HSNC
UNIVERSITY,
MUMBAI

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 2020-2021 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 (to be 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 across three years essentially in Inter / Intra Disciplinary course.

A learner who joins Regular Undergraduate Program will have to opt for Honours Program in the first year of the Program. However, the credits for honours, though divided across three years can be completed within three years to become eligible for award of honours Degree.

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 ear marked 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 adhoc 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 assigned for 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 is construed as corresponding to approximately 30 to 40 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

O***** The fees for transfer of credits or performance will be based on number of credits that a learner has to complete for award of the degree.

The Scheme of Teaching and Examination:

The performance of the learners shall be evaluated in two components: Internal Assessment with 40% marks by way of continuous evaluation and by Semester End Examination with 60% marks by conducting the theory examination.

INTERNAL 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.

The semester end examination (external component) of 60% will be as follows:
1) Duration – 2 Hours

2) i) Theory Question Paper Pattern: -

Evaluation Scheme (60:40)

a) Semester End Theory Assessment - 60 Marks

i. Duration - These examinations shall be of 2 1/2 Hours duration.

ii. Theory question paper pattern: -

- There shall be four questions. On each unit there will be one question with 15 Marks each & fourth one will be based on all the three units with 15 Marks.
- All questions shall be compulsory with internal choice within the questions. Question 1 (Unit-I), Question 2 (Unit-II) & Question 3 (Unit-III) & Question4 (combined units) will be of 60 Marks with internal options.
- Questions I, II and III may be sub divided into sub questions of short or long questions of 5 marks each. Please note that the allocation of marks depends on the weightage of the topic.
- Question IV will be objective questions.

b) Continuous evaluation- 40 Marks

- 20 Marks Test
- 15 Marks Projects/Presentations (On Current topics/Syllabus)
- 5 Marks Overall Conduct and Active Participation.

2) ii) Practical Question Paper Pattern: -

Semester End Examination-50 Marks per Paper
Paper-I based on Course-I & Paper-II based on Course-II and Paper III based on Course III in each semester.

Internal Assessment-20 Marks per Paper

Sr. No.	Particulars	Marks	Total
1	**Laboratory work (Paper I ,II,III)**	30+30+30	90
2	**Journal (Paper I ,II,III)**	05 + 05+05	15
3	**Viva (Paper I,II,III)**	05 + 05+05	15
4	**Practical Test Marks**	10+10+10	30
	Grand Total	50+50+50	150

HSNC University, Mumbai

Ordinances and Regulations

With Respect to

Choice Based Credit System
(CBCS)
For the Programmes under

The Faculty of Science and Technology

In the subject of

Microbiology

With effect from the Academic year 2021-2022

Preamble

Microbiology is the study of microbes such as bacteria, viruses, fungi, algae, cyanobacteria, protozoa and many other microscopic organisms. They are very important as they carry out diverse activities ranging from causing diseases in humans, animals and plants to the production of highly useful products like antibiotics, enzymes, alcohol, fermented foods, and recycling of dead and decaying organic matter in the environment. Microbiology is emerging as a key biological science as recognition of the ability of microorganisms to decompose materials such as herbicides, pesticides, and oils in oil spills; the potential of microorganisms as food supplements; exploitation of microbial activity to produce energy such as methane gas for rural consumption; and the potential of new therapeutic substances by microorganisms.

Knowledge of different aspects of Microbiology has become crucial and indispensable to the society. Several discoveries in the last two to three decades, which significantly impact these areas, have put Microbiology on the center stage of teaching, research and development all over the globe. In a country like ours, where fast and tremendous technological advancement and population growth happens, the demand and supply of trained manpower are not on par. The introduction of a Microbiology program with an amalgamation of interdisciplinary aspects of the field is the remedy to this major skill gap in the country.

1. Course objective

The S.Y.B.Sc. Microbiology syllabus (SMB) is a Choice-based credit system comprising of three papers having three units each in both semesters. The course covers different disciplines like Genetics, Environmental, Air, Space, Food, Dairy and Industrial microbiology, Immunology and Epidemiology, Macromolecular metabolism and Enzymology, Ecology, Evolution, Microbial biotechnology and modern-day diagnostic methods and instrumentation. The course will concentrate on strengthening the basics of the subject and also on amalgamating the knowledge with an informative approach to understand tools and techniques to build up a strong research and industry-based core. It will cover general principles of infectious diseases and laboratory diagnosis coupled with a problem-solving approach towards the betterment of healthcare and diagnostic sectors.

The understanding, knowledge and skills in Microbiology need to be developed through a

thorough teaching-learning process in the class, practical skills through the laboratory work, their presentation and articulation skills, exposure to industry and interaction with industry experts, write short research-based projects where they are guided and mentored by the academic and other experts of the subject.

It is envisaged that the students trained under this curriculum will have the required attributes of knowledge, skills, temperament and ethics related to the subject of Microbiology, Diagnostics and healthcare to meet the increasing demand.

2. Process adopted for curriculum designing

The curriculum was designed in a stepwise manner, firstly based on feedback obtained from department teachers and students. Later several meetings were conducted with representatives from academia, industries and research institutions to assure that the syllabus is enriched in all aspects.

3. Salient features, how it has been made more relevant

While designing the syllabus, care has been taken to balance the fundamental techniques of Microbiology with some advanced modern-day techniques of diagnostic, clinical, food, industrial and environmental microbiology.

The course would allow students to develop skills in areas that have direct relevance to employability in diagnostics, health, food and pharmaceutical industries, agriculture and environment-related job opportunities in Microbiology.

4. Learning Outcomes

The curriculum is designed to educate the learner about various fields of Microbiology like Genetics, Medical Microbiology and Diagnostics, the Pharmaceutical industry, Molecular, Environmental and Biotechnology. The course would help students to apply their microbiological concepts to summarize, analyze, and inculcate problem-solving approach in the newer developments and innovations in the future. The curriculum design and the teaching and evaluation patterns would help students to develop skills and competencies to build a progressive and successful career in the field of Microbiology.

- The learner will learn to analyze macromolecules chemically and determine their concentration in clinical and industrial samples.
- The learner will learn about the evolution of microbes and new emerging and re-emerging diseases. The learner will learn the handling of various instruments which will help them to understand the principle and working of the same.
- The learner will understand food spoilage and adulteration concepts of food.
- The learner will know the role of microbes in the fields of environment, medicine and industrial microbiology. The course will help them to study the ability of microbes as decomposers, food supplements, energy sources and infectious agents.
- The learner will also acquire skills to analyze water, soil and sewage samples.
- The learner will learn the handling of various instruments which will help them to understand its component, parts, principle and working.
- The learner will learn about the skills required to work in a basic diagnostic and clinical laboratory.

5. Input from stakeholders (Which Sections have been modified) with a relevant introduction

New topics were introduced such as, Research Methodology, Industrial Microbiology, Astro microbiology and Scientific communication. Also, Quality Standards of food, dairy, water and air, are introduced, thus highlighting their significance in analysis.

Existing components were modified, practical applications of HACCP were incorporated in food microbiology as suggested by the industrial, research and academic experts.

The academic expert suggested adding microbe-based databases for studying bioinformatics streamlining its relation to the fields of microbiology.

New references with latest editions related to the topics were also introduced as suggested by the academic experts.

SEMESTER III

Course Code	Unit	Topics	Credits	L / Week
USMB-301		**Biomolecules, Diagnostics and Taxonomy**	**2**	
	I	Macromolecule composition and estimation		**1**
	II	Nucleic acid metabolism		**1**
	III	Diagnostics and Taxonomy		**1**
USMB-302		**Environmental Microbiology**	**2**	
	I	Aeromicrobiology and Astromicrobiology		**1**
	II	Freshwater, Marine and Sewage microbiology		**1**
	III	Soil microbiology		**1**
USMB-303		**Applied Microbiology and Instrumentation**	**2**	
	I	Microbial biotechnology		**1**
	II	Research methodology and Biostatistics		**1**
	III	Instrumentation I		**1**
USMBP-3	Practicals based on the above three courses in theory		**3**	**9**

SEMESTER IV

Course Code	Unit	Topics	Credits	L / Week
USMB-401		**Microbial Metabolism, Genetics and Bioinformatics**	**2**	
	I	Introduction to metabolism and bioenergetics		**1**
	II	Classical Genetics and Bioinformatics		**1**
	III	Enzymology		**1**
USMB-402		**Microbial Ecology, Immunology, Epidemiology and Instrumentation**	**2**	
	I	Microbial ecology and evolution		**1**
	II	Immunology & Epidemiology -		**1**
	III	Instrumentation II		**1**
USMB-403		**Food, Industrial and Dairy Microbiology**	**2**	
	I	Food Microbiology		**1**
	II	Industrial Microbiology		**1**
	III	Dairy Microbiology		**1**
USMBP-4	Practicals based on the above three courses in theory		**3**	**9**

S.Y.B.Sc. Microbiology Syllabus
Credit Based and Grading System
To be implemented from the Academic year 2021-22

SEMESTER III

Course Code	Unit	Topics	Credits	L / Sem
USMB-301	**I**	**Biomolecules, Diagnostics and Taxonomy** **Macromolecule composition and estimation** **1.1 Macromolecular composition of a microbial cell [1L]** **1.2 Methods of elemental analysis [3L]** 1.2.1 Carbon estimation by Van Slyke manometer 1.2.2 Nitrogen estimation by Microkjehldahl method 1.2.3 Phosphorus estimation by ANSA method **1.3 Estimation of Proteins and amino acids [3L]** 1.3.1 Amino acid estimation by Ninhydrin method 1.3.2 Protein estimation by Biuret method (Direct and indirect) **1.4 Estimation of Carbohydrates [3L]** 1.4.1 Total carbohydrates by Anthrone method 1.4.2 Reducing Sugars (Glucose and maltose) by DNSA method 1.4.3 Reducing sugar by Fehling's method **1.5 Extraction of Lipids by Soxhlet method [1L]** **1.6 Estimation of Nucleic acids [4L]** 1.6.1 General principles and extraction of nucleic acids 1.6.2 DNA by DPA method 1.6.3 RNA by Orcinol method	**2**	**15 lectures**

Course Code	Unit	Topics	Credits	L / Sem
USMB-301	**II**	**Nucleic acid Structures** **2.1 Nucleic Acid Structure [7L]** 2.1.1 DNA stores genetic information 2.1.2 DNA molecules have a distinctive base composition 2.1.3 DNA is a double helix DNA that can occur in different 3D forms 2.1.4 DNA sequences adopt unusual structures 2.1.5 Messenger RNAs code for polypeptide chains 2.1.6 Many RNAs have complex 3D structures **2.2 Nucleic acid chemistry [5L]** 2.2.1 Denaturation of double-helical DNA and RNA 2.2.2 Nucleic acid from different species can form hybrids 2.2.3 Nucleotides and nucleic acids undergo non-enzymatic transformations 2.2.4 DNA methylation **2.3 Other Functions of nucleotides [1L]** **2.4 Structures of chromosomes of eukaryotic cell [2L]**		**15 lectures**
	III	**Diagnostics and Taxonomy** **3.1 Growth-Independent Diagnostic Methods [8L]** 3.1.1 Serology 3.1.2 Phage typing 3.1.3 Fatty Acid Profiles 3.1.4 Flow cytometry 3.1.5 DNA fingerprinting 3.1.6 DNA sequencing 3.1.7 Nucleic acid hybridization 3.1.8 Nucleic Acid Amplification Tests (NAATs) 3.1.9 Southern blotting 3.1.10 DNA chips 3.1.11 Ribotyping and Ribosomal RNA sequencing 3.1.12 Fluorescent In Situ Hybridization (FISH) **3.2 Bergey's manual of Systematic Bacteriology [2L]** Understanding classification and identification schemes for bacteria using Bergey's manual **3.3 Molecular Phylogeny [2L]** Making sense of molecular sequences 3.3.1 Obtaining DNA sequences		**15 lectures**

		3.3.2 Role of 16S rRNA in phylogeny 3.3.3 Sequence Alignment (ex 16S rRNA) **3.4 Phylogenetic Trees [2L]** 3.4.1 Tree Construction 3.4.2 Limitations of Phylogenetic Trees **3.5 Numerical Taxonomy [1L]**		

Paper I Self-Learning topics (Unit wise)

Unit	Topics
1	**1.1 Macromolecular composition of a microbial cell**
2	**2.1.1 DNA stores genetic information**
3	**3.1.4 Flow cytometry**

Online Resources

Online module: Cell chemistry
https://nptel.ac.in/courses/102/105/102105087/

Online module: DNA-1
https://www.swayamprabha.gov.in/index.php/program/archive/9

Online module: Experimental Biotechnology
https://onlinecourses.nptel.ac.in/no

Course Code	Unit	Topics	Credits	L / Sem
USMB-302	**I**	**Environmental Microbiology** **Aeromicrobiology and Astromicrobiology** **1.1 Aeromicrobiology [6 L]** 1.1.1 Important airborne pathogens and toxins 1.1.2 Aerosols, nature of bioaerosols 1.1.3 Aeromicrobiological pathway, microbial survival in the air 1.1.4 Extramural aeromicrobiology 1.1.5 Intramural aeromicrobiology **1.2 Sampling devices for the Collection of air samples, detection of microorganisms on fomites [2L]**	**2**	**15 lectures**

		1.3. Air Sanitation [3L] **1.4 Air Quality Standards - ISO, NAAQS [1L]** **1.5 Astromicrobiology [3L]** 1.5.1 Survival of Microorganisms in Outer Space 1.5.2 Microbiological research in the space environment.		
	II	**Freshwater and Sewage microbiology** **2.1 Freshwater Environments and micro-organisms found in- [1L]** 2.1.1 Springs, lakes, wetlands, glaciers 2.1.2 Permanently frozen lakes, streams and rivers **2.2 Potable water [3L]** 2.2.1 Definition 2.2.2 Water purification 2.2.3 Water quality standards - Bureau of Indian Standards (BIS) specifications for potable water (IS -10500: 2012). 2.2.4 Pathogens transmitted through water **2.3 Microbiological analysis of water [3L]** 2.3.1 Indicator organisms and their detection in water 2.3.2 Total Coliforms, Fecal Coliforms and *E.coli*, Fecal *Streptococci, Clostridium perfringens* **2.4 Sewage Microbiology [8L]** 2.4.1 Types and characteristics of wastewater 2.4.2 Modern wastewater treatment: Primary, Secondary and Tertiary treatment. 2.4.3 Monitoring of wastewater treatment process (BOD, COD) 2.4.4 Removal of pathogens by sewage treatment processes 2.4.5 Sludge processing 2.4.6 Oxidation ponds, Septic tank 2.4.7 Disposal of solid waste, Modern sanitary landfills, Composting		**15 lectures**
	III	**Soil & Geo Microbiology** **3.1 Soil as microbial environment [3L]** 3.1.1 Biotic and abiotic stresses 3.1.2 Types of micro-organisms in Soil **3.2 Methods of studying soil microorganisms [5L]** 3.2.1 Sampling		**15 Lectures**

		3.2.2 Cultural methods 3.2.3 Physiological methods 3.2.4 Immunological methods 3.2.5 Nucleic acid-based methods 3.2.6 Radioisotope technique **3.3 Biogeochemical cycles [5L]** 3.3.1 Carbon 3.3.2 Nitrogen 3.3.3 Phosphorous 3.3.4 Sulphur 3.3.5 Iron **3.4 Soil Bioremediation [2L]** 3.4.1 Microorganisms used in remediation technologies 3.4.2 Stimulation of bioremediation by the utilization of biogenic substances 3.4.3 The classification of bioremediation methods 3.4.4 In situ methods 3.4.5 Ex-situ methods		

Paper II Self-Learning topics (Unit wise)

Unit	Topics
2	**2.4.1Types of waste water**
2	**2.4.7 Composting**
2	**3.3.1 Carbon cycle**
3	**3.3.2 Nitrogen cycle**

Online Resources

Online module : Sources & types of waste water

https://nptel.ac.in/courses/105/105/105105178/

Online module: Biogeochemical cycles-1
https://nptel.ac.in/courses/102/105/102105087/

Online module: Biogeochemical cycles-1
https://nptel.ac.in/courses/102/105/102105087/

Online module: Vermicomposting
https://nptel.ac.in/courses/126/105/126105014/

Course Code	Unit	Topics	Credits	L / Sem

USMB-303	**I**	**Applied Microbiology and Instrumentation** **Microbial Biotechnology** **1.1 Energy and Biotechnology [4L]** 1.1.1 Biofuels 1.1.2 Sources of biomass 1.1.3 Production of ethanol and methane from biomass 1.1.4 Hydrogen production **1.2 Biotechnology and Health care [3L]** 1.2.1 Use of probes in disease diagnosis 1.2.2 Use of monoclonal antibodies in disease diagnosis and treatment. **1.3 Biofertilizer, Biopesticide [2L]** **1.4 Novel uses of marine microbes and microbial enzymes [1L]** **1.5 Nanobiotechnology [5L]** 1.5.1 Introduction of nanobiotechnology 1.5.2 Types of nanomaterials- nanoparticles, nano capsules, nanotubes, liposomes, nanogels, dendrimers 1.5.3 Application in drug and gene delivery	**2**	**15 lectures**
	II	**Research Methodology and Biostatistics** **2.1 Introduction to Research Methodology [2L]** 2.1.1 Difference between action research and fundamental research 2.1.2 Research design – Experimental and Non-experimental research design 2.1.3 Field research 2.1.4 Survey research **2.2 Methods of data collection [2L]** 2.2.1 Secondary data collection methods 2.2.2 Qualitative methods of data collection 2.2.3 Survey methods of data collection **2.3 Questionnaire designing [1L]** **2.4 Sampling techniques – The nature of sampling, sampling design, Determination of sample size [2L]** **2.5 Scientific Writing Skills - Report generation [2L]** **2.6 Biostatistics [6L]** 1.6.1 Variance, Standard error		**15 lectures**

		1.6.2 Hypothesis testing 1.6.3 Normal and Poisson distribution 1.6.4 Validation of analytical data- confidence limit and confidence interval; Students t-test, Q test, F test, ANOVA		
	III	**Instrumentation-I** **3.1 Centrifugation [5L]** 3.1.1 Introduction 3.1.2 Basic principles of sedimentation 3.1.3 Types, care and safety aspects of centrifuges 3.1.4 Types of rotors, care and maintenance, 3.1.5 Preparative centrifugation & its applications 3.1.6 Analytical centrifugation and its application **3.2. Chromatographic techniques [10L]** 3.2.1 General Principles of chromatography, General techniques of chromatography (Column Chromatography, Thin Layer chromatography, Paper Chromatography). 3.2.2 Adsorption chromatography 3.2.3 Partition chromatography 3.2.4 Ion exchange chromatography 3.2.5 Exclusion chromatography 3.2.6 Affinity chromatography 3.2.7 High-performance liquid chromatography 3.2.8 Gas chromatography		**15 Lectures**

Paper III Self-Learning topics (Unit wise)

Unit	Topics
1	**1.3 Biofertilizers**
1	**1.5 Introduction of nanobiotechnology**
2	**2.5 Scientific writing skills-Report generation**
3	**3.2.4 Ion exchange chromatography**

Online Resources

Online module: Introduction to Nanotechnology, Lec-1
https://nptel.ac.in/courses/102/107/102107058/

Online module: Biofertilizers, Lec-55
https://nptel.ac.in/courses/102/105/102105058/

Online module: Ion exchange chromatography, Lec-17

https://nptel.ac.in/courses/102/107/102107028/

Online module: 16-Report writing
https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/330

SEMESTER III PRACTICALS

USMBP-3	Practicals based on the above three courses in theory	Credits 3	135 Lectures / Semester
	Section I		**45L**
	1. Estimation of total sugar by Anthrone method (Demonstration) 2. Estimation of reducing sugars by DNSA method 3. Estimation of reducing method by Fehling's method 4. Estimation of protein Biuret method (indirect and direct) 5. Extraction of lipid by Soxhlet method (Demonstration) 6. Estimation of DNA by DPA method 7. Estimation of RNA by Orcinol method 8. Identification of bacteria using Bergey's manual 9. Construction/Interpretation of phylogenetic tree		
	Section II		**45L**
	1. Enumeration of microorganisms in air and study its load after fumigation 2. Study of air microflora and determination of sedimentation rate 3. Routine analysis of water: a. Standard Plate Count b. Detection of Coliforms in water: Presumptive Test, Confirmed Test and Completed Test c. Rapid Detection of *E.coli* by MUG Technique 4. Wastewater analysis: a. Study of microbial flora in raw and treated sewage b. Determination of total solids in wastewater c. Determination of BOD and COD of wastewater 5. Visit to a sewage treatment plant or water purification plant 6. Total viable count of soil microflora 7. Isolation of bacteria, actinomycetes and fungi from soil 8. Enrichment and isolation of Nitrosifiers, Nitrifiers, Cellulose degraders, Sulphate reducers and Phosphate solubilizers from soil		

	9. Winogradskys column of an aquatic ecosystem		
USMBP-3	**Section-III**		**45L**
	1. Extraction and detection of biopolymers from Azotobacter 2. Demonstration of Vermicomposting 3. Preparation of nanoparticles and study their antibacterial activity 4. Calculation of Mean, Median, Mode and Standard deviation (using Excel) 5. Problems on Students t-test, Q test, F test, ANOVA 6. Writing a Review paper/ report writing 7. Separation and identification of amino acids by ascending paper chromatography. 8. Separation and identification of sugars by TLC 9. Sizing yeast cell by density gradient centrifugation 10. Demonstration of 2D TLC		

SEMESTER IV

Course Code	Unit	Topics	Credits	L / Sem
USMB-401		**Microbial Metabolism, Genetics and Bioinformatics**	**2**	
	I	**Introduction to metabolism & bioenergetics** **1.1 Biological systems conform to the general laws of thermodynamics (Free energy, Enthalpy, Entropy) [1L]** **1.2 Introduction to metabolism and metabolic pathways [1L]** **1.3 Organic reaction mechanisms [2L]** **1.4 Experimental approaches to study metabolism [2L]** **1.5 High-energy phosphates play a central role in energy capture and transfer [5L]** 1.5.1 Thermodynamics of phosphate compounds 1.5.2 Structure and properties of ATP **1.6 Oxidation-reduction reactions [3L]** **1.7 Role of NAD, NADPH and FAD in metabolic pathways [1L]**		**15 lectures**
	II	**Classical Genetics and Bioinformatics** **2.1 Mendels law of heredity [5L]** 2.1.1 Genotype and phenotype 2.1.2 Monohybrid cross: Principle of dominance and segregation, test Cross, Punnett square 2.1.3 Dihybrid cross: Principle of independent assortment. 2.1.4 Mendel's Principle in Human genetics - Pedigree Analysis **2.2 DNA Replication [6L]** 2.2.1 Historical perspective - Conservative, dispersive, semi-conservative, bidirectional and semi-discontinuous, Theta model of replication 2.2.2 Prokaryotic DNA replication - Details of molecular mechanisms involved in Initiation,		**15 lectures**

		Elongation and Termination 2.2.3 Rolling circle mode of DNA replication **2.3 Bioinformatics[4L]** 2.3.1 Classification of databases 2.3.2 Nucleic acid sequence databases- EMBL, DDBJ, GenBank, GSDB, Ensembl and specialized Genomic resources. 2.3.3 Protein sequence databases- PIR, SWISS-PROT, TrEMBL, NRL-3D. 2.3.4 Protein structure databases-SCOP, CATH, PROSITE, PRINTS and BLOCKS. KEGG 2.3.5 Databases for microbiologists- MicrobesOnline, SEED		
	III	**Enzymology** **3.1 Introduction to Enzymes [5L]** 3.1.1 Definitions of enzymes, coenzymes, cofactors, prosthetic group, apoenzymes, holoenzymes, metalloenzymes, endo/exoenzyme, inducible/ constitutive enzymes, zymogen, isoenzymes and ribozymes with important examples 3.1.2 General properties of enzymes 3.1.3 Mechanism of enzyme action 3.1.4 Derivation of Michaelis-Menten equation 3.1.5 Lineweaver Burk plot 3.1.6 Classification of enzymes **3.2 Overview of Coenzyme [1L]** Coenzymes: Different types and reactions catalyzed by water-soluble coenzymes and fat-soluble vitamins (in tabular form) **3.3 Enzyme Kinetics [7L]** 3.3.1 Effect of temperature and pH 3.3.2 Effect of substrate concentration (Saturation kinetics) 3.3.3 Effect of Inhibitors- Irreversible and Reversible- Competitive, Non-competitive and Uncompetitive inhibitors 3.3.4 Multi substrate reactions- Ordered, Random and Ping Pong reactions 3.3.5 Regulation of Enzyme Activity- Allosteric regulation, Covalent Modification (Only definitions) 3.3.6 Allosteric effects in enzyme catalyzed reactions- Koshland-Nemethy and Filmer model & Monod, Wyman and Changeux model.		**15 lectures**

		3.4 Principles of Enzyme Purification [2L]		

Self-Learning topics (Unit wise)

Unit	Topics
1	**1.4 Experimental approaches to study metabolism**
2	**2.1 Mendels law of heredity**
2	**2.2 DNA Replication**
3	**3.1 Introduction to Enzymes**

Online Resources

Online module : Experimental approaches to study metabolism
https://nptel.ac.in/courses/104/105/104105102/

Online module: Mendelian Inheritance Patterns & Law of Heredity
https://www.swayamprabha.gov.in/index.php/program/archive/9

Online module: DNA Replication(overview)
https://www.swayamprabha.gov.in/index.php/program/archive/9

Online module: Introduction to Enzymes
https://nptel.ac.in/courses/102/102/102102033/

Course Code	Unit	Topics	Credits	L / Sem
USMB-402		**Microbial Ecology, Immunology, Epidemiology and Instrumentation**	**2**	
	I	**Microbial ecology and evolution** **1.1 Microbial evolution [2L]** 1.1.1 Formation and early history of the earth, 1.1.2 Origin of cellular life, 1.1.3 Microbial diversification 1.1.4 Endosymbiotic origin of eukaryotes **1.2 Microbial ecosystems [1L]** 1.2.1 Principles of microbial ecology **1.3 The microbial habitats [6L]** 1.3.1 Freshwater		**15 lectures**

		1.3.2 Soil and plant microbial ecosystems, 1.3.3 Marine microbial ecosystems **1.4 Microbial Ecology and its Methods - An Overview [6L]** 1.4.1 Culture-Dependent Analyses of Microbial Communities 1.4.2 Culture-Independent Analyses of Microbial Communities 1.4.3 Measuring Microbial Activities in Nature		
	II	**Immunology and Epidemiology** **2.1 Host defense [8L]** 2.1.1 Overview of hematopoiesis 2.1.2 Systems involved in immune defenses The reticuloendothelial system (RES), the spaces surrounding tissue cells that contain extracellular fluid (ECF),the bloodstream, and the lymphatic system 2.1.3 Chemical barriers involved in immune response (cationic peptides, bacteriocins, cytokines, interferons, pyrogens, acute-phase proteins, and complement) 2.1.4 Different stages of phagocytosis, PAMP, PRR & Inflammation: Dynamics of inflammatory mediators **2.2 Epidemiology [7L]** 2.2.1 Epidemiological terminologies Epidemiology, Sporadic diseases, Endemic diseases, Hyperendemic diseases, Epidemic diseases, Index case, Pandemic disease, Outbreak, Morbidity rate, Prevalence rate, Mortality 2.2.2 Patterns of disease Predisposing factors, development of disease, the spread of infection, the transmission of disease 2.2.3 Healthcare-associated infections microorganisms in the hospital, compromised host, chain of transmission, control of healthcare-associated infections 2.2.4 Emerging infectious diseases (List) 2.2.5 Bioterrorism- Biological warfare and biological weapons		**15 lectures**
	III	**Instrumentation II** **3.1 Spectroscopy: Principle, Instrumentation & Applications [4L]** 3.1.1 UV- Visible spectrophotometry 3.1.2 IR spectroscopy		**15 lectures**

		3.2 NMR and ESR spectroscopy: Principle, Instrumentation and Applications [3L] **3.3 Electrophoresis: [6L]** 3.3.1 General principles 3.3.2 Factors affecting electrophoresis 3.3.3 Support media: Agarose Gels & Polyacrylamide gels 3.3.4 Protein Electrophoresis: SDS-PAGE (in details), Isoelectric Focusing gels, 2-D PAGE (overview) 3.3.5 Nucleic Acid electrophoresis: AGE **3.4 PCR : Principle, Instrumentation and Applications [2L]**		

Self-Learning topics (Unit wise)

Unit	Topics
1	**1.1 Microbial evolution**
1	**1.2 Microbial ecosystems**
2	**2.2 Epidemiology**
2	**2.1Host defense**
3	**3.1 Spectroscopy**

Online Resources

Online module : Microbial evolution

https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/230

Online module : Microbial ecosystems

https://nptel.ac.in/courses/105/107/105107173/

Online module: Epidemiology
https://nptel.ac.in/courses/105/107/105107173/

Online module: Host Defense-Introduction to immune system
https://nptel.ac.in/courses/104/108/104108055/

Online module: Spectroscopy
https://www.swayamprabha.gov.in/index.php/program/archive/9

Course Code	Unit	Topics	Credits	L / Sem
USMB-403		**Food, Industrial and Dairy Microbiology**	**2**	
	I	**Food Microbiology** **1.1 Introduction: Significance, food as a substrate and sources [1L]** **1.2 Microbial growth in foods, Intrinsic and extrinsic factors influencing growth [1L]** **1.3 General Principles of spoilage [1L]** 1.3.1 Spoilage of fresh foods: fruits and vegetables, eggs, meat, poultry and seafood (a tabular form with examples) **1.4 General principles of food preservation (principle of each method and example of foods only) [3L]** 1.4.1 High temperature 1.4.2 Low temperature 1.4.3 Drying 1.4.4 Radiations (UV, Gamma rays and Microwave processing) 1.4.5 Food additives and chemical preservatives with examples (Tabular Representation-Organic acids and their salts, Sugar, Salt) **1.5 Foodborne diseases and intoxications (tabular form) [1L]** **1.6 Methods of detection of microorganisms in food [3L]** 1.6.1 Overview of cultural, microscopic, physical, chemical and bioassay methods **1.7 Food control with an introduction to HACCP [1L]** **1.8 Food sanitation [4L]** 1.8.1 Food handling 1.8.2 Sanitation and hygiene, 1.8.3 Food laws and adulteration 1.8.4 Consumer protection and guidance society		**15 lectures**

	II	**Industrial Microbiology** **2.1 Introduction [3L]** 2.1.1 An introduction to fermentation processes 2.1.2 The range of fermentation processes 2.1.3 The Component parts of a fermentation process **2.2 Desirable characteristics and strains of industrially important microorganisms [2L]** **2.3 Types of fermentations [1L]** 2.3.1 Aerobic fermentation 2.3.2 Anaerobic fermentation **2.4 Modes of fermentation [5L]** 2.4.1 Batch, continuous and fed-batch fermentation 2.4.2 Surface, Submerged and Solid-state fermentation. **2.5 Typical Fermenter design [4L]** 2.5.1 Design of a typical aerobic fermenter 2.5.2 Components of a typical fermenter		**15 lectures**
	III	**Dairy Microbiology** **3.1 Milk [2L]** 3.1.1 Definition, composition 3.1.2 Sources of contamination of milk **3.2 Pasteurization of milk [2L]** 3.2.1 LTLT 3.2.2 HTST 3.2.3 UHT method **3.3. Milk products:- production and spoilage of** 3.3.1 Yoghurt [2L] 3.3.2 Butter [2L] 3.3.3 Cheese-Cheddar and Cottage cheese [2L] 3.3.4 Fermented milks [1L] 3.3.5 Concentrated and dry milk [1L] **3.4. Microbiological Quality of Milk & Milk Products [3L]** 3.4.1 SPC 3.4.2 Coliform count 3.4.3 LPC 3.4.4 Thermophilic 3.4.5 Psychrophilic counts		**15 lectures**

		3.4.6 RPT (RRT, MBRT, DMC) 3.4.7 Standards used for Quality of Milk & Milk Products - ISO, FSSAI, BIS/ISI, AGMARK, FAO- Codex		

Self-Learning topics (Unit wise)

Unit	Topics
1	**1.4 General principles of food preservation**
1	**1.2 Microbial growth in foods, Intrinsic and extrinsic factors influencing growth**
2	**2.1 Industrial Microbiology-Introduction**
3	**3.2 Pasteurization of milk**
3	**3.3. Milk products:- spoilage**

Online Resources

Online module : General principles of food preservation
https://ugcmoocs.inflibnet.ac.in/index.php/courses/view_ug/134

Online module: Microbial growth in foods, Intrinsic and extrinsic factors influencing growth
https://onlinecourses.nptel.ac.in/noc19_ag07/preview

Online module: Industrial microbiological processes and fermentation in industry
https://www.swayamprabha.gov.in/index.php/program/archive/9

Online module: Pasteurization of milk
https://nptel.ac.in/courses/126/105/126105013/

Online module: Milk products:- spoilage

https://www.digimat.in/nptel/courses/video/126105013/L39.html

SEMESTER IV PRACTICALS

USMB P-4	Practicals based on the above three courses in theory	Credits 3	135 Lectures/ Sem
	Section I		
	1. Problems on bioenergetics to calculate the Keq., Gibb's energy, enthalpy, etc. 2. Isolation of amylase, protease, lipase producers. 3. Extracellular production of invertase from yeast. 4. Effect of pH, Temperature, substrate and enzyme concentration on the activity of invertase. 5. Determination of Km and Vmax of an enzyme by Michaelis Menton's graph. 6. Problems based on Mendelian genetics 7. Visiting & exploring various databases mentioned in the syllabus		**45 L**
	Section II		**45L**
	1. Differential staining: Blood staining 2. Pyocin typing 3. Isolation of genomic DNA from Onion and *E. Coli* 4. Measurement of DNA concentration by UV-VIS spectroscopy. 5. Study of genomic and plasmid DNA using AGE 6. Separation of a mixture of proteins using SDS-PAGE. 7. Demonstration of working of PCR		
	Section-III		**45L**
	1. Visit to Food/Dairy industry 2. Rapid platform tests of raw and pasteurized milk 3. Microbiological analysis of raw and pasteurized milk 4. Microbiological analysis of Butter, Cheese 5. Isolation of amino acid producers 6. Isolation of antibiotic producers from soil 7. Isolation of proteolytic, lipolytic, saccharolytic and pectinolytic microorganisms causing food spoilage 8. Determination of TDT and TDP 9. Determination of Salt and sugar tolerance 10. Determination of MIC of a Chemical preservative 11. Food adulteration 12. Design a seven-step HACCP plan for a particular food product		

References

Course: USMB-301

1. Methods in Microbiology, Vol.5B, Ed. Norris & Ribbon, Academic Press.
2. Laboratory Manual in Biochemistry, J. Jayaraman, (2011), 2nd edition, New Age International.
3. Peter J. Russell (2006), ―I Genetics-A molecular approach‖, 3rd edition.
4. Benjamin A. Pierce (2020), ―Genetics a conceptual approach, 7th edition, W. H. Freeman and company.
5. R. H. Tamarin, (2017), ―Principles of genetics, 7th Edition, Tata McGraw Hill.
6. Robert Weaver, (2011), ―Molecular biology, 5th edition, Mc Graw Hill international edition.
7. S. Ignacimuthu, (2012), ―Basic Bioinformatics, 2nd edition, Narosa publishing house.
8. Arthur Lesk, (2013) ―Introduction to Bioinformatics, 4th Edition, Oxford University.
9. Brock biology of microorganisms / Michael T. Madigan. [et al.] — 15th edition, Pearson.
10. Prescott Harley Kleins Microbiology, 7th Edition, McGraw-Hill.
11. Tortora, Funke, and Case's Microbiology: An Introduction, 13th Edition.

Course: USMB-302

1. Environmental Microbiology, 2nd Edition; Raina M. Maier, Ian L. Pepper, Charles P. Gerba, 2011 Academic Press.
2. Fundamental Principles of Bacteriology, 7th Edition; A.J. Salle, Tata Mc Graw Hill Publishing Company.
3. Air Quality Standards- NAAQS Manual, Volume I. Environmental microbiology by Ian L Pepper Charles P Gerba Terry J, 3rd edition.
4. Prescott Harley Klein's Microbiology, 7th Edition, McGraw-Hill.
5. Fundamentals of Microbiology, Martin Frobisher, 9th Edition.
6. Introduction to Environmental Microbiology Barbara Kolwzan, Waldemar Adamiak, 6th edition.
7. Soil Microbiology-4th Edition, N.S Subba Rao, 2000, Oxford and IBH Publishing Co. Pvt Ltd.

Course: USMB-303

1. Principles & techniques of Biochemistry & Molecular biology, 7th edition, Keith Wilson & John Walker, Cambridge University Press, 2010.
2. A handbook book of Organic analysis: qualitative and quantitative 4th edition, Hans Thacher Clarke, CBS publishers & distributors, New Delhi.
3. Singh Y.K., Fundamental of Research Methodology and Statistics. New age international publishers, 2006.
4. Kothari C.R. & Garg G., Research methodology methods and techniques, New age international publishers, 4th Edition, 2019.

5. Mahajan B.K., Methods in Biostatistics, Jaypee brothers medical publishers, 7th edition, 2010.

Course: USMB-401

1. Harper's illustrated biochemistry. Rodwell, V. 31st edition. New York: Lange Medical Books/McGraw-Hill.
2. Fundamentals of Biochemistry. D. Voet and J. Voet Publisher Wiley Plus Edition 5th.
3. The physiology and biochemistry of prokaryotes, White D., 4th edition Oxford University Press, 2011.
4. Lehninger- Principles of Biochemistry- David Nelson, Michael Cox. 7th edition W.H. Freeman & Company.
5. iGenetics: A Molecular Approach Peter J. Russell (Pearson international edition), 3rd Edition.

Course: USMB-402

1. Brock biology of microorganisms / Michael T. Madigan. [et al.], 15th edition, Pearson.
2. Talaro: Foundations in Microbiology, 11th edition.
3. Prescott Harley Kleins Microbiology, 7th edition, McGraw-Hill.
4. Tortora, Funke, and Case's Microbiology: An Introduction, 13th edition.
5. Principles & techniques of Biochemistry & Molecular biology, 7th edition, Keith Wilson & John Walker, Cambridge University Press, 2010.
6. Williams B.L. & Wilson K., A Biologist's Guide to Principles and Techniques of Practical Biochemistry, American Elsevier Pub. Co. 1975.

Course: USMB-403

1. Outlines of Dairy Technology, Sukumar De, Oxford University Press.
2. Modern Food Microbiology. James Jay, 7th edition.
3. Frazier and Westhoff, Food Microbiology, Tata McGraw Hill, 5th edition.
4. Food Science by Sumati R. Mudambi, Shalini Rao, M.V. Rajagopal, revised 2nd edition, (2006), New Age international publications.
5. HACCP Principles & Application Guidelines by FDA.
6. Managing Food Safety: A Manual for the Voluntary Use of HACCP Principles for Operators of Food Service and Retail Establishments.

Modality of Assessment:

1. Internal Assessment - 40% **40 marks**

a) Theory **40 marks**

Sr No	Evaluation type	Marks
1	Two Assignments/Case study/Project	20
2	One class Test (multiple choice questions/objective)	10
3	Active participation in routine class instructional deliveries(case studies/ seminars//presentation)	05
4	Overall conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through organizing co-curricular activities, etc.	05

b) Practicals **20 marks**

Sr No	Evaluation type	Marks
1	Two best practicals	10
2	Journal	05
3	Viva	05

2. External examination - 60 %

Semester End Theory Assessment - 60% **60 marks**

- Duration - These examinations shall be of two hours duration.
- Theory question paper pattern:-
  1. There shall be four questions each of 15 marks. On each unit, there will be one question & the fourth one will be based on all three units.
  2. All questions shall be compulsory with internal choice within the questions. Each question will be of 20 to 23 marks with options.
  3. Questions may be sub-divided into sub-questions a, b, c, d & e only & the allocation of marks depends on the weightage of the topic.

3. **Practical Examination**

Pattern: Semester III

Course: USMBP- 3	Internal	External	Total
SECTION- I	20 marks	30 marks	50 marks
SECTION - II	20 marks	30 marks	50 marks
SECTION - III	20 marks	30 marks	50 marks

Semester IV

Course: USMBP-4	Internal	External	Total
SECTION- I	20 marks	30 marks	50 marks
SECTION - II	20 marks	30 marks	50 marks
SECTION - III	20 marks	30 marks	50 marks

Internal Practical Examination (20 marks)

Semester III-Internal Practical Examination				
USMBP -3	**Journal-Marks**	**Assignment /Viva Seminar Marks**	**Practical test- 02 Marks**	**Total**
SECTION- I	**05**	**05**	**10**	**20**
SECTION – II	**05**	**05**	**10**	**20**
SECTION – III	**05**	**05**	**10**	**20**
Semester IV-Internal Practical Examination				
USMBP -4	**Journal-Marks**	**Assignment /Viva Seminar Marks**	**Practical test- 02 Marks**	**Total**
SECTION- I	**05**	**05**	**10**	**20**
SECTION – II	**05**	**05**	**10**	**20**
SECTION – III	**05**	**05**	**10**	**20**

Overall Examination Pattern

	SectionI/ PaperI			Section II/PaperII			Section III/PaperIII		
	Internal	**External**	**Total**	**Internal**	**External**	**Total**	**Internal**	**External**	**Total**
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**40**	**60**	**100**
Practicals	**20**	**30**	**50**	**20**	**30**	**50**	**20**	**30**	**50**