Progressive Education Society's
Modern College of Arts, Science and Commerce (Autonomous)
Shivajinagar, Pune 5

(An Autonomous College Affiliated to Savitribai Phule Pune University)

Framework of Syllabus

For

M.Sc. Microbiology

(Based on NEP 2020 framework)
(To be implemented from the Academic Year 2023-2

Semester 1 (First Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory Theory (4+4+4+2)	23ScMicP111	Major Theory Paper 1	Microbial Taxonomy & Systematics	4	4	50	50	100
	23ScMicP112	Major Theory Paper 2	Biochemistry and Metabolism	4	4	50	50	100
	23ScMicP113	Major Practical 1	Practical course based on Microbial Taxonomy & Systematics	8	4	50	50	100
	23ScMicP114	Major Practical 2	Practical course based on Biochemistry	4	2	25	25	50
Major Elective Theory (4)	23ScMicP121	Major Elective 1 (Theory + `Practical)	Instrumentation & Molecular biophysics (Theory)	2	2	25	25	50
			Practical based on Biophysics	4	2	25	25	50
	23ScMicP122	Major Elective 2 (Theory + Practical)	Cell cytology & Communication Biology (Theory)	2	2	25	25	50
			Practical Based on Communication Biology	4	2	25	25	50
RM (4)	23ScMicP131	RM Theory Paper	Research Methodology (Section 1)	2	2	50	50	100
		RM Practical Paper	Research Methodology (Section 2)	4	2			
OJT (4)		–	–	–	–	–	–	–
Total				32	22	275	275	550

Semester 2 (First Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory Theory (4+4+4+2)	23ScMicP211	Major Theory Paper 1	Industrial Wastewater Treatment & Management	4	4	50	50	100
	23ScMicP212	Major Theory Paper 2	Enzymology, Biochemistry and Metabolism	4	2	25	25	50
	23ScMicP213	Major Practical 1	Practical course I: Based on Industrial Wastewater Treatment	8	4	50	50	100
	23ScMicP214	Major Practical 2	Practical course II: Based on Enzymology	4	2	25	25	50
Major Electives (4)	23ScMicP221	Major Elective 1 (Theory + Practical)	Quantitative Biology	2	2	25	25	50
			Practicals based on Quantitative Biology	4	2	25	25	50
	23ScMicP222	Major Elective 2 (Theory + Practical)	Microbial & Plant Physiology	2	2	25	25	50
			Practicals based on Microbial & Plant Physiology	4	2	25	25	50
RM (4)		–	–	–	–	–	–	–
		–	–	–				
OJT (4)	23ScMicP241	OJT	On Job Training	8	4	50	50	100
Total				32	22	275	275	550

Semester 3 (Second Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandatory Theory (4+4+4+2)	23ScMicP311	Major Theory Paper 1	Immunology	4	4	50	50	100
	23ScMicP312	Major Theory Paper 2	Molecular Biology & Biotechnology I	4	4	50	50	100
	23ScMicP313	Major Practical 1	Practical Course I : Lab course based on Molecular Biology	8	4	50	50	100
	23ScMicP314	Major Practical Paper 2	Practical Course II : Lab course based on Immunology	4	2	25	25	50
Major Electives (4)	23ScMicP321	Major Elective 1 (Theory + Practical)	Microbial Technology	2	2	25	25	50
			Lab course based on Microbial Technology	4	2	25	25	50
	23ScMicP322	Major Elective 2 (Theory)	Microbial Technology and Pharmaceutical Microbiology	4	4	50	50	100
RP (4)	23ScMicP352	RP	Research Project	8	4	50	50	100
OJT (4)								
Total				28	22	275	275	550

Semester 4 (Second Year)

Course Type	Code	Course	Course / Paper Title	Hours / Week	Credit	CIA	ESE	Total
Major Mandator Theory (4+4+4)	23ScMicP411	Major Theory Paper 1	Pharmaceutical Microbiology	4	4	50	50	100
	23ScMicP412	Major Theory Paper 2	Virology	4	4	50	50	100
	23ScMicP413	Major Practical 1	Practical Course I : Lab course based on Pharmaceutical Microbiology and Virology	8	4	50	50	100
Major Electives (4)	23ScMicP421	Major Elective 1 (Theory)	Molecular Biology & Biotechnology II (Elective)	4	4	50	50	100
	23ScMicP422	Major Elective 2 (Theory)	Virology and Molecular Biology (Elective)	4				
RP (4)	23ScMicP452	RP	Research Project	12	6	75	75	150
OJT (4)								
Total				22	22	275	275	550

OJT: On Job Training
RM: Research Methodology
RP: Research Project

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PG Part 2 Year of M.Sc. (Microbiology)

(2024 Course under NEP 2020)

Course Code : 23ScMicP311 **Course Name : Immunology**

Teaching Scheme: TH: 4Hours/Week **Credit : 04**

Examination Scheme: CIA : 50 Marks **End-Sem : 50 Marks**

Prerequisite Courses:

- First Year M.Sc. Microbiology

Course Objectives:

- To Study the structure and functions of various cell surface receptors and functions
- To understand the regulation of immune responses
- To learn the techniques in experimental immunology
- To study tumor immunology

Course Outcomes:

On completion of the course, student will be able to–

- Identify the structure and function of various receptors present on the surface of the cell
- Comment on the techniques used in experimental immunology
- Examine immunological response and how it is triggered and regulated.
- Explain the escape mechanisms of tumor form host defense and immune response to tumor
- Predict how the immune system works and carries out its functions
- Write about tumor immunology

Course Content:

Unit	Topic	Lectures
Unit 1	Cell surface molecules and receptors	15
	• Adhesion molecules in immune activation, structure and function of G-protein coupled receptors, Toll like receptors, Cytokine receptors, T Cell receptor, B Cell Receptor, Tyrosine kinase linked receptor, TCR-CD3 complex • Signal transduction pathways: IL-2 pathway (JAK/STAT and Ras/MAP Kinase Pathways)	
Unit 2	Regulation of Immune Response	15
	• Negative regulation - Immunological tolerance, Mechanisms of tolerance induction (related experimentation using transgenic animals), T cell mediated suppression of immune response • Regulation of immune responses by antigen, • Antigen antibody complexes, Network theory and	

	its experimental evidence • Cytokine mediated cross regulation of TH subsets (TH1-TH2) • Regulation of complement system Classical and alternative pathway • Biological Response Modifiers for cancer therapy and autoimmune disorders	
Unit 3	Experimental Immunology	15
	• Animal Cell Culture techniques: Definition of terms primary cell culture and cell lines, established cells lines, suspension and anchorage dependent cell cultures, transformation of cells in culture, culture media, factors affecting cells in culture, cell line nomenclature. • In vitro systems –Quantification of cytokines (ELISPOT assay), functional assays for phagocytes and cytokines (cytotoxicity and growth assays) • In vivo systems – Experimental animals in immunology research (Inbred animal strains, Knockout mice, transgenic animals), Animal models for autoimmunity and AIDS	
Unit 4	Tumor Immunology	15
	• Cellular transformations during neoplastic growth, Classification of tumors based on histological, Tumors of lymphoid system (lymphoma, myeloma, Hodgkin's disease) • Escape mechanisms of tumor from host defense, Host immune response to tumor – Effector mechanisms, Immuno- surveillance theory • Diagnosis of tumors – biochemical and immunological tumor markers • Approaches in cancer immunotherapy: Immune adjuvant and tumor vaccine therapy	

References :

1. Kindt, Osborne, Goldsby, (2006), Kuby Immunology, 6th Ed., and 7th Ed., W. H. Freeman & Co
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3. Roitt I. M. (1988) Essentials of Immunology, ELBS, London.
4. Lodish H. Molecular cell biology , 5th Editon
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6. Bruce Alberts, Molecular Biology of the Cell (2007), 5th Edition, Garland Science
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8. Paul W. E. (2003). Fundamental Immunology. 5th Ed. Lippincott. Williams and Wilkins Publishers.
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PGPart 2 Year of M.Sc. (Microbiology)

(2023 Course under NEP 2020)

Course Code : 23ScMicP312 Course Name : Molecular Biology and Biotechnology I

Teaching Scheme: TH: 4 Hours/Week **Credit 04**

Examination Scheme: CIA : 50 Marks **End-Sem : 50 Marks**

Prerequisite Courses:

- M.Sc. first year Microbiology

Course Objectives:

- To study gene processing, expression and it's control.
- To learn molecular biology tools and techniques.
- To know the applications of molecular biology in biotechnology

Course Outcomes:

On completion of the course, student will be able to–

On completion of the course, students will able to –

- Perform molecular biology experiments by using different molecular biology tools.
- Analyze and decide about the application of correct tools for experiment.
- Explain RNA processing and splicing processes
- Explain fine control of gene expressions in different operons
- Describe and discuss different methods used for proteomics, transcriptomics and metabolomics
- Plan / construct molecular biology experiments and also can perform them successfully

Course Contents

Unit 1	**RNA Processing**	No of Lectures
	• mRNA processing: splicing, capping, polyadenylation, RNA editing, coordination of mRNA processing, • rRNA processing: tRNA processing, • Non codingRNAs and their production and role. • RNA interference; SiRNA, micro-RNA role in gene Silencing • Riboswitches	15
Unit 2	Fine Control of Prokaryotic transcription	15
	• Lactose operon: repressor-operator interactions, mechanism of repression, Positive control of lac operon-Mechanism of CAP action.(with necessary experiments)	

	• The Arabinose operon: Ara operon repression loop, evidence for repression loop, auto regulation of araC.(with necessary experiments) • The trp operon:- control of trp operon by attenuation, defeating attenuation. (with necessary experiments) • Sigma factor Switching:- Phage infection- T4,T7 • Infection in *E. coli*, SPO1 infection in *B. subtilis*.	
Unit 3	Tools and Techniques in Molecular Biology	15
	• Assays- Activity gel assay, ChIP, DMS foot printing, DNA helicase assay, Epitope tagging, Sequence tagged sites, Filter binding assay, Yeast two andthree hybrid assay,. • Knockout mice, phage display, Expressed sequence tags, • DNA finger printing • CRISPR / Cas9 in Genome Editing- Concept, Introduction, Applications including nanocarriers, Applications based on specific emphasis on Chinese and American clinical trials • Measuring transcription rates,	
Unit 4	Proteomics, Transcriptomics and Metabolomics	14
	• Proteomics – (Introductory) ▪ Expression, Analysis and Characterization of Protein, ▪ Analysis of protein structure, ▪ Protein interaction. ▪ Applications • Transcriptomics – (Introductory) ▪ Expression, analysis and characterization. ▪ Applications –diagnostics, responses to environment. • Microbial or Human metabolomics (Introductory)	
Unit 5	**Field Visit/ Internship/ Experiential learning**	01

Note : Problems on suitable credits will be practiced and can be asked in examination.

References :

1. James D. Watson, Tania Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Loswick (2004) Molecular Biology of the Gene, 5th Edition, Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.USA
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PG Part 2 Year of M.Sc. (Microbiology)

(2023 Course under NEP 2020)

Course Code : 23ScMicP313 Course Name : Lab course based on Molecular Biology

Teaching Scheme: TH: 8 Hours/Week **Credit 04**

Examination Scheme: CIA : 50 Marks **End-Sem : 50 Marks**

Prerequisite Courses:

- M. Sc. Microbiology first year

Course Objectives:

- To study basic techniques in Molecular Biology which are needed in research work
- To teach the students with development of industrial products

Course Outcomes:

On completion of the course, student will be able to–

- Acquire principles and science behind different techniques, their role, and importance in research as well as in different applications
- Students will be taught how to apply these techniques in research as well as industries
- Students will be aware of recent techniques used in industry for optimization of process parameters

Course Contents

	Topic	No of Practicals
Unit 1		10
	1. Plasmid DNA isolation 2. Plasmid Characterization 3. Agarose gel electrophoresis 4. Transformation a) Preparation of competent cells b) Transformation of *E. coli* with standard plasmids c) Detection by Blue white assay d) Calculation of transformation efficiency 5. Concept of lac-operon: a) Diauxic growth curve of *E.coli*	
Unit 2	Molecular Biology – II	7
	1. Restriction enzyme, Ligation and cloning: a) Restriction digestion of plasmid DNA b) Vector and Insert Ligation c) Confirmation of the insert by PCR and Restriction mapping d) Expression of recombinant protein (GFP) 2. Gene Annotation	

	*Any 15 practical will be conducted	

References :

Molecular biology :
J. Sambrook and D. W. Russel (2001), Molecular Cloning: A Laboratory Manual, Volume 1, 2, 3, Cold Spring Harbour Laboratory Press, Cold

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PG Part 2 Year of M.Sc. (Microbiology)

(2023 Course under NEP 2020)

Course Code : 23ScMicP314 **Course Name : Lab course based on Immunology**

Teaching Scheme: TH: 4 Hours/Week **Credit :02**

Examination Scheme: CIA : 25 Marks **End-Sem : 25 Marks**

Prerequisite Courses:

- First Year M.Sc. Microbiology

Course Objectives:

- To Study precipitation reactions of antigen-antibody
- To understand the different between precipitation and agglutination
- To learn different types of cell culture and gain knowledge about their cultivation.
- To learn preparation of serum from blood and perform its analysis

Course Outcomes:

On completion of the course, student will be able to–

- Identify different techniques used in immunology for antigen antibody interactions
- Compare between different types of cell cultures and gain knowledge about their cultivation
- Prepare the serum from blood sample and analysis it
- Calculate the concentration of unknown antigen
- Comment on Agglutination and measure the titre of antibody
- Solve or troubleshoot the problems which arise during performing experiments

Course Contents

	Name of the practical	No of Practical
	• Precipitation reactions of antigen-antibody: 1) Single radial immunodiffusion 2) rocket immuno-electrophoresis 3) Ouchterlony Double Diffusion for antigen-antibody pattern	4
	• Agglutination techniques: Titer determination of isoantibodies to human blood group antigens	1
	• Preparation of serum from the blood sample and analysis of its proteins by electrophoresis a) Preparation of serum from whole blood sample. b) Separation of serum proteins by agarose gel electrophoresis. c) Analysis of separated protein fractions by densitometry (by Image J software).	3
	• Density gradient based separation of peripheral lymphocytes – Preparation of lymphocyte culture	2
	• Chick embryo fibroblast cell culture	2

	*Any 8 practical out the 12 practical will be performed	

References:

1. Axelsen N. H., Kroll J. and Weeke B. (1973). A manual of quantitative immune electrophoresis: methods and applications. Scand. J. Immunol. 2(Suppl. 1): 37- 46
2. Galvão de França N.D., Cristovão Poli M.C., Almeida Ramos P.G., Rocha Borsoi C.S. and Colella R. (2011). Titers of ABO antibodies in group O blood donors.Rev Bras Hematol Hemoter. 33: 259–262
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6. Freshney R. I. (2005). Culture of Animal Cells: A Manual of Basic Technique, 5th Ed., John Wiley and Sons, Inc
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10. Dasso, M. (1998). Cell culture. Current protocols in cell biology.
11. Donovan, J., and Brown, P. (2011). Care and handling of laboratory animals. Current protocols in immunology, 73(1), 1-6.
12. Helgason, C. D., & Miller, C. L. (Eds.). (2005). Basic cell culture protocols (Vol. 290). Totowa, NJ: Humana Pres

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PG Part Part 2 Year of M.Sc. (Microbiology) SEMESTER III
(2024 Course under NEP 2020)
Course Code : 23ScMic321 Course Name : Microbial Technology Elective I(T+P)

Teaching Scheme: TH: (2+4) Hours/Week **Credit: 02+02**

Examination Scheme: CIA : 25 Marks **End-Sem : 25 Marks**

Prerequisite for Course : First Year M.Sc. Microbiology (NEP)

Course Objectives:

- To Study the concept of microbial growth, metabolism and applications of microbial technology in varied fields.
- To provide a strong understanding of applied microbiology and will help the students to explore work opportunities in Biotechnology Companies and Industries as well.

Course Outcomes:

On completion of the course, student will be able to–

- Portray the production methods for industrially important products of microbial origin such as antibiotics, vaccines, proteins, primary and secondary metabolites, as well as food and dairy products.
- Clarify application of microorganisms in varied fields.

Course Contents : Microbial Technology Theory

Unit	Name of the Topic	No. of Lectures
Unit 1	**Process variables**	**20**
	• The configuration (placement) of impellers in a vessel and the different types of impellers (types of turbines and propellers, and their combinations) • Aeration - Theory of oxygen transfer in bubble aeration, Oxygen transfer kinetics (Oxygen Uptake Rate –OUR; Oxygen Transfer Rate OTR; Ccrit), determination of KLa • Fermentation broth rheology and power requirements for agitation – Concept of Newtonian and non- Newtonian fluids, effect of broth rheology on heat, nutrient and oxygen transfer, Reynold's number, Power number, Aeration number • Effect of type of growth on fermentation: The type of growth (mycelial pellet form, mycelial filamentous form, free cell, cells producing exopolysaccharides) affects mass transfer of nutrients, oxygen and heat; as also cell proliferation can be affected by shearing of cells. At least one example of each type may be explained to show these effects in any suitable fermentation	

Unit 2	Monitoring of process/ Method Validation:	10
	Monitoring of process variables: • Use of various types of sensors and biosensors for monitoring environmental parameters (pressure, pH, • temperature, DO and DCO2), Basic principles of operation, types of biosensors • **Preparation of SOPs** • Process validation *The above should be discussed within WHO Norms.* *Exercises on preparation of SOPs, operation and validation for analytical methods*	

Note: Problems on each credit will be practiced and can be asked in examination.

Course Contents : Lab course based on Microbial Technology

	Topic	No. of Practical's
	1. Laboratory scale production and media optimization for exopolysaccharide / bioemulsifier production	3
	2. Bioconversions using immobilized cell system Parameter testing: a. Effect of gel concentration b. Effect of enzyme concentration	3
	3. Demonstration using hypothetical examples for optimization (PBD & RSM).	1
	4. Process of patent filing (Experiential learning).	1
	5. Preparation of SOPs and process validation.	1

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1. Doran Pauline (1995) Bioprocess Engineering Principles, Academic Press.
2. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993) Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and Sons Inc.
3. Lydersen B., N. a. D' Elia and K. M. Nelson (Eds.) (1993), Bioprocess Engineering: Systems, Equipment and Facilities, John Wiley and Sons Inc.
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13. The FDA's draft process validation Guidance-A perspective from industry. By Naula Calnan, Alice Redmond and Stan O' Neill. Process Validation Guidance
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PG Part Part 2 Year of M.Sc. (Microbiology) SEMESTER III
(2024 Course under NEP 2020)

Course Code: 23ScMicP322
Course Name: Microbial Technology and Pharmaceutical Microbiology (Elective)
Teaching Scheme: TH:4 Hours/Week
Credit : 04 Examination Scheme: CIA: 50 Marks End-Sem IV : 50 Marks
Prerequisite Courses: First Year M.Sc. Microbiology (NEP)

Course Objectives:

- To provide the students with an opportunity to familiarize Quality Assurance and Validation in the Pharmaceutical Industry
- To introduce the student's biopharmaceuticals as well as regulations and their sources.
- To allow the students to know about therapeutics and pharmaceutical biotechnology.
- To allow students to show the applications of Microbial Technology

Course Outcomes:
On completion of the course, the student will be able to–

- Understand GMP, GLP, QA, QM, sterilization control and sterility testing in the pharmaceutical industry.
- Get information on regulatory authorities and their role, drug formulations in the pharmaceutical industry. Students will also get introduced to pharmacokinetics and Pharmacodynamics in ADME studies.
- Get information about sources of biopharmaceuticals and will understand the working principles of biosensors produced in the pharmaceutical industry.
- Understand the microbial biotechnology, its scope, applications microbial products and their purification.

Course Contents

Unit	**Topic**	**No. of Lectures**
Unit 1	**Quality Assurance and Validation in the Pharmaceutical Industry**	**16**
	a. Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in the pharmaceutical industry. b. Quality assurance (QA) and quality management (QM) in pharmaceuticals ISO, WHO and USFDA certification. Safety in the Microbiology laboratory. c. Sterilization control and sterility testing i. Heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization ii. Chemical and biological indicators.	
Unit 2	**Biopharmaceuticals –Regulations and their Sources**	**14**

	a. Regulatory authorities and its role: FDA and Pharmacopeia (IP, UK, US) b. Drug formulations - Carriers and delivery systems, targeted drug delivery, sustained release c. Pharmacokinetic – ADME / Bioavailability studies	
Unit 3	**Therapeutic and Pharmaceutical Biotechnology**	**15**
	a. Sources of biopharmaceuticals - i. *E. coli* as a source of recombinant, therapeutic proteins Expression of recombinant proteins in animal cell culture systems. For example, Streptokinase and Recombinant Hepatitis B vaccine ii. Production systems using yeasts and fungi iii. Transgenic animals iv. Transgenic plants b. Biosensors	
Unit 4	**Microbial Technology**	**14**
	a. Microbial biotechnology: Scope in human therapeutics, agriculture b. Use of prokaryotic and eukaryotic microorganisms in biotechnological applications c. Microbial based transformation of steroids and sterols d. Microbial product purification, Immobilization methods, and their application	
Unit 5	**Industrial visit/ Experiential learning/ Internship**	**01**

References :

1. Jay, J. M., Loessner, M. J., & Golden, D. A. (2008). Modern food microbiology. Springer Science & Business Media.
2. Baird, R. M., Hodges, N. A., & Denyer, S. P. (Eds.). (2000). Handbook of microbiological quality control in pharmaceuticals and medical devices. CRC Press.
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PG Part 2 Year of M.Sc. (Microbiology)

(2023 Course under NEP 2020)

Course Code : 23ScMicP411 Course Name : Pharmaceutical Microbiology

Teaching Scheme: TH: 4 Hours/Week **Credit 04**

Examination Scheme: CIA : 50 Marks **End-Sem : 50 Marks**

Prerequisite Courses:

- M.Sc First Year Microbiology

Course Objectives:

- To Study the drug development process
- To learn the mode of action of certain antibiotics against bacteria
- To study how to perform antibiotic susceptibility test by using various methods
- To learn how pathogenic bacteria attack the host cell.

Course Outcomes:

On completion of the course, student will be able to–

- Highlight the intricacies of drug development
- Understand the concept of Pharmacodynamics and Pharmacokinetics
- Determine the growth and inhibiton of bacteria by using various techniques.
- Deconstruct every step in the process of drug development
- Test and Experiment various drug testing strategies and methods to quantify effects of anti-infectives
- Devise strategies for the process of drug development

Course Contents

	Name of the topic	No of Lectures
Unit 1	Introduction to Pharmaceutical Mirobiology	15
	• Definitions of the following term Hit, Lead, Candidate drug selection, New Investigational Drug, New Drug Entity, Drug and its active Principle • Drug Development Process Target identification, Target validation, Assay Development, High throughput screening, Hit identification, Hit to lead, Lead optimization (lead	

	likeness, drug likeness, determination of biological, biochemical properties of drug, pharmacovigilance), Drug candidate • Drug Discovery Conventional Process bioprospecting – Methods of extraction, Purification and Characterization of bioactive molecules from natural sources Rational Drug Design – Ligand based and receptor based drug design, Combinatorial synthesis , Pharmacogenomics • Drug Development 1) Preclinical Development Toxicity testing – Acute, Sub-acute and Chronic 2) Clinical Development Clinical trails (aim, objective and conduct) – Clinical Trails I, II, III and IV)	
Unit 2	Discovery of anti-infectives	15
	• Drug targets in bacteria with examples of established drugs: Cell wall biosynthesis, Cell membrane function, Proteins synthesis and Nucleic acid synthesis and metabolism • Methods to quantify growth / inhibition and metabolic changes in microbial population on exposure to anti-infectives, for evaluation of anti infective activity and developing insight in its' mode of action: 1) Direct counts (Counting chambers, calibrated smears, proportionate counts), 2) Tubidometry and nephalometry, 3) Electrical impedance, 4) Microcalorimetry, 5) Flow cytometry and 6) Radiometric methods • Laboratory methods to assess activity of antimicrobial combinations (antagonism, Synergism, and addictive effect) • Safety Profile of Drug 1) Pyrogenicity testing 2) Mutagenicity and carcinogenicity testing 3) Teratogenicity testing	

	4) Adverse Drug Reaction 5) In vivo and in vitro drug interaction	
Unit 3	Development of Anti-infectives	15
	• Concepts Bioavailability Therapeutic ratio, MIC and MBC, Thrapeutic index, selective toxicity • Susceptibility testing 1) Factors affecting susceptibility testing, CLSI Guidelines 2) Use of liquid and solid media 3) Diffusion methods – agar dilution technique, gradient plate techniques, E-test, Kirby Bauer, Stokes method 4) Susceptibility testing for: i. Anti-mycobacterial agents ii. Anti-fungal agents iii. Anti-protozoan agents iv. Anti-viral agents	
Unit 4	Physicochemical properties of drug and drug metabolism	15
	• Dose-Response Relationship • Physicochemical properties of drug and drug metabolism 1) Passage of molecules through biological barriers. Membrane transport (paracellular, transcellular). 2) Drug absorption: Drug dosages, from gastric emptying to gastric permeability to drug, first pass effect, bioavailablity. 3) Drug distribution: Drug-plasma/ serum binding, blood brain barrier, accumulations in tissues. 4) Drug elimination: Drug excretion, Drug biotransformation, Biotransformation reactions, Functionalization, Conjugation reaction, Reactions leading to toxic metabolites	

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PG Part Part 2 Year of M.Sc. (Microbiology) SEMESTER IV

(2024 Course under NEP 2020)

Course Code : 23ScMic412 Course Name : Virology

Teaching Scheme: TH: 4 Hours/Week Credit: 04

Examination Scheme: CIA : 50 Marks End-Sem : 50 Marks

Prerequisite for Course : First Year M.Sc. Microbiology (NEP)

Course objectives:

- To study life cycle of viruses
- To study cultivation and detection of viruses
- To understand viral therapeutics

Course outcomes:

- Acquire principles of viral replication and virus-host interaction.
- Develop the capacity to device strategy for elimination of viral infections applying viral therapeutic knowledge.

Unit No	Topic	No. of Lectures
1	**Structure and classification of viruses Structure of viruses**	**15**
	● Enveloped and Non enveloped viruses ● Capsid symmetries – Icosahedral/ polyhedral and Helical ● Structural components of virus ○ Protein – Envelope proteins, Matrix proteins and Lipoproteins ○ Genome – dsDNA, ssDNA, dsRNA, ssRNA (positive sense, negative sense and ambisense), linear, circular, segmented. **Classification and nomenclature of viruses** ● ICTV nomenclature and classification Baltimore classification	
Unit 2	**Replication of viruses**	**15**

	● Mechanism of virus adsorption and entry into host cell ● Genome replication ● Post transcriptional processing ● Translation of viral proteins ● Protein nucleic acid interactions and genome packaging ● Assembly, exit and maturation of progeny virions	
Unit 3	**Cultivation and detection of viruses** **Cultivation of viruses:**	15
	● *In ovo*: using embryonated chicken eggs ● *In vivo*: using experimental animals ● *Ex vivo / In vitro:* using various cell cultures – primary and secondary cell lines, suspension cell cultures and monolayer cell culture ● In plants and plant cell cultures **Diagnostic and detection methods for viruses:** ● Sampling techniques and Processing of samples – Enrichment and concentration ● Direct methods of detection – Light microscopy (inclusion bodies), Electron microscopy and Fluorescence microscopy ● Immunodiagnosis, Hemagglutination and Hemagglutination inhibition tests, Complement fixation, Neutralization, Western blot, Radioactive Immunoprecipitation Assay (RIPA), Flow Cytometry and Immunohistochemistry ● Nucleic acid based diagnosis: Nucleic acid hybridization, Polymerase Chain Reaction (PCR), Microarray and Nucleotide sequencing, LINE probe assay, quantitative PCR for viral load. ● Infectivity assay for animal and bacterial viruses – Plaque method, Pock counting, End point methods, LD50, ID50, EID50, TCID50, checking susceptibility of virus to antiviral therapies. ● Infectivity assays of plant viruses	
Unit 4	**Viral Therapeutics**	**15**
	Modern approaches of virus control ● Small interfering RNA (siRNA) ● Ribozymes **Antiviral drugs**	

	• Designing and screening of antiviral agents • Mechanism of action (e.g. Nucleoside analogues, Nucleotide analogues, Antisense, Topical immune modulator, neuraminidase inhibitors, Ion channel function inhibitors of M2 proteins, Pyrimidines) • Antiretroviral drugs: Mechanism of action and resistance • Antiviral drugs against HCV	

Note : Problems on each credit will be practiced and can be asked in examination.

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PG Part 2 M.Sc. (Microbiology)

(2023 Course under NEP 2020)

Course Code :23ScMicP413 Course Name : Lab course based on Pharmaceutical Microbiology and Virology

Teaching Scheme: TH: 4 Hours/Week **Credit 04**

Examination Scheme: CIA : 50 Marks **End-Sem : 50 Marks**

Prerequisite Courses:

- First year M.Sc Microbiology

Course Objectives:

- To learn practicals related to pharmaceutical microbiology
- To learn the cultivation of viruses by egg inoculation method
- To study the one step growth curve of bacteriophage
- To learn various techniques related to virology

Course Outcomes:

On completion of the course, student will be able to–

- Identify procedures for practicals related to pharmaceutical Microbiology
- Comment on MIC and MBC of an antibiotic
- Examine the antibiotic susceptibility testing for gram positive and gram negative bacteria
- Estimate the titre of animal virus
- Comment on routes of inoculation of animal virus
- Write experiments related to virology

Course Contents

Unit 1	Pharmaceutical Microbiology	lectures
	• Extraction of bioactive principles from plant and activity fractionation. • Estimation of its antimicrobial activity using standard guidelines (CLSI) • Bacterial Endotoxin Test • Ames test • Determining the MIC and MBC of an antibiotic against a bacterial culture	2 2 1 2

	• Bacterial Antibiotic sensitivity test for gram positive and gram negative bacteria.	2
Unit 2	Virology	
	• Demonstration of Egg inoculation technique for virus cultivation by various routes – embryo, yolk sac, allantoic fluid, amniotic cavity, chorioallontoic membrane. • Animal virus titration by Hemagglutination test. • Qualitative and quantitative detection of bacteriophage • One step Growth curve of Bacteriophage • Phage Genome annotation using the RAST pipeline • Any 15 practicals will be performed	1 1 3 2 1

References :

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PG Part Part 2 Year of M.Sc. (Microbiology) SEMESTER IV

(2024 Course under NEP 2020)

Course Code : 23ScMic421 Course Name : Molecular Biology and Biotechnology II (Elective)

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA : 50Marks **End-Sem : 50 Marks**

Prerequisite for Course : First Year M.Sc. Microbiology (NEP)

Course objectives:

- To study gene technology and get aware with the recent research in the field of gene technology.
- To understand the tools and techniques used in genetic engineering and its applications in biotechnology.

Course outcomes:

On completion of the course,

- Students will have strong theoretical knowledge of this technology
- Student will be able to design and perform gene technology experiments.
- Apply RDTfor industrial use.
- Infer the significance of gene technology in the field of research.

Course Contents

Unit No	Topic	No. of Lectures
1	**Epigenetics and genetic variation**	**15**
	• Chromatin higher organization: chromosome, centromere and telomere. • Concept of Epigenetics – DNA methylation, histone modification, epigenetic inheritance, effect of environment on epigenetic changes. • Genomic variation-SNPs, SNPs diseases and medical therapies. Costs of prolonged life. Recognition oftrades offs associated with genomic variation.	

	• Eukaryotic and bacterial SNPS and pharmacogenomics	
Unit 2	**Gene technology**	**15**
	• Gene cloning strategies: genome libraries, cDNA libraries, PCR cloning and alternatives. Library screening. • Cloning and manipulating large fragments of DNA ; YAC BAC HAC • Site directed mutagenesis and protein engineering, Directed Mutagenesis: Oligonucleotide directed mutagenesis with M-13 phage, PCR-amplified oligonucleotide directed mutagenesis, error-prone PCR, Random insertion and deletion mutagenesis, selection of mutant peptide – phage display and cell surface display. Protein Engineering: Adding disulfide bonds, changing asparagine to other amino acids, reducing number of free sulfhydryl residues, increasing enzymatic activity, modifying metal cofactor requirement, decreasing protein sensitivity, modifying protein sensitivity, increasing enzyme stability and specificity, altering multiple properties.	
Unit 3	**Applications of recombinant DNA technology**	**14**
	• Synthesis of products – • amino acids(tryptophan), ascorbic acid, novel antibiotics(from Streptomyces spp), recombinant antibodies (staph Toxin, chemically linked monoclonal antibodies, anticancer antibodies) • polysaccharide(Xanthum gum), polyesters (Polyhydroxyalkanoates) • Gene augmentation and gene therapy • Design of vaccines for TB, Leprosy and Hepatitis B. • DNA vaccines – design and advantages	

Unit 4	**Genetically modified organisms & Genome project**	**15**
	• Genetically modified animals and plant (Ti plasmids and its applications), • Applications of these transgenic plants and animals. • Genetically modified organisms- social and ethical issues. • Concept and meaning of genome project. Strategies used (shot gun/ whole genome projects). Human Genome projects and their applications. • DNA barcoding, Gene annotation • Comparative genomics	
Unit 5	**Field Visit/ Internship/ Experiential learning**	**01**

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PG Part Part 2 Year of M.Sc. (Microbiology) SEMESTER IV

(2024 Course under NEP 2020)

Course Code : 23ScMic422 Course Name : Virology and Molecular Biology(Elective)

Teaching Scheme: TH: 4 Hours/Week **Credit: 04**

Examination Scheme: CIA : 50 Marks **End-Sem : 50 Marks**

Prerequisite for Course : First Year M.Sc. Microbiology (NEP)

Course objectives:

- To study pathogenicity and life cycle of viruses
- To understand virus-host interaction and elimination of viral infections.

Course outcomes:

- Acquire principles of viral replication and virus-host interaction.
- Understand the properties of oncogenic viruses and thereby device treatment for the same.
- Develop the capacity to device strategy for elimination of viral infections.

Course Content :

Unit 1	**Topic**	**Workload**
	Bacteriophage: Bacteriophage ecology Morphology, Genome organization and Life cycles i) T (odd and even phages) ii) Lambda phage iii) M13 phage iv) Phi X 174phage v) MS2 phage Bacteriophage therapy for control of bacterial poultry diseases	10
Unit 2	**Animal viral diseases:**	**15**

	● **Cytopathic effects of virus** a) Effects of viruses on animals i) Appearance of infected animal cells ii) Histological iii) Physiological and cytological changes in infected animal cells b) Behaviour of viruses in animals i) Early stages of infection ii) Biochemistry of virus replication iii) Cellular sites of virus replication and assembly iv) Release and translocation of virus particles in tissues (Heterozygosity, mutation, structure, function, and mode of infection of single-stranded DNA and RNA viruses. Biosynthesis, translation, genetics, and replication of mammalian DNA and RNA viruses) ● Emerging viruses, Principles of viral disease control, elimination and eradication, (with examples of smallpox, polio) Human viruses (Antigenic characteristics, pathophysiology and epidemiology) i) Herpes viruses ii) Ebola iii) Corona (COVID-19) ● Prion diseases of animals ● Disaster management of infectious viral diseases	
Unit 3	**Plant viral diseases:**	**15**
	● Cytopathic effects of virus a) Effects of viruses on plants ii) Appearance of infected animal cells iii) Histological iv) Physiological and cytological changes in infected animal cells b) Behavior of viruses in plants ii) Early stages of infection iii) Biochemistry of virus replication iv) Cellular sites of virus replication and assembly v) Release and translocation of virus particles in tissues (Heterozygosity, mutation, structure, function, and mode of infection of single-stranded DNA and RNA viruses. Biosynthesis, translation, genetics, and replication of mammalian DNA and RNA viruses)	

	• Methods for detection of plant viruses • In seeds, seed stocks and diseased plants • Indicator plants • Antigen based methods • Histopathological methods i) TMV ii) CMV • Transmission and prevention of plant viruses	
Unit 4	**Transformation and oncogenesis**	**20**
	• Oncogenic viruses • Activation of cellular signal transduction pathways by viral oncogenic products • Disruption of cell cycle control pathways by viral oncogene products • Transformed cells must also grow and survive • Tumorigenesis requires additional changes in the properties of transformed cells • Non transducing, complex oncogenic retroviruses With reference to HIV and Hepatitis B	

Note : Problems on each credit will be practiced and can be asked in examination.

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