HSNC UNIVERSITY,
MUMBAI

Board of Studies in Faculties of Science & Technology

Board of Studies in Microbiology Subject

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

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

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 (**Assistant Professor, Department of Microbiology, K.C college, Churchgate) pratibha.shah@kccollege.edu.in

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

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

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

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

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

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

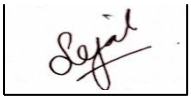
c.) **Dr. Mehul Rajpurkar** (Regional Medico Marketing Manager, SRL Diagnostics, Goregaon West) mehul.rajpurkar@gmail.com

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

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) uzma25.shaikh@gmail.com

b.) Ms. Soni Gupta (Postgraduate student -18-19 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 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 and Paper IV based on Course IV in each semester.

Internal Assessment-20 Marks per Paper

Sr. No.	Particulars	Marks	Total
1	**Laboratory work (Paper I, II, III, IV)**	30+30+30+30	120
2	**Journal (Paper I ,II,III,IV)**	05 + 05+05+05	20
3	**Viva (Paper I,II,III,IV)**	05 + 05+05+05	20
4	**Practical Test Marks**	10+10+10+10	40
	Grand Total	50+50+50+50	200

HSNC University Mumbai

(2020-2021)

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

Semester-V and Semester -VI

With effect from the Academic year 2022-2023

Section D

Microbiology

Part 1- Preamble

The syllabus is as per the Credit Based Semester and Grading System (CBSGS) and continuous evaluation consisting of components of Internal Assessment and External Assessment.

The changes are introduced to conform to the learning objectives.

Keeping in tune with the progression of the syllabus and maintaining continuity of flow of information from F.Y.B.Sc. and S.Y.B.Sc., the T.Y.B.Sc syllabus has been devised. Several changes are introduced in the syllabus of the T.Y.B.Sc to keep the students up to date with the latest developments in the field of Microbiology.

Some of the modules of the University syllabus dealing with fundamentals of Microbiology have been retained whilst other modules have been restructured as per the need of learning objectives.

In semesters V and VI the learner will learn Advanced Genetics, Virology, Medical Microbiology, Immunology, Microbial Biochemistry and Bioprocess Technology. Some of the interdisciplinary modules such as bioinformatics, recombinant biotechnology, and bioinstrumentation will help the learner to understand the subject from a broader perspective.

All the 8 courses of theory and practicals (Semester-V and Semester-VI together) are compulsory to the students offering microbiology as a single major subject (6 units pattern of the old course).

These courses are

US-TMB - 501 - Microbial Genetics

US-TMB - 502 -Medical Microbiology and Immunology-I

US-TMB - 503 -Microbial Biochemistry: Part-I

US-TMB - 504 -Bioprocess Technology- I

US-TMB - 601 -Recombinant DNA technology, Bioinformatics and Virology

US-TMB - 602 -Medical Microbiology and Immunology-II

US-TMB - 603 -Microbial Biochemistry- II

US-TMB - 604 -Bioprocess Technology- II

The approach towards designing this syllabus has been to retain the classic concepts of Microbiology as well as keeping abreast with the latest discoveries in Microbiology and other interdisciplinary fields. In conclusion, the revised syllabus aims at inculcating a spirit of learning and kindling curiosity towards

the subject in the minds of learners, resulting in their pursuit of higher education in Microbiology.

1. Course Objectives:

Semester V

US-TMB - 501: Microbial Genetics

Learning Objectives:

With a background of nucleic acids in FYBSc and Mendelian genetics, DNA structure and prokaryotic DNA replication at the SYBSc level, the undergraduate T.Y. B.Sc. Microbiology course under the Paper on Microbial Genetics introduces the learner to the underlying theories of genetics by elaborating both conceptual and practical tools for Molecular genetics. It elaborates on Transcription, Translation, Regulation of gene expression, Mutations, Repair and Recombination of DNA. The course deals in detail with generating, processing and understanding biological genetic information.

Learning Outcomes:

Students should be able to-

- Understand DNA replication in Eukaryotes and how different is it from prokaryotic DNA replication.
- Understand flow of information through transcription and translation in prokaryotes
- Understand the molecular mechanism involved in Regulation of gene expression
- Understand how to identify and classify mutations in DNA followed by mechanism of DNA repair
- Understand basic concepts of homologous recombination and genetic exchange among prokaryotes

US-TMB - 502: Medical Microbiology and Immunology-I

Learning Objectives:

With a background of overview of the bacterial and host factors affecting infection at FYBSc and the introduction to various Systems involved in host immune defenses, the undergraduate T.Y.B.Sc. Microbiology course under the Paper on Medical Microbiology and Immunology-I introduces the learner to various Bacterial virulence factors, Antigens and its type , structure of Immunoglobulins and its classes , along with the structure and function of various Organs, and Microenvironments of the Immune System. The course also includes the study of Upper and Lower Respiratory Tract, Skin, gastrointestinal tract and Urinary tract Diseases and to the principle of various Experimental systems and Methods.

Learning Outcomes:

- To understand the molecular guidelines for establishing the causes of infectious diseases
- To understand the pathogenesis of disease causing agents.
- To be able to predict the disease based on the clinical signs and symptoms.

- To understand the mode of transmission of diseases, and thereby the prophylaxis measures to be undertaken
- To understand the laboratory methods of diagnosis of the disease.
- To understand the factors that influence immunogenicity.
- To conceptualize the structure of the Microenvironments, functioning of peripheral and secondary lymphoid organs
- To understand the structure & functions of different classes of immunoglobulin
- To understand the important role of cytokines, MHC, APCs in adaptive immunity
- To understand the principle and significance of various antigen-Antibody Assays

US-TMB -503: Microbial Biochemistry: Part-I

Learning Objectives:

This course is designed for T.Y.B.Sc. students graduating in Microbiology, keeping in mind the basics of biochemistry studied in previous 2 classes. Biochemistry explores the chemical processes that take place inside all living cells, both prokaryotic and eukaryotic.

The course elaborates on study of nutrient uptake and methods to study metabolism by invitro and invivo mechanisms. The course explains carbohydrate metabolism and the principles of energy generation by different physiological groups of organisms.

The topic of bioenergetics describes the universal mechanisms of energy generation by using electron transport systems and energy conservation. The student learns about the anabolic mechanisms by studying the glucose, glycogen and peptidoglycan biosynthesis.

Learning Outcomes: The student learns:

- The process of solute transport across the cell and the mechanisms of electron transport chains in prokaryotes and mitochondria along with mechanism of ATP synthesis. The mechanism of bioluminescence and its significance is also learnt.
- The experimental aspect of studying catabolism, anabolism and the various pathways for the breakdown of carbohydrates along with reactions in amphibolic pathways.
- Various other pathways which produce different end products.
- The anabolic reactions in carbohydrate synthesis.
- To apply the concepts of energetics and catabolism in biodegradation of various substrates.

US-TMB -504: Bioprocess Technology I

Learning Objectives:

Industrial Microbiology is an amalgamation of several sciences, and it is rare that a single discipline is sufficient to solve a problem. Instead, success is often dependent on the fusion of ideas, which is impossible unless everyone is familiar with the same basic principles, which is the primary objective of this course.

The goal of this course is to improve the learner's ability to understand the procedures employed in many phases of industrial microbiology, such as strain improvement, basic fermentation equipment, and sterilising. It delves into the various types of fermenters used in industry for the production of various goods, as well as their process parameters along with

important analytical techniques. It covers the fundamentals as well as the key steps and processes involved in the industrial manufacturing of beverages and enzymes.

Learning Outcomes:
Students will be able to-

- To understand the isolation techniques, strain improvement for better yield and improved characteristics for industrially important Microorganisms
- To learn about the design and components of a fermentation media
- To understand the types and principles of sterilization procedures.
- To understand scale-up and scale- down.
- To describe the design of bioreactors for different applications and its process parameters
- To understand the details of productions of important traditional fermentation products like wine, beer, vinegar and enzymes.

Semester VI

US-TMB -601: Recombinant DNA technology, Bioinformatics and Virology

Learning Objectives

This course introduces the learner to gene manipulation techniques which are an essential tool for modern day Genetic studies. This course also gives students theoretical and hands-on competence in major analytical techniques used in bioinformatics. In Virology, the course covers basic structure, life cycle of different types of viruses, and cultivation of viruses. The course elaborates on different terminologies like cancer, prions, viriods and their mechanisms of infection.

Learning Outcomes:

Students should be able to-

- Understand the fundamentals of gene manipulation
- Use bioinformatics tools for genetic analysis
- Understand the basic structure, classification, enumeration, cultivation and life cycle of viruses
- Understand the terms like cancer, prions, viroids and their mechanisms
- Become aware of Human Microbiome Initiative and Indian Biological Data centre

US-TMB -602: Medical Microbiology and Immunology-II

Learning Objectives:

With a background of overview of first, second and third line of host defense at FYBSc and the study of Chemical barriers involved in immune response at the SYBSc level, the undergraduate T.Y.B.Sc. Microbiology course under the Paper on Medical Microbiology and Immunology-II introduces the learner to humoral and cell mediated immunity in detail. The student will also be introduced to mode of action of various chemotherapeutic agents, Antimicrobial resistance, vaccines and Immunohematology. The course also includes the Study of Central Nervous system, vector-borne, Sexually transmitted diseases.

Learning outcome:

- On studying the clinical features to be able to identify the likely causative agent
- To understand the pathogenesis of disease causing agents.
- To understand the mode of transmission of diseases, and thereby the prophylaxis measures to be undertaken
- To understand the laboratory methods of diagnosis of the disease
- To understand the attributes of an ideal chemotherapeutic agent
- To study the mode of actions of bacterial, viral and protozoan drugs.
- To understand the problem of Antimicrobial resistance and how to prevent it.
- To learn the branch of hematology and transfusion medicine.
- To understand the types and role of vaccine in preventing diseases
- To study the B:T cell interaction with pathogen
- To study the structure and role of T and B cells in generating adaptive immunity and thereby study effector responses in both Humoral & Cell Mediated Immunity
- To expand and update our understanding of the functioning and interaction between innate and adaptive immune response.
- To learn the activation of complement system.
- To study the Production and application of Monoclonal Antibodies.

US-TMB -603: Microbial Biochemistry II

Learning Objectives

In semester V students learn utilization of carbohydrates via central metabolic pathways. Semester VI is designed to explain how numerous organic compounds such as lipids, proteins and nucleic acids can be utilized by the living cells. The learners are also exposed to the vital regulatory role played by enzymes. Various levels and mechanisms of regulation are dealt with to make the learner aware of coordinated mechanisms of metabolism in the living cell. Photosynthesis is studied to understand the diversity in mechanism of its electron transfer, pigments and localization of photosynthetic apparatus. Microorganisms are diverse with respect to their metabolism and the field of lithotrophy explains how some universal inorganic compounds can be used to make constituents of cell biomass, use them as electron acceptors and as source of energy.

Learning Outcomes:

The learner will have an understanding of the following metabolic process and their significance.

- ❖ Metabolism of Lipids, Fatty acids, Nucleotides and Amino acids
- ❖ Catabolism of Protein and aliphatic hydrocarbons
- ❖ Regulation of metabolic process at various levels
- ❖ Photosynthesis
- ❖ Metabolism of inorganic molecules with special reference to nitrate and sulfate
- ❖ Biological Nitrogen fixation and Lithotrophy

US-TMB -604: Bioprocess Technology- II

Learning Objectives:

With a back ground of a few traditional fermentations and information about upstream processing, Bioprocess Technology-II introduces learners to downstream processing. The students will also learn about advances like plant tissue culture, animal tissue culture and enzyme immobilization. The course also includes topics like intellectual property rights, QA/ QC, Bioassay and Sterility Control and assurance. The learner is provided with the details of productions of important products like antibiotics, vitamins, organic acid, amino acids and mushrooms.

Learning Outcomes:

- To understand the process involved in fermentations of important pharmaceutical and food products.
- To learn about the basics of ATC and PTC and apply the knowledge gained for applications of animal and plant tissue culture techniques. •
- To learn the applications of immobilized enzymes in various fields.
- To learn the salient features of analytical quality management, regulatory and patenting procedures.

First Year Semester III - Units - Topics - Teaching Hours

S. N	Subject Code		Subject Unit Title	Hours /Lectures	Total No. of hours/lectures	Credit	Total Marks
1	US-TMB-501 **Microbial Genetics**	1	**DNA Replication, Transcription and Translation**	15	60 L	4	100 (60+40)
		2	**Regulation of Gene Expression**	15			
		3	**DNA Mutations and Repair**	15			
		4	**Genetic Exchange & Homologous Recombination**	15			
2	US-TMB-502 **Medical Microbiology and Immunology-I**	1	**Study of Bacterial Pathogenicity and Study of Upper and Lower Respiratory Tract Diseases**	15	60 L	4	100 (60+40)
		2	**Study of Skin, gastrointestinal tract and Urinary tract infections**	15			
		3	**General Immunology – I**	15			
		4	**General Immunology – II and Experimental systems and Methods**	15			
3	US-TMB-503 **Microbial Biochemistry: Part-I**	1	**Biological Membranes & Transport**	15	60 L	4	100 (60+40)
		2	**Bioenergetics & Bioluminescence**	15			
		3	**Studying Metabolism & Catabolism of Carbohydrates**	15			
		4	**Fermentative Pathways & Anabolism of Carbohydrates**	15			
4	US-TMB -504 **Bioprocess Technology- I**	1	**Upstream Processing I**	15	60 L	4	100 (60+40)
		2	**Upstream Processing II**	15			
		3	**Fermenter Types, Monitoring and Instrumentation**	15			
		4	**Traditional fermentations**	15			

5	US-TMB -5P1	1	**Practicals based on US-TMB -501 and 502**	4	60x2= 120 lectures per batch	4	100 (80+10 +10)
7	US-TMB -5P2	1	**Practicals based on US-TMB -503 and 504**	4	60x2= 120 lectures per batch	4	100 (80+10 +10)
			TOTAL			24	600

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination, PA-Project Assessment, AT- Attendance

Part -3 Detailed Scheme Theory

Curriculum Topics along with Self-Learning topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

Course Code: US-TMB -501 (Microbial Genetics)

Unit	Topic	Credits	Lectures	References
1	**DNA Replication, Transcription and Translation**	01	15	Concepts of Genetics Eleventh Edition By Pearson – 1 January 2019 by William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino iGenetics: A Molecular Approach January 2016 by Russell Lehninger-Principles of biochemistry-5th edition David L. Nelson Michael M. Cox
	1.1 Overview of Prokaryotic DNA replicartion **1.2 Eukaryotic DNA replication -** Molecular details of DNA synthesis, replicating the ends of the chromosomes assembling newly replicated DNA into nucleosomes. **1.2 Transcription in Eukaryotes -** Eukaryotic RNA polymerase, Transcription of protein-coding genes by RNA polymerase II, Transcription initiation, The structure and production of Eukaryotic mRNAs, Production of mature mRNA in Eukaryotes, Processing of Pre-mRNA to mature mRNA. Self Splicing of Introns, RNA editing **1.3 Genetic code -** Nature of genetic code and characteristics of genetic code. **1.4 Translation process -** Transfer RNA, structure of tRNA, tRNA genes, Recognition of the tRNA anticodon by the mRNA codon, Adding of amino acid to tRNA, Ribosomal RNA and Ribosomes, Ribosomal RNA Genes, Initiation of translation, Initiation in Bacteria, Initiation in eukaryotes, Elongation of the polypeptide chain, termination of translation, protein sorting in the cell.		1L 2L 5L 2L 5L	
2	**Regulation of Gene Expression**	01	15	
	2.1 **Constitutive, Inducible, and Repressible Gene Expression**		1L	Snustad, Simmons, –Principles of

	2.2 Positive and Negative Control of Gene Expression 2.3 **Operons**: 2.3.1 The Lactose Operon in E. coli: Induction and Catabolite Repression, Mutations 2.3.2 The Tryptophan Operon in E. coli: Repression and Attenuation **2.4 Translational Control of Gene Expression and Posttranslational Regulatory Mechanisms**		1L 9L 4L	genetics‖, 3rd edition. John Wiley & sons, Inc. 2012 iGenetics: A Molecular Approach January 2016 by Russell
3	**DNA Mutations and Repair**	01	15	
	3.1 Mutation 3.1.1 **Terminology:** alleles, homozygous, heterozygous, genotype, phenotype, Somatic mutation, Germline mutation, Gene mutation, Chromosome mutation, phenotypic lag, hotspots and mutator genes 3.1.2 Fluctuation test. 3.1.3 **Types of mutations:** Point mutation, reverse mutation, suppressor mutation, frameshift mutation, conditional lethal mutation, base pair substitution, transition, transversion, missense mutation, nonsense mutation, silent mutation, neutral mutation, pleiotropic mutations. 3.1.4 **Causes of mutation:** Natural/spontaneous mutation- replication error, depurination, deamination. Induced mutation: principle and mechanism with illustrative diagrams for: 3.1.4.1 Chemical mutagens - base analogues, nitrous acid, hydroxyl amine, intercalating agents and alkylating agents. 3.1.4.2 Physical mutagens 3.1.4.3 Biological mutagens (only examples) 3.1.5 Ames test 3.1.6 Detection of mutants		2L 1L 2L 4L 1L 1L	iGenetics: A Molecular Approach January 2016 by Russell Le h n i n g e r- Principles of biochemistry- 5t h e d i t i o n David L. Nelson Michael M. Cox

	3.2 DNA Repair 3.2.1 Mismatch repair, 3.2.2 Light repair 3.2.3 Repair of alkylation damage 3.2.4 Base excision repair 3.2.5 Nucleotide excision repair 3.2.6 SOS repair		4L	
4	**Genetic Exchange & Homologous Recombination**	01	15	
	4.1 Genetic analysis of Bacteria **4.2 Gene transfer mechanisms in bacteria** 4.2.1 Transformation - Introduction and History, Types of transformation in prokaryotes--Natural transformation in *Streptococcus pneumoniae, Haemophilus influenzae,* and *Bacillus subtilis*. Mapping of bacterial genes using transformation. Problems based on transformation. **4.2.2 Conjugation** Discovery of conjugation in bacteria, Properties of F plasmid/Sex factor, The conjugation machinery, Hfr strains, their formation and mechanism of conjugation, F' factor, origin and behavior of F' strains, Sexduction. Mapping of bacterial genes using conjugation (Wolman and Jacob experiment). Problems based on conjugation **4.2.3 Transduction** Introduction and discovery, Generalized transduction, Use of Generalized transduction for mapping genes, Specialized transduction Problems based on transduction **4.3 Recombination in bacteria** 4.3.1 General/Homologous recombination 4.3.2 Molecular basis of recombination 4.3.3 Holliday model of recombination (Single strand DNA break model only) 4.3.4 Enzymes required for recombination 4.3.5 Site –specific recombination		1L 9L 5L	iGenetics: A Molecular Approach January 2016 by Russell Snustad, Simmons, –Principles of genetics‖, 3rd edition. John Wiley & sons, Inc.

US-TMB -**502 (Medical Microbiology and Immunology-I)**

Unit	Topic	Credits	Lectures	References
1	**Study of Bacterial Pathogenicity and Study of Upper and Lower Respiratory Tract Diseases**	01	15	
	1.1 Guidelines for Establishing the Causes of Infectious Diseases 1.1.1 Molecular Koch's Postulates 1.1.2 Molecular Guidelines for Establishing Microbial Disease Causation		2L	Jawetz, Medical Microbiology, 28th Edition, Lange publication
	1.2 Genomics And Bacterial Pathogenicity with examples 1.2.1 Pathogenicity islands 1.2.2 The Clonal Nature of Bacterial Pathogens 1.2.3 Mobile Genetic Elements 1.2.4 Toxins 1.2.4.1 Exotoxins 1.2.4.2Exotoxins associated with diarrhoeal diseases and food poisoning 1.2.4 LPS of gram negative bacteria 1.2.5. IgA1 proteases 1.2.6 Bacterial Secretion Systems 1.2.7 The requirement for iron		6L	
	1.3. **Study of A Few Infectious Diseases of the Upper and Lower Respiratory Tract** (wrt.Cultural Characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention only) 1.3.1 *S. pyogenes* infections 1.3.2 Tuberculosis 1.3.3 Bacterial Pneumonia caused by *K.pneumoniae* 1.3.4 Measles-Rubeola-Rubella-Mumps 1.3.5 Influenza 1.3.6 COVID-19		7L	Ananthanarayan and Panicker's, Textbook of Microbiology, 10th edition 2017
2	**Study of Skin, gastrointestinal tract and Urinary tract infections** (w.r.t. Cultural characteristics of the etiological agent, pathogenesis & clinical features, laboratory diagnosis, treatment and prevention only)	01	15	
	2.1 Study of skin infections 2.1.1 Pyogenic skin infections caused by *Pseudomonas* and *S.aureus.*		6L	Jawetz, Medical

	2.1.2 Leprosy 2.1.3 Fungal infections- Candidiasis, Tinea pedis 2.1.4 Viral Infections- Herpes simplex **2.2 Study of gastrointestinal tract infections** *2.2.1* Infections due to Enteropathogenic *E.coli* strains *2.2.2* Enteric fever- *Salmonella* 2.2.3 Dysentery- Bacillary (Shigella) and amoebic (*Entamoeba histolytica*) dysentery 2.2.4 Rotavirus diarrhea 2.2.5 Cholera **2.3 Study of urinary tract infections (only pathogens and factors involved)**		7L 2L	Microbiology, 28th Edition, Lange publication
3	**General Immunology – I**	01	15	
	3.1. Cells, Organs, and Microenvironments of the Immune System 3.1.1 Primary lymphoid organs - structure and function of Thymus and Bone marrow 3.1.2 Microenvironments of secondary lymphoid organs (SLOs). Secondary lymphoid organs – structure and function of Spleen, Lymph node, Mucosa associated lymphoid tissues, Gut associated lymphoid tissue, Cutaneous associated lymphoid tissue, tertiary lymphoid tissue. **3.2 Antigens** 3.2.1 Concept of Immunogenicity versus antigenicity, Haptens. Haptens as valuable research and diagnostic tools 3.2.2 Factors that influence immunogenicity - Foreignness, Molecular size, Chemical composition, Heterogeneity, Susceptibility of antigen to be processed and presented, Contribution of the biological system to immunogenicity Genotype of the recipient, Immunogen dosage, Route of administration 3.2.3 Epitopes / antigen determinants - General concept, Characteristic properties of B - cell epitopes, concepts of sequential and non-sequential epitopes (with only one example each). Properties of B - cell and T - cell epitopes. Comparison of antigen recognition by T cells and B cells 3.2.4 Types of antigens – heterophile antigens, isophile antigens, sequestered antigens, super antigens, bacterial and viral antigens		4L 6L	Kuby Immunology, WH Freeman, 8th Edition, 2018

	3.3 Immunoglobulins 3.3.1 Immunoglobulins – basic structure of Immunoglobulins, heterodimer; types of heavy and light chains; constant and variable regions, Immunoglobulin domains-hinge region. Basic concepts - hypervariable region, complementarity-determining regions (CDRs), framework regions (FRs) and their importance. 3.3.2 Immunoglobulin classes and biological activities - Immunoglobulin G, Immunoglobulin M, Immunoglobulin A, Immunoglobulin E, Immunoglobulin D, (including diagrams) 3.3.3 Antigenic determinants on immunoglobulins – isotypes,allotypes, idiotypes. 3.3.4 Immunoglobulin Superfamily		5L	Kuby Immunology, WH Freeman, 8th Edition, 2018
4	**General Immunology – II and Experimental systems and Methods**	01	15	
	4.1 Cytokines 4.1.1 Concepts - cytokines, lymphokines, monokines, interleukines, chemokines. 4.1.2 Properties of cytokines 4.1.3 Attributes of cytokines 4.1.4 Biological functions of cytokines		2L	Kuby Immunology, WH Freeman, 8th Edition, 2018
	4.2 Major histocompatibility complex 4.2.1 Introduction 4.2.2 Three major classes of MHC encoded molecules 4.2.3 The basic structure and functions of Class I and Class II MHC Molecules 4.2.4 Peptide binding by Class I and Class II MHC molecule		3L	
	4.3 Antigen presenting cells 4.3.1 Types of APC‘s 4.3.2 Endogenous antigens: The cytosolic pathway 4.3.3 Exogenous antigens: The endocytic pathway		3L	
	4.4 Experimental systems and Methods. 4.4.1 Immunoprecipitation- Based Techniques 4.4.2 Agglutination Reactions - heme-agglutination, Hemagglutination inhibition reaction, bacterial agglutination (Widal test)		7L	

	4.4.3 Antibody Assays Based on Molecule Binding to Solid-Phase Supports 4.4.3.1 RadioImmunoAssay 4.4.3.2 Enzyme Linked Immunosorbent Assay – direct, indirect,competitive and sandwich ELISA, ELISPOT assay (only significance) 4.4.3.3 Immunofluorescence- Direct and indirect.			

US-TMB -503 (MICROBIAL BIOCHEMISTRY: PART-I)

Unit	Topic	Credits	Lectures	References
1	**Biological Membranes & Transport**	**01**	15	White, D., The Physiology and Biochemistry of Prokaryotes, 4th edition, Rose, A.H. Chemical Microbiology, 3rd edition, Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition Nelson, D. L. and M.M. Cox, Lehninger, Principles of biochemistry. 8th Edition, Zubay, G. L Principles of Biochemistry,
	1.1 Composition and architecture of membrane 1.1.1 Lipids and properties of phospholipid membranes 1.1.2 Integral & peripheral proteins & interactions with lipids 1.1.3 Permeability 1.1.4 Aquaporins 1.1.5 Mechanosensitive channels		**2L**	
	1.2 Methods of studying solute transport 1.2.1 Use of whole cells 1.2.2 Liposomes 1.2.3 Proteoliposomes		**2L**	
	1.3 Solute transport across membrane 1.3.1 Passive transport and facilitated diffusion by membrane proteins, Transporters - grouped into Superfamilies 1.3.2 Co-transport across plasma membrane - (Uniport, Antiport, Symport) 1.3.3 Active transport & electrochemical gradient 1.3.4 Ion gradient provides energy for secondary active transport -e.g. Lactose transport 1.3.5 ATPases and transport (Na-K ATPase) 1.3.6 Shock sensitive system – Role of binding proteins 1.3.6.1 Maltose uptake (Diagram and description) 1.3.6.2 Histidine uptake (Diagram and description) 1.3.7 Phosphotransferase system 1.3.8 Schematic representation of various membrane transport systems in bacteria.		**8L**	

	1.4 Other examples of solute transport: 1.4.1 Iron transport: A special problem 1.4.2 Assembly of proteins into membranes and protein export 1.4.3 Bacterial membrane fusion central to many biological processes		**3L**	
2	**Bioenergetics & Bioluminescence**	01	15	White, D., The Physiology and Biochemistry of Prokaryotes, 4th edition, Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition Nelson, D. L. and M.M. Cox, Lehninger, Principles of biochemistry. 8th Edition, Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. Outlines of Biochemistry, 5th edition, Wilson and Walker, 8th edition,
	2.1 Biochemical mechanism of generating ATP: Substrate-Level Phosphorylation, Oxidative Phosphorylation & Photophosphorylation **2.2 Electron transport chain** 2.2.1 Universal Electron acceptors that transfer electrons to E.T.C. **2.2.2 Carriers in E.T.C.** 2.2.2.1 Hydrogen carriers – Flavoproteins, Quinones 2.2.2.2 Electron carriers – Iron Sulphur proteins, Cytochromes. 2.2.3 Mitochondrial ETC 2.2.3.1 Biochemical anatomy of mitochondria 2.2.3.2 Complexes in Mitochondrial ETC 2.2.3.3 Schematic representation of Mitochondrial ETC. **2.3 Prokaryotic ETC** 2.3.1 Organization of electron carriers in bacteria 2.3.1.1 Generalized electron transport pathway in bacteria 2.3.1.2 Different terminal oxidases 2.3.2 Branched bacterial ETC 2.3.3 Pattern of electron flow in E. coli - aerobic and anaerobic *2.3.4* Pattern of electron flow in *Azotobacter vinelandii* **2.4 ATP synthesis**		**1L** **3L** **3L** **3L**	

	2.4.1 Explanation of terms – Proton motive force, Proton pump, Coupling sites, P:O ratio, Redox potential, Standard reduction potential) 2.4.2 Free energy released during electron transfer from NADH to O_2 2.4.3 Chemiosmotic theory 2.4.4 Structure & function of Mitochondrial ATP synthase (No Kinetics) 2.4.5 Structure of bacterial ATP synthase 2.4.6 Mechanism by Rotational catalysis 2.4.7 Inhibitors of ETC and ATPase, uncouplers and ionophores **2.5 Other modes of generation of electrochemical energy** 2.5.1 ATP hydrolysis 2.5.2 Oxalate formate exchange 2.5.3 End product efflux, Lactate efflux 2.5.4 Bacteriorhodopsin: - Definition, function as proton pump and significance **2.6 Bioluminescence** 2.6.1 Brief survey of bioluminescent systems 2.6.2 Biochemistry of light emission 2.6.3 Schematic diagram 2.6.4 Significance / Application		**2L** **3L**	
3	**Studying Metabolism & Catabolism of Carbohydrates**	**01**	**15**	

	3.1 Experimental Analysis of metabolism 3.1.1 Goals of the study 3.1.2 Levels of organization at which metabolism is studied 3.1.3 Metabolic probes. 3.1.4 Use of radioisotopes in biochemistry 3.1.4.1 Pulse labelling 3.1.4.2 Assay and study of radiorespirometry to differentiate EMP & ED 3.1.5 Use of biochemical mutants 3.1.6 Sequential induction **3.2 Catabolism of Carbohydrates** 3.2.1 Breakdown of polysaccharides – Glycogen, Starch, Cellulose 3.2.2 Breakdown of oligosaccharides - Lactose, Maltose, Sucrose, Cellobiose. 3.2.3 Utilization of monosaccharides - Fructose and Galactose 3.2.4 Major pathways – (with structure and enzymes) 3.2.4.1 Glycolysis (EMP) 3.2.4.2 HMP Pathway - Significance of the pathway 3.2.4.3 ED pathway 3.2.4.4 TCA cycle - Action of Pyruvate Dehydrogenase complex, Significance of TCA 3.2.4.5 Incomplete TCA in anaerobic bacteria 3.2.4.6 Anaplerotic reactions 3.2.4.7 Glyoxylate bypass **3.3 Amphibolic role of EMP; Amphibolic role of TCA cycle** **3.4 Energetics of Glycolysis, TCA and ED pathway – Balance sheet only. Format as in Lehninger (2.5 ATP/NADH and 1.5 ATP / FADH2) (balance sheet for Glycolysis - Lactic acid and Alcohol fermentation and for ED pathway)**		**3L** **10L** **1L** **1L**	Mathews, C.K., K.E. van Holde, D.R. Appling, S, J, Anthony-Cahill Biochemistry, 4th edition. White, D., The Physiology and Biochemistry of Prokaryotes, 4th edition, Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition Nelson, D. L. and M.M. Cox, Lehninger, Principles of biochemistry. 8th Edition, Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. Outlines of Biochemistry, 5th edition,

4	**Fermentative Pathways & Anabolism ofCarbohydrates**	**01**	15	
	4.1 Fermentative pathways (with structure and enzymes) 4.1.1 Lactic acid fermentation 4.1.1.1 Homofermentation 4.1.1.2 Heterofermentation 4.1.2 Bifidium pathway 4.1.3 Alcohol fermentation 4.1.3.1 By ED pathway in bacteria 4.1.3.2 By EMP in yeasts **4.2 Other modes of fermentation in microorganisms** 4.2.1 Mixed acid 4.2.2 Butanediol 4.2.3 Butyric acid 4.2.4 Acetone-Butanol 4.2.5 Propionic acid (Acrylate and succinate propionate pathway) **4.3 Anabolism of Carbohydrates** 4.3.1 General pattern of metabolism leading to synthesis of a cell from glucose 4.3.2 Sugar nucleotides 4.3.3 Gluconeogenesis (bacterial and mitochondrial) 4.3.4 Biosynthesis of glycogen 4.3.5 Biosynthesis of Peptidoglycan		**4L** **5L** **6L**	White, D., The Physiology and Biochemistry of Prokaryotes, 4th edition, Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition Nelson, D. L. and M.M. Cox, Lehninger, Principles of biochemistry. 8th Edition, Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. Outlines of Biochemistry, 5th edition,

US-TMB **-504- (Bioprocess Technology- I)**

Unit	Topic	Credits	Lectures	References
1	**Upstream Processing – I**	01	15	
	1.1 Screening of Industrial Cultures- 1.1.1 Primary and secondary screening 1.1.2 High throughput screening methods		3L	Industrial Microbiology by Casida,; Stanbury and Whitakar- 3rd edition
	1.2 Strain improvement 1.2.1 The improvement of industrial microorganisms 1.2.2 The selection of induced mutants synthesizing improved levels of primary metabolites 1.2.3 The isolation of induced mutants producing improved yields of secondary metabolites. 1.2 .4 The improvement of strains by modifying properties other than the yield of product		10L 2L	Principles of Fermentation Technology- 2nd edition by Stanbury and Whitakar
	1.3 Preservation of cultures 1.3.1 Preservation of industrially important organisms 1.3.2 Quality control of preserved stock 1.3.2.1. Key Criteria 1.3.2.2. Development of a master culture bank (MCB) 1.3.2.3. Variability test to ensure reproducibility of the MCB			Stanbury and Whitakar- 3rd edition
2	**Upstream Processing – II**		15	Bioprocess Technology by H. A. Modi- Volume 1 & Fermentation Medium Optimization; Research Journal of Microbiology 2 (3), 201-208, 2007
	2.1 Fermentation media formulation and raw materials 2.1.1 Media formulation and Optimization- Classical approach – One factor at a time, Full factorial design 2.1.2 Raw materials for fermentation media		3L	
	2.2 The development of inocula for industrial fermentations 2.2.1 Introduction 2.2.2 Development of inocula for yeast process 2.2.3 Development of inocula for unicellular		3L	Principles of

	bacterial process 2.2.4 Development of inocula for mycelial process 2.2.5 Aseptic inoculation of plant fermenter **2.3 Sterilization and achievement of aseptic conditions** 2.3.1 Introduction 2.3.2 Medium sterilization (concept of nabla factor) 2.3.3 Methods of batch sterilization 2.3.4 The design of continuous sterilization process 2.3.5 Sterilization of the Fermenter 2.3.6 Sterilization of the Feeds 2.3.7 Sterilization of the liquid wastes 2.3.8 Filter Sterilization 2.3.8.1 Filter sterilization of fermentation media 2.3.8.2 Filter sterilization of air 2.3.8.3 Filter sterilization of fermenter exhaust air 2.3.9 Achievement of aseptic conditions **2.4 Scale up and scale down** 2.4.1 Objective of scale-up 2.4.2 Levels of fermentation (laboratory, pilot-plant and production levels) 2.4.3 Criteria of scale-up for critical parameters (aeration and agitation, broth rheology and sterilization) 2.4.4 Scale-down		7L 2L	Fermentation Technology- 2nd edition by Stanbury and Whitakar Principles of Fermentation Technology- 2nd edition by Stanbury and Whitakar Bioprocess Technology by H. A. Modi- Volume 2
3	**Fermenter Types, Monitoring and Instrumentation**		15	
	3.1 Types of fermentors - typical constructional features and their importance in the specific processes. 3.1.1 Mechanical – Stirred tank fermenter 3.1.2 Hydrodynamic- deep-jet fermenter 3.1.3 Pneumatic - air-lift fermenter 3.1.4 Photo-bioreactor **3.2 Measurement and control** 3.3.1 Introduction to sensors and its types 3.3.2 Measurement and control of: pH, temperature, pressure, foam sensing, dissolved oxygen, inlet and exit gas analysis.		5L 5L	Principles of Fermentation Technology- 2nd edition by Stanbury and Whitakar Bioprocess Technology by H. A. Modi- Volume 1 Textbook of

	3.3 Instrumentation: Principles, working and application of 3.3.1 Mass Spectroscopy 3.3.2 AAS & AES (Flame photometry) 3.3.3 Geiger- Muller Counter and Scintillation counting		5L	Biotechnology- H. K. Das Practical Biochemistry- 8th edition by Wilson and Walker
4	**Traditional Fermentations**		15	
	4.1 Wine – Red, White, Champagne and Sherry: 4.1.1 Alcoholic fermentation, 4.1.2 Composition of grape juice 4.1.3 Sulphur dioxide addition 4.1.4 Factors affecting wine fermentation 4.1.5 Examples and role of yeasts involved in fermentation 4.1.6 Malolactic fermentation 4.1.7 Technological aspects of wine making- red, white, champagne, sherry 4.1.8 Examples of aroma compounds of wine, 4.1.9 Types and examples of wine		3L	Industrial Microbiology by Prescott and Dunn
	4.2 Beer – Ale and Lager: 4.2.1 Elements of brewing process 4.2.2 Process details 4.2.3 Use of cylindro-conical vessel 4.2.4 Primary fermentation, continuous fermentation, aging and finishing 4.2.5 Yeasts involved in fermentation.		3L	Industrial Microbiology by Prescott and Dunn & Industrial Microbiology by Casida
	4.3 Alcohol from Molasses: 4.3.1 Introduction 4.3.2 Biosynthesis of ethanol 4.3.3 Production process- preparation of nutrient solution, fermentation 4.3.4 Recovery by distillation.		2L	Industrial Microbiology by Prescott and Dunn
	4.4 Vinegar (acetic acid): 4.4.1 Introduction 4.4.2 Biosynthesis 4.4.3 Production using Generator 4.4.4 Production using submerged fermenter 4.4.5 Recovery		2L	Textbook of Industrial Microbiology by Crueger and Modern

	4.5 Baker's yeast: 4.5.1 Outline of production 4.5.2 Yeast strains and their properties 4.5.3 Factors important in production-oxygen requirement and aeration, concentration of sugar, pH, temperature 4.5.4 Preparation of substrate, fermentation, harvesting of yeast cells 4.5.5 Production of compressed and active dry yeast. **4.6 Fungal amylase production:** 4.6.1 Alpha amylase- production from bacteria and fungi 4.6.2 Beta amylase and gluco amylase, 4.6.3 Concentration and purification.		2L 2L	Industrial Microbiology and Biotechnology by Nduka Okafor Industrial Microbiology by Prescott and Dunn Prescott and Dunn and Textbook of Industrial Microbiology by Crueger

Part 4: Detailed scheme Practicals

Course Code: US-TMB **– 501**

1	UV survival curve – determination of exposure time leading to 90% reduction
2	Isolation of mutants using UV mutagenesis
3	Gradient plate technique (dye resistant mutant)
4	Replica plate technique for selection & characterization of mutants – auxotroph
5	Isolation and detection of plasmid DNA.
6	Preparation of competent cells and transformation
7	Demonstration of conjugation.
8	Genetics problems.
9.	Visit to a Genetics research centre

Course Code: US-TMB **- 502**

1	Acid fast staining
2	Identification of Candida species using the germ tube test and growth on Chrom agar
3	To determine SLO and SLS activity of S .pyogenes
4	Study of standard cultures E. *coli, Klebsiella spp., Proteus spp., Pseudomonas spp., Salmonalla typhi, S. paratyphi A, S. paratyphi B, Shigella spp., S .pyogenes, S. aureus*
5	Identification of isolates obtained from pus, sputum, stool and urine by morphological, cultural and biochemical properties.
6	Antigen Preparation: O & H antigen preparation of *Salmonella*. Confirmation by slide agglutination
7	Single Radial Immunodiffusion Assays
8	VDRL Test
9	Widal Test
10	Demonstration of Line Probe Assay
11	Demonstration of Vitek system
12	Visit to Diagnostic Laboratory

Course Code: US-TMB **- 503**

1	Isolation and study of Bioluminescent organisms
2	Study of oxidative and fermentative metabolism
3	Qualitative and Quantitative assay of Phosphatase
4	Study of Homo – Heterofermentations
5	Mixed acid fermentations- Detection of organic acids by TLC
6	Isolation and detection of Mitochondria

7	Glucose detection by GOD/POD
8.	Glucometric detection of blood glucose
8	Study of biochemical pathway and study of end products of enzymes in characterization of microorganisms

Course Code: US-TMB **– 504**

1	Determine the alcohol tolerance for yeast.
2	Determine the sugar tolerance for yeast.
3 **a** **b** **c**	Alcohol Fermentation Preparation and standardization of yeast inoculums for alcohol fermentation Laboratory Alcohol fermentation using jaggery medium, Calculation of efficiency of fermentation.
4	Chemical estimation of sugar by Cole‘s ferricyanide method
5	Chemical estimation of alcohol
6	Production of amylase- detection, shake flask or solid substrate cultivation and detection (Qualitative).
7	Determination of antibiotic spectrum using agar strip / streak method.
8	Bioautography
9	Industrial Visit

First Year Semester IV - Units - Topics - Teaching Hours

S. N	Subject Code		Subject Unit Title	Hours/Lectures	Total No. of hours/lectures	Credit	Total Marks
1	US-TMB -601 **Recombinant DNA technology, Bioinformatics and Virology**	1	Recombinant DNA Technology	15	60 L	2.5	100 (60+40)
		2	Applications of rDNA Technology & Bioinformatics	15			
		3	Basic Virology	15			
		4	Advanced Virology	15			
2	US-TMB -602 **Medical Microbiology and Immunology-II**	1	Study of a vector-borne, STD's and central nervous system infections	15	60 L	2.5	100 (60+40)
		2	Chemotherapy of Infectious Agents	15			
		3	Immunology – I	15			
		4	Immunology – II	15			
3	US-TMB -603 Microbial Biochemistry- II	1	Lipid Metabolism & Catabolism of Hydrocarbons	15	60 L	2.5	100 (60+40)
		2	Metabolism of Proteins and Nucleic Acids	15			
		3	Metabolic Regulation	15			
		4	Prokaryotic Photosynthesis & Inorganic Metabolism	15			
4	US-TMB -604 Bioprocess Technology II	1	Downstream Processing	15	60 L	2.5	100 (60+40)
		2	Advances in Bioprocess Technology	15			
		3	Quality Assurance, Quality Control, Bioassay and IPR	15			
		4	Industrial Fermentations	15			
5	US-TMB -6P1	1	Practicals based on US-TMB -601 and 602	4	60 x2= 120 lectures per batch	2	100 (80+10 +10)

6	US-TMB -6P2	2	Practicals based on US-TMB -603 and 604	4	60x2= 120 lectures per batch	2	100 (80+10 +10)
			TOTAL			24	600

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination , PA-Project Assessment, AT- Attendance

Part 6: Detail Scheme Theory

First Year Semester - IV Units - Topics - Teaching Hours

Curriculum Topics along with Self-Learning topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective Unit

US-TMB **-601 (Recombinant DNA technology, Bioinformatics and Virology)**

Unit	Topic	Credits	Lectures	References
1	**Recombinant DNA Technology**		15	Primrose and Twyman, (2001),
	1.1 Branches of Genetics 1.1.1 Transmission genetics 1.1.2 Molecular genetics 1.1.3 Population genetics 1.1.4 Quantitative genetics		**1 L**	–Principles of gene manipulation and genomics‖, 6th edition, Blackwell Publishing
	1.2 Model Organisms 1.2.1 Characteristics of a model organism 1.2.2 Examples of model organisms used in study 1.2.3 Examples of studies undertaken using prokaryotic and eukaryotic model organisms		**2L**	iGenetics by Russell 3rd edition
	1.3 Plasmids 1.3.1 Physical nature 1.3.2 Detection and isolation of plasmids 1.3.3 Plasmid incompatibility and Plasmid curing 1.3.4 Cell to cell transfer of plasmids 1.3.5 Types of plasmids 1.3.6 Resistance Plasmids, Plasmids encoding Toxins and other Virulence characteristics, Colfactor, Degradative plasmids		**2L**	
	1.4 Transposable Elements in Prokaryotes 1.4.1 Insertion sequences 1.4.2 Transposons: Types, Structure and properties, Mechanism of transposition, Integrons		**2 L**	
	1.5 Basic steps in Gene Cloning.		**1 L**	
	1.6 Cutting and joining DNA molecules - Restriction and modification systems, restriction endonucleases, DNA ligases		**3 L**	
	1.7 Vectors 1.7.1 Plasmids as cloning vectors. plasmid vectors,		**3 L**	

	pBR322 vector 1.7.2 Cloning genes into pBR322 1.7.3 Phage as cloning vectors, cloning genes into phage vector 1.7.4 Cosmids 1.7.5 Shuttle vectors 1.7.6 YAC 1.7.7 BAC 1.7.8 Expression Vectors **1.8 Methods of transformation**		**1 L**	
2	**Applications of rDNA Technology & Bioinformatics**	01	12	
	2.1 PCR- basic PCR and different types of PCR (Reverse transcriptase PCR, Real-time quantitative PCR) **2.2 Basic techniques** 2.2.1 Southern, Northern and Western blotting. 2.2.2 Autoradiography **2.3 Screening and selection methods for identification and isolation of recombinant cells** **2.4 Applications of recombinant DNA technology:** Site-specific mutagenesis of DNA, Uses of DNA polymorphism, STRS and VNTRS, DNA molecular testing for human genetic diseases (Only RFLP), DNA typing, gene therapy, Genetic engineering of plants and animals. **2.5 Bioinformatics** 2.5.1 Explain the terms: Transcriptome, Metabolomics, Pharmacogenomics, Phylogenetic analysis, Phylogenetic tree, Annotation, 2.5.2 Genomics- structural, functional and comparative genomics, 2.5.2 Proteomics - structural and functional proteomics, 2.5.3 Sequence alignment - global v/s local alignment, FASTA, BLAST (Different types of BLAST) 2.5.4 Human Microbiome Initiative and Indian Biological Data centre		**2 L** **3 L** **2 L** **4 L** **4 L**	Primrose and Twyman, (2001), –Principles of gene manipulation and genomics‖, 6th edition, Blackwell Publishing S.Ignacimuthu, (2005), –Basic Bioinformatics‖, Narosa publishing house.

3	**Basic Virology**		15	
	3.1 Viral architecture - Capsid, viral genome and envelope **3.2 Viral classification (Baltimore classification)** **3.3 Viral replication cycle** - Attachment, penetration, uncoating, types of viral genome, their replication, assembly, maturation & release **3.4 Structure** of TMV, T4 phage, Lambda phage, Influenza virus, HIV. **3.5 Life cycle** of T4 phage, Lambda phage, TMV, Influenza Virus and HIV in detail **3.6 Regulation** of Lytic and Lysogenic cycle in Lambda phage		2L 1L 3L 2L 4L 3L	Edward Wagner and Martinez Hewlett, (2005) –Basic Virology‖, 2nd edition, Blackwell Publishing Teri Shors,.(2009), –Understanding viruses‖, Jones and Bartlett publishers.
4	**Advanced Virology**		15	
	4.2 Cultivation of viruses- cell culture techniques, embryonated egg, laboratory animals, Cell culture methods: Equipment required for animal cell culture, Isolation of animal tissue **4.3 Visualization and enumeration of virus particles**		3L 5L	Edward Wagner and Martinez Hewlett, (2005) –Basic Virology‖, 2nd edition,

	4.3.1 Measurement of infectious units 4.3.1.1 Plaque assay 4.3.1.2 Fluorescent focus assay 4.3.1.3 Infectious center assay 4.3.1.4 Transformation assay 4.3.1.5 Endpoint dilution assay. 4.3.2 Measurement of virus particles and their components 4.3.2.1 Electron microscopy 4.3.2.2 Atomic force microscopy 4.3.2.3 Haemagglutination 4.3.2.4 Measurement of viral enzyme activity. 4.3.3 Advanced methods for viral detection **4.4 Role of viruses in cancer:** Important definitions, characteristics of cancer cell, Human DNA tumor viruses- EBV, Kaposis sarcoma virus, Hepatitis B and C virus, Papiloma Virus. **4.5 Prions:** Definition, Examples of diseases caused by prions, Kuru, PrP protein and protein only hypothesis **4.6 Viroids**		4L 2L 1L	Blackwell Publishing Teri Shors,.(2009), –Understanding viruses‖, Jones and Bartlett publishers. Flint, Enquist, Racanillo and Skalka, –Principles of virology‖, 2nd edition. ASM press.

US-TMB **-602 (Medical Microbiology and Immunology-II)**

Unit	Topic	Credits	Lectures	References
1	**Study of a vector-borne, STD's and central nervous system infections** (with Emphasis on Cultural Characteristics of the Etiological Agent, Pathogenesis, Laboratory Diagnosis and Prevention).	01	15	Jawetz, Medical Microbiology, 28th Edition, Lange publication Ananthanarayan and Panicker's, Textbook of Microbiology, 10th edition 2017
	1.1 **Study of vector-borne infection** – Malaria, Dengue, List of emerging and remerging vector-borne infections in India		1L	
	1.2 Study of sexually transmitted infectious diseases 1.2.1 Syphilis 1.2.2 AIDS 1.2.3 Gonorrhoea 1.2.4 Chlamydial Infections 1.2.5 Human PapillomavirusInfection		7L	
	1.3 Study of central nervous system infectious diseases 1.3.1 Tetanus 1.3.2 Polio 1.3.3 Rabies 1.3.3 Meningitis (Bacterial and Viral)		7L	
2	**Chemotherapy of Infectious Agents**	01	15	Prescott's microbiology 11th edition 2019 Jawetz, Medical Microbiology,
	2.1 Attributes of an ideal chemotherapeutic agent - Selective toxicity, Bioavailability of drug, routes of drug administration, LD50, MIC, MBC.		2L	
	2.2 Mode of action of antibiotics on: a) Bacteria 2.2.1 Cell wall (Beta-lactams- Penicillin,		8L	

	Cephalosporins and Carbapenems) 2.2.2 Cell Membrane (Polymyxin and Imidazole) 2.2.3 Protein Synthesis (Streptomycin, Tetracycline, Chloramphenicol,Macrolides) 2.2.4 Nucleic acid (Quinolones, Nalidixic acid, Rifamyicn)2.2.5 Enzyme inhibitors (Sulfa drugs, Trimethoprim) b.Fungi Imidazole, Griseofulin,Nystatin,Amphotericin B c) Viruses Acyclovir,Zidovudine,Oseltamivir d)Protozoa Metronidazole,Mepacrine **2.4 Antimicrobial Resistance** 2.4.1 Development and Mechanisms of Antibiotic resistance (ESBL, VRE, MRSA,CRE) 2.4.2 Reasons and mechanisms of drug resistance 2.4.3 Antibiotics Misuse 2.4.4 Prevention and Control of AMR **2.5 Selection and testing of antibiotics for bacterial isolates-** Kirby Bauer method, E-test, Synergy (Additive effect and Antagonism		2L	28th Edition, Lange publication Introduction to diagnostic microbiology for lab Science, Maria Dannessa Delost 2020 Prescott's microbiology 11th edition 2019 and Jawetz, Medical Microbiology, 28th Edition, Lange publication
3	Immunology – I	01	15	
	3.1 T cells 3.1.1 T Cell Receptor-structure (alpha-beta, gamma-delta TCR) 3.1.2 TCR-CD3 complex - structure and functions. Accessory molecules 3.1.3 T cell activation 3.1.3.1 TCR mediated signaling – Overview 3.1.3.2 Costimulatory signals 3.1.3.3 Superantigens induced T cell activation 3.1.4 T cell differentiation (Memory and Effector cells) **3.2 Cell mediated effector response** 3.2.1 General properties of effector T cells 3.2.2 Cytotoxic T cells and destruction of target cell by perforin/granzyme pathway and Fas pathway 3.2.3 Killing mechanism of NK cells 3.2.4 Antibody mediated cell cytotoxicity (ADCC)		4L 3L	Kuby Immunology, WH Freeman, 8th Edition, 2018

	3.3 B cells 3.3.1 B cell receptor and co-receptor-structure and function 3.3.2 B cell activation and Differentiation 3.3.2.1 Thymus dependant and independent antigens 3.3.2.2 Signal transduction pathway activated by BCR overview 3.3.2.3 Role TH cell in B cell response-Formation of T-B conjugates, CD40/CD40L interaction, TH cells cytokine signals **3.4 Humoral Response** 3.4.1 Primary and secondary responses 3.4.2 In vivo sites for induction of Humoral response 3.4.3 Germinal centers and antigen induced B cell Differentiation 3.4.3.1 Cellular events within germinal centers-Overview 3.4.3.2 Affinity maturation, somatic hyper-mutation and class switching 3.4.3.3 Generation of plasma cells and memory cells		4L 4L	
4	**Immunology – II**	01	15	
	4.1 Vaccines 4.1.1 Properties of Ideal vaccine 4.1.2 Route of vaccine administration 4.1.3 Active and passive immunization 4.1.4 Types of vaccines - Killed and attenuated vaccines, Whole organism vaccines, Purified macromolecules as vaccines, recombinant viral vector vaccines, DNA vaccines,Conjugant or Multivalent vaccine 4.1.5 Emerging Technologies in Vaccine development(Virus like Particle vaccine, Nanoparticle vaccines, RNA vaccines, Cancer vaccines) 4.1.6 Use of Adjuvants to Enhance the Immune Response to a Vaccine 4.1.7 Challenges of vaccine strategies. 4.1.8 Immunization schedule (India) **4.2 Immunohaematology** 4.2.1 Human blood group systems, ABO, secretors and nonsecretors, Bombay Blood group. Rhesus system and list of other blood		7L 4L	Kuby Immunology, WH Freeman, 8th Edition, 2018 Ananthanarayan and Panicker‘s, Textbook of Microbiology, 8th edition Kuby Immunology,

	group systems, transfusion reactions 4.2.2 Haemolytic disease of new born, Coombs test. **4.3 Complement System** **4.3.1** Functions and components of complement **4.3.2** Complement Activation—classical, alternative and lectin pathway **4.3.3** Biological consequences of complement activation **4.3.4** Complement Deficiency Diseases (only names) **4.3.5** Complement fixation test **4.4 Monoclonal Antibodies** 4.4.1 Hybridoma Technology 4.4.2 Application and clinical uses 4.4.3 Abzymes		2L 2L	WH Freeman, 8th Edition, 2018 Kuby Immunology, WH Freeman, 8th Edition, 2018

US-TMB **-603 (MICROBIAL BIOCHEMISTRY: PART-II)**

Unit	Topic	Credits	Lectures	References
1	**Lipid Metabolism & Catabolism of Hydrocarbons**	01	15	White, D., The Physiology and Biochemistry of Prokaryotes, 4th edition, Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition Nelson, D. L. and M.M. Cox, Lehninger, Principles of biochemistry. 8th Edition, Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. Outlines of Biochemistry, 5th edition,
	1.1 Introduction to Lipids 1.1.1 Lipids –Definition, classification & functions 1.1.2 Types and role of fatty acids found in bacteria 1.1.3 Common phosphoglycerides in bacteria 1.1.4 Action of lipases on triglycerides /tripalmitate		**2L**	
	1.2 Catabolism of Fatty Acids and Poly Hydroxybutyric acid (PHB) 1.2.1 Oxidation of saturated fatty acid by β oxidation pathway 1.2.2 Energetics of β oxidation of Palmitic acid 1.2.3. Oxidation of a monounsaturated fatty acid 1.2.4 Oxidation of propionyl CoA by acrylyl-CoA pathway and methylcitrate pathway 1.2.5 PHB as a food reserve and its degradation		**5L** **6L**	
	1.3 Anabolism of Fatty Acids & Lipids 1.3.1 Biosynthesis of straight chain even and odd carbon saturated fatty acid 1.3.2 Biosynthesis of phosphoglycerides in bacteria 1.3.3 Biosynthesis of PHB		**2L**	
	1.4 Catabolism of aliphatic hydrocarbons 1.4.1 Organisms degrading aliphatic hydrocarbons 1.4.2 Hydrocarbon uptake mechanisms 1.4.3 Omega oxidation pathway 1.4.3.1 Pathway in *Corynebacterium* and yeast *1.4.3.2* Pathway in *Pseudomonas*			

2	**Metabolism of Proteins and Nucleic Acids**		15	G. Moat, J.W. Foster, M, P. Spector. Microbial Physiology, 4th edition WILEY-LISS White, D., The Physiology and Biochemistry of Prokaryotes, 4th edition, Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition Nelson, D. L. and M.M. Cox, Lehninger, Principles of biochemistry. 8th Edition,
	2.1 Protein / amino acid catabolism 2.1.1 Enzymatic degradation of proteins 2.1.2 General reactions of amino acids 2.1.2.1 Amino acid decarboxylases 2.1.2.2 Amino acid deaminases 2.1.2.3 Amino acid transaminases 2.1.2.4 Amino acid racemases 2.1.3 Metabolic fate of amino acids - Glucogenic and ketogenic amino acids *2.1.4* Fermentation of single amino acid - Glutamic acid by *Clostridium tetanomorphum* 2.1.5 Fermentation of pair of amino acids - Stickland reaction		**6L**	
	2.2 Anabolism of amino acids 2.2.1 Schematic representation of amino acid families 2.2.2 **Biosynthesis of amino acids of Serine family** (Serine, Glycine and Cysteine)		**2L**	
	2.3 Catabolism of Nucleotides 2.3.1 Degradation of purine nucleotides up to uric acid formation 2.3.2 Salvage pathway for purine and pyrimidine nucleotides		**3L**	
	2.4 Biosynthesis of nucleotides 2.4.1 Nomenclature and structure of nucleotides 2.4.2 Metabolic origin of atoms in purine and pyrimidine ring 2.4.3 Biosynthesis of pyrimidine nucleotides 2.4.4 Biosynthesis of purine nucleotides 2.4.5 Biosynthesis of deoxyribonucleotides 2.4.6 Role of nucleotides (high energy triphosphates)		**4L**	
3	**Metabolic Regulation**	01	**15L**	

	3.1 Definition of terms and major modes of regulation **3.2 Regulation of enzyme activity** 3.2.1 Noncovalent enzyme inhibition 3.2.1.1 Allosteric enzymes and feedback inhibition 3.2.1.2 Patterns of Feed-back Inhibition, combined activation and inhibition 3.2.2 Covalent modification of enzymes 3.2.2.1 Monocyclic cascades 3.2.2.2 Examples of covalent modification (without structures) 3.2.2.3 Regulation of Glutamine synthetase **3.3 DNA binding proteins and regulation of transcription by positive & negative control** 3.3.1 DNA binding proteins 3.3.2 Negative control of transcription: Repression and Induction -eg- Enzyme repression in the arginine operon, Ara operon *3.3.3* Positive control of transcription: Maltose and arabinose catabolism in *E. coli.* **3.4 Global regulatory mechanisms** 3.4.1 Global control & catabolite repression 3.4.2 Stringent response **3.5 Regulation of EMP and TCA cycle - (Schematic and Regulation of Pyruvate dehydrogenase Complex)**		**2L** **5L** **4L** **2L** **2L**	Madigan, M.T. and J.M. Martinko 15th edition, Brock Biology of Microorganisms. Pearson Prentice Hall. Nelson, D. L. and M.M. Cox, Lehninger, Principles of biochemistry. 8th Edition, Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. Outlines of Biochemistry, 5th edition,
4	**Prokaryotic Photosynthesis & Inorganic Metabolism**	01	15	White, D., The Physiology and Biochemistry of Prokaryotes, 4th edition, Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition,
	4.1 Photosynthesis - Definition of terms in photosynthesis (light and dark reactions, Hill reaction & reagent, Photophosphorylation) 4.1.1 Photosynthetic pigments 4.1.2 Location of photochemical apparatus 4.1.3 Photochemical generation of reductant		**4L**	

	4.2 Light reactions: (with details) 4.2.1 Purple photosynthetic bacteria 4.2.2 Green sulphur bacteria 4.2.3 Cyanobacteria		**3L**	Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition
	4.3 Dark reaction 4.3.1 Calvin Benson cycle 4.3.2 Reductive TCA cycle 4.3.3 The role of malate and aspartate as CO_2 carriers in C_4 photosynthesis (brief description only)		**2L**	Nelson, D. L. and M.M. Cox, Lehninger, Principles of biochemistry. 8th Edition,
	4.4 Inorganic Metabolism 4.4.1 Assimilatory pathways: 4.4.1.1 Assimilation of nitrate, 4.4.1.2 Ammonia fixation – Glutamate dehydrogenase, Glutamine synthetase, GS-GOGAT, Carbamoyl phosphate synthetase 4.4.1.3 Biological nitrogen fixation (Mechanism for N_2 fixation and protection of nitrogenase) 4.4.1.4 Assimilation of sulphate 4.4.2 Dissimilatory pathways: 4.4.2.1 Nitrate as an electron acceptor (Denitrification in *Paracoccus denitrificans*) 4.4.2.2 Sulphate as an electron acceptor		**5L**	
	4.5 Lithotrophy–Enlist organisms and products formed during oxidation of Hydrogen, carbon monoxide, Ammonia, Nitrite, Sulphur, Iron		**1L**	

US-TMB **-604 (Bioprocess Technology- II)**

Unit	Topic	Credits	Lectures	References
1	**Downstream Processing**		15	
	1.1 Recovery and purification 1.1.1 Introduction 1.1.2 Methods of DSP 1.1.2.1 Removal of microbial cells and other solid matter 1.1.2.2 Foam separation 1.1.2.3 Precipitation 1.1.2.4 Filtration- Theory, Use of filter aids, Batch filters- Plate and frame filters, Continuous filters- Rotary vacuum filter 1.1.2.5 Centrifugation 1.1.2.6 Cell Disruption- Physical- mechanical and Chemical methods 1.1.2.7 Liquid-Liquid Extraction 1.1.2.8 Solvent Recovery 1.1.2.9 Two- phase aqueous extraction 1.1.2.10 Chromatography- Adsorption and Ion Exchange 1.1.2.11 Membrane Processes 1.1.2.12 Drying 1.1.2.13 Crystallization 1.1.2.14 Whole Broth Processing		10L	Principles of Fermentation Technology- 2nd edition by Stanbury and Whitakar Pg. no 277 to 308
	1.2 Effluent treatment **1.2.1** Introduction **1.2.2** Dissolved oxygen concentration as indicator of water quality **1.2.3** The strength of fermentation effluents **1.2.4** Treatment process 1.2.4.1 Physical processes 1.2.4.2 Chemical processes 1.2.4.3 Biological processes (Aerobic and Anaerobic process) 1.2.5 Introduction to carbon credits		5L	Principles of Fermentation Technology- 2nd edition by Stanbury and Whitakar Pg. no 313 to 326
2	**Advances in Bioprocess Technology**		15	

	2.1 Animal biotechnology 2.1.1 Primary cell culture and Established cell lines cultures 2.1.2 Equipments and Materials for ATC 2.1.3 Basic Techniques of Mammalian Cell culture 2.1.3 Growth media 2.1.4 Cell viability and Cytotoxicity 2.1.5 Manipulation of cultured cells and tissue 2.1.6 Applications of cell culture: Vaccines, somatic cell fusion, valuable products. **2.2 Plant tissue culture** 2.2.1 Introduction 2.2.2 Requirements for in vitro culture, Methods of plant cell and tissue culture **2.2.3** Types of cultures of plant materials: explants, callus, organogenesis, root culture, shoot culture, micro-propagation, suspension culture, protoplast culture, protoplast fusion and somatic hybridization**.** 2.2.4 Applications: production of disease resistant plants, production of virus free plant, In vitro selection of cell lines for disease resistance, micro-propagation, secondary metabolites from cell culture, transgenic plants for crop improvement **2.3 Immobilized enzyme and cells** 2.3.1 Introduction and Definitions 2.3.2 Methods 2.3.3 Immobilized Enzyme Reactors 2.3.4 Applications		5L 5L 5L	Text of Biotechnology by H. K. Das; 5th edition Textbook of Biotechnology by R. C. dubey Bioprocess Technology by H. A. Modi- Volume 2
3	**Quality Assurance, Quality Control, Bioassay and IPR**		15	
	3.1 Quality assurance and quality control 3.1.1 Definitions- Manufacture, Quality, Quality Control, InProcess Control, Quality Assurance, Good Manufacturing Practices. Chemicals, Pharmaceuticals, Nutraceuticals 3.1.2 Variables of batch process		5L	Bioprocess Technology by H. A. Modi- Volume 2

	3.1.3 Q.A and Q.C w.r.t Raw materials, method of manufacturing, in process items, finished products, label and labeling, packaging materials 3.1.4 Control of microbial contamination during manufacturing **3.2 Sterilization control and assurance** 3.2.1 Introduction 3.2.2 Bioburden determinations 3.2.3 Environmental Monitoring 3.2.4 Sterilization Monitoring 3.2.5 Sterility Testing 3.2.6 Viruses (phages) in Industrial Microbiology **3.3 Bioassay** 3.3.1 Introduction 3.3.2 Types: Diffusion, End Point, Turbidometric, Metabolic Response, Enzymatic 3.3.3 Modern methods for assay of fermentation products **3.4 Intellectual property rights** 3.4.1Genesis, Types of Intellectual Property – Patents, Copyright, Trademark, Trade secret Plant varieties protection act, Designs, Geographical Indications 3.4.2 Role of WTO and TRIPS 3.4.2 Overview of patent system 3.4.3 Requirements for patentability 3.4.4 Patent Categories 3.4.5 Preliminary steps for patent applications 3.4.6 Patent Procedures, Indian Patent office site- http://www.ipindia.nic.in/ 3.4.7 Applications for biotech and microbiological products		3L 3L 4L	Bioprocess Technology by H. A. Modi- Volume 2 Bioprocess Technology by H. A. Modi- Volume 2
4	**Industrial Fermentations**		15	
	4.1 Penicillin and semisynthetic penicillins: 4.1.1 Introduction 4.1.2 Biosynthesis and regulation 4.1.3 Strain development 4.1.4 Production and recovery methods 4.1.5Semisynthetic penicillins: Examples, production, advantages **4.2 Aminoglycoside: Streptomycin:** 4.2.1 Aminoglycoside antibiotics		3L 3L	Textbook of Industrial Microbiology by Crueger Hugo and Russell Textbook of

	4.2.2 Biosynthesis and regulation of biosynthesis 4.2.3 Strain development, 4.2.4 Production method 4.2.5 Recovery 4.2.6 Important by- products **4.3 Vitamin B $_{12}$:** 4.3.1 Occurrence and economic significance, 4.3.2 Structure and biosynthesis *4.3.3* Production based on media containing carbohydrates by- *Propionibacteria* and *Pseudomonas* 4.3.4 Recovery. **4.4 Citric acid:** 4.4.1 Introduction 4.4.2 Strains used for production, 4.4.3 Biosynthesis 4.4.4 Nutrient media 4.4.5 Production processes- surface and submerged 4.4.6 Product recovery. **4.5 Glutamic acid:** 4.5.1 Production strains 4.5.2 biosynthesis 4.5.3 Effect of permeability on production conditions of manufacturing, 4.5.4 Production process and recovery **4.6 Mushroom cultivation (Agaricus):** 4.6.1 Edible mushroom species, 4.6.2 Preparation of substrate- composting- phase I and phase II 4.6.3 Factors affecting composting 4.6.4 Preparation of spawn, casing, induction of fruiting body formation, harvesting		2L 2L 2L 2L	Industrial Microbiology by Crueger Textbook of Industrial Microbiology by Crueger Textbook of Industrial Microbiology by Crueger Textbook of Industrial Microbiology by Crueger

Part 7: Detailed scheme Practicals

Course Code: US-TMB **- 601**

1	Isolation of genomic DNA of E. coli and measurement of its concentration by UV-VIS.
2	Enrichment of coliphages, phage assay (pilot & proper).
3	Restriction digestion of lambda phage /any plasmid DNA
4	Beta galactosidase assay
5	Bioinformatics practicals a. Using BLAST and FASTA for sequence analysis b. Fish out homologs for given specific sequences evolution of a specific protein in bacteria, predicting function of unknown protein from a new organism based on its homology) c. Pair-wise alignment and multiple alignment of a given protein sequences d. Formation of phylogenetic tree
6	Animal cell culture (Demo)
7	Demonstration of Polymerase Chain Reaction
8	Demonstration of Blotting Technique (Western or Southern)

Course Code: US-TMB **- 602**

1	Demonstration of malarial parasite in blood films
2	Selection and testing of antibiotics using the Kirby-Bauer method.
3	Determination of MBC of an antibiotic.
4	Blood grouping – Direct & Reverse typing
5	Coomb‘s Direct test
6	Determination of Isoagglutinin titre
7	Determination of MIC of an antibiotic by E-test
8	Demonstration of AIDS detection test

Course Code: US-TMB - 603

1	Detection of PHB producing bacteria
2	To study catabolite repression by diauxic growth curve.
3	Protein estimation by Lowry‘s method
4	Estimation of uric acid
5	Qualitative and Quantitative assay of Protease
6	Qualitative detection of Lipase
7	Study of breakdown of amino acids – Lysine decarboxylase and Deaminase activity
8	Study of Lithotrophs – Nitrosification and Nitrification

Course Code: US-TMB **– 604**

1	Bioassay of an antibiotic (Ampicillin / Penicillin)
2	Bioassay of Cyanocobalamin.
3	Perform immobilization of yeast cells for invertase activity - making of beads, Determination of activity and count by haemocytometer and viable count.
4	Plant tissue culture – Callus culture (Demo).
5	Sterility testing of injectable.
6	Chemical estimation of Penicillin
7	Estimation of phenol.
8	Industrial Visit

REFERENCES:

Semester V

US-TMB -501

1. Peter J. Russell (2006), ‒I Genetics-A molecular approach‖, 2nd edition.
2. Benjamin A. Pierce (2008), ‒Genetics a conceptual approach‖, 3rd edition, W. H. Freeman and company.
3. R. H. Tamarin, (2004), ‒Principles of genetics‖, Tata McGraw Hill.
4. M. Madigan, J. Martinko, J. Parkar, (2009), ‒Brock Biology of microorganisms‖, 12th edition, Pearson Education International.
5. Fairbanks and Anderson, (1999), ‒Genetics‖, Wadsworth Publishing Company.
6. Robert Weaver, (2008), ‒Molecular biology‖, 3rd edition, Mc Graw Hill international edition.
7. Primrose and Twyman, (2001), ‒Principles of gene manipulation and genomics‖, 6th edition, Blackwell Publishing
8. Arthur Lesk, (2009), ‒Introduction to Bioinformatics‖, 3rd edition, Oxford University Press
9. Snustad, Simmons, ‒Principles of genetics‖, 3rd edition. John Wiley & sons, Inc.
10. A textbook of biotechnology R. C. Dubey 4 th edition. S. Chand.

US-TMB -502

1. Jawetz, Melnick and Adelberg‘s Medical Microbiology, 28th Edition, Lange publication
2. Ananthanarayan and Panicker‘s, Textbook of Microbiology, 10th edition 2017
3. Ananthanarayan and Panicker‘s, Textbook of Microbiology, 9th edition
4. Ananthanarayan and Panicker‘s, Textbook of Microbiology, 8th edition
5. Kuby Immunology, 8th Edition, W H Freeman and Company
6. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
7. Fahim Khan, Elements of Immunology, Pearson Education
   Internet references:
8. http://www.ncbi.nlm.nih.gov/books/NBK7627/
9. http://www.macmillanlearning.com/catalog/static/whf/kuby/

US-TMB -503

1. Nelson, D. L. and M.M. Cox, Lehninger, Principles of biochemistry. 8th Edition, 2021, W. H. Freeman and Company
2. White, D., The Physiology and Biochemistry of Prokaryotes, 4th edition, 2013, Oxford University Press
3. Rose, A.H. Chemical Microbiology, 3rd edition, 2014, Butterworth-Heinemann
4. Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. Outlines of Biochemistry, 5th edition, 2016. John Wiley &Sons. New York.

5. Mathews, C.K., K.E. van Holde, D.R. Appling, S, J, Anthony-Cahill (2012) Biochemistry, 4th edition. Pearson
6. Wilson and Walker, 8th edition, 2018, Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University press.
7. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd
8. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag
Suggested Reading:-
9. Zubay, G. L (1996), Principles of Biochemistry, Wm. C. Brown publishers
10. Cohen, G.N. (2011). Microbial Biochemistry. 2nd edition, Springer

US-TMB -504

1. Casida L. E., "Industrial Microbiology‖ (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
2. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of Fermentation Technology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
3. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
4. H. K. Das., ―Text book of Biotechnology‖, 2nd and 3rd edition.
5. H. A. Modi, (2009). _‘Fermentation Technology‘‘ Vol. 1 & 2, Pointer Publications, India
6. Okafor Nduka (2007) _‘Modern Industrial Microbiology and Biotechnology‘‘, Science Publications Enfield, NH, USA.
7. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology", 2 nd edition, Panima Publishing Corporation, New Delhi.
8. Prescott and Dunn's _‘Industrial Microbiology‘‘ (1982) 4th edition, McMillan Publishers.

Semester VI

US-TMB -601

1. Peter J. Russell (2006), ‒I Genetics-A molecular approach‖, 2nd edition.
2. Benjamin A. Pierce (2008), ‒Genetics a conceptual approach‖, 3rd edition, W. H. Freeman and company.
3. M. Madigan, J. Martinko, J. Parkar, (2009), ‒Brock Biology of microorganisms‖, 12th edition, Pearson Education International.
4. Fairbanks and Anderson, (1999), ‒Genetics‖, Wadsworth Publishing Company.
5. Prescott, Harley and Klein, ‒Microbiology‖,. 7th edition Mc Graw Hill international edition.
6. Edward Wagner and Martinez Hewlett, (2005) ‒Basic Virology‖, 2nd edition, Blackwell Publishing
7. Teri Shors,.(2009), ‒Understanding viruses‖, Jones and Bartlett publishers.
8. S.Ignacimuthu, (2005), ‒Basic Bioinformatics‖, Narosa publishing house.
9. Robert Weaver, (2008), ‒Molecular biology‖, 3rd edition, Mc Graw Hill international edition.
10. Primrose and Twyman, (2001), ‒Principles of gene manipulation and genomics‖, 6th edition, Blackwell Publishing
11. Arthur Lesk, (2009), ‒Introduction to Bioinformatics‖, 3rd edition, Oxford University Press
12. Snustad, Simmons, ‒Principles of genetics‖, 3rd edition. John Wiley & sons, Inc.
13. A textbook of biotechnology R. C. Dubey 4 th edition. S. Chand.

US-TMB -602

1. Jawetz, Melnick and Adelberg‘s Medical Microbiology, 28th edition, Lange publication
2. Ananthanarayan and Panicker‘s, Textbook of Microbiology, 10th edition 2017
3. Ananthanarayan and Panicker‘s, Textbook of Microbiology, 9th edition
4. Ananthanarayan and Panicker‘s, Textbook of Microbiology, 8th edition
5. Introduction to diagnostic microbiology for lab Science Maria Dannessa Delost 2020
6. Prescott‘s microbiology 11th edition 2019
7. Kuby Immunology,4th and 6th edition, W H Freeman and Company
8. Kuby Immunology,8th edition, W H Freeman and Company
9. Pathak & Palan, Immunology: Essential & Fundamental, 1st& 3rd edition, Capital Publishing Company
10. Fahim Khan, Elements of Immunology, Pearson Education

US-TMB -603

1. Nelson, D. L. and M.M. Cox, Lehninger, Principles of biochemistry. 8th Edition, 2021, W. H. Freeman and Company
2. White, D., The Physiology and Biochemistry of Prokaryotes, 4th edition, 2013, Oxford University Press

3. Conn, E.E., P. K .Stumpf, G. Bruening and R. Y. Doi. Outlines of Biochemistry, 5th edition, 2016. John Wiley &Sons. New York.
4. Stanier, R. Y., M. Doudoroff and E. A. Adelberg. General Microbiology, 5th edition, The Macmillan press Ltd
5. G. Moat, J.W. Foster, M, P. Spector. (2009), Microbial Physiology, 4th edition WILEY-LISS
6. Madigan, M.T. and J.M. Martinko 2018. 15th edition, Brock Biology of Microorganisms. Pearson Prentice Hall.
7. Gottschalk,G., (1985), Bacterial Metabolism, 2nd edition, Springer Verlag WILEY-LISS Suggested Reading
8. Zubay, G. L (1996), Biochemistry, 4th edition, Wm. C. Brown publishers
9. Principles of Biochemistry, Lehninger, 5th edition, W. H. Freeman and Company

US-TMB -604

9. Casida L. E., "Industrial Microbiology‖ (2009) Reprint, New Age International (P) Ltd, Publishers, New Delhi.
10. Stanbury P. F., Whitaker A. & Hall S. J., (1997), "Principles of FermentationTechnology", 2nd Edition, Aditya Books Pvt. Ltd, New Delhi.
11. Stanbury P. F., Whitaker A. & Hall S. J 3rd edition (2017) "Principles of Fermentation Technology"
12. H. K. Das., ―Text book of Biotechnology‖, 2nd and 3rd edition.
13. A textbook of biotechnology R. C. Dubey 4th edition. S. Chand.
14. H. A. Modi, (2009). _‘Fermentation Technology‘‘ Vol. 1 & 2, Pointer Publications, India
15. Okafor Nduka (2007) _‘Modern Industrial Microbiology and Biotechnology‘‘, Science Publications Enfield, NH, USA.
16. Crueger W. and Crueger A. (2000) "Biotechnology -"A Textbook of Industrial Microbiology", 2 nd edition, Panima Publishing Corporation, New Delhi.
17. Prescott and Dunn's _‘Industrial Microbiology‘‘ (1982) 4th edition, McMillan Publishers.
18. Pharmaceutical Microbiology, Hugo and Russell, 7 th edition, Blackwell Science

HSNC UNIVERSITY,
MUMBAI

Board of Studies in Faculties of Science &

TechnologyBoard of Studies in Microbiology

Subject

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

a) **Dr. Sejal Rathod** (Assistant Professor and Head, Department of Microbiology, K.C College, Churchgate) sejal.rathod@kccollege.edu.in

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 (**Assistant Professor, Department of Microbiology, K.C College, Churchgate) pratibha.shah@kccollege.edu.in

b) **Mrs. Rajitha Satish** (Assistant Professor, Department of Microbiology, K.C College, Churchgate) rajitha.satish@kccollege.edu.in

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

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

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

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

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

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

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

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) uzma25.shaikh@gmail.com

b) **Ms. Soni Gupta** (Postgraduate student -18-19) 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 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, hand outs 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 / counselling 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 Hours duration.

ii. Theory question paper pattern: -

- There shall be five questions each of 12 marks. On each unit there will be one question & fifth one will be based on all the four units
- All questions shall be compulsory with internal choice within the questions. Each question will be of 24 marks with options.
- Questions may be sub divided into sub questions a, b, c & d only, each carrying six marks OR a, b, c, d,e & f only each carrying four marks and the allocation of marks depends on the weightage of the topic.

b) Continuous evaluation- 40 Marks

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

2ii) Practical Question Paper Pattern: -

Semester End Examination-100 Marks

Internal Assessment- 20 Marks per Paper

Semester end practical examination in applied component shall be conducted by the concerned department of the Institute/ College at the end of each semester and the marks of the candidates are to be sent to the University in the prescribed format.

Sr. No.	Particulars	Marks	Total
1	**Laboratory work**	60	60
2	**Journal**	10	10
3	**Viva**	10	10
4	**Practical Test Marks**	20	20
	Grand Total	100	100

HSNC University,
Mumbai

(2022-2023)

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

Course: Applied Component Biotechnology (US-TMBAC)

Semester-V and Semester -VI

With effect from the Academic year 2022-2023

Programme: B.Sc.

Course: Applied Component- Biotechnology (TMBAC)Part 1- Preamble

In the syllabus of applied component, applied topics having commercial propositions have been incorporated that further adds to the enhancement of entrepreneurial potential and skills amongst the learners. The approach towards designing this syllabus has been to retain the classic concepts of Microbiology as well as keeping abreast with the latest discoveries in Microbiology and other interdisciplinary fields. In conclusion, the revised syllabus aims at inculcating a spirit of learning and kindling curiosity towards the subject in the minds of learners, resulting in their pursuit of higher education in Microbiology.

The courses included are

US-TMBAC- 501- Concepts & Application of Biotechnology

US-TMBAC -601 – Applied Biotechnology

Course Objectives:

Semester V

US-TMBAC - 501: Concepts & Application of Biotechnology

Learning Objectives:
With a background of molecular techniques and principles, food and fermentation industry, the undergraduate T.Y. B.Sc. Applied Component course under the Paper on Concepts & Application of Biotechnology introduces the learner to the applications of various biotechnological and molecular techniques. It also introduces food technology with reference to the base of food microbiology is SYBSc class. It introduces a new concept and topic of modern technology -nanobiotechnology. The course deals in detail with concepts and applications of biotechnology

Learning Outcomes:

Students should be able to-

- Understand the emerging techniques in biotechnology
- Understand the commercial importance of biotechnology
- Understand the molecular techniques used for protein, DNA analysis
- Understand concepts of Nutrigenomics
- Understand the criteria that can be used to assess quality of food
- Understand the importance of nanobiotechnology.

Semester VI

US-TMBAC - 601 – Applied Biotechnology Learning

Objectives:

With a background of various concepts of biotechnology undergraduate T.Y. B.Sc. Applied Component course under the Paper on Applied Biotechnology introduces the learner to the various aspects where biotechnological methods can be applied. The course introduces the learner to different areas of biotechnology like marine, agricultural and food biotechnology. It also introduces the learner to different ways in which biotechnology has made advances in medicine.

Learning Outcomes:

Students should be able to-

- Understand the impact of biotechnology on environment.
- Understand the different biotechnological tools used in environmental biotechnology.
- Understand the diversity marine biotechnology.
- Understand bioremediation, bioaugmentation and biocontrol.
- Understand the concept and application of nutraceuticals
- Understand concepts of prebiotics and probiotics
- Understand the concept and applications of Medical Biotechnology
- Understand application of biotechnology in pharmaceutical production.

Semester V - Units – Topics – Teaching Hours

Sr No	Subject Code	Subject Unit Title		Hours /Lectures	Total No. of hours/lectures	Credit	Total Marks
1	US-TMBAC-501	1	Introduction & Commercial importance of biotechnology	15	60 L	2	100
		2	Application of Biomolecular methods in biotechnology	15			
		3	Introduction to Food biotechnology	15			
		4	Nanobiotechnology & pharmaceutical biotechnology	15			
2	US-TMBACP-501	1	Practicals based on the above course	60	60L per batch	2	100
			TOTAL			4	200

L: Lecture: Tutorials P: Practical Ct-Core Theory, Cp-Core Practical, SLE- Self learning evaluation CT-Commutative Test, SEE- Semester End Examination , PA-Project Assessment, AT- Attendance

Part 3: Detailed Scheme Theory

Curriculum Topics along with Self-Learning topics - to be covered, through self-learning mode along with the respective Unit. Evaluation of self-learning topics to be undertaken before the concluding lecture instructions of the respective UNIT

Course Code: US-TMBAC -501 (Concepts & Applications of biotechnology)

Unit	Topics	Credits-2	Lectures	References
1	**Unit I- Introduction and Commercial importance of Biotechnology**		**15**	
	1.1 Definition, History of Biotechnology, Traditional and Modern Biotechnology, Different Branches (Health care, Agriculture, Human genome project, Environment)		**5L**	A Textbook of Biotechnology by RC Dubey Biotechnology by V. Kumaresan Biotechnology in medical science by Firdous Alam khan A Review on Biotechnology and Its Commercial and Industrial Applications
	1.2. Biotechnology as an interdisciplinary area 1.2.1 Biotechnology in India and the Developing World		**2L**	
	1.3. Emerging trends in Biotechnology		**1L**	
	1.4. Commercial importance of biotechnology		**2L**	
	1.5. Public perception of biotechnology		**2L**	
	1.6. Legal, ethical & social issues of biotechnology		**2L**	
2	**Unit II- Applications of Biomolecular methods in biotechnology**		**15**	
	2.1. Electrophoresis (SDS-PAGE, Native PAGE and 2D gel electrophoresis, Agarose gel electrophoresis, Capillary & Pulse Field Gel Electrophoresis)		**4L**	Spectroscopy in Biotechnology Research and Development. Applications of CRISPR- Cas9 mediated genome engineering.
	2.2. Blotting techniques (Western, Southern & Northern) & Variants of PCR		**4L**	
	2.3. Mass spectrometry- MALDI, ESI		**2L**	
	2.4. Spectroscopy (FT-IR, Fluorescence spectroscopy, NMR)		**3L**	
	2.5. Next Generation DNA sequencing		**1L**	
	2.6. CRISPR-Cas9, Zinc finger nucleases, Talens		**1L**	

3	**UNIT III- Introduction to Food Biotechnology**		**15**	
	3.1. Biotechnological applications in enhancement of Food Quality 3.1.1. Hunger, biotechnology & World Food needs 3.2. Biotechnology in Food Processing 3.2.1. Unit Operation in Food Processing 3.2.2. Quality Factors in Pre-processed Food 3.2.3. Food Deterioration and its Control 3.2.4. Rheology of Food products 3.3. Nutrigenomics 3.3.1. Introduction, Gene- diet interaction 3.3.2. Principles and practice behind dietary management of genetically transmitted disorders 3.4. Introduction to Foodomics		**3L** **7L** **4L** **1L**	Biotechnology by John E Smith Nutritional Genomics by Jim Kaput, 1st ed., 2006.
4	**Unit IV: Nanobiotechnology & Pharmaceutical biotechnology**		**15**	
	4.1. Nanobiotechnology 4.1.1. Introduction of Bionanoscience, Bionanomaterials, Bionanomachines, DNA Nanotechnology, Peptide Nanotechnology, Magnetic Nanoparticles and scope of Nanobiotechnology 4.1.2. Commercialised Nanobiotechnology related products: Biosilicon in drug delivery, Pura Matrix in tissue repair and cell therapies, Genia Beads for wound, Cetaphil liposomal based sunscreen. 4.1.3. Nanotoxicology: A threat to environment & human health 4.2. Introduction to Pharmaceutical biotechnology 4.2.1. Pharmaceuticals & biopharmaceutical 4.2.2 Biologics & Biosimilars		**10L** **5L**	Nanobiotechnology : Concepts, Applications and Perspectives Pharmaceutical biotechnology: Concepts and application by Gary Walsh

Part 5: Detailed scheme Practical
Course Code: US-TMBACP – 501

1	Isolation of genomic DNA (bacterial /yeast). a) Measurement of DNA by UV-Vis Spectrophotometry. b) Gel electrophoresis of DNA.
2	Amplification of DNA by PCR (Demonstration)
3	Microbiological analysis of probiotics.
4	PAGE for protein
5	Synthesis, characterisation and antimicrobial studies of Nanoparticles produced from plant materials or microorganisms
6	Biocompatibility of nanoparticles – Haemolytic assay
7	FT-IR (Demonstration)
8	Assignment or case study on any commercially important biotechnological product or Case study on ethical or legal issues of biotechnology

Semester VI - Units – Topics – Teaching Hours

Course Code: US-TMBAC -601 (Applications of biotechnology)

Sr. No	Subject Code		Subject Unit Title	Hours/Lectures	Total No. of hours/lectures	Credit	Total Marks
1	US-TMBAC-601	1	Environmental biotechnology	15	60 L	2	100
		2	Food Biotechnology	15			
		3	Marine & Agricultural biotechnology	15			
		4	Medical Biotechnology	15			
2	USTMB-ACP-601	1	Practicals based on the above course	60	60L per batch	2	100
			TOTAL			4	200

Part 4: Detailed Scheme Theory

Course Code: US-TMBAC -601 (Applications of biotechnology)

Unit	Topic	Credits -2	Lectures	References
1	**UNIT I- Environmental Biotechnology**		**15**	
	1.1. Overview of bioremediation 1.2. Biological fuels: ethanol, methane and Hydrogen production. Petroleum prospecting and Microbially Enhanced Oil Recovery (MEOR) 1.3. Biomining & bioleaching 1.4. Biotechnology in pollution control 1.4.1. Definition, Role of biotechnology in pollution control 1.4.2. Environmental monitoring, Environmental impact assessment, Biosensor, DNA Probes 1.5. Biological monitoring of hazardous waste: Degradation of xenobiotic, Application of Superbug, Phytoremediation		**1L** **4L** **2L** **5L** **3L**	Environmental biotechnology by Alan Scragg Biotechnology by V. Kumaresan Industrial pollution management, S.D Jogdand, Himalaya publishing house
2	**Unit II: Food Biotechnology**		**15**	
	2.1. Functional foods, Prebiotics & Probiotics 2.1.1. Introduction- definitions 2.1.2 Production of nutraceuticals (lycopene), prebiotics and probiotics 2.1.3. Food additives and ingredients: Food additives-definitions and functions, (Preservatives, antioxidants, colours, emulsifiers, sequestrants, natural and microbial flavours) 2.1.4 Encapsulation and Controlled Release of Bio functional Ingredients in Functional Foods, Bioactive, Antimicrobial Bioactive Agents 2.2. Application of Enzymes in the Food Industry: Commercially important enzymes used in Food industry, As additives e.g., antioxidant or antimicrobial, Food Uses of Enzyme Inhibitors.		**1L** **3L** **4L** **3L** **4L**	Nutraceutical and Functional Food as Future Food: A Review Advances in food biotechnology by Rai V. ravishankar

3	**Unit III: Marine & Agricultural biotechnology**		**15**	
	3.1. Introduction to Marine Biotechnology 3.1.1. Bioprospecting 3.1.2. Applications of Marine biotechnology (Marine Drugs as Pharmaceuticals, Bioactive compounds, Marine Nutraceuticals, Marine Probiotics, Marine Components in Cosmetics and Cosmeceuticals) 3.2. Introduction to Agricultural biotechnology 3.2.1. Characteristics and applications for Bacterial, fungal & algal biofertilizers. 3.2.2. Biological control of plant pathogens, Insects and weeds, Bioaugmentation & Biostimulation.		**1L** **1L** **6L** **1L** **3L** **3L**	Handbook of Marine Biotechnology. Marine Bioactive Compounds Sources, Characterization and Applications.
4	**Unit IV: Medical Biotechnology**		**15L**	
	4.1. Introduction to Genetic testing and disorders, Prenatal diagnosis (NIPT, Double &Triple marker test) , Amniocentesis, Genetic counselling 4.2. Protein therapeutics- (Hormones, cytokines, monoclonal antibodies) 4.3 Nucleic acid therapeutics- Antisense Technology 4.4. Introduction to Tissue engineering 4.5. Stem cells -Introduction, Classification (terms) & Applications (Heart damage, baldness, Infertility, Orthopaedics)		**3L** **4L** **2L** **1L** **5L**	Medical Biotechnology, Himalaya Publishing House, Mumbai. Medical Biotechnology, Churchill Livingstone, Elsevier.

Part 6: Detailed scheme
PracticalsCourse Code: US-TMBACP – 601

1	Isolation and cultivation of Phosphate solubilizers
2	Preparation of biofertilizer: mass production and Method of seed application
3	Estimation of Lycopene.
4	Estimation of Antioxidant activity
5	MIC of food preservative
6	Visit to vermicomposting/ biocomposting facility
7	Isolation of pigment producing bacteria from marine environments
8	To prepare a market survey report on the any one Nutraceutical functional food product.

Reference books:

Semester V

- Principles and Techniques of Biochemistry and Molecular Biology, Seventh edition, by Wilson and Walker.
- Spectroscopy in Biotechnology Research and Development. http://dx.doi.org/10.1016/B978-0-12-374413-5.00035-X
- Applications of CRISPR-Cas9 mediated genome engineering, https://doi.org/10.1186/s40779-015-0038-1
- Molecular diagnostics Fundamentals, Methods and Clinical Applications (3rd Edition)
- Food Science: Potter N.N. CBS publication
- Food Science and Technology: B.S.Khattar,Daya Publishing House,Delhi
- Biotechnology by B.D.Singh,Kalyani Publishers
- Food Microbiology by Frazier
- J Nutrigenetics Nutrigenomics 2011;4:69–89; Nutrigenetics and Nutrigenomics: Viewpoints on the Current Status and Applications in Nutrition Research and Practice.
- J Am Diet Assoc. 2006;106:569-576; Nutrigenomics: From Molecular Nutrition to Prevention of Disease.
- Yang, X. Applications of CRISPR-Cas9 mediated genome engineering. Military Med Res 2, 11 (2015). https://doi.org/10.1186/s40779-015-0038-1
- Nutritional Genomics by Jim Kaput, 1st ed., 2006.
- Nutritional Genomics by Regina Brigelius-Flohé, 2006
- Biotechnology in Medical Science by Firdous Alam khan
- A Review on Biotechnology and Its Commercial and Industrial Applications
- Pharmaceutical biotechnology:Concepts and application by Gary walsh
- Biotechnology by V. Kumaresan
- Biotechnology by John E Smith

Reference books:

Semester VI

- Nanobiotechnology: Concepts, Applications and Perspectives by Mirkin Chad, Wiley
- Nanobiotechnology-Concepts and Applications in Health, Agriculture, and Environment by R. Tomar, Apple Academic Press
- Sharma, P., Sharma, N. (2017) Industrial and Biotechnological Applications of Algae: A Review. Journal of Advances in Plant Biology - 1(1):01-25. (Review Paper)
- Biotechnology by V. Kumaresan
- R. C. Dubey. A Textbook of Biotechnology. 2006 S. Chand and Company Ltd.
- Bernard R Glick and Jack J Pasternak. Molecular Biotechnology: Principles and Applications of recombinant DNA. 3rd Edition.
- B. D. Singh. Biotechnology. Kalyani Publishers.A. Singh, A. Parmar and R.C.Kuhad. Bioaugmentation, Biostimulation and Biocontrol. Soil Biology Volume 28. Springer.

- Advances in food biotechnology by Rai V. ravishankar
- Kim, S.K. Springer Handbook of Marine Biotechnology; Springer: Berlin, Germany; Heidelberg, Germany, 2015.
- Fabio Rindi, Anna Soler-Vila, Michael D. Guiry (auth.), Maria Hayes (eds.)-Marine Bioactive Compounds_ Sources, Characterization and Applications-Springer US (2012)
- W. Evans-Trease and Evans Pharmacognosy 15 th ed.-Saunders (2010
- Jogdand S. N., Medical Biotechnology, Himalaya Publishing House, Mumbai, (2008)
- Judit Pongracz, Mary Keen, Medical Biotechnology, Churchill Livingstone, Elsevier(2009)
- Enviromental biotechnology by Alan Scragg
- Nutraceutical and Functional Food as Future Food: A Review by Raj K. Keservan
- Biotechnology by B.D. Singh