HSNC University Mumbai

Ordinances and Regulations with Respect to

Choice Based Credit

System (CBCS)

For the Programmes Under

The Faculty of Science and Technology HSNC University Mumbai

Ordinances and Regulations

With Respect to

Choice Based Credit

System (CBCS)

For the Programmes Under The Faculty of Science and Technology

For the Course Microbiology Curriculum –

First Year Postgraduate Programs

Semester-I and Semester -II

NEP- 2020

HSNC UNIVERSITY, MUMBAI

Board of Faculty of Science & Technology

Board of Studies in Microbiology Subject

1.) Name of Chairperson/Co-Chairperson/Coordinator: -

a.) Dr. Sejal Rathod (Associate Professor and Head, Department of Microbiology, K.C college, Churchgate) sejal.rathod@kccollege.edu.in 9930082028

2.) Two to five teachers each having minimum five years teaching experience amongst the full-time teachers of the Departments, in the relevant subject.

a.) Dr. Pratibha Shah (Associate Professor, Department of Microbiology, K.C college, Churchgate) pratibha.shah@kccollege.edu.in 9773321760

b.) Dr. Rajitha Satish (Assistant Professor, Department of Microbiology, K.C college, Churchgate) rajitha.satish@kccollege.edu.in 9833716190

c.) Ms. Amina Dholkawala (Assistant Professor, Department of Microbiology, K. C college, Churchgate) amina.dholkawala@kccollege.edu.in 7208724194

3.) One Professor / Associate Professor from other Universities or professor / Associate Professor from colleges managed by Parent Body; nominated by Parent Body; -

a.) Dr Bela Nabar (Associate Professor, HOD of Microbiology, Department of Microbiology, CHM College, Ulhasnagar) belamsn23@gmail.com 9322760417

b.) Dr. S. Raut (Associate professor, Department of Microbiology, Bhavans college, Andheri West, Mumbai, Maharashtra 400058) svrmicro@yahoo.co.in 9869053676

4.) Four external experts from Industry / Research / eminent scholar in the field relevant to the subject nominated by the Parent Body;

a.) Mrs. Prabha Padmanabha (former Associate Professor, Department of Microbiology, KC College Mumbai- 400 020) prabhapadmanabha@hotmail.com 9820860049

b.) Dr. Sahayog Jamdar (Scientific Officer G, Food and Technology Division BARC) snjam2@gmail.com 2225595375

c.) Dr. Mehul Rajpurkar (Regional Medico Marketing Manager, SRL Diagnostics, Goregaon West) mehul.rajpurkar@gmail.com 9819107505

d.) Dr. Surekha Zingde (Former Dy. Director, Cancer Research Institute, ACTREC,) Tata Memorial Centre, Kharghar) surekha.zingde@gmail.com 9820633284

5.) Top rankers of the Final Year Graduate and Final Year Post Graduate examination of previous year of the concerned subject as invitee members for discussions on framing or revision of syllabus of that subject or group of subjects for one year.

a.) Ms. Uzma Shaikh (Undergraduate student- 18-19) Contact – 9004718231 , uzma25.shaikh@gmail.com

b.) Ms. Soni Gupta (Postgraduate student -18-19) Contact - 9167147185 , sonigupta445@gmail.com

Dr. Sejal Rathod

Chairperson- BOS Microbiology

Part –I

Outline of Choice Based Credit System as outlined by University Grants Commission:

R. **** : The Definitions Of The Key Terms Used In The Choice Based Credit System And Grading System Introduced From The Academic Year 2023-2024 are as under:

1. Core Course: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. Elective Course: Generally, a course which can 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 is called an Elective Course.

   2.1 Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (tobe offered by main discipline/subject of study).

   2.2 Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project. A Project/Dissertation work would be of 6 credits. A Project/Dissertation work may be given in lieu of a discipline specific elective paper.

   2.3 Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective.
   P.S.: A core course offered in a discipline/subject may be treated as an elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. Choice Base Credit System : CBCS allows students to choose inter- disciplinary, intra-disciplinary courses, skill oriented papers (even from other disciplines according to their learning needs, interests and aptitude) and more flexibility for students.

4. Honours Program : To enhance employability and entrepreneurship abilities among the learners, through aligning Inter Disciplinary / Intra Disciplinary courses with Degree Program. Honours Program will have 40 additional credits to be undertaken by the learner in fourth year.

5. Program: A Program is a set of course that are linked together in an academically meaningful way and generally ends with the award of a Degree Certificate depending on the level of knowledge attained and the total duration of study, B.Sc. Programs.

6. Course: A 'course' is essentially a constituent of a 'program' and may be conceived of as a composite of several learning topics taken from a certain knowledge domain, at a certain level. All the learning topics included in a course must necessarily have academic coherence, i.e. there must be a common thread linking the various components of a course. A number of linked courses considered together are in practice, a 'program'.

7. Bridge Course: Bridge course is visualized as Pre semester preparation by the learner before commencement of regular lectures. For each semester the topics, whose knowledge is considered as essential for effective and seamless learning of topics of the Semester, will be specified. The Bridge Course can be conducted in online mode. The Online content can be created for the Bridge Course Topics.

8. Module and Unit: A course which is generally an independent entity having its own separate identity, is also often referred to as a 'Module' in today's parlance, especially when we refer to a 'modular curricular structure'. A module may be studied in conjunction with other learning modules or studied independently. A topic within a course is treated as a Unit. Each course should have exactly 3 Units.

9. Self-Learning: 20% of the topics will be marked for Self-Learning. Topics for Self-Learning are to be learned independently by the student, in a time- bound manner, using online and offline resources including online lectures, videos, library, discussion forums, fieldwork, internships etc.

Evaluative sessions (physical/online), equivalent to the credit allocation of the Self Learning topics, shall be conducted, preferably, every week for each course. Learners are to be evaluated real time during evaluative sessions. The purpose of evaluative sessions is to assess the level of the students' learning achieved in the topics earmarked for Self-Learning.

The teacher's role in these evaluative sessions will be that of a Moderator and Mentor, who will guide and navigate the discussions in the sessions, and offer concluding remarks, with proper reasoning on the aspects which may have been missed by the students, in the course of the Self-Learning process.

The modes to evaluate self-learning can be a combination of the various methods such as written reports, handouts with gaps and MCQs, objective tests, case studies and Peer learning. Groups can be formed to present self- learning topics to peer groups, followed by Question-and-Answer sessions and open discussion. The marking scheme for Self-Learning will be defined under Examination and Teaching.

The topics stipulated for self-learning can be increased or reduced as per the recommendations of the Board of Studies and Academic Council from time to time. All decisions regarding evaluation need to be taken and communicated to the stakeholders preferably before the commencement of a semester. Some exceptions may be made in exigencies, like the current situation arising from the lockdown, but such ad hoc decisions are to be kept to the minimum possible.

10. **Credit Point:** Credit Point refers to the 'Workload' of a learner and is an index of the number of learning hours deemed for a certain segment of learning. These learning hours may include a variety of learning activities like reading, reflecting, discussing, attending lectures / counseling sessions, watching especially prepared videos, writing assignments, preparing for examinations, etc. Credits assignedfor a single course always pay attention to how many hours it would take for a learner to complete a single course successfully. A single course should have, by and large a course may be assigned anywhere between 2 to 8 credit points wherein 1 credit in theory is construed as corresponding to approximately 15 learning hours.

11. **Credit Completion and Credit Accumulation:** Credit completion or Credit acquisition shall be considered to take place after the learner has successfully cleared all the evaluation criteria with respect to a single course. Thus, a learner who successfully completes a 4 CP (Credit Point) course may be considered to have collected or acquired 4 credits. learner level of performance above the minimum prescribed level (viz. grades / marks obtained) has no bearing on the number of credits collected or acquired. A learner keeps on adding more and more credits as he completes successfully more and more courses. Thus the learner 'accumulates' course wise credits.

12. **Credit Bank:** A Credit Bank in simple terms refers to stored and dynamically updated information regarding the number of Credits obtained by any given learner along with details regarding the course/s for which Credit has been given, the course-level, nature, etc. In addition, all the information regarding the number

of Credits transferred to different programs or credit exemptions given may also be stored with the individual's history.

13. **Credit Transfer:** (performance transfer) When a learner successfully completes a program, he/she is allowed to transfer his/her past performance to another academic program having some common courses and Performance transfer is said to have taken place.

14. **Course Exemption:** Occasionally, when two academic programs offered by a single university or by more than one university, may have some common or equivalent course-content, the learner who has already completed one of these academic programs is allowed to skip these 'equivalent' courses while registering for the new program. The Learner is 'exempted' from relearning' the common or equivalent content area and from re-appearing for the concerned examinations. It is thus taken for granted that the learner has already collected in the past the credits corresponding to the exempted courses.

Part-II

The Scheme of Teaching and Examination

The performance of the learners shall be evaluated in two components for total 100 marks per Paper: Formative by way of continuous evaluation and Summative assessment by Semester End Examination.

Formative Assessment:- It is defined as the assessment of the learners on the basis of continuous evaluation as envisaged in the credit based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

Summative assessment :- It is defined as the assessment of the learners on the basis of Semester end assessment as envisaged in the credit based system by way of participation of learners in various academic and correlated activities in the given semester of the programme.

Distribution of Marks

Sr. No.	Particulars	Marks
1	End-Semester Examination	60 Marks
2	Self-Learning Evaluation	15 Marks
3	Practicals	25 Marks

A. Semester End Examination- 60 % of overall marks - 60 Marks

B. Practical Examination-25% of overall marks - 25 Marks

1. Practical exam would be conducted over a period of 3 days; 25M for each practical paper (2 Majors and 1 Minor in each semester).
2. Each student to perform at least 1 major and 1 minor practical for Semester I and II.
3. Viva would be conducted during the practical during the practical examination.

The marks will be given for all examinations and they will be converted into grade (quality) points. The semester-end, final grade sheets and transcripts will have only credits, grades, grade points, SGPA and CGPA.

Project and Assignment:

- Project or Assignment, which can in the following forms
  - Case Studies, Videos, Blogs

- Research paper (Presented in Seminar/Conference)
- Field Visit Report
- Presentations related to the subject (Moot Court, Youth Parliament, etc.)
- Internships (Exposition of theory into practice), Open Book Test
- any other innovative methods adopted with the prior approval of Director Board of Examination and Evaluation.

4. Self-Learning Evaluation

– 20% OF THE TOPICS OF CURRICULUM ARE LEARNED BY THE STUDENT THROUGH SELF LEARNING USING ONLINE / OFFLINE ACADEMIC RESOURSE SPECIFIED IN THE CURRICULUM.

- HENCE 20% OF THE LECTURES SHALL BE ALLOCATED FOR EVALUATION OF STUDENTS ON SELF LEARNING TOPICS

– The identified topics in the syllabus shall be learnt independently by the students in a time bound manner preferably from online resources.

CLUB The self-learning topics into 3-4 GROUPS OF TOPICS ONLY FOR EVALUATION.

• PRESCRIBE TIME DURATION (IN DAYS) FOR COMPLETION OF EACH GROUP OF TOPIC AND EARMARK SELF LEARNING EVALUATION LECTURES IN THE TIMETABLE. HENCE EACH GROUP OF TOPIC CAN BE ASSIGNED 3 REGULAR LECTURES FOR THIS EVALUATION FOR ENTIRE CLASS

Methods for Evaluation of Self-learning topics:
- Seminars/presentation (PPT or poster), followed by Q&A − Objective questions /Quiz / Framing of MCQ questions.
- Debates
- Group discussion
- You-Tube videos (Marks shall be based on the quality and viewership)
- Improvisation of videos
- Role Play followed by question-answers,
- Viva Voce
- Any other innovative method

TEACHERS CAN FRAME OTHER METHODS OF EVALUATION ALSO PROVIDED THAT THE METHOD, DULY APPROVED BY THE COLLEGE EXAMINATION COMMITTEE, IS NOTIFIED TO THE STUDENTS AT LEAST 7 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION AND IS FORWARDED FOR INFORMATION AND NECESSARY ACTION AT LEAT 3 DAYS BEFORE THE COMMENCEMENT OF THE EVALUATION SESSION

Microbiology

Part 1- Preamble

This two- year M. Sc. program is designed by experts from Academia, Industry and research institution to develop skilled Microbiologists who can progress to diverse fields of microbiological interests that include industry, research, teaching, medical science and entrepreneurship.

The course is aimed at adding to the knowledge base of Microbiology graduates through significant inputs of the latest information on the subject. It also envisages that the students read original research publications and develop the ability of critical evaluation of the study. Development of communication skills - written and spoken - as well as laboratory work and teamwork, creativity, planning and execution are also a primary objective of this program.

In the core courses, the students study the basics of Microbiology along with the basics of subjects allied to and useful in Microbiology. The specializations include topics on various fields of Cell Biology, Genetics, Molecular Biology, Biochemistry, Medical Microbiology and Immunology in the first year of the program.

Students are required to undergo a training program and complete online courses as a part of their continuous internal evaluation. Students will also have to learn literature survey, writing a scientific report, and research proposal for their continuous evaluation. This will prepare them well for the Research Project in Semester IV.

The student should study Microbiological aspects in the Industry and submit their report. Students are also required to compulsorily undertake an educational tour organized by the Department each year (M. Sc. I and M. Sc. II) to various places of Microbiological interest and submit a Report.

1. Course Objectives and Outcomes:

Semester I

MBO501B: Genetics and Molecular Biology I

Learning Objectives

- To learn Rational mutagenesis
- To study the various molecular tools for genetics
- To learn the development of Drosophila
- To study Population genetics
- To learn Metagenomics, proteomics and epigenetics

Learning Outcomes

- The students will understand the various methods of carrying out Rational Site specific and random Mutagenesis.
- The students will also understand the principle and working of Molecular biology techniques and set up experiments using them.
- Students will gain knowledge of the Development Biology of Drosophila.
- Students will understand the laws governing Population Genetics and will be able to solve numericals and problems related to population genetics.
- The students will know the importance, tools and techniques involved in the study of Genomics, Proteomics and Epigenetics.

MBO502B: Medical Microbiology and Immunology I

Learning objectives

- To learn the different methods of testing antimicrobials activity and drug-resistant organisms.
- To learn principles of epidemiology and different ways of public health surveillance
- To understand the threat of antibiotic resistance and different methods of testing drug-resistant organisms
- To study 'Emerging and re-emerging diseases' in India and worldwide.
- To learn about the types of hypersensitivity and mechanisms of immune tolerance.
- To understand the Human gut microbiome project and its importance.

Learning Outcomes

- The students will be able to carry out different methods of testing antibiotic resistant organisms.

- The students will get the knowledge of emerging and reemerging infectious diseases in India and around the world.
- The students will be able to recognize and describe the different types and causes of hypersensitivity and allergy.
- The students will be able to understand the significance of gut microbiome and Human genome project.
- The student will be able explain genetic recombination and expression of immunoglobulin genes.

MBO503B: Biochemistry

Learning Objectives:

- To strengthen the fundamental concepts of Biochemistry and understand the broad domains of biochemistry.
- To study the structure and function of organic molecules.
- To learn the mechanisms of transport of biomolecules.

Learning Outcomes

- The current syllabus will enable the students to grasp the structure and functions of biomolecules.
- The students will gain knowledge about the protein structure, folding and its transport.
- The students will be able to prepare buffers, solutions and carry out unit conversions.

Semester II

MBO504B: Cell Biology

Learning Objectives:

- To understand the organization of the cellular components.
- To study the events of the cell cycle and how they are controlled and coordinated.
- To learn the features of some cell-cell communication systems
- To study the variations in chromosomal structure and number and associated syndromes.

Learning Outcomes

- The learner will be able to understand the complexity of the cell membrane, protein sorting and vesicular transport.
- The students will be able to understand the role of cell-cell adhesion molecules and junctions.
- The learner will be able to understand the regulation and control of cell cycle and cell death.
- The students will be able to understand cell signaling and communication
- To understand the chromosomal abnormalities associated with cytogenetic disorders

MBO505B: Medical Microbiology and Immunology II

Learning Objectives

- To learn about the different types of immunodeficiency and autoimmune disorders and their modes of treatment
- To understand the concepts of applied immunology such as transplantation and tumor immunology
- To study different experimental techniques useful in immunological diagnosis
- To learn about recent advances in diagnostics methods

Learning Outcome

- The student will be able to summarize the role of immune system in the etiology and treatment of cancer/oncogenic malignancies.

- The student will be able to describe and understand the recent advances in diagnostic techniques.

- The student will be able to identify and describe different types of immunological disorders

MBO506B: Microbial Biochemistry

Learning Objectives:

- To learn enzyme kinetics, regulation and mechanism of enzyme action.
- To study the metabolism of aromatic compounds, one and Two carbon compounds.
- To understand signalling systems and stress responses in bacteria.

Learning Outcomes:

- The students will be able to analyze the kinetics of enzyme catalysis and enzyme inhibitions.
- The students will have the knowledge of molecular mechanisms of responses to different stress signals.
- The learner will know about the mechanisms of complex degradation of unusual carbon compounds.

- **Scheme of Examination**

ASSESSMENT PATTERN:

- **Theory**
- Semester End Examination (60 M per paper)
- Internal Assessment (40M per paper)
  20 Marks – SLE and 20 Marks – Assignment

- **Practical**
- **Semester End Practical examination: (50 M per paper)**

First Year Semester I - Units – Topics – Teaching Hours

Sr No	Subject Code	Subject Unit Title		Hours/ Lectures	Total No. of hours/lectures	Credits
1	MBO501B- Genetics and Molecular Biology	I	Rational mutagenesis and molecular tools for genetics	15	45 L	3
		II	Drosophila development and population genetics	15		
		III	Metagenomics, proteomics and epigenetics	15		
2	MBO502B- Medical Microbiology and Immunology- I	I	Epidemiology of infectious diseases and Clinical bacteriology	15	45 L	3
		II	Emerging and Re-emerging Diseases.	15		
		III	Tolerance, Hypersensitivity and Immunobiology	15		
3	MBO503B- Biochemistry Microbiology	I	Chemical reactivity, Minerals, Vitamins and coenzymes and Hormones	15	45 L	3
		II	Biomolecules	15		
		III	Transport of biomolecules	15		
4	MBO501D-		Practicals based on MBO501B-	30	-	1
5	MBO502D-		Practicals based on MBO502B-	30	-	1
6	MBO503D-		Practicals based on MBO503B-	30	-	1

MBO501B- (Genetics and Molecular Biology)

Unit	Topic	Credits	Lectures	References
1	**Rational mutagenesis and molecular tools for genetics**	01	15	Molecular Biotechnology - Glick
	1.1 Rational Mutagenesis 1.1.1 Oligonucleotide directed mutagenesis – with M13 and plasmid DNA 1.1.2 PCR amplified oligonucleotide directed mutagenesis 1.1.3 Random mutagenesis – with degenerate oligonucleotide primer and with nucleotide analogues, Error-prone PCR, DNA shuffling Mutant proteins with unusual amino acids		04	
	1.2 Molecular tools 1.2.1 Labeled tracers (autoradiography, phosphorimaging, liquid scintillation counting, non-radioactive tracers), Overview of Nucleic acid hybridization, In situ hybridization, DNA sequencing, Restriction mapping 1.2.2 Mapping and quantifying transcripts (S1 mapping, primer extension, run-off transcription) Measuring transcription rates in vivo (Nuclear run – on transcription, reporter gene transcription) 1.2.3 Assaying DNA –protein interactions (filter binding, gel mobility shift, DNase and DMS footprinting)		08	
	1.3 Polymerase Chain Reaction 1.3.1 Fundamentals of the PCR, 1.3.2 Variations/ Modifications of PCR: Reverse transcriptase PCR, Differential display PCR, Real time Fluorescent PCR(taq man and SYBR green), Hot- Start PCR, Multiplex PCR, Nested PCR, 1.3.3 Applications		03	
2	**Drosophila development and population genetics**	01	15	Genetics: A Conceptual Approach, Benjamin Pierce
	2.1 Drosophila developmental - Stages, Embryonic development, Maternal effect genes, segmentation genes, Homeotic genes		05	

	2.2 Population genetics 2.2.1 Genetic structure of population 1. Hardy-Weinberg Law 2. Genetic variation in space and time 3. Genetic variation in Natural population 4. Forces that change gene frequencies in populations: i. Mutation, ii. Random genetic drift iii. Migration iv. Natural selection v. Balance between mutation and selection vi. Assertive mating vii. Inbreeding 2.2.2 Summary of the effects of evolutionary forces on the genetic structure of population The role of genetics in conservation Biology		10	iGenetics- Russell
3	**Metagenomics, proteomics and epigenetics**	01	15	
	3.1 Metagenomics 3.1.1 Comparative Genomics: finding Genes that make us human, recent changes in the human genome 3.1.2 Characterization of Gene amplification and deletions in microbiome using DNA microarrays (Representational Oligonucleotide Microarray Analysis (ROMA) 3.1.3 Functional genomics-DNA Microarray technology, Serial analysis of gene expression (SAGE)		07	iGenetics- A Molecular Approach, Russell
	3.2 Proteomics 3.2.1 Separation and identification of proteins (2D PAGE, MALDI –TOF), Protein profiling (LC- MS), 3.2.1 Protein interaction by Co-immunoprecipitation, protein tagging system, Protein Microarrays, Protein protein interaction Mapping (Two hybrid assay, TAP tag procedure)		06	C. David
	3.3 Epigenetics 3.3.1 Definition, Model Systems for the Study of Epigenetics 3.3.2 Regulation of chromatin structure through histone post-translational modifications and covalent modification of DNA		02	

Self-Learning topics (Unit wise)

Sub- Unit	Topics
1.2.1	Autoradiography, liquid scintillation counting
2.1	Drosophila development
3.2	Proteomics

Online Resource
Online module: Autoradiography, liquid scintillation counting https://nptel.ac.in/courses/102/107/102107028/ (lectures 8-12) **Online module: Drosophila development** **https://nptel.ac.in/courses/104/108/104108056/(Mod-07 Lec-24)** https://www.youtube.com/watch?v=LU6xHqcVfCQ **Online module: Proteomics** https://nptel.ac.in/courses/102/101/102101068/

MBO502B- Medical Microbiology and Immunology - I

Unit	Topic	Credits	Lectures	References
1	**Epidemiology of infectious diseases and Clinical bacteriology**	01	15	
	1.1 Epidemiology of infectious diseases 1.1.1 Epidemiological principles in prevention and control of Diseases 1.1.2 Measures of risks : fr equency measures, morbidity, mortality ,natality(birth) measures, measures of association, measures of public health impact 1.1.3 Public health surveillance: i. Identifying health problems for surveillance ii. Collecting data for surveillance, iii. Analyzing and interpreting data, iv. Knowledge of the Geo-sentinel network and Geographical Information mapping of various diseases		08	Nikuchia,N W. Ahrens, I. Robert H Friis www.cdc.gov
	1.2 Clinical bacteriology 1.2.1 Time kill curves 1.2.2. Serum killing curves 1.2.3 Testing antibiotic combinations 1.2.4 Methicillin(Oxacillin) resistance in *Staphylococcus* spp 1.2.5 Beta lactam antibiotic resistance 1.2.6 Vancomycin resistant Enterococci		07	Baile y And Scotts

2	**Emerging and Re-emerging Diseases.**	01	15	Suparna Duggal
	2.1 Emerging infectious diseases in India(with emphasis on Etiology, Transmission, Pathogenesis, Clinical Manifestations, Lab diagnosis, Prophylaxis, Prevention, Treatment and Epidemiology. 2.1.1 Viral Infections:Pandemic Influenza, Swine flu, Bird flu, SARS, COVID-19, Nipah Virus, Chikungunya, Ebola, Dengue, Tomato flu virus. 2.1.2 Overview of Emerging viral outbreaks in India		10	https://wwwnc. cdc.gov/eid/ https://www.co ronavirus.gov/ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8639133/table/table001/
	2.2 Bacteria: MDR-TB, XDR-TB, Legionellosis, Listeriosis, MRSA		04	
	2.3 Fungi: Nonalbicans candida, Histoplasmosis.		01	
3	**Tolerance, Hypersensitivity and Immunobiology**	01	15	
	3.1 Immuno tolerance 3.1.1 Central Tolerance 3.1.2 Peripheral Tolerance 3.1.3 Tolerance Induction 3.1.4 T-cell Tolerance 3.1.5 B-cell Tolerance		05	Kuby 6th Ed Roitt's Palan.and Pathak
	3.2 Classification of Hypersensitivity reactions (type I,II,III,IV).		04	Kuby 6th Ed
	3.3 The Human Microbiome 3.3.1 Introduction to Gut microbiome - types of organisms 3.3.2 Functions and their role in health and disease 3.3.3. The Human Microbiome Project		2	Pathak a nd Palan.
	3.4 Molecular basis of diversity of immunoglobulin molecules. 3.4.1 Multigene organization of Ig genes 3.4.2 Variable-Region Gene Rearrangements. 3.4.3 Mechanism of Variable- Region DNA Rearrangements. 3.4.4 Generation of antibody diversity. 3.4.5 Manipulations of the immune response.		04	Kuby 6th Ed

Self-Learning topics (Unit wise)

Sub Units	SLE topics
1.1.2	Measures of risks
2.1	Swine Flu and H5N1 virus
3.3	Hypersensitivity

Online module: Measures of risks https://nptel.ac.in/courses/109/106/109106095 / (you tube link-https://youtu.be/ZhFUlsAoWd0) Dr Ramakrishnan IIT Madras.
Online module: Measures of risks https://nptel.ac.in/courses/109/106/109106095/ (you tube link-https://youtu.be/ZhFUlsAoWd0) Dr Ramakrishnan IIT Madras.
Online module: Hypersensitivity https://www.youtube.com/watch?v=QEzH9zepZZA Essentials in Immunology by Dr. R. Manjunath, Dr.Dipankar Nandi, Prof. Anjali Karande, Department of Biochemistry, IISc Bangalore

MBO503B- Biochemistry Microbiology				
Unit	**Topic**	**Credits**	**Lectures**	**References**
	Semester I			
1	**Chemical reactivity, Minerals, Vitamins and coenzymes and Hormones**	**01**	**15**	Lehninger, Metzler Harper, Lehninger, Segel Irvin H. (1997). Biochemical Calculations.
	1.1 Chemical reactivity 1.1.1 Overview - Types of Bonds 1.1.2. Various units of expressing and inter-converting concentration of solutions- molarity, moles, normality, osmolarity, molality, mole fraction. 1.1.3. Bronsted concept of conjugate acid-conjugate base pairs, ionization of solutions, pH, titration curves, 1.1.4. Buffers: preparation, action, and application. 1.1.5. Henderson-Hasselbalch equation, buffer capacity (pH control), polyproteic acids, amphoteric salts, ionic strengths. (Problems to be solved)		08	
	1.2 Minerals, Vitamins and coenzymes 1.2.1 Presence, metabolic role, digestion, absorption, excretion, balance, and deficiency of Calcium, Phosphorus,Magnesium, Iron, Iodine, Fluoride, Copper, Zinc, Selenium, Manganese, Chromium and Molybdenum in the human body, Sources & RDA. 1.2.2 Vitamins and coenzymes – Water-soluble vitamins and their coenzymeforms(Niacin, Riboflavin, Pantothenic acid, Thiamine, Pyridoxal, Vitamin B12, Folic acid, Glutathione) Fat soluble vitamins (A, D, E, and K). Biochemical basis for deficiency symptoms.		04	B.K. Sharma Lehninger Conn & Stumpf

	1.3 Hormones 1.3.1 Classes and functions of hormones (Tabular). 1.3.2 General mechanisms of hormone action, Chemical signalling - endocrine, paracrine, autocrine, intracrine and neuroendocrine mechanisms.		03	Lehninger Harper
	1.3.3 Hormone receptors - extracellular and intracellular, G proteins, G protein coupled receptors, Secondary messengers - cAMP, cGMP, DAG, Ca^{2+}, NO.			
2	**Biomolecules**	**01**	**15**	
	2.1 Lipids and sterols 2.1.1 Lipid classification. 2.1.2 Functions of lipid -signals, cofactors, pigments.		02	Lehninger, Gottschalk David White
	2.2 Nucleic acid chemistry 2.2.1 Overview of nucleosides, nucleotides, phosphodiester linkages,pairing of bases. 2.2.2 Three-Dimensional Forms of DNA and its Unusual structures. 2.2.3 Denaturation and reassociation of DNA, Tm value, Cot curve analysis. 2.2.4 Types and structure of RNAs – RNAs involved in protein synthesis (t-RNA, r-RNA, and m- RNA) 2.2.5 Regulatory RNAs and parasitic RNAs.		05	Conn & Stumpf Lehninger
	2.3 Glycobiology 2.3.1 Overview of Monosaccharides, Disaccharides and Polysaccharides. 2.3.2 Microbial polysaccharides and plant polysaccharides and their commercial applications. 2.3.3 Glycoconjugates:Proteoglycan,Glycoprotein, and glycolipids (gangliosides and lipopolysaccharides) 2.3.4 Carbohydrates as Informational Molecules: The Sugar Code.		03	Conn & Stumpf Lehninger

	2.4 Amino acids and Proteins 2.4.1 Amino acids - Classification, titration curves. 2.4.2 Hierarchy of protein structure- peptide bond and its stability, Primary structure, Secondary structure - α helix and β-Sheets, Ramachandran plot, Tertiary structure and Quaternary structure, protein motifs. 2.4.3 Protein folding and degradation, Role of disulphide bonds, Chaperones, and chaperonins,prion motifs and domains		05	Lehninger, Conn & Stumpf White
	2.4.4 Post-translational modification (PTM) of proteins. eg phosphorylation, glycosylation, lipidation, ubiquitination, methylation and acetylation.			
3	**Transport of biomolecules**	**01**	**15**	Baltimore Lehninger, Conn & Stumpf White, Harper Stryer Brock, Harper
	3.1 Role of Biological membrane in transport 3.1.1 Overview of Biological membranes, 3.1.2 Role of transporters in solute transport, 3.1.3 Diseases caused due to mutations in membrane in humans.		01	
	3.2 Transport of biomolecules 3.2.1 Drug export system in bacteria 3.2.2 Protein Transport - Overview of protein synthesis and sorting. 3.2.3 Translocation, export, and secretion of proteins. 3.2.4 Translocation of proteins –Sec system, *E. coli* SRP system. 3.2.5 Translocation of Folded Proteins - Tat System. 3.2.6 Extracellular protein secretion in Gram-negative and Gram-positive bacteria. (Type I, Type II, Type III, type IV, Type V, Chaperone/usher pathway).		01 06 07	

Online learning		
Unit	Topic	Link
1	Overview of Monosaccharides, Disaccharides & Polysaccharides.	https://www.youtube.com/watch?v=93ngcQHOixQ (https://www.swayamprabha.gov.in/)
2	Vitamins and coenzymes	https://www.youtube.com/watch?v=VxtQPuXiMAA (https://www.swayamprabha.gov.in/)
2	Protein folding	https://www.youtube.com/watch?v=h_ZPur9E_jg (https://www.swayamprabha.gov.in/)
4	Functions of hormones	https://www.youtube.com/watch?v=pBKdfpF2es4 https://www.youtube.com/watch?v=XX11BaP4m8I (https://www.swayamprabha.gov.in/) https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod4.pdf

List of Practicals

1	Practicals based on MBO501B Credit -1 30 hrs
	1. Micropipetting- basic techniques- negative and positive pipetting, viscous and non viscous fluids 2. Blotting techniques 3. Protein electrophoresis 4. Problems on population genetics 5. Training in Basic Molecular Biology techniques (Agarose gel electrophoresis, Geldoc system, Screening of databases, 16SrRNA analysis) 6. Primer design and PCR 7. Scintillation technique - Demonstration 8. Random mutagenesis using analogues 9. Protein expression profile, LC-MS protein expression profile , MALDI-TOF, Microarray- Visit to research institute
2	Practicals based on MBO502B- Credit -1 30 hrs
	1. Detection of specific types of Antibiotic Resistance: MRSA,VRE,ESBL 2. Antibiotic susceptibility testing by Conventional broth microdilution method according to CLSI guideline. 3. Checker Board Assay for detecting synergistic activity of two antibiotics. 4. Mono - Spot Test for diagnosis of Chickengunya (Demonstration expt.) 5. Acid fast staining for *Mycobacterium spp.* 6. Preparation and Quality Analysis of media. 7. Rapid identification for Dengue virus (IgM &IgG) by kit method . 8. Assay of the Antibiotic Activity of Serum 9. Time Kill Kinetics Assay for evaluation of antimicrobial agents , using CLSI guideline 10. Problems on Epidemiology: based on diseases caused by SARS, Corona, Swine flu, Bird Flu, Nipah Virus, Chikungunya, Dengue, Legionellosis, Listeriosis, prions, Nonalbicans candida, Histoplasmosis. 11. For internal assessment: Case study for epidemiology of the diseases/. Collection of data, criteria, methodology etc. Assignment to be submitted.
3	List of practicals based on MBO503B- Credit -1 30 hrs
	1. Preparation of buffers 2. Isolation of lactose from bovine milk 3. Estimation of total sugars by phenol - sulphuric acid method 4. Determination of pK and PI value for an amino acid 5. Determination of the isoelectric point of protein 6. Extraction, isolation, purification and estimation of albumin and globulin from egg white. 7. Interpretation of Ramachandran plot 8. Isolation of cholesterol and lecithin from egg yolk 9. Identification of fatty acids and other lipids by TLC 10. Preparation of liposomes (Demonstration) 11. DNA: RNA Hybridization Kinetics, Tm value, cot value- calculations

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1) iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2016, Pearson International edition
2) Fundamental Bacterial Genetics, Trun, Trempy, 1st edition, 2004, Blackwell Publishing
3) Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education
4) Genes XII, Lewin, B., 2017, Jones and Bartlett Publishers
5) Genetics: A Conceptual Approach, Benjamin Pierce 7th edition, 2020, W. H. Freeman & Co
6) Principals of Genetics, Snustad & Simmons, 7th edition, 2019, John Wiley & Sons Inc
7) Molecular biology –Genes to proteins 3rd ed. by Burton E. Tropp (Jones & Bartlett publishers)
8) Molecular Genetics of bacteria, 3rd Edition by Larry Snyder and Wendy Champness (ASM press)
9) Molecular Biotechnology Principles and applications of Recombinant DNA 6th edition 2022 Glick, Pastermak, Patten
10) Recombinant DNA J.D. Watson 2nd ed
11) Molecular Biology by R. F. Weaver 3rd edition, McGraw-Hill international edition

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1) Introduction to Diagnostic Microbiology for the Laboratory Sciences, Maria Dannessa Delost,2015, Jones and Bartlett Learning
2) Ananthanarayan and Paniker's Textbook of Microbiology, by Reba Kanungo, 10thedUniversities Press; Tenth edition, 2017
3) Bailey and Scotts Diagnostic Microbiology Forbes, Sahem et al 12thed, Moshby
4) A brief guide to emerging infectious diseases and zoonoses.WHO. 2016.
5) Understanding emerging and re-emerging infectious diseases by SuparnaDuggal and Jyoti Mantri Himalaya Publishing House
6) Friis, Robert H_Sellers, Thomas A, Epidemiology for Public Health Practice-Jones and Bartlett Learning (2014).pdf.
7) https://wwwnc.cdc.gov/eid/Center for Disease control and Prevention
8) https://www.coronavirus.gov/
9) Kuby Immunology, Kindt, J. T., Osborne, A. B. and Goldsby, A. R., 6th edition, 2006, W. H. Freeman and company.
10) Kuby Immunology, Owen, J., Punt, J. and Stanford, S., 7th edition, 2013, International edition, Macmillan higher education.
11) Roitt's Essential Immunology, Delves, J. P., Martin, J. S., Burton, R. D. and Roitt, M. I., 12th edition, 2011, John Wiley & Sons.
12) Immunology – Essential and Fundamental, SulabhaPathak and UrmiPalan. 3rd edition Capital publishing company.
13) The Elements of immunology- Fahim Halim Khan- Pearson Education.
14) Immunology an introduction, Tizard, R. I., 4th edition, 1995, Saunders College Pub.
15) Janeway's Immunobiology –the immune system in health and disease, Murphy, M. K., Travers, P., Walport, M. and Janeway, C., 6th edition, 2011, Garland Science
16) Handbook of Microbiological Quality Control, Pharmaceutical and Medical Devices Rosamund M Baird. (CRC Press)
17) Clinical Immunology – Principle & Practice 3rd ed. 2008 (Part -11 –Clinical diagnostic immunology)

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1. Analytical Chemistry, B.K. Sharma, Krishna Prakashan Media ltd, 2006.
2. Bacterial metabolism, Gottschalk, Springer-Verlag, 1985
3. Biochemical calculations, Segel I.R., John Wiley and Sons, 1995
4. Biochemistry - The Chemical Reactions of Living Cells, 2nd Edition, David Metzler. Academic Press, 2003.
5. Biochemistry 3rd edition, Mathew, Van Holde and Ahern, Pearson Education
6. Biochemistry, 4th edition, Voet D. and Voet J.G., John Willey and Sons Inc., 1995
7. Biochemistry.Berg, J. M., Tymoczko, J. L., Stryer, L., &Stryer, L. New York: W.H. Freeman, 2002
8. Conn, Stumpf, P. K., Bruening, G. R. H (1987) Outlines of Biochemistry, 5th edition, John Wiley & sons
9. Harper's illustrated biochemistry. Rodwell, V. 30th ed. New York: Lange Medical Books/McGraw-Hill, 2015.
10. Principles of Biochemistry, Horton, R. and Moran, L., 5th edition, 2011, Prentice Hall
11. Principles of Biochemistry, 4th edition, Zubay, G., Wm.C. Brown Publishers, 1998
12. Principles of Biochemistry, Lehninger A.L., Cox and Nelson, 4th edition and 8th edition (2021)
13. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.
14. The physiology and biochemistry of prokaryotes, White D., Oxford University Press, 2000, 2nd edition - 2011
15. Van Wely KH, Swaving J, Freudl R, Driessen AJ. Translocation of proteins across the cell envelope of Gram-positive bacteria. FEMS Microbiol Rev. 2001 Aug;25(4):437-54. doi: 10.1111/j.1574-6976.2001.tb00586.x. PMID: 11524133.
16. Forster BM, Marquis H. Protein transport across the cell wall of monoderm Gram-positivebacteria. Mol Microbiol. 2012 May;84(3):405-13.

Practical MBO503D-

- Laboratory manual in biochemistry -Jayaraman J, New Age International Publishers
- An introduction to practical biochemistry3rd edition, David T Plummer,Tata McGraw Hill edition 1998

- Experimental biochemistry A student companion, Rao Beedu, S. Deshpande, IK international Pvt. Ltd.
- Laboratory manual in biochemistry, Immunology and Biotechnology, Nigam A and Ayyagiri A. TataM cGraw Hill edition

First Year Semester II - Units – Topics – Teaching Hours

Sr No	Subject Code	Subject Unit Title		Hours/Lectures	Total No. of hours/lectures	Credit
1	MBO504B- Cell Biology	I	Internal organization of the cell	15	45 L	3
		II	Cell Cycle and Communication	15		
		III	Cytogenetics	15		
2	MBO505B- Medical Microbiology and Immunology - II	I	Immunological disorders	15	45 L	3
		II	Transplantation & Cancer Immunology	15		
		III	Recent Advances in Diagnostic and Experimental Techniques in Immunology	15		
3	MBO506B- Microbial Biochemistry	I	Enzymology	15	45 L	3
		II	Signalling and stress	15		
		III	Degradation of C1, C2, and aromatic compounds	15		
4	MBO504D-		Practicals based on MBO504B-	30	-	1
5	MBO505D-		Practicals based on MBO505B-	30	-	1
6	MBO506D-		Practicals based on MBO506B-	30	-	1

MBO504B- Cell Biology				
Unit	**Topic**	**Credits**	**Lectures**	**References**
1	**Internal organization of the cell**	01	15L	
	1.1. Cell membrane structure: Overview of Lipid bilayer and Membrane proteins, Spectrin, Glycophorin, Multipass membrane proteins Bacteriorhodopsin		2L	Molecular Biology of The Cell – Albert B 6th edition
	1.2. Overview of Organelles involved in energy conversion: Mitochondria & Chloroplast		1L	
	1.3. Cytoskeleton: Cytoskeletal filaments, Microtubules, Actin regulation, molecular motors		2L	
	1.4. Cell Junctions and cell adhesion: Anchoring, adherence junctions, Desmosomes, Gap junctions, cell-cell adhesion, Cadherins		3L	Lodish 5th edition
	1.5. Intracellular Compartments and protein sorting: Compartmentalization of cells, transport of molecules between the nucleus and cytosol, Peroxisomes, Endoplasmic reticulum, transport of proteins into Mitochondria and Chloroplasts		4L	
	1.6. Intracellular vesicular traffic: Endocytosis, exocytosis, transport from the ER through the Golgi apparatus.		3L	Karp G.7thEdn
2	**Cell Cycle and Communication**		15	
	2.1. Mechanism of cell division: Overview of Phases of cell cycle, Mitosis, Meiosis		1L	Cell Biology, Karp G.7th Edn.
	2.2.Cell cycle and Programmed cell death: Control system, intracellular control of cell cycle events, Apoptosis, extracellular control of cell growth		5L	
	2.3. Cell communication: 2.3.1. Extracellular signal molecules, nitric oxide, carbon monoxide and hydrogen sulfide gas signal, classes of cell surface receptor proteins 2.3.2. Signaling through enzyme linked cell surface receptors: Docking sites, Ras, MAP kinase, Pl-3 kinase, TGF 2.3.3. Signaling in plants: Serine / Threonine kinases, role of ethylene, Phytochromes 2.3.4. Cell signaling in Dictyostlium		9L	Alberts B. 6th edition

3	**Cytogenetics**	01	15L	
	3.1. Overview of Structure of Chromosome - Heterochromatin, Euchromatin, Polytene Chromosomes.		1L	iGenetics – Russel 3rd edition
	3.2. Variation in Chromosomal Structure and Number: 3.2.1. Types of chromosomal mutations or aberrations 3.2.2. Alteration in Chromosome structure: Deletion, Duplication, Inversion, Translocation. 3.3.3 Copy number variations: Aneuploidy and its types, Euploidy and Polyploidy and its types 3.3.4. Syndromes- Klinefelter, Turner, Cri-du-Chat, Trisomy -21, Trisomy 18 and Trisomy 13,Prader–Willi syndrome, Wolf-Hirschhorn syndromes, The Fragile X syndrome 3.3.5 Karyotype (Spectral karyotypic) and Banding techniques 3.3.6 Comparative genomic hybridization and Fluorescence in situ Hybridization used for Cytogenetic testing.		7L	iGenetics – Russel 3rd edition Genetics-5th edition
	3.3 Sex Determination and Sex Linkage: 3.3.1. Mechanisms of Sex Determination- (XX-XY, ZZ-ZW, XX-XO) Genic and environmental sex determination, Dosage Compensation and Barr Body. 3.3.3. Genetic Linkage, Crossing Over and Chromosomal Mapping: Tetrad Analysis; Two Point Cross; Three-point Cross; Pedigree Analysis.		7L	Genetics-5th edition & iGenetics 3rd edition

Self-Learning topics (Unit wise)

Unit	Topics
1.2.1	Cytoskeleton
2.1.1	Cell Junctions and cell adhesion
3.3	Cell signalling
4.3	Structure of Chromosome

Online Resource
Online module: Cytoskeleton https://www.youtube.com/watch?v=jnoJqDZtf3E (https://www.swayamprabha.gov.in/) https://nptel.ac.in/courses/102/103/102103012/, Online module: Cell Junctions and cell adhesion https://www.youtube.com/watch?v=ElDO-mnswlM https://nptel.ac.in/courses/102/103/102103012/ (https://www.swayamprabha.gov.in/) Online module: Cell signalling https://ocw.mit.edu/courses/biology/7-016-introductory-biology-fall-2018/lecture-videos/lecture-20-cell-signaling-12014overview/ Online module: Structure of Chromosome and Variation in Chromosomal Structure and Number https://nptel.ac.in/courses/102/104/102104052/ (module 1)

MBO505B- Medical Microbiology and Immunology- II				
Unit	**Topic**	**Credits**	**Lectures**	**References**
1	**Immunological disorders**	01	15	
	1. Immunodeficiency disorders – Pathophysiology, diagnosis, prognosis and therapeutic approaches:		08	Tizard
	1.1.1 Humoral deficiencies,			Fahim Halim Khan
	1.1.2 Tcell deficiencies,			
	1.1.3combined deficiencies			
	1.1.4complement deficiencies			Pathak&Palan
	1.1.5 Treatment Approaches for Immunodeficiency			
	1.1.6 Secondary Immunodeficiency & AIDS			Kuby 6th Ed
	1.2 Autoimmune diseases		07	
	1.2.1. Theories of autoimmunity			Tizard
	1.2.1. Pathogenic effects of autoantibody			
	1.2.3. Pathogenic effects of complexes with auto antigens			Pathak&Palan
	1.2.4 T cell mediated hypersensitivity as a Pathogenic factor in autoimmune diseases.			
	1.2.5 Autoimmune disorders Rheumatoid arthritis, Systemic Lupus Erythomatosus (SLE), Guillain-Barré Syndrome , Myasthenia gravis,Ankylosing spondylitis			Roitt's
	1.2.6 Diagnosis and Treatment of Autoimmune Diseases			Kuby 6th Ed
2	**Transplantation & Cancer Immunology**			
	2.1 Transplantation Immunology .2 Antigens Involved in Graft Rejection .3 Allorecognition - The foetus as an allograft 2.1.4 Graft Rejection-Role of APCs & Effector Cells 2.1.5.Graft v/s Host Diseases 2.1.6 Immuno Suppressive Therapies	01	08	Pathak & Palan Kuby-7th Ed

	1. Cancer immunology 3.1.1 Tumors of the Immune System 3.1.2 Tumor Antigens 3.1.3 Tumor Evasion of the Immune System 3.1.4 Cancer Immunotherapy 3.1.5 Monoclonal Antibodies and engineered Antibody for Immunotherapy 3.1.6 Oncogenic viruses		07	Kuby-7th Ed Saeed et al, 2017
3	**Recent Advances in Diagnostic and Experimental Techniques in Immunology**	01	15	
	3.1 Invitro and Invivo system 3.1.1 In vitro systems –Quantification of cytokines (ELISPOT assay), functional assays for phagocytes and cytokines (cytotoxicity and growth assays) 3.1.2 In vivo systems – Experimental animals in immunology research (Inbred animal strains, Knockout mice, transgenic animals 3.1.3 , Animal models for autoimmunity		05	Freshney R. Ian Kuby-6th Ed
	3.2 Experimental techniques in Immunology 3.2.1Assays of Cell Death Immunofluorescence-Based Imaging Techniques 3.3.3 Fluorescence-activated cell sorter		05	Kuby-7th Ed
	3.3 Modern Diagnostic Methods: 3.1 Lab-on-a-chip (LOC) 3.3.2 Recent Advances in ELISA 3.3.3 Biomarkers in clinical medicine		05	Kuby-7th Ed Current Published papers on recent advances to be referred.

Unit wise - SLE Topics

1.2.1	Mechanisms of Autoimmunity
2.1.1	Good Clinical Practice
3.3	Graft Rejection/ Acceptance

Online Resource
Online module: Mechanisms of Autoimmunity https://nptel.ac.in/courses/104/108/104108055/ IISc Bangalore Online module: Graft Rejection/ Acceptance https://nptel.ac.in/courses/104/108/104108055/ IISc Bangalore Online module: lab-on-a-chip (LOC) https://nptel.ac.in/courses/102/105/102105068/ https://nptel.ac.in/courses/102/105/102105068/ NPTEL course, IIT Kharagpur

MBO506B- Microbial Biochemistry				
Unit	**Topic**	**Credits**	**Lectures**	**References**
	Semester II			
1	**Enzymology**	**01**	**15**	
	1.1 Overview - Active site, Activation energy, Reaction rate, Enzyme – substrate interaction (Induced fit, Lock and Key); Units of Enzyme activity. 1.2 Mechanisms of enzyme catalysis General Acid-Base Catalysis, CovalentCatalysis, Metal Ion Catalysis, 1.3 Catalytic antibodies, isozymes, ribozymes.		03	Voet, Lehninger Harper
	1.4 Enzyme kinetics 1.4.1 Kinetics of enzyme catalyzed reactions, (Michaelis-Menten, Lineweaver-Burk equation), 1.4.2 Multiple factors affecting the rates of enzyme catalyzed reactions, 1.4.3 Enzyme inhibition – Reversible (Competitive, Noncompetitive, Uncompetitive) and Non-reversible inhibition.		06	Harper, Conn & Stumpf
	1.5 Multisubstrate enzymes: Properties and reactions - Random, ordered and Ping-pong		02	
	1.6 Regulation of enzyme activitiy Allosteric regulation and covalent modification, Reversible covalent modification in regulation of mammalian proteins.		03	Harper Conn & Stumpf
	1.7 Applications of Enzymes Enzymes used in clinical biochemistry as reagents. HIV enzyme inhibitors and drug design		01	
2	**Signalling and stress**	**01**	**15**	
	2.1. Introduction to two-component signalling systems 2.1.1 Response by facultative anaerobes to Anaerobiosis, Nitrate and nitrite, Nitrogen supply.		03	David White Lehninger

	2.2 Effect of oxygen and light: Response to oxygen and light in purple photosynthetic bacteria 2.2.1 Response of bacteria to - i. Osmotic pressure and temperature, ii. Potassium ion and external osmolarity, iii. Carbon sources		04	
	2.3Bacterial response to environmental stress Heat-shock response, oxidative stress.		02	
	2.4 Synthesis of virulence factors Synthesis of virulence factors in response to - Temperature, pH, Nutrient, Osmolarity. 2.5 Chemotaxis 2.6Bacterial development and quorum sensing - Myxobacteria and biofilms.		06	
3	**Degradation of C1, C2 and aromatic compounds**	**01**	**15**	
	3.1 Microbial growth on C1 Compounds Study of Methylotrophs, Methanogens, Carboxidotrophs, Cynogens and cynotrophs (Cyanide, Methane, Methanol, methylated amines, carbon monoxide)		07	Atlas and Bartha, Gottschalk, David White
	3.2 Microbial growth on C2 Compounds 3.2.1 Metabolism of Glyoxylate and Glycollate - The glycerate pathway, β-hydroxyaspartate pathway. 3.2.2 Oxalate as carbon and energy source- Oxidation of oxalate by *P. oxalaticus*		03	Gottschalk
	3.3 Microbial degradation of aromatic compounds 3.3.1 Common pathways of aromaticdegradation (catecholand protocatechuate), 3.3.2Dissimilation of catechol and protocatechuate by meta-cleavage		04	
	3.4 Microbes in degradation of Xenobiotics (Tabular).		01	

Online learning		
Unit	Topic	Link
1	Enzyme kinetics	https://www.youtube.com/watch?v=pHtxWquZV8k https://www.youtube.com/watch?v=aIR-SnRPwSA (https://www.swayamprabha.gov.in/)
2	Quorum sensors	http://eacharya.inflibnet.ac.in/data-server/eacharya-documents/55d44ff9e41301fd23d8facc_INFIEP_203/1319/ET/203-1319-ET-V1-S1__lecture_2.pdf

Practical List – Semester II

1	**Practicals based on MBO504B- Credit 01 - hours -30**
	1. Study of Cell membrane integrity using uptake of neutral red. 2. Preparation of protoplast using Lysozyme. 3. Isolation of Chloroplasts. 4. Isolation of Mitochondria from the cell. 5. Study of Mitosis. 6. Study of Meiosis 7. Estimation of NO (Nitric Oxide) produced by Macrophages. 8. Study of Phagocytosis using bacterial culture / yeast cells 9. Write a review w.r.t. Techniques used to study cell cycle. 10. Karyotyping 11. Mapping based on Tetrad Analysis and Three Point Cross. 12. Problems based on Pedigree Analysis- Autosomal and Sex-Linked 13. Visit for Study of cell cytology using Phase contrast Microscopy.(Demonstration) 14. Screening of databases for microbes, genes and proteins.

2	**Practicals based on MBO505B- Credit 01 - hours -30**
	1) SRID: For detection of immune deficiency and Complement deficiency. 2) Rheumatoid factor test for laboratory diagnosis of Rheumatoid arthritis 3) Lupus erythematosus (LE) cell preparation-Principle, Procedure and Significance 4) RIST and RAST- Principle, Procedure and Significance - Demonstration 5) Immunodiagnosis by ELISA 6) Ames test for identification of carcinogens. 7) Internal Assignment on advanced diagnostic kits.

3	**List of practicals MBO506B- Credit 01 - hours -30**
	1. Purification of an extracellular enzyme(βamylase) by salting out and dialysis 2. Study of enzyme kinetics – ● Effect of enzyme and substrate concentration, ● Effect of pH, temperature and inhibitors on enzyme activity. 3. Demonstration of proteolytic activity 4. Determination of glucose isomerase present intracellularly in *Bacillus spp.* 5. Adaptation of *E. coli* to anaerobiosis 6. Chemotaxis of *Pseudomonas* 7. Effect of temperature and water activity on swarming of *Proteus* 8. Different bacteriolytic response associated with addition of lysozyme and salt. 9. Microbial degradation of polycyclic aromatic hydrocarbon (PAH)-enrichment, isolation and screening of bacteria. 10. PAH degradation studies.

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1. Molecular Biology of The Cell 6th edition – Albert, Johnson, Lewis, Raff, Roberts &Walter.
2. Molecular Cell Biology. Lodish ,Birk, and Zipursky. Freeman
3. The Structure and Dynamics of Cell Membrane. – Lipowsky and Sackmann. Elsevier.
4. Cell Biology. Karp G.7thEdn. International Student Version, Wiley. 2013.
5. Molecular Biology by R. F. Weaver 3rd edition, McGraw-Hill international edition
6. iGenetics- A Molecular Approach, Russell, P.J., 3rd edition, 2010, Pearson International edition
7. Genetics: A Conceptual Approach, Benjamin Pierce 4th edition, 2008, W. H. Freeman
8. Molecular Biology of the Gene, Watson, Baker, Bell, Gann, Levine, Losick, 7th edition, 2007, Pearson Education
9. Genes IX, Lewin, B., 2006, Jones and Bartlett Publishers
10. Pinkel D, Albertson DG (2005) Comparative genomic hybridization. Annu Rev Genom Hum Genet 6:331–354.

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1. Roitt's Essential Immunology 13th Ed. –Wiley Blackwell
2. Kuby Immunology 6th Ed – W. H. Freeman and Company, New York
   Reference Books:
3. Immunology –Essential and Fundamental – SulbhaPathak, UrmiPalan, 3rd Ed. Capital Publishing Company (New Delhi-Kolkata)
4. Kuby Immunology 7th Ed – W. H. Freeman and Company, New York
5. Immunology – An Introduction 4th Ed – Tizard 5. Elements of Immunology- Fahim Halim Khan –Pearson Education
6. Medical Laboratory Technology - Kanai Mukherjee vol.
7. Current Published papers on recent advances to be referred.
8. Textbook of clinical trials- editors David Machim, Simson Day & Sylvan Green- John Wiley & Sons.
9. Management of Data in Clinical Trials- Eleanor McFadden M.A. - John Wiley & Sons

Theory: MBO506B-

1. Bacterial metabolism, Gottschalk, Springer-Verlag, 1985
2. Biochemical calculations, Segel I.R., John Wiley and Sons, 1995
3. Biochemistry - The Chemical Reactions of Living Cells, 2nd Edition, David Metzler. Academic Press, 2003.
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7. Brock biology of microorganisms, 12thedMichael T Madigan; Thomas D Brock, San Francisco, CA : Pearson/Benjamin Cummings,2009
8. Conn, Stumpf, P. K., Bruening, G. R. H.(1987) Outlines of Biochemistry, 5th edition, John Wiley & sons
9. Harper's illustrated biochemistry. Rodwell, V. 30th ed. New York: Lange Medical Books/McGraw-Hill, 2015.
10. Microbial ecology: Fundamentals and applications 4th ed. Ronald H.Atlas and Richard Bartha, Reprint 2005, Pearson education.
11. Principles of Biochemistry, 4th edition, Zubay, G., Wm.C. Brown Publishers, 1998
12. Principles of Biochemistry, Lehninger A.L., Cox and Nelson, 4th edition.
13. The physiology and biochemistry of prokaryotes, White D., Oxford University Press, 200 0

Practicals: MBO506D

- Laboratory manual in biochemistry -Jayaraman J, New Age International Publishers
- An introduction to practical biochemistry 3rd edition, David Plummer, Tata McGraw Hill edition 1998
- Experimental biochemistry A student companion, Rao Beedu, S. Deshpande, IK internati onal Pvt. Ltd.
- Laboratory manual in biochemistry, Immunology and Biotechnology, Nigam A and Ayya giri A. TataMcGraw Hill edition
- Source of Experiments for teaching Microbiology, Primrose and Wardlaw
- Microbial Physiology and Biochemistry Laboratory manual: A quantitative approach, Da vid White
- Principles and techniques of practical biochemistry, 4th edition, Wilson K and Walker J. Cambridge University Press, 1994

H(S)NC University,

Mumbai

Syllabus for M.Sc. part I

Program: MSc.

Course: Microbiology (MBO)

Choice based Credit system with effect from the academic year 2023-24

DSE -Pharmaceutical Microbiology

Course Objectives and Outcomes:

This course covers the study of microbiology and its relevance to pharmacy.

Semester I-Introduction to Pharmaceutical Microbiology

Learning objectives

- The course introduces the role of microbiology in the pharmaceutical industry.
- The course introduces students to understand the detailed processing of pharmaceutical products
- The course discusses the role of recombinant technology and use in manufacturing important biopharmaceuticals

Learning Outcomes

- The students will identify microorganisms of relevance to healthcare and the pharmaceutical industry and their sources.
- The students will learn Microbial contamination/product spoilage and antimicrobial preservation of pharmaceutical formulations during production and in products
- The students will understand the sterility testing of pharmaceutical products and development of
- The students will learn the manufacturing of several biopharmaceuticals products

Semester II- Advances in Pharmaceutical Microbiology

Learning objectives

- Students will learn the Good manufacturing practices concerned with quality control and production of quality drugs and products in the pharmaceutical industry
- The course Introduces the students to the principle, working and applications of basic and advanced instrumentation used in Pharmaceuticals
- The students will learn concepts in Pharmacogenomics, personalized medicine and gene therapy
- The students will learn application of Biocatalysis for manufacture of drugs in pharmaceuticals

Learning Outcomes

- The students will gain knowledge about the Good manufacturing practices essential in the pharmaceutical industry.
- The students will know how to carry out quality control using the Indian, UK and US Pharmacopeia.
- The students will gain knowledge about the ethics and methodologies of Clinical research
- The students will be able to calibrate and handle instruments used in Pharmaceuticals.
- The students will know the details of Human genome and Human proteome project and link the concepts to the idea of Personalized Medicine.

M.Sc. (Semester – I & Semester - II)
Microbiology Syllabus
To be implemented from the Academic year 2023-24

Semester I

Course Code	UNIT TOPIC	HEADINGS	Credits	L / Week
MBO507B- **Introduction to Pharmaceutical Microbiology**	**I**	**Introduction to pharmaceutical microbiology**	3	1
	II	**Biopharmaceuticals processing and Drug development**		1
	III	**Pharmaceutical therapeutics**		1

Semester II

Course Code	UNIT TOPIC	HEADINGS	Credits	L / Week
MBO508B- **Advances in Pharmaceutical Microbiology**	**I**	**Clinical research and Quality Assurance and Validation in Pharmaceutical Industry**	3	1
	II	**Pharmaceutical Analytical Techniques**		1
	III	**Advances in Pharmaceutical Microbiology**		1

MBO507B- Introduction to Pharmaceutical Microbiology				
Unit	**Topic**	**Credits**	**Lectures**	**References**
	Semester I			
1	**Introduction to pharmaceutical microbiology**	1	**15**	
	1.1 Introduction pharmaceutical microbiology 1.2 Microbiological test methods in pharmaceutical industry Product-related testing regimes, Starting materials, In-process samples/intermediate product, Finished product Testing of utilities, Environmental monitoring		02	Pharmaceutical Microbiology- essentials for quality assurance and quality control by Tim Sandle Essential Microbiology for pharmacy and pharmaceutical sciences- Geoffrey Hanlon and Norman Hodges
	1.3 The application of microbiology in pharmaceutical Enumeration of microorganisms, Sampling Microorganisms detected from pharmaceutical manufacturing environment, C ontamination control strategy		02	
	1.4 Microbiology and pharmaceuticals Microbiological culture media, Types of culture media Quality control and manufacture of culture media Media release and quarantine		02	
	1.5 Bioburden determination Nonsterile products and microbial limits testing, In-process material bioburden assessment, Presterilization bioburden assessment, Alternative methods of bioburden assessment 1.6 Laboratory management and design Pharmaceutical microbiological laboratories, laboratory management, laboratory design, Good storage practices.		03	
	1.7Assessment of pharmaceutical water systems			
	1.8 Sterilization and sterility assurance Sterility, Sterility assurance and the sterility assurance level Sterility testing, Parametric release, Sterile products Sterilization, Factors affecting sterilization effectiveness Risk assessment		04	

	1.9 Microbiological challenges to the pharmaceuticals and healthcare Microbial risks to pharmaceuticals, Microbial challenges to process environments, Sources of microbial contamination, Fate of microbial contamination in pharmaceutical		02	
2	**Biopharmaceuticals processing and Drug development**	01	**15**	Pharmaceutical Biotechnology: Concepts and Applications- Gary Walsch
	2.1 Introduction to pharmaceuticals, biologics and biopharmaceuticals 2.2 History and discovery and the age of biopharmaceuticals 2.3 Delivery of biopharmaceuticals 2.4 Pharmacokinetics and pharmacodynamics 2.5 Impact of genomics, gene chip, proteomics and structural genomics upon drug discovery		05	
	2.6 Sources of biopharmaceuticals Escherichia coli as a source of recombinant therapeutic proteins 2.7 Expression of recombinant proteins in animal cell culture system Yeast as a production system Fungal production system Cell based systems Insect cell-based systems		03	
	2.8 Upstream processing Cell banking systems, Microbial cell fermentation Mammalian cell culture systems		02	
	2.9 Downstream processing Initial product recovery, Cell disruption, Removal of nucleic acid, Product concentration- Filtration, chromatography, Chromatofocusing, Purification and final product formation, Stabilizing excipients in final product, Final product fill, Freeze drying, Labelling and packing		05	

3	**Pharmaceutical therapeutics**	01	**15**	
	3.1 Insulin: Production and Application Insulin production, Production of human insulin by recombinant DNA technology, Formulation of insulin products, Engineered insulins 3.2 Enzymes of therapeutic value: Production and Application Asparaginase, Glucocerebrosides, Superoxide dismutase 3.3 Monoclonal antibodies: Production and Application Production of Monoclonal Antibodies (MABs) Application of Monoclonal Antibodies (MABs)		07	Pharmaceutical Biotechnology: Concepts and Applications- Gary Walsch
	3.4 Vaccines: Preparation, Standardization and Storage Synthetic Peptide Vaccines, Multivaccine System Anthrax Vaccine. Cancer Vaccine, Polio Vaccine, Whooping Cough Vaccine (Pertussis Vaccine), Diphtheria Vaccines Varicella-Zoster Vaccine 3.5 Future Development Scope of Vaccines i)Vaccine against Cervical Cancer ii)Vaccination without Needles		04	Pharmaceutical Biotechnology By K. Sambamurthy, Ashutosh Kar
	3.6 Anticoagulants: Production and Application Hirudin and Antithrombin 3.7 Thrombolytic agents: Production and Application Streptokinase, Staphylokinase and Albumin		04	Pharmaceutical Biotechnology: Concepts and Applications- Gary Walsch

	List of practicals- MBO507D	
	1. Sterility testing of pharmaceutical products, according to the Pharmacopoeia 2. Quality Assurance of Microbiological media 3. Preparation of vaccine. 4. Bioburden of pharmaceutical raw products. 5. Determination of Water quality used for making injectables in the pharmaceutical industry 6. Assignment on nucleic acid therapeutics manufactured in pharmacy	
	7. Visit to the pharmaceutical industry.	

Self-Learning topics (Unit wise)

Unit	Topic
1	The application of microbiology in pharmaceutical industry
2	Drug development and pharmacokinetics
3	Future Development Scope of Vaccines

Online Resources
Online module:Future Development Scope of Vaccines https://archive.nptel.ac.in/courses/102/108/102108077/ Online module : Drug delivery and pharmacokinetics https://archive.nptel.ac.in/courses/102/108/102108077/ Online module: Application of microbiology in pharmaceutical industry https://lab-training.com/how-microbiology-contributes-to-the-pharmaceutical-industry/?amp https://www.udemy.com/course/pharmaceutical-microbiology-basics/ https://youtu.be/ZaOjrVKSHRc

REFERENCES:

1. Pharmaceutical Biotechnology: Concepts and Applications- Gary Walsch
2. Goodman & Gilman's The pharmacological basis of therapeutics, (12th ed.) by McGraw Hill education.
3. Pharmaceutical Biotechnology By K. Sambamurthy, Ashutosh Kar
4. Pharmaceutical Microbiology- essentials for quality assurance and quality control by Tim Sandle
5. Essential Microbiology for pharmacy and pharmaceutical sciences- Geoffrey Hanlon and Norman Hodges.
6. Handbook of Microbiological Quality Control, Pharmaceutical and Medical Devices Rosamund M Baird. (CRC Press)

Semester II Detail Syllabus

MBO508B- Advances in Pharmaceutical Microbiology				
Unit	**Topic**	**Credits**	**Lectures**	**References**
	Semester II			
1	**Clinical research and Quality Assurance and Validation in Pharmaceutical Industry**	01	15	
	1.1 Introduction to Clinical Research. 1.1.1 Good Clinical practice Guidelines 1.1.2 Ethical aspects of Clinical Research. Regulatory Requirements in clinical research 1.1.3Clinical Research Methodologies and Management 1.1.4 Clinical Data Management and Statistics in Clinical Research, Data analysis and Medical Writing in Clinical Research		07	David Machim Eleanor McFadden
	1.2 Quality Assurance and Validation in Pharmaceutical Industry 1.2.1 Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. 1.2.2 Quality assurance and quality management in pharmaceuticals ISO, WHO and US certification. 1.2.3 Safety profile of drugs: Pyrogenicity testing Mutagenicity and Carcinogenicity testing Teratogenicity testing Adverse Drug Reactions In vivo and in vitro drug interactions 1.2.4. Regulatory authorities and its role: FDA and Pharmacopeia (IP, UK, US)		08	Kokate C. K Mannfred A. Micheles P. S OsolArther
2	**Pharmaceutical Analytical Techniques**	**01**	**15**	

	2.1 UV-Visible Spectroscopy: Introduction, theory, laws, instrumentation associated with UV-Visible spectroscopy, choice of solvents and solvent effect, Applic ations.		02	Pharmaceutical Analysis- Watson
	2.2. IR Spectroscopy: Theory, modes of molecular vibrations, sample handling, instrumentation of dispersive and Fourier-Transform IR spectrometer, factors affecting vibrational frequencies and applications of IR spectroscopy.		02	
	2.3 Spectroflourimetry: Theory of fluorescence, factors affecting fluorescence, quenchers, instrumentation and applications of fluorescence spectrophotometry.		01	
	2.4 Flame Emission Spectroscopy and atomic absorption spectroscopy: Principle, instrumentation, interferences and applications.		01	
	2.5 NMR Spectroscopy: Quantum numbers and their role in NMR, principle, instrumentation, solvent requirement in NMR, relaxation process, NMR signals in various compounds, chemical shift, factors influencing chemical shift, Spin-Spin coupling, coupling constant, nuclear magnetic double resonance, brief outline of principles of FT-NMR and 13C NMR. Applications of NMR spectroscopy.		03	
	2.6 Mass Spectroscopy: Principle, theory, instrumentation of mass spectroscopy, different types of ionization like electron impact, chemical, field, FAB and MALDI, APCI, ESI, APPI analyzers of quadrupole and time of flight, mass fragmentation and its rules, meta stable ions, isotopic peaks and applications of mass spectroscopy.		03	
	2.7 High-performance liquid chromatography Instrumentation, Stationary and mobilephases Structural factors which govern rate of elution of compounds from HPLC columns, reverse-phase chromatography, Summary of detectors used in HPLC, Applications of HPLC		02	
3	**Advances in Pharmaceutical Microbiology**	1	15	

	3.1 Pharmacogenomics 3.1.1 The human genome project: a brief study. Overview and advances in Pharmacogenomics, individual's variabilities to drug response, polymorphisms, types, detection of single nucleotide polymorphism (SNP), SNP in drug metabolizing enzymes, applications. 3.1.2 Human Proteome project 3.1.3 Proteogenomics 3.1.4 Personalized medicine 3.1.5 Gene therapy: Gene augmentation therapy (GAT), gene inhibition therapy, gene editing using CRISPR-Cas9. Analysis of SNP RFLP, RAPD, AFLP and SNP genotyping by fragment analysis, National Guidelines for Gene Therapy Product Development and Clinical Trials (2019)		06	Pharmacogenomics and Personalized Medicine- Erika Cecchin
	3.2 Biocatalysis 3.2.1 Catalytic activity of biomolecules – enzymes and ribozymes; Enzyme applications: Hydrolase enzymes – lipases, esterases, proteases etc. with specific examples and mechanism, Lyases – e.g. Aspartase, tyrosine-phenol lyase; Isomerases – e.g. glucose isomerise; Transferases – e.g. aminotransferases, PLP as cofactor; Ligases; Oxidoreductases – dehydrogenases, oxidases, oxygenases, peroxidases.		09	Biocatalysis in the Pharmaceutical and Biotechnology Industries Edited by Ramesh N. Patel
	3.2.2 Whole cells as catalysts- Energetically unfavourable reactions at low temperatures and in unfavourable solvents; Multienzyme systems; Selection and screening of biocatalysts for activity, stability and substrate or product selectivity 3.2.3 Extremozymes – protein catalysts for reactions at extremes of temperature, pressure and pH.			

	3.2.4 Biocatalysis for Synthesis for Chiral Pharmaceutical Intermediates- Antiviral drugs, Anticancer drugs.			

Self-Learning topics (Unit wise)

Unit	Topics
1.1.1	Good Clinical Practice
2.6	Mass Spectroscopy
3.2.1	Catalytic activity of biomolecules

Online Resource
Online module: Good Clinical Practice https://nptel.ac.in/courses/127/106/127106009/ Online module:Mass Spectroscopy https://nptel.ac.in/courses/102101050 Online module:Catalytic activity of biomolecules https://archive.nptel.ac.in/courses/104/105/104105032/

	List of practicals- MBO508D
	1. UV/Visible Spectroscopy i. Calibration of UV spectrophotometer ii. Study effect of solvent on wavelength maxima of drugs. 2. Analysis of SNP by RFLP 3. Determination of glucose isomerase activity 4. Internal Assignment on drug discovery, different stages of clinical trials, FDA approval and marketing of a drugs. 5. Screening of extremozymes from Extremophiles a. Extremophilic Oxidoreductases- halophilic catalases b. Extremophilic Hydrolases -Thermostable α-amylases c. Extremophilic Lyases-Thermostable pectate lyases 6. Study of whole cells as a source of Lipase enzyme – Determination of enzyme activity.

REFERENCES:

1 Pharmaceutical Analysis- A Textbook for Pharmacy Students and Pharmaceutical Chemists third edition 2012. David G.Watson RuAngelie Edrada-EbelB, Elsevier

2 Pharmacogenomics and Personalized Medicine, Erika Cecchin Gabriele Stocco 2020 MDPI

3 Laurence L. Brunton, Bruce A. Chabner, Björn C. Knollmann ., 2011 Goodman & Gilman's The pharmacological basis of therapeutics, (12th ed.) by McGraw Hill education.

4 Guilherme Suarez-Kurtz., 2007 Pharmacogenomics in Admixed Populations, by Landes Biosciences. 143.

5 Alan H.B. Wu . Kiang-Teck J. Yeo., 2010 Pharmacogenomic Testing in Current Clinical Practice by Humana Press

6 Biocatalysis in the Pharmaceutical and Biotechnology Industries Edited by Ramesh N. Patel

7 Handbook of Microbiological Quality Control, Pharmaceutical and Medical Devices Rosamund M Baird. (CRC Press)

8 Microbial extremoenzymes- novel sources and Industrfial applications. Edited by Mohammed Kuddus

HSNC University,

Mumbai

Syllabus for M.Sc. part I

Program: MSc

Course: Microbiology (PS-FMB)

DSE- Virology

Choice based Credit system with effect from the academic year 2023-24

Semester I-Introduction to virology

Learning objectives

- To learn the structure and general properties and classification of viruses.
- To understand the architecture and replication of bacteriophages.
- The course discusses the life cycle of different viruses.

Learning Outcomes

- The learner will be able to understand the complexity of the architecture of the viruses.
- The students will be able to understand the classification of viruses.
- The learner will be able to carry out cultivation and enumeration of viruses.
- The students will be able to learn about phage therapy.

Semester II- Advances in Virology

Learning objectives

- To understand the structure and replication of Plant viruses.
- To understand the structure and replication of animal viruses causing significant diseases.
- To learn about diagnosis and treatment of viral infections.
- To learn about cellular oncogenesis and transformation caused by viruses.

Learning Outcomes

- The learner will be able to comprehend the diseases caused by plant viruses.
- The students will be able to understand the different methods available to carry out diagnosis and treatment of viral diseases.
- The students will be able to know about cellular oncogenesis and transformation caused by viruses.

M.Sc. (Semester – I & Semester - II)
Microbiology Syllabus
To be implemented from the Academic year 2023-24

Semester I

Course Code	UNIT TOPIC	HEADINGS	Credits	L / Week
Introduction to Virology	I	Structure of viruses	03	01
	II	Bacteriophages:		01
	III	Baltimore classification of viruses		01

Semester II

Course Code	UNIT TOPIC	HEADINGS	Credits	L / Week
Viral infections and Cancer	I	Plant Viruses	03	01
	II	Viruses: Detection, Enumeration and Antivirals		01
	III	Cellular transformation and oncogenesis		01

Unit	Topic	Credits	Lectures	References
	Semester I			
1	**General Virology:**	01	**15**	
	1.1 Structure of viruses 1.1.1. Enveloped and non-enveloped viruses 1.1.2. Structural proteins and Capsid symmetries 1.1.3. Viral genomic organization and replication 1.1.4. Protein nucleic acid interactions and genome packaging 1.1.5. ICTV nomenclature and classification of viruses 1.2Cultivation And Enumeration Of viruses: Growth of viruses in – 1.2.1. *In ovo*: using embryonated chicken eggs 1.2.2. *In vivo*: using experimental animals 1.2.3. *Ex vivo / In vitro* : using various cell cultures - primary and secondary cell lines, suspension cell cultures and monolayer cell cultures 1.2.4. Plants and plant cell cultures 1.3 - Virus related structures – viroids, prions and plant satellite viruses		05 05 05	
2	**Bacteriophages:**	01	**15**	
	2.1 Bacteriophages: General properties of phages, properties of phage infected Bacterial cultures, Specificity of Phage Infection 2.2*E. coli* Phage T7: Properties of T7 DNA, Genetic organization, the T7growth cycle, Replication of T7 DNA- can be removed 2.3*E.coli* Phage Lambda: Organization of the Lambda genes, Growth Cycle, Regulation of transcription of Lambda phage. 2.4Phage therapy for control of bacterial poultry diseases and Mycobacteriophages		06	

3	**Baltimore classification of viruses**	**01**	**15**	
	General characters and genomic structure, and replication for: 3.1 Class I: Double stranded DNA (dsDNA) viruses- Herpesviridae. 3.2 Class II: Single stranded DNA (ssDNA) viruses- Parvoviridae.		03	Introduction to Plant Virology – I. Longman Basic Virology, Wagner 3rd edition Understanding Viruses, Teri Shors
	3.3 Class III: Double stranded RNA (dsRNA) viruses-*Rheoviridae* Class IV: Single stranded RNA (ssRNA) viruses positive-sense RNA genome- *Coronaviridae* Class V: Single stranded RNA (ssRNA) negative-sense RNA genome viruses- *Paramyxoviridae*. 3.3 Class VI: Positive-sense ssRNA reverse transcriptase viruses-HIV. Class VII: Double stranded DNA (dsDNA) reverse transcriptase viruses- Hepatitis B.		06 04	

	Practicals
	1. Egg inoculation and cultivating animal virus in embryonated egg. Demonstration 2. Cultivation of macrophage cell lines and study of cell viability 3. Isolation and Purification of coliphages from sewage 2. Phage Typing of E. coli and Salmonella strains. 3. Study of One Step Growth Curve of Lambda phage / T4 Phage. 4. Study of Lysogeny in E. coli. 5. Induction of lambda lysogen by UV radiation 6. Isolation of lambda phage 7. Assignment on Virology – Research Paper.

REFERENCES:

1. Understanding Viruses – Teri Shors. Jones and Bartlett pub.
2. Bacterial and Bacteriophage Genetics – Edward Birge
3. Basic Virology, Wagner E,K; Hewlett, M.J, Bloom, D.C., Camerini, D, 3rded, 2008, Blackwell Publishing
4. Principles of Virology – Flint, Enquist, Racaniello&Skalka, Vol I and II. ASM
5. Azimi T, Mosadegh M, Nasiri MJ, Sabour S, Karimaei S, Nasser A. Phage therapy as a renewed therapeutic approach to mycobacterial infections: a comprehensive review. *Infect Drug Resist*. 2019;12:2943-2959https://doi.org/10.2147/IDR.S218638
6. Chemistry of Viruses – Knight C. Springer Verlag. NY
7. Virology – Delbecco and Giasberg. Harper and Ravi Pub. NY
8. International Congress on Taxonomy of Viruses:http://www.ncbi.nlm.nih.gov/ICTV

Self learning topics (unit wise)

unit	Topics
1.1	Enveloped virus, Structural proteins and capsid symmetry
1.3	Prions
2.4	Phage therapy for control of bacterial poultry diseases and Mycobacteriophages
3.1	DNA virus

Online resources
Online module: Enveloped virus, structural proteins and capsid symmetry https://www.youtube.com/watch?v=jY3axuAm2AA&feature=youtu.be https://www.classcentral.com/course/virology-952 **Online module**: Prions https://www.coursera.org/lecture/advanced-neurobiology1/3-3-7-prion-diseases-PcOq7 **Online module:** Phage therapy for control of bacterial poultry diseases and Mycobacteriophages https://onlinecourses.swayam2.ac.in/cec20_bt15/preview **Online module:** DNA virus https://www.youtube.com/watch?v=73nXMQO-new&feature=youtu.be https://www.classcentral.com/course/virology-952

Semester II Detail Syllabus

Unit	Topic	Credits	Lectures	References
	Semester II			
1	**Plant Viruses:**	01	**15**	
	1.1. Plant viruses : Morphology, Transmission of plant viruses, symptoms of plant diseases caused by viruses. 1.2 Plant virus life cycles, Plant satellite viruses and satellite Nucleic acids 1.3 TMV, Citrus Tristeza Virus (CTV), : Viral structure, Genome, Host range, Transmission, Symptom and Control.		04 03 06	
2	**Viruses: Detection, Enumeration and Antivirals**	**01**	**15**	
	2.1 Sampling techniques 2.1.1. Processing of samples – Enrichment and concentration 2.2.2. Direct methods of detection – light microscopy (inclusion bodies), electron microscopy and fluorescence microscopy 2.2.3. Immunodiagnosis, hemagglutination and hemagglutination-Inhibition tests,Complement fixation, Neutralization, Western blot, Radioactive Immunoprecipitation Assay (RIPA), Flow cytometry and Immunohistochemistry. 2.2.4. Nucleic acid based diagnosis: Nucleic acid hybridization, polymerase chain reaction, microarray and nucleotide sequencing, LINE probe assay 2.2.5. Infectivity assay for animal and bacterial viruses - plaque method, pockcounting, end point methods, LD50, ID50, EID50, TCID50 2.2.6. Infectivity assays of plant viruses		03	
	2.2 Antivirals: Interferons, designing and screening for antivirals, mechanisms of action, antiretrovirals — mechanism of action and drug resistance		06	

3	**Cellular transformation and oncogenesis**	**01**	**15**	
	3.1 Oncogenic viruses 3.1.1 Discovery of Oncogenic viruses 3.1.2 Viral Genetic Information in Transformed Cells 3.1.3 The origin and nature of viral transforming genes 3.1.4 Functions of viral transforming proteins		05	
	3.2 Activation of Cellular Signal Transduction Pathways by Viral Transforming Proteins 3.2.1 Viral Signalling Molecules Acquired from the Cell		06	
	3.2.2 Viral homologues of cellular genes 3.2.3 Alteration of the Production or Activity of Cellular Signal Transduction Proteins 3.2.4 Viral Proteins That Alter Cellular Signalling Pathways 3.3 Mechanisms of Transformation and Oncogenesis by Human Tumor Viruses 3.3.1 Nontransducing Oncogenic Retroviruses: Tumorigenesis with Very Long Latency 3.3.2 Oncogenesis by Hepatitis Viruses (Hepatitis B Virus, Hepatitis C Virus)		04	

	Practicals based on PS-FMB -204
	1. Enumeration of viruses by plaque assay. 2.Haemagglutination inhibition test 3. Western blotting 4. RT- PCR 5. Rapid diagnostic test kit of SARS-CoV 6. Assignment on Plant viruses/ oncogenic viruses

REFERENCES:

1. Introduction to Plant Virology – BOS, I. Longman, London, NY.
2. Virology – Dulbecco and Giasberg. Harper and Ravi Pub. NY.
3. Hamilton W. Allan, (1987) Biofilms: Microbial Interactions and Metabolic activities, in Ecology of Microbial Communities, (Eds. M. Fletcher, T. R. G. Gray and J. G. Jones) Cambridge University Press, Cambridge. s
4. Edward K. Wagner, Martinez J. Hewlett, (2004), Basic Virology, Blackwell Publishing
5. Flint S. J., V. R. Racaniello, L. W. Enquist, V. R. Rancaniello, A. M. Skalka, (2003), Principles of Virology: Molecular Biology, Pathogenesis, and Control of Animal Viruses, American Society Microbiology, Chapters 3-13
6. Understanding Viruses – Teri Shors. Jones and Bartlett pub.
7. Haaheim L. R., J. R. Pattison and R. J. Whitley, (2002), A Practical Guide to Clinical Virology. 2nd Ed. Edited by, John Wiley & Sons, Ltd.
8. Knipe David M., Peter M. Howley, Diane E. Griffin, Robert A. Lamb, Malcolm A. Martin, Bernard Roizman, Stephen E. Straus, (2007), Field's Virology, 5th Ed. Lippincott Williams & Wilkins
9. Luria S. E. et.al. (1978) General virology, 3rd Ed, New York. John Wiley and Sons.

Self learning topics (unit wise)

unit	Topics
1.1	Tobacco mosaic virus (TMV)
1.3	Immunodiagnosis
2.4	Oncogenes, tumor suppressor genes.
3.1	Viral homologues of cellular genes

Online resources
Online module: Tobacco mosaic virus (TMV) https://www.youtube.com/watch?v=LBz5YFlz4Kw **Online module:** Immunodiagnosis https://onlinecourses.swayam2.ac.in/cec20_bt15/preview **Online module:** Oncogenes, tumor suppressor genes. https://onlinecourses.swayam2.ac.in/cec20_ma14/preview **Online module:** Viral homologues of cellular genes https://www.youtube.com/watch?v=d4SpwHIe6e4s