi.
4. Maier, R., Pepper, I and Gerba, C.P.2006. Environmental Microbiology, Reed Elsevier India Private Limited, New Delhi, India
5. Patnail, P. 1997. Hand Book of Environmental Analysis. CRC Press, Inc., USA.
6. Subba Rao, N.S. 1999. Soil Microbiology, Oxford & IBH Publishing Co. Pvt. Ltd, New Delhi, India
7. Thakur, I. S. 2006. Environmental Biotechnology, I. K. International Pvt. Ltd. New Delhi.

MBS- 4.4: Microbial Biotechnology

Teaching: 2hours/Week
Credits: 2Total 30 hours

Unit1: Introduction: Principle, applications, economics and milestones in microbial technology.

Microbial products for commercial use: Industrial production of organic acids (acetic acid). Amino acids (glutamic acid), Solvents (ethanol), Antibiotics (Cephalosporin,), Microbial polysaccharides and polyesters, Vitamin (B12), Hormones (insulin), anticholesterol compound (Lovastatin). Microbial insecticides. Secondary metabolites in bacteria and fungi (anti-cancer) and anti-diabetic compounds). Microbial surfactants, biosimilars; bioflavours. **Microbial enzymes**: History; Use of enzymes in starch processing, food (baking, oil, breweries and textile, detergent, leather, paper, therapeutics); Immobilized enzymes and cells: Techniques and types of immobilization, merits and demerits. Use of RSM

15 Hrs

Unit2: Microbial transformation and organic synthesis: Transformation of steroids and sterols, over production of glutathione by genetically engineered cells. Metabolic engineering for vitamin C production, Synthesis of acrylamide by nitrile hydratase. **Clinical trial of microbial products:** preclinical and clinical trials; basic principle oftoxicology; oral toxicity, sub-acute, acute and chronic toxicity. Toxic dose: LD_{50}, dose response relationship; local verses systemic toxicity; antagonism and synergism**.** **Nanotechnology**: Introduction, types, properties and synthesis of nanoparticles (Physical, Chemical and Biological), Nanoparticles synthesized using microorganisms-advantages and disadvantages; Bionanosensors; Applications of bionanoparticles. Biomining

15Hrs

References;

1. Casida, L. E. 2007. Industrial microbiology, new age international (P) Ltd., New Delhi.
2. Clark, D. Pand Pazdernik, N. J. 2009. Biotechnology applying the genetic revolution, Elsevier Academic Press, UK.
3. Glazer, Aand Nikaido. 1995. Microbial biotechnology fundamentals of applied microbiology, W. H. Freemn and company, USA.
4. Glick, B. Rand Pasternak, J. J. 2003. Molecular Biotechnology Principles and Applications of Recombinant DNA, 3rd edition, ASM Press, USA.
5. Harider, S. I. and Ashok, A. 2009. Biotechnology, A Comprehensive Training Guide for the Biotechnology Industry, CRC Press, New York.
6. Sridhar, S. 2010. Industrial Microbiology, Dominant Publishers, New Delhi.
7. Tanuja. Sand Purohit, S. S. 2008. Fermentation Technology, Agrobios Publication, Jodhpur, India.

MBP 4.5: Project /Dissertation

Teaching: 4hours/Week
Credits:4Total 50 hours

PRACTICALS

MBHP -4.6: Based on MBH 4.1 Agriculture Microbiology

Teaching: 4hours/Week **Credits:2**

1. Isolation of *Azotobacter*
2. Isolation of *Rhizobium*
3. Isolation of *Azospirillium*
4. Isolation of phosphate solubilizing microorganisms
5. Estimation of phosphate
6. Detection and quantification of mycorrhizae by root clearing technique
7. Seed health testing by dry seed examination and seed wash method
8. Detection of seed-borne fungi
   a. blotter method
   b. Agar plate method
   c. Deep freeze method
9. Study of plant diseases caused by fungi, bacteria and viruses
10. Mushroom cultivation using locally available substrates and evaluation of total protein content.
11. Visit to agricultural University.

MBHP -4.7: Based on MBH 4.2 Industrial Microbiology

Teaching: 4hours/Week **Credits:2**

1. Demonstration of a basic fermentor
2. Raw materials used in industrial Microbiology
3. Production of amylase by solid state fermentation/ submerged fermentation
4. Estimation of citric acid by solid state fermentation/submerged fermentation
5. Estimation of alcohol by specific gravity method
6. Estimation of alcohol by colorimetric method
7. Study of fermentation using yeast
8. Laboratory scale production of wine/beer.
9. Sterility tests for pharmaceutical products

MBHP – 4.8 Based on MBH 4.3 Environmental Microbiology

Teaching: 4hours/Week **Credits:2**

1. Soil moisture content determination
2. Isolation of Coliphages from sewage
3. Estimation of total alkalinity of soil
4. Ammonification in soil
5. Estimation of dissolved oxygen of water
6. Estimation of free carbon-dioxide
7. Estimation of total solid content of water
8. Estimation of total acidity and total alkalinity of water
9. Estimation of catalase activity in water
10. Estimation of BOD of sewage water
11. Determination of chemical oxygen demand of water
12. Estimation of chloride in water sample
13. Bacteriological examination of water-MPNtest