REVISED

GENERAL INSTRUCTIONS AND COURSE CURRICULUM

FOR

B.Sc. (HONS.)

MICROBIOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS-ANNUAL)

(EFFECTIVE FROM JULY, 2018)

DEPARTMENT OF BIOTECHNOLOGY
FACULTY OF LIFE SCIENCES
HIMACHAL PRADESH UNIVERSITY
(NAAC Accredited "A" Grade University)
SUMMER HILL- SHIMLA-171005 (HP)-India
www.hpuniv.ac.in/biotech

SCHEME FOR CHOICE BASED CREDIT SYSTEM FOR B.Sc. HONOURS MICROBIOLOGY

Year	CORE COURSE (14)		Credits	Ability Enhancement Compulsory Course (AECC), (2)	Credits	Skill Enhancement Course (SEC), (2)	Credits	Generic Elective (GE): (4)/ Discipline Specific Elective: (DSE): (4)	Credits
I	MICRO1C01TH MICRO1C01PR	Introduction to Microbiology & Microbial Diversity Introduction to Microbiology & Microbial Diversity	4 2	ENGL103/Hindi/MIL Communication	4	Nil		GE-1 BIOTECH1GE01TH: Mycology and Phycology BIOTECH1GE01PR: Mycology and Phycology	 4 2
	MICRO1C02TH MICRO1C02PR	Bacteriology Bacteriology	4 2						
	MICRO1C03TH MICRO1C03PR	Biochemistry Biochemistry	4 2	ENVS1AECC02 Environment Science	4				
	MICRO1C04TH MICRO1C04PR	Virology Virology	4 2					GE-2 BIOTECH1GE02TH: Cell Biology BIOTECH1GE02PR: Cell Biology	 4 2
II	MICRO2C05TH MICRO1C05PR	Microbial physiology & Metabolism Microbial physiology & Metabolism	4 2			*Any 2 SEC Subjects in year II*	08	GE-3 BIOTECH2GE3TH: Molecular Biology BIOTECH2GE3PR: Molecular Biology	 4 2
	MICRO2C06TH MICRO2C06PR	Environmental Microbiology Environmental Microbiology	4 2						
	MICRO2C07TH MICRO2C07PR	Recombinant DNA Technology Recombinant DNA Technology	4 2						
	MICRO2C08TH MICRO2C08PR	Industrial Microbiology Industrial Microbiology	4 2					GE-4 BIOTECH2GE04TH: Immunology BIOTECH2GE04PR: Immunology	 4 2
	MICRO2C09TH MICRO2C09PR	Microbes in Sustainable Agriculture and Development Microbes in Sustainable Agriculture and Development	4 2						
	MICRO2C10TH MICRO2C10PR	Molecular Diagnostics Molecular Diagnostics	4 2						
III	MICRO3C11TH MICRO3C11PR	Food and Dairy Microbiology Food and Dairy Microbiology	4 2			Nil		*Any 4 **DSE Subjects** in III year from the list (Theory=4 & Practical=2)*	24
	MICRO3C12TH MICRO3C12PR	Medical Microbiology Medical Microbiology	4 2						
	MICRO3C13TH MICRO3C13PR	Bioprocess Technology Bioprocess Technology	4 2						
	MICRO3C14TH MICRO3C14PR	Instrumentation & Biotechniques Instrumentation & Biotechniques	4 2						
		Core Course Total Credits =	**84**	**AECC Total Credits =**	**8**	**SE Total Credits =**	**08**	**GE/DSE Total Credits =**	**48**

Total Credits: 84+8+8+48 = 148

TH: Theory; PR : Practical; C: Core Courses; AECC: Ability Enhancement Compulsory Course; SEC: Skill Enhancement Courses; GE: Generic Elective; DSE: Discipline Specific Elective

STRUCTURE OF
B.Sc. HONOURS MICROBIOLOGY
(CBCS-Annual)
Core Course (C)

1st YEAR	2nd YEAR	3rd YEAR
MICRO1C01: Introduction to Microbiology & Microbial Diversity	**MICRO2C05:** Microbial physiology & Metabolism	**MICRO3C11:** Food and Dairy Microbiology
MICRO1C02: Bacteriology	**MICRO2C06:** Environmental Microbiology	**MICRO3C12:** Medical Microbiology
MICRO1C03: Biochemistry	**MICRO2C07:** Recombinant DNA Technology	**MICRO3C13:** Bioprocess Technology
MICRO1C04: Virology	**MICRO2C08:** Industrial Microbiology	**MICRO3C14:** Instrumentation & Biotechniques
	MICRO2C09: Microbes in Sustainable Agriculture and Development	
	MICRO2C10: Molecular Diagnostics	

Ability Enhancement Compulsory Course (AEC)

ENGL103: English Communication

ENVS1AECC02: Environment Science

Skill Enhancement Elective Course (SEC)
(*Any 2 SEC Subject in 2nd year from the list*)

2nd YEAR	
MICRO2SEC01	Microbial Quality Control in Food and Pharmaceutical Industries
MICRO2SEC02	Microbial Diagnosis in Health Clinics
MICRO2SEC03	Biofertilizers and Biopesticides
MICRO2SEC04	Agriculture Microbiology
MICRO2SEC05	Management of Human Microbial Diseases

Generic Elective Courses
(For streams other than B.Sc. Hons. Microbiology (CBCS-Annual)

1st YEAR	2nd YEAR
GE-1 **MICRO1GE01TH:** Cell Biology **MICRO1GE01PR:** Cell Biology	***GE-3*** **MICRO2GE3TH:** Bio Analytical Tools **MICRO2GE3PR:** Bio Analytical Tools
GE-2 **MICRO1GE02TH:** Inheritance Biology **MICRO1GE02PR:** Inheritance Biology	***GE-4*** **MICRO2GE04TH:** Microbial Genetics **MICRO2GE04PR:** Microbial Genetics

Discipline Specific Elective
(*Any 4 DSE Subjects in 3rd year from the list)*

3rd YEAR Only	
MICRO3DSE01	Biochemical Engineering
MICRO3DSE02	Biostatistics
MICRO3DSE03	Ecology and Environment Management
MICRO3DSE04	Parasitology
MICRO3DSE05	Plant Pathology
MICRO3DSE06	Advances in Microbiology

CHOICE BASED CREDIT SYSTEM

B.Sc. (Hons.) Microbiology

Ist Year	
CORE COURSES	
MICRO1C01	Introduction to Microbiology & Microbial Diversity
MICRO1C02	Bacteriology
MICRO1C03	Biochemistry
MICRO1C04	Virology
ABILITY ENHANCEMENT COMULSORY COURSE (AECC)	
ENGL103/Hindi/MIL Communication	
ENVS1AECC02: Environment Science	
GENERIC ELECTIVE (From other streams)	
GE1	
GE2	

2nd Year	
CORE COURSES	
MICRO2C05	Microbial physiology & Metabolism
MICRO2C06	Environmental Microbiology
MICRO2C07	Recombinant DNA Technology
MICRO2C08	Industrial Microbiology
MICRO2C09	Microbes in Sustainable Agriculture and Development
MICRO2C10	Molecular Diagnostics
SKILL ENHANCEMENT COURSES (SEC-Any TWO)	
MICRO 2SEC01	Microbial Quality Control in Food and Pharmaceutical Industries
MICRO2SEC02	Microbial Diagnosis in Health Clinics
MICRO2SEC03	Biofertilizers and Biopesticides
MICRO2SEC04	Agriculture Microbiology
MICRO2SEC05	Management of Human Microbial Diseases
GENERIC ELECTIVE (From streams other than biotechnology)	
GE3	
GE4	

3rd Year	
CORE COURSES	
MICRO3C11	Animal Biotechnology
MICRO3C12	Plant Biotechnology
MICRO3C13	Medical Microbiology
MICRO3C14	Food Biotechnology
DISCIPLINE SPECIFIC ELECTIVE (DSE-Any FOUR)	
MICRO3DSE01	Biochemical Engineering
MICRO3DSE02	Biostatistics
MICRO3DSE03	Ecology and Environment Management
MICRO3DSE04	Parasitology
MICRO3DSE05	Plant Pathology
MICRO 3DSE06	Advances in Microbiology

HIMACHAL PRADESH UNIVERSITY
SUMMER-HILL, SHIMLA-171005

B.Sc. (Honors) Microbiology
GENERAL INSTRUCTIONS/ GUIDELINES FOR EXECUTION OF CURRICULUM

I. The B.Sc. (Honors) Microbiology will be of three years duration Choice Based Credit System [CBCS] course.

II. There will be broadly three types of courses for B.Sc. (Honors) Microbiology degree program.

1. The **Core Courses** (14 courses for Honours) will be of 6- credits each including 2 credits assigned to the practical component. Thus a candidate will have to pass 14 courses for earning 14 X 6 = 84 credits during 1st, 2nd and 3rd year. Each of the 6-credits courses will carry 100 marks. These 100 marks will be split into marks assigned for Theory [TH]: 50 marks; Practical [PR]: 20 marks and Internal Assessment [IA]: 30. The Internal Assessment [30 marks] will include one Multi Choice Questions (MCQ)-based examination of 10 marks, Classroom Attendance Incentive marks (5 marks), Presentation/Assignment of 5 marks and Lab Seminar/Lab Assignment of 10 marks. The Lab-based practical will be of 2-hours [One credit]. A total of 14 X 6 = 84 credits could be accumulated under these courses during the Honours degree program.

2. The **Elective Courses** will be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/ subject/ domain or nurtures the candidate's proficiency / skill. The Elective Courses will include;

Generic Elective (GE) Courses: A total of 4 courses offered under the discipline/ subject of study is referred to as Generic Elective and will be studied by the candidates in 1st and 2nd year. These courses will be of 6-credits each including 2 credits assigned for the practical component of each of these courses. These courses are interdisciplinary in nature. A total of 4X6 = 24 credits could be accumulated under GE courses during the Honours degree program.

Discipline Specific Elective [**DSE**] Courses: A total of 4 courses offered under the main discipline/ subject of study is referred to as Discipline Specific Elective and will be studied by the candidates in 3rd year. These courses will be of 6-credits each including 2 credits assigned for the practical component of each of these courses. These courses are discipline related and/ or interdisciplinary in nature. A total of 4X6 = 24 credits could be accumulated under DSE courses during the Honours degree program.

3. **Ability Enhancement Compulsory Courses [AECC]:** Ability Enhancement Courses are of two types; Ability Enhancement Compulsory Courses [AECC] and Skill Enhancement Courses [SEC]. The AECC courses are the mandatory courses based upon the content that leads to knowledge enhancement; i. Environment Science and ii. English/ Hindi/ MIL Communication. All these are mandatory courses for obtaining a B.Sc. (Honours) degree in the concerned subject. These courses are mandatory for all disciplines. A total of 2 X 4 = 08 credits in 1st year could be accumulated under these courses during the Honours degree program.

Skill Enhancement Courses (SEC) courses are value-based and/ or skill-based and are aimed at providing hands-on-training, competencies, skills *etc*. A minimum of two such courses (2 SEC in 2nd Year) for obtaining an Honours degree are selected amongst the courses designed to provide value-based and/ or skill-based knowledge and may contain both theory and lab/ hands-on training. The main purpose of these courses is to provide students life-skills in hands-on mode so as to increase their employability. A total of 2X 4 = 8 credits could be accumulated under SEC courses during the Honours degree program. Each of the 4-credits courses will carry 100 marks. These 100 marks will be split into marks assigned for Theory [TH]: 70 marks; and Internal Assessment [IA]: 30.

III. Practical [PR] component has been included in every core and discipline/ generic specific elective paper. The list of practicals to be conducted by the candidates has been provided alongside each of such courses. The marks (20 marks) for the practical examination will be split as follows;

Write up of Practical:	4 marks
Performance of practicals:	7 marks
Practical record/ notebook:	3 marks
Viva voce:	6 marks

IV. **Classroom Attendance Incentive**: Those candidates who have greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CAI marks as follows:

≥ 75% but < 80%	1 mark
≥ 80% but <85%	2 marks
≥ 85 but <90%	3 marks
≥ 90% but < 95%	4 marks
≥ 95% to 100%	5 marks

V. The candidate has to secure minimum pass marks individually in Theory paper, Practical as well as Internal Assessment to earn full credits in the concerned course. A candidate thus failing in any of these components shall be considered failed in that course.

VI. The admission to B.Sc. (Honors) Biotechnology programme of Himachal Pradesh University will be as per guidelines of Himachal Pradesh University, Shimla from time to time.

i. The candidate should have passed 10+2 (class XII) Examination or its equivalent from a recognized Board/ University with any of the three subjects out of Physics, Chemistry and Biology or any other science subject with 50% or equivalent grade (for SC/ ST candidates marks of eligibility will be 45% or equivalent grade).

ii. In case of candidates who are studying in University/Board/College/Schools in any of the foreign countries the eligibility/Qualifying marks will be the same as recognized/equivalent to 10+2 by the University or the association of the Indian University with 50% marks of equivalent grade (for SC/ ST candidates, eligibility will be 45% marks or equivalent grade).

iii. The candidate who has appeared in the qualifying examination but whose result has so far not been declared can also apply but his/her eligibility for the entrance test will be purely provisional subject to the condition that he/she has to produced a passing certificate scoring at least the minimum percentage of marks as prescribed for the qualifying examination on the day and the specified time of counseling.

The candidate shall not be more than 22 years of age as on 01st July of the year of admission. Date of birth as recorded in the Secondary Education Board/ University Certificate Only will be considered as authentic.

B.Sc. (HONORS)

MICROBIOLOGY

I YEAR

(CBCS STRUCTURE)

CORE COURSES

COURSE: MICRO1C01TH

INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 History of Development of Microbiology (15 Periods)

A. Development of microbiology as a discipline, Spontaneous generation *vs*. biogenesis. Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming

Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology, Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner

B. An overview of Scope of Microbiology

Unit 2 Diversity of Microbial World (15 Periods)

Systems of classification: Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Difference between prokaryotic and eukaryotic microorganisms

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

B. **Protozoa:** General characteristics with special reference to *Amoeba, Paramecium, Plasmodium, Leishmania and Giardia*

Unit 3 (15 Periods)

Algae: 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 with suitable examples: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Applications of algae in agriculture, industry, environment and food.

Unit 4 (15 Periods)

Fungi: 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. Economic importance of fungi with examples in agriculture, environment, Industry, medicine, food, biodeterioration and mycotoxins.

COURSE: MICRO1C01PR
INTRODUCTION TO MICROBIOLOGY AND MICROBIAL DIVERSITY (PRACTICAL)

Practicals

1. Microbiology Good Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets,
3. autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter) used in the
4. microbiology laboratory.
5. Preparation of culture media for bacterial cultivation.
6. Sterilization of medium using Autoclave and assessment for sterility
7. Sterilization of glassware using Hot Air Oven and assessment for sterility
8. Sterilization of heat sensitive material by membrane filtration and assessment for sterility
9. Demonstration of the presence of microflora in the environment by exposing nutrient agar plates to air.
10. Study of *Rhizopus*, *Penicillium*, *Aspergillus* using temporary mounts
11. Study of *Spirogyra* and *Chlamydomonas*, *Volvox* using temporary Mounts
12. Study of the following protozoans using permanent mounts/photographs: *Amoeba*, *Entamoeba*, *Paramecium* and *Plasmodium*

Suggested Readings

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education

2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edition

3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited 4.Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.

4. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM. T. Brown Publishers.

5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.

6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

COURSE: MICRO1C02TH

BACTERIOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Cell organization (14 Periods)

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 2 Bacteriological techniques and Microscopy (13 Periods)

Pure culture isolation: Streaking, serial dilution and plating methods; cultivation, maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria, and accessing non-culturable bacteria.

Bright Field Microscope, Dark Field Microscope, Phase Contrast Microscope, Fluoresence Microscope, Confocal microscopy, Scanning and Transmission Electron Microscope

Unit 3 Growth , nutrition and reproduction in Bacteria (13 Periods)

Nutritional requirements in bacteria and nutritional categories;

Culture media: components of media, natural and synthetic media, chemically defined media, complex media, selective, differential, indicator, enriched and enrichment media *Physical methods of microbial control*: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation

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

Chemical methods of microbial control: disinfectants, types and mode of action

Unit 4 Bacterial Systematics and archaeal and eubacterial groups (20 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.

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*)]

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

Gram Negative: General characteristics with suitable examples of Non proteobacteria, Alpha proteobacteria, Beta proteobacteria, Gamma proteobacteria, Delta proteobacteria, Epsilon proteobacteria, Zeta proteobacteria.

Gram Positive: General characteristics with suitable examples of Low G+ C (Firmicutes), High G+C (Actinobacteria).

***Cyanobacteria*:** An Introduction.

COURSE: MICRO1C02PR

BACTERIOLOGY (PRACTICAL)

Practicals

1. Preparation of different media: synthetic media BG-11, Complex media-Nutrient agar, McConkey agar, EMB agar.
2. Simple staining
3. Negative staining
4. Gram's staining
5. Acid fast staining-permanent slide only.
6. Capsule staining
7. Endospore staining.
8. Isolation of pure cultures of bacteria by streaking method.
9. Preservation of bacterial cultures by various techniques.
10. Estimation of CFU count by spread plate method/pour 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. (2014). Brock Biology of Micro-organisms. 14th 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. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.
9. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

COURSE: MICRO1C03TH

BIOCHEMISTRY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Bioenergetics and Carbohydrates (20 Periods)

First and second laws of Thermodynamics. Definitions of Gibb's Free Energy, enthalpy,and Entropy and mathematical relationship among them, Standard free energy change and equilibrium constant Coupled reactions and additive nature of standard free energy change, Energy rich compounds: Phosphoenolpyruvate, 1,3- Bisphosphoglycerate, Thioesters, ATP Carbohydrates :Families of monosaccharides: aldoses and ketoses, trioses, tetroses, pentoses, and hexoses.Stereo isomerism of monosaccharides, epimers, Mutarotation and anomers of glucose. Furanose and pyranose forms of glucose and fructose, Haworth projection formulae for glucose; chair and boat forms of glucose, Sugar derivatives, glucosamine, galactosamine, muramic acid, N-acetyl neuraminic acid, Disaccharides; concept of reducing and non-reducing sugars, occurrence and Haworth projections of maltose, lactose, and sucrose, Polysaccharides, storage polysaccharides, starch and glycogen. Structural Polysaccharides, cellulose, peptidoglycan and chitin

Unit2 Lipids and vitamins (16 Periods)

Lipids :Definition and major classes of storage and structural lipids. Storage lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties. Saponification Structural lipids. Phosphoglycerides: Building blocks, General structure, functions and properties. Structure of phosphatidylethanolamine and phosphatidylcholine, Sphingolipids: building blocks, structure of sphingosine, ceramide. Special mention of sphingomyelins cerebrosides and gangliosides Lipid functions: cell signals, cofactors, prostaglandins, Introduction of lipid micelles, monolayers, bilayers. Vitamins :Classification and characteristics with suitable examples, sources and importance

Unit 3 Proteins (12 Periods)

Functions of proteins, Primary structures of proteins: Amino acids, the building blocks of proteins. General formula of amino acid and concept of zwitterion. Titration curve of amino acid and its Significance, Classification, biochemical structure and notation of standard protein amino acids Ninhydrin reaction.Natural modifications of amino acids in proteins hydrolysine, cystine and hydroxyproline, Non protein amino acids: Gramicidin, beta-alanine, D-alanine and D- glutamic acid Oligopeptides: Structure and functions of naturally occurring glutathione and insulin and synthetic aspartame, Secondary structure of proteins: Peptide unit and its salient features. The alpha helix, the beta pleated sheet and their occurrence in proteins, Tertiary and quaternary structures of proteins. Forces holding the polypeptide together. Human haemoglobin structure, Quaternary structures of proteins

Unit 4. Enzymes (12Periods)

Structure of enzyme:Apoenzyme and cofactors, prosthetic group-TPP, coenzyme,NAD,metal cofactors, Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis, and Induced Fit hypothesis. Significance of hyperbolic, double reciprocal plots of enzyme activity, Km, and allosteric mechanism Definitions of terms – enzyme unit, specific activity and turnover number, Multienzyme complex : pyruvate dehydrogenase; isozyme: lactate dehydrogenase, Effect of pH and temperature on enzyme activity. Enzyme inhibition: competitive- sulfa drugs; non-competitive-heavy metal salts

COURSE: MICRO1C03PR
BIOCHEMISTRY (PRACTICAL)

Practicals

1. Properties of water, Concept of pH and buffers, preparation of buffers and Numerical problems to explain the concepts
2. Numerical problems on calculations of Standard Free Energy Change and Equilibrium constant
3. Standard Free Energy Change of coupled reactions
4. Qualitative/Quantitative tests for carbohydrates, reducing sugars, non reducing sugars
5. Qualitative/Quantitative tests for lipids and proteins
6. Study of protein secondary and tertiary structures with the help of models
7. Study of enzyme kinetics – calculation of V_{max} , Km, Kcat values
8. Study effect of temperature, pH and Heavy metals on enzyme activity
9. Estimation of any one vitamin

Suggested Readings

1. Campbell, MK (2012) Biochemistry, 7th ed., Published by Cengage Learning
2. Campbell, PN and Smith AD (2011) Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
3. Tymoczko JL, Berg JM and Stryer L (2012) Biochemistry: A short course, 2nd ed., W.H.Freeman
4. Berg JM, Tymoczko JL and Stryer L (2011) Biochemistry, W.H.Freeman and Company
5. Nelson DL and Cox MM (2008) Lehninger Principles of Biochemistry, 5th Edition., W.H. Freeman and Company,
6. Willey MJ, Sherwood, LM & Woolverton C J (2013) Prescott, Harley and Klein's Microbiology by. 9th Ed., McGrawHill

COURSE: MICRO1C04TH
VIROLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Nature and Properties of Viruses (12 Periods)

Introduction: Discovery of viruses, nature and definition of viruses, general properties, concept of viroids, virusoids, satellite viruses and Prions. Theories of viral origin Structure of Viruses: Capsid symmetry, enveloped and non-enveloped viruses Isolation, purification and cultivation of viruses Viral taxonomy: Classification and nomenclature of different groups of viruses

Unit 2 Viral Transmission, Salient features of viral nucleic acids and Replication (20 Periods)

Modes of viral transmission: Persistent, non-persistent, vertical and horizontal, Salient features of viral Nucleic acid : Unusual bases (TMV,T4 phage), overlapping genes (ϕX174, Hepatitis B virus), alternate splicing (HIV), terminal redundancy (T4 phage), terminal cohesive ends (lambda phage), partial double stranded genomes (Hepatitis B), long terminal repeats (retrovirus), segmented (Influenza virus), and non-segmented genomes (picornavirus), capping and tailing (TMV) Viral multiplication and replication strategies: Interaction of viruses with cellular receptors and entry of viruses. Replication strategies of viruses as per Baltimore classification (phi X 174, Retroviridae, Vaccinia, Picorna) , Assembly, maturation and release of virions

Unit3 Prevention & control of viral diseases (14 Periods)

Antiviral compounds and their mode of action Interferon and their mode of action General principles of viral vaccination, Viruses and Cancer: Introduction to oncogenic viruses, Types of oncogenic DNA and RNA viruses: Concepts of oncogenes and proto-oncogenes

Unit4 Bacteriophages and Applications of Virology (14 Periods)

Diversity, classification, one step multiplication curve, lytic and lysogenic phages (lambda phage) concept of early and late proteins, regulation of transcription in lambda phage, Use of viral vectors in cloning and expression, Gene therapy and Phage display

COURSE: MICRO1C04PR
VIROLOGY (PRACTICAL)

Practicals

1. Study of the structure of important animal viruses (rhabdo, influenza, paramyxo hepatitis B and retroviruses) using electron micrographs
2. Study of the structure of important plant viruses (caulimo, Gemini, tobacco ring spot, cucumber mosaic and alpha-alpha mosaic viruses) using electron micrographs
3. Study of the structure of important bacterial viruses (ϕX 174, T4, λ) using electron micrograph.
4. Isolation and enumeration of bacteriophages (PFU) from water/sewage sample using double agar layer technique
5. Studying isolation and propagation of animal viruses by chick embryo technique
6. Study of cytopathic effects of viruses using photographs
7. Perform local lesion technique for assaying plant viruses.

Suggested Readings

1. Dimmock, NJ, Easton, AL, Leppard, KN (2007). Introduction to Modern Virology. 6th edition, Blackwell Publishing Ltd.
2. Carter J and Saunders V (2007). Virology: Principles and Applications. John Wiley and Sons.
3. 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.
4. Levy JA, Conrat HF, Owens RA. (2000). Virology. 3rd edition. Prentice Hall publication, New Jersey.
5. Wagner EK, Hewlett MJ. (2004). Basic Virology. 2nd edition. Blackwell Publishing.
6. Mathews. (2004). Plant Virology. Hull R. Academic Press, New York.
7. Nayudu MV. (2008). Plant Viruses. Tata McGraw Hill, India.
8. Bos L. (1999) Plant viruses-A text book of plant virology by. Backhuys Publishers.
9. Versteeg J. (1985). A Color Atlas of Virology. Wolfe Medical Publication.

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

Course: ENGL103: ENGLISH COMMUNICATION
Course: ENVS1AECC02: ENVIRONMENT SCIENCE

Theory examination: 100 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(20 Periods)**

Introduction to environmental studies & ecosystems:Multidisciplinary nature of environmental studies: Scope and importance; What is an ecosystem? The structure and function of ecosystem, Energy flow in an ecosystem, food chains, food webs and ecological succession, forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems; Levels of biological diversity such as genetic, species and ecosystem diversity; biogeography zones of India, biodiversity patterns and global biodiversity hot spots, India as a mega-biodiversity nation, endangered and endemic species of India, threats to biodiversity, habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions, conservation of biodiversity, *in-situ* and *ex-situ* conservation of biodiversity, concept of sustainability and sustainable development.

UNIT II **(15 Periods)**

Natural resources & its management and conservation:Land resources and land use change: Land degradation, soil erosion and desertification; Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations; Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter-state); Energy resources: Renewable and non renewable energy sources, use of alternate energy sources and growing energy needs.

UNIT III **(15 Periods)**

Environmental pollution & management:Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution, Solid waste management: Control measures of urban and industrial waste. Climate change, global warming, ozone layer depletion, acid rain and their impact on human communities and agriculture. Environment Laws: Environment Protection Act, Air (Prevention & Control of Pollution) Act, Water (Prevention and control of pollution) Act, Wildlife Protection Act, Forest Conservation Act; International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD); Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

UNIT IV **(10 Periods)**

Environment & social issues:Human population growth: Impacts on environment, human health and welfare; Resettlement and rehabilitation of project affected persons; case studies; Disaster management: floods, earthquake, cyclones and landslides; Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan; Environmental ethics: Role of Indian and other religions and cultures in environmental conservation; environmental communication and public awareness.

SUGGESTED READING

1. Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
2. Gadgil, M., & Guha, R. 1993. *This Fissured Land: An Ecological History of India*. Univ. of California Press.
3. Gleeson, B. and Low, N. (eds.) 1999. *Global Ethics and Environment,* London, Routledge.
4. Gleick, P. H. 1993. *Water in Crisis*. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. *Principles of Conservation Biology*. Sunderland: Sinauer Associates, 2006.
6. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. *Science,* 339: 36-37.

GENERIC ELECTIVE

GE-1

Course: BIOTECH1GE01TH

MYCOLOGY AND PHYCOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT 1 **(15 Periods)**

An introduction to algae:

a) The position of algae in continuation of life

b) General classification

c) Comparative morphology and reproduction

Phycoviruses: Structure and multiplication of phyco Viruses (Mainly Cyanophages)

Physiological Aspects of Ecology: Fresh water algae, soil algae, marine algae (seaweeds), aerial algae and algae as symbionts.

Nitrogen Fixation: Site of nitrogen fixation, heterocyst, ultrastructure of heteorocyst, heteorocyst in nitrogen fixation in Cyanobacteria, nitrogenase and biochemistry of nitrogen.

Nitrogen assimilation, amino acids and proteins, inorganic phosphorous uptake and metabolism. Sulphur, halogen, major cations and inorganic micronutrients.

UNIT 2 **(15 Periods)**

Photosynthesis, The physical nature of light, pigments in systems of photo synthesis, the photosynthesis apparatus path electron in photosynthesis, factors affecting the rate of photosynthesis and carbon fixation. Respiration. Photorespiration fermentation, substrate assimilation and heterotrophy.

Algae as bio fertilizer, algae as food including single cell protein. Source of agar agar, alginate, diatomic and iodine etc .Antibiotics from algae, Role of algae in indicating pollution (water pollution)Algal photosynthesis in sewerage treatment.

UNIT 3 **(20 Periods)**

General characteristics of molds, types of reproduction, spore types Ecophysiology: Lichens, their associations and applications syngamy horones, synthetic fungicides, fungal toxins, absorption of nutrients, transport mechanism, chemical and physical environment for growth.

Fungal attackmechanisms.Mycotechnology: Fungi in the production of antibiotics, organic acids , vitamins and single cell protein, alcohols, oriental food fermentation and solid substrate fermentations. mushrooms and cultivation of mushrooms. Fungal genetics and Mycoviruses: General information about genetics of fungi, various mycoviruses, their nature and multiplication.

UNIT 4 **(10 Periods)**

Medical Mycology: Fungal infection of skin, nail and hair, subcutaneous mycoses systemic mycoses, opportunistic fungal infections, Mushroom food poisoning. Plant Pathology: Fungi in relation to plant diseases.

Course: BIOTECH1GE01PR

MYCOLOGY AND PHYCOLOGY (PRACTICAL)

Practicals

1. Identification of Pathogenic and non Pathogenic Fungi.

2. Preparation of media for isolating Fungi.

3. To find Heterocyst frequency.

4. Quantification of total Chlorophyll by cold extraction method.

5. Quantification of total Chlorophyll by warm extraction method.

6. Quantification of carotenoids in given algal sample using organic solvents.

7. To examine the amylolytic activity of Fungi.

8. To prepare media for isolating non symbiotic-nitrogen fixing bacteria ammonifying bacteria and nitrifying bacteria.

Suggested Readings

1. The Fungi by Ain Sworth vol 2, 3, 4 (1997)

2. Introduction to Fungi by Webster (1992)

3. The Biology of Fungi , In gold (1994)

4. Phycotoxin & Mycotoxin Steyn Vleggaar (1994)

5. Human Mycoses –Ben eke Rippan and Rogers (1995)

6. The Fungi Vol 1 and Vol 2 (1993)

7. Ectomycorrihizal Fungi Caiey J.W.C 1999

8. The Mycota Esserk

GE-2
COURSE: BIOTECH1GE02TH
CELL BIOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Structure and organization of Cell **(20 Periods)**

Cell Organization – Eukaryotic (Plant and animal cells) and prokaryotic Plasma membrane: Structure and transport of small molecules
Cell Wall: Eukaryotic cell wall, Extra cellular matrix and cell matrix interactions, Cell-Cell Interactions - adhesion junctions, tight junctions, gap junctions, and plasmodesmata (only structural aspects)
Mitochondria, chloroplasts and peroxisomes
Cytoskeleton: Structure and organization of actin filaments, association of actin filaments with plasma membrane, cell surface protrusions, intermediate filaments, microtubules
Nucleus :Nuclear envelope, nuclear pore complex and nuclear lamina Chromatin – Molecular organization Nucleolus

Unit 2 Protein Sorting and Transport **(15 Periods)**

Ribosomes, Endoplasmic Reticulum – Structure, targeting and insertion of proteins in the ER, protein folding, processing and quality control in ER, smooth ER and lipid synthesis, export of proteins and lipids
Golgi Apparatus – Organization, protein glycosylation, protein sorting and export from Golgi Apparatus
Lysosomes

Unit 3 Cell Signalling **(10 Periods)**

Signalling molecules and their receptors Function of cell surface receptors
Pathways of intra-cellular receptors **–** Cyclic AMP pathway, cyclic GMP and MAP kinase pathway

Unit 4 Cell Cycle, Cell Death and Cell Renewal **(15 Periods)**

Eukaryotic cell cycle and its regulation, Mitosis and Meiosis
Development of cancer, causes and types
Programmed cell death
Stem cells
Embryonic stem cell, induced pleuripotent stem cells

COURSE: BIOTECH1GE02PR

CELL BIOLOGY (PRACTICAL)

Practicals

1. Study a representative plant and animal cell by microscopy.
2. Study of the structure of cell organelles through electron micrographs
3. Cytochemical staining of DNA – Feulgen
4. Demonstration of the presence of mitochondria in striated muscle cells/ cheek epithelial cell using vital stain Janus Green B
5. Study of polyploidy in Onion root tip by colchicine treatment.
6. Identification and study of cancer cells by photomicrographs.
7. Study of different stages of Mitosis.
8. Study of different stages of Meiosis.

Suggested Readings

1. Hardin J, Bertoni G and Kleinsmith LJ. (2010). Becker's World of the Cell. 8th edition. Pearson.
2. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

B.Sc. (HONORS)

MICROBIOLOGY

II YEAR

(CBCS STRUCTURE)

CORE COURSES

COURSE: MICRO1C05TH

MICROBIAL PHYSIOLOGY AND METABOLISM (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Microbial Growth and Effect of Environment on Microbial Growth (14 Periods)

Definitions of growth, measurement of microbial growth, Batch culture, Continuous culture, generation time and specific growth rate, synchronous growth, diauxic growth curve

Microbial growth in response to environment -Temperature (psychrophiles, mesophiles, thermophiles, extremophiles, thermodurics, psychrotrophs), pH (acidophiles, alkaliphiles), solute and water activity (halophiles, xerophiles, osmophilic), Oxygen (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe),barophilic.

Microbial growth in response to nutrition and energy – Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph.

Unit 2 Nutrient uptake ,transport and Nitrogen Metabolism (16 Periods)

Passive and facilitated diffusion

Primary and secondary active transport, concept of uniport, symport and antiport Group translocation, Iron uptake
Introduction to biological nitrogen fixation Ammonia assimilation
Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification

Unit 3 Chemoheterotrophic Metabolism - (20 Periods)

Aerobic Respiration : Concept of aerobic respiration, anaerobic respiration and fermentation
Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway
TCA cycle
Electron transport chain: components of respiratory chain, comparison of mitochondrial and bacterial
ETC, electron transport phosphorylation, uncouplers and inhibitors
Anaerobic respiration and fermentation: with special reference to dissimilatory nitrate reduction (Denitrification; nitrate /nitrite and nitrate/ammonia respiration; fermentative nitrate reduction)
Fermentation - Alcohol fermentation and Pasteur effect; Lactate fermentation (homofermentative and heterofermentative pathways), concept of linear and branched fermentation pathways

Unit 4 Chemolithotrophic and Phototrophic Metabolism (10 Periods)

Introduction to aerobic and anaerobic chemolithotrophy with an example each. Hydrogen oxidation (definition and reaction) and methanogenesis (definition and reaction)
Introduction to phototrophic metabolism - groups of phototrophic microorganisms,
anoxygenic *vs.* oxygenic photosynthesis with reference to photosynthesis in green bacteria, purple bacteria and cyanobacteria

COURSE: MICRO2C05PR

MICROBIAL PHYSIOLOGY AND METABOLISM (PRACTICAL)

Practicals

1. Study and plot the growth curve of *E. coli* by turbidometric and standard plate count methods.
2. Calculations of generation time and specific growth rate of bacteria from the graph plotted with the given data
3. Effect of temperature on growth of *E. coli*
4. Effect of pH on growth of *E. coli*
5. Effect of carbon and nitrogen sources on growth of *E.coli*
6. Effect of salt on growth of *E. coli*
7. Demonstration of alcoholic fermentation
8. Demonstration of the thermal death time and decimal reduction time of *E. coli.*

Suggested Readings

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.
2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons
3. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India
4. Gottschalk G. (1986). Bacterial Metabolism. 2nd edition. Springer Verlag
5. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, McMillan Press.
6. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

COURSE: MICRO2C06TH
ENVIRONMENTAL MICROBIOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Microorganisms and their Habitats **(14 Periods)**

Structure and function of ecosystems

Terrestrial Environment: Soil profile and soil microflora

Aquatic Environment: Microflora of fresh water and marine habitats

Atmosphere: Aeromicroflora and dispersal of microbes

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

Extreme Habitats: Extremophiles: Microbes thriving at high & low temperatures, pH, high hydrostatic & osmotic pressures, salinity, & low nutrient levels.

Microbial succession in decomposition of plant organic matter

Unit 2 Microbial Interactions and Bioremediation **(17 Periods)**

Microbe interactions: Mutualism, synergism, commensalism, competition, amensalism, parasitism, predation

Microbe-Plant interaction: Symbiotic and non symbiotic interactions

Microbe-animal interaction: Microbes in ruminants, nematophagus fungi and symbiotic luminescent bacteria

Principles and degradation of common pesticides, organic (hydrocarbons, oil spills) and inroganic (metals) matter, biosurfactants

Unit 3 Biogeochemical Cycling **(12 Periods)**

Carbon cycle: Microbial degradation of cellulose, hemicelluloses, lignin and chitin

Nitrogen cycle: Nitrogen fixation, ammonification, nitrification, denitrification and nitrate reduction

Phosphorus cycle: Phosphate immobilization and solubilisation

Sulphur cycle: Microbes involved in sulphur cycle

Other elemental cycles: Iron and manganese

Unit 4 Waste Management and Water Potability **(17 Periods)**

Solid Waste management: Sources and types of solid waste, Methods of solid waste disposal (composting and sanitary landfill)

Liquid waste management: Composition and strength of sewage (BOD and COD), Primary, secondary (oxidation ponds, trickling filter, activated sludge process and septic tank) and tertiary sewage treatment

Treatment and safety of drinking (potable) water, methods to detect portability 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

COURSE: MICRO2C06PR

ENVIRONMENTAL MICROBIOLOGY (PRACTICAL)

Practicals

1. Analysis of soil - pH, moisture content, water holding capacity, percolation, capillary action.
2. Isolation of microbes (bacteria & fungi) from soil (28°C & 45°C).
3. Isolation of microbes (bacteria & fungi) from rhizosphere and rhizoplane.
4. Assessment of microbiological quality of water.
5. Determination of BOD of waste water sample.
6. Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.
7. Isolation of *Rhizobium* from root nodules.

Suggested Readings

1. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
2. Madigan MT, Martinko JM and Parker J. (2014). Brock Biology of Microorganisms. 14th edition. Pearson/ Benjamin Cummings
3. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
4. Okafor, N (2011). Environmental Microbiology of Aquatic & Waste systems. 1st edition, Springer, New York
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
7. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
8. Lynch JM & Hobbie JE. (1988). Microorganisms in Action: Concepts & Application in Microbial Ecology. Blackwell Scientific Publication, U.K.
9. Martin A. (1977). An Introduction to Soil Microbiology. 2nd edition. John Wiley & Sons Inc. New York & London.
10. Stolp H. (1988). Microbial Ecology: Organisms Habitats Activities. Cambridge University Press, Cambridge, England.
11. Subba Rao NS. (1999). Soil Microbiology. 4th edition. Oxford & IBH Publishing Co. New Delhi.
12. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill.

COURSE: MICRO2C07TH

RECOMBINANT DNA TECHNOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit1 Molecular Cloning- Tools and Strategies (20 Periods)

Introduction **:** Milestones in genetic engineering and biotechnology; Cloning Tools; Restriction modification systems: Types I, II and III. Mode of action, nomenclature, applications of Type II restriction enzymes in genetic engineering DNA modifying enzymes and their applications: DNA polymerases. Terminal deoxynucleotidyl transferase, kinases and phosphatases, and DNA ligases Cloning Vectors: Definition and Properties Plasmid vectors: pBR and pUC series Bacteriophage lambda and M13 based vectors Cosmids, BACs, YACs Use of linkers and adaptors Expression vectors: *E.coli* lac and T7 promoter-based vectors, yeast YIp, YEp and YCp vectors, Baculovirus based vectors, mammalian SV40-based expression vectors

Unit 2 Methods in Molecular Cloning (20 Periods)

Transformation of DNA: Chemical method, Electroporation,

Gene delivery: Microinjection, electroporation, biolistic method (gene gun), liposome and viral-mediated delivery, *Agrobacterium* - mediated delivery; DNA, RNA and Protein analysis: Agarose gel electrophoresis, Southern - and Northern - blotting techniques, dot blot, DNA microarray analysis, SDS-PAGE and Western blotting; Construction and Screening of Genomic and cDNA libraries: Genomic and cDNA libraries: Preparation and uses, Screening of libraries: Colony hybridization and colony PCR, Chromosome walking and chromosome jumping

Unit3 DNA Amplification and DNA sequencing (10 Periods)

PCR: Basics of PCR, RT-PCR, Real-Time PCR; Sanger's method of DNA Sequencing: traditional and automated sequencing Primer walking and shotgun sequencing

Unit 4 Applications of Recombinant DNA Technology (10 Periods)

Products of recombinant DNA technology: Products of human therapeutic interest - insulin, hGH, antisense molecules. Bt transgenic - cotton, brinjal, Gene therapy, recombinant vaccines, protein engineering and site directed mutagensis

COURSE: MICRO2C07PR

RECOMBINANT DNA TECHNOLOGY (PRACTICAL)

Practicals

1. Preparation of competent cells for transformation
2. Demonstration of Bacterial Transformation and calculation of transformation efficiency.
3. Digestion of DNA using restriction enzymes and analysis by agarose gel electrophoresis
4. Ligation of DNA fragments
5. Cloning of DNA insert and Blue white screening of recombinants.
6. Interpretation of sequencing gel electropherograms
7. Designing of primers for DNA amplification
8. Amplification of DNA by PCR
9. Demonstration of Southern blotting

Suggested Reading

1. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
4. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press
5. Wiley JM, Sherwood LM and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. McGraw Hill Higher Education
6. Brown TA. (2007). Genomes-3. Garland Science Publishers
7. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.

COURSE: MICRO2C08TH
INDUSTRIAL MICROBIOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1: Introduction and Isolation of industrially important microbial strains (14 Periods)

Brief history and developments in industrial microbiology; Sources of industrially important microbes and methods for their isolation, preservation and maintenance of industrial strains, strain improvement, Crude and synthetic media; molasses, corn-steep liquor, sulphite waste liquor, whey, yeast extract and protein hydrolysates

Unit 2: Types of fermentation processes, bio-reactors and measurement of fermentation parameters (14 Periods)

Types of fermentation processes - Solid-state and liquid-state (stationary and submerged) fermentations; batch, fed-batch (eg. baker's yeast) and continuous fermentations; Components of a typical bio-reactor, Types of bioreactors-Laboratory, pilot- scale and production fermenters, constantly stirred tank and air-lift fermenters, Measurement and control of fermentation parameters - pH, temperature, dissolved oxygen, foaming and aeration

Unit 3: Microbial production of industrial products (micro-organisms involved, media, fermentation conditions, downstream processing and uses) (18 Periods)

Citric acid, ethanol, penicillin, glutamic acid, Vitamin B12 ; Enzymes (amylase, protease, lipase) ;Wine, beer

Unit 4: Enzyme immobilization and Down-stream processing (14 Periods)

Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase); Cell disruption, filtration, centrifugation, solvent extraction, precipitation, lyophilization and spray drying

COURSE: MICRO2C08PR
INDUSTRIAL MICROBIOLOGY (PRACTICAL)

Practicals

1. Study different parts of fermenter
2. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
- **(a)** Enzymes: Amylase and Protease
- **(b)** Amino acid: Glutamic acid
- **(c)** Organic acid: Citric acid
- **(d)** Alcohol: Ethanol

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

Suggested Readings

1. Patel A.H. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited
2. Okafor N. (2007). Modern Industrial Microbiology and Biotechnology. 1st edition. Bios Scientific Publishers Limited. USA
3. Waites M.J., Morgan N.L., Rockey J.S. and Higton G. (2001). Industrial Microbiology: An Introduction. 1st edition. Wiley – Blackwell
4. Glaze A.N. and Nikaido H. (1995). Microbial Biotechnology: Fundamentals of Applied Microbiology. 1st edition. W.H. Freeman and Company
5. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
6. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
7. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.

COURSE: MICRO2C09TH

MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Soil Microbiology (15 Periods)

Soil as Microbial Habitat, Soil profile and properties, Soil formation, Diversity and distribution of microorganisms in soil

Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium

Unit 2 Microbial Activity in Soil , Green House Gases and Soil Borne Plant Pathogens (14 Periods)

Carbon dioxide, methane, nitrous oxide, nitric oxide – production and control.

Microbial Control of Soil Borne Plant Pathogens: Biocontrol mechanisms and ways, Microorganisms used as biocontrol agents against Microbial plant pathogens, Insects, Weeds

Unit 3 Biofertilization, Phytostimulation, Bioinsecticides (15 Periods)

Plant growth promoting bateria, biofertilizers – symbiotic (*Bradyrhizobium, Rhizobium, Frankia*), Non Symbiotic (*Azospirillum, Azotobacter*, Mycorrhizae, MHBs, Phosphate solubilizers, algae), Novel combination of microbes as biofertilizers, PGPRs

Unit 4 Secondary Agriculture Biotechnology and GM crops (16 Periods)

Biotech feed, Silage, Biomanure, biogas, biofuels – advantages and processing parameters;

GM crops: Advantages, social and environmental aspects, Bt crops, golden rice, transgenic animals.

COURSE: MICRO2C09PR

MICROBES IN SUSTAINABLE AGRICULTURE AND DEVELOPMENT (PRACTICAL)

Practicals

1. Study soil profile
2. Study microflora of different types of soils
3. *Rhizobium* as soil inoculants characteristics and field application
4. *Azotobacter* as soil inoculants characteristics and field application
5. Design and functioning of a biogas plant
6. Isolation of cellulose degrading organisms

Suggested Readings

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA
7. Campbell RE. (1983). Microbial Ecology. Blackwell Scientific Publication, Oxford, England.
8. Coyne MS. (2001). Soil Microbiology: An Exploratory Approach. Delmar Thomson Learning.
9. Altman A (1998). Agriculture Biotechnology, I st edition, Marcel decker Inc.
10. Mahendra K. Rai (2005). Hand Book of Microbial Biofertilizers, The Haworth Press, Inc. New York.
11. Reddy, S.M. et. al. (2002). Bioinoculants for Sustainable Agriculture and Forestry, Scientific Publishers.
12. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG

COURSE: MICRO2C10TH

MOLECULAR DIAGNOSTICS (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT 1 Enzyme Immunoassays (15 Periods)

Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes. Solid phases used in enzyme immunoassays. Homogeneous and heterogeneous enzyme immunoassays. Enzyme immunoassays after immuno blotting. Enzyme immuno histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immuno assays.Applications of enzyme immunoassays in diagnostic microbiology

UNIT 2 Molecular methods in clinical microbiology (15 Periods)

Applications of PCR, RFLP, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology. Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures. Susceptibility tests:Diffusion test procedures. Susceptibility tests: Tests for bactericidal activity. Automated procedures for antimicrobial susceptibility tests.

UNIT 3 (18 Periods)

Automation in microbial diagnosis, rapid diagnostic approach including technical purification and standardization of antigen and specific antibodies. Concepts and methods in idiotypes. Antiidiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immuno florescence. Radioimmunoassay.

UNIT 4 (12 Periods)

GLC, HPLC, Electron microscopy, flowcytometry and cell sorting. Transgenic animals.

COURSE: MICRO2C10PR

MOLECULAR DIAGNOSTICS (PRACTICAL)

Practicals [*(Wherever wet lab experiments are not possible the principles and concepts can be demonstrated through any other material or medium including videos/virtual labs etc.)*

1. Perform/demonstrate RFLP and its analysis
2. Kirby-Bauyer method (disc-diffusion method) to study antibiotic sensitivity of a bacterial culture
3. A kit-basd detection of a microbial infection (Widal test)
4. Study of Electron micrographs (any four).
5. Perform any one immuno diagnostic test (Typhoid, Malaria, Dengue)

Suggested Readings

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker
2. Bioinstrumentation, Webster
3. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. Van Impe,Kluwer Academic
4. Ananthanarayan R and Paniker CKJ. (2005). Textbook of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
5. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
6. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology. 4th edition. Elsevier.
7. Joklik WK, Willett HP and Amos DB (1995). Zinsser Microbiology. 19th edition. AppletonCentuary-Crofts publication.
8. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
9. Microscopic Techniques in Biotechnology, Michael Hoppert

SKILL ENHANCEMENT COURSES
(ANY TWO)
COURSE: MICRO2SEC01
MICROBIAL QUALITY CONTROL IN FOOD AND PHARMACEUTICAL INDUSTRIES

Year end examination: 70 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing seven (7) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Microbiological Laboratory and Safe Practices (12 Periods)

Good laboratory practices - Good laboratory practices, Good microbiological practices; Biosafety cabinets – Working of biosafety cabinets, using protective clothing, specification for BSL1, BSL-2, BSL-3. Discarding biohazardous waste – Methodology of Disinfection, Autoclaving & Incineration

Unit 2 Determining Microbes in Food / Pharmaceutical Samples (18 Periods)

Culture and microscopic methods - Standard plate count, Most probable numbers, Direct microscopic counts, Biochemical and immunological methods: Limulus lysate test for endotoxin, gel diffusion, sterility testing for pharmaceutical products; Molecular methods - Nucleic acid probes, PCR based detection, biosensors.

Unit 3 Pathogenic Microorganisms of Importance in Food & Water (18 Periods)

Enrichment culture technique, Detection of specific microorganisms - on XLD agar, Salmonella Shigella Agar, Manitol salt agar, EMB agar, McConkey Agar, Saboraud Agar. Ascertaining microbial quality of milk by MBRT, Rapid detection methods of microbiological quality of milk at milk collection centres (COB, 10 min Resazurin assay)

Unit 4 HACCP for Food Safety and Microbial Standards (12 Periods)

Hazard analysis of critical control point (HACCP) - Principles, flow diagrams, limitations. Microbial Standards for Different Foods and Water – BIS standards for common foods and drinking water

Suggested Readings

1. Harrigan WF (1998) Laboratory Methods in Food Microbiology, 3rd ed. Academic Press
2. Garg N, Garg KL and Mukerji KG (2010) Laboratory Manual of Food Microbiology I K International Publishing House Pvt. Ltd.
3. Jay JM, Loessner MJ, Golden DA (2005) Modern Food Microbiology, 7th edition. Springer
4. Baird RM, Hodges NA and Denyer SP (2005) Handbook of Microbiological Quality control in Pharmaceutical and Medical Devices, Taylor and Francis Inc.

COURSE: MICRO2SEC02

MICROBIAL DIAGNOSIS IN HEALTH CLINICS

Year end examination: 70 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing seven (7) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Importance of Diagnosis of Diseases and Collection of Clinical Samples (18 Periods)

Bacterial, Viral, Fungal and Protozoan Diseases of various human body systems, Disease associated clinical samples for diagnosis. Collection of Clinical Samples: How to collect clinical samples (oral cavity, throat, skin, Blood, CSF, urine and faeces) and precautions required. Method of transport of clinical samples to laboratory and storage.

Unit 2 Direct Microscopic Examination and Culture. (18 Periods)

Examination of sample by staining - Gram stain, Ziehl-Neelson staining for tuberculosis, Giemsa-stained thin blood film for malaria. Preparation and use of culture media - Blood agar, Chocolate agar, Lowenstein-Jensen medium, MacConkey agar, Distinct colony properties of various bacterial pathogens.

Unit 3 Serology, Molecular Methods and Kits for Rapid Detection of Pathogens (14 Periods)

Serological Methods - Agglutination, ELISA, immunofluorescence, Nucleic acid based methods - PCR, Nucleic acid probes. Kits for Rapid Detection of Pathogens: Typhoid, Dengue and HIV, Swine flu.

Unit 4 Testing for Antibiotic Sensitivity in Bacteria (10 Periods)

Importance, Determination of resistance/sensitivity of bacteria using disc diffusion method, Determination of minimal inhibitory concentration (MIC) of an antibiotic by serial double dilution method

Suggested Readings

1. Ananthanarayan R and Paniker CKJ (2009)Textbook of Microbiology, 8th edition, Universities Press Private Ltd.
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Randhawa, VS, Mehta G and Sharma KB (2009) Practicals and Viva in Medical Microbiology 2nd edition, Elsevier India Pvt Ltd
4. Tille P (2013) Bailey's and Scott's Diagnostic Microbiology, 13th edition, Mosby
5. Collee JG, Fraser, AG, Marmion, BP, Simmons A (2007) Mackie and Mccartney Practical Medical Microbiology, 14th edition, Elsevier.

COURSE: MICRO2SEC03
BIOFERTILIZERS AND BIOPESTICIDES

Year end examination: 70 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing seven (7) short-answer type questions of 2 marks eachthat will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Biofertilizers (20 Periods)

General account of the microbes used as biofertilizers for various crop plants and their advantages over chemical fertilizers. Symbiotic N2 fixers: *Rhizobium* - Isolation, characteristics, types, inoculum production and field application, legume/pulses plants. *FranIia* - Isolation, characteristics, Alder, Casurina plants, non-leguminous crop symbiosis. Cyanobacteria, *Azolla* - Isolation, characterization, mass multiplication, Role in rice cultivation, Crop response, field application.

Unit 2 Non - Symbiotic Nitrogen Fixers and Phosphate Solubilizers (15 Periods)

Free living *Azospirillum*, *Azotobacter* - free isolation, characteristics, mass inoculums, production and field application.

Phosphate solubilizing microbes - Isolation, characterization, mass inoculum production, field application.

Unit 3 Mycorrhizal Biofertilizers (15 Periods)

Importance of mycorrizal inoculum, types of mycorrhizae and associated plants, Mass inoculum production of VAM, field applications of Ectomycorrhizae and VAM.

Unit 4 Bioinsecticides (10 Periods)

General account of microbes used as bioinsecticides and their advantages over synthetic pesticides, *Bacillus thuringiensis*, production, Field applications, Viruses – cultivation and field applications.

Suggested Readings

1. Kannaiyan, S. (2003). Bioetchnology of Biofertilizers, CHIPS, Texas.
2. Mahendra K. Rai (2005). Hand book of Microbial biofertilizers, The Haworth Press, Inc. New York.
3. Reddy, S.M. et. al. (2002). Bioinoculants for sustainable agriculture and forestry, Scientific Publishers.
4. Subba Rao N.S (1995) Soil microorganisms and plant growth Oxford and IBH publishing co. Pvt. Ltd. NewDelhi.
5. Saleem F and Shakoori AR (2012) Development of Bioinsecticide, Lap Lambert Academic Publishing GmbH KG
6. Aggarwal SK (2005) Advanced Environmental Biotechnology, APH publication.

COURSE: MICRO2SEC04
AGRICULTURE MICROBIOLOGY

Year end examination: 70 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit1: Soil Microbiology (15 Periods)

Soil microorganisms: microbial diversity in soil, decomposition of organic matter. Soil as microbial habitat; soil profile and properties, soil formation. Root exudates and rhizosphere effects. Manipulation of rhizosphere microflora in plant productivity.

Unit 2: Mineralization of organic and inorganic matter in soil (15 Periods)

Mineralization of cellulose, hemicelluloses, lignocelluloses, lignin and humus, phosphate, nitrate, silica, potassium. Microbial transformation of phosphorus, sulphur and minor nutrients. Nitrogen cycle, ammonification, nitrification, denitrification, biological nitrogen fixation: symbiotic and asymbiotic. Biochemistry and genetics of nitrogen fixation.

Unit 3: Biofertilizers, Phytostimulation and Bioinsecticides (15 Periods)

Plant growth promoting bacteria, biofertilizers- symbiotic (*Bradyrhizobium*, *Rhizobium*, *Frankia*), non-symbiotic (Azospirillum, Azotobacter, Mycorrhizae, MHBs, Phosphate solubilizers, algae). Role of biofertilizers in agriculture and forestry. Novel combinations of microbes as biofertilizers, PGPRs.

Unit 4: Bioremediation and Biocontrol (15 Periods)

Bioremediation of problem soil. Biocontrol mechanisms and ways; microbes used as biocontrol agents against microbial plant pathogens, insects weeds.

Suggested Readings

1. Agrios GN. (2006). Plant Pathology. 5th edition. Academic press, San Diego,
2. Singh RS. (1998). Plant Diseases Management. 7th edition. Oxford & IBH, New Delhi.
3. Glick BR, Pasternak JJ, and Patten CL (2010) Molecular Biotechnology 4th edition, ASM Press,
4. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
5. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
6. Barton LL & Northup DE (2011). Microbial Ecology. 1st edition, Wiley Blackwell, USA

COURSE: MICRO3SEC05
MANAGEMENT OF HUMAN MICROBIAL DISEASES

Year end examination: 70 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing seven (7) short-answer type questions of 2 marks each that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Human Diseases (15 Periods)

Infectious and non infectious diseases, microbial and non microbial diseases, Deficiency diseases, occupational diseases, Incubation period, mortality rate, nosocomial infections.

Unit 2 Microbial diseases (15 Periods)

Respiratory microbial diseases, gastrointestinal microbial diseases, Nervous system diseases, skin diseases, eye diseases, urinary tract diseases, Sexually transmitted diseases: Types, route of infection, clinical systems and general prevention methods, study of recent outbreaks of human diseases (SARS/ Swine flu/Ebola) – causes, spread and control, Mosquito borne disease – Types and prevention.

Unit 3 Therapeutics of Microbial diseases (14 Periods)

Treatment using antibiotics: beta lactam antibiotics (penicillin, cephalosporins), quinolones, polypeptides and aminoglycosides**.** Judicious use of antibiotics, importance of completing antibiotic regimen, Concept of DOTS, emergence of antibiotic resistance, current issues of MDR/XDR microbial strains. Treatment using antiviral agents: Amantadine, Acyclovir, Azidothymidine. Concept of HAART.

Unit 4 Prevention of Microbial Diseases (16 Periods)

General preventive measures, Importance of personal hygiene, environmental sanitation and methods to prevent the spread of infectious agents transmitted by direct contact, food, water and insect vectors. Vaccines:Importance, types, vaccines available against microbial diseases, vaccination schedule (compulsory and preventive) in the Indian context.

Suggested Readings

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson International Edit

GENERIC ELECTIVE

GE-3

Course: BIOTECH2GE3TH

MOLECULAR BIOLOGY (THEORY)

Theory examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

DNA structure and replication:DNA as genetic material, Structure of DNA, Types of DNA, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

UNIT II **(10 Periods)**

DNA damage, repair and homologous recombination:DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.

UNIT III **(17 Periods)**

Transcription and RNA processing:RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains
Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5' cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

UNIT IV **(18 Periods)**

Regulation of gene expression and translation:Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyltRNAsynthetases, Mechanism of initiation, elongation and termination of polypeptides, Fidelity of translation, Inhibitors of translation.,Posttranslational modifications of proteins.

Course: BIOTECH2GE3PR

MOLECULAR BIOLOGY (PRACTICAL)

PRACTICALS

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method
4. Agarose gel electrophoresis of genomic DNA & plasmid DNA
5. Preparation of restriction enzyme digests of DNA samples
6. Demonstration of AMES test or reverse mutation for carcinogenicity

SUGGESTED READING

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons.
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.

GE-4

Course: BIOTECH2GE4TH
IMMUNOLOGY (THEORY)

Theory examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(20 Periods)**

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T-lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

UNIT II **(15 Periods)**

Regulation of immunoglobulin gene expression – clonal selection theory, allotypes&idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.

UNIT III **(13 Periods)**

Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection – immunity to different organisms, pathogen defense strategies, avoidance of recognition.Autoimmune diseases, Immunodeficiency-AIDS.

UNIT IV **(12 Periods)**

Vaccines & Vaccination – adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics – RIA, ELISA.

Course: BIOTECH2GE4PR
IMMUNOLOGY (PRACTICAL)

PRACTICALS

1. Differential leucocytes count
2. Total leucocytes count
3. Total RBC count
4. Haemagglutination assay
5. Haemagglutination inhibition assay
6. Separation of serum from blood
7. Double immunodiffusion test using specific antibody and antigen.
8. ELISA.

SUGGESTED READING

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6 th 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'sImmunobiology. 7th edition Garland Science Publishers, New York.
5. Peakman M, and Vergani D. (2009). Basic and Clinical Immunology. 2nd edition Churchill Livingstone Publishers, Edinberg.

B.Sc. (HONORS)

MICROBIOLOGY

III YEAR

(CBCS STRUCTURE)

CORE COURSES

COURSE: MICRO3C11TH
FOOD AND DAIRY MICROBIOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Microbial spoilage of various foods (10 Periods)

Intrinsic and extrinsic factors that affect growth and survival of microbes in foods, natural flora and source of contamination of foods in general. Principles, Spoilage of vegetables, fruits, meat, eggs, milk and butter, bread, canned Foods.

Unit 2 Principles and methods of food preservation (20 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 3 Fermented foods (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, Probiotics: Health benefits, types of microorganisms used, probiotic foods available in market.

Unit 4 Food borne diseases ,detection methods and Food sanitation (20 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.* Cultural and rapid detection methods of food borne pathogens in food and introduction to predictive microbiology. HACCP, Indices of food sanitary quality and sanitizers

COURSE: MICRO3C11PR
FOOD AND DAIRY MICROBIOLOGY (PRACTICAL)

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 food borne bacteria from food products.
4. Isolation of spoilage microorganisms from spoiled vegetables/fruits.
5. Isolation of spoilage microorganisms from bread.
6. Preparation of Yogurt/Dahi.

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.

COURSE: MICRO3C12TH

MEDICAL MICROBIOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Normal microflora of the human body and host pathogen interaction (8 Periods)

Normal microflora of the human body: Importance of normal microflora, normal microflora of skin, throat, gastrointestinal tract, urogenital tract. Host pathogen interaction: Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection, Pathophysiologic effects of LPS.

Unit 2 Sample collection, transport , diagnosis and Antimicrobial agents (14 Periods)

Collection, transport and culturing of clinical samples, principles of different diagnostic tests (ELISA, Immunofluorescence, Agglutination based tests,Complement fixation, PCR, DNA probes). Antibacterial agents: Five modes of action with one example each: Inhibitor of nucleic acid synthesis; Inhibitor of cell wall synthesis; Inhibitor of cell membrane function; Inhibitor of protein synthesis; Inhibitor of metabolism. Antifungal agents: Mechanism of action of Amphotericin B, Griseofulvin. Antiviral agents: Mechanism of action of Amantadine, Acyclovir, Azidothymidine. Antibiotic resistance, MDR, XDR, MRSA, NDM-1

Unit 3 Bacterial and Protozoan diseases (20 Periods)

Bacterial diseases : List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control. Respiratory Diseases: *Streptococcus pyogenes, Haemophilus influenzae, Mycobacterium tuberculosis* Gastrointestinal Diseases: *Escherichia coli*, *Salmonella typhi*, *Vibrio cholerae*, *Helicobacter pylori* Others: *Staphylococcus aureus, Bacillus anthracis*, *Clostridium tetani, Treponema pallidum, Clostridium difficie*. Protozoan diseases :List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control Malaria, Kala-azar.

Unit 4 Viral and Fungal diseases (18 Periods)

Viral diseases :List of diseases of various organ systems and their causative agents. The following diseases in detail with Symptoms, mode of transmission, prophylaxis and control. Polio, Herpes, Hepatitis, Rabies, Dengue, AIDS, Influenza with brief description of swine flu, Ebola, Chikungunya, Japanese Encephalitis. Fungal diseases :Brief description of each of the following types of mycoses and one representative disease to be studied with respect to transmission, symptoms and prevention. Cutaneous mycoses: Tinea pedis (Athlete's foot) Systemic mycoses: Histoplasmosis Opportunistic. Mycoses: Candidiasis

COURSE: MICRO3C12PR

MEDICAL MICROBIOLOGY (PRACTICAL)

Practicals

1. Identify bacteria (any three of *E. coli, Salmonella, Pseudomonas, Staphylococcus, Bacillus*) using laboratory strains on the basis of cultural, morphological and biochemical characteristics: IMViC, TSI, nitrate reduction, urease production and catalase tests
2. Study of composition and use of important differential media for identification of bacteria: EMB Agar, McConkey agar, Mannitol salt agar, Deoxycholate citrate agar, TCBS
3. Study of bacterial flora of skin by swab method
4. Perform antibacterial sensitivity by Kirby-Bauer method
5. Determination of minimal inhibitory concentration (MIC) of an antibiotic.
6. Study symptoms of the diseases with the help of photographs: Polio, anthrax, herpes, chicken pox, HPV warts, AIDS (candidiasis), dermatomycoses (ring worms)
7. Study of various stages of malarial parasite in RBCs using permanent mounts.

Suggested Readings

1. Ananthanarayan R. and Paniker C.K.J. (2009) Textbook of Microbiology. 8th edition, University Press Publication
2. Brooks G.F., Carroll K.C., Butel J.S., Morse S.A. and Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Microbiology. 26th edition. McGraw Hill Publication
3. Goering R., Dockrell H., Zuckerman M. and Wakelin D. (2007) Mims' Medical Microbiology. 4th edition. Elsevier
4. Willey JM, Sherwood LM, and Woolverton CJ. (2013) Prescott, Harley and Klein's Microbiology. 9th edition. McGraw Hill Higher Education
5. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms. 14th edition. Pearson

COURSE: MICRO3C13TH

BIOPROCESS TECHNOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT 1 **(10 Periods)**

Introduction to bioprocess technology. Range of bioprocess technology and its chronological development. Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fedbatch and Continuous culture.

UNIT 2 **(20 Periods)**

Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; Cyclone Column; Packed Tower and their application in production processes. Principles of upstream processing – Media preparation, Inocula development and sterilization.

UNIT 3 **(15 Periods)**

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system with special reference to computer aided process control.

UNIT 4 **(15 Periods)**

Introduction to downstream processing, product recovery and purification. Effluent treatment. Microbial production of ethanol, amylase, lactic acid and Single Cell Proteins.

COURSE: MICRO3C13PR

BIOPROCESS TECHNOLOGY (PRACTICAL)

Practicals

1. Bacterial growth curve.
2. Calculation of thermal death point (TDP) of a microbial sample.
3. Production and analysis of ethanol.
4. Production and analysis of amylase.
5. Production and analysis of lactic acid.
6. Isolation of industrially important microorganism from natural resource.

SUGGESTED READING

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.

COURSE: MICRO3C14TH

INSTRUMENTATION AND BIOTECHNIQUES (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Microscopy (12 Periods)

Brightfield and darkfield microscopy, Fluorescence Microscopy, Phase contrast Microscopy,Confocal Microscopy, Electron Microscopy (Scanning and Transmission Electron Microscopy) and Micrometry.

Unit 2 Chromatography (14Periods)

Principles and applications of paper chromatography (including Descending and 2-D), Thin layerchromatography. Column packing and fraction collection. Gel filtration chromatography, ion-exchange chromatography and affinity chromatography, GLC, HPLC.

Unit 3 Electrophoresis (14 Periods)

Principle and applications of native polyacrylamide gel electrophoresis, SDS- polyacrylamide gelelectrophoresis, 2D gel electrophoresis, Isoelectric focusing, Zymogram preparation and Agarose gelelectrophoresis.

Unit 4 Spectrophotometry and Centrifugation (20 Periods)

Principle and use of study of absorption spectra of biomolecules. Analysis of biomolecules using UV and visible range. Colorimetry and turbidometry.

Preparative and analytical centrifugation, fixed angle and swinging bucket rotors. RCF andsedimentation coefficient, differential centrifugation, density gradient centrifugation and ultracentrifugation.

COURSE: MICRO3C14PR

INSTRUMENTATION AND BIOTECHNIQUES (PRACTICAL)

Practicals

1. Study of fluorescent micrographs to visualize bacterial cells.
2. Ray diagrams of phase contrast microscopy and Electron microscopy.
3. Separation of mixtures by paper / thin layer chromatography.
4. Demonstration of column packing in any form of column chromatography.
5. Separation of protein mixtures by any form of chromatography.
6. Separation of protein mixtures by Polyacrylamide Gel Electrophoresis (PAGE).
7. Determination of λmax for an unknown sample and calculation of extinction coefficient.
8. Separation of components of a given mixture using a laboratory scale centrifuge.
9. Understanding density gradient centrifugation with the help of pictures.

Suggested Readings

1. Wilson K and Walker J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. 7th Ed., Cambridge University Press.
2. Nelson DL and Cox MM. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
3. Willey MJ, Sherwood LM & Woolverton C J. (2013). Prescott, Harley and Klein's Microbiology. 9thEd., McGraw Hill.
4. Karp G. (2010) Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc.
5. De Robertis EDP and De Robertis EMF. (2006). Cell and Molecular Biology. 8th edition. Lipincott Williams and Wilkins, Philadelphia.
6. Cooper G.M. and Hausman R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.
7. Nigam A and Ayyagari A. 2007. Lab Manual in Biochemistry, Immunology and Biotechnology. Tata McGraw Hill

DISCIPLINE SPECIFIC ELECTIVE

(ANY 4)

COURSE: MICRO3DSE01TH
BIOCHEMICAL ENGINEERING

Theory examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(15 Periods)**

Microbial Growth Kinetics: Thermodynamic principles, Stationary cell growth, Growth yield, Specific growth rate, Product yield, Saturation constant, Biomass energetics, Yield equations based on Y_G, Y_{O2}, Y_{ATP}, Maintenance energy, Growth kinetics of batch, fed-batch, plug flow and continuous culture, High cell density cultures; Types of fermentation depending upon the product formation, Product synthesis kinetics, Growth and non-growth associated product synthesis.

UNIT II **(15 Periods)**

Bioreactors and Scale up: Basic concepts of bioreactors, parameters of biochemical process, packed bed, fed-batch, bubble column, fluidized bed, trickle bed, CSTR, plug flow reactors, Innovative bioreactors, Reactor Dynamics and reactors with non-ideal characteristics; Translation of laboratory, pilot and plant scale data, Criteria for translation between two scale of operation, Scale-up practices; Manual and automatic control system, on-line and off-line analytical instruments.

UNIT III **(20 Periods)**

Kinetics and Engineering of Sterilization: Kinetics of media sterilization, design of batch sterilization process,D-time, Z-value and F-value, calculation of Del-factor and holding time, Richards rapid method for design of sterilization cycles, Design of continuous sterilization, Air sterilization-design of air filters, Effect of air velocity and bed depth on filtration.

UNIT IV **(10 Periods)**

Mass Transfer and Downstream Processing: Fluids and its properties, Non-Newtonian fluids, introduction to transport phenomena, Gas–liquid mass transfer, mass transfer resistances, and determination of oxygen transfer coefficient; Recovery and purification of products from fermentation broth, Main Unit Operations in downstream processing, Membrane separation (microfiltration and ultrafiltration), Disruption of microbial cells.

Course: MICRO3DSE01PR
BIOCHEMICAL ENGINEERING

PRACTICALS

1. Microbial Growth kinetics-Determination of specific growth rate (μ_{max}), saturation constant (K_S) and growth yield ($Y_{X/S}$) for *Saccharomyces cerevisiae* in batch culture.
2. Determination of K_La by sulphite oxidation method.
3. Determination of thermal death rate constant and decimal reduction time for *E. coli*.
4. Disruption of microbial cells (Baker's yeast) for the release of the intracellular protein.
5. Bio-transformation of sucrose into high fructose syrup by immobilized cell of *Saccharomyces cerevisiae*

SUGGESTED READING

1. Biochemical Engineering: Aiba and Hemphery
2. Biochemical Engineering Fundamentals: J. E.Bailey and D. F.Ollis
3. Principles of Microbes and Cell Cultivation: S. John Pirt
4. Bioprocess Engineering Principles: Pauline M. Doran
5. Principles of fermentation technology: P.F. Stanbury and A. Whitekar

COURSE: MICRO3DSE02TH
BIOSTATISTICS (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Biomathematics (15 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. 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 2 (15 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. Differential Equations of first order, Linear Differential Equations. Points in plane and space and coordinate form. Examples of matrices arising in Biological Sciences and Biological networks. Sum and Produce of matrices upto order 3.

Unit 3 Biostatistics (15 Periods)

Measures of central tendency, Measures of dispersion; skewness, kurtosis; Elementary Probability and basic laws; Discrete and Continuous Random variable, Mathematical Expectation; Curve Fitting; Correlation and Regression. Emphasis on examples from Biological Sciences; Mean and Variance of Discrete and Continuous Distributions namely Binomial, Poisson, Geometric, Weibull, Logistic and Normal distribution. Fitting of Distributions;

Unit 4 (15 Periods)

Statistical methods: Scope of statistics: utility and misuse. Principles of statistical analysis of biological data. Sampling parameters. Difference between sample and Population, Sampling Errors, Censoring, difference between parametric and non-parametric statistics; Sampling Distributions, Standard Error, Testing of Hypothesis, Level of Significance and Degree of Freedom; Large Sample Test based on Normal Distribution, Small sample

test based on t-test, Z- test and F test; Confidence Interval; Distribution-free test - Chi-square test; Basic introduction to Multivariate statistics, etc.

COURSE: MICRO3DSE02PR
BIOSTATISTICS (PRACTICAL)

Practicals

1. Word Problems based on Differential Equations
2. Mean, Median, Mode from grouped and ungrouped Data set
3. Standard Deviation and Coefficient of Variation
4. Skewness and Kurtosis
5. Curve fitting
6. Correlation
7. Regression
8. Finding area under the curve using normal probability
9. Testing of Hypothesis- Normal Distribution, t-test and Chi-Square-test
10. Confidence Interval

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.

COURSE: MICRO3DSE03TH
ECOLOGY AND ENVIRONMENT MANAGEMENT

Theory examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT-I **(12 Periods)**

Our Environment: Geological consideration of Atmosphere, Hydrosphere, Lithosphere Scope of Ecology. Development & Evolution of Ecosystem. Principles & Concepts of Ecosystem. Structure of ecosystem. Strata of an ecosystem. Types of ecosystem including habitats. Cybernetics & Homeostasis. Biological control of chemical environment.

UNIT II **(20 Periods)**

Energy transfer in an Ecosystem. Food chain, food web, Energy budget, Production & decomposition in a system. Ecological efficiencies, Trophic structure & energy pyramids, Ecological energetic, principles pertaining to limiting factors, Bio-geochemical cycles (N,C,P cycles).

UNIT-III **(18 Periods)**

Pollution & environmental Health related to Soil, Water, Air, Food, Pesticides, Metals, Solvents, Radiations ,Carcinogen, Poisons. Detection of Environmental pollutant. Indicators & detection systems. Bio-transformation, Plastic, Aromatics, Hazardous wastes Environmental cleanup : Case studies

UNIT-IV **(10 Periods)**

Environmental biotechnologies, Biotechnologies in protection and preservation of environment. Bioremediation, Waste disposal.

Course: MICRO3DSE03PR
ECOLOGY AND ENVIRONMENT MANAGEMENT

PRACTICALS

1. Study of all the biotic and abiotic components of any simple ecosystem- natural pond or terrestrial ecosystem or human modified ecosystem.
2. Determination of population density in a terrestrial community or hypothetical community by quad rate method and calculation of the Simpson's and Shannon- Weiner diversity index for the same community.
3. Principle of GPS (Global Positioning System).
4. Study of the life table and fecundity table, plotting of the three types of survivorship curves from the hypothetical data.
5. Study of the types of soil, their texture by sieve method and rapid tests for –pH, chlorides, nitrates, carbonates and organic carbon
6. Study any five endangered/ threatened species- one from each class.

SUGGESTED READING

1. Chapman, J.L., Reiss, M.J. 1999. Ecology: Principles and applications (2nd edition) Cambridge University Press.
2. Divan Rosencraz, Environmental laws and policies in India, Oxford Publication.
3. Ghosh, S.K., Singh, R. 2003. Social forestry and forest management. Global Vision Publishing House
4. Joseph, B., Environmental studies, Tata Mc Graw Hill.
5. Michael Allabay, Basics of environmental science, Routledge Press.
6. Miller, G.T. 2002. Sustaining the earth, an integrated approach. (5thedition) Books/Cole, Thompson Learning, Inc.
7. Mohapatra Textbook of environmental biotechnology IK publication.
8. Rana SVS, Environmentalpollution – health and toxicology, Narosa Publication
9. Sinha, S. 2010. Handbook on Wildlife Law Enforsement in India. TRAFFIC, India.
10. Thakur, I S, Environmental Biotechnology, I K Publication.

COURSE: MICRO3DSE04TH
PARASITOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT 1 **(10 Periods)**

Protozoology: Brief history of protozoology, ecology and host parasite relationship (parasitism and symbiosis): Basis of host cell parasite interactions with special reference to autoimmune response and pathogenesis of protozoan diseases in general, zoonotic potentiality of protozoa.

UNIT 2 **(20 Periods)**

Amoeba: Non pathogenic and pathogen amoeba. Morphology and life cycle of amoeba pathology .Symptomatology Laboratory Diagnosis of

a) Giardia (G.Limblia)

b) Flagellates of genital tract Trichomonas (T. tenax, T.hominis, T.vaginalis)

c) Malaria parasite (Plasmodium vivax, P.malariae, P.ovale,) Genaral life cycle of Malarial parasite in man and anopheles mosquito, sequal of malaria, Toxoplasma gondi, life cycle, Symptomatology, Transmission and Lab diagnosis of Toxoplasmosis.

UNIT 3 **(15 Periods)**

Helminthology: Genaral introduction of helminthes and classification , medically important hemimths. Immunity in Taenia saginata, T.solium. Echinococcus granulosis, Trematodes, Schistosomes (S. haematobium, S.mansoni, S.Japonicum) Nematodes. Ascaris lumbriicoides, Ancylostome duodenale, Strongyloides stercoralis, Enterrobius, Wuchereria bancrofti, Brugia malayi, Dracunculus medinesis.

UNIT 4 **(15 Periods)**

Medical entomology: Role of arthrophods in the spread and causation of parasite diseases .Classification and general characteristics of important insects vectors. Mode of transmission of various diseases.

COURSE: MICRO3DSE04PR
PARASITOLOGY (PRACTICAL)

Practicals

1. To perform microscopic examination of cyst like *E.histolytica,E.coli.Giardia.*
2. Intestinalis in the given stool sample.
3. To observe the given stool sample &identify helmenthic ova.
4. To perform microscopic examination for the given urine sample .
5. To perform microscopic examination for the given stool sample .
6. Examination of stool sample using concentration technique for ova.
7. Examination of blood film for Malaria,Filaria,Leishman

Suggested Readings

1. Parasitology(K.D Chatterjee)
2. Medical Parasitology (Gillespie and Hawkey)
3. Modern Parasitology (F.E.G Cox)
4. Essential of Parasitology(Schimidt).

Course: MICRO3DSE05PR
PLANT PATHOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Introduction, History of plant pathology, Stages in development of a disease its epidemiology (12 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 DeBary, 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. Stages in development of a disease: Infection, invasion, colonization, dissemination of pathogens and perennation. Plant disease epidemiology: Concepts of monocyclic, polycyclic and polyetic diseases, disease triangle & disease pyramid, forecasting of plant diseases and its relevance in Indian context.

Unit 2 Host Pathogen Interaction (19 Periods)

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

B. *Genetics of Plant Diseases*: 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:* 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 3 Control of Plant Diseases (10 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 4 Specific Plant diseases (19 Periods)

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

A. Important diseases caused by fungi: 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;* Wilt of tomato - *Fusarium oxysporum* f.sp. *lycopersici;* Red rot of sugarcane - *Colletotrichum falcatum;* Early blight of potato - *Alternaria solani*

B. Important diseases caused by phytopathogenic bacteria: Angular leaf spot of cotton, bacterial leaf blight of rice, crown galls, bacterial cankers of citrus

C. Important diseases caused by phytoplasmas: Aster yellow, citrus stubborn

D. Important diseases caused by viruses: Papaya ring spot, tomato yellow leaf curl, banana bunchy top, rice tungro

E. Important diseases caused by viroids: Potato spindle tuber, coconut cadang cadang

COURSE: MICRO3DSE05PR
PLANT PATHOLOGY (PRACTICAL)

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.

COURSE: MICRO3DSE06TH
ADVANCES IN MICROBIOLOGY (THEORY)

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Evolution of Microbial Genomes (15 Periods)

Salient features of sequenced microbial genomes, core genome pool, flexible genome pool and concept of pangenome, Horizontal gene transfer (HGT), Evolution of bacterial virulence - Genomic islands, Pathogenicity islands (PAI) and their characteristics.

Unit 2 Metagenomics (15 Periods)

Brief history and development of metagenomics, Understanding bacterial diversity using metagenomics approach, Prospecting genes of biotechnological importance using metagenomics Basic knowledge of viral metagenome, metatranscriptomics, metaproteomics and metabolomics.

Unit 3 Molecular Basis of Host-Microbe Interactions (15 Periods)

Epiphytic fitness and its mechanism in plant pathogens, Hypersensitive response (HR) to plant pathogens and its mechanism, Type three secretion systems (TTSS) of plant and animal pathogens, Biofilms: types of microorganisms, molecular aspects and significance in environment, health care, virulence and antimicrobial resistance.

Unit 4 Systems and Synthetic Biology (15 Periods)

Networking in biological systems, Quorum sensing in bacteria, Co-ordinated regulation of bacterial virulence factors, Basics of synthesis of poliovirus in laboratory, Future implications of synthetic biology with respect to bacteria and viruses

COURSE: MICRO3DSE06PR
ADVANCES IN MICROBIOLOGY (PRACTICAL)

Practicals

1. Extraction of metagenomic DNA from soil
2. Understand the impediments in extracting metagenomic DNA from soil
3. PCR amplification of metagenomic DNA using universal 16s ribosomal gene primers
4. Case study to understand how the poliovirus genome was synthesized in the laboratory
5. Case study to understand how networking of metabolic pathways in bacteria takes place

Suggested Readings

1. Fraser CM, Read TD and Nelson KE. Microbial Genomes, 2004, Humana Press
2. Miller RV and Day MJ. Microbial Evolution- Gene establishment, survival and exchange, 2004, ASM Press
3. Bull AT. Microbial Diversity and Bioprospecting, 2004, ASM Press
4. Sangdun C. Introduction to Systems Biology, 2007, Humana Press
5. Klipp E, Liebermeister W. Systems Biology – A Textbook, 2009, Wiley –VCH Verlag
6. Caetano-Anolles G. Evolutionary Genomics and Systems Biology, 2010, John Wiley and Sons
7. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Bejamin Cummings
8. Wilson BA, Salyers AA Whitt DD and Winkler ME (2011)Bacterial Pathogenesis- A molecular Approach, 3rd edition, ASM Press,
9. Bouarab K, Brisson and Daayf F (2009) Molecular Plant-Microbe interaction CAB International
10. Voit EO (2012) A First Course in Systems Biology, Ist edition,Garland Science

GENERIC ELECTIVE COURSES

(FOR STREAMS OTHER THAN B.Sc. HONS. MICROBIOLOGY)

GE-1
COURSE: MICRO1GE01TH
CELL BIOLOGY

Year end examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.

UNIT II **(15 Periods)**

Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III **(20 Periods)**

Lysosomes: Vacuoles and micro bodies: Structure and functions. Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis. Nucleus: Structure and function, chromosomes and their structure.

UNIT IV **(15 Periods)**

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extra cellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis, characteristics and molecular basis of cancer.

COURSE: MICRO1GE01PR
CELL BIOLOGY

PRACTICALS

1. Study the effect of temperature and organic solvents on semi permeable membrane.
2. Demonstration of dialysis.
3. Study of plasmolysis and de-plasmolysis.
4. Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.
5. Study of structure of any Prokaryotic and Eukaryotic cell.
6. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney, ovary, testes.
7. Cell division in onion root tip/ insect gonads.
8. Preparation of Nuclear, Mitochondrial & cytoplasmic fractions.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition.Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress& 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. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

GE-2
COURSE: MICRO1GE02TH
INHERITANCE BIOLOGY

Theory examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Introduction to Genetics and Characteristics of Chromosomes (20 Periods)

Historical developments. Model organisms in genetic analyses and experimentation: *Escherichia coli*, *Saccharomyces cerevisiae, Neurospora crassa, Caenorhabditis elegans Drosophila melanogaster, Arabidopsis thaliana.*

Characteristics of Chromosomes: Structural organization of chromosomes - centromeres, telomeres and repetitive DNA, Packaging DNA molecules into chromosomes, Concept of euchromatin and heterochromatin, Normal and abnormal karyotypes of human chromosomes, Chromosome banding, Giant chromosomes: Polytene and lampbrush chromosomes, Variations in chromosome structure: Deletion, duplication, inversion and translocation, Variation in chromosomal number and structural abnormalities - Klinefelter syndrome, Turner syndrome, Down syndrome

Unit 2 Mendelian Principles and Linkage (20 Periods)

Mendel's Laws: Dominance, segregation, independent assortment, deviation from Mendelian inheritance, Rediscovery of Mendel's principles, Chromosome theory of inheritance: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian genetics: Allelic interactions, concept of dominance, recessiveness, Incomplete dominance and co-dominance, Multiple alleles, Epistasis, penetrance and expressivity

Linkage and Crossing over: Linkage and recombination of genes, Cytological basis of crossing over, Crossing over at four-strand stage, Molecular mechanism of crossing over, mapping

Unit 3 Extra-Chromosomal Inheritance (10 Periods)

Rules of extra nuclear inheritance, Organelle heredity - Chloroplast mutations in *Chlamydomonas*, mitochondrial, mutations in *Saccharomyces*, Maternal effects – Shell coiling in *Limnaea peregra* Infectious heredity - Kappa particles in *Paramecium*

Unit 4 Recombination and Human genetics (10 Periods)

Homologous and non-homologous recombination, including transposition, site-specific recombination.

Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders. Polygenic inheritance, heritability and its measurements, QTL mapping

COURSE: MICRO1GE02PR
INHERITANCE BIOLOGY

Practicals

1. Mendelian deviations in dihybrid crosses
2. Studying Barr Body with the temporary mount of human cheek cells
3. Studying *Rhoeo* translocation with the help of photographs
4. Karyotyping with the help of photographs
5. Chi-Square Analysis
6. Study of polytene chromosomes using temporary mounts of salivary glands of *Chiromonas / Drosophila* larvae
7. Study of pedigree analysis
8. Analysis of a representative quantitative trait

Suggested Readings

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Snustad DP, Simmons MJ (2011). Principles of Genetics. 6th Ed. John Wiley and Sons Inc.
3. Weaver RF, Hedrick PW (1997). Genetics. 3rd Ed. McGraw-Hill Education
4. Klug WS, Cummings MR, Spencer CA, Palladino M (2012). Concepts of Genetics. 10th Ed. Benjamin Cummings
5. Griffith AJF, Wessler SR, Lewontin RC, Carroll SB. (2007). Introduction to Genetic Analysis. 9th Ed. W.H.Freeman and Co., New York
6. Hartl DL, Jones EW (2009). Genetics: Analysis of Genes and Genomes. 7th Ed, Jones and Bartlett Publishers
7. Russell PJ. (2009). *i* Genetics - A Molecular Approach. 3rd Ed, Benjamin Cummings

GE-3
COURSE: MICRO2GE03TH
BIO ANALYTICAL TOOLS

Theory examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

UNIT I **(10 Periods)**

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

UNIT II **(15 Periods)**

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

UNIT III **(15 Periods)**

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

UNIT IV **(20 Periods)**

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

COURSE: MICRO2GE03PR
BIO ANALYTICAL TOOLS

PRACTICALS

1. Native gel electrophoresis of proteins
2. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
3. Preparation of the sub-cellular fractions of rat liver cells.
4. Preparation of protoplasts from leaves.
5. Separation of amino acids by paper chromatography.
6. To identify lipids in a given sample by TLC.
7. To verify the validity of Beer's law and determine the molar extinction coefficient of NADH.

SUGGESTED READING

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th 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.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

GE-4
COURSE: MICRO2GE04TH
MICROBIAL GENETICS

Theory examination: 50 marks
Practical examination: 20 marks
Internal Assessment: 30 marks

Note: The Examiner will set a total of nine (9) questions covering all topics/ units of the prescribed course by setting at least two questions from each unit. Out of the nine questions, one question containing ten (10) short-answer type questions that will cover entire course will be compulsory. The candidate will attempt a total of five questions (one from each unit) including the compulsory question. All questions will carry equal marks.

Unit 1 Genome Organization and Mutations (18 Periods)

Genome organization: *E. coli, Saccharomyces, Tetrahymena.* Mutations and mutagenesis: Definition and types of Mutations; Physical and chemical mutagens; Molecular basis of mutations; Functional mutants (loss and gain of function mutants); Uses of mutations. Reversion and suppression: True revertants; Intra- and inter-genic suppression; Ames test; Mutator genes'

Unit 2 Plasmids and Phage Genetics (18 Periods)

Types of plasmids – F plasmid, R Plasmids, colicinogenic plasmids, Ti plasmids, linear plasmids, yeast- 2 μ plasmid, Plasmid replication and partitioning, Host range, plasmid-incompatibility, plasmid amplification, Regulation of copy number, curing of plasmids. Features of T4 genetics , Genetic basis of lytic *versus* lysogenic switch of phage lambda

Unit 3 Mechanisms of Genetic Exchange (12 Periods)

Transformation - Discovery, mechanism of natural competence. Conjugation - Discovery, mechanism, Hfr and F' strains, Interrupted mating technique and time of entry mapping. Transduction - Generalized transduction, specialized transduction, LFT & HFT lysates, Mapping by recombination and co-transduction of markers

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Unit 4 Transposable elements (12 Periods)

Prokaryotic transposable elements – Insertion Sequences, composite and non-composite transposons, Replicative and Non replicative transposition, Mu transposon. Eukaryotic transposable elements - Yeast (Ty retrotransposon), Drosophila (P elements), Maize (Ac/Ds). Uses of transposons and transposition

COURSE: MICRO2GE04PR
MICROBIAL GENETICS

Practicals

1. Preparation of Master and Replica Plates
2. Study the effect of chemical (HNO2) and physical (UV) mutagens on bacterial cells
3. Study survival curve of bacteria after exposure to ultraviolet (UV) light
4. Isolation of Plasmid DNA from *E.coli*
5. Study different conformations of plasmid DNA through Agaraose gel electrophoresis.
6. Demonstration of Bacterial Conjugation
7. Demonstration of bacterial transformation and transduction
8. Demonstration of AMES test

Suggested Readings

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning
3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
4. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
6. Russell PJ. (2009). *i* Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings
7. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.
8. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett Publishers