Syllabus
For
B.Sc. (Hons.)MICROBIOLOGY

THREE YEAR FULL TIME PROGRAMME UNDER CBCS

RANI DURGAVATI UNIVERSITY

JABALPUR-482001

Note: Syllabus applicable for students seeking admission in the B.Sc. (HONS) Microbiology Course from the academic year 2018-2019 onwards

Approved by

Board of Studies in Microbiology on 25/06/2018, **Faculty of Life Science on** 25/06/2018

Standing committee on , **Executive Council on**

Syllabus For
B.Sc. (Hons.) MICROBIOLOGY
(CBCS Pattern)

ACADEMIC YEAR 2018-2019 Onwards

The B.Sc. (Hons.) Microbiology course would be of three years duration, divided into three parts- Part I, Part II and Part III. Each part would consist of two semesters. Semester I to V would comprise of three theory papers including practicals and one Elective with practical out of two choices, making a total of 20 papers in five semesters. Students will carry out Research work and submit a Dissertation in Semester VI. There would be 12 cores, 8 common (elective) and 4 interdisciplinary papers. The new course will commence from the academic session 2016-17. The syllabus has been prepared keeping in view the unique requirements of B.Sc. (Hons.) microbiology students under CBCS Programme. The contents have been drawn to accommodate the widening horizons of the Microbiology discipline. It reflects the changing needs of the students, pertaining to the fields of Chemistry, Statistics and Computational skills. The detailed syllabus for each paper is appended with a list of suggested readings. Teaching time allotted for each paper shall be 4 periods for each theory paper and 4 periods for each practical class per week and 1 tutorial period for each paper per week. Each practical batch should not have more than 20 students. Any number exceeding 20 will be divided into two equal batches. This is because microbiology practicals require individual attention for imparting correct and adequate hands – on training to the students.

The six common papers (Cell Biology - I and II, Genetics and Genomics – I and II and Molecular Biology I and II) will be taught by teachers of the department of Biological Sciences. The interdisciplinary courses like Fundamental of Statistics, Basics of Computers, Computational Skills, Chemistry and Technical Writing and Communication in English) will be taught by teachers of the respective departments. One short educational trip will be conducted to industry/national/research institutes in the $5^{th}/6^{th}$ semester to keep the students abreast with latest developments in the field of microbiology.

BACHELOR OF SCIENCE IN MICROBIOLOGY
THREE YEAR FULL TIME PROGRAMME
PROGRAMME STRUCTURE

PART	SEMESTER	PAPER
PART-I	**Semester-1**	
	UMB 101	Introduction to Microbial World
	UMB 102	Techniques in Microbiology
	UMB 103	Chemistry-I
	UMB 104	Practical based on UMB 101&102
	UMB 105	Practical based on UMB 103 & UMBE 101/102
	UMBE 101/	Communicative English
	UMBE 102	Basics of Computers
	Semester-2	
	UMB 201	Bacteriology
	UMB 202	Medical Microbiology
	UMB 203	Chemistry-II
	UMB 204	Practical based on UMB 201& 202
	UMB 205	Practical based on UMB 203 & UMBE 201/202
	UMBE 201/	Fundamentals of Statistics
	UMBE 202	Recombinant DNA Technology
PART II	**Semester-3**	
	UMB 301	Virology
	UMB 302	Phycology & Mycology
	UMB 303	Cell Biology-I
	UMB 304	Practical based on UMB 301& 302
	UMB 305	Practical based on UMB 303 & UMBE 301/302
	UMBE 301/	Molecular Biology-I
	UMBE 302	Bioanalytical Techniques
	Semester- 4	
	UMB 401	Microbial Physiology & Metabolism
	UMB 402	Genetics & Genomics-I
	UMB 403	Cell Biology-II
	UMB 404	Practical based on UMB 401& 402
	UMB 405	Practical based on UMB 403 & UMBE 401/402
	UMBE 401/	Molecular Biology-II
	UMBE 402	Immunology
PART III	**Semester-5**	
	UMB 501	Food & Dairy Microbiology
	UMB 502	Microbiology Ecology
	UMB 503	Industrial Microbiology
	UMB 504	Practical based on UMB 501& 502
	UMB 505	Practical based on UMB 503& UMBE 501/502
	UMBE 501/	Genetics & Genomics-II
	UMBE 502	Plant Pathology
	Semester-6	
	DISSERTATION	

(B) SCHEME OF EXAMINATION

FIRST SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	**Course Title**				
Core Courses					
UMB 101	**Introduction to Microbial World**	**03**	**40**	**60**	**100**
UMB 102	**Techniques in Microbiology**	**03**	**40**	**60**	**100**
UMB 103	**Chemistry-I**	**03**	**40**	**60**	**100**
Practical core courses					
UMB 104	**Practical based on UMB 101 and UMB 102**	**04**	**40**	**60**	**100**
UMB 105	**Practical based OnUMB103and UMBE 101 or UMBE 102**	**04**	**40**	**60**	**100**
Elective Courses (Any one to choose)		**03**	**40**	**60**	**100**
UMBE 101	**Communicative English**				
UMBE 102	**Basics of Computers**				
(B) Comprehensive viva voce (Virtual credits)		**04**			**50**

SECOND SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	**Course Title**				
Core Courses					
UMB 201	**Bacteriology**	**03**	**40**	**60**	**100**
UMB 202	**Medical Microbiology**	**03**	**40**	**60**	**100**
UMB 203	**Chemistry-II**	**03**	**40**	**60**	**100**
Practical core courses					
UMB 204	**Practical based on UMB 201 and UMB 202**	**04**	**40**	**60**	**100**
UMB 205	**Practical based on UMB 203 and UMBE 201/ UMBE 202**	**04**	**40**	**60**	**100**
Elective Courses (Any one to choose)		**03**	**40**	**60**	**100**
UMBE 201	**Fundamentals of Statistics**				
UMBE 202	**Recombinant DNA Technology**				
(B) Comprehensive viva voce (Virtual credits)		**04**			**50**

THIRD SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	Course Title				
Core Courses					
UMB 301	Virology	03	40	60	100
UMB 302	Phycology & Mycology	03	40	60	100
UMB 303	Cell Biology-I	03	40	60	100
Practical core courses					
UMB 304	Practical based on UMB 301 and UMB 302	04	40	60	100
UMB 305	Practical based on UMB 303 and UMBE 301 or UMBE 302	04	40	60	100
Elective Courses (Any one to choose)		03	40	60	100
UMBE 301	Molecular Biology-I				
UMBE 302	Bioanlytical Techniques				
(B) Comprehensive viva voce (Virtual credits)		04			50

FOURTH SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	Course Title				
Core Courses					
UMB 401	Microbial Physiology & Metabolism	03	40	60	100
UMB 402	Genetics & Genomics-I	03	40	60	100
UMB 403	Cell Biology-II	03	40	60	100
Practical core courses					
UMB 404	Practical based on UMB 401 and UMB 402	04	40	60	100
UMB 405	Practical based on UMB 403and UMBE 401 or UMBE 402	04	40	60	100
Elective Courses (Any one to choose)		03	40	60	100
UMBE 401	Molecular Biology-II				
UMBE 402	Immunology				
(B) Comprehensive viva voce (Virtual credits)		04			50

FIFTH SEMESTER

(A) Continuous evaluation, Theory, Practical		Credits	Maximum Marks		
			Continuous Evaluation	End Semester Exam	Total
Course Code	**Course Title**				
Core Courses					
UMB 501	Food & Dairy Microbiology	**03**	**40**	**60**	**100**
UMB 502	Microbiology Ecology	**03**	**40**	**60**	**100**
UMB 503	Industrial Microbiology	**03**	**40**	**60**	**100**
Practical core courses					
UMB 504	**Practical based on UMB 501 and UMB 502**	**04**	**40**	**60**	**100**
UMB 505	**Practical based on UMB 503 and UMBE 501 or UMBE 502**	**04**	**40**	**60**	**100**
Elective Courses (Any one to choose)		**03**	**40**	**60**	**100**
UMBE 501	Genetics & Genomics-II				
UMBE 502	Plant Pathology				
(B) Comprehensive viva voce (Virtual credits)		**04**			**50**

SIXTH SEMESTER

DISSERTATION	Credits	Maximum Marks
A. Valuation 1. Language & Presentation 2. Review of Literature 3. Methodology 4. Analysis & Interpretation of Result **B. Viva –Voce**	**18**	**300**

FIRST SEMESTER

Course Code UMB 101: INTRODUCTION TO MICROBIAL WORLD

THEORY **Total periods: 46**

UNIT I

History of Development of Microbiology (Ch 2 Pelczar et al., Ch 1 Stanier) (9 periods)
Development of Microbiology as a discipline, Spontaneous generation vs. biogenesis, development of various Microbiological techniques, concept of fermentation, establishment of fields of medical Microbiology, immunology and environmental Microbiology with special reference to the work of following scientists : Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty

UNIT II

Classification, systematic and ultrastructure

A. Systems of classification (Ch 1 Pelczar et al., Ch 1 Willey et al.) (8 periods)
Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms

B. General characteristics of different groups:
A cellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

UNIT III

Viruses, viroids and prions (Ch 20 Pelczar et al., Ch 13 Tortora et al.) (6 periods)
A general introduction with special reference to the structure of the following: TMV, poliovirus, T4 and λ phage, lytic and lysogenic cycles, one step multiplication curve

Bacteria (Ch 2 Madigan et al.) (2 period)A very precise account of typical eubacteria, chlamydiae & rickettsiae (obligate intracellular parasites), mycoplasma, and archaebacteria (extremophiles).

UNIT IV

Algae (Ch 1, 2 &12 Kumar) (8 periods)
History of phycology with emphasis on contributions of Indian scientists; General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Detailed life cycle of Chlamydomonas and Spirogyra.

Unit V

Fungi (Ch 2, 5, 11 Alexopoulus et al.) (10 periods)
Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements, fungal cell ultra- structure, thallus organization and aggregation, fungal wall

structure and synthesis, asexual reproduction, sexual reproduction, heterokaryosis, heterothallism and parasexual mechanism. Detailed life cycle of Aspergillus and Rhizopus.

• Protozoa (Ch 19 Pelczar et al., Ch 12 Tortora et al.) (3 periods)

General characteristics with special reference to Amoeba, Paramecium and Giardia. Clinical significance of these pathogens, diagnosis and treatment.

PRACTICALS

1. Study of the life history of the following scientists and their contributions with the help of their photographs: Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff and Ananda M. Chakraborty.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven) used in the Microbiology laboratory.
3. Study of the following algae by preparing temporary mounts: *Chlamydomonas* and *Spirogyra*.
4. Study of the following fungi by preparing temporary mounts: *Rhizopus* and *Aspergillus*.
5. Study of the following protozoans using permanent mounts/photographs*: Amoeba, Paramecium* and *Giardia.*
6. Study of the following viruses using electron micrographs : TMV, Polio virus, T4 and λ phage.

SUGGESTED READINGS

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4th edition. John and Sons, Inc.
2. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education limited.
4. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
5. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
8. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
9. Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.
10. Vashishta BR. (2005). Algae. 3rd edition. S. Chand and Company Limited, New Delhi.
11. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

FIRST SEMESTER

Course Code UMB 102: TECHNIQUES IN MICROBIOLOGY

Total periods: 47

UNIT I (15 periods)

Definitions and Principles: Culture, Pure culture, Auxenic culture, strains, Pure culture techniques; pour plate, streak plate and spread plate method, Enrichment culture technique, Rolling tube and Candle jar method, Plaque assay techniques, Camera lucida, micrometry. Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media. Sterilization and Disinfection Physical methods of MICROBIAL control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation Chemical methods of MICROBIAL control: disinfectants, types and mode of action.

UNIT II (8 periods)

Instruments, basic principles and usage: pH meter, fluorimetry, colorimetry, Spectrophotometry (visible, UV, infra-red), polarography, centrifugation, Principle & application of scanning & transmission electron microscopy.

Principle of Fixation and staining techniques for cell wall, capsule, flagella, endospore, EM, freeze-etch and freeze-fracture method for EM. Direct & indirect staining, negative staining

UNIT III (8 periods)

Principle and application of electrophoresis: Agarose gel electrophoresis, Density gradient gel electrophoresis, capillary electrophoresis, Pulsed field gel electrophoresis. Southern blotting, Northern blotting. Hybridization. DNA sequencing, pyrosequencing.

UNIT IV (8periods)

Principles and application of electrophoresis: SDS-PAGE and NATIVE-PAGE, Isolectric focusing and 2- D PAGE, Western Blotting, MALDI-TOF, N-terminal sequencing.

UNIT V (8 periods)

Principles and methods used for analysis biopolymers; X-ray Crystallography, fluorescence, ORD/CD, NMR & ESR spectroscopy; Hydrodynamic methods; Atomic absorption & Plasma emission spectroscopy.

SUGGESTED READINGS:

1. Wilson K. and Walker J. (2008). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press.
2. Nelson D and Cox MM. (2009). Principles of Biochemistry. W.H. Freeman and Company, New York.
3. Talaro K. P. & Talaro A. (2006). Foundations in Microbiology. McGraw-Hill College Dimensi.
4. Potter GWH and Potter GW (1995). Analysis of Biological Molecules: An Introduction to Principles, Instrumentation and Techniques, Kluwer Academic Publishers.
5. Willey J, Sherwood L. and Woolverton C (2007). Prescott/Harley/Klein's Microbiology, McGraw Hill.
6. Willard, HH and Merritt LL (1986). Instrumental Methods of Analysis. CBS Publishers and Distributors.
7. Williams, BL. and Wilson, K. (1975). A Biologists Guide to Principles and Techniques of Practical Biochemistry.John Wiley and Sons. Inc., New York.

FIRST SEMESTER
Course Code UMB 103: CHEMISTRY

UNIT I

Quantitative methods. Significant figures. Mole concept. Empirical and molecular formula. Molar and molal solutions, mole fraction, ppm and ppb solutions. Stoichiometry and calculations based on it involving acid-base, precipitation, redox, and complex formation reactions. *Chemical methods:* Principle, methodology and calculations involved in for dissolved oxygen (Winkler method), biological oxygen demand, chemical oxygen demand, and hardness of water. Determination of nitrogen in proteins (Kjeldahl method). *Spectrophotometric methods:* Determination of ammonia (by indophenol formation), nitrate (by nitrophenol formation), nitrite (by azo dye formation), and phosphorus (by molybdenum blue formation).

UNIT II

Chemical bonding and molecular structure.

Kossel-Lewis theory, octet rule, electrovalent and covalent bond. Formal charge. Polarity of bonds. The valence shell electron pair repulsion (VSEPR) theory, its postulates and geometry of molecules. Valence bond theory, orbital concept, hybridisation (sp, sp^2, sp^3, sp^3d and sp^3d^2). Molecular orbital theory. Linear combination of atomic orbitals (LCAO). Types and energy level diagram of molecular orbitals. Bond order. Bonding in homonuclear diatomic molecules. Magnetic properties.

UNIT III

Fundamental organic chemistry.

Structure and reactivity. Inductive and electromeric effects. Tautomerism, hyperconjugation and resonance. Intramolecular and intermolecular hydrogen bonding. Structure and stability of carbocations, carbanions and free radicals. Relative strength of organic carboxylic acids, phenols and amines. pKa and pKb values.

Reagents and reactions. Periodic acid, Grignard reagent, ethyl acetoacetate and diethyl malonate.

Reaction and mechanism. Claisen condensation, Benzoin condensation, Perkin reaction, Pinacol-pinacolone rearrangement,

UNIT IV

Stereochemistry of organic compounds.

Conformations. Fisher, sawhorse and Newman structures. IUPAC namenclature of conformational isomers. Conformations and their analysis of ethane, n-butane, cyclohexane and decalins.

Configurations. Chirality. Elements of symmetry. Optical activity, specific rotation. Enantiomers, diastereomers, and meso compounds. Racemic modification. Thereo and erythro compounds. R and S configuration, sequence rules. Geometrical isomerism, E and Z nomenclature.

Stereochemical aspects of chemical reactions. Addition of bromine to Z- and E-butene. E2 reactions.

UNIT IV

Ionic equilibria.

Ostwald dilution law and its experimental verification. Application of Ostwald dilution law. Ionization of water. The pH value, relation between pH and pOH, the pH scale (numerical problems). The salt hydrolysis, and application to (i) salts of strong acids and strong bases, (ii) salts of weak acis and strong bases, (iii) salts of strong acids and weak bases, and (iv) salts of weak acids and weak bases. Hydrolysis constant and degree of hydrolysis.

Buffer solutions. Solubility and solubility product of sparingly soluble salts. Applications of solubility product principle.

PRACTICAL

1. Determination of hardness of water by titration with EDTA.
2. Determination of dissolved oxygen in environmental waters by the Winkler method.
3. Determination of chemical oxygen demand in environmental waters.
4. Determination of strength of a solution of sulphuric acid by titration with sodium hydroxide using pH meter.
5. Determination of ammonia by the indophenol formation, and spectrophotometry.
6. Determination of solubility product of mercuric iodate or lead iodate.

Suggested reference materials

1. Analytical Chemistry, G.D. Christian, John Wiley & Sons (Asia), Singapore
2. Fundamentals of Analytical Chemistry, D.S. Skoog, D.M. West, F.J. Holler and S.R. Cruch, Thomson, Singapore.
3. Organic Chemistry, R.T. Morrison and R.N. Boyd, Pearson Education, Delhi.
4. Organic Chemistry, P.Y. Bruice, Pearson Education, Delhi.
5. A Guidebook to Mechanism in Organic Chemistry, P.Sykes, Orient Longman, New Delhi.
6. Essentials of Physical Chemistry, A. Bahl, B.S. Bahl and G.D. Tuli, S. Chand & Company Ltd, New Delhi.

FIRST SEMESTER
Course Code UMBE 101: COMMUNICATIVE ENGLISH

Total periods: 36

UNIT I **(6 periods)**

Communication: Language and communication, differences between speech and writing, distinct features of speech, distinct features of writing. Speech drills, pronunciation and ascent, stress and intonation.

UNIT II **(6 periods)**

Writing Skills; Selection of topic, thesis statement, developing the thesis, introductory, developmental, transitional and concluding paragraphs. Articles, parts of speech, tenses, sentence structure, subject- verb agreement, punctuation.

UNIT III **(6 periods)**

Use of dictionary. Use of words: Diminutives, Homonyms and Homophones. Linguistic unity, coherence and cohesion, descriptive, narrative, expository and argumentative writing.

UNIT IV **(6 periods)**

Effective writing skills, avoiding common errors. Technical Writing: Scientific and technical subjects; formal and informal writings; formal writings/reports, handbooks, writing assignments.

UNIT V **(6 periods)**

Purpose and scope of Report, Memo, Agenda and Minutes. Notice, Letters; types and minutes, Manuals.

SUGGESTED READINGS

1. M. Frank. Writing as thinking: A guided process approach, Englewood Cliffs, Prentice Hall Reagents.
2. L. Hamp-Lyons and B. Heasely: Study Writing; A course in written English. For academic and professional purposes, Cambridge Univ. Press.
3. R. Quirk, S. Greenbaum, G. Leech and J. Svartik: A comprehensive grammar of the English language, Longman, London.
4. Daniel G. Riordan & Steven A. Panley: "Technical Report Writing Today" - Biztaantra. Additional Reference Books
5. Daniel G. Riordan, Steven E. Pauley, Biztantra (2004).: Technical Report Writing Today, 8th edition.
6. Contemporary Business Communication, Scot Ober, Biztantra, 5th Edition (2004).

FIRST SEMESTER
Course Code UMBE 102: BASICS OF COMPUTERS

Total periods: 42

UNIT I

Computer Fundamentals (12 Periods)

Introduction to Computers: Characteristics of Computers, Uses of computers, Types and generations of Computers Basic Computer Organization - Units of a computer, CPU, ALU, memory hierarchy, registers, I/O devices User Interface with the Operating System, System Tools

UNIT II

Data Representation (8 Periods)

Binary representation of integers and real numbers, 1's Complement, 2's Complement, Addition and subtraction of bi

UNIT III

Networks terminology (4 Periods)

Types of networks, router, **switch, server-client architecture**

Multimedia (4 Periods)

Introduction, Characteristics, Elements, Applications

UNIT IV

Problem Solving (10 Periods)

Notion of algorithms, stepwise methodology of developing an algorithm, developing macros in spreadsheet

UNIT V

General Awareness (4 Periods)

IT Act, System Security (virus/firewall etc.) I-Tax, Reservations,Banking

PRACTICALS

1. Defined projects will be done by the students and evaluated by the instructor.
2. Document Preparation
3. Presentation Software
4. Familiarizing with the Operating System, Control Panel, Networking Configuration, Firewall setting
5. Spreadsheet Handing, Working with worksheets, Creating a spreadsheet, entering and formatting information, basic functions and formulas, creating charts, tables and graphs.

SUGGESTED READING

1. V Rajaraman, Fundamentals of Computers, Fourth Edition, PHI.
2. Anita Goel, Fundamentals of Computers; Forthcoming title in Pearson-Education

Note: Use of Open Office/Star Office is recommended, as they are freely downloadable.
Reference manual for Open Office available at: http://www.openffice.org
Reference manual for Star Office available at: http://www.sun.com/software/staroffice/

SECOND SEMESTER
Course Code UMB 201:BACTERIOLOGY

THEORY **Total periods: 47**

UNIT I

Cell organization (Ch 6 Stanier et al., Ch 3 Willey et al.) (15 periods)

The morphology and fine structure of bacteria. Cell size, shape and arrangement, glycocalyx, capsule, flagella, endoflagella, fimbriae and pili.Cell-wall: Composition and detailed structure of gram positive and gram-negative cell walls, Archaebacterial cell wall, Gram and acid fast staining mechanisms, lipopolysaccharide (LPS), sphaeroplasts, protoplasts, and L-forms. Effect of antibiotics and enzymes on the cell wall.

Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.

Cytoplasm: Ribosomes, mesosomes, inclusion bodies, nucleoid, chromosome and plasmids

Endospore: Structure, formation, stages of sporulation.

UNIT II

Growth and nutrition (Ch 7 Tortora et al., Ch 5 Willey et al.) (5 periods)

Definition; photoautotrophs, photohetrotrophs, chemoautotrophs, chemohetrotrophs; Nutritional categories among microorganisms Nutritional requirements in bacteria and nutritional categories; The requirements for carbon, nitrogen and sulphur, growth factors, the role oxygen, Continous cultures, their applications, chemostats and turbidostats.

Reproduction in Bacteria (Ch 7 Pelczar et al., Ch 6 Tortora et al.) (3 periods)

Asexual methods of reproduction, logarithmic representation of bacterial populations, phases of growth, calculation of generation time and specific growth rate.

UNIT III B

Bacterial Systematics (Ch 19 Willey et al.) (8 periods)

Aim and principles of classification, systematics and taxonomy, concept of species, taxa, strain; conventional, molecular and recent approaches to polyphasic bacterial taxonomy, evolutionary chronometers, rRNA oligonucleotide sequencing, signature sequences, and protein sequences. Differences between eubacteria and archaebacteria

UNIT IV

Important archaeal groups (Ch 11 -13 Madigan et al., Ch 20–24 Willey et al.) (6 periods)

According to Bergey's Manual of Systematic Bacteriology (Second Edition)

Archaebacteria: General characteristics, phylogenetic overview, genera belonging to Nanoarchaeota (*Nanoarchaeum*), Crenarchaeota (*Sulfolobus*, Thermoproteus) and *Euryarchaeota* [Methanogens (*Methanobacterium*, *Methanocaldococcus*), thermophiles (*Thermococcus*, *Pyrococcus*, *Thermoplasma*), and Halophiles (*Halobacterium*, *Halococcus*)]

UNIT V

Important eubacterial groups (Ch 11 -13 Madigan et al., Ch 20–24 Willey et al.) (8 periods)

Eubacteria: Morphology, metabolism, ecological significance and economic importance of following groups:

Gram Negative:

• **Alpha proteobacteria**

Rickettsia, Coxiella, Caulobacter, Rhizobium, Hyphomicrobium Agrobacterium.

• **Beta proteobacteria**

Neisseria, Burkholderia, Thiobacillus

• **Gamma proteobacteria**

Enterobacteriaceae family, Pseudomonas, Vibrio.

• **Delta proteobacteria**

Bdellovibrio, Myxococcus

• **Epsilon proteobacteria**

Helicobacter, Campylobacter

Gram Positive:

• Low G+ C (Firmicutes)

Mycoplasmas, Clostridium, Lactobacillus, Staphylococcus, Streptococcus, Bacillus.

• High G+C (Actinobacteria)

Arthrobacter, Corynebacterium, Mycobacterium, Streptomyces, Thermomonospora,

PRACTICALS

1. Introduction to light microscope
2. Preparation of different media: synthetic media BG-11, Complex media-nutrient agar, McConkey agar, EMB agar.
3. Simple staining
4. Negative staining
5. Gram's staining
6. Acid fast staining-permanent slide only.
7. Capsule staining
8. Spore staining.
9. Isolation of pure cultures of bacteria by streaking method.
10. Estimation of CFU count by spread plate method.
11. Motility by hanging drop method.

SUGGESTED READINGS

1. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
2. Black JG. (2008). Microbiology: Principles and Explorations. 7th edition. Prentice Hall
3. Madigan MT, and Martinko JM. (2006). Brock Biology of Micro-organisms. 8th edition. Parker J. Prentice Hall International, Inc.
4. Pelczar Jr MJ, Chan ECS, and Krieg NR. (2004). Microbiology. 5th edition Tata McGraw Hill.
5. Srivastava S and Srivastava PS. (2003). Understanding Bacteria. Kluwer Academic Publishers, Dordrecht
6. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology. 5th edition McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition Pearson Education.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and 9. Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

SECOND SEMESTER
Course Code UMB 202: MEDICAL MICROBIOLOGY

THEORY **Total Periods – 46**

UNIT 1 Normal microflora of the human body (Ch 11 Brooks et al.) (2 periods)

Skin, throat, gastrointestinal tract, urogenital tract

Host-pathogen interaction (Ch 9 Brooks et al.) (3 periods)

Definitions of invasion, pathogen, parasite, pathogenicity, toxigenicity, virulence, carriers and their types, nosocomial infections, opportunistic infections, septicemia, septic shock, transmission and spread of infection

UNIT 2 Sample collection, transport and diagnosis (Ch 47 Brooks et al.) (4 periods)

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests, Complement fixation, PCR, DNA probes).

UNIT 3 Bacterial diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control) **(Ch 12, 13, 15, 16, 18, 19, 21, 24, 25 Brooks et al.) (12 periods)**

Bacillus anthracis, Corynebacterium diphtheriae, Streptococcus pyogenes, Escherichia coli, Salmonella typhi and *paratyphi, Shigella dysenteriae, Helicobacter pylori, Vibrio cholerae, Haemophilus influenza, Neisseria gonorrhoeae, Mycobacterium tuberrculosis, Treponema pallidum.*

UNIT 4 Viral diseases (with reference to symptoms, pathogenesis, transmission, prophylaxis and control) **(Ch 33, 35-36, 38-39, 42-44 Brooks et al.) (15 periods)**

Polio, Chicken pox, Herpes, Hepatitis, Rabies, Influenza with brief description of bird and swine flu, Dengue, AIDS, Viral cancers. An overview of emerging viral diseases: Japanese Encephalitis, Ebola, Marburg, SARS, Hanta, Nipah, Chandipura, Chikungunya.

UNIT 5 Introduction to protozoan diseases (Ch 46 Brooks et al.) (3 periods) Malaria, Kala-azar, and Toxoplasmosis

Introduction to fungal diseases (Ch 46 Brooks et al.) (3 periods)

Different types of mycoses with particular reference to Dermatomycoses and Opportunistic mycoses

AntiMICROBial agents and drug resistance (Ch 10 Brooks et al.) (4 periods)

Mechanism of action of important chemotherapeutic agents. Principles of drug resistance in bacteria

PRACTICALS

1. To identify pathogenic bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus)* based on cultural, morphological and biochemical characteristics,

Cultural characteristics on nutrient agar and in nutrient broth, Gram characteristic, motility, presence of endospore and capsule, IMViC, TSI, sugar fermentation, nitrate reduction, urease production, oxidase and catalase tests.

2. To study composition and use of important differential media for identification of pathogenic bacteria EMB agar, McConkey agar, TCBS agar and Salmonella-Shigella agar (any two).

3. To perform antibacterial testing by Kirby-Bauer method.

4. To study symptoms of the diseases with the help of photographs Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis, kaposi's sarcoma), dermatomycoses (ring worms), kala-azar

SUGGESTED READINGS

1. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.

2. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

3. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.

4. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. Appleton-Centuary-Crofts publication.

5. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

SECOND SEMESTER

Course Code UMB 203: CHEMISTRY

UNIT I

Energy and the electromagnetic spectrum.

Units (wavelength, wavenumber, frequency) and energy of radiation.

UV-Visible spectroscopy.

Theory of electronic spectroscopy. Types of electronic transitions. Allowed and forbidden transitions. Solvent effects on electronic transitions. Beer and Lambert law. Molar absorptivity. Components of UV-Visible spectrophotometer. Application of electronic spectroscopy to conjugated dienes, and α,β-unsaturated carbonyl compounds. Woodward and Fieser rules.

Infrared spectroscopy.

Molecular vibrations, and calculation of vibrational frequencies. Factors affecting vibrational frequency, Vibrational coupling, hydrogen bonding, electronic effects and bond angles. Components of IR spectrophotometer. Interpretation of IR spectra of model organic compounds.

UNIT II

Electrochemistry.

The electrochemical cell. Galvanic and electrolytic cells. Electrode potential and its measurement. Nernst equation. Measurement of equilibrium constant by Nernst equation. Gibbs energy of the reaction. Conductance of electrolytic solutions. Measurement of conductivity of ionic solutions.

Molar conductivity. Kohlrausch law of independent migration of ions. Faraday laws of electrolysis.

UNIT III

Carbohydrates.

Classification and general properties of carbohydrates. Osazone formation with phenylhydrazine. Open chain and cyclic structures. Mutarotation. Ascending and descending of monosaccharides. Anomers and epimers. Determination of structure of glucose and fructose. Determination of ring size. Disaccharides and polysaccharides, and general ideas about the structure of sucrose, maltose, lactose, starch and cellulose.

UNIT IV

Amino acids.

Amino acids. General structures. Configuration of amino acids. The zwitter ion, isoelectric point and electrophoresis. Reactions of amino acids, acetylation, esterification and complexation. Ninhydrin test. Synthesis of amino acids by amination of α-haloacids, Gabriel synthesis and diethyl malonate synthesis.

UNIT V

Peptides and proteins.

The peptide bond. General idea about the structure of oxytocin. Primary, secondary, tertiary and quaternary structure of proteins. Determination of primary structure of proteins by N-terminal (Edmann degradation using 1-fluoro-2,4-dinitrobenzene, and phenylisothiocyanate) and C-terminal (hydrazinolysis) methods. Peptides (up to 3 amino acids) synthesis by N-protection and C-activation methods. Merrifield solid-phase synthesis.

PRACTICAL

1. Interpretation of bands in the pre-recorded standard IR spectra of model organic compounds.
2. Separation of mixture of amino acids (2 or 3 components) by paper chromatography.
3. Preparation of thin layer plates, and separation of organic compounds (coloured and colourless).
4. Preparation of chromatographic column and separation of carotenoids and chlorophyll from spinach.
5. Identification of glucose, fructose, sucrose, lactose and starch by standard chemical tests.
6. Determination of glucose by the Fehling reaction (titration and spectrophotometric methods). Demonstration on the application of glucometer.

Suggested reference materials

1. Organic Spectroscopy, W. Kemp, ELBS, Hampshire, UK.
2. Spectroscopic methods in Organic Chemistry, D.H. Williams and I. Fleming, Tata McGraw-Hill, New Delhi.
3. Organic Chemistry, R.T. Morrison and R.N. Boyd, Pearson Education, Delhi.
4. Organic Chemistry, P.Y. Bruice, Pearson Education, Delhi.
5. Essentials of Physical Chemistry, A. Bahl, B.S. Bahl and G.D. Tuli, S. Chand & Company Ltd, New Delhi.
6. Organic Chemistry, T.W.G. Solomons and C.B. Fryhle, Wiley India, New Delhi.

SECOND SEMESTER
Course Code UMBE 201: FUNDAMENTALS OF STATISTICS

THEORY **Total periods: 48**

UNIT I **(12 periods)**

Sets, Functions and their graphs: polynomial, sine, cosine, exponential and logarithmic functions, Motivation and illustration for these functions through projectile motion, simple pendulum, biological rhythms, cell division, muscular fibres etc. Simple observations about these functions like increasing, decreasing and, periodicity. Sequences to be introduced through the examples arising in Science beginning with finite sequences, followed by concepts of recursion and difference equations. For instance, the Fibonacci sequence arising from branching habit of trees and breeding habit of rabbits.

UNIT II **(10 periods)**

Intuitive idea of algebraic relationships and convergence, Infinite Geometric Series, Series formulas for ex, log (1+x), sin x, cos x. Step function. Intuitive idea of discontinuity, continuity and limits.

UNIT III **(8 periods)**

Differentiation. Conception to be motivated through simple concrete examples as given above from Biological and Physical Sciences. Use of methods of differentiation like Chain rule, Product rule and Quotient rule. Second order derivatives of above functions. Integration as reverse process of differentiation. Integrals of the functions introduced above.

UNIT IV **(8 periods)**

Points in plane and space and coordinate form. Examples of matrices inducing Dilation, Rotation, Reflection and System of linear equations. Examples of matrices arising in Physical, Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

UNIT V **(10 periods)**

Measures of central tendency. Measures of dispersion; skewness, kurtosis. Elementary Probability and basic laws. Discrete and Continuous Random variable, Mathematical Expectation, Mean and Variance of Binomial, Poisson and Normal distribution. Sample mean and Sampling variance. Hypothesis testing using standard normal variate. Curve Fitting. Correlation and Regression. Emphasis on examples from Biological Sciences.

SUGGESTED READINGS

1. H. S. Bear: Understanding Calculus, John Wiley and Sons (Second Edition); 2003.

2. E. Batschelet : Introduction to Mathematics for Life Scientists,Springer Verlag, International Student Edition, Narosa Publishing House, New Delhi (1971, 1975)

3. A. Edmondson and D. Druce : Advanced Biology Statistics, Oxford University Press; 1996.

4. W. Danial : Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc; 2004.

Note: It is desirable that softwares should be used for demonstrating visual, graphical and application oriented approaches.

SECOND SEMESTER
Course Code UMBE 202: RECOMBINANT DNA TECHNOLOGY

THEORY **Total Periods – 48**

UNIT I

Introduction to basic biotechnology (Ch 14 Willey) (2 periods)

Milestones in genetic engineering and biotechnology

Tools of recombinant DNA technology

A. Hosts (Ch 1 Clark, Ch 11 Primrose and Twyman) (2 periods)

E. coli strains; Yeast (*Saccharomyces cerevisiae, Pichia pastoris*); Fungi (*Penicillium, Aspergillus*); Mammalian cell lines - names and genotypes

B. Enzymes (Ch 4 Brown, Ch 3 Primrose and Twyman) (6 periods)

Restriction modification systems: Types I, II and III. Mode of action, nomenclature. Application of Type II restriction enzymes in genetic engineering. DNA modifying enzymes and their applications: Terminal deoxynucleotidyl transferase, kinases and phosphatases, DNA ligases and DNA polymerases, reverse transcriptases, bacteriophage RNA polymerases, exonuclease III, BAL31, mung bean nuclease, S1 nuclease

C. Vectors (Ch 2, 7 Brown, Ch 4, 5 Primrose and Twyman) (4 periods)

Cloning Vectors- Definition and Properties. Plasmid vectors-pBR and pUC series, Bacteriophage lambda and M13 based vectors. Cosmids. Shuttle vectors. BACs, YACs, MACs.

D. Mammalian Expression Vectors (Ch 5 Primrose and Twyman) (3 periods)

SV40, Vaccinia, Retroviral promoter based vectors

UNIT II

Basic DNA Cloning (Ch-5 Brown) (7 periods)

Simple cloning of DNA fragments, Vectors: Definition and properties. E. coli expression vectors-lac, tac and T7 promoter based vectors. Yeast expression vectors - pET yeast vectors, YIp, YEp and YCp vectors.

Baculovirus based vectors. Ti based vectors (Binary and Cointegrated vectors) and cloning using linkers and adaptors. Transformation of DNA by chemical method and electroporation

Methods of gene delivery in plants and animals (Ch 14 Primrose and Twyman) (1 period)

Microinjection, biolistic method (gene gun), liposome and viral-mediated delivery, Agrobacterium-mediated delivery.

UNIT III

Methods of DNA, RNA and Protein analysis and DNA typing

(Ch 3, 8 Clark, Ch 2 Primrose and Twyman) (9 periods)

Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot and colony hybridizations. Chromosome walking and jumping. DNA fingerprinting by RFLP and RAPD. Gel retardation assays. DNA footprinting by DNase I, DNA microarray analysis. SDS-PAGE and Western blotting. Phage display

Amplification of nucleic acids (Ch 9 Brown, Ch 2 Primrose and Twyman) (4 periods)

Polymerase chain reaction - enzymes used, primer design. Cloning PCR products. RT-PCR and principles of real time PCR. Ligation chain reaction

UNIT IV

Construction of Genomic and cDNA libraries

(Ch 8 Brown, Ch 6 Primrose and Twyman) (3 periods)

Genomic and cDNA libraries: Preparation and uses. Screening of libraries by colony hybridization and colony, PCR

DNA sequencing and synthesis (Ch 10 Brown, Ch 4,8 Clark) (3 periods)

Maxam-Gilbert's and Sanger's method. Automated sequencing. Human genome sequencing project

UNIT V

Product of DNA technology (Ch 14-15 Brown, Ch 26 Primrose and Twyman) (4 periods)

Human protein replacements-insulin, hGH and Factor VIII. Human therapies - tPA, interferon, antisense molecules. Bt transgenics-rice, cotton, brinjal, Analysis of biological processes, DNA typing, gene therapy, commercial products.

PRACTICLAS

1. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis.
2. Ligation of DNA fragments.
3. Demonstration of PCR.
4. Interpretation of sequencing gel electropherograms.

SUGGESTED READINGS

1. Alcamo IE. (2001). DNA Technology: The Awesome Skill. 2nd edition. Elsevier Academic Press, USA.
2. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
3. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic Revolution. Elsevier Academic Press, USA.
4. Glick BR and Pasternak JJ. (2003). Molecular Biotechnology. 3rd edition. ASM Press Washington D.C.
5. Nigam A and Ayyagari A. (2007). Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill, India.
6. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
7. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008) Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

THIRD SEMESTER
Course Code UMB 301:VIROLOGY

THEORY **Total Periods: 47**

UNIT I Introduction (Ch 1 Flint, Ch 1 Wagner and Hewlett) (6 periods)

Discovery of viruses, nature and definition of viruses, general properties of viruses. Concept of viroids, virusoids, satellite viruses and prions. Theories of viral origin.

Structure of viruses: Capsid symmetry, enveloped and non-enveloped viruses

(Ch 3 Carter and Saunders, Ch 3 Dimmock et al., Ch 4 Flint) (3 periods)

UNIT II

Isolation, purification and cultivation of viruses. (Ch 11 Wagner and Hewlett) (2 periods)

Classification and nomenclature of different groups of viruses infecting microbes, plants and animals. **(Ch 3, 10 Carter and Saunders, Appendices Dimmock et al.) (6 periods)**

UNIT III

Salient features of viral genome: (Ch 4, Dimmock and Primrose, Appendix Flint) (5 periods)

Unusual bases (TMV, T4 phage), overlapping genes (ΦX174, Hepatitis B virus), alternate splicing (Picornavirus), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), ambisense genomes (arenavirus), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (influenza virus) and non segmented genomes (picornavirus), capping and tailing (TMV).

UNIT IV

Bacteriophages (Ch 5, 9, 15 Dimmock et al, Ch 19 Carter and Saunders) (6 periods)

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda and P1 phage), concept of early and late proteins, regulation of transcription in lambda phage and applications of bacteriophages.

UNIT V

Viral multiplication and replication strategies (Ch 5,6, 7, 8, 9, 10 Dimmock et al) (8 periods)

Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification. Assembly, maturation and release of virions. Concept of defective particles.

Transmission of viruses. (Ch 4 Carter and Saunders, Ch 11 Mathews) (2 periods)

Oncogenic viruses (Ch 20 Dimmock et al., Ch 18 Flint) (3 periods)

Types of oncogenic DNA and RNA viruses. Concepts of oncogenes, protoncogenes and tumor suppressor genes.

Prevention and control of viral diseases (Ch 21 Dimmock et al, Ch 19 Flint) (5 periods)

Antiviral compounds, interferons and viral vaccines.

Applications of Virology (Ch 23 Dimmock et al, Ch 22 Wagner) (1 period)

Use of viral vectors in cloning and expression, Gene therapy and Phage display

PRACTICALS

1. To study structure of important animal viruses (rhabdo, influenza, paramyxo, Hepatitis B & retroviruses) using electron micrographs

2. To study structure of important plant viruses (caulimo, gemini, tobacco ring spot, cucumber mosaic & alpha-alpha mosaic viruses) using electron micrographs
3. To study structure of important bacterial viruses (λ, T4 & φX174) using electron micrographs.
4. Isolation and enumeration of bacteriophages from water/sewage sample using double agar layer technique
5. Isolation and propagation of animal viruses by cell culture and chick embryo techniques
6. Study of cytopathic effects using photographs
7. To perform local lesion technique for assaying plant viruses

SUGGESTED READINGS

1. Dimmock NJ, and Primrose SB. (1994). Introduction to Modern Virology. 4th edition. Blackwell Science Ltd.
2. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition (First Indian reprint 2007), Blackwell Publishing Ltd.
3. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
4. Flint SJ, Enquist, LW, Krug, RM, Racaniello, VR, Skalka, AM (2004). Principles of Virology, Molecular biology, Pathogenesis and Control. 2nd edition. ASM press Washington DC.
5. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
6. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
7. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
8. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
9. Bos L. 1999 Plant viruses-A text book of plant virology by. Backhuys Publishers.
10. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

THIRD SEMESTER

Course Code UMB 302: PHYCOLOGY & MYCOLOGY

THEORY **Total Periods: 48**

Section A: Phycology

UNIT I

Classification of Algae **(Ch 1 Kumar, Ch 2 Sharma) (2 periods)**

Study of the following classes with reference to genera listed below (occurrence, thallus organization and life cycles):

a) Chlorophyceae: Volvox, Coleochaete (Ch 12 Kumar, Ch 9 Sharma) (3 periods)

b) Charophyceae: Chara (Ch 12 Kumar, Ch 9 Sharma) (3 periods)

c) Diatoms: General features with reference to pinnate and centric diatoms (Ch 7 Kumar, Ch 11 Sharma) (3 periods)

d) Xanthophyceae: Vaucheria (Ch 10 Kumar, Ch 10 Sharma) (2 periods)

e) Phaeophyceae: Ectocarpus (Ch 11 Kumar, Ch 12 Sharma) (3 periods)

f) Rhodophyceae: Polysiphonia (Ch 4 Kumar, Ch 13 Sharma) (3 periods)

g) Cyanobacteria: Nostoc (Ch 3 Kumar, Ch 8 Sharma) (2 periods)

UNIT II

Applications of algae (Ch 14 Kumar) (3 periods)

Application of algae in agriculture, biofertilizer, Industrial application of algae, medicinal importance, Nutritional value, environmental implications, algal blooms

Section B: Mycology

UNIT III

Classification of fungi (Ch 3 Alexopoulos et al., Ch 1 Sumbali) (2 periods)

Recent advances in fungal classification, General Characteristics, Ultrastructure, Physiology and Reproduction.

UNIT IV

Study of the following classes with reference to the genera listed below (occurrence, somatic structure and life cycles):

a) Cellular slime molds - *Dictyostelium* **(Ch 27 Alexopoulos et al.) (1 period)**

b) True slime molds (Myxomycetes) – *Physarum* **(Ch 29 Alexopoulos et al.) (1 period)**

c) Oomycetes - *Saprolegnia*, *Phytophthora* **(Ch 23 Alexopoulos et al) (3 periods)**

d) Chytridiomycetes – *Neocallimastix* **(Ch 4 Alexopoulos et al.) (1 period)**

e) Zygomycetes – *Mucor* **(Ch 5 Alexopoulos et al.) (1 period)**

f) Ascomycetes - *Saccharomyces*, *Penicillium*, *Neurospora*

(**Ch 10 -12 Alexopoulos et al.) (3 periods)**

g) Basidiomycetes – *Agaricus* **(Ch 17 Alexopoulos et al.) (2 periods)**

h) Deuteromycetes - *Candida*, *Alternaria* **(Ch 8 Alexopoulos et al.) (2 periods)**

UNIT V

Economic importance of fungi with examples

In Agriculture, Environment, Industry, Medicine, Food, Biodeterioration (of wood, paper, textile, leather), Mycotoxins **(Ch 1 Alexopoulos et al., Ch 5 Sumbali) (6 periods)**

Lichens: classification, physiology and importance.

(Ch 13 Alexopoulos et al., Ch 5 Sumbali) (2 periods)

PRACTICALS

Section A - Phycology

1. Study of the following genera through temporary and permanent slides:

1. *Volvox, Coleochaete, Vaucheria, Ectocarpus, Polysiphonia and Nostoc*
2. Section B - Mycology
3. Preparation of Potato Dextrose Medium
4. Study of the vegetative and reproductive structures of following genera through temporary and permanent slides: *Mucor, Saccharomyces, Penicillium, Agaricus and Alternaria*

SUGGESTED READINGS

Section A - Phycology

1. Barasanti L and Guaaltieri P. (2006). Algae: Anatomy Biochemistry and Biotechnology. Taylor and Francis Group, New York.

2. Graham LE, Graham JM and Wilcox LW. (2009). Algae. 2nd edition. Benjamin Cumming, New York.

3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Kumar HD. (1995). The Text Book on Algae. 4th edition. Affiliated East Western Press.
5. Lee RE. (1999). Phycology. 4th edition. Cambridge Press.
6. Sharma OP. (2005). Textbook of Algae. Tata McGraw Hill Publishing Co. Ltd.
7. Vashishta BR. (2005). Algae. 3rd edition. S. Chand and Company Ltd., New Delhi.

Section B - Mycology

1. Alexopoulos CJ, Mims CW and Blackwell M. (1996). Introductory Mycology. 4th edition. John Wiley and Sons, Inc.
2. DUMBE HC. (1981). An Introduction to Fungi. Vikas Publishing House Pvt. Ltd.
3. Sumbali G. (2005). The Fungi. 1st edition. Narosa Publishing India House.
4. Vashishta BR and Sinha AK. (2008). Fungi. S. Chand and Company Ltd.
5. Webster J. (1980). Introduction to Fungi. 2nd edition. Cambridge University Press.

THIRD SEMESTER
Course Code UMB 303: CELL BIOLOGY-I

THEORY **Total periods: 44**

UNIT I. An Overview of Cells (Ch 1 Cooper et al./ Ch 1 Karp) (6 periods)

Overview of prokaryotic and eukaryotic cells, cell size and shape, Phages, Viriods, Mycoplasma and *Escherichia coli*. Chemical foundations: atomic bonds and molecular interactions, chemical building blocks of cells. Chemical equilibrium, equilibrium constants, dissociation constants, maintenance of pH and ionic balance.

UNIT II. Tools and techniques of Cell Biology (10 periods)
(Ch 1 Cooper et al./ Ch 18 Karp/ Ch 3 De Robertis)

Microscopic-Principles of Light microscopy; Phase contrast microscopy; Confocal microscopy;Electron microscopy (EM)- scanning EM and scanning transmission EM (STEM); Fluorescence microscopy; Analytical-Flow cytometry- flurochromes, fluorescent probe and working principle; Spectrophotometry; Mass spectrometry; X-ray diffraction analysis.

Separation-Sub-cellular fractionation- differential and density gradient centrifugation; Chromatographypaper, thin-layer, gel-filtration, ion-exchange, affinity and High-Performance Liquid Chromatography (HPLC).

UNIT III. Composition of Cells (Ch 2 Cooper et al.) (8 periods)

Molecules of cell, cell membranes and cell Proteins.

The Nucleus (Ch 9 Cooper et al.)

Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Transport across Nuclear Envelope, Chromatin: molecular organization, Nucleolus and rRNA Processing.

Protein Sorting and Transport (Ch 10 Cooper et al.)

The Endoplasmic reticulum, The Golgi Apparatus, Mechanism of Vesicular Transport, Lysosomes.

UNIT IV. Mitochondria, Chloroplasts and Peroxisomes (Ch 11 Cooper et al.) (10 periods)

Structural organization, Function, Marker enzymes,Mitochondrial biogenesis, Protein import in mitochondria, Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisomes'assembly

UNIT V. Cytoskelton and Cell Movement (Ch 12 Cooper et al.) (10 periods)

Structure and organization of actin filaments; the dynamics of actin assembly actin, myosin and cell movement; intermediate filaments; microtubules. Kinesin and Dynein powered movements, microtubule dynamics and motor proteins in mitosis.

PRACTICALS

1. Separation of nucleic acid bases by paper chromatography.
2. Microscopy- Theoretical knowledge of Light and Electron microscope.
3. Study of the following techniques through electron / photo micrographs: Fluorescence microscopy,

autoradiography, positive staining, negative staining, freeze fracture, freeze etching, shadow casting.

4. Study of structure of cell organelles through electron micrographs.

Permanent slide preparation:

5. Cytochemical staining of DNA-Feulgen.
6. Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP).
7. Cytochemical staining of Polysaccharides-Periodic Acid Schiff's (PAS).
8. Cytochemical staining of Total proteins- Bromophenol blue.
9. Cytochemical staining of Histones -Fast Green.

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

THIRD SEMESTER
Course Code UMBE 301: MOLECULAR BIOLOGY-I

THEORY **Total periods: 42**

UNIT I.

Nucleic Acids convey Genetic Information (Ch 2 Watson) (6 periods)

DNA as the carrier of genetic information, Key experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics.

UNIT II

.The Structures of DNA and RNA / Genetic Material (10 periods)

(Ch 6 Watson/ Ch 18 Becker)

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNAProkaryotes, Viruses, Eukaryotes. RNA Structure Organelle DNA -- mitochondria and chloroplast DNA.

UNIT III

I. Genome Structure, Chromatin and the Nucleosome (8 periods)

(Ch 7 Watson/ Ch 18 Becker)

Genome Sequence and Chromosome Diversity, Chromosome Duplication and Segregation, The Nucleosome Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin. Regulation of Chromatin Structure and Nucleosome Assembly. Organization of Chromosomes

UNIT IV

The Replication of DNA (Prokaryotes and Eukaryotes) (10 periods)

(Ch 8 Watson/ Ch 19 Becker)

Chemistry of DNA synthesis, general principles - bidirectional replication, Semiconservative, Semi discontinuous, RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication, replication of linear ds-DNA, replicating the 5'end of linear chromosome. Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins

UNIT V. The Mutability and Repair of DNA (8 periods)

(Ch 9 Watson)

Definitions, Mutation, muton, replicon, principles of mutation, Replication Errors, DNA Damage, different types of mutations, deletions, duplications, UV induced mutations, repair mechanisms against mutations and their importance.

PRACTICALS

1. Preparation of Polytene chromosome from Chironomous larva/Drosophila larva
2. Demonstration of mammalian sex chromatin.
3. Preparations of temporary mount and study the different stages of Mitosis (Onion root tip).

4. Perform Southern Blot Hybridization (Restrict DNA for Southern Blot electrophoresis, perform electrophoresis of restricted DNA, perform southern transfer, hybridization and detection of gene of interest)
5. Demonstration of Northern Blotting.
6. Demonstration of Western Blotting.
7. Perform DNA amplification by PCR.
8. Study of semiconservative replication of DNA through micrographs/schematic representations.

SUGGESTED BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

THIRD SEMESTER
Course Code UMBE 302: BIOANALYTICAL TECHNIQUES

UNIT I

Instruments, basic principles and usage: pH meter, absorption and emission spectroscopy, Principle and law of absorption, fluorimetry, colorimetry,

UNIT II

Instruments, basic principles and usage: Spectrophotometry (visible, UV, infra-red), polarography, centrifugation, atomic absorption, NMR, X-ray crystallography.

UNIT III

Chromatography techniques: Paper chromatography, thin layer chromatography, column chromatography, gas chromatography, gel filtration and ion exchange chromatography,

UNIT IV

Electrophoresis: SDS polyacrylamide electrophoresis, immunoelectrophoresis, Isoelectric focusing. MALDI-TOF, ESI

UNIT V

Radioisotope tracer techniques and autoradiography

Suggested reading

• Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
• Bioinstrumentation, Webster
• Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
• Crystal Structure Analysis, J.P. Glusker and K.N. Trueblood, Oxford University Press
• Modern Spectroscopy, J.M. Hollas, John Wiley and Son Ltd.
• NMR Spectroscopy: Basic Principles, Concepts and Applications in Chemistry, H. Gunther, John Wiley and Sons Ltd.
• Principles of Physical Biochemistry, K.E. Van Holde, Prentice Hall.
• Principles and Practice of Bioanalysis, Richard F. Venn
• Microscopic Techniques in Biotechnology, Michael Hoppert
• Principles of Fermentation Technology, P.F. Stanbury, A. Whitaker, S.J. Hall

FOURTH SEMESTER

Course Code UMB 401: MICROBIAL PHYSIOLOGY AND METABOLISM

THEORY **Total Periods – 58**

UNIT I

Nutritional classification of microorganisms based on carbon, energy and electron sources **(Ch 1 Gottschalk, Ch 5 Willey et al.) (1 Period)**

Metabolite Transport **(Ch 5 Gottschalk, Ch 9 Moat et al.) (6 Periods)**

Diffusion: Passive and facilitated, Primary active and secondary active transport, Group translocation (phosphotransferase system), symport, antiport and uniport, electrogenic and electro neutral transport, transport of Iron.

MICROBIAL Growth **(Ch 7 Stanier et al., Ch 6 Willey et al.) (10Periods)**

Definition of growth, balanced and unbalanced growth, growth curve, the mathematics of growth-generation time, specific growth rate, batch and continuous culture, synchronous growth, diauxie growth curve.

Effect of the environment on MICROBIAL growth **(Ch 18 Moat & Foster, Ch 8 Stanier et al., Ch 6 Willey et al.) (7 Periods)**

Temperature- temperature ranges for MICROBIAL growth, classification based on temperature ranges and adaptations, pH-classification based on pH ranges and adaptations, solutes and water activity, oxygen concentration, radiation and pressure.

UNIT II

Chemolithotrophic metabolism **(Ch 8 & 9 Gottschalk, Ch 12, 17 Madigan et al.) (2 Periods)**

Physiological groups of aerobic and anaerobic chemolithotrophs. Hydrogenoxidizing bacteria and methanogens. Phototrophic metabolism **(Ch 9 Gottschalk) (8 periods)**

Historical account of photosynthesis, diversity of phototrophic bacteria, anoxygenic and oxygenic photosynthesis, photosynthetic pigments: action and absorption spectrum, type, structure and location, physiology of bacterial photosynthesis: light reactions, cyclic and non-cyclic photophosphorylation. Calvin cycle and reductive TCA cycle.

UNIT III

Enzymes and their regulation

(Ch 7 Conn & Stumpf, Ch 7 Gottschalk, Ch 8-9 Lehninger, Ch 8-9, 16 Stryer) (8 periods)

Importance, structure and classification of enzymes. Apoenzyme and cofactors. Mechanism of enzyme action. Activation energy, Lock and key hypothesis, induced fit. Enzyme kinetics and inhibition. Substrate saturation curve, Michaelis-Menten kinetics, Irreversible and reversible inhibition: competitive and non-competitive inhibition. Enzyme regulation. Synthesis: introduction of enzyme induction and repression. Activity: allostery, covalent modification and feedback inhibition.

UNIT IV

MICROBIAL ENERGETICS

(Ch 5 Atlas, Ch 2, 4, 5, 8 Gottschalk, Ch 16, 17, 19 Lehninger) (8 periods)

Concept of aerobic respiration, anaerobic respiration and fermentation. Central metabolic pathways: EMP pathway, ED pathway, PP pathway, and TCA cycle. Components of respiratory chain, and their inhibitors. Oxidative phosphorylation: ATP synthesis and ATP synthase. Uncouplers, inhibitors and ionophores. Chemical coupling, conformational coupling and chemiosmotic hypotheses.

UNIT V

Nitrogen Fixation (Ch 10 Gottschalk) (8 periods)

Physiology of nitrogen cycle. Assimilatory and dissimilatory nitrate reduction, biological nitrogen fixation. Nitrogen fixers and mechanism of nitrogen fixation, properties of nitrogenase, and ammonia assimilation. Genetics of nitrogen fixation and regulation of nitrogenase activity and synthesis. Alternate nitrogenase.

PRACTICALS

1. To study and plot the growth curve of *E coli* using turbidometric method and to calculate specific growth rate and generation time.
2. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
3. To study the effect of pH on the growth of *E. coli*
4. To study the effect of temperature of *Aspergillus niger* by dry weight method.
5. Demonstration of the thermal death time and decimal reduction time of *E. coli*.

SUGGESTED READINGS

1. Devlin RM. (1975). Plant Physiology. 3rd edition, Willard Grant Press.
2. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
3. Madigan MT, Martinko JM and Parker J. (2003). Brock Biology of Microorganisms. 10th edition. Pearson/Benjamin Cummings.
4. Moat AG and Foster JW. (2002). MICROBIAL Physiology. 4th edition. John Wiley & Sons.
5. Reddy SR and Reddy SM. (2005). MICROBIAL Physiology. Scientific Publishers India.
6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
7. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
8 Atlas RM. (1989). Microbiology: Fundamentals and Applications. 2nd Edition, MacMillan Publishing Company, New York.
9. Conn EE and Stumpf PK. (1976). Outlines of Biochemistry. John Wiley & Sons.
10. Gallon JR and Chaplin AE. (1987). An Introduction to Nitrogen Fixation. Cassell Education Ltd.
11. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag.
12. Lehninger A. (1982). Biochemistry. Worth Publ.
13. Moat AG and Foster JW. (2002). MICROBIAL Physiology. John Wiley and Sons.
15. Stryer L. (1988). Biochemistry. Freeman & Co. NewYork.

FOURTH SEMESTER
Course Code UMB-402: GENETICS AND GENOMICS-I

THEORY **Total periods: 42**

UNIT I

Introduction to Genetics (Ch 1 Klug and Cummings) (10 periods)

Definition: gene, genome, trait, genetic material, genetic maps, genotype, phenotype. Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. Mitosis and Meiosis **(Ch 2 Klug and Cummings)**

Interrelation between the cell structure and the genetics function, Mitosis, Meiosis (explaining Mendel's ratios).

UNIT II

The structure of genetic material **(Ch 10, 11, 12 Russel) (10 periods)**

The nature of the genetic material, Discovery of DNA and RNA as genetic material, the chemical composition of DNA and RNA, Organization of DNA in chromosomes, Structural characteristics of bacterial and viral chromosomes, DNA replication in prokaryotes and Eukaryotes.

UNIT III

Mendelian Genetics and its Extension (Ch 3-4 Klug and Cummings) (5 periods)

Principles of Inheritance, Chromosome theory of inheritance, Laws of Probability, Pedigree analysis, Incomplete and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Environmental effects on phenotypic expression, sex linked inheritance.

Linkage, Crossing Over and Chromosomal Mapping (5 periods) (Ch 5 Klug and Cummings, Ch 7, Gardner)

Linkage and crossing over, Cytological basis of crossing over, Molecular mechanism of crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics – an alternative approach to gene mapping.

UNIT IV Mutations (Ch 8 Klug and Cummings/ Ch 11 Gardner) (6 periods)

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy. Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations, Molecular basis of Mutations in relation to UV light and chemical mutagens, Detection of mutations: CLB method, Attached X method, DNA repair mechanisms.

UNIT V. Extrachromosomal Inheritance (6 periods) (Ch 9 Klug and Cummings/ Ch 20 Gardner)

Chloroplast mutation/Variegation in Four o' clock plant and Chlymodomonas, Mitochondrial mutations in Neurospora and yeast, Maternal effects, Infective heredity- Kappa particles in Paramecium.

Quantitative Genetics (Ch 25 Klug and Cummings/ Ch 21, Gardner)

Quantitative and multifactor inheritance, Transgressive variations, Heterosis.

PRACTICALS

1. Mendelian laws and gene interaction using Drosophila crosses.

2. Chi-square and probability.
3. Study of Linkage, recombination, gene mapping using marker based data from Drosophila.
4. Study of Human and Phlox/ Allium Karyotype (normal and abnormal).
5. Pedigree analysis of some human inherited traits.
6. Study of Hardy-Weinberg Law using simulations (seeds).

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). VIII ed. Principles of Genetics. Wiley India.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. XI Edition. Benjamin Cummings.
4. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
7. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.

ADDITIONAL READINGS

Both students as well as teachers of genetics can further benefit from knowledge of following topics as given below-

- **Epigenetics-** http://www.nature.com/nrg/focus/epigenetics/index.html
- **Tetrad Analysis in fungi**
- **Centromere Mapping**
- **Cytogenetic Mapping**

FOURTH SEMESTER
Course Code UMB 403: CELL BIOLOGY-II

THEORY **Total periods: 44**

UNIT I

The Plasma Membrane **(Ch 13 Cooper et al.) (10 periods)**

Structure; Lipid composition and structural organization, classes of lipids, protein interaction within the membranes, trans-membrane proteins and glycolipids. Transport of small molecules, Endocytosis

Cell Wall, **the Extracellular Matrix and Cell Interactions** **(Ch 14 Cooper et al.)**

Bacterial and Eukaryotic Cell Wall; the extracellular matrix and cell matrix interactions; cell-cell interactions.

UNIT II

Cell Signaling **(Ch 15 Cooper et al.) (8 periods)**

Signaling at the cell surface, Signaling molecules and their receptor; receptor proteins, ligand binding and effector specificity, functions of cell surface receptors; Intracellular signal

transduction pathway; signaling networks, conserved intracellular protein functions in signal transduction, appropriate cellular responses.

UNIT III

The Cell Cycle (Ch 16 Cooper et al.) (8 periods)

Eukaryotic Cell Cycle-overview of the cell cycle and its control, Regulation of Cell cycle progression, diverse experimental systems for regulation of cell cycle, Events of Mitotic Phase, Meiosis, Biochemical studies with oocytes, eggs and early embryos.

UNIT IV

Cell Death and Cell Renewal (Ch 17 Cooper et al.) (8 periods)

The birth of cells, cell type specification in yeast, regulation of asymmetric cell division, specification and differentiation of muscles, Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning.

UNIT V

Cancer (Ch 18 Cooper et al.) (10 periods)

Tumor cells and the onset of cancer, Development and Causes of Cancer, the genetic basis of cancer, Oncogenic mutations in growth promoting proteins, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment- molecular approach.

PRACTICALS

1. To demonstrate the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B.
2. Study of polyploidy in Onion root tip by colchicine treatment.
3. Preparations of temporary mount of Grasshopper testis / onion flower bud anthers and study the different stages of Meiosis.
4. Study of mitosis and meiosis from permanent slides.
5. Identification and study of cancer cells- Slides/Photomicrographs.

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

FOURTH SEMESTER
Course Code UMBE 401: MOLECULAR BIOLOGY-II

THEORY **Total periods: 40**

UNIT I.

Mechanism of Transcription (Ch 12 Watson/ Ch 21 Becker) (8 periods)

RNA Polymerase and the transcription unit, Transcription in Prokaryotes, Transcription in Eukaryotes

RNA Modifications (Ch 13 Watson)

Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport.

UNIT II.

Translation (Prokaryotes and Eukaryotes) (8 periods)

(Ch 14 Watson/ Ch 22 Becker/ Ch 21 DeRobertis)

Assembly line of polypeptide synthesis - ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis. Regulation of translation Translation-dependent regulation of mRNA and Protein Stability.

UNIT III

Transcription Regulation in Prokaryotes (Ch 16 Watson) (10 periods)

Transcription Regulation in Prokaryotes: Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, regulation of transcription termination.

UNIT IV

Transcription Regulation in Eukaryotes (Ch 17 Watson) (8 periods)

Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing

UNIT V

Regulatory RNAs (Ch 18 Watson) (8 periods)

Transcription Regulation in Eukaryotes & Regulatory RNAs: Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and Xinactivation

PRACTICALS

1. Preparation of culture medium (LB) for E.coli (both solid and liquid) and raise culture of *E.coli.*
2. Demonstration of antibiotic resistance. (Culture of E.coli containing plasmid (pUC 18/19) in LB medium with/without antibiotic pressure and interpretation of results).
3. Isolation and quantitative estimation of salmon sperm / calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement).
4. To perform Ames test in Salmonella / E.coli to study mutagenicity.

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

FOURTH SEMESTER
Course Code UMBE 402: IMMUNOLOGY

THEORY **Total Periods: 45**

UNIT I **Introduction (Ch 1 Goldsby et al.) (3 periods)**

Concept of Innate and Adaptive immunity; Contributions of following scientists to the development of field of immunology - Edward Jenner, Karl Landsteiner, Robert Koch, Paul Ehrlich, Elie Metchnikoff, Peter Medawar, MacFarlane Burnet, Neils K Jerne, Rodney Porter and Susumu Tonegawa.

UNIT II **Immune Cells and Organs (Ch 2 Goldsby et al.) (6 periods)**

Structure, Functions and Properties of: Immune Cells – Stem cell, T cell, B cell, NK cell, Macrophage, Neutrophil, Eosinophil, Basophil, Mast cell, Dendritic cell; and Immune Organs – Bone Marrow, Thymus, Lymph Node, Spleen, GALT, MALT, CALT

Antigens **(Ch 4 Goldsby et al.) (3 periods)**

Characteristics of an antigen (Foreignness, Molecular size and Heterogeneity); Haptens; Epitopes (T & B cell epitopes); T-dependent and T-independent antigens; Adjuvants

Antibodies **(Ch 4, 5 Goldsby et al.) (6 periods)**

Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies (Isotypic,
allotypic, idiotypic); VDJ rearrangements; Monoclonal and Chimeric antibodies

UNIT III Major Histocompatibility Complex (Ch 8 Goldsby et al.) (5 periods)

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; Antigen processing and presentation (Cytosolic and Endocytic pathways)

Complement System **(Ch 7 Goldsby et al.) (3 periods)**

Components of the Complement system; Activation pathways (Classical, Alternative and Lectin pathways); Biological consequences of complement activation

UNIT IV Generation of Immune Response (Ch 10-11, 14 Goldsby et al.) (7 periods)

Primary and Secondary Immune Response; Generation of Humoral Immune Response (Plasma and Memory cells); Generation of Cell Mediated Immune Response (Self MHC restriction, T cell activation, Costimulatory signals); Killing Mechanisms by CTL and NK cells, Introduction to tolerance.

UNIT V Immunological Disorders and Tumor Immunity

(Ch 15-16, 20, 21 Goldsby et al.) (6 periods)

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice), SCID, DiGeorge syndrome, Chediak- Higashi syndrome, Leukocyte adhesion deficiency, CGD; Characteristics of tumor antigens.

Immunological Techniques **(Ch 6 Goldsby et al.) (6 periods)**

Principles of Precipitation, Agglutination, Immunodiffusion, Immunoelectrophoresis, ELISA, ELISPOT, Western blotting, Immunofluoresence, Flow cytometry, Immunoelectron microscopy, RIST, RAST, MLR.

PRACTICALS

1. Identification of human blood groups.
2. To perform Total Leukocyte Count of the given blood sample.
3. To perform Differential Leukocyte Count of the given blood sample.
4. To separate serum from the blood sample (demonstration).
5. To perform immunodiffusion by Ouchterlony method.
6. To perform DOT ELISA.
7. To perform immunoelectrophoresis.

SUGGESTED READINGS

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11th edition Wiley- Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W.H. Freeman and Company, New York.
4. Murphy K, Travers P, Walport M. (2008). Janeway's Immunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology. 6th edition. Wiley Blackwell Publication edition, Elsevier Science Ltd.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology

FIFTH SEMESTER
Course Code UMB 501: FOOD AND DAIRY MICROBIOLOGY

THEORY **Total Periods – 50**

UNIT I

Foods as a substrate for microorganisms **(Ch 3 Jay et al.) (6 periods)**

Intrinsic and extrinsic factors that affect growth and survival of MICROBes in foods, natural flora and source of contamination of foods in general MICROBIAL spoilage of various foods **(Ch 11, 13-14, 16, 18-19 Frazier and Westhoff) (8 periods)**

Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned foods

UNIT II

Principles and methods of food preservation **(Ch 13-19 Jay et al.) (10 periods)**

Principles, physical methods of food preservation: temperature (low, high, canning, drying), irradiation, hydrostatic pressure, high voltage pulse, microwave processing and aseptic packaging, chemical methods of food preservation: salt, sugar, organic acids, SO2, nitrite and nitrates, ethylene oxide, antibiotics and bacteriocins.

UNIT III

Fermented foods **(Ch 7-8 Jay et al.) (10 periods)**

Dairy starter cultures, fermented dairy products: yogurt, acidophilus milk, kumiss, kefir, dahi and cheese, other fermented foods: dosa, sauerkraut, soy sauce and tampeh and probiotics.

UNIT IV

Food borne diseases (causative agents, foods involved, symptoms and preventive measures) **(Ch 23–28, 30 Jay et al.) (8 periods)**

Food intoxications: *Staphylococcus aureus*, *Clostridium botulinum* and mycotoxins; Food infections: *Bacillus cereus*, *Vibrio parahaemolyticus*, *Escherichia coli*, *Salmonellosis*, *Shigellosis*, *Yersinia enterocolitica*, *Listeria monocytogenes* and *Campylobacter jejuni*

UNIT V

Food sanitation and control **(Ch 20-21 Jay et al.) (3 periods)**

HACCP, Indices of food sanitary quality and sanitizers

Water Potability **(Ch 27 Tortora et al.) (5 periods)**

Treatment and safety of drinking (potable) water, methods to detect potability of water samples: (a) standard qualitative procedure: presumptive test/MPN test, confirmed and completed tests for faecal coliforms (b) Membrane filter technique and (c) Presence/absence tests.

PRACTICALS

1. MBRT of milk samples and their standard plate count.
2. Alkaline phosphatase test to check the efficiency of pasteurization of milk.
3. Isolation of any pathogenic bacteria (Staphylococcus or Salmonella) from food products.

4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.
7. Determination of potability and faecal contamination of water samples by presumptive test/MPN test, confirmed and completed tests.

SUGGESTED READINGS

1. Adams MR and Moss MO. (1995). Food Microbiology. 4th edition, New Age International (P) Limited Publishers, New Delhi, India.
2. Banwart JM. (1987). Basic Food Microbiology. 1st edition. CBS Publishers and Distributors, Delhi, India.
3. Davidson PM and Brannen AL. (1993). AntiMICROBIALs in Foods. Marcel Dekker, New York.
4. Dillion VM and Board RG. (1996). Natural AntiMICROBIAL Systems and Food Preservation. CAB International, Wallingford, Oxon.
5. Frazier WC and Westhoff DC. (1992). Food Microbiology. 3rd edition. Tata McGraw-Hill Publishing Company Ltd, New Delhi, India.
6. Gould GW. (1995). New Methods of Food Preservation. Blackie Academic and Professional, London.
7. Jay JM, Loessner MJ and Golden DA. (2005). Modern Food Microbiology. 7th edition, CBS Publishers and Distributors, Delhi, India.
8. Lund BM, Baird Parker AC, and Gould GW. (2000). The MICROBiological Safety and Quality of Foods. Vol. 1-2, ASPEN Publication, Gaithersberg, MD.
9. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

FIFTH SEMESTER

Course Code UMB 502: MICROBIAL ECOLOGY

THEORY **Total periods - 48**

UNIT I

History, significance and developments in the field of MICROBIAL ecology

(Ch 1 Atlas and Bartha) (2 periods)

Contributions of Beijerinck, Winogradsky, Kluyver, Van Niel, Martin Alexander, Selman A. Waksman, Environmental chemistry, Atmosphereic pollutants, Types of wastes, The Atmosphere, Organization of life, Ecosystems.

UNIT II

Microorganisms & their natural habitats (Ch 9 Atlas and Bartha)

A. Terrestrial Environment: Soil characteristics, Soil profile, Soil formation, Soil as a natural habitat of microbes, Soil microflora **(3 periods)**

B. Aquatic Environment: Stratification & Microflora of Freshwater & Marine habitats **(3 periods)**

C. Atmosphere: Stratification of the Atmosphere, Aeromicroflora, Dispersal of microbes.

(2 periods)

D. Animal Environment: Microbes in/on human body (Microbiomics) & animal (ruminants) body.

(3 periods)

E. Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels. **(4 periods)**

UNIT III

Succession of microbial communities in the decomposition of plant organic matter

(Ch 6 Atlas and Bartha) (2 periods)

Biological Interactions (Ch 3-5 Atlas and Bartha)

A. Microbe–Microbe Interactions (3 periods)

Mutualism, Synergism, Commensalism, Competition, Amensalism, Parasitism, Predation, Biocontrol agents

B. Microbe–Plant Interactions (3 periods)

Roots, Aerial Plant surfaces, Biological Nitrogen fixation (symbiotic/nonsymbiotic - biofertilizers)

C. Microbe–Animal Interactions (2 periods)

Role of Microbes in Ruminants, Nematophagus fungi, Luminescent bacteria as symbiont

UNIT IV

Biogeochemical cycles an introduction (Ch 10, 11 Atlas and Bartha)

Carbon cycle: (3 periods)

Microbial degradation of polysaccharide (cellulose, hemicellulose, lignin, chitin)

Nitrogen cycle: (3 periods)

Ammonification, nitrification, denitrification & nitrate reduction. Nitrate pollution.

Phosphorous cycle: (1 period)

Phosphate immobilization and phosphate solubilization

Sulphur Cycle: (1 period)

Microbes involved in sulphur cycle

UNIT V

Solid Waste Management (Ch 12 Atlas and Bartha) (3 periods)

Sources and types of solid waste, methods of disposal of solid waste (incineration, composting, sanitary landfill)

Liquid Waste Management (Ch 12 Atlas and Bartha) (7 periods)

Composition of sewage; strength of sewage (BOD and COD); Primary, secondary (aerobic – oxidation pond, trickling filter, rotating biological contractor/biodisc system, activated sludge process and anaerobic – septic tank, imhoff tank, anaerobic digestor) and tertiary sewage treatment

Bioleaching (Ch 17 Atlas) (1 period)

Biodeterioration (Ch 17 Atlas) (2 periods)

MICROBIAL deterioration of metals (corrosion), textile and paper

PRACTICALS

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action
2. Isolation of microbes (bacteria & fungi) from soil (28ºC & 45ºC)
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Detection (qualitative) of the presence of enzymes (dehydrogenase, amylase, urease) in soil.
5. Isolation of *Rhizobium* from root nodules of legumes
6. Isolation of *Azotobacter/Azospirillum* from soil
7. Isolation of phosphate solubilizers from soil

SUGGESTED READINGS

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA.
2. Atlas RM. (1989). Microbiology: Fundamentals and Applications. 2nd Edition, MacMillan Publishing Company, New York.
3. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/ Benjamin Cummings.
4. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
5. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
6. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in MICROBIAL Ecology. Blackwell Scientific Publication, U.K.
7. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press.
8. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
9. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
10. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.

FIFTH SEMESTER
Course Code UMB 503: INDUSTRIAL MICROBIOLOGY

THEORY **Total periods: 47**

UNIT I

Introduction to industrial Microbiology (Ch 1 Casida, Ch 1 Stanbury et al.) (2 periods)

Brief history and developments in industrial Microbiology

Fermentation processes (Ch 2 Stanbury et al.) (4 periods)

Solid-state and liquid-state (stationary and submerged) fermentations; Batch, fedbatch and continuous fermentations

UNIT II

Bioreactors/fermenters (Ch 3 Casida, Ch 7 Stanbury et al.) (7 periods)

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.

UNIT III

Control parameters, industrially important strains, media ingredients

Measurement and control of fermentation parameters (Ch 8-9 Stanbury et al.) (4 periods)

Control and monitoring of different parameters in a bioreactor; pH, temperature, dissolved oxygen, foaming and aeration

Isolation of industrially important MICROBIAL strains (Ch 4 Casida, Ch 3 Patel) (4 periods)

Primary and secondary screening, strain development, preservation and maintenance of industrial strains

Media and ingredients for industrial fermentations (Ch 7 Casida, Ch 4 Stanbury et al.) (3 periods)

Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey and yeast extract.

UNIT IV

Down-stream Processing (Ch 10 Stanbury et al.) (5 periods)

Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying.

UNIT V

MICROBIAL production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses)

(Ch 8-9, 11-13, 15 Crueger and Crueger; Ch 17-18, 23-25 Casida) (13 periods)

Citric acid, ethanol, penicillin, glutamic acid, riboflavin, enzymes (amylase, cellulase, protease, lipase, glucose isomerase, glucose oxidase), wine, beer, bioinsecticides (Bt) and Steroid transformations.

Enzyme immobilization **(Ch 11 Crueger and Crueger) (5 periods)**

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).

PRACTICALS

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
2. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.

SUGGESTED READINGS

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

FIFTH SEMESTER

Course Code UMBE 501: GENETICS AND GENOMICS II

THEORY **Total periods: 44**

UNIT I.

Genetic Analysis and Mapping in Bacteria and Bacteriophages

(5 periods) (Ch 6, Klug and Cummings/ Ch 5, Griffith et al.)

Conjugation; Transformation; Transduction, Recombination.

Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses

(5 periods) (Ch 22, Klug and Cummings/ Ch 14, Griffith et al.)

Prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements; Eukaryotic transposable elements- Ac-Ds system in maize and P elements in Drosophila; Uses of transposons; Eukaryotic Viruses.

UNIT II

Developmental Genetics and Model System (8 periods) (Ch 19, Klug and Cummings)

Study of model systems in developmental genetics- *Drosophila melanogaster Sachharomyces cerevisiae, Caenorhabditis elegans, Arabidopsis thaliana,* and *Xenopus laevis.*

UNIT III

Genomics, Bioinformatics and Proteomics (10 periods)

(Ch 21, Klug and Cummings/Ch 8-9, Russell/ Ch2, 3, 4 Ghosh, Z. and Mallick,V.)

Genomes of bacteria, Drosophila and Humans; Human genome project; Evolution and Comparative Genomics. Introduction to Bioinformatics, Gene and protein databases; Sequence

similarity and alignment; Gene feature identification. Gene Annotation and analysis of transcription and translation; Post-translational analysis- Protein interaction.

UNIT IV

Genomic Analysis- Dissection of Gene Function (10 periods)

(Ch 23, Klug and Cummings)

Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and system biology. Genetics of cancer, Oncogenes, Tumor suppressor genes, Mutator genes.

UNIT V

Population Genetics (8 periods) (Ch 27, Klug and Cummings)

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.

Evolutionary Genetics (Ch 28, Klug and Cummings)

Genetic variation and Speciation. Genetic variation in natural population. Changes in the genetic structure of the populations

PRACTICALS

1. Genomic DNA isolation from E.coli (without plasmid).
2. Restriction enzyme digestion of genomic DNA from E.coli.
3. Isolation of plasmid DNA and genomic DNA together from E.coli. and restriction enzyme digestion.
4. Restriction enzyme digestion (EcoRI) of genomic and plasmid DNA (obtained from Expt.3).
5. Estimation of size of a DNA fragment after electrophoresis using DNA markers.
6. Construction of Restriction digestion maps from data provided.
7. Demonstration of DNA fingerprinting.

SUGGESTED READINGS

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. IX Edition. Benjamin Cummings.
4. Russell, P. J. (2009). iGenetics- A Molecular Approach. III Edition. Benjamin Cummings.
5. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
6. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.
7. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis.
8. Ghosh, Z. and Mallick,V. (2008). Bioinformatics-Principles and Applications. Oxford Univ. Press

FIFTH SEMESTER
Course Code UMBE 502: PLANT PATHOLOGY

THEORY **Total Periods – 45**

UNIT I

Introduction and History of plant pathology (Ch 1 Agrios) (4 periods)

Concept of plant disease- definitions of disease, disease cycle & pathogenicity, symptoms associated with microbial plant diseases, types of plant pathogens, economic losses and social impact of plant diseases. Significant landmarks in the field of plant pathology- Contributions of Anton De Bary, Millardet, Burrill, E. Smith, Adolph Mayer, Ivanowski, Diener, Stakman, H.H. Flor, Van Der Plank, molecular Koch's postulates. Contributions of eminent Indian plant pathologists.

UNIT II

Stages in development of a disease (Ch 2 Agrios) (1 period)

Infection, invasion, colonization, dissemination of pathogens and perennation.

Plant disease epidemiology **(Ch 8 Agrios) (3 periods)**

Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

UNIT III

Host Pathogen Interaction

A. MICROBIAL Pathogenicity (Ch 3, 5 Agrios)

Virulence factors of pathogens: enzymes, toxins (host specific and non specific) growth regulators, virulence factors in viruses (replicase, coat protein, silencing suppressors) in disease development. **(4 periods)**

Effects of pathogens on host physiological processes (photosynthesis, respiration, cell membrane permeability, translocation of water and nutrients, plant growth and reproduction). **(3 periods)**

B. Genetics of Plant Diseases (Ch 4 Agrios) (3 periods)

Concept of resistance (R) gene and avirulence (avr) gene; gene for gene hypothesis, types of plant resistance: true resistance– horizontal & vertical, apparent resistance.

C. Defense Mechanisms in Plants (Ch 6 Agrios) (4 periods)

Concepts of constitutive defense mechanisms in plants, inducible structural defenses (histological- cork layer, abscission layer, tyloses, gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinones, oxidative bursts].

UNIT IV Control of Plant Diseases (Ch 9 Agrios) (7 periods)

Principles & practices involved in the management of plant diseases by different methods, viz. **regulatory** - quarantine, crop certification, avoidance of pathogen, use of pathogen free propagative material

cultural - host eradication, crop rotation, sanitation, polyethylene traps and mulches

chemical - protectants and systemic fungicides, antibiotics, resistance of pathogens to chemicals**.**

biological - suppressive soils, antagonistic microbes-bacteria and fungi, trap plants genetic engineering of disease resistant plants- with plant derived genes and pathogen derived genes

UNIT V

Specific Plant diseases (Agrios, Singh)

Study of some important plant diseases giving emphasis on its etiological agent, symptoms, epidemiology and control

A. Important diseases caused by fungi (9 periods)

- White rust of crucifers - *Albugo candida*
- Downy mildew of onion - *Peronospora destructor*
- Late blight of potato - *Phytophthora infestans*
- Powdery mildew of wheat - *Erysiphe graminis*
- Ergot of rye - *Claviceps purpurea*
- Black stem rust of wheat - *Puccinia graminis tritici*
- Loose smut of wheat - *Ustilago nuda*

B. Important diseases caused by phytopathogenic bacteria (3 periods)

Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus

C. Important diseases caused by phytoplasmas (1 period)

Aster yellow, citrus stubborn

D. Important diseases caused by viruses (2 periods)

Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro

E. Important diseases caused by viroids (1 period)

Potato spindle tuber, coconut cadang cadang

PRACTICALS

1. Demonstration of Koch's postulates in fungal, bacterial and viral plant pathogens.

2. Study of important diseases of crop plants by cutting sections of infected plant material - *Albugo, Puccinia, Ustilago, Fusarium, Colletotrichum.*

SUGGESTED READINGS

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,

2. Lucas JA. (1998). Plant Pathology and Plant Pathogens. 3rd edition. Blackwell Science, Oxford.

3. Mehrotra RS. (1994). Plant Pathology. Tata McGraw-Hill Limited.

4. Rangaswami G. (2005). Diseases of Crop Plants in India. 4th edition. Prentice Hall of India Pvt. Ltd., New Delhi.

5. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.

SIXTH SEMESTER

DISSERTATION
A. Valuation 1. Language & Presentation 2. Review of Literature 3. Methodology 4. Analysis & Interpretation of Result **B. Viva –Voce**