

**M.SC.,
BIOTECHNOLOGY**

SYLLABUS

AUGUST- 2023

**TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION,
CHENNAI – 600 005**

**Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credits
and Hours Distribution System
for all Post – Graduate Courses including Lab Hours**

First Year – Semester – I

Part	List of Courses	Credits	No. of Hours
	Core – I	4	5
	Core – II	4	5
	Core – III	4	5
	Elective – I	2	4
	Elective – II	2	3
	Practical-I	6	8
		20	30

Semester-II

Part	List of Courses	Credits	No. of Hours
	Core – IV	4	4
	Core – V	4	4
	Core – VI	4	4
	Elective –III	4	4
	Elective –IV	2	2
	Practical -II	2	2
	Skill enhancement Course-1	2	2
		22	30

METHODS OF EVALUATION		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments / Snap Test / Quiz	
	Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
Total		100 Marks
METHODS OF ASSESSMENT		
Remembering (K1)	<ul style="list-style-type: none"> • The lowest level of questions require students to recall information from the course content • Knowledge questions usually require students to identify information in the textbook. 	
Understanding (K2)	<ul style="list-style-type: none"> • Understanding of facts and ideas by comprehending or organizing, comparing, translating, interpolating and interpreting in their own words. • The questions go beyond simple recall and require students to combine data together 	
Application (K3)	<ul style="list-style-type: none"> • Students have to solve problems by using/applying a concept learned in the classroom. • Students must use their knowledge to determine an exact response. 	
Analyze (K4)	<ul style="list-style-type: none"> • Analyzing the question is one that asks the student to break down something into its component parts. • Analyzing requires students to identify reasons, causes or motives and reach conclusions or generalizations. 	
Evaluate (K5)	<ul style="list-style-type: none"> • Evaluation requires an individual to make judgment on something. • Questions to be asked to judge the value of an idea, a character, a work of art, or a solution to a problem. • Students are engaged in decision-making and problem-solving. • Evaluation questions do not have single right answers. 	
Create (K6)	<ul style="list-style-type: none"> • The questions of this category challenge students to get engaged in creative and original thinking. • Developing original ideas and problem-solving skills 	

Structure for Semester I & II

<i>Study Components</i>		<i>ins. hrs /week</i>	<i>Credit</i>	<i>Title of the Paper</i>
<i>Course Title</i>				
SEMESTER I				
	Core Course I	5	4	Biochemistry
	Core Course II	5	4	Cell and Molecular Biology
	Core Course III	5	4	Microbiology
	Elective I	4	2	A. Genetics B. Virology C. Basic Analytical Methods
	Elective-II	3	2	A. ENZYME TECHNOLOGY B. DAIRY TECHNOLOGY C. PHARMACETICAL TECHNOLOGY
	Practical-I	8	4	Practical 1-Lab in Biochemistry and Cell & Molecular Biology & Microbiology
		30	20	
SEMESTER II				
	Core IV	5	4	Immunology
	Core V	5	4	Genetic Engineering
	Core VI	5	4	Developmental and Stem cell Biology

	ELECTIVE - IV		4	2	A. Medical Laboratory Technology B. Food and Nutrition C. Biodiversity
	Elective - III		3	2	A. GENOMICS & PROTEOMICS B. Environmental Sciences C. Herbal Biotechnology
	Practical-II		6	4	Practical –II- Lab in Immunology & Genetic Engineering
	Skill Enhancement Course [SEC] - I		2	2	A. Mushroom Cultivation and Apiculture B. Vermiculture Technology C. Validation of Medicinal Plants
			30	22	

SEMESTER -1**PAPER 1: BIOCHEMISTRY****Paper code:
Biochemistry****Subject:****Hours/Week:5****Credits: 4**

Aim: To enable the students to understand the basic concepts of biochemistry and biomolecules and also to learn the various metabolic cycles and also to analyze the significance of biochemical findings

Course Objectives

1. To learn the physical and chemical nature of Biomolecules
2. To learn various types of biomolecules
3. To develop knowledge on intermediary metabolism of CHO, Proteins, and Lipids
4. To teach the basics and advance of enzymes and their classifications
5. To develop a piece of knowledge in clinical biochemistry.

Course Out Comes

1. After studied unit 1, the students will be able to identify the nature of solvents and solutions concerning pH and its important
2. After studied unit 2, the students will be able to classify carbohydrates, proteins lipids, and nucleic acids of biomolecules
3. After studied unit 3, the students will be able to describe the biomolecules involved in intermediary metabolism
4. After studied unit 4, the students will be able to explain enzymes and enzyme kinetics
5. After studied unit 5, the students will be able to apply Biochemistry, in clinical biochemistry procedures.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Basic Concepts: Units of measurements of solutes in solution, e.g. Normality, Molality, Molarity. The hyper and hypotonic solution, pH, pK, acids, bases, ionic bonds, covalent bonds, and secondary bonds (hydrogen bonds and Vander Waal" bonds)	12 hours
Unit-II	Biomolecules: Definitions, nomenclature, classification, structure, chemistry, and properties of carbohydrates, Definitions, nomenclature, classification, structure, chemistry, and properties of amino acids and proteins (hemoglobin, myoglobin, and plasma proteins), lipids and Nucleic acids,	12 hours
Unit-III	Metabolism: Metabolism of Carbohydrates, EMP, TCA, HMP. Glycogen metabolism, Gluconeogenesis. Amino Acids-Transamination, Deamination, Urea cycle. Lipids and Nucleic Acids-Their Biosynthesis. Mechanism of Oxidative Phosphorylation and Its Inhibitors, Uncouplers, Photophosphorylation	12 hours
Unit-IV	Enzymology: Enzymes: general aspects (classifications and structure). The allosteric mechanism, regulatory and active sites, and active energy. Iso-enzymes. Enzyme kinetics (MM, LB plot, Km) and hormones.	12 hours
Unit-V	Clinical biochemistry: Blood sugar level, Factors controlling blood sugar level – hypo, hyperglycemia, Diabetes mellitus, types – GTT. Metabolism of bilirubin- jaundice-types. Differential diagnosis and liver function tests. Renal functional test and gastric function test.	12 hours
Unit-VI	Internal Assessments, Seminars, and Guest lecture	05 hours
Total Teaching hours		65

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Textbook:

1. J.L. Jain, S. Jain and N. Jain. Fundamentals of Biochemistry. S. Chand & Co, 2016.
2. Ambika Shanmugam. Biochemistry. Published by Wolters Kluwer, 8th Edition, 2016.
3. A.C. Deb. Fundamental of Biochemistry. New Central Book Agency, 2012
4. Biochemistry ,7th Edition, jermy M.Berg John,L .Tymoczko,Lubertstryer 2012.W.H,freeman & company ,newYork 2.
5. Molecular Bio methods handbook,2nd edition R.Rapley & J.M Walker,2 008, Humanapress.
6. Principles of Biochmeistry , 5th Edition AL. Lehninger ,D.L. Nelson and M.M Cox ., 2008.worth publishers , NewYork.
7. Biochemistry 4THEdition,G.Zubay,1998.Mc Millan publishing Co.NewYork.
 1. Harper''s Biochemistry,29th Edition-Rober K.Murray,Daryl K.Grammer,2012 McGrawHill, lange Medical Books
2. Understanding enzymes -5theditionTrevorpalmer,Prentice Hall/Ellias Horwood1995
 3. Text Book Medical Biochemistry M.N.Chatterjee 8th edition Jaypee brothers Medicalpublishers2013

Reference Book:

1. D.L. Nelson and M.M. Cox. Lehninger Principles of Biochemistry, WH FreemanPublishers, 7th Edition, 2017.
2. V.W. Rodwell, D.A. Bender, K.M. Botham, P.J. Kennell and P.A. Weil. Harper's Illustrated Biochemistry, 30th Edition. McGraw Hill, 2015.
3. Wilson and Walker. Principles and Techniques of Practical Biochemsity, 6th edition, Cambridge University, Press. 2005.
4. Upadhyaya A Upadhyaya K and Nath. Biophysical Chemistry: Principles and Techniques, 3rd Edition. Himalayan publications, 2009.
5. M.N. Chatterjee and Rana Shinde, Textbook of Medical Biochemistry, 8th Edition. Jaypee Brothers Medical Publishers (P) Ltd., 2012.
6. Biochemistry – 4th edition Donald voet and Judith G.Voet ,VP Publishers 2011 steitz and A.M.Weiner ,The Benjamin /CUMMINGS publ.Co.,Inc.,California,2013
7. Genes VI(9th Ed).Benjamin Lewin, oxford universitypress,uk.,2007 10. Molecular biology of cell (5th edition) brucealberts,alexanderjohnson,Julianlewis,martinraff,keithRoberts,peterwalter ,garland sciencepublications.2008
8. Molecular Biology (5th edition).weaver .R.F,McGraw Hillpublications,2011. Cell and molecular biology : concepts and experiments (5th edition).geraldkarp,wiley publications,2013

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites, etc.]
<https://nptel.ac.in/courses/104105076>, <https://oli.cmu.edu/courses/biochemistry-open-free/>,
https://onlinecourses.nptel.ac.in/noc20_cv10/preview,

E-Books: <https://www.pdfdrive.com/biochemistry-books.html>,

E-journals: Process Biochemistry (Elsevier), Journal of Cellular Biochemistry (Wiley)

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	S	S	S	M	M	M
CO4	S	S	S	M	M	M	S	S	M	S
CO5	M	M	M	S	M	S	M	M	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

PAPER 2: CELL AND MOLECULAR BIOLOGY

Credits: 4

**Hours of teaching: 5
Theory**

Paper type: Core

Overall Course Objectives: Understanding the structural and functional aspects of the cell provides the students with a strong foundation in the molecular mechanism underlying cellular functions.

Course objectives :

1. To understand the basic concepts of the prokaryotic and eukaryotic cells.
2. To Understand the individual and coordinated functions of various cell organelles.
3. To familiarize the student with various aspects of cell and molecular biology streams including cellular organization and their interactions in DNA replication, protein biosynthesis, and translational regulation
4. To develop a comprehensive understanding of the complete cellular and molecular function of cell organelles in terms of cell-to-cell interaction, gene regulation, cellular signaling
5. To impart the molecular biology knowledge in applications of various human health care

Course Outcomes

1. After studied unit-1, the student will be able to equip with a basic knowledge of the structural and functional properties of cells.
2. After studied unit-2, the student will be able to understand process of cell division and replication process.
3. After studied unit-3, the student will be able to understand the occurrence of central dogma of life in the cell and the machineries involved to initiate and inhibit RNA and protein synthesis.
4. After studied unit-4, the student will be able to control of gene expressions in prokaryotes and eukaryotes and transposable elements.
5. After studied unit-5, the student will be able to understand mechanism of epigenetic controls and cancer biology.

Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	No	Yes	No	Yes	Yes	Yes
4	No	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I	Cell Biology: Structure and function of cells in prokaryotes and eukaryotes; Structure and organization of Membrane - Membrane Model, active and passive, transport channels and pumps., Structure & Biogenesis of Mitochondria and Chloroplast. Structure of Endoplasmic reticulum, Golgi complex, lysosomes.	12 hours
UNIT-II	Cell division: Mitosis, Meiosis, regulation of cell cycle; factors regulating cell cycle. Nucleic acid structure, Genome Organization. DNA replication: Enzymes and mechanisms of DNA replication in prokaryotes and eukaryotes, Telomeres, telomerase and end replication. Role of telomerase in aging and cancer. DNA replication models DNA damage, Mutations, DNA repair and recombination.	12 hours
UNIT – III	Transcription: Basic mechanism in prokaryotes and eukaryotes. RNA polymerase, Reverse transcriptase and regulation. Post- transcriptional processing: 5'-Cap formation; 3'-end processing and polyadenylation; splicing: RNA editing; Nuclear export of mRNA; mRNA stability. Translation-Prokaryotic and eukaryotic translation, the translation machinery, Mechanisms of initiation, elongation and termination, Regulation of translation, co-and post-translational modifications of proteins and localization.	12 hours
UNIT – IV	Gene regulation: Prokaryotic gene regulation- Operon concept ; Lac operon and tryptophan operon. Eukaryotic gene regulation: Chromatin Structure, Regulation at transcriptional Level: DNA binding domains of the regulatory proteins. Biochemistry and applications of ribozyme technologies. Transposable genetic elements	12 hours
UNIT-V	Epigenetics: Epigenetic regulation of gene expression, Modifications, Cancer Epigenetics. Cancer Biology: Viral and cellular oncogenes; Tumor suppressor genes - Structure, function and mechanism of action of pRB and p53, p21, BRACA1. Oncogenes as transcriptional activators.	12 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lectures	5 hours
Total Lecture hours 65 hours		65 hours

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text Books

Molecular cell Biology, by Darnell, Lodish, Baltimore, Scientific American Books, Inc., 1994.

Molecular and cellular Biology, Stephen L. Wolfe, Wadsworth Publishing Company, 1993.

Cell and Molecular Biology: Concepts and Experiments 5th Ed, Gerald Karp. Wiley publications, 2013.

1. Cell biology D E Sadava CBS Publishers & Distributors, 2009

2. Reference books

3. Molecular and cellular Biology, Stephen L. Wolfe, Wadsworth Publishing Company, 1993
4. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford, 1991
5. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford, 1991.
6. Molecular Biology of the Gene (4th Edition), J.D. Watson, N.H. Hopkins, J.W. Roberts,
7. J.A. Steitz and A.M. Weiner, The Benjamin/Cummings Publ. Co., Inc., California, 1987.
8. Genes VI (6th Edition) Benjamin Lewin, Oxford University Press, U.K., 1998
9. Molecular biology of cell – Albert Bruce et al., 1994 3rd Ed
10. Molecular Biology-Weaver. R. F. 3rd ed. Mc Graw Hill publication, 2005
11. The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication. 2002

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites, etc.]

1. Swayam- Molecular biology course by Dr. Nayan K. Jain, Gujarat University
2. Swayam- Cell Biology by Dr K. Sanatombi
3. NPTEL - Molecular Cell Biology by Prof. D. Karunakaran
4. <https://www.coursera.org/courses?query=molecular%20biology>
5. <https://www.cdc.gov/labtraining/training-courses/basic-molecular-biology/index.html>

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	S	S	S	M	S	S	S	S	M
CO2	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	M	S	S	S
CO4	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M

PO – Programme Outcome, CO – Course outcome S – Strong, = 3, M – Medium, L – Low (may be avoided)

PAPER 3: MICROBIOLOGY

Paper Code:
Microbiology Hours/Week: 5

Subject:

Credits: 4

Aim: Studying the diversity and activity of microorganisms in their natural environment, their mutual interactions, and their survival and adaptation strategies.

Course Objectives

1. To understand the History of Microbiology.
2. To well understand the Nutritional classification of bacteria, etc.
3. To obtain knowledge about Sterilization and Disinfection.
4. To obtain knowledge of Microbial diversity.
5. To know the basic Microbial community in natural habitats.

Course Out Comes

1. After studying unit 1 the students will be able to identify the Classification of microorganisms practical's.
2. After studying unit 2 the students will be able to identify and differentiate the pure culture technique.
3. After studying unit 3 the students will be able to identify and describe the chemotherapeutic agent
4. After studying unit 4 the students will be able to identify and explain enzymes and their regulations by kinetic parameters
5. After studying unit 5 the students will be able to identify and cross-examine the Biotechnological applications of Extremophiles

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	No	No
3	No	Yes	No	Yes	Yes	Yes
4	No	No	Yes	Yes	Yes	Yes
5	Yes	Yes	No	Yes	Yes	Yes

Units	Course Contents	Teaching Hours
Unit-I	History of Microbiology - Classification of microorganism – Kingdom - Protista, Prokaryotic and eukaryotic microorganisms, Five kingdom concept of classification, Archaeobacteria, Eubacteria, and eukaryotes. Microscope - Light field, Dark field, Fluorescent and Electron microscope, Prokaryotic and Eukaryotic cell structure. Staining techniques - Simple and Differential staining.	12 hours
Unit-II	Nutritional classification of bacteria, Isolation, cultivation, enumeration, and preservation of microbes; Culture media and its types - Pure culture technique - Growth curve; Axenic culture, Synchronous culture, Continuous culture; Effect of physical and chemical factors on microbial growth.	12 hours
Unit-III	Sterilization and Disinfection: Moist heat, Dry heat, Radiation, Filtration, Phenols, Halogens, Phenol coefficient method. Antibiotics - Inhibitors of Nucleic acid, protein, and cell wall synthesis. Chemotherapeutic agents - Antimicrobial susceptibility test.	12 hours
Unit-IV	Microbial diversity- methods to assess microbial diversity, Culture dependent, and culture-independent methods. Molecular analysis of bacterial community; Denaturing Gradient Gel Electrophoresis (DGGE), Terminal Restriction Fragment Length (TRFL) Polymorphism (T- RFLP), Amplified Ribosomal DNA and Restriction Analysis(ARDRA).	12 hours
Unit-V	Microbial community in natural habitats – air, water, soil, food, and milk. Food and milk-borne diseases, Extremophiles-habitant & Classification, Halophiles, Thermophiles, Alkaliphiles, Acidophiles, Biotechnological applications of Extremophiles.	12 hours
Unit-VI	Internal Assessments, Seminars, and Guest Lectures	05 hours
	Total Teaching hours	65

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text book:

1. Microbiology 3rd Edition by Dave Wessner (Author), Christine Dupont (Author), TrevorCharles (Author), Josh Neufeld (Author) 3rd edition (December 3, 2020)

2. Fundamentals of Microbiology 12th Edition by [Jeffrey C. Pommerville](#) (Author) 12th edition (March 29, 2021)
3. Burton's Microbiology for the Health Sciences 11th Edition by [Paul G. Engelkirk](#) (Author) 11th edition (October 10, 2018)
4. Brock Biology of Microorganisms plus Pearson Mastering Microbiology with Pearson eText, Global Edition 15th Edition 15th edition (March 27, 2018)
5. Microbiology: An Evolving Science Fifth Edition by [Joan L. Slonczewski](#) (Author), [John W. Foster](#) (Author), [Erik R. Zinser](#) (Author) Fifth edition (July 1, 2020)
6. Microbiology with Diseases by Taxonomy, Loose-Leaf Plus Mastering Microbiology with Pearson eText -- Access Card Package (6th Edition) 6th Edition 6th edition (January 14, 2019)

Reference Book:

1. Medical Microbiology: A Guide to Microbial Infections: Pathogenesis, Immunity, Laboratory Diagnosis and Control. With STUDENT CONSULT Online Access (Greenwood,Medical Microbiology) 17th Edition by [David Greenwood BSc PhD DSc FRCPath](#) (Author), [Richard C. B. Slack MA MB BChir FFPHM MRCPath DRCOG](#) (Author), [John F. Peutherer BSc MB ChB MD FRCPath FRCPE](#) (Author), & 1 more Churchill Livingstone; 17th edition (June 6, 2007)
2. Microbiology Experiments: A Health Science Perspective Paperback – International Edition, January 1, 2018MC GRAW HILL; 9th edition (January 1, 2018)
3. Hugo and Russell's Pharmaceutical Microbiology, 8th Edition 8th Editionby [Denyer](#) (Author) Wiley-Blackwell; 8th edition (August 12, 2011)
4. Clinical Bacteriology Hardcover – August 1, 1980 by [E Joan Stokes E Arnold](#); Fifth Edition (August 1, 1980)
5. Review of Medical Microbiology and Immunology (Medical Microbiology & Immunology (Levinson)) 9th Edition (March 10, 2006)

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	M	S	S	M	M	M
CO4	S	M	S	M	M	S	S	S	M	S
CO5	M	M	M	S	M	S	M	M	S	M

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low (may be avoided)

ELECTIVE 1 (A) GENETICS

Subject: Genetics

Hours/Week: 4

Credits: 2

Aim: To enable us to explore many different components of living systems and the advent of proteomics will made it possible to identify a broad spectrum of proteins in living systems. This elective subject will help to understand basic principles and applications in genomics and proteomics.

Course objectives:

1. To provide the basic knowledge of genetics in higher eukaryotic domains and over all concepts of Mendelian genetics.
2. To understand about genetic inheritance and linkages
3. To provide the basic concept sex determination
4. To understand about genetic code, mutation and regulations
5. To Enrich the students' knowledge with respect to genetic engineering, transgenesis and ethics

Course Out Comes (five outcomes for each units should be mentioned)

1. After studied unit-1, the student will be able to know about Mendelian laws.
2. After studied unit-2, the student will be able to understand how gene inherited
3. After studied unit-3, the student will be able to understand about sex determination.
4. After studied unit-4, the student will be able to gene regulations.
5. After studied unit-5, the student will be able to know about ethics and transgenesis.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	No	No
5	Yes	Yes	Yes	No	Yes	Yes

UNIT I	History of Genetics: Definition and scope of Genetics- Pre- mendelian genetic concepts. Basis of Mendelian Inheritance and Mendelian genetics. Chromosome theory of linkage, crossing over, recombinations and mapping of genes on chromosomes	12 hours
UNIT-II	Blood Groups and their Inheritance in Human – Linkage and Crossing Over:- Drosophila – Morgans“ Experiments – Complete and Incomplete Linkage, Linkage Groups, Crossing Over types, Mechanisms – Cytological Evidence for Crossing Over, Mapping of Chromosomes – Interference and Coincidence.	8 hours
UNIT – III	Sex Linkage in Drosophila and Man, Sex influenced and Sex Limited Genes – Non- Disjunction and Gynandromorphs – Cytoplasmic Inheritance – Meternal Effect on Limnaea(Shell Coiling), Male Sterility (Rode“s Experiment)	9 hours
UNIT – IV	Nature and Function of Genetic Material – Genetic code – Why the genetic code is comma less, non ambiguous, degenerate triplet code. Fine Structure of the Gene .Gene Regulation – Operon Concept – Lac Operon – Positive and Negative Regulation. Mutation – Molecular Basis of Mutation, Types of Mutation, Mutagens, Mutable and Mutator Genes. Chromosomal Aberrations – Numerical and Structural Examples from Human.	8 hours
UNIT-V	Genetic engineering – Objectives, tools, gene cloning, and gene isolation. Transgenic plants and animals, Animal Breeding – Heterosis, Inbreeding, Out Breeding, Out Crossing, Hybrid Vigour. Population Genetics- Hardy Weinberg Law – Gene Frequency, Factors Affecting Gene Frequency, Eugenics, Euphenics and Ethenics, Bioethics.	8 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
	Total Lecture hours 65 hours	50 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text Books

1. Gardner et al (1991). Principles of Genetics. John Wiley.
2. Hartl. D.L. A primer of population genetics. III edition, Sinauer associates inc. Sunderland, 2000
3. Human genetics, A. Gardner, R. T. Howell and T. Davies, Published by Vinod Vasishtha for Viva Books private limited, 2008.
4. The science of Genetics by Alan G. Atherly, Jack. R, Girton, Jhon. F, Mc Donald. Sounderscollege publishers.

Reference Books

1. Strachan and Read (2003). Human Molecular Genetics. Wiley.
2. Pasternak (2005). An Introduction to Molecular Human Genetics. Fritzgarald.
3. Prichard & Korf (2004). Medical Genetics at a Glance. Blackwell.
4. Manu L Lothari, Lopa A Mehta, Sadhana S Roy Choudhury (2009). Essential of Human Genetics (Universities Press India Ltd) Publishing.

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. <https://www.classcentral.com/course/swayam-genetics-and-genomics-17623>
2. <https://nptel.ac.in/courses/102/104/102104052/>
3. <https://www.coursera.org/learn/genetics-evolution>

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	S	S	S	M	S	S	S	S	M
CO2	S	S	M	S	S	S	S	M	S
CO3	S	S	S	S	S	M	S	S	S
CO4	S	M	S	S	M	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low (may be avoided)

ELECTIVE 1: (B) VIROLOGY

Subject: Virology

Hours/Week: 4

Credit: 2

Aim: To understand the biology of viruses, pathogenesis, clinical features, epidemiology, and prophylaxis of dreadful viral infections in susceptible hosts.

Course Objectives

1. Contrast differences in virus architecture and classification.
2. To understand the viral diagnostic and detection methods.
3. Distinguish characteristics of normal cells and virus-infected cells.
4. Explain and apply methods used in research and diagnosis of viral diseases.
5. Describe cellular and therapeutic antiviral strategies and social stigmas against infected individuals.

Course Outcomes (five outcomes for each unit should be mentioned)

1. After studied unit-1, the student will be able to—describe and review the General Virology and cultivation of viruses
2. After studied unit-2, the student will be able to –know the Viral diagnostic and detection methods
3. After studied unit-3, the student will be able to - explain viral replication strategies; and compare and contrast replication mechanisms used by viruses relevant to human disease
4. After studied unit-4, the student will be able to - discuss principles of virus pathogenesis
5. After studied unit-5, the student will be able to - explain host antiviral immune mechanisms at a cellular and molecular level and vaccine strategies and mechanisms of antiviral drugs

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	No	No	No	No
2	Yes	Yes	No	No	No	No
3	Yes	Yes	No	No	No	No
4	Yes	Yes	No	No	No	No
5	Yes	Yes	No	No	No	No

Units	Course Contents	Teaching hours
Unit I	General Virology: Structure of viruses: Enveloped and non-enveloped viruses, Capsid symmetries-icosahedral, polyhedral and helical, structural proteins- matrix proteins and lipoproteins, viral genomic organization and replication- types of nucleic acids, protein-nucleic-acid interactions and genome packaging, Virus related structures-viroids and prions. Cultivation of viruses: In vivo, Ex vivo/In vitro. Cytopathic effect-pock forming unit.	10 hours
Unit-II	Viral diagnostic and detection methods: Sample processing-enrichment and concentration, Direct methods of detection-light microscopy (inclusion bodies), electron microscopy, Immuno diagnosis, hemagglutination, Complement fixation, neutralization, Western blot, Radioactive Immuno precipitation Assay (RIPA), Flow Cytometry and Immuno histochemistry. Nucleic acid-based diagnosis: Nucleic acid hybridization, PCR, microarray and nucleotide sequencing, LINE probe assay.	08 hours
Unit-III	Bacterio phages and plant viruses: Bacterio phage: Morphology, genome organization, classification-Lifecycle-Lytic and Lysogenic Cycle, Head and tail phages-T4 phage- phage-Filamentous Bacteriophages-174-M13, phage therapy for control of bacterial poultry diseases. Viral Disease in Plants: Histological, physiological and cytological changes in infected plants, Behavior of viruses in plants, Methods for detection of plant viruses, Transmission of plant viruses through vectors-insects, nematodes and fungi.	13 hours
Unit-IV	Clinical virology: Pathogenesis, clinical symptoms, epidemiology and prophylaxis of DNA Viruses-pox virus, Herpes Virus, Adenovirus, Hepatitis Virus. RNA Viruses- Picorna Virus, Orthomyxo Virus, Rabies Virus, HIV. Oncogenic viruses; Virus-induced cell transformation and oncogenesis, Mechanism of cell transformation by tumor viruses, Retrovirus mediated oncogenesis.	08 hours
Unit-V	Viral vaccines and anti-viral drugs: Viral vaccines, conventional vaccines-killed and attenuated, Modern vaccines-DNA vaccines, recombinant DNA/protein vaccines, subunits vaccines, peptide vaccines, anti-idio type vaccines, edible vaccines, immuno modulators (cytokines), adjuvants to increase immunogenicity of vaccines. Antivirals: Interferons, 21 designing and screening for antivirals, mechanisms of action, anti retrovirals-mechanism of action and drug resistance.	05 hours
Unit-VI	Internal Assessments, Seminars, and Guest lecture	5 hours
	Total Teaching hours	50

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference & Text Books:

1. Virology principles and application John Carter and Venetia Saunders (2007) John Wiley and Sons publishers.
2. Principles of Virology 4th edition Jane Flint.
3. Real –Time PCR: Current technology and applications 1st edition (2009) edited by Julie Logan *et al.*,
4. Analytical techniques in DNA sequencing edited by Brian K. Nunnally
5. Medical Microbiology: with student consult by Patrick R. Murray Ph.D. (Author), Ken S. Rosenthal PhD Saunders; 7th edition.
6. Antiviral Agents, Vaccines and Immunotherapies. Stephen K. Tryng. October 2004. Marcel Dekker.

Course Material:

1. International Congress on Taxonomy of Viruses ;<http://WWW.ncbi.nlm.nih.gov/ICTV>
2. Knipe David M.,PeterM.Howley, Diane E.Griffin,Rober t A.Lamb,Malcolm A. Martin,BernardRoizman, Stephen E .Straus,(2007),Field’s Virology, 5th Ed. LippincottWilliams &Wilkins
3. Cann Alan j, (2000),DNA virus Replication, Oxford University press
4. <https://www.yourgenome.org/facts/what-is-PCR-polymerase-chain-reaction>.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low (may be avoided)

ELECTIVE 1: (C) BASIC ANALYTICAL METHODS

Subject: Basic Analytical Methods (Core Elective)

Hours/Week: 4

Credits: 2

Aim: To provide knowledge of various analytical techniques in biological research
Course Objectives

1. To learn the principles of the various analytical instrument.
2. To teach the SOP of analytical instruments.
3. To study the different chromatography separation methodologies
4. To study different electrophoresis isolation methodologies
5. To learn advanced microscopic methods in image processing

Course Outcomes:

1. After studied unit 1 the students will be able to know the significance of instruments concerning diagnostic procedures.
2. After studied unit 2 the students will be able to handle qualitative and quantitative chromatographic techniques
3. After studied unit 3 the students will be able to handle centrifugation and separate samples for further practical's/research
4. After studied unit 4 the students will be able to handle different qualitative and quantitative electrophoresis techniques
5. After studied unit 5 the students will be able to handle microscopes and validate microscopic images.

Matching Table (Put Yes / No in the appropriate box)

Unit/	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	No	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	Electrochemical techniques- basic principles- The pH electrode- Ion-selective gas- sensing and oxygen electrodes. Elementary details of biosensors. Beer- Lambert law, light absorption, and its transmittance. Basic principles & brief outline of instrumentation of UV- Visible Spectroscopy: Infrared Spectroscopy. NMR. Mass spectrometry. Spectrofluorometric, Flame photometry, Atomic absorption spectrophotometry– Principles, instrumentation, and applications	10 hours
Unit-II	Introduction & classification of chromatography. Theory, instrumentation & applications of Column chromatography, TLC, Paper chromatography, GC, HPTLC, HPLC - detection methods, and systems qualitative and quantitative aspects applications	08 hours
Unit-III	Centrifugation- basic principles-instrumentation-centrifugation units. Nature of particles centrifugation methods and accessories. Sedimentation velocity- sedimentation equilibrium-cell fractionation method. Differential, density gradient, isopycnic, and equilibrium centrifugation. Preparative and analytical ultracentrifugation techniques. Isoelectric focusing, blotting methods, western-southern and northern- application- methods in life sciences and biotechnology.	13 hours
Unit-IV	General principles. Factors affecting the migration rate – sample, electric field, buffer, and supporting medium. Tiselius moving boundary electrophoresis. PAGE. SDS– PAGE. Pulse-field gel electrophoresis. Cellulose acetate membrane electrophoresis. Agarose gel electrophoresis	08 hours
Unit-V	Radio isotopic techniques: Introduction to radioisotopes, Detection. Measurement and uses of radioisotopes, Counting efficiency and autoradiography. Principles of microscopy, Fluorescent, Transmission and Scanning electron microscopy, confocal microscopy. Biotechnological applications Microscopy. Microtome analysis and measurement of images	05 hours
Unit-VI	Internal Assessments, Seminars, and Guest lecture	5 hours
Total Teaching hours		50

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Textbook:

1. Keith Wilson, John M Walker. Principles and techniques of biochemistry and molecularbiology. Cambridge University Press. 7th edition, 2017.
2. Shawney. Practical Biochemistry. Narosa Publishing, 1995.
3. Upadhyaya A Upadhyaya K and Nath. Biophysical Chemistry: Principles and Techniques, 3rd Edition. Himalayan publications, 2009.
4. D. Frifelder and M. Malacinski. Essentials of Molecular Biology, Jones & Bartlett, 5th Edition, 2015.
5. R.D. Braun. Introduction to Instrumental Analysis. Pharma Book Syndicate, 2006.
6. Chatwal and Anand. Instrumental Methods of Analysis. 5th Edition, Himalayan publication, 2007.
7. Jag Mohan. Organic Spectroscopy, Principles and Application. Narosa Publishing House, 2nd Edition, 2007.

Reference Book:

1. Principles and Techniques of Practical Biochemistry (Paperback) by Keith Wilson (Editor), John Walker (Editor), John M. Walker (Author) “ Fifth Edition 2000
2. Introductory Practical Biochemistry (Hardcover).by S. K. Sawhney; Randhir Singh (Editor) 2005
3. Principles of Physical Biochemistry (2nd Edition) by Kensal E van Holde, Curtis Johnson, and Pui Shing Ho (Hardcover – April 16, 2005)
4. Physical Biochemistry: Applications to Biochemistry and Molecular Biology by David M. Freifelder (Paperback – Aug 15, 1982)
5. Instrumental Methods of Chemical Analysis by G R Chatwal and S K Anand (Hardcover – Jun 1980).

Course Material:

Website links: [https://www.edx.org/course/basic-analytical-chemistry,](https://www.edx.org/course/basic-analytical-chemistry)

E-Books: <http://shvaiko.ru/wp-content/uploads/2010/02/Analytical-Techniques-Julia-C.-Drees-Alan-H.-B.-Wu.pdf> tml,

[https://www.uvm.edu/~gpetrucc/courses/chem196/Textbooks/Manahan%20-](https://www.uvm.edu/~gpetrucc/courses/chem196/Textbooks/Manahan%20-%20Fundamentals%20of%20Environmental%20Chemistry/1491Ch25.pdf)

[%20Fundamentals%20of%20Environmental%20Chemistry/1491Ch25.pdf](https://www.uvm.edu/~gpetrucc/courses/chem196/Textbooks/Manahan%20-%20Fundamentals%20of%20Environmental%20Chemistry/1491Ch25.pdf), E- journals:

[https://onlinelibrary.wiley.com/series/8247,](https://onlinelibrary.wiley.com/series/8247)

https://link.springer.com/chapter/10.1007/978-3-642-75490-6_15, Mapping with Programme

Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	M	S	M	S	S
CO2	M	S	M	M	M	S	S	S	M	M
CO3	S	M	M	S	S	M	M	S	M	S
CO4	M	S	S	M	M	S	M	M	S	S
CO5	S	M	S	M	S	M	S	M	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

ELECTIVE II : (A) ENZYME TECHNOLOGY

Paper type: Enzyme

Technology

Hours of teaching: 3

Credits: 2

Aim: To provide knowledge of various enzymes and enzyme technology applied in the industries.

Course objectives :

1. To Learn about the classification and structure properties of enzymes
2. To Understand the kinetics, catalysis and inhibitions activities of enzymes
3. To understand physical properties, downstream process and purification of enzymes.
4. To Expedite how enzymes are used as co-factors.
5. To Enrich the students' knowledge with respect to different applications of Enzymes

Course Out Comes (five outcomes for each units should be mentioned)

6. After studied unit-1, the student will be able to know about basic knowledge of enzymes
7. After studied unit-2, the student will be able to understand mechanism of enzyme activities
8. After studied unit-3, the student will be able to understand physical properties of enzyme.
9. After studied unit-4, the student will be able to function of enzyme in different processes.
10. After studied unit-5, the student will be able to know various application of enzyme technologies.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	No	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	No	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I	Introduction to enzymes: History of enzymes, nomenclature and classification of enzymes. Structural features of Enzymes: Chemical nature of Enzymes: amino acids, protein structure: Primary, secondary, tertiary and quaternary structure. Specificity of Enzymes: Types of specificity, the Koshland "induced fit" hypothesis, strain or transition-state stabilization hypothesis.	10 hours
UNIT-II	Enzyme Catalysis and Kinetics: Factors affecting the rate of chemical reactions, kinetics of uncatalyzed chemical reactions, kinetics of enzyme-catalyzed reaction, methods for investigating the kinetics of enzyme-catalyzed reaction, nature of enzyme catalysis, inhibition of enzyme activity.	8 hours
UNIT – III	Extraction and purification of microbial enzymes : Importance of enzyme purification, different sources of enzymes. Extracellular and intracellular enzymes. Physical and Chemical methods used for cell disintegration. Enzyme fractionation by precipitation(using Temperature ,salt, solvent pH, etc.),liquid-liquid extraction, ionic exchange, gel chromatography, affinity chromatography and other special purification methods, Enzyme crystallization techniques. Criteria of purity of enzymes. Pitfalls in working with pure enzymes.	12 hours
UNIT – IV	Enzymes inhibition and Co-factors: Irreversible, reversible, competitive, non-competitive and un-competitive inhibition with suitable examples and their kinetic studies. Allosteric inhibition ,types of allosteric inhibition and their significance in metabolic regulation & their kinetic study Vitamins and their co-enzymes: Structure and functions with suitable examples ,Metallo enzymes and Metal ions as co-factors and enzymes activators.	9 hours
UNIT-V	Immobilization of microbial enzymes and Enzyme Engineering: Methods viz. adsorption, covalent bonding ,entrapment& membrane confinement and their analytical, therapeutic & industrial applications. Applications of microbial enzymes: Microbial enzymes in textile ,leather, wood industries and detergents. Enzymes in clinical diagnostics. Enzyme sensors for clinical processes and environmental analyses. Enzymes as therapeutic agents.	9 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
	Total Lecture hours	50hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text Book(s)

1. Introduction to proteins Structure by Branden and Tooze (1998): Garland Publishing Group.
2. Biotechnology . Volume 7 A- Enzymes in Biotechnology. 1983 Edited by H.J.Rehm and G.Reed. Verlag Chemie.
3. Methods of Enzymatic analysis by Hans Ulrich, Bergmeyer, Academic Press.
4. Methods in Enzymology by W.A.Wood, Academic Press.
5. Topics in Enzyme and Fermentation Biotechnology by L.N. Wiseman ,John Wiley and sons.

References Books

1. Enzymes by palmer(2001): Horwood publishing series.
2. Fundamentals of Enzymology by price and Stevens (2002): Oxford University Press.
3. Enzyme Technology by Helmut Uling (1998): John Wiley.
4. Methods in Enzymology. Volume 22-Enzyme purification and related techniques. Edited by William B.Jakoby. Academic press, New York.
5. Allosteric Enzymes-Kinetic Behaviour. 1982. By B.I .Kurganov ,John Wiley and Sons. Inc., New York.
6. Enzymes as Drugs Edited by John S. Holcenberg and Joseph Roberts, John Wiley & sons New York.
7. Advances in Enzymology by Alton Meister, Interscience Publishers.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low

ELECTIVE II: (B) DAIRY TECHNOLOGY

Name of the Paper: Dairy Technology

Total Hours per Week: 3

Credits: 2

Aim: To impart current knowledge of basic and applied microbiological aspects of fluid milks and dairy products for improved quality and food safety.

Course objective:

1. To teach the microbial knowledge in milk
2. To learn the processing of milk microbiological methods
3. To understand how the milk products are in quality make through dairy industry
4. To made knowledge in differentiate the traditional and industrial make dairy products and its processing
5. To aware the students about milk borne diseases

Course outcome

1. After studied unit-1, the student will be able to know about basic knowledge of milk microbes and its changes in maintaining the storage of milk.
2. After studied unit-2, the student will be able to understand mechanism of processing of milk through microbiological methods
3. After studied unit-3, the student will be able to understand dairy products quality and its changes through microbes
4. After studied unit-4, the student will be able to differentiate dairy products in industry and homemade.
5. After studied unit-5, the student will be able to know various application of milk and milk borne microbial diseases.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	No	No
5	Yes	Yes	Yes	No	Yes	Yes

UNIT I	Common microbes in milk and their significance .sources of microbial contamination of raw milk in influencing quality of milk during production, collection, transformation and storage. Cleanmilk production and antimicrobial systems in raw milk. Microbial changes in raw milk during long storage. Microbiological grading of raw milk.	12 hours
UNIT-II	Microbiological processing techniques: bactofugation, thermization ,pasteurization, sterilization ,boiling ,UHT, non thermal processes and membrane filtration of milk role of psychrophilic mesophilic, thermophilic and thermoduric bacteria in spoilage of processed milks and prevention microbiological standards (BIS/PFA) of heat treated fluid milks.	12 hours
UNIT – III	Microbiological quality of dairy products; fat rich (cream and butter),frozen (ice cream),concentrated (evaporated and condensed milk),dried milks(roller and spray dried), infant dairy foods and legal standards. Factors affecting microbial quality of these products during processing, storage and distribution. Pro biotics and pre biotics(GRAS),cloning - sanitation, control of micro organisms in dairy processing	12 hours
UNIT – IV	Microbiology quality of traditional dairy products; heat desiccated (khoa, burfi, peda, kheer), acid coagulated (paneer, chhana,rasgulla), fermented (lassi, srikhand)and frozen (kulfi).sources of microbial contaminants and their role in spoilage. Importance of personnel and environmental hygiene on quality of traditional milk products. microbiological standards for indigenous dairy foods.	12 hours
UNIT-V	Milk-borne diseases – viral and bacterial, zoonotic infections ,pathogens associated with fluids milks, dairy products and their public health significance. sources of pathogens and their prevention .importance of bio flims, their role in transmission ofpathogens in dairy products and preventive strategies. regulatorycontrol of dairy products, testing of milk and milk products, treatment of dairy wastes.	12 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
	Total Lecture hours 65 hours	65 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text Books:

1. Adams MR and Moss MO.(1995).food microbiology, the royal society ofchemistry,Cambridge.
2. Andrews AT, Varley J(1994) biochemistry of milk products. Royal society ofchemistry.
3. BanwartGJ(1989),basic food microbiology, Chapman & hall, new York.
4. Frazier WC and Westhoff DC.(1988) food microbiology, TATA McGraw hill publishingcompany Ltd. NewDelhi.

References

1. Hobbs BC and Roberts D. (1993) food poisoning and food hygiene, EdwardArnold(adivision of Hodder and Stoughton),London.
2. May JM. (1987) modern food microbiology, CBS publishers and distributors, NewDelhi.
3. Robinson RK. 1990.the microbiology of milk. Elsevier applied Science.London
4. Edward Harth ,J.T.Steele. Applied dairy microbiology .1998. Marcel DeckerInc.
5. Modi, HA (2009) dairy microbiology pointer publishers, India. Marth, E.H and steel J. L(2001) applied Dairy microbiology, 2nd Edition, Marcel Dekker, Inc.270 MadisonAvenue,new York, New York10016.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low

ELECTIVE II : (C) PHARMACEUTICAL TECHNOLOGY

Total Hours per Week: 3

Credits: 2

Aim: To impart knowledge on the importance of drug during life span. To enlighten on the biotechnological modifications in drugs. To find mechanism of action of drugs used in therapy.

Course objectives

- 1 To learn drugs and its involved detoxification through phase 1 & 2 reactions
- 2 To teach drug mechanism like passive and active phases
- 3 To learn the drugs manufacture biotechnological pharmaceutical industry
- 4 To understand the importance of drugs in treating various metabolic disorders
- 5 To teach various applications of drugs in various fields.

Course out Comes (five outcomes for each units should be mentioned)

1. After studied unit-1, the student will be able to know about basic knowledge of drugs of phase I & II
2. After studied unit-2, the student will be able to understand drug mechanism and its adverse effects.
3. After studied unit-3, the student will be able to understand biotechnology in drug development, especially for AIDS
4. After studied unit-4, the student will be able to know drugs and its importance various treatment like diabetes, cancer, lipidemia and infertility
5. After studied unit-5, the student will be able to know various application of drug dependence and abuse-management

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	No	No
5	Yes	Yes	Yes	No	Yes	Yes

UNIT I	Drug- structural feature and pharmacology activity, pro drug concept. Absorption – first – pass effect .distributor , metabolism- phase I, II reactions, action of cyto chrome p450 & elimination of drug receptor-localization, type and subtypes, models and their drug- receptor interaction, against & antagonist .	10 hours
UNIT-II	Adverse response to drugs, drug tolerance, drug intolerance, Idio SYNERACY (pharmacogenesis), drug allergy. Tachyphylaxis, drug abuse, vaccination against infection	08 hours
UNIT – III	Biotechnology and pharmacy: genetically engineered protein and peptide agents. novel drug delivery systems – nonconventional routes of administration. Anti AIDS drug development, oncogenes target for drugs, multi- drugs resistance.	13 hours
UNIT – IV	Mechanism of action of drugs used in therapy of :respiratory system- cough, bronchial- asthma, pulmonary tuberculosis .GIT – digestents , appetite suppressants. hypolipidemia agents,, vomiting, constipation and peptic ulcer. antimicrobial drugs- sulfonamide s,trimethoprim, cotrimoxazole, penicillin and macrolides . amino glycosides, cephalosporin and bacterial resistance .Insulin and oral diabetic drugs, anti fertility and ovulation inducing drugs.	08 hours
UNIT-V	Drugs of plant origin: drug dependence and abuse- management of self poisoning cancer. Chemotherapy- cytotoxic drug. immuno suppressive drug therapy. New biological targets for drug development. Novel drug screening strategies.	08 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
	Total Lecture hours	50 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text Book:

1. The pharmacology Vol I and Vol II– Goodman and Gillman, Mc Graw Hillprofessional;12 ed (2010)
2. Basic pharmacology – Foxter cox bulter worth“s1980.
3. Pharmacology and pharmaco therapeutics – R.S.Satoskar. S.D.Bhandhhakar&S.S.Anilapure popular

PrakasharBombay.

Reference

- a. Principles of medical chemistry – William O. Foge. B.I. Waverks Pvt Ltd, NewDelhi.
- b. Oxford text books of clinical pharmacology and drug therapy.D.G.Burger's Medicalchemistry & drugdiscovery.
- c. Principles and practice – Manfred. E. Wolf John Wiley andsons.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low

Practical 1 : Lab In Biochemistry, Cell & Molecular Biology and Microbiology

1. Determination of Chl.a, Chl.b & total Chl. By Arnon method.
2. Estimation of Carbohydrates
3. Estimation of salivary amylase activity in relation to, substrate/pH/Temperature
4. Estimation of blood glucose & urea
5. Estimation of LDH.
6. Estimation of total serum proteins
7. Estimation of creatinine in urine.
8. Paper / thin layer chromatography

Cell and Molecular biology

9. Isolation of Genomic DNA from E.coli
10. Isolation of plasmid DNA from E.coli
12. Elution & quantification of DNA from agarose gel.
13. Preparation of competent cells and transformation
14. PCR
15. Isolation of Total RNA from bacteria
16. Synthesis of cDNA by Reverse transcription polymerase chain reaction

Microbiology

1. Sterilization techniques
2. Preparation of culture media(Selective and Enriched media)
3. Staining techniques- Simple, Differential, Negative staining and Motility studies
4. Determination of Bacterial growth curve
5. Enumeration of bacteria from environmental samples- soil, water, air and milk.
6. Pure culture techniques - Streak, pour plate and spread plate.
7. Biochemical tests for identification of bacteria (IMViC, TSI, Catalase, Oxidase)
8. Antimicrobial assay, phenol coefficient, agar plate sensitivity method.
9. Water quality analysis – MPN method.
10. Milk quality analysis – MBRT method

Reference

1. Introduction to Practical Biochemistry, E.F Plummer Mu, Plummer Tata McGraw-Hill Education, 1998.
2. Molecular cloning: a laboratory manual, 4th ed. J.Sambrook, Fritsch and

- T.Maniatis.coldspring harbor laboratory press ,New York,2012
3. Essential cell biology : a practical approach volume 1: cellstructure. John Davey,J.Michaellord. Oxford university press,USA,2003
 4. Principles and techniques of biochemistry and molecular biology (7th ed).keithWilson(editor),john walker (editor),Cambridge universitypress,2010.

 6. Microbiology- A Laboratory manual P. Gunasekaran . New age publications, Newdelhi,1995.
 7. Molecular cloning-A Laboratory manual. Sambrook, J , Fritsch. E.F, and T.Maniatis, 2nd Edition. Cold spring Harbor Laboratory press, New York,1989.
 8. Laboratory exercise of Microbiology, J.P. Harley and L.M. Prescott, 5th Edition, theMcGraw-Hill companies,2002.
 9. Microbiology: A Laboratory Manual, J.G. Cappuccino and N. Sherman, Addison-Wesley,2002.
 10. Laboratory Manual of Experimental Microbiology ,R.M.Atlas, A.E.Brown and L.C.Parks, 1995. Mosby,St.Louis,2002.
 11. Laboratory manual in General Microbiology, N.Kannan, Panimapublishers.
 12. Bergey"s Manual of Determinative Bacteriology. Ninth Edition J.G.Holt, N.R.Krieg.,Lippincott Williams, Wilkin publishers, 2000.

Semester: II

SEMESTER II PAPER 4: IMMUNOLOGY

Hours of teaching: 5

Credits: 4

Aim: to provide the students insights into the various aspects of immunology such as classical immunology, clinical immunology, immunotherapy and diagnostic immunology.

Course objectives :

1. To Learn the basic components and principles of defense mechanism against infections
2. To Understand the properties antigens and structure and types of Immunoglobulin
3. To understand principle behind Antigens- Antibody reactions.
4. To Expedite how the immune system recognizes foreign antigen and the significance of self/non-self-discrimination
5. To Enrich the students' knowledge with respect to different applications of Immunotechnology

Course Out Comes (five outcomes for each units should be mentioned)

1. After studied unit-1, the student will be able to know about basics of Immunity and various components of Immune system
2. After studied unit-2, the student will be able to understand about Antigens and structural properties of Immunoglobulin
3. After studied unit-3, the student will be able to understand principle of antigen-antibody reaction and their types
4. After studied unit-4, the student will be able to how immune cells are signaled, processed and destroyed
5. After studied unit-5, the student will be able to know various immunological technologies.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	No	No
5	Yes	Yes	Yes	No	Yes	Yes

UNIT I	Introduction to the study of Immunology: Historic perspective, Overview and Concepts, Humoral and cellular- Mediated Immunoresponses. Components of immunity, Innate and Adaptive immunity. Haematopoiesis and differentiation of immune cells. Cells and Tissues of the immune system: Cells involved in the Immune response: Macrophages, B and T lymphocytes, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells. The lymphoid organs: Thymus, Bone marrow, Spleen, lymph nodes, MALT.	12 hours
UNIT-II	Antigens and Immunogenicity. Nature of Antigens and antibodies. Theories of Antibody formation. Antibody structure, structural basis of Antibody diversity; Immunoglobulin as Antigen, Properties of immunoglobulin and subtypes. Complement and its role in Immune Responses.	12 hours
UNIT – III	Antigen - Antibody Reaction, Strength of Antigen and Antibody reaction, Cross reactivity, Precipitation and Agglutination reactions, Radioimmunoassay and ELISA. B-cell generation, activation and differentiation. Antibody production, Regulation and Diversity.	12 hours
UNIT – IV	Cytokines: structure of Cytokines; function of Cytokines. Complement fixation. Structure and function of MHC class I and II molecules - antigen recognition and presentation, HLA typing, Cellular Immunity. Hypersensitivity Reactions, Types of Hypersensitivity, Immune tolerance , Autoimmunity and transplantation.	12 hours
UNIT-V	Hybridoma secreting monoclonal antibodies-Recombinant antibody molecules. Catalytic Antibodies. Vaccine technology including DNA vaccines. Immunological techniques for identification of infectious diseases : immune-electrophoresis, western blot, flowcytometry and immune-fluorescence microscopy including <i>in situ</i> localization techniques such as FISH and GISH.	12 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
	Total Lecture hours	65 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text Book(s)

1. Parham, P. (2014). The Immune System (4th edition). W. W. Norton & Company.
2. Murphy, K., Travers, P., Walport, M., & Janeway, C. (2012). Janeway's Immunobiology. New York: Garland Science.
3. Paul, W. E. (1993). Fundamental Immunology. New York: Raven Press. Goding, J. W. (1986). Monoclonal Antibodies: Principles and Practice
4. C.V.Rao. 2002, An Introduction to Immunology, Narosa Publishing House, Chennai.

References Books

1. Immunology (7th ed) J.Kuby, W.H freeman and company, new York. 2013
2. Basic immunology updates ed: functions and disorders of immune system (3rd ed). abulk.abbas, Andrew H. Hlctman, saunders publishers, new York, 2010
3. Immunology: an introduction (4th) I.R Tizard, saunders college publishers, new York.
4. Essential immunology (11th ed). peter delves, seamus martin, dennjis burton, Ivan Roitt, Wiley – Blackwell publication, Singapore, 2006
5. Immunology (Lippincotts illustrated reviews series) thaodoan, roger melvold, susanviselli, Carl Waltenbaugh, Lippincott Williams & Wilkins publications 2012
6. Fundamental immunology (7th ed) William e Paul, Lippincott Williams & Wilkins publications, 2012
7. Essentials of clinical immunology (6th ed) Helen chapel, Manselhaeney, Siraj misbah, Neil snowden, Wiley-Blackwell publications, 2014
8. Monoclonal antibodies principles and practice (3rd ed) W. Goodings, academic press, 2010
9. Monoclonal antibodies :P methods and protocols (2nd ed) .Vincentossipo, Nicolas fisher, Humanapress, 2014
10. Essentials of clinical immunology (6th ed). Helen chapel, Manselhaeney, Siraj misbah, Neil Snowden, Wiley- Blackwell publications, 2014 J.Kuby, 2003, Immunology 5th edition, W.H. Freeman and Company, Newyork..
12. I.R.Tizard, 1995, Immunology: An Introduction, 4th edition, Saunders College Publishers, New York.
13. I.Roitt, 1994, Essential Immunology, Blackwell Science, Singapore.
14. A. Bul and K.Abbas, 1994, Cellular and Molecular immunology
15. Current Protocols in Immunology 3 Volumes, Wiley Publications 1994.
16. Monoclonal Antibodies: Principles and Practice, J. W. Goding, 1983. Academic Press
17. Hybridoma Technology in the Biosciences and medicine, T.A. Springer, 1985. Plenum Press NY

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. <https://nptel.ac.in/courses/102/105/102105083/>
2. <https://www.coursera.org/specializations/immunolog>

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S		S

PO – Programme Outcome, CO – Course outcome S – Strong , M – Medium, L – Low

PAPER 5: GENETIC ENGINEERING

Subject: Genetic Engineering

Hours/Week: 5

Credits: 4

Aim: To modify the genes to enhance the capabilities of the organisms beyond what is normal. Ethical controversy surrounds the possible use of both of these technologies in plants, nonhuman animals, and humans.

Course Objectives

1. To understand the basis of Enzyme, Ligases in Genetic Engineering Tools.
2. To well understood the Cloning Vectors.
3. To obtain knowledge about Gene cloning strategies and transformation techniques.
4. To obtain the knowledge of Selection, Screening, and analysis of recombinants.
5. To know the basic Genetic Engineering Techniques- Application of rDNA technology.

Course Out Comes

On completion of the course, the students will be able to:

1. After studying unit 1 the students will be able to identify the tools which are used in Genetic Engineering and exhibit them their practical's.
2. After studying unit 2 the students will be able to differentiate methods in Cloning Vector.
3. After studying unit 3 the students will be able to describe the Techniques in Gene cloning – Physical, chemical and methods.
4. After studying unit 4 the students will be able to explain techniques and recombine recombinants like PCR, DNA sequencing, etc
5. After studying unit 5 the students will be able to analyze and can cross-examine the Genetic Engineering of patients who visit the Lab.

The Matching Table (Put Yes / No in the appropriate box)

Units	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	No	Yes	Yes	Yes
4	Yes	Yes	No	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	No

Units	Course Contents	Teaching Hours
Unit-I	Tools of Genetic Engineering: Enzymes - endo &exo nucleases, Restriction endonucleases- types, nomenclature, recognition sequences and mechanism of action; Isochizomers, Iso customers - star activity, Methylation, and modification. Ligases – types (NAD and ATP dependent), mechanism of action. Role of Kinases, phosphatases, polynucleotide phosphorylase, polynucleotide kinases, terminal transferase, Alkaline phosphatase, Reverse transcriptase - Taq polymerase.	12 hours
Unit-II	Cloning vectors: General characteristics of vectors, Brief account of naturally occurring plasmids. The promoter, MCS, Ori, and Marker genes-lac Z. Construction of pBR 322, pBR325, pBR327, pUC8 , pUC 18 & 19 vectors, and Expression vectors, Bacteriophage vectors, Lambda phage, Insertion vectors, Replacement vectors, Cosmids, Phagemids, Mini chromosomes, BAC's, YAC's, Shuttle vectors, Ti plasmids, Vectors for animals-SV40 and Bovine papillomavirus.	12 hours
Unit-III	Gene cloning strategies and transformation techniques: Chimeric DNA, Cloning strategies- ligation, Transformation and selection, use of adaptors and linkers, Homopolymer tailing in cDNA cloning, genomic DNA libraries, Short gun method, Partial digestion, End modification, Cloning from mRNA- Isolation and purification of RNA, Synthesis of cDNA, Isolation of plasmids, Cloning cDNA in plasmid vectors, Cloning cDNA in bacteriophage vectors. cDNA library. Advanced cloning strategies- synthesis and Cloning of cDNA, PCR amplified DNA. Transformation techniques: Preparation of competent cells, Physical methods - Electroporation, Microinjection, Gene gun, chemical methods - PEG, DEAE, CaCl ₂ , calcium phosphate precipitation method, liposome-mediated method	12 hours

Unit-IV	Selection, screening, and analysis of recombinants: Genetic selection - Insertional inactivation, Antibiotic Resistant genes, lac Z genes, Blue white screening, α - Complementation, colony hybridization, Immunological screening, Plaque hybridization, Blotting techniques, DNA sequencing - chemical and enzymatic methods, PCR and its variants, Preparation of radio labelled and non - radiolabelled probes and its applications.	12 hours
Unit-V	Applications of rDNA technology: Production of vaccines – Hepatitis B, Edible Vaccine, Hormones – Somatotropin, Humulin, Blood clotting factor VIII, Interferons, Diagnostics of inherited disorders and infectious diseases, Gene therapy, ADA- Cystic fibrosis.	12 hours
Unit-VI	Internal Assessments, Seminars, and Guest Lecture	05 hours
	Total Teaching hours	65

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Textbook:

1. Concepts of Genetics (Masteringgenetics) 12th Edition by William Klug (Author), Michael Cummings (Author), Charlotte Spencer (Author), Michael Palladino (Author), Darrell Killian (Author)
2. Genetics: A Conceptual Approach Sixth Edition by Benjamin A. Pierce (Author) W. H. Freeman; Sixth edition (December 19, 2016)
3. Genetics: From Genes to Genomes, 5th edition 5th Edition by Leland H. Hartwell (Author), Michael L. Goldberg (Author), Janice A. Fischer (Author), Leroy Hood (Author), Charles F. Aquadro (Author) McGraw-Hill Education; 5th edition (September 5, 2014)
4. Genetics: Analysis of Genes and Genomes: Analysis of Genes and Genomes 9th Edition by Daniel L. Hartl (Author), Bruce Cochrane (Author) Jones & Bartlett Learning; 9th edition (December 14, 2017)
5. Principles of Genetics 6th Edition by D. Peter Snustad (Author), Michael J. Simmons (Author) John Wiley and Sons; 6th edition (August 23, 2011)
6. An Introduction to Genetic Engineering 3rd Edition, author : Desmonds S.T. Nicholl, University of Paisley May 2008.
7. Gene Cloning and DNA Analysis: An Introduction 7th Edition by T. A. Brown Wiley-Blackwell; 7th edition (January 19, 2016)
8. Biotechnology: Applying the Genetic Revolution 1st Edition by David P. Clark BA (honors) Christ's College Cambridge 1973
 PhD University of Bristol (England) 1977 (Author), Nanette Pazdernik Academic Cell; 1st edition (September 19, 2008)

Reference Book:

1. An Introduction to Genetic Engineering (Studies in Biology) 2nd Edition by Desmond S. T. Nicholl
2. Genetically Engineered Foods (Volume 6) (Handbook of Food Bioengineering, Volume 6) 1st Edition by Alexandru Mihai Grumezescu (Editor), Alina Maria Holban (Editor) 2017.
3. Genetically Engineered Foods Hardcover – January 1, 2021 by Armando Mills (Author) ED-

Tech Press; 1st edition

4. Genetic Engineering: A Christian Perspective Paperback – December 27, 2019 by [Michael Scaife](#).

Course Material:

Website links: <https://www.genome.gov/genetics-glossary/Genetic-Engineering>

https://www.amazon.in/s?k=genetic+engineering+book&hvadid=82669701180826&hvbm=bp&hvdev=c&hvqmt=p&tag=msndeskstdin-21&ref=pd_sl_3hztgcyjhj_p

E-journals: Process Biochemistry (Elsevier), Journal of Cellular Biochemistry (Wiley)

Mapping with Programme Outcomes

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	M	M	S	S	S
CO2	M	M	M	S	S	M	S	S	M	M
CO3	M	M	M	S	S	S	S	M	M	M
CO4	S	S	S	M	M	M	S	M	M	S
CO5	M	M	M	S	S	S	M	M	S	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low

PAPER 6: DEVELOPMENTAL BIOLOGY AND STEM CELL BIOLOGY

Subject: Developmental Biology and Stem Cell Biology

Hours/Week: 5

Credits: 4

Aim: To understand the recent advances and its applications to modern biotechnology

Course objectives:

1. To study the basics of sperm, egg cell cycle and its various stages
2. To teach the developmental concepts of drosophila and chick
3. To teach the concepts of stem cell, embryonic and adult stem cell
4. To study the types of stem cell and stem cell mediated antigen role different stem cell
5. To understand the recent advances and its applications to modern biotechnology.

Course outcomes

1. After studied unit-1, the student will be able to know about basic knowledge of Developmental Biology
2. After studied unit-2, the student will be able to understand mechanism of developmental morphogenesis and organogenesis
3. After studied unit-3, the student will be able to understand the stem cell and its importance
4. After studied unit-4, the student will be able to know the different types of stem cell
5. After studied unit-5, the student will be able to know various application of stem cell in medicine.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	No	No
5	Yes	Yes	Yes	No	Yes	Yes

Units	Course Contents	Teaching Hours
Unit-II	Introduction to Developmental Biology: Cells and morphogens gradients. Ultrastructure of sperm, egg, pollen and ovule. Production of gametes in animal and plant (Spermatogenesis, Oogenesis). Cell surface molecules in sperm - egg recognition in animals; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals.	12 hours
Unit-II	Developmental Concepts: Morphogenesis and organogenesis in animals (Drosophila and Chick). Cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting. Role of in development. Cellular differentiation and Differential activation. Role of cell death in development. Terato genesis - Ageing, transgenic.	12 hours
Unit-III	Introduction to stem cell biology: Introduction to concepts in stem cell biology (renewal and potency)introduction to stem cells, Germ line stem cells and germ line derived pluripotent cell, Epigenetics, nuclear transfer and cloning, introduction to cell, tissues and organ. Introduction to embryonic and adult stem cell.	12 hours
Unit-IV	Basic and Types of Stem cell: Stem cell basic: Reprogramming and induced pluripotent cells (iPS cells), chromatin and stem cells, telomeres and stem cells, stem cell differentiation and characterization : CD antigens and its role in stem cell differentiation. Neuronal stem cell, mesenchymal stem cell, cardiac stem cells, hematopoietic stem cells	12 hours
Unit-V	Technique and Application Techniques used for stem cell isolation, enumeration and <i>in vivo</i> expansion, techniques used for stem cell characterization. Therapeutic applications of stem cell: fundamentals of regenerative medicine, autologous and allogenic stem cell transplantation, HLA typing, Stem cell banking – cryopreservation techniques, national and international guideline, recent advances in stem cell biology.	12 hours
Unit-VI	Internal Assessments, Seminars, and Guest Lecture	05 hours

Total Teaching hours	65
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Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text Books

- Essentials of stem cell biology 2009, (second ed) Robert Lanza, John Gearhart, Brigid Hogan, Douglass Melton, Roger Pedersen, E. Donnall Thomas, James Thomson and Sir Ian Wilmut.
- Ann A. Kiessling, Human Embryonic Stem Cells: An Introduction to the Science and Therapeutic Potential, Jones and Bartlett, 2003
- Peter J. Quesenberry, Stem Cell Biology and Gene Therapy, 1st ed, Wiley, 1998
- Developmental biology, (2018), 11th edition by Michael J. F. Barresi, Scott F. Gilbert. Reference Books
- Human Embryology & Developmental Biology (2019), 6th edition by Bruce M. Carlson
- Principles of Development (2019), 6th edition by Cheryll Tickle; Lewis Wolpert; Alfonso Martinez Arias.
- Freshney R.I. 2016. Culture of animal cells: A manual of basic technique and Specialized Applications. 7th Edn. Wiley- Blackwell.. United States of America.
- Singh, B., Mal, G., Gautam, S.K., Mukesh, M. 2019 Advances in animal biotechnology 1st Edn Springer International Publishing. Switzerland

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

<https://www.youtube.com/watch?v=dXknffXeDM>

<https://courseware.cutm.ac.in/courses/biochemistry-and-enzyme-technology/>

<https://freevideolectures.com/course/85/enzyme-science-and-engineering>

E-Journals: Reproductive Biology, Stem cell biology, Fertility and Sterility, Urology

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S		S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

ELECTIVE IV : (A) MEDICAL LABORATORY TECHNOLOGY

Subject: Medical Laboratory Technology Hours/Week: 4

Credits: 2

Aim: To enable the students to learn about the General laboratory and instrumentation. Know the significance of biological samples examination & understand the various types of infection and clinical symptoms caused by microorganisms.

Course Objectives

1. To teach the physical and chemical nature of Body fluids
2. To teach the safety measures in diagnostic laboratory
3. To learn knowledge about laboratory techniques
4. To learn hematology and pathology laboratory techniques
5. To teach advanced methods in collection and storage, preparation, analysis of body fluids, and results.

Course outcomes:

1. After studied unit 1 the students will be able to follow safety precautions in the diagnostic laboratory.
2. After studied unit 2 the students will be able to general laboratory and instrumentation.
3. After studied unit 3 the students will be able to know the significance of biological samples and their importance in the examination
4. After studied unit 4 the students will be able to understand the various types of infection and clinical symptoms caused by microorganisms.
5. After studied unit 5 the students will be able to analyze and can cross-examine the Haematology tests of patients who visit the hospital.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	No	Yes	Yes	Yes	No
3	Yes	Yes	No	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes

Units	Course Contents	Teaching hours
Unit I	General Laboratory and instrumentation: Code of conduct for laboratory personnel-safety measures the laboratory-chemical/Reagents, labeling, storage, and usage. First aid in laboratory accidents-Precautions and first aid equipment. Sterilization, and preparation of reagents. The general approach to quality control, quality control of quantitative data	5 hours
Unit-II	Clinical pathology: Urine analysis: Collection, composition, preservation, gross examination, chemical examination. Significance of sugar in the urine, ketone bodies, bile pigment, hematuria, uric acid, microscopic examination of the urinary sediment: stool Examination-specimen collection, pH, Interfering substance. Test for occult blood, fecal fat, and microscopic examination of a stool specimen.	5 hours
Unit-III	Clinical Hematology: Collection of blood-Anticoagulant, preservation Estimation of Hb, PCV, WBC (TC & DC), RBC, platelets, ESR Clotting time, bleeding time-normal value, clinical interpretation Serology-VDRL, CRP, RA, HIV, HBs Ag.	5 hours
Unit-IV	Histology: Basic concepts of different mammalian tissues and their histological structure. Different human organs and their gross and histological structure and functions. Receiving of biopsy specimens at the laboratory (Clinical notes/fixatives). Fixation of tissue –different fixatives and their mode of action.Methods of decalcification.Use of microtomes, selection, and maintenance of knives, the technique of section cutting & mounting on slides. Staining of tissue sections, preparation of different stains, staining methods for Haematoxylin& Eosin.	5 hours
Unit-V	Blood banking: blood group(ABO & Rh)-methods of grouping & reverse grouping. Basic blood banking procedures- a collection of blood, anticoagulants used, cross-matching, different screening, Tests including Coomb's Test for incomplete antibodies preparation of different blood components for use and how to serve a requisition. preparation of red cell suspension. Blood transfusion & hazards. Detect the time when to discard blood in the blood bank, computerized record.	5 hours
Unit-VI	Internal Assessments, Seminars, and Guest lecture	05 hours
	Total Teaching hours	30

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Textbook:

11. Medical
12. Hand book medical laboratory technology 2nd edition-V.H.Talib CBS publishers& 2008.
13. Clinical laboratory practices in CMC procedure, CMC, Vellore
14. Text book of Medical lab technology, 1st Edition-Ranmniksood.jaypee2006.
15. Laboratory manual in biochemistry-Jayaraman New Age International Pvt Ltd publishers2011.

Reference Book:

1. Kanai L. Mukherjee and Anuradha Chakravarthy, Medical Laboratory Technology, Procedure Manual for Routine Diagnostic Tests, Vols. I, II and III. Tata McGraw Hill Publishing Company Ltd., 2017.
2. Ramnik Sood, Concise Book of Medical Laboratory Technology Methods and Interpretations. Jaypee Brothers Medical Publishers (P) Ltd., New Delhi, 2015.
3. N. Pattabiraman. Laboratory Manual in Biochemistry, 4th Edition. All India Publishers & Distributors, 2015.
4. Namita Jaggi. Microbiology Theory for MLT. 2nd Edition. Jaypee Brothers Medical Publishers (P) Ltd., 2013.
5. Alan H. Lowenclock. Varley's Practical Clinical Biochemistry, 6th Edition. CBS Publishers and Distributors, 1988.

Course Material:

Website links: <https://library.fvtc.edu/MLT/Links>, <https://libguides.gvsu.edu/MLS/websites>, **E-**

Books: <https://www.pdfdrive.com/medical-laboratory-technician-e23958474.html>,

E-journals : <https://onlinelibrary.wiley.com/journal/10982825>,

<https://academicjournals.org/journal/JMLD>. **Mapping with Programme Outcomes**

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	S	M	M	M	S	M	S	S
CO2	M	S	M	M	M	S	S	S	M	M
CO3	S	M	M	S	S	M	M	S	M	S
CO4	M	S	S	M	M	S	M	M	S	S
CO5	S	M	S	M	S	M	S	M	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low

ELECTIVE IV (B): FOOD & NUTRITION

Name of the Paper: Food and Nutrition

Total Hours/Week: 4

Credits: 2

Aim: To enable students to gain a deeper understanding about principles of nutrition and also to develop competence to carry out investigation in nutrition

Course Objectives

1. To enable the students to learn the basic concepts of nutrition and different categories of foods.
2. To enable the students to gain knowledge of different nutrient contents and their importance.
3. To make them learn the basics of nutritive and calorific value.
4. To enable the students to know food adulterants and food poisoning, disadvantages & health problems.
5. To enable the students learn the food spoilage and preservation methods.

Course Outcomes

1. The student will be able to differentiate the food types and their nutritive value.
2. The student will be able to develop competence to carry out investigation in nutrition
3. The student will be able to measure and calculate calorific value of different types of foods
4. The student will be able to identify the food adulterants and food poisoning
5. The student will be able to practice food sterilization, preservation and processing.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	No	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I	Definition and basis of food and nutrition, Different Food groups and classification, Nutritional significance and physiological role of food groups, Protein Energy Malnutrition (PEM), definition and types, Treatment and preventive measures of PEM.	5 hours
UNIT-II	Introduction to Vitamins., Fat soluble vitamins, Water soluble vitamins	5 hours
UNIT – III	Introduction to calorific value and nutritive value, Bomb calorimeter, Measurement of calorific value and nutritive of foods, RQ value, BMR and SDA of food stuffs, their measurements and influencing factors, Nutritive value of proteins and amino acids, Balanced diet, composition of balanced diet for pregnant woman, infants, old age.	5 hours
UNIT – IV	Definitions of food adulterations and food poisoning, Sources of foods and types of adulterants, advantages and disadvantages of adulteration, Constituents of foods, carbohydrates, proteins, fats,oils, Flavours, colours and natural toxicants, Sources causes and remedies for acidity, gastritis, indigestion and constipation.	5 hours
UNIT-V	Introduction to food spoilage, food preservation and food processing, Causes and types of food spoilage, types of food preservation and food processing, Food sterilization and pasteurization.	5 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lectures	05 hours
	Total Lecture hours	30

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text book:

1. Albanese, Anthony A Ed, Protein And Amino Acid Nutrition Academic Press New York 1959.
2. Devlin T.M., Biochemistry by Stryer Text book of Biochemistry with clinical correlations.
3. Lehninger, Principles of Biochemistry, by 4th Ed. By Nelson D.L. and Cox. M.M. 6
4. Murray R.K., Grammer, D.K., Mayer P.A., Rodwell V.W., Harpers Biochemistry, a large medical book 26thEd. Mc. Graw Hill, Health Professions Division.
5. West. E.S., Todal, W.R., Mason H.S. and Van Brygen J.T., Text Book of Biochemistry.
6. Mayer, J., Human Nutrition, Charles, C. Thomas, spring field.
7. Michael, J. Gibney, Barrie, M. Margetis, John, M. Kearney. Lenore Arab. Public Health Nutrition. Blackwellscience, Blackwell Publishing Company (2004).
8. Frazier, We, Food Microbiology, Tata Mc Graw₄Hill 1978.

9. Meyer, Lilian H. Ed. (1987), Food chemistry. Indian Ed. CBS Publishers and Distributors
10. Barker, D.J. P (1998), Mothers, Babies and Health in later life. Edinburgh, Churchill livingstone.
11. Ward, R.H.T; Smith, S.K. Donnai, D. (Eds.) (1994) Early fetal Growth and Development. London, & COG Press.
- 12.. Wallace, H.M. and Giri, K. (1990), Health care of women and children indeveloping countries, third party publishing co.Oakland.

Reference Book:

1. Seema yadav: - Food Chemistry, anmol publishing (P) Ltd, NewDelhi
2. Car H.Synder: -the extraordinary chemistry for ordinary things, John Wiley & sonsinc, NewYork,1992.
3. B.Sivasankar – food processing and preservation – PHI learni9ng (P) LTD , New Delhi – 11001.

Course Material: website links, e-Books and e-journals

1. <https://chico-primo.hosted.exlibrisgroup.com>

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome, S – Strong , M – Medium, L – Low

ELECTIVE IV (C) : BIODIVERSITY

Name of the Paper: Biodiversity

Total Hours/Week: 4

Credits: 2

Objectives: To enable students to gain a deeper understanding about the every living things including plants, bacteria, animals and humans .and enormous variety of life on Earth.

Course Objectives

1. To learn the basic concepts of ecosystem and ecology
2. To teach various biodiversity across the country and globe face.
3. To understand the History, guiding principles, conservation of ecology and biodiversity as per ICUN.
4. To learn the importance of pollution damages environmental through how it influence biodiversity
5. To teach and understand how water pollution affects environment and its remedies.

Course Out Comes

1. After studied unit-1, the student will be able to understand the ecosystem and environment.
2. After studied unit-2, the student will be able to understand various types of biodiversity.
 3. After studied unit-3, the student will be able to Understand History, guiding principles, conservation challenges and models of conservation biology.
4. After studied unit-4, the student will be able to Gain knowledge of biosafety and risk assessment of Environmental Pollution.
5. After studied unit-5, the student will be able to Understand Water conservation, Rain water harvesting and disaster management of biodiversity.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	No	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I	Ecosystem concept Introduction and overview of ecosystem ecology - History of ecosystem ecology, Ecosystem structure and functioning, Ecosystem diversity and landscapes, Ecosystem resilience and change, Trophic dynamics and temporal dynamics, Ecological efficiencies	5 hours
UNIT-II	Biodiversity and its origin, Global and local trends , Mega biodiversity countries, hot spots and heritage sites, types of diversity, levels of biodiversity (genetic, species, ecological diversities), value of biodiversity.	5 hours
UNIT – III	History, guiding principles, conservation challenges and models of conservation biology. IUCN Red list categories and criteria, habitat management and establishment of wildlife corridors and protected areas, bio-indicators. Biosphere reserves, in situ and ex situ conservations (sanctuaries, national parks, zoological parks, botanical gardens, oceanorium).	5 hours
UNIT – IV	Environmental Pollution- Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution and solid waste management. Environment Protection Act: Air, water, forest and wild life acts, issues involved in enforcement of environmental legislation.	5 hours
UNIT-V	Water conservation, Rain water harvesting & watershed management, and environmental ethics. Climate change, global warming, acid, rain, ozone layer depletion. Environmental protection act, population explosion. Disaster management.	5 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lectures	5 hours
	Total Lecture hours 50 hours	30 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Textbooks

1. Alcock J 2013 Animal Behavior: An Evolutionary Approach, 10th edition (SinauerAssociates,Inc.)
2. Bolhuis J J and L Giraldeau (eds) 2005 The behaviour of animals (BlackwellPub.)
3. Breed and Moore 2011 Animal Behavior, 1st Edition (Academic Press) 4. Burnse D (ed.) 2001Animal: the definitive visual guide to worlds“ wildlife (Cambridge UniversityPress)
4. Collen B, Pettorelli N, Baillie J E M and Durant S M (Eds) 2013 Biodiversity Monitoring andConservation: Bridging the Gap Between Global Commitment and Local Action(WileyBlackwell)
5. GL. Karia and R.A. Christian, West Water Treatment, Concepts and Design Approach, PrenticeHall of India,2005.
6. Benny Joseph, Environmental Studies, Tata McGrawHill,2005

Reference book

1. Introduction to bioethics (2018), 2nd edition by J.A. Bryan

Related Online Contents [MOOC, SWAYAM, NPTEL, Websites etc.]

1. https://swayam.gov.in/nd1_noc20_hs18/preview
2. <https://nptel.ac.in/courses/109/106/109106092/>
3. https://onlinecourses.nptel.ac.in/noc20_hs18/preview
4. <https://nptel.ac.in/courses/102/104/102104068/>
5. <https://www.futurelearn.com/courses/biosecurity>

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low

ELECTIVE V (A) : GENOMICS & PROTEOMICS

Hours of teaching: 3

Credits:2

Aim: To enable us to explore many different components of living systems and the advent of proteomics will made it possible to identify a broad spectrum of proteins in living systems. This elective subject will help to understand basic principles and applications in genomics and proteomics.

Course objectives:

1. To provide the basic knowledge of gene characteristic feature and mapping concepts
2. To understand about the sequencing technologies
3. To provide the basic concept for protein analysis
4. To understand about protein sequencing
5. To Enrich the students' knowledge with respect to metagenomic and applications

Course Out Comes (five outcomes for each units should be mentioned)

11. After studied unit-1, the student will be able to know about genes functional properties.
12. After studied unit-2, the student will be able to understand how gene sequencing are done
13. After studied unit-3, the student will be able to understand Protein analysis.
14. After studied unit-4, the student will be able to protein sequencing methods.
15. After studied unit-5, the student will be able to know about metagenomics and its application .

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	Yes	Yes	Yes	Yes
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	No	No
5	Yes	Yes	Yes	No	Yes	Yes

UNIT I	Organization of genes across living systems, interrupted genes, overlapping genes, alternative genes , (RNA editing and RNA Splicing) etc. identification and characterization of insert DNA fragments, gene content and C value paradox – gene cluster and gene families .restriction mapping, chromosome walking and chromosomal localization of genes. RFLP and other uses of cloned sequences, cloning of microbial genes.	10 hours
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UNIT-II	Methods of preparing genomic DNA, DNA sequence analysis methods, Sanger Di deoxy method, next generation sequencing, SNP – single nucleotide polymorphism, expressed sequenced Tags(ESTs),Gene disease association, site directed mutagenesis and molecular chimeras , gungal genome and genomics.PCR based Analysis, DNA Fingerprinting.	08 hours
UNIT – III	Scope of proteomics, protein separation techniques – ion exchange chromatography, size – exclusion and affinity chromatography techniques, size – exclusion and affinity chromatography techniques , protein analysis (includes measurement of concentration , amino acid composition, N-terminal sequencing); SDS-PAGE , two dimensional gel electrophoresis and image analysis.	13 hours
UNIT – IV	Introduction to mass spectrometry; strategies for protein identification ; protein sequencing ; protein modifications and proteomics ; applications of proteome analysis to drug; protein – protein interaction (Two hybrid interaction screening), analysis and sequencing individual spots by mass spectrometry (Maldi toff) and protein microarrays .	08 hours
UNIT-V	a genomics – construction, vector design and screening o f meta genomic libraries- biotechnological applications of meta genomics.	08 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
	Total Lecture hours	50 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text Books

1. Introducing proteomics (2011) Josip lovric. John Wiley Publication
2. Principles of proteomics (2013). R. M Twyman. Taylor and Francis publishers.

Reference Books

1. Expression Genetics: accelerated and High Throughput Methods (1999). Edited by M. McClelland and A. Pardee, Eaton Publishing, MA.
2. Microbial Functional Genomics (2004). J. Zhou, D.K. Thomson, Y. Xu and J.M. Tiedje, Wiley Liss.
3. Reviews and articles from Journals such as Nature, Science, PNAS (USA), Nucleic Acids Research, Trends and Current Opinion Series.
4. Principles of Gene Manipulation and Genomics (2013) Sandy B. Primrose, Richard Twyman – Blackwell Publishing.
5. An Introduction to Genetic Engineering 3rd Edition Desmond S. T. Nicholl Cambridge University Press
6. Molecular Biotechnology: Principles and Applications of Recombinant DNA 4th Edition Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten ASM Press
7. Post-translational modifications in host cells during bacterial infection, D. Ribert, P. Cossart, FEBS letters, 2010.
8. Proteomics in practice: a laboratory manual of proteome analysis (2002). Westermeier, R., & Naven, T. John Wiley & Sons, Inc.
9. Proteomics for biological discovery. Veenstra, (2006). Timothy D. and John R. Yates John Wiley & Sons,
10. Plant proteomics: methods and protocols. (2007). Thiellement, H., Zivy, M., Damerval, C. and Méchin, V. eds. Totowa (NJ): Humana Press.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong, M – Medium, L – Low

ELECTIVE V (B) : ENVIRONMENTAL SCIENCES

Total Hours per Week: 3

Credits: 2

Course Objectives

1. To introduce students to the basics of Environment.
2. To enable the students learn basic structure and functions of ecosystem.

3. To make students understand the distribution of life and life forms on earth.
4. To make students aware of the different forms of energy in environment.
5. To make the students understand the different pollutants and pollution and their Management.

Course Out Comes (five outcomes for each units should be mentioned)

1. The student will be able to understand the principles and scope of environment.
2. The student will be able to understand the distribution and cycling of energy and matter in Environment.
3. The student will be able to identify and characterize the earth sciences.
4. The student will be able to explore the sources of energy from environment.
5. The students will be able to apply methods to control and manage the environment pollution.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	No	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	No	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I	Definitions, principles and scope of environmental science. Structure and composition of atmosphere, hydrosphere, lithosphere, biosphere. Meteorological parameters. Environmental education and awareness. Environmental Ethics.	5 hours
UNIT-II	Introduction to origin of life and speciation, Ecosystem structure and functions, food chains and webs, Basis of ecosystem classification, Biotransformation, water and air borne microbes, Bioremediation, Bioindicators, Biofertilizers, Biofuels, Biosensors.	5 hours
UNIT – III	Introduction to origin of earth, components of earth, zones of earth, Climates of India, weather reactions, erosion, transport, deposition of sediments, Soil forming minerals and process, identification and characterization of clay minerals, Ground water quality, pollution of ground water and mitigation of its impacts.	5 hours
UNIT – IV	Sources of energy, Sun as source of energy, Solar radiation and its spectral characteristics, Characteristics and energy content of coal, petroleum, and natural gases, Energy usage pattern in world and India, Pollutants, emissions of CO ₂ and Global warming.	5 hours
UNIT-V	Introduction to pollution, air, noise, water, soil, thermal, marine and radioactive Pollution, Concept of Waste management, Solid and hazardous waste management, Electrical energy generation, e-waste, fly ash, plastic waste, Environmental management system standards, IPCC, UNEP, IGBP, Global environmental issues- Biodiversity loss, climate change, Ozone depletion, sea level rise.	5 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
	Total Lecture hours	30 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text book:

1. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
2. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
3. Minkoff, E.C. 1983. Evolutionary Biology. Addison Wesley. Publishing Company.
4. Nei, M. & Kumar, S. 2000. Molecular Evolution and Phylogenetics. Oxford University Press.
5. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2006. Environmental and Pollution Science. Elsevier Academic Press.

6. Purohit, S.S.& Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.
7. Owen, O.S, Chiras, D.D, & Reganold, J.P. 1998. Natural Resource Conservation –Management for Sustainable Future (7th edition). Prentice Hall.
8. Elliott, D. 1997. Sustainable Technology. Energy, Society and Environment (Chapter 3). New York, Routledge Press.
9. Bagchi, A. 2004. Design of Landfills and Integrated Solid Waste Management. JohnWiley & Sons.
10. Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders.
11. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
12. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S.&Sen, K. 2004. Climate Change and India. Universities Press, India.

Reference Book:

1. Botkin, Daniel B. (2011). Environmental Science: Earth as a living Planet, John Wiley andSons, New Delhi.
2. Chapman. J. L. and Reiss, M.J. (2005). Ecology, Principles ad Applictions, CambridgeUniversity Press, London.
3. Dash, M.C. (1994).Fundamentals of Ecology, Tata Mc Graw Hill, New Delhi.
4. Gunther, O. (1998) Environmental Information Systems. Berlin, New York, Springer.
5. Miller G. Taylor and Scot Spoolman. (2011). Essentials of Ecology, Books/ Cole Learning, sU.S.A.
6. Odum, E.P. (1971). Fundamentals of Ecology, W.B. Saunder Company, Philadelphia
7. Sharma P. D. (1996). Environmental Biology, Rastogi Publications, Meerut.
8. Verma P.S. and V.K. Agarwal. (1985). Principles of Ecology. S. Chand and Company(Pub.), New Delhi.
9. Strahler, A. V. and Strahler, A.A (1973). Environmental Geoscience, Wiley International.
10. PrimackR.B. 2014. Essentials of Conservation Biology, Oxford University Press, USA.

Course Material: website links, e-Books and e-journals

1. <https://www.hzu.edu.in/bed/E%20V%20S.pdf>.
2. <https://www.intechopen.com/books/1882>.

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome, S – Strong , M – Medium, L – Low

ELECTIVE V (C) : Herbal Biotechnology

Hours/Week: 3

Credit:2

Aim: To give the details of plant-derived value-added compounds and their functions. To provide knowledge on biotech-based production of Herbal medicines

Course Objectives

1. To enable the students to learn about the biochemical parameters used in the identification and utilization of medicinal plants
2. To enable the students to learn about the extraction of phytochemicals and procedures
3. To exploit and explore the medicinal values of plants
4. know the evaluation techniques for the herbal drugs
5. To provide knowledge on biotech-based production of Herbal medicines

Course Outcomes (five outcomes for each unit should be mentioned)

1. After studied unit-1, the student will be able to – know the Study of on history and scope of herbals
2. After studied unit-2, the student will be able to – understand the Important medicinal herbs in treating diseases
3. After studied unit-3, the student will be able to –learn the Biotechnological methods of plant propagation
4. After studied unit-4, the student will be able to –explore methods Involved in secondary metabolite production
5. After studied unit-5, the student will be able to –know about pharmaceutical applications and Intellectual Property Rights

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	No	No	No	No
2	Yes	Yes	No	No	No	No
3	Yes	Yes	No	No	No	No
4	Yes	Yes	No	No	No	No
5	Yes	Yes	No	No	No	No

Units	Course Contents	Teaching hours
Unit I	Study of on history and scope of herbals - Introduction to the Indian system of medicine – Herbal drugs and importance- Herbal Cosmetic and Cosmeceuticals - Formulation Development of herbal preparations - Herbal Drug discovery and Novel drug delivery systems.	10 hours
Unit-II	Important medicinal herbs in treating diseases- Phytochemistry of medicinal plants- alkaloids- flavones- flavonoids and xanthones - furocoumarins - glycosides - naphthoquinones - phenols and acylphloroglucinols - resins, oleoresins and gum resins. Saponins - sterols and steroid-like compounds - tannins and terpenes.	08 hours
Unit-III	Biotechnological methods of plant propagation. - Micropropagation – Somatic Embryogenesis and somoclonal variation. Herbal gardening and maintenance- Standardization of cultivation protocols of selected medicinal plants; <i>in vitro</i> production of secondary metabolites. Polyhouse Technology- Important diseases of medicinal plants and their management.	13 hours
Unit-IV	Methods Involved in secondary metabolite production - Organ culture, Cellculture, Biotransformation (Microbial and Plant cells) - Scale up - Enhancement of product formation by elicitation-Immunodiagnosics and molecular diagnostics in selection of elite plant species.	08 hours
Unit-V	Introduction to analysis and quality controls of herbal products (TLC, HPLC, IR, NMR, and mass spectroscopy). Pharmaceutical application of alkaloids, terpenoids, glycosides, volatile oils, tannins and resins. - Intellectual Property Rights - Regulatory Affair herbal pharmaceuticals - Entrepreneurship Management.	08 hours
Unit-VI	Internal Assessments, Seminars, and Guest lecture	5 hours
	Total Teaching hours	50 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Reference & Text Books:

1. Harborne, J.B., 1998. Phytochemical methods to modern techniques of plant analysis. Chapman & Hall, London.
2. Trease G. E, M. C. Evans, 1979. Textbook of Pharmacognosy 12th ed. Balliere-Tindal, London.
3. Irfan A. Khan and AtityaKhanum (Eds.). 2004. Role of Biotechnology in medicinal and Aromatic plants, Vols. I-X. Ukaaz Publications, Hyderabad. Analytical techniques in DNA sequencing edited by Brian K. Nunnally. 97

4. Agrawal S.S. and M. Paridhavi, Herbal Drug Technology, University press 2007.
5. Henry, R. J. 1997. Practical Applications of Plant Molecular Biology. Chapman & Hall, London, UK.
6. Bidlack, W.R., Omaye, S.T., Meskin, M.S. and Topham, D.K.W., "Phytochemicals as Bioactive Agents", 1st Edition, CRC Press, 2000.
7. Sharol Tilgner, N. D. 1999. Herbal medicine - From the heart of the earth. Edn. 1, Printed in the USA by Malloy Lithographing Inc.
8. Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman (ed), Concepts in Biotechnology, University Press, 1996.
9. Anderson, F.J Illustrated History of the Herbals. New York: Columbia University press. 2009.
10. Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use, CAB International, Oxon UK.
11. Gokhale, S.S, C.K. Kokate and A.P. Purohit (1994). Pharmacognosy. Nirali Prakashan, Pune.
12. Farooqi, A.A. and B.S. Sreeramu (2004), Cultivation of Medicinal and Aromatic crops. University Press (India) P.Ltd., Hyderabad.
13. Pal. D.C and S.K. Jain (1998), Tribal medicine, Naya Prakash, 206, Bidhan Sarani, Calcutta.
14. Thirugnanam, Akbarsha and Krishnamurthy (2010), Indian Medicinal plants and Home F

Course Material:

1. Rasheeduzzafar (2006), Medicinal plants of India, CBS publication.
2. International Journal of Herbal Medicine
3. Journal of Herbal medicine Elsevier
4. en.wikipedia.org/wiki/Herbal medicine

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	S	S	S	S	S
CO3	S	S	S	S	S	S	S	S	S	S
CO4	S	S	S	S	S	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	S	S

PO – Programme Outcome, CO – Course outcome, S – Strong , M – Medium, L – Low

PRACTICAL II LAB IN IMMUNOLOGY & GENETIC ENGINEERING

1. Blood grouping
2. Lymphocyte subset identification and enumeration.
3. Radial immuno-diffusion test.
4. Ouchterlony double diffusion
5. Immuno electrophoresis
6. Rocket Immuno electrophoresis
7. Latex Agglutination
8. Quantitative Precipitin assay
9. Complement fixation test
10. ELISA
11. Western Blotting
12. Antigen-antibody reaction (precipitation and agglutination reaction tests).

GENETIC ENGINEERING

1. Isolation of genomic DNA from the given sample and its molecular weight determination
2. Isolation of RNA from the given sample and its molecular weight determination
3. Isolation of plasmid DNA from the given sample
4. Restriction digestion of Lambda phage DNA
5. Ligation of DNA and analysis by electrophoresis
6. DNA amplification by PCR and RAPD
7. Preparation of competent cells and transformation by CaCl_2 method and Selection of transformed colony by X-Gal method
8. Determination of molecular weight of proteins by SDS PAGE

SKILL ENHANCEMENT COURSE-I

(A) MUSHROOM CULTIVATION AND APICULTURE

Total Hours per Week: 2

Credits: 2

Aim: To exploit possibilities and assist in building up a mushroom cultivation and apiculture industry that will make a significant contribution to the general economy.

1. To make the students to know about mushroom and their types.
2. To enable the students to learn the mushroom spawn production conditions.
3. To make the students learn about mushroom cultivation and maintenance.
4. To make the students to know about apiculture scope and bee keeping and types.
5. To enable the students to understand the importance of honey and applications.

Course Out Comes (five outcomes for each units should be mentioned)

1. The student will be able to differentiate the edible and poisonous mushrooms.
2. The student will be able to develop mushrooms culture conditions.
3. The student will be able to practice the mushroom cultivation and production.
4. The student will be able to practice the bee keeping and culture maintenance.
5. The student will be able to produce and analyze the applications of honey in different fields.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	No	Yes	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	Yes
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I	History of Mushroom, cultivations and its practice, Introduction to mushroom cultivation, Classification of Mushrooms and different types, Edible Mushrooms, its types and their origin, Poisonous Mushrooms, its types and their origin.	5 hours
UNIT-II	Introduction to mushroom cultivation, sources of beds and types, Spawn, Sources, spawn run, cultivation set up, Culture ventilation and humidity management, temperature, lighting, moisture, pH, CO ₂ , Culture chambers preparation, sterilization, Instructions, precautions, handling and sensors.	5 hours
UNIT – III	Mushroom cultivation maintenance, conditions, and duration, Spawn collection, preparation, storage, Spawning techniques, Environmental conditions, temperature, moist, Fruiting initiation, monitoring, maintenance and harvest.	5 hours
UNIT – IV	Introduction to apiculture, definitions, history, scope, importance of apiculture, Bee Keeping methods practiced in world and in India, Traditional Bee keeping techniques, Modern Bee keeping methods, Urban Beekeeping methods.	5 hours
UNIT-V	Introduction to nutritional product of honey and its constituents, Honey properties biological activities, medicinal values, Applications of Honey in various fields, Honey types and value added honey products.	5 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
	Total Lecture hours 65 hours	30 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text book:

1. Paul Stamets, J.S. and Chilton, J.S. 2004. Mushroom cultivation A practical guide to growing mushrooms at home, Agarikon Press.
2. Tewari and Pankaj Kapoor S.C. 1993. Mushroom cultivation. Mittal Publication. Delhi.
3. Marimuth et al., 1991. Oyster Mushrooms. Dept. of Plant pathology, TNAU, Coimbatore.
4. Nita Bahl. 1988. Hand book of Mushrooms, 2nd Edition, Vol I & II.
5. Shu Fing Chang, Philip G. Miles and Chang, S.T. 2004. Mushrooms Cultivation, nutritional value, medicinaleffect and environmental impact. 2nd ed., CRC press.
6. Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
7. Bisht D.S., Apiculture, ICAR Publication.
8. Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi

Reference Book:

1. Laidlaw, H.H., 1997. Contemporary queen rearing. Published by Dadant and Sons. R. A. Morse, Rearing queen honeybees. Wicwas press, NY.

2. Alison Benjamin, By (author) Brian McCallum, 2008. Keeping Bees and Making Honey. David & Charles, NewtonAbbot.
3. Kim Pezza, 2013. Backyard Farming: Keeping Honey Bees: From Hive Management to Honey Harvesting and More. Hatherleigh Press, U.S.
4. Kim Flottum, 2014. The Backyard Beekeeper: An Absolute Beginner's Guide to Keeping Bees in Your Yard and Garden. Quarry Books.
5. Kannaiyan, S. Ramasamy, K. (1980). A hand book of edible mushroom, Today & Tomorrows Printers & Publishers, New Delhi.
6. Pandey B P 1996. A textbook of fungi. Chand and Company N Delhi. **Course Material: website links, e-Books and e-journals**

1. https://books.google.co.in/books/about/Mushroom_Cultivation_in_India.

2. https://books.google.co.in/books/about/Mushroom_Cultivation_in_India.html?id=6AJx99OGTKEC&redirhttps://

books.google.co.in/books/about/Mushroom_Cultivation_in_India.html?id=6AJx99OGTKEC&redir

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome, S – Strong, M – Medium, L – Low (may be avoided)

(B) VERMICULTURE TECHNOLOGY

Total Hours per Week: 2

Credits: 2

Aim: To exploit possibilities and assist in building up a Vermiculture technology in significant contribution to the general economy.

Course Objectives

1. To enable the students learn about Vermiculture composting.
2. To enable the students to know the humus cycle, soil transformation
3. To enable the students analyze the nutritional composition of vermicompost.
4. To enable the students to learn Vermiculture technology.
5. To enable the students to learn the harvest of vermicompost.

Course Out Comes (five outcomes for each units should be mentioned)

1. The student will be able to understand the Vermiculture and 4R's of recycling.
2. The student will be able to identify the decomposing organic matter and humus formation.
3. The student will be able to differentiate nutritional value of vermicompost and fertilizer.
4. The student will be able to practice the Vermiculture composting and maintain conditions.
5. The student will be able to produce Vermiculture compost, harvest the compost and application.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	No	Yes	No	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	No
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I	Introduction to Vermiculture technology, definition, meaning and history, Economic importance of Vermiculture, their value in soil texture, Concept of recycling, Concept of four r' s reduce, reuse, recycle and restore.	5 hours
UNIT-II	Introduction to matter, types of matter, Introduction to Humus, Humus cycle, Sources, quality of products for Humus formation, Ground population, and transformation process in organic matter.	5 hours
UNIT – III	Introduction of plant fertilizers, nutritional value and their importance, Vermicompost composition and its nutritional value, Importance of vermicompost as fertilizer for plants, Comparison of vermicompost with other fertilizers.	5 hours
UNIT – IV	Introduction to vermibeds, sources, types, Preparation of vermibeds, measurements, Maintenance of vermicompost, Compositing conditions, moist, temperature, aeration.	5 hours
UNIT-V	Vermicompost identification, conditions, and separation, compost packing, sources and methods, Compost storage, conditions and durations, Vermicompost handling and transport.	5 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
	Total Lecture hours 65 hours	30 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text book:

1. Kevin, A and K.E.Lee (1989) “ Earthworm for Gardeners and Fisherman” (CSIRO,Australia, Division of Soils)
2. Rahudakar V.B. (2004). Gandul khatashivay Naisargeek Paryay, Atul Book Agency,Pune.
3. Satchel, J.E. (1983) “Earthworm Ecology” Chapman Hall, London.
4. Wallwork, J.A. (1983) “Earthworm Biology” Edward Arnold (Publishers) Ltd. London.
5. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other IndiaPress, Goa, India. 2.Bhatnagar & Patla,2007.
6. Earthworm vermiculture and vermin-composting, Kalyani Publishers,New Delhi

Reference Book:

1. Bhatt J.V. & S.R. Khambata (1959) "Role of Earthworms in Agriculture" Indian Council of Agricultural Research, New Delhi 2.
2. Dash, M.C., B.K.Senapati, P.C. Mishra (1980) " Vermis and Vermicomposting" Proceedings of the National Seminar on Organic Waste Utilization and Vermicomposting Dec. 5-8, 1984, (Part B), School of Life Sciences, Sambalpur University, Jyoti Vihar, Orissa.
3. Edwards, C.A. and J.R. Lofty (1977) "Biology of Earthworms" Chapman and Hall Ltd., London.
4. Lee, K.E. (1985) "Earthworms: Their ecology and Relationship with Soils and Land Use" Academic Press, Sydney. 5. Kevin, A and K.E.Lee (1989) " Earthworm for Gardeners and Fisherman" (CSIRO, Australia, Division of Soils)
5. Mary Violet Christy, 2008. Vermitechnology, MJP Publishers, Chennai.
6. Aravind Kumar, 2005. Vermis & Vermitechnology, A.P.H. Publishing Corporation, New Delhi.

Course Material: website links, e-Books and e-journals

1. Vermiculture Technology, Earthworms, Organic Wastes, and Environmental Management Edited By Clive A. Edwards, Norman Q. Arancon, Rhonda L. Sherman,
2. <https://www.scirp.org/journal/paperinformation.aspx?paperid=2490>, **DOI:** 10.4236/ti.2010.13019

Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome S – Strong , M – Medium, L – Low (may be avoided)

C) VALIDATION OF MEDICINAL PLANTS

Total Hours per Week: 2

Credits: 2

Aim: The course aims to introduce the students to the identification and validation of medicinal plant and to understand the cultivation and propagation techniques. To understand the importance of medicinal plants in human health care.

Course Objectives

1. To enable the students to understand the importance of medicinal plants.
2. To enable the students to identify the medicinal plants.
3. To enable the students to learn the techniques of validation of medicinal plants.
4. To enable the students to learn the cultivation methods and maintenance of medicinal plants.
5. To enable the students to understand the importance of medicinal plant in human health.

Course Outcomes (five outcomes for each units should be mentioned)

1. The student will be able to gain knowledge about importance of medicinal plant parts and its medicinal value.
2. The student will be able to classify the medicinal plants on Bentham and Hooker and Practice herbarium techniques.
3. The student will be able to identify the medicinal values of plants using different validation Techniques.
4. The student will be able to cultivate and propagate the medicinal plants
5. The student will be able to practice the usage of medicinal plants in treatment of human Diseases.

Matching Table (Put Yes / No in the appropriate box)

Unit	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
1	Yes	Yes	No	Yes	No	No
2	Yes	Yes	Yes	Yes	Yes	No
3	Yes	Yes	Yes	Yes	Yes	No
4	Yes	Yes	Yes	Yes	Yes	Yes
5	Yes	Yes	Yes	Yes	Yes	Yes

UNIT I	Introduction to Medicinal plants, meaning, definition and types, Medicinal properties of plants and their importance, Medicinal values in plant parts, fruits, stem, leaves and roots, Leaf, fruit, root and stem modifications, aerial and underground.	5 hours
UNIT-II	Introduction to Medicinal plant identification, Elementary knowledge of binomial nomenclature, Bentham and Hooker classification, Herbarium, preparation and preservation.	5 hours
UNIT – III	Introduction to validation of medicinal plants, Macroscopic characteristics of medicinal plants, Microscopic characteristics of medicinal plants, Chemical compounds and tests of medicinal plants, Chromatographic techniques for validation TLC, HPLC, HPTLC & gas, Chromatography.	5 hours
UNIT – IV	Introduction to medicinal plant cultivation, Cultivation techniques, and factors affecting cultivation of medicinal plants, Propagation of medicinal plants and different methods of propagation, Management and Maintenance of medicinal plants.	5 hours
UNIT-V	Importance of medicinal value in plants, Medicinal properties of plants in human health and its role, advantages, Role of medicinal plants in prevention and treatment of human diseases, Traditional knowledge and utility of Indian medicinal plants.	5 hours
UNIT-VI	Internal Assessment: Assignments, Seminars and Guest lecturers	5 hours
		30 hours

Internal Assessment Methods: (25 marks)

Distribution for internals	Test (CIA I + CIA II + CIA III)	Seminars	Assignment	Total marks
Marks	15	05	05	25

Text book:

1. Indian Medicinal Plants by P.C. Trivedi (2009).
2. Medicinal Plants of Indian Himalaya by S.S. Samant and U. Dhar.
3. Indian Medicinal Plants (Vol 1- 4) by K.R. Kirtikar and B.D. Basu (2006).
4. Indigenous Medicinal Plants Social Forestry & Tribals by M.P. Singh et al. (2003).
5. Ayurvedic Drugs and their Plant Sources by V.V. Sivarajan & I. Balachandran, Oxford & IBH (1994).
6. The Handbook of Ayurveda Shantha by Godagama, Bishen Singh Mahendrapal Singh, Dehradun (2004).
7. Direct uses of medicinal plants and their identification by Vardhana, Sarup and Sons, Ansari Road, Dariyaganj,

New Delhi (2008).

8. Medicinal plants, applied biology of domestication and export by K. Singh, S.K. Tyagi, Bishen Singh Mahendrapal Singh Dehradun.
9. Quality Control Methods for Medicinal Plants Materials, W.H.O. (1998).
10. Evaluation of herbal medicinal products by Houghton

Reference Book:

1. A Class Book of Botany. A.C. Dutta. Oxford University Press.
2. Cultivation of Medicinal Plants by C.K. Atal & B.M. Kapoor.
3. Hartmann, H.T & Kester, D.E (1989). Plant Propagation – Principles and Practices. PrenticeHall of India.
4. Awadesh N, Ghoemi A and Sharma R, Indigenous Health Care and Ethnomedicine, Sarupand Sons.
5. Medicinal Plants Cultivation: A Scientific Approach by S.S. Purohit, (2004).
6. Bruneton Jean, Caroline K. Hatton, Pharmacognosy, Phytochemistry, Medicinal plants.Lavoisier, 1999.ISBN 1898298637.
7. Nikolaus J. Sucher, Maria C. Carles, Genome-Based Approaches to the Authentication of Medicinal Plants. *Planta Med.*, 74: 603–623; 2008.
8. WHO guidelines on good agricultural and collection practices (GACP) for medicinal plants, World Health Organization, Geneva, 2003.
9. Iqbal Ahmad, Farrukh Aqil, and Mohammad Owais, Modern Phytomedicine: Turning Medicinal Plants into Drugs. WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2006. ISBN-10: 3-527-31530-6.
10. Ved D.K. & Goraya, G.S. Demand & supply of medicinal plants in India, NMPB, New Delhi & FRLHT, Bangalore, India, 2008.

Course Material: website links, e-Books and e-journals

2. *Planta Medica*, Issue 13 · Volume 79 · August 2013. <https://www.thieme-connect.com/products/ejournals>
3. <https://www.sciencedirect.com/book/9780128008744/evidence-based-validation-of-herbal-medicine>.
3. <https://www.tandfonline.com/doi/citedby/10.1080/13880200902800196?scroll=top&needAccess=true>.

4. Mapping with Programme Outcomes

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	S	M	S	S	S	S	M	S
CO2	S	S	M	S	S	S	S	M	S	M
CO3	S	S	S	S	S	M	S	S	S	S
CO4	S	M	S	S	M	S	S	S	S	S
CO5	S	S	S	S	S	S	S	S	M	S

PO – Programme Outcome, CO – Course outcome, S – Strong , M – Medium, L – Low

For question paper setting ANNEXURE - III

BLOOM TAXONOMY QUESTION PAPER SETTING CHECKLIST

Q. No.	COs	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
PART – A (Two questions from each category except vi. Creating)							
1.	CO1	1	Nil	Nil	Nil	1	Nil
2.	CO1	Nil	Nil	Nil	1	Nil	Nil
3.	CO2	Nil	1	Nil	Nil	Nil	Nil
4.	CO2	Nil	Nil	1	Nil	Nil	Nil
5.	CO3	Nil	Nil	Nil	Nil	Nil	Nil
6.	CO3	Nil	Nil	Nil	1	Nil	Nil
7.	CO4	Nil	Nil	Nil	Nil	1	Nil
8.	CO4	Nil	Nil	Nil	Nil	Nil	Nil
9.	CO5	Nil	Nil	1	Nil	Nil	Nil
10.	CO5	1	Nil	Nil	1	Nil	Nil
PART – B (At the least one question from each category not more than two questions from one category)							
11. A.	CO1	Nil	Nil	1	Nil	Nil	Nil
11. B.	CO1	Nil	Nil	Nil	Nil	1	Nil
12. A.	CO2	Nil	Nil	1	Nil	Nil	Nil
12. B.	CO2	Nil	Nil	Nil	1	Nil	Nil
13. A.	CO3	Nil	Nil	Nil	Nil	Nil	1
13. B.	CO3	Nil	Nil	Nil	Nil	1	Nil
14. A.	CO4	1	Nil	Nil	Nil	Nil	Nil
14. B.	CO4	Nil	1	Nil	Nil	Nil	Nil
15. A.	CO5	Nil	Nil	Nil	Nil	1	Nil
15. B.	CO5	Nil	Nil	Nil	Nil	Nil	1
PART – C (One question from each category except i. Remembering)							
16.	CO1	Nil	Nil	Nil	1	Nil	Nil
17.	CO2	Nil	Nil	Nil	Nil	Nil	1
18.	CO3	Nil	1	Nil	Nil	Nil	Nil
19.	CO4	Nil	Nil	Nil	Nil	1	Nil
20.	CO5	Nil	Nil	1	Nil	Nil	Nil
Total Marks *							

* Not exceeding 24 total marks in each category of (ii), (iii), (iv) and (v). Not exceeding 14 marks in category (i) and 20 marks in category (vi).

Revised Bloom - Anderson 2000 Taxonomy: Code and Verbal Content

Definitions	i. Remembering	ii. Understanding	iii. Applying	iv. Analyzing	v. Evaluating	vi. Creating
Bloom's Definition	Exhibit memory of learned material by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptions, and stating main ideas	Solve problems in new situations by applying acquired knowledge, facts, techniques and rules in a different way	Examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations	Present and defend opinions by making judgments about information, validity of ideas, or quality of work based on a set of criteria	Compile information together in a different way by combining elements in a new pattern or proposing alternative solutions
Verbs	1.1: Choose 1.2: Define Find How Label List Match Name Omit Recall Relate Select Show Spell Tell What When Where Which Who Why	Classify Compare Contrast Demonstrate Explain Extend Illustrate Infer Interpret Outline Relate Rephrase Show Summarize Translate	Apply Build Choose Construct 3.6 Develop 3.7 Experiment with Identify Interview 3.10 Make use of 3.11 Model 3.12 Organize Plan Select Solve Utilize	4.1. Analyse Assume Categorize Classify 3.7 Compare Conclusion Contrast Discover 4.9 Dissect 4.10 Distinguish Divide Examine Function Inference Inspect List 4.17 Motive 4.18 Relationships Simplify Survey 4.21 Take part in Test for Theme	Agree Appraise Assess Award Choose Compare Conclude Criteria Criticize Decide Deduct 5.12 Defend 5.13 Determine Disprove Estimate Evaluate 5.17 Explain 5.18 Importance Influence Interpret Judge Justify Mark Measure Opinion Perceive Prioritize Prove 5.29 Rate 5.30 Recommend Rule on Select Support Value	Adapt Build Change Choose Combine Compile Compose Construct Create Delete Design Develop Discuss Elaborate Estimate Formulate Happen Imagine Improve Invent Make up Maximize Minimize Modify Original Originate Plan Predict Propose Solution Solve Suppose Test Theory

Technical Terms – Definition

Programme Objectives:

Total papers, teaching, learning and evaluation comes under programme. Aim of the study including theoretical, practical courses.

Programme Educational Objectives:

Program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve.

Programme Specific Outcomes:

Program specific outcomes are statements that describe what the Post Graduates of a specific Science Programme should be able to do.

Programme Outcomes:

Programme outcomes describe what students are expected to know and would be able to do by the time of Post-Graduation. These relate to the skills, knowledge, and behaviours that students acquire as they progress through the program.

Course Objectives:

Aim of the paper including unit wise contents.

Course Outcomes:

Statements indicating what a student can do after the successful completion of a course. Every course leads to some course outcomes. The Course Outcomes statements are defined by considering the course content covered in each module of a course. For every course there may be 4 or 5 course outcomes. The keywords used to define course outcomes are based on Bloom's Taxonomy.