

AC- 15/04/2023

Item No: 5.30



RAYAT SHIKSHAN SANSTHA'S
KARMAVEER BHAURAO PATIL COLLEGE, VASHI
NAVI MUMBAI

EMPOWERED AUTONOMOUS COLLEGE

DEPARTMENT OF MICROBIOLOGY

Program: F.Y.BSc. Microbiology
Syllabus for F.Y.BSc. Microbiology

[Syllabus as per NEP 2020]

With effect from the academic year 2023-2024

Rayat Shikshan Sanstha's
KARMAVEER BHAURAO PATIL COLLEGE, VASHI
[EMPOWERED AUTONOMOUS]
Sector: 15- A, Vashi, Navi Mumbai - 400703

Syllabus for FYBSc. Microbiology

Program: FYBSc.

Program: FYBSc. Microbiology [UGMB]

[Syllabus as per NEP 2020]

Academic Year 2023-24

Rayat Shikshan Sanstha's
Karmaveer Bhaurao Patil College Vashi, Navi Mumbai
(EMPOWERED AUTONOMOUS)

Syllabus

Sr. No.	Heading	Particulars
1	Title of Course	F.Y.B.Sc. Microbiology (NEP 2020)
2	Eligibility for Admission	XII th Class From a recognized Board
3	Passing Marks	40%
4	Ordinances/Regulations (if any)	--
5	No. of Years/Semesters	One year/Two semester
6	Level	U.G.
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic year	2023-2024

Preamble

Bachelor of Science (B.Sc.) in Microbiology is undergraduate programme of the Department of Microbiology, Karmaveer Bhaurao Patil College Vashi, Navi Mumbai [Empowered Autonomous]. With the introduction of the NEP system, this syllabus in Microbiology has been revised for B.Sc. semester I and semester II. This syllabus is implemented with the effect from 2023-2024. The revised syllabus has been approved by the concerned authorities of the Empowered Autonomous College Committees formed by the college, BOS members and Head/senior teachers from the Department of Microbiology. The syllabus has been designed such that the theory goes hand in hand with the practicums thus enabling students to develop the professional skills set of Microbiologist. The topics included will give hand on practising each paper has been designed emphasizing the need to develop research skills and critical thinking/reasoning in students. This aids the students in their specific area of their interest/specialization in particular. The syllabus covers various topics enlisted for employability and entrance exams that are CSIR-NET, SET, GATE, PET, research institutes etc.

This revised syllabus is aimed at equipping students with theoretical foundations and practical techniques required in R&D, Quality control, regulatory function in pharmaceutical, environmental sciences, pharmaceutical microbiology, advances in molecular biology, applied and medical microbiology. Applied and environmental monitoring and management. The areas covered in Semester I and II will boost employability of the students

As mentioned in the syllabus all the courses of theory and practical are compulsory to Microbiology.

I. Program Outcome

PO-1	Disciplinary Knowledge and Skills: Acquire the comprehensive and in-depth knowledge of various subjects in sciences such as Physics, Chemistry, Mathematics, Microbiology, Bio-analytical Science, Computer Science, Data Science, Information Technology and disciplinary skills and ability to apply these skills in the field of science, technology and its allied branches.
PO-2	Communication and Presentation Skills: Develop various communication skills including presentation to express ideas evidently to achieve common goals of the organization.
PO-3	Creativity and Critical Judgement: Facilitate Solutions to current issues based on investigations, evaluation and justification using evidence-based approach.
PO-4	Analytical Reasoning and Problem Solving: Build a critical and analytical attitude in handling the problems and situations.
PO-5	Sense of Inquiry: Curiously raise relevant questions based on highly developed ideas, scientific theories and their applications including research.
PO-6	Use of Digital Technologies: Use various digital technologies to explore information/data for business, scientific research and related purposes.
PO-7	Research Skills: Construct, collect, investigate, evaluate and interpret information/data relevant to science and technology to adapt, evolve and shape the future.
PO-8	Application of Knowledge: Develop a scientific outlook to create consciousness against the social myths and blind faith.
PO-9	Moral and Ethical Reasoning: Imbibe ethical, moral and social values to develop virtues such as justice, generosity and charity as beneficial to individuals and society at large.
PO-10	Leadership and Teamwork: Work cooperatively and lead proactively to achieve the goals of the organization by implementing the plans and projects in various field-based situations related to science, technology and society at large.
PO-11	Environment and Sustainability: Create social awareness about the environment and develop sustainability for betterment of the future.
PO-12	Lifelong Learning: Realize that pursuit of knowledge is a lifelong activity and in combination with determined efforts, positive attitude and other qualities to lead a successful life.

Program Specific Outcomes (PSO)	
At the end of the two year programme the student will understand and be able to	
PSO1	Understand the various aspects of microbial world and history of microbiology
PSO2	Differentiate and classify different types of microorganism and its characteristics
PSO3	Distinguish between Prokaryotes and Eukaryotes with respect to their ultra-structure and functions
PSO4	Understand & differentiate the requirement of nutrients and environmental conditions for the growth of microorganisms
PSO5	Apply the knowledge of basic instrumentation, basic techniques in microbiology and control of microorganism
PSO6	Explain and describe types and functions of different biomolecules found in living cells
PSO7	Describe the aspects of microbial ecology and industrial microbiology
PSO8	Illustrate the basic immunology and medical microbiology

Objectives of the Course	
The important objectives of this course are as below-	
1	The students will gain an understanding of morphology of prokaryotic cells and eukaryotic cells and also about various groups of microorganisms.
2	The students will be acquainted with the concepts of microbial evolution and their diversity.
3	The students will be apprised with nutritional requirements of microbes and their growth cycle
4	The students will study in detail about the biomolecules.
5	The students will read and analyze various methods of controlling microorganisms.
6	The students will be familiarized with concepts of immunity and infection
7	The students will be introduced to instrumentation in microbiology, industrial microbiology
8	The students will be trained in all basic microbiological techniques

Teaching - Evaluation Scheme

Semester-I

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	CIE	Sem End-Exam	Term	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
UGMB101	Fundamentals of Microbiology	03	-	-	30	45	-	-	-	75	03	-	-	03
UGMBP101	Practicum of Core Course UGMB101: Methods in Microbiology	03	-	-	-	-	-	25	-	25	-	01	-	01
UGMBOE102	Microbial World	03	-	-	30	45	-	-	-	75	03	-	-	03
UGMBOEP102	Practicum: Microbial World	03	-	-	-	-	-	25	-	25	-	01	-	01
UGMBBTH103	Basic Techniques in Haematology	03	-	-	25	-	-	25	-	50	01	01	-	02
UGMBSEC104	Food safety and Quality control	03	-	-	20	30	-	-	-	50	02	-	-	02
Total					105	120	-	75	-	300	09	03	-	12
Total Credit											09	03	-	12

Teaching - Evaluation Scheme

Semester-II

Course Code	Course Name	Teaching Scheme (Hours/Week)			Examination Scheme and Marks						Credit Scheme			
		Lecture	Practical	Tutorial	CIE	Sem End-Exam	Term	Practical	Oral	Total	Lecture	Practical	Tutorial	Total
UGMB201	Basic Techniques in Microbiology	03	-	-	30	45	-	-	-	75	03	-	-	03
UGMBP201	Practicum of Core Course UGMB201: Basic Techniques in Microbiology	03	-	-	-	-	-	25	-	25	-	01	-	01
UGMBOE202	Food safety and hygiene	03	-	-	30	45	-	-	-	75	03	-	-	03
UGMBOEP202	Practicum: Food safety and hygiene	03	-	-	-	-	-	25	-	25	-	01	-	01
UGMBBTH203	Clinical Biochemistry	03	-	-	25	-	-	25	-	50	01	01	-	02
UGMBSEC204	Fermented food Technology	03	-	-	20	30	-	-	-	50	02	-	-	02
Total					105	120	-	75	-	300	09	03	-	12
Total Credit											09	03	-	12

**COURSE STRUCTURE FOR F.Y.BSc. I MICROBIOLOGY
SEMESTER I**

Paper I [UGMB101]: Fundamentals of Microbiology				
Course Code	Unit	Topic	Credit	L/W
UGMB101	I	Introduction to Microbial World	2	3
	II	Prokaryotic Cell Structure & Function		
	III	Eukaryotic Cell Structure and Function		
UGMBP101	Laboratory Session	Practicum: Methods in Microbiology	2	6

Paper II [UGMBOE-102]: Microbial World				
Course Code	Unit	Topics	Credits	L / W
UGMBOE101	I	Prokaryotic and Eukaryotic cell structure	03	03
	II	Microbial Pathology		
	III	Beneficial Microbial Associations		
UGMBOEP101		Laboratory sessions	01	02

VSC [UGMBBTH103]: BASIC TECHNIQUES IN HEMATOLOGY				
Course Code	Unit	Topics	Credits	L / W
UGMBBTH101	I	Introduction to Hematology	2	2
	II	Introduction to Immuno-hematology.		
UGMBBTHP101		Laboratory sessions		

SEC [UGMBSEC104]: Food Safety and Quality Control				
Course Code	Unit	Topics	Credits	L / W
UGMBBTH101	I	Basic Concepts: Food	2	2
	II	Food Quality and Control		
	III	Food quality control		

SEMESTER II

Paper I [UGMB-201]: Basic Techniques in Microbiology				
Course Code	Unit	Topics	Credits	L / W
UGMB201	I	Cultivation and Pure Culture Technique	03	03
	II	Control of Microorganism		
	III	Basic Instrumentation		
UGMBP201		Laboratory sessions	01	02

Course Code	Topics	Credits	L/Week
UGMBCB203	Clinical Biochemistry [Practicum session]	2	2

[UGMBOE202]: Food safety and Hygiene				
Course Code	Unit	Topics	Credits	L / W
UGMBOE1 01	I	Food composition & analysis	03	03
	II	Food Quality and Hazard analysis		
	III	Food safety & hygiene		
UGMBOEP1 01		Laboratory sessions	01	02

SEC [UGMBSEC204]: FERMENTED FOOD TECHNOLOGY				
Course Code	Unit	Topics	Credits	L / Week
UGMBSEC101	I	Introduction to Fermented Foods	02	02
	II	Fermented food products		

Teaching Pattern for Semester I and II:

1. Four lectures per week per course. Each lecture is of 60 minutes duration.
2. For SEC four lectures per week per course and practical sessions for 16Hrs. Each lecture is of 60 minutes duration.
3. In addition, there shall be tutorials, seminars as necessary for each of the five courses.

Objective:

1. To introduce the application-based research in Microbiology
2. To inculcate sense of scientific responsibilities and social and environment awareness
3. To enrich students' knowledge and train them in the applied microbial sciences
4. To help student's build-up a progressive and successful care

Paper I [UGMB101]: Fundamentals of Microbiology

Course Learning Outcome:

By the end of the course, a student should develop the ability to

C01: Students will learn the multifaceted existence of microorganisms. [1]*

C02: Students will gain knowledge about the major groups of microorganisms and its distribution.[1] *

C03: Students will able to classify the microorganisms.[3]

C04: Students will able to determine the requirement of nutrients and environmental conditions for the growth of microorganisms [5] *

C05: Students will able to design growth media for microorganisms.[6]

***Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
C01	1	-	-	1	-	-	-	-	-	-	-	-
C02	1	-	-	2	-	-	-	-	-	-	-	-
C03	1	-	-	2	-	-	-	-	-	-	-	-
C04	2	-	-	2	-	-	-	-	-	-	-	-
C05	1	-	-	3	-	-	1	-	-	-	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

SEMESTER I: Paper I		
Course Code	Title	Credits
UGMB101	Fundamentals of Microbiology-I	03
Unit-I	History and Scope of microbiology	01
	<ul style="list-style-type: none"> ● Introduction to Microbiology ● The discovery of microorganisms ● Conflict over spontaneous generation ● Golden age of microbiology ● Major contribution of scientists ● The scope and relevance of microbiology ● Future of microbiology ● Microbial evolution ● Introduction to microbial classification and taxonomy <ul style="list-style-type: none"> a. Five Kingdom System of Classification b. Eight Kingdom System of Classification c. Three Domain System of Classification d. Taxonomic ranks ● Types of microorganisms <ul style="list-style-type: none"> Bacteria Fungi Protozoa Algae Virus 	
Unit-II	Prokaryotic Cell structure& function	01
	<ul style="list-style-type: none"> ● An overview of prokaryotic cell structure ● Cell size and the significance of being small ● Bacterial and Archaeal cell wall ● Bacterial and Archaeal cell membrane ● The cytoplasmic matrix ● Inclusion bodies ● Ribosomes ● The nucleoid ● Plasmids ● Components external to the cell wall ● Tactic Behaviours ● Bacterial Endospore 	
Unit-III	Microbial nutrition and Growth	01
	<ul style="list-style-type: none"> ● The Common Nutrient Requirements: <ul style="list-style-type: none"> a. Macro-nutrients b. Micro-nutrients, Oxygen and Electrons ● Growth Factors ● Nutritional Types of Microorganisms ● Culture Media ● Uptake of Nutrients by the Cell ● Microbial growth- prokaryotic cell cycle ● The growth curve 	

	<ul style="list-style-type: none">● The influence of environmental factors on growth● Microbial growth in natural environments● Preservation of bacterial cultures	
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Reference:

1. Prescott L.M., Harley J.P., AND Klein D.A. (2008). Microbiology, 7th Edition. MacGraw Hill CompaniesInc.
2. Madigan M.T., Martinko J.M. (2009). Brock's Biology of Microorganisms. 12th Edition. Pearson EducationInc.
3. Madigan M.T., Martinko J.M. (2015). Brock's Biology of Microorganisms. 14th Edition. Pearson EducationInc.
4. Tortora G.J., Funke B.R., Case C.L. (2017). Microbiology: An Introduction. 11th Edition. Pearson EducationInc.
5. John M. Willey, L. M. Sherarred, Christopher J. Woolverton, Prescott's Microbiology, 9th edition(2014)
6. Benson's Microbiological Applications(2015) -Laboratory Manual in General Microbiology, Thirteenth Edition, Alfred Brown and Heidi Smith, ISBN 978-0-07-340241-3, MHID 0-07-340241-9

Practicum Session Semester I

UGMBP101: Fundamentals of microbiology

Course Learning Outcomes:

By the end of the course, a student will able to,

- C01.** Study the Microscopic Morphology of Microorganisms: [3] *
- C02.** Design/organize an experiment to isolate and culturing bacteria in given sample 6*
- C03.** Enumeration of Microorganisms by different methods [5]*
- C04.** Differentiate between different staining procedures 4*
- C05.** Design an experiment to isolate and cultivate microorganisms from different sources. 6*

***Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO1 1	PO1 2
C01	1	-	1	2	1	-	-	-	1	-	-	-
C02	1	-	-	1	2	-	-	-	-	-	-	-
C03	1	-	-	2	1	-	1	3	-	-	-	2
C04	2	-	-	3	1	-	3	-	-	-	-	-
C05	1	-	-	1	-	-	-	2	-	1	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

Laboratory Sessions

Course Code	Title	Credits
UGMB P1	Fundamentals of microbiology	01
	1. Orientation to Microbiology laboratory	
	2. Introduction to safety measures in laboratory and disposal of microbial cultures	
	3. Introduction to safety measures in laboratory and disposal of microbial cultures	
	4. Study of Brightfield microscope and its care	
	5. Survey of Microorganisms a. Ubiquity of bacteria b. Microbiology of Pond Water—Protists, Algae, and Cyanobacteria c. Bread mold and the Fungi d. Spoiled fruits- Yeasts e. Demonstration- Bacteriophage from rhizosphere soil	
	6. Stains, Staining procedures and Observation of Microorganisms <ul style="list-style-type: none"> ● Introduction to stains ● Smear Preparation ● Simple Staining ● Negative Staining a. Differential staining <ul style="list-style-type: none"> ● Gram staining b. Special staining <ul style="list-style-type: none"> ● Cell wall ● Capsule ● Spore ● Metachromatic granule staining c. Motility Determination by Hanging drop method	
●	7. Study of types of media <ul style="list-style-type: none"> ● Simple media-Nutrient Broth & Sabouraud's Agar ● Selective & differential media MacConkey, Superimposed blood agar and Mannitol Salt Agar, 	
a.	8. Measurement of microbial growth Enumeration of Microorganisms b. Viable count c. Haemocytometer c. Breed's Count Method d. Opacity Tube Method	

Semester I:

UGMBOE102: Microbial World [Open Elective]

Course Learning Outcome:

By the end of the course, a student should develop the ability to,

CO1. Diagrammatically explain the Ultrastructure of the Prokaryotic & Eucaryotic cells.

CO2. Describe the role of biomolecules and their functions, microbes and their niche, nutrition, mode of reproduction, emerging infections

CO3. Differentiate different types of infections and their mode of transmission

CO4. Evaluate and Understand the role of microorganisms in ecology.

CO5. Application based knowledge in Industrial, food, fermentation microbiology.

CO-PO Mapping Matrix												
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	2	2	1	0	2	1	2	0	2	2
CO2	1	0	0	0	0	0	0	2	0	0	0	1
CO3	1	0	2	2	0	1	2	1	1	0	3	1
CO4	1	2	0	0	0	3	1	2	0	0	0	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

SEMESTER I: Paper I		
Course Code	Title	Credits
UGMBE 102	Microbial World	4 Credits (60 lectures)
Unit-I	Prokaryotic and Eukaryotic cell structure	15
	<ol style="list-style-type: none"> 1. Introduction to Microbiology Scope of Microbiology- Applied areas of microbiology, History of Microbiology 2. Types of Microorganisms- Prokaryotes cell structure and function: Bacteria An Overview of Prokaryotic Cell Structure Eucaryotes Cell Structure and function: Archaea, Fungi, Protozoa, Algae 3. An Overview of Viruses 4. Differentiation between Prokaryotic and Eukaryotic Cells 5. Stain and staining procedures: Simple positive negative, Gram staining. Capsule staining 6. Nutritional requirement of microorganisms: 	
Unit II	Microbial Pathology	15
	<ol style="list-style-type: none"> 1. Introduction to Harmful Microbes 1. Microbes and disease 2. Infections: Introduction & Definitions of medical terms 3. Classification of infections (Primary and secondary) 4. Modes of transmission of infection 5. Sources of infection 6. Examples- Malaria, Ebola Virus, Chikungunya, Leptospirosis, 7. Opportunistic Infections by <i>E. coli</i>, Nipah virus, Swine flu 	
Unit III	Beneficial Microbial Associations	15
	<ol style="list-style-type: none"> 1. Introduction to beneficial microbes 1. Role of microorganisms in ecosystem 2. Nitrogen fixation 3. Decomposition of organic matter 4. Role of Microorganisms in Biogeochemical cycling 2. Food, Dairy and Pharmaceutical industries Probiotics and prebiotics 	

LABORATORY SESSION
Practicum of Other Elective Course
UGMBOEP102 Microbial World

Course Outcome: At the end of the course, learners will be able to:

CO1. Follow Safety measures In Microbiology Laboratory[2*]

CO2. Use apparatus, instruments & techniques used in microbiology laboratory.[4*] .

CO3. Prepare media for growth of Microorganisms'. .[4*]

CO4. Isolate microorganism and study them.[5*]

*Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating

CO-PO Mapping Matrix												
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	2	2	1	0	2	1	2	0	2	2
CO2	1	0	0	0	0	0	0	2	0	0	0	1
CO3	1	0	2	2	0	1	2	1	1	0	3	1
CO4	1	2	0	0	0	3	1	2	0	0	0	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

(All Results have to be done with proof unless otherwise stated)

Major Course Code	Title	Credits/Lectures
UGMBOE102	Practicum of Other Elective Microbial World	1 credit
Practicum of Other Elective Microbial world	<ol style="list-style-type: none"> 1. Orientation to Microbiology laboratory 2. Introduction to safety measures in Laboratory and Disposal of microbial cultures 3. Microscopy: Study of parts of Compound microscope 4. Study of Microscopic Morphology of Microorganisms <ol style="list-style-type: none"> a. Monochrome staining b) Gram staining c)Special staining 5. Cultivation of Microorganisms <ol style="list-style-type: none"> a) Preparation of Culture Media-Nutrient Agar, Nutrient Broth, Mac Conkey, b. Mannitol Salt Agar, Sabourauds <i>agar</i>. c. b) Inoculation techniques using Liquid media, Solid media-Slant, Butt and Plate d. c) Cultural characteristics of microorganisms 6. Sterilization of Glassware and Culture media 7. Autoclave b. Hot Air Oven c. Bacteriological filter. 8. Isolation of microorganisms 	2 Hr/Week

References:

1. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
2. Prescott L.M., Harley J.P., AND Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc.
3. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.
4. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc.
5. Kathleen Park Talaro & Arthur Talaro - Foundations in Microbiology International edition 2002, | McGrawHill.
6. Lehninger. Principles of Biochemistry. 4th Edition. D. Nelson and M. Cox. W.H. Freeman and Company. New York 2005.
7. Manual of Microbiology: Tools & Techniques by Kanika Sharma 2nd edition.

SEMESTER I

VSC [UGMBBTH103]: BASIC TECHNIQUES IN HEMATOLOGY

Course Learning Outcome:

By the end of the course, a student should develop the ability to,

CO1: The student will understand of the role of technician in the hematology laboratory and health care system [2]*

CO2: Students will gain knowledge about basic techniques.[1]*

CO3: Students will able to classify the microorganisms.[3]

CO4: Students will develop excellent technical skills in hematology [3]*

CO5: Students will able to classify different blood groups.[3]

CO6: Student will able to apply methods to diagnose the clinical problems.[6]

***Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	1	1	1	3	2	3	1	0	1	1
CO2	3	0	1	2	1	3	2	3	2	1	1	1
CO3	1	1	2	3	1	2	2	2	1	1	0	0
CO4	2	0	1	3	2	2	2	2	0	2	2	1
CO5	2	2	3	3	2	3	2	3	0	0	0	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

SEMESTER I: Paper I		
Course Code	Title	Credits
UGMBBTH103	BASIC TECHNIQUES IN HAEMATOLOGY	2 Credits
Unit-I	Introduction to Haematology	
1.1 Introduction to Haematology, composition of blood 1.2 Collection of blood, different methods, difference between Capillary and venous sample. 1.3. Haemoglobin: composition, different methods of estimation. 1.4 Blood cells : <ul style="list-style-type: none"> ● Identification :Peripheral blood smear, ● Enumeration :Total count(RBC,WBC, Platelets)by ● Hemocytometry: Normal, abnormal values and physiological variations ● Differential count (WBC) :normal, abnormal values and physiological variations ● Red cell indices- PCV Normal, abnormal values. 2.1 Coagulation factors 1 Introduction to Immunohaematology. 4.2 Blood grouping systems: ABO/ Rh Blood grouping system, MNS, Kell, . 4.3 Blood Pressure measurement. 3.2 Coagulation mechanism : Intrinsic and Extrinsic Pathway 3.3 Estimation of Coagulation factors		

Practicum: Basic Techniques in Haematology

Practicum Session: Basic Techniques in Haematology		Credits
		01
	1. Introduction to Hematology and its application in Laboratory and Blood collection techniques: - a) Capillary b) Vein puncture method c) Butterfly needle d) vacutainer 2. Estimation of hemoglobin by a) Sahli's method b) Copper sulphate method 3. Estimation of WBC and RBC count by Hemocytometer 4. Estimation of WBC count by Differential method 5. Estimation of Erythrocyte sedimentation Rate (ESR) 6. Estimation of Packed Cell Volume (PCV) 7. Determination of Bleeding Time (BT) and clotting Time (CT) by capillary method 8. Determination of ABO and Rh blood group by a) Slide method b) Tube method 9. BP measurement	

References:

- 1) P.B.Godkar, text book of Medical Laboratory Technology, 2nd edition, 2003, Bhalani publication.
- 2) K.Mukharji, Medical Laboratory Techniques, vol-2, 5th edition, 1988, Tata McGraw Hill publication

F. Y. B. Sc. NEP syllabus 2020

SEMESTER I

UGMBSEC101: Food Safety and Quality Control

UGMBSEC101: FOOD SAFETY AND QUALITY CONTROL

Course Learning Outcome:

By the end of the course, a student should develop the ability to

C01: To acquire knowledge about basic properties of food components, quality and safety aspects of food.

C02: To learn about the various ways of evaluating and controlling food quality

CO-PO Matrix Mapping												
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
C01	1	0	0	0	2	0	0	3	0	0	0	0
C02	1	0	0	0	2	0	0	3	0	0	0	0
C03	0	0	1	0	0	2	0	0	0	0	0	3
C04	0	0	3	2	0	0	0	1	0	0	0	0
C05	1	0	0	2	0	0	0	0	0	0	0	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO

SEMESTER I		
Course Code	Title	Credits
SEC	Food Safety and Quality Control	4 Credits (60 lectures)
Unit I	Basic Concepts: Food	15
	1. Introduction to Food Science a. Food basics- Food as a source of nutrients. b. Different Food from Sources – Plant, Animal 2. Food Chemistry a. Water, b. Carbohydrates, c. Proteins and Enzymes, d. Lipids, e. Vitamins and Minerals, f. Food Additives 3. Food Analysis: a. Sampling Techniques of Food Products b. Physical and Chemical Analysis of Food c. Sensory Evaluation of Food Products 4. Outline of Food Fortification and Health ² Innovation in food Analysis ³	
Unit II	Food Quality and control	15
	1. Meaning and definition of food quality, Importance of microbes in food 2. Quality factors in foods, indicators of food quality- Meaning, importance and ways of Food Quality Assessment Overview of Hazard Analysis and Risk Assessment	
Unit III	Food quality control	15
	1. Food Hygiene Practices: Personal hygiene, Training programs, Infrastructure, Personal habits, Hygiene verification, Water in the food industry, Water sources, Water uses, Water quality, Treatments, Cleaning and sanitation, Cleaning agents, Sanitizing agents, Equipment and systems, Evaluation of sanitation efficacy,. Pest Control, Pest Classification (insects, rodents and birds), Prevention and control 2. Food safety regulation in India: An overview of Food Regulation in India; Food Laws and Regulations; Structure, organization and duties of regulatory system; Duties and responsibilities of food business operator	

Reference:

1. Manay, Shakuntala N. Food: Facts and Principles. 3rd Edition 2017. New Age International (P) Ltd., Publishers. ISBN-13: 9788122422153
2. Suzanne Nielsen. Food Analysis. 4th Edition 2014. Springer International Publishing. Food Safety and standards Act 2006, Rules 2011, Regulations, 2011, 10th Edition, ILBCO India, Indian Law Book Company, 2013.
3. Victor R. Preedy, Rajaventhana Srirajaskanthan, Vinood B. Patel. Nutrition and Health: Handbook of Food Fortification and Health. Humana New York, 2013 NY ISBN978-1-4614-7110-3
4. Charis M. Galanakis, Innovative Food Analysis. Academic Press ISBN 978-0-12-819493-5
5. Food Safety and standards Act 2006, Rules 2011, Regulations, 2011, 10th Edition, ILBCO India, Indian Law Book Company, 2013 and website for updates
6. Jinap Selamat, Shahzad Zafar Iqbal. Food Safety: Basic Concepts, Recent Issues, and Future Challenges 2018 ISBN: 9783319818504, 3319818503

SEMESTER II

Paper I [UGMB-201]: Basic Techniques in Microbiology

Course Learning Outcome: By the end of the course, a student should develop the ability to,

C01. Describe various types of culture media for isolation and cultivation of bacteria [2*]

C02. Design/organize an experiment to isolate and culturing bacteria in given sample [6*4*]

C03. Differentiate and apply different staining procedures [3*]

C04. Handle microscope and various analytical instruments [3*]

C05. Apply sterilization for culture media and lab equipment [3*]

C06. Exemplify different methods for control of microorganisms with respect to Physical, Chemical and Biological methods. [2*]

***Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

CO\PO	P01	P02	P03	P04	P05	P06	P07	P08	P09	P010	P011	P012
C01	1	-	1	2	1	-	-	-	1	-	-	-
C02	1	-	-	1	2	-	-	-	-	-	-	-
C03	1	-	-	2	1	-	1	3	-	-	-	2
C04	2	-	-	3	1	-	3	-	-	-	-	-
C05	1	-	-	1	-	-	-	2	-	1	-	-
C06	1	-	1	-	-	-	-	-	-	-	1	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO

SEMESTER II		
Course Code	Title	Credits
UGMBP201	Basic Techniques in Microbiology	03
Unit-I	Cultivation and Pure Culture Technique	01
	<ol style="list-style-type: none"> 1. Cultivation & Detection of Microorganisms 2. Preparation of Culture Media: <ol style="list-style-type: none"> i. Liquid medium (Nutrient Broth) ii. Solid Media (Nutrient agar, Sabourauds agar) iii. Preparation of slant, butts & plates 3. Isolation of microorganisms and pure culture techniques <ol style="list-style-type: none"> i. Streak plate technique ii. Spread plate technique iii. Pour plate technique 4. Inoculation techniques and Study of Growth: <ol style="list-style-type: none"> i. Inoculation of Liquid Medium ii. Inoculation of Solid Media (Slants, Butts and Plates) iii. Study of Colony Characteristics 5. Types of culture media <ol style="list-style-type: none"> i. Synthetic, ii. Complex, iii. Selective and Differential iv. Enriched medium, v. Anaerobic 6. Maintenance and preservation of pure culture 	
Unit II	Control of microorganisms	01
	<ol style="list-style-type: none"> 1. Basic terminologies 2. The pattern of microbial death 3. Conditions influencing the effectiveness of antimicrobial agents 4. Mechanism of action of microbial control agents 5. The use of physical methods in control 6. The use of chemical agents in control 7. Biological methods of microbial control 8. Evaluation of antimicrobial agent effectiveness 9. Control of viruses and eukaryotic pathogens 10. Chemical food preservatives 	
Unit III	Basic Instrumentation	01
	<ol style="list-style-type: none"> 1. Microscopy <ol style="list-style-type: none"> a. Compound Microscope and types b. Electron microscopes – TEM & SEM c. New generations of Microscopes-Atomic Force microscope d. Care & use of Microscope 2. Autoclave 3. Incubator 4. pH meter 5. Colorimeter 6. Centrifuge and types 7. Shaker and types 8. Laminar air flow and Biosafety cabinets 	

References:

1. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.
2. Prescott L.M., Harley J.P., AND Klein D.A. (2005). Microbiology, 6th Edition. MacGraw Hill Companies Inc.
3. Salle A.J. (1971) Fundamental Principles of Bacteriology. 7th Edition. Tata MacGraw Publishing Co.
4. Stanier R.Y., Adelberg E.A. and Ingraham J.L. (1987) General Microbiology, 5th Edition. Macmillan Press Ltd.
5. Tortora G.J., Funke B.R., Case C.L. (2006). Microbiology: An Introduction. 8th Edition. Pearson Education Inc.
6. Kathleen Park Talaro & Arthur Talaro - Foundations in Microbiology International edition 2002, McGraw Hill.
7. Wilson K. and Walker J.M. (2005) Principles and Techniques of Biochemistry and Molecular Biology. 6th Edition. Cambridge University Press.
8. Lehninger. Principles of Biochemistry. 4th Edition. D. Nelson and M. Cox. W.H. Freeman and Company. New York 2005.
9. Microbiology: An Introduction. 6th Edition. Tortora, Funke and Case. Adisson Wesley Longman Inc. 1998.
10. Manual of Microbiology: Tools & Techniques by Kanika Sharma 2nd edition.
11. Advanced Virology: Wagner 3rd Edition.
12. Prescott, Hurley, Klein-Microbiology, 9th edition, McGraw Hill. 9th Edition
13. Ananthanarayan and Panicker's, Textbook of Microbiology, 9th edition

Practicum Session Semester II

UGMBP201: Basic Techniques of Microbiology

Course Learning Outcomes:

By the end of the course, a student will able to,

- C01.** Study the Microscopic Morphology of Microorganisms: [3] *
- C02.** Design/organize an experiment to isolate and culturing bacteria in given sample 6*
- C03.** Enumeration of Microorganisms by different methods [5]*
- C04.** Differentiate between different staining procedures 4*
- C05.** Design an experiment to isolate and cultivate microorganisms from different sources. 6*

***Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

CO\PO	P01	P02	P03	P04	P05	P06	P07	P08	P09	P01 0	P01 1	P01 2
C01	1	-	1	2	1	-	-	-	1	-	-	-
C02	1	-	-	1	2	-	-	-	-	-	-	-
C03	1	-	-	2	1	-	1	3	-	-	-	2
C04	2	-	-	3	1	-	3	-	-	-	-	-
C05	1	-	-	1	-	-	-	2	-	1	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

Course code	Practical Session	Credits
UGMBP2	Section I- Basic Techniques in Microbiology	01
	1. Cultivation of Microorganisms: <ul style="list-style-type: none"> a. Preparation of Culture Media-Nutrient Agar, Nutrient Broth, MacConkey, Mannitol Salt Agar, Sabouraud's Agar b. Inoculation techniques using Liquid media, Solid media- Slant, Butt and Plate 	
	2. Sterilization of Glassware and Culture media <ul style="list-style-type: none"> a. Autoclave b. Hot Air Oven c. Bacteriological filter 	
	3. Isolation of microorganisms <ul style="list-style-type: none"> a. Streak Plate Method b. Pour Plate method a. Spread Plate method 	
	4. Control of Microorganisms <ul style="list-style-type: none"> a. Physical Methods - Temperature Chemical Methods –Phenol, Antibiotic and Dyes 	
	5. Environmental influences and control of microbial growth <ul style="list-style-type: none"> a. Effect of Salt, pH and Temperature on growth of microorganisms. b. Demonstration: Ultraviolet Light - lethal Effects c. Evaluation of Alcohol: Its Effectiveness as an antiseptic d. Evaluation of Disinfectant (Phenol), Antibiotic and Dyes: Filter Paper Disk Method e. Effectiveness of Hand Scrubbing 	
	6. Preparation of buffer and study of pH meter	
	7. Verification of Beer-Lambert's Law by Colorimeter	

References:

1. Wilson K. and Walker J.M. (2005) Principles and Techniques of Biochemistry and Molecular Biology. 6th Edition. Cambridge University Press.
2. Lehninger. Principles of Biochemistry. 4th Edition. D. Nelson and M. Cox. W.H. Freeman and Company. New York 2005.
3. Manual of Microbiology: Tools & Techniques by Kanika Sharma 2nd edition.
4. Madigan M.T., Martinko J.M. (2006). Brock's Biology of Microorganisms. 11th Edition. Pearson Education Inc.

Semester II: FOOD SAFETY AND QUALITY CONTROL
UGMBOE204: [Open Elective]

Course Learning Outcome:

By the end of the course, a student should develop the ability to,

CO1: To acquire knowledge about basic properties of food components, quality and safety aspects of food.

CO2: To learn about the various ways of evaluating and controlling food quality

CO-PO Matrix Mapping												
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	0	0	2	0	0	3	0	0	0	0
CO2	1	0	0	0	2	0	0	3	0	0	0	0
CO3	0	0	1	0	0	2	0	0	0	0	0	3
CO4	0	0	3	2	0	0	0	1	0	0	0	0
CO5	1	0	0	2	0	0	0	0	0	0	0	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

SEMESTER I: Paper I		
Course Code	Title	Credits
UGMB OE204	FOOD SAFETY AND QUALITY CONTROL [Open Elective]	
Unit-I	Food composition & analysis	15
	<p>Basic Concepts: Food</p> <ol style="list-style-type: none"> 1. Introduction to Food Science <ol style="list-style-type: none"> a. Food basics- Food as a source of nutrients. b. Different Food from Sources – Plant, Animal 2. Food Chemistry <ol style="list-style-type: none"> a. Water, b. Carbohydrates, c. Proteins and Enzymes, d. Lipids, e. Vitamins and Minerals, f. Food Additives 3. Food Analysis : <ol style="list-style-type: none"> a. Sampling Techniques of Food Products b. Physical and Chemical Analysis of Food c. Sensory Evaluation of Food Products 4. Outline of Food Fortification and Healthz 	
Unit II	Food Quality and Hazard analysis	15
	<p>Food quality control</p> <ol style="list-style-type: none"> 1. Meaning and definition of food quality, Importance of microbes in food 2. Quality factors in foods, Indicators of food quality-meaning, importance and ways of Food Quality Assessment 3. Overview of Hazard Analysis and Risk Assessment 	
Unit III	Food safety & hygiene	15
	<ol style="list-style-type: none"> 1. Food Hygiene Practices: Personal hygiene, Training programs, Infrastructure, Personal habits, Hygiene verification, Water in the food industry, Water sources, Water uses, Water quality, Treatments, Cleaning and sanitation, Cleaning agents, Sanitizing agents, Equipment and systems, Evaluation of sanitation efficacy,. Pest Control, Pest Classification (insects, rodents and birds), Prevention and control 2. Food safety regulation in India: An overview of Food Regulation in India; Food Laws and Regulations; Structure, organization and duties of regulatory system; Duties and responsibilities of food business operator 	

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References:

1. Manay, Shakuntala N. Food: Facts and Principles. 3rd Edition 2017. New Age International (P) Ltd., Publishers. ISBN-13: 9788122422153
2. Suzanne Nielsen. Food Analysis. 4th Edition 2014. Springer International Publishing. ISBN: 9783319833712
3. Food Safety and standards Act 2006, Rules 2011, Regulations, 2011, 10th Edition, ILBCO India, Indian Law Book Company, 2013.
4. Victor R. Preedy, Rajaventhana Srirajaskanthan, Vinood B. Patel. Nutrition and Health: Handbook of Food Fortification and Health. Humana New York, 2013 NY ISBN978-1-4614-7110-3
<https://doi.org/10.1007/978-1-4614-7110-3>.
5. Charis M. Galanakis, Innovative Food Analysis. Academic Press ISBN 978-0-12-819493-5
<https://doi.org/10.1016/C2019-0-00106-9>
6. Food Safety and standards Act 2006, Rules 2011, Regulations, 2011, 10th Edition, ILBCO India, Indian Law Book Company, 2013 and website for updates
7. Jinap Selamat, Shahzad Zafar Iqbal. Food Safety: Basic Concepts, Recent Issues, and Future Challenges 2018 ISBN: 9783319818504, 3319818503

LABORATORY SESSION
Practicum of Other Elective Course

UGMBOEP201: FOOD SAFETY AND HYGEINE

Course Outcome: At the end of the course, learners will be able to:

- CO1** Carry tests to understand composition of food [2*]
- CO2.**Analyze if food is adulterated.[4*] .
- CO3.** Carryout rapid microbial analysis of milk . .[4*]
- CO4.** Understand the concept of Nutritional labeling [2*]
- CO5** Produce Product from milk [6*]

***Note: According to Bloom’s Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

CO-PO Mapping Matrix												
	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	1	0	2	2	1	0	2	1	2	0	2	2
CO2	1	0	0	0	0	0	0	2	0	0	0	1
CO3	1	0	2	2	0	1	2	1	1	0	3	1
CO4	1	2	0	0	0	3	1	2	0	0	0	3
CO5	1	0	0	2	0	2	0	3	1	0	0	3

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and ‘-’ indicate there is no correlation in respective CO and PO.

Course Code	Title	Credits/ Lecture s
UGMBOE201	Practicum of Other Elective Food Safety & Hygiene	1 credit
Practicum of Other Elective Food Safety & Hygiene	<ol style="list-style-type: none"> 1. Moisture Content in food sample - Lab Oven Method 2. Qualitative Test for presence of a)Carbohydrates b) Proteins c) Aminoacids in food sample 3. Food adulteration detection in Milk, Spices, Cereals, oils etc. 4. Rapid platform tests of raw and pasteurized milk. 5. Study natural fermentation of raw milk 6. Nutritional labeling, BIS, FSSAI 7. Visit to Food Industry/Assignment/Report. 	2 Hr/Week

SEMESTER II

F. Y. B. Sc. NEP syllabus 2020

UGMBCB203- Clinical Biochemistry

Course Learning Outcome:

By the end of the course, a student should develop the ability to,

CO1: Students will learn the basic analytical instruments for analysis. [1]*

CO2: Students will gain knowledge about the medically relevant biochemical processes and molecules.[1]*

CO3: Students will able to classify cholesterol.[3]

CO4: Students will able to determine the role of hormones and enzymes in disease. [5]*

CO5: Students will able to do estimation of chemical molecules and will know disease process at molecular level.[6]

CO6: Student will able to apply methods to identify abnormal function at earlier stage of diseases and it is also useful for prognostic purpose. .[6]

***Note: According to Bloom's Taxonomy- [1]: Remembering, [2]: Understanding, [3]: Applying, [4]: Analyzing, [5]: Evaluating, [6]: Creating**

CO No.	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12
CO1	3	3	2	1	0	0	0	0	0	0	0	0
CO2	3	3	2	2	1	0	1	2	0	0	0	2
CO3	3	3	2	1	1	1	0	1	0	0	0	1
CO4	3	3	3	2	2	1	0	3	0	0	0	1
CO5	3	3	1	1	2	1	1	2	0	0	0	1

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

Laboratory Sessions

Course Code	Title	Credits
UGMBCB 201	Clinical Biochemistry	2 Credit
	<p>A) Study of analytical instruments</p> <ul style="list-style-type: none"> • Centrifuges • pH meter • Colorimeter • Spectrophotometer • Preparation and Standardization of volumetric solutions <p>B) Estimations of Clinical importance</p> <ol style="list-style-type: none"> 1. Estimation of blood sugar 2. Estimation of urea and creatinine 3. Estimation of uric acid 4. Estimation of plasma proteins. albumin and A/G ratio 5. Estimation of bilirubin 6. Estimation of transaminases 7. Estimation of alkaline phosphatase 8. Estimation of amylase and lipase 9. Estimation cholesterol and types 10. Estimation of triglycerides 11. Estimation of calcium and inorganic phosphorus Estimation of electrolytes (sodium. potassium, chloride) 	

References:

1. Harpers Illustrated Biochemistry, Murrav et al, Lange
2. Textbook of Medical Laboratory Technology, Praful Godker
3. Handbook of Biochemistry, M.A. Siddique, Vijay Bhagat Scientific Book
4. Practical Clinical Biochemistry by Harold Varly

F. Y. B. Sc. NEP syllabus 2020

SEMESTER II

UGMBSEC201: FERMENTED FOOD TECHNOLOGY

Course Outcomes:

After successful completion of this course, students will be able

CO-1: To acquire knowledge about basic properties of Fermented food and its importance in the food industry.

CO-2: Know about various types of food products made using Fermentation technology.

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	3	-	-	-	-	-	-
CO2	3	-	-	-	-	3	-	-	-	-	-	-

***In CO-PO Mapping Matrix:** a correlation is established between COs and POs in the scale of 1 to 3, 1 being the slight (low), 2 being moderate (medium), 3 being substantial (high), and '-' indicate there is no correlation in respective CO and PO.

SEMESTER II	
Course Code	Title
UGMBSEC201	FERMENTED FOOD TECHNOLOGY
Unit I	Introduction to Food Fermentation
	Introduction to Food Fermentation 1. Classification of fermentation process - c. Lactic acid fermentation d. Alcoholic fermentation. 2. Importance of fermentation in food industry- a. Flavour b. Enhancement c. Nutritional value d. Preservation e. Antibiotic properties
Unit II	Fermented food products
	3. Fermented soy products- Soy sauce, fermented whole soy beans, fermented whole soy beans, fermented tofu, tempeh. 2. Fermented Vegetables- Chinese pickle, kimchi, sauerkraut. 3. Technology for Fermented cereal products- Idli, Dosa Batter, Bread, beer, Wine, Vinegar.

REFERENCE:

1. K.H. Steinkrus: Handbook of Indigenous Fermented Foods, Marcel Dekker, Inc
2. Sukumar De: Outlines of Dairy Technology, Oxford University Press, 1980
3. Prescott & Dunn Industrial Microbiology, CBS Publishers and Distributors, 2004
4. L.E. Casida Industrial Microbiology, John Wiley & Sons Canada, Limited, 1986