GURU NANAK COLLEGE
(AUTONOMOUS)

VELACHERY ROAD, CHENNAI – 600042

(Re-accredited at 'A'-Grade by NAAC) Affiliated to University of Madras

B.Sc. (BIOTECHNOLOGY)

(SEMESTER PATTERN WITH CHOICE BASED CREDIT SYSTEM)

SYLLABUS

(For the candidates admitted for the Academic year 2022-23 and thereafter)

PREAMBLE

Biotechnology is a branch of Applied Biology which incorporates the principles of all the disciplines of Science, Engineering, Commerce and Humanities, to develop and market products & technologies. Biotechnology aims towards societal issues, developing eco-friendly, biocompatible products to suit every living form upon this biosphere. Biotechnology connects the lacuna between Science, Humanities and Commerce. Biotechnology is the backbone for Circular Economy. The B.Sc. Biotechnology offered at Guru Nanak College is designed with a Multi-Disciplinary Approach to suit academic needs. The core subjects like **Bioprocess technology, Genetic Engineering, Bioinformatics, Environmental Biotechnology, Plant & Animal Biotechnology and Bionanotechnology** and the supportive electives like **Marine Biotechnology, Bioethics, Biosafety, IPR and Environmental Biotechnology subjects**. There are concepts which explain to the students about the exclusive Indian Governmental norms adapted for Biotechnological based product production and ethical commercialization. The students will be motivated to learn the etiquette to become entrepreneurs and have their own start-ups. At the end of Second-year students are encouraged to take up internship and during the Third year to take up a group project which would make them understand the problem statement and to find a solution through their knowledge gained.

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LEARNING OUTCOME BASED CURRICULUM FRAMEWORK

From the Academic Year 2022- 23 and thereafter

Vision

To enable the students to be ready to fill the talent gaps in the field of Biotechnology particularly in the lateral emerging areas of Biotechnology.

Mission

1. To attain the center of excellence in the environment and product resource sustainability.
2. To develop special skill set programmes which prepare the students readily employable and sustain the industrial challenges.

PROGRAMME OUTCOMES
B.Sc. BIOTECHNOLOGY

The following points are the expected outcomes of the three-year B.Sc. Biotechnology Programme of Guru Nanak College:

PO1: Dissipate knowledge of fundamental conceptual approach in the fields of Biotechnology.

PO2: Familiarize the mechanisms involved in the specific fields of Biotechnology.

PO3: Opportunities and challenges discussions pertaining to the field of Biotechnology.

PO4: Analysis and apply the new cut edge technologies in the field of Biotechnology.

PO5: Demonstration of sustainable development through the skills acquired through Biotechnology.

PROGRAMME SPECIFIC OUTCOMES
B.Sc. BIOTECHNOLOGY

PSO1: Critical knowledge and analytical skills will be acquiring to be readily placed in various jobroles in industry.

PSO2: Professional status attainment in the core fields like Fermentation technology, Health care industries: therapeutic agent development like Vaccine production and formulation nutraceutical productdevelopment and formulations, diagnostic kit development, Food industry, and also in the lateral fields like as Patent officers, Biostatisticians, *In-silico* fields like bioelectronics, bioinformatics, in the field of environmental sustainability, Bio-entrepreneurs to support the bio-based industries, Science communicators which are the need of the hour in today's world.

B.SC. BIOTECHNOLOGY
COURSE STRUCTURE 2022-25 (Onwards)

Semester	Part	Course Component	Subject Name	Credit	Hours	Internal	External	Total
Semester- I	I	Language	Tamil-I/Hindi-I/ French- I / Sanskrit-I	3	6	50	50	100
	II	English	English-I	3	4	50	50	100
	III	Core-I	Cell Biology	4	5	50	50	100
	III	Core-II	Practical I-Cell Biology and Chemistry	3	6	50	50	100
	III	Allied-I	Chemistry	5	5	50	50	100
	IV	NME/ Basic Tamil/ Adv. Tamil/ Basic Hindi	Biotechnology for society welfare/ National and International Scenario of Biotechnology/ Human Physiology / Basic Tamil/ Adv. Tamil	2	2	-	100	100
	IV	Skill based subjects	Soft skill I: Introduction to Study skills	3	2	-	100	100
Total Credit: 23 / Total Hours per week: 30								
Semester- II	I	Language	Tamil-II/Hindi-II/ French-II/ Sanskrit-II	3	6	50	50	100
	II	English	English II	3	4	50	50	100
	III	Core-III	Biochemistry	4	5	50	50	100
	III	Core-IV	Practical II-Biochemistry and Bioinstrumentation	3	6	50	50	100
	III	Allied-II	Biotechniques and Bioinstrumentation	5	5	50	50	100
	IV	NME/ Basic Tamil	Marine Biotechnology/ Herbal Science/ Basic Tamil/ Adv. Tamil	2	2	---	100	100
	IV	Skill based subjects	Soft Skill II: Life Skills	3	2	---	100	100
Total Credit: 23 / Total Hours per week: 30								
Semester- III	I	Language	Tamil-III / Hindi-III / French-III/ Sanskrit-III	3	6	50	50	100
	II	English	English III	3	4	50	50	100
	III	Core-V	Genetics	4	6	50	50	100
	III	Core-VI	Practical III – Genetics and Microbiology	3	6	50	50	100
	III	Allied-III	Microbiology	5	6	50	50	100
	IV	Skill based subjects	Soft Skill III: Job Oriented Skills	3	2	---	100	100
Total Credit: 21 / Total Hours per week: 30								

B.SC. BIOTECHNOLOGY
COURSE STRUCTURE 2022-25 (Onwards)

Semester	Part	Course Component	Subject Name	Credit	Hours	Internal	External	Total
Semester- IV	I	Language	Tamil-IV/Hindi-IV/ French-IV/ Sanskrit-IV	3	6	50	50	100
	II	English	English IV	3	4	50	50	100
	III	Core-VII	Genetic Engineering	4	5	50	50	100
	III	Core-VIII	Practical III – Genetic Engineering and Immunotechnology	3	6	50	50	100
	III	Allied-IV	Immunology and Immunotechnology	5	5	50	50	100
	IV	Skill based subjects	Soft Skills IV: Quantitative Aptitude /Digital Marketing Lab/Presentation Skills	3	2	-	100	100
	IV	EVS	Environmental Studies	2	2	-	100	100
Total Credit: 23 / Total Hours per week: 30								
Semester- V	III	Core -IX	Molecular Developmental Biology	4	5	50	50	100
	III	Core- X	Bioprocess Technology	4	4	50	50	100
	III	Core - XI	Bioinformatics and Biostatistics	3	4	50	50	100
	III	Core XII	Pharmaceutical Biotechnology	4	5	50	50	100
	III	Core XIII	Practical III - Molecular Developmental Biology, Bioprocess Technology and Bioinformatics	3	6	50	50	100
	III	Elective-I (IDE)	Intellectual Property Rights/ Herbs for healthy living	5	5	50	50	100
	IV	Value Education	Value Education	2	1	*	100	100
	V	Internship	Internship	2	-	-	-	-
Total Credit: 27 / Total Hours per week: 30								
Semester- VI	III	Core XIV	Plant Biotechnology	4	5	50	50	100
	III	Core XV	Animal Biotechnology	4	5	50	50	100
	III	Core XVI	Biosafety, Bioethics and Intellectual Property Rights	3	5	50	50	100
	III	Core XVII	Plant Biotechnology and Animal Biotechnology	3	6	50	50	100
	III	Elective II	Environmental Biotechnology/ Food Biotechnology	5	4	50	50	100
	III	Elective III	Project	5	5	50	50	100
	V	Extension Activities	Extension Activities	1	-	-	-	-
Total Credit: 25 / Total Hours per week: 30								
Grand Total Credit: 142 / Total Hours : 180								

SEMESTER-I

CORE I: CELL BIOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: I	**Credits:** 4	**Total Hours:** 75

Course Framework:

- To learn about the cellular organization in different life forms
- To learn about the different types subcellular organization and their importance.
- To learn about the various, inter and intra-cellular communication mechanisms.

Course Outcome:

On completion of the course the students will be able

1. To discuss the various fields of biotechnology and their scopes.
2. To analyse and explain the organization of living organism and to assess the role of different organelles and components of a cell.
3. To demonstrate the overview of transcription and translation of eukaryotic cells and its regulatory mechanism.
4. To analyse the types of cellular communication and to assess the phases of cell cycle and their role in cancer biology.
5. To accomplish a clear view on the structural and functional organization of cells.

Unit I: Basic Biology of Cells **(15 hrs.)**

History and Discovery of cells – Diversity of cells – General functions and properties of living cells – Formulation of cell theory - Modern Cell theory – Molecules of the cell and their chief functions – Basic Structure of bacterial, plant and animal cells – Differences between prokaryotic and eukaryotic cells.

Unit II: Structure and functions of cell organelles **(15 hrs.)**

Overview of cellular organization - Cell wall - Cell membrane: Fluid mosaic membrane model - Cell membrane Transport (Active: Symport, Uniport, Antiport and Passive transport) - Cytoplasm – Nucleus - Endoplasmic Reticulum (RER & SER) – Ribosomes – Golgi apparatus and dictyosomes - Mitochondria - Plastids - Lysosomes - Peroxisomes and glyoxysomes – Vacuoles and vesicles - Centrioles - Cytoskeleton - Microfilaments, Microtubules and Intermediate filaments – Pili, Cilia and Flagella.

Unit III: An overview of Nucleic acids **(15 hrs.)**

Discovery of Nucleic acids – Types of nucleic acids – Structure of DNA at primary and secondary levels – DNA Replication in prokaryotes and eukaryotes – Errors in DNA replication: DNA damages - DNA Proof reading methods – DNA repair mechanisms – RNA structure, types and functions.

Unit IV: The central dogma of molecular biology **(15 hrs.)**

The concept of central dogma – Gene expression and its importance - Transcription Unit - Transcription in prokaryotes and eukaryotes – RNA Processing and RNA editing – Genetic code - Translation in prokaryotes and eukaryotes - Post translational modification in prokaryotes and eukaryotes – Protein folding, protein sorting and protein degradation.

Unit V: Cell Division, differentiation, apoptosis & cancer **(15 hrs.)**

Cell cycle – Cell cycle check points – Cell division by mitosis and meiosis – cell differentiation – Apoptosis and necrosis – Formation of cancer cells - Differences between normal cell and cancer cells – Types of cancer cells.

Reference Books:

1. Devasena, Cell biology by, Oxford University Press, I Ed., 2012.
2. Geoffrey M. Cooper and Robert E. Hausman, Molecular approach to cell by, Oxford University Press, 7th Ed., 2018.
3. Channarayappa, Molecular Biology, Universities Press, 2010.
4. Gerald Karp, "Cell and Molecular Biology Concepts and Experiments", Wiley 6th Edition, 2010.
   - Harvey Lodish (Author), David Baltimore (Author), Arnold Berk,, Molecular Cell Biology 3rd Ed., W H Freeman & Co (Sd).
5. The lives of a cell –A practical –Experimental Biology-A laboratory manual by Lewis Thomas.

Useful URL:

1. https://www.youtube.com/watch?v=dMPXu6GF18M&list=PLSy2IqrL3nn9etf2mmBU3OOGY xlR H1BNN
2. https://www.youtube.com/watch?v=y623clAREHI&list=PL3993356C72C83C
3. https://www.youtube.com/watch?v=qOVkedxDqQo
4. https://www.youtube.com/watch?v=4qf1BSXn_tk
5. https://www.youtube.com/watch?v=89W6uACEb7M

6. https://www.youtube.com/watch?v=KIvBn6gfRgY

7. https://www.youtube.com/watch?v=uK6po1sLiYY

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

CORE II - PRACTICAL - I: CELL BIOLOGY AND CHEMISTRY

(a.) CORE II - PRACTICAL - I: CELL BIOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: I	**Credits:** 3	**Total Hours:** 45

Course Framework:

- To use the laboratory microscopes in a perfect approach to stain, observe, identify and examine various types of cells.
- To count, analyze and interpret the results with critique justification.

Course Outcome:

On completion of the course the students will be able

1. To handle the microscope for studying the special properties of cells
2. To distinguish various types of prokaryotic and eukaryotic cells
3. To observe different stages of cell division
4. To analyze the changes in the pattern of nucleus at various stages of cell division
5. To differentiate mitosis and meiosis cell division processes

Practical Experiments:

- Description about the Compound Microscope: Principle and construction.
- Preparation of buccal smear and examination of squamous epithelial cells
- Counting of White blood cell using Hemocytometer
- Counting of Red blood cell using Hemocytometer
- Isolation and Observation of plant cells
- Identification of Mitotic stages by root squash of *Allium cepa* (onions)
- Isolation and Observation of animal cells
- Observation of the biomolecules present in the cells
- Measurement of cell size using micrometer and occulometer
- Observation of photosynthetic algae in pond water using phase contrast microscope

Demonstration Experiments:

- Staining and observation cellular organelles (Membrane, Nucleus, Flagella & Cell wall)
- Identification of meiotic stages using Grasshopper testes
- Comparison of bacterial, plant and animal cell structure using photomicrographs & microscopes

NON-MAJOR ELECTIVE (NME-1): BIOTECHNOLOGY FOR SOCIETY WELFARE

Subject Code:	**Theory**	**Marks:** 100
Semester: I	**Credits:** 2	**Total Hours:** 30

Course Framework:

- To inculcate the importance of sustainable development.
- To identify the bio-based industries and their importance.
- To interrupt the role of Biotechnology in environmental mitigation.
- To define Bioentrepreneurship

Course Outcome:

On completion of the course the students will be able

1. To describe the impact of Biotechnology in our day-to-day life
2. To analyse the importance of Indian bio-based industries
3. To understand the role of Biotechnology in various fields
4. To discuss the applications of transgenic plants and animals
5. To demonstrate the importance of Bioentrepreneurship

Unit-I: Introduction to Biotechnology **(6 hrs.)**

Scope of Biotechnology, History of Biotechnology: Conventional and Modern Biotechnology, Branches of Biotechnology.

Unit-II: Bio-based industries **(6 hrs.)**

Bio-based cottage industries; Sericulture, Aquaculture, Apiculture, Vermicomposting technology, Mushroom technology. Historic Indian concepts of Nanobiotechnology: Wootz steel, Indian Therapies using plant extract and metal.

Unit-III: Environmental Biotechnology **(6 hrs.)**

Role of Biotechnology in Medicine, agriculture and environmental sustainability.

Unit-IV Transgenesis **(6 hrs.)**

Role of Biotechnology in improvising of economic importance flora and fauna.

Unit-V: Bioentrepreneurship **(6 hrs.)**

Meaning, Needs and Importance of Bioentrepreneurship.

Reference Books:

1. Bernard R. Glick and Jack J. Pasternak, Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press (2010).
2. S.C.BhatiaTextbook of Biotechnology, Atlantic Publishers & Dist. (2005).
3. P.K.Gupta, Elements of Biotechnology, Rastogi Publications (2014).

Useful URL:

1. https://youtu.be/g_ZswrLFSdo
2. https://youtu.be/CVa_IZVzUoc
3. https://youtu.be/N2vXsnlHxcA

NON-MAJOR ELECTIVE (NME-1): HUMAN PHYSIOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: I	**Credits:** 2	**Total Hours:** 30

Course Framework:

- To describe the types of organ system in human body
- To demonstrate the basics of human physiology

Course Outcome:

On completion of the course the students will be able

1. To explain physiological processes of all body systems in detail and on an appropriate level (knowledge, comprehension, application and analysis).
2. To explain the role of body systems and mechanisms in maintaining homeostasis.
3. To explain how the activities of organs are integrated for maximum efficiency.
4. To demonstrating higher level critical thinking skills, solving problems, and following directions.
5. To directing their own learning activities to meet course objectives.

Unit - I: Organization of human anatomy system (6 hrs)

Overview of levels of Organization in human body. Types of skeletal system and its function, Types of Muscular system and its function.

Unit - II: Circulatory System (6hrs.)

Circulatory System- Blood composition and lymph composition, Functional anatomy of the heart, bleeding time, Clotting time, Heartbeat, Cardiac cycle, Pacemaker.

Unit - III: Respiratory and Digestive system (6hrs.)

Respiratory System-Structure and functions of Lungs. Transport of gases, Non respiratory functions of the lungs. General structure of Digestive system and its functions, Gastric secretion, pancreatic secretion, mechanism of digestion, gastrointestinal hormones.

Unit - IV: Nervous System (6 hrs.)

Nervous System-Overview of nervous system, Brain: parts, functions, Spinal cord and its functions.

Unit - V: Excretory system and Endocrine system (6hrs.)

Respiratory System-Structure and functions of Lungs. Transport of gases, Non respiratory functions of the lungs. Endocrinology-Endocrine glands and their hormonal secretions, their functions.

Reference Books:

1. G. K. Pal, 'Text Book of Medical Physiology', Second Edition, 2014.
2. T. S. Ranganathan,Text Book of Human Anatomy , S.Chand&Co. Ltd.,5th,1996
3. Arthur.C.Guyton, John E Hall, 'Textbook of Medical Physiology', W.B. Saunders Company, Twelfth edition, 2006
4. Kim E. Barrett, Susan M. Barman, Scott Boitano, Ganong's Review of Medical
5. Physiology', 24th Edition, 1 May 2012.
6. Sylvia Mader (Author), Michael Windelspecht, Human Biology by, McGraw Hill publications, 14th Ed., 2015.
7. K. Sembulingam, Essentials of Medical Physiology, 6th Edition

Useful URL:

1. https://www.youtube.com/watch?v=vii3YLGouv0
2. https://www.youtube.com/watch?v=Evsqy0a_Lrk&t=246s
3. https://www.youtube.com/watch?v=Evsqy0a_Lrk
4. https://www.youtube.com/watch?v=WPjqgaMmOTE
5. https://youtu.be/URrXh0LJ6JE https://youtu.be/PLFq-1h4870 https://youtu.be/hn6YDo39tx4

NON-MAJOR ELECTIVE (NME-1)
NATIONAL AND INTERNATIONAL SCENARIO OF BIOTECHNOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: I	**Credits:** 2	**Total Hours:** 30

Course Framework:

- To recollect the concept of Traditional Biotechnology
- To illustrate the steps involved in recombinant DNA technology
- To interpret the products production through the principals of Biotechnology
- To apply the regulations at both National and International level.

Course Outcome:

On completion of the course the students will be able

1. To correlate the importance of Biotechnology.
2. To appreciate the role in bio-based product production.
3. To discuss the process of Genetic Engineering.
4. To comprehend the importance of cottage industries in scientific manner.
5. To interpret the importance of various schemes for Start-up in India.

Unit-I: History of Biotechnology (6 hrs)

Disciplines of Biotechnology and its objectives (Agricultural Biotechnology- Green, Medical Biotechnology- Red, Marine Biotechnology- Blue, Industrial Biotechnology- Grey, Food Biotechnology- Yellow, IPR and Patent- Purple, Bioinformatics & Nanobiotechnology- Gold, Environmental Biotechnology- Grey, Risk assessment in Biotechnology- Light, Bio warfare- Black/ dark). Traditional products (Curd, wine), Modern: Enzymes, Antibiotics, Vaccines, Eli Lilly-first commercial Insulin production company, Hindustan Antibiotics company Ltd.

Unit-II: Steps involved in Biotechnology (6 hrs)

- Types of Cells (Microbial, Plant and Animal)
- Enzymes involved in manipulation (Restriction enzymes, Ligase)
- Vectors: Cloning vector and Expression vector
- Selection of recombinant cells (Blue white colony)

Unit-III: Bio-based products through Biotechnology methods (6 hrs)

Vermicompost, Mushroom cultivation, Sericulture, Apiculture, Bioplastics, Biofuel, Self-cleaning paints, Antibacterial tiles, Antibacterial bed spread, Colored cotton, Essential oils and pigment from flower, waste Biofortified food (Salt, Golden rice), Insect repellent.

Unit-IV: Indian Schemes for Biotechnology based Start-ups (6 hrs)

Objectives of the following: Department of Biotechnology, BioNEST, BIRAC- Biotechnology Ignition Grant (BIG), Research Parks, Atal Incubation Centres, Bio-incubators (Infrastructure Support and marketing support), Social Innovation Immersion Program, Social Innovation Program for Products (SPARSH), Sustainable entrepreneurship and enterprise development fund (SEED fund), Students Innovations for Advancement of Research Explorations (SITARE), Promoting innovations in Individuals, Start-ups and MSMEs (PRISM), Patent Acquisition and Collaborative Research and Technology Development (PACE)

Unit-V: Global and Indian Biotechnology Industries (6 hrs)

Case study on: National: Biocon (Pharmaceutical Products), Auroville (Biobased products), Hindustan Antibiotics Limited (recombinant DNA product, rHU-Erythropoietin) International: Pfizer (Pharmaceutical Product), Syngenta (Agriculture Biotechnology), Novozymes (Industrial enzymes) A/S (Diagnostic kits).

Course Outcome:

- To apply the principles of Biotechnology in product production
- To interpret the importance of biobased product production
- To remember Indian support system for the biobased cottage industries.

Reference:

1. https://www.biotech.co.in/sites/default/files/2020-01/Biotechnology-Startup-Ecosystem-in-India.pdf

SEMESTER-II
CORE III: BIOCHEMISTRY

Subject Code:	**Theory**	**Marks:** 100
Semester: II	**Credits:** 4	**Total Hours**: 75

Course Framework:

- To demonstrate various metabolic cycles and to relate the metabolic disorders.
- To explain the properties and significance of biomolecules.
- To illustrate the significance of Enzymes.
- To interpret the role of Porphyrins and Secondary metabolites
- To describe the role of vitamins in metabolism.
- To relate the complications of metabolic disorders.

Course Outcome:

On completion of the course the students will be able

1. To compile the principles of bioenergetics, metabolism of carbohydrates
2. To compile the principles of bioenergetics, metabolism of proteins.
3. To compile the principles of bioenergetics, metabolism of lipids.
4. To relate bio applications and classifications of vitamins and hormones relate to health management.
5. To understand the metabolic disorders of Carbohydrates, Proteins and Lipids

Unit- I: Carbohydrates and its metabolism (15 hrs)

Carbohydrates: Classification and its properties (Physical and Chemical) - Carbohydrate Metabolism: Glycolysis (aerobic and anaerobic), TCA cycle - Electron Transport Chain, Gluconeogenesis, Glycogen metabolism - Functions of Carbohydrates.

Unit- II: Proteins and its metabolism (15 hrs)

Amino acids- classification properties and its biological functions .Proteins- Classification, properties and its biological significance .Biosynthesis of Amino acids (Arginine, Tyrosine, Tryptophan) and Urea Cycle.

Unit- III: Lipids and its metabolism (15 hrs)

Lipids: Classification, properties and biological importance; Fatty acid synthesis (saturated and unsaturated) and degradation (α, β, ω oxidation) - Cholesterol: Biosynthesis and degradation.

Unit- IV: Vitamins **(15 hrs)**

Vitamins -Definition and Classification (Water soluble vitamins and Fat soluble vitamins) Sources and their biological importance and vitamin deficiency diseases.

Unit- V: Metabolic disorders: **(15 hrs)**

Carbohydrate metabolic disorders - Diabetes Mellitus, Glycogen storage diseases. Protein metabolic disorders - Kwasikor, Marasmus. Lipid metabolic disorder: Fatty Liver, Atherosclerosis.

Reference Books:

1. Albert Lehninger, David Nelson, Michael Cox, Principles of Biochemistry; W.H.Freeman, 2000.
2. Donald Voet, Judith G.Voet, Charlotte W.Pratt, Fundamentals of Biochemistry: Life at the molecular level, Wiley, 5th Ed., 2016.
3. J.L.Jain, Sunjay Jain, Nitin Jain, Fundamentals of Biochemistry, S.Chand Publishers, 7th Ed., 2006.
4. Satyanaryana.U, Essentials of Biochemsitry, New India Book Agency, 2nd, 2008.
5. T.Devasena, Biomolecules, MJP Publishers, Ist Ed., 2010.
6. Donald Voet, Judith G.Voet, Biochemistry, Vol. 1: Biomolecules, Mechanisms of Enzyme Action, and Metabolism, Wiley Publishers, Ist Ed., 2003.
7. V.K. Ahluwalia, Biomolecules Chemistry of Living System, Manakin Press, 2015.
8. MN Chatterjea, Textbook of Medical Biochemistry, 8th Edition

Useful URL:

1. https://www.youtube.com/watch?v=8qij1m7XUhk
2. https://www.youtube.com/watch?v=rdF3mnyS1p0
3. https://www.youtube.com/watch?v=FmafhSMv0e0
4. https://www.youtube.com/watch?v=wQ1QGZ6gJ8w
5. https://www.youtube.com/watch?v=KwNe9x0eChs
6. https://youtu.be/9dMsDgWMq1w
7. https://youtu.be/8qij1m7XUhk
8. https://youtu.be/ubzw64PQPqM
9. https://youtu.be/C8VHyezOJD4

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum:** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

CORE IV - PRACTICAL - II: BIOCHEMISTRY AND BIOINSTRUMENTATION

(a.) **CORE IV - PRACTICAL - II: BIOCHEMISTRY**

Subject Code:	**Theory**	**Marks: 100**
Semester: II	**Credits: 3**	**Total Hours: 45**

Course Framework:

To describe the principles behind the qualitative and quantitative estimation of biomolecules (proteins, carbohydrates, lipids)

Course Outcome:

On completion of the course the students will be able

1. To apply the titrimetric principles in acid base estimations.
2. To explain and evaluate the quantitative analysis of biomolecules by colorimetric methods.
3. To demonstrate qualitative analysis of carbohydrates and amino acids.
4. To detect the biomolecules from food sample.
5. To apply the major theory and practical knowledge to contemporary industrial demands

Practical Experiment

- **Volumetric analysis:**

  a. Estimation of ascorbic acid using 2, 6 – Dichlorophenol indophenol as link solution. b. Estimation of calcium in milk.

- **Qualitative analysis:**

  a. Qualitative analysis of carbohydrates- glucose, fructose, galactose, lactose, maltose and sucrose.

  b. Qualitative analysis of amino acids – arginine, cysteine, tryptophan and tyrosine.

- **Quantitative analysis:**

  a. Colorimetric estimation of protein by Lowry's method.

  b. Colorimetric estimation of Carbohydrate by Anthrone method.

  c. Colorimetric estimation of Cholesterol by Zak's method.

- **Biochemical preparations:**

  a. Preparation of casein from milk.

  b. Preparation of starch from potato.

Demonstration Experiments:

- Demonstration of density gradient centrifugation by separating of Blood cell by using sucrose density.
- TLC separation of Carbohydrates (glucose and fructose) and amino acid (Glycine and proline).
- Demonstration of the usage of semi auto-analyzer for blood, serum and urine biochemical parameters.

Reference Books:

1. David Plummer, An introduction to practical Biochemistry, Tata McGraw-Hill Education, 1998
2. Sowbhagya Lakshmi and Divya ShanthiD'Sa, An easy guide for practical Biochemistry by,Jaypee Brothers Medical Publishers (P) Ltd., 2010.
3. T.Devasena, Techniques in Biochemistry, Ahuja Publishing House, 2010.
4. G. Devala Rao, A manual of practical biochemistry, *Birla* Publications (Regd) Pvt Ltd., 2015.

(b.) CORE IV - PRACTICAL - II: BIOINSTRUMENTATION

Subject Code:	**Theory**	**Marks:** 100
Semester: II	**Credits:** 3	**Total Hours:** 45

Course Framework:

- To operate the basic laboratory instruments and record the results for further interpretations.
- To separate mixtures, analyze the samples qualitatively and relate their properties
- To learn about the working principles and handling of laboratory instruments.

Course Outcome:

On completion of the course the students will be able

1. To become proficient in instrumentation handling.
2. To isolate bioactive compounds from various plants extract.
3. To follow standard operating procedures.
4. To apply the theory principles easily in every experiment.
5. To carry out small research projects on their own.

Practical Experiments:

1. Separation of blood cells based on sucrose density gradient centrifugation
2. Extraction of plant compounds by using Soxhlet Apparatus
3. Separation of Plant leaf components by Thin Layer Chromatography
4. Separation of Plant pigments by column chromatography
5. Estimation of proteins from food sample (egg) by UV- Spectrophotometer
6. Visualization of various DNA fragments by using Agarose Gel Electrophoresis (nicked, linear, super coiled and circular single strand DNA, degraded DNA bands).

Demonstration Experiments:

1. Examination of pond water sample by Phase Contrast Microscope.
2. Demonstration of salivary amylase activity using pH meter.

ALLIED II: BIOTECHNIQUES AND BIOINSTRUMENTATION

Subject Code:	**Theory**	**Marks:** 100
Semester: II	**Credits:** 5	**Total Hours:** 75

Course Framework:

- To understand the good and suitable practical knowledge of Biotechnology lab.
- To understand the usage of instruments in analyses, purification of biomolecules, cells and tissues.
- To understand the collection, interpretation of data in a mathematical and computer aid method.

Course Outcome:

On completion of the course the students will be able

1. To interpret the principle, instrumentation, types and applications of microscopes.
2. To demonstrate the types and applications of centrifuges.
3. To perform various chromatography techniques independently.
4. To analyze the biomolecules qualitatively and quantitatively.
5. To integrate the principles of electrophysiology techniques in the field of biotechnology.

Unit – 1: Microscopy **(15 hrs.)**

Microscopes – Magnification and resolution power - Micrographs – Microscope lenses and types - Simple microscopes – Compound microscopes — Basic operation procedures of a Bright field microscope – Types of microscopes - Dark field microscopes - Phase contrast microscopes – Fluorescent microscopes – Electron microscope (SEM & TEM) – Applications of microscopes and cell architecture studies.

Unit – II: Centrifugation **(15 hrs.)**

Forces involved in centrifugation: Gravitational force, centrifugal force and centripetal force. Principles of sedimentation – Stroke's law - Factors influencing centrifugation – Rotors used in centrifuges -Types of centrifuges – Preparative centrifugation – Analytical centrifugation – Applications of centrifugation in separation of cells and molecules.

Unit – III: Chromatography **(15 hrs.)**

Stationary phase – Mobile phase – Types of separation mixtures – Capillary action - Partition coefficient – Distribution coefficient – Rf Value - Paper chromatography – Thin layer chromatography –- Column chromatography – Size exclusion chromatography - Ion exchange chromatography – Affinity chromatography – High pressure liquid chromatography – Gas liquid chromatography.

Unit – IV: Colorimetry and Spectroscopy **(15 hrs.)**

Colorimeter: Principles, types and application. Spectroscopy: Overview. Principles, instrumentation and applications of UV-Visible spectroscopy - Fluorescence spectroscopy – Atomic absorption spectroscopy - Gas Chromatography - Mass Spectrometry.

Unit – V: Electrophysiology **(15 hrs.)**

Basics of electrophysiology - Voltage clamp technique: Principle and applications. Patch clamp technique: General Principles – Types: Cell attached recording, whole cell recording, Inside out recording, outside out recording. Applications of patch clamp technique in various fields.

Reference Books:

1. Keith Wilson, John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th Ed) Cambridge University Press
2. David Sheehan (2009), Physical Biochemistry: Principles and Applications (2^{nd} Ed), Wiley- Blackwell
3. David M. Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W.H.Freeman
4. Rodney F. Boyer (2012), Biochemistry Laboratory: Modern Theory and techniques, (2^{nd} Ed), Prentice Hall
5. Kaloch Rajan (2011), Analytical techniques in Biochemistry and Molecular Biology, Springer.

Useful URL:

1. https://www.youtube.com/watch?v=VpiqscrcbME
2. https://www.youtube.com/watch?v=U5N2uxHNzxg
3. https://www.youtube.com/watch?v=Dq5JgsxJpTY
4. https://www.youtube.com/watch?v=W0oacysFTko
5. https://www.youtube.com/watch?v=1uPyq63aRvg
6. https://www.youtube.com/watch?v=SsIYDEma_cU
7. https://www.youtube.com/watch?v=2rYmUxqz3jo&list=PLFD540BF4995B4469

8. https://www.youtube.com/watch?v=x8one-B_Y1w
9. https://www.youtube.com/watch?v=sOb9b_AtwDg

***Industrial Visit to sophisticated instrumentation facility**

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

NON - MAJOR ELECTIVE (NME-2): MARINE BIOTECHNOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: II	**Credits:** 2	**Total Hours:** 30

Course Framework:

- To identify the importance of marine eco-system
- To demonstrate concept of genetic engineering in the betterment of aquatic culture.

Course Outcome:

On completion of the course the students will be able

1. To understand the marine life and ecology.
2. To demonstrate the bioprospectiveness of marine organisms in the Indian Coast.
3. To discuss the importance of Aquaculture
4. To demonstrate the strategies of Marine Bioprospecting
5. To list out the commercial products from marine bacteria.

Unit-I: Marine ecosystem **(6 hrs.)**

Marine ecosystem, Estuarine ecosystem, Marine micro flora and fauna diversity in Coromandel coast; Introduction to marine pharmacology**:** Terms and definitions; therapeutic compounds from marine flora and fauna.

Unit-II: Marine organisms in Indian coast **(6 hrs.)**

Salient features of economically important marine organisms in Indian coast (i.) Algae (Micro and macro) (ii.) Sponges (iii.) Mollusc (iv.) Hydrocoral, (v.) Soft corals, (vii.) Hard corals (vi.) Sea cucumber, (vii.) Zooanthids, (viii.) Bivalves, (ix.) Sea grass, (x.) Star fishes, (xi.) Jelly fish, (xii.) Shrimps, (xiii) Crabs, (xiv) lobsters; Economic important marine fishes.

Unit-III Importance of Aquaculture **(6 hrs.)**

Commercial importance aquaculture breeds (Fin Fishes, Rotifers, Crustaceans, Oyster: Classification and salient features); Kappaphycus and Sargassum algal culture and feed formulation for Sea Bass and Milkfish, Aquaculture farm: Set-up & management (Fin-fishes farm, crustacean farms, Shell fishes); Feed formulation; Health management of commercially important animals

Unit- IV Marine Bioprospecting **(6 hrs.)**

Indian marine research institutes and marine products based Indian industries; Bioproducts from marine organisms: (i.) Molluscan Derived Compounds (Ziconotide, Elisidepsin) (ii.) Cnidarian

Derived Compounds (Prialt and Yondelis), (iii.) Ascidian Derived Compounds (Benzopentathiepin varacin), (iv.) Bryozoans Derived Compounds (Bryostatins), (v.) Helminth Derived Compounds (Lacto-N-Fucopentose III), (vi.) fish derived compounds (Vitamin A & D, Eicosapentaenoic acid and docosahexaenoic acid), (vii.) Marine algae based compound (Agar, Carrageenan, β-Carotene, Phycocyanin, Biofuel).

Unit-V Commercial products from marine bacteria (6 hrs.)

Marine Bacteria: Examples (emphasizing upon beneficial bacteria) and Commercial products (Nutraceuticals, therapeutic, diagnostic compounds- GFP); Role of marine bacteria in: Biodegradation, Bioagumentation, Bioremediation, Biofouling.

Reference books:

1. Garth L. Fletcher, Matthew L. Rise, Aquaculture Biotechnology, Wiley Blackwell, 2012.
2. Marine Biotechnology: enabling solutions for ocean productivity and sustainability, Organisation for Economic Co-Operation and Development, OECD, 2013
3. V. Ramachandran, Aquaculture Biotechnology, Black Prints India Inc., 2013.
4. Manjushree Acharya, Aquatic and Marine Biology, Mittal Publishers, 2011.

Useful URL:

1. https://www.youtube.com/watch?v=hv1U19J3yfw
2. https://www.youtube.com/watch?v=KTy_0dzLiu8
3. https://www.youtube.com/watch?v=8_1Ng3SCvCU
4. https://www.youtube.com/watch?v=pnjFfxj9FHE
5. https://www.youtube.com/watch?v=EXb2hK7odd4

NON-MAJOR ELECTIVE (NME-2): HERBAL SCIENCE

Subject Code:	**Theory**	**Marks:** 100
Semester: II	**Credits:** 2	**Total Hours:** 30

Course Framework:

- The interpret the history of the herbal medication in India
- Compare and analyse the compound with medical property, which are available.
- To identify and discuss the extraction of various phytochemical present in plants.
- To give examples for the herbal therapies used for various diseases.
- To develop herbal garden and to justify the importance of herbal medicines.

Course Outcome:

On completion of the course, the students will be able

1. To clarify the traditional medication
2. To differentiate the herbs and the medications.
3. To extract and analyse the phytochemicals from plant samples.
4. To understand the herbal based therapies for diseases
5. To maintain the herbal garden and to demonstrate its applications.

Unit I: History of Herbal Medication (6 hrs.)

History of herbal medicine, Herbal medication in India (Ayurveda, Unnai, Siddha)

Unit II: Regional Herbs with medicinal importance (8 hrs.)

Medicinal plants in India and Tamil Nadu and their medicinal properties: (i.) Spices: *Zingiber officinale* (Ginger), *Capsicum annuum* (pepper), *Murraya koenigii* (curry leaf), *Cinnamomum zeylanicum* (cinnamon), *Curcuma longa* (Turmeric), *Ocimum tenuiflorum* (Tulasi) , *Sesamum indicum* (Sesame Seeds), *Phyllanthus emblica* (Amla), *Plectranthus amboinicus* (Mexican mint), *Centella asiatica* (Vallarai), *Withania somnifera* (Ashwagandha), (*Trigonella foenum-graecum*) Fenugreek, *Piper longum* (Thipilli), *Acorus calamus* (Vasambu); (ii.) *Mangifera indica* (Mango), *Psidium guajava* (Guava), *Daucus carota* (Carrot), *Cissus quadrangularis* (Pirandai), *Azadirachta indica* (Neem), *Momordica charantia* (Bitter guard), *Moringa oleifera* (Drumstick), Amaranthus, *Linum usitatissimum* (Flax seeds), *Aloe barbadensis* (Aloe vera).

Unit III: Phytochemical analyses **(6 hrs.)**

Plant extract preparation (Hot and cold extraction), Phytochemical detection and qualitative analyses of the phytochemicals.

Unit IV: Herbal based therapies for disease **(6 hrs.)**

Fracture: *Ormocarpum sen noides* (Elumbotti), Dengue- *Carica papaya* (Papaya) leaf extract, Cancer: *Vinca rosea*, Lycopene – *Lycopersicum esculentum* (Tomato), Astaxanthin – Algae.

Unit V: Field Work **(4 hrs.)**

Study of medicinal plant present within Guru Nanak College campus.

***Herbarium and Herbal Garden maintenance, Field visit to Herbal Garden**

Reference Books:

1. Herbal Drugs Industry, V. Rajpal and DPS Kohli. 2nd Edition, 2009, Business Horizons.
2. Traditional Herbal Medicine Research Methods: Identification, Analysis, Bioassay, and Pharmaceutical, 2011, Willow J.H. Liu Hardcover, Publishers-Wiley.
3. Herbal Medicine in India, Indigenous Knowledge, Practice, Innovation and its Value, **Sen**, Saikat, Chakraborty, Raja, 2020, Springer.
4. The Complete Handbook of Nature Cure 5th edition, by Dr. H.K. Bakhru, Publications by Jaico. The Complete Book Of Ayurvedic Home Remedies: A comprehensive guide to the ancient healing of India, by Vasant Lad, 2006, Publications by Piatkus
5. Secrets of Natural Diet, by Dr. Brij Bhushan Goyal, 2013, Sterling ***Publishers*** Pvt Ltd.
6. Herbs of Siddha Medicine, Volume 1: The First 3D Book on Herbs, J Raamachandran, Publication by DR.J. Raamachandran**.**

Useful URL:

1. https://www.youtube.com/watch?v=efM3_aKO0E0
2. https://www.youtube.com/watch?v=rE-z_0Nt_kA
3. https://www.youtube.com/watch?v=fLIs4Z4xHWQ
4. https://www.youtube.com/watch?v=Kt0Lgy17I78
5. https://www.youtube.com/watch?v=HzTvEK1sVi0

SEMESTER-III
CORE V: GENETICS

Subject Code:	**Theory**	**Marks:** 100
Semester: III	**Credits:** 4	**Total Hours:** 90

Course Framework:

- To relate genotypes with phenotypes and describe the inheritance pattern of Mendelian and non-mendelian genetic principles
- To categorize and discuss various types of genetic disorders and their clinical complications.

Course Outcome:

On completion of the course, the students will be able

1. To demonstrate the classical Mendelian experiments.
2. To interpret the impact non-Mendelian concepts.
3. To explain the principles of molecular basis of inheritance.
4. To discuss the theories and mechanism of evolution on genetic basis.
5. To discuss the effects of mutation in genetic disorders and gender defects.

UNIT I: Classical Genetics & Mendelian inheritance (18 Hours)

Historical concepts of genetics – Gregor Mendel's experiments on pea plants (Monohybrid cross and dihybrid cross) – Mendelian laws of inheritance: Law of dominance, law of segregation and law of independent assortment – Back cross – Test cross – Rediscovery of Mendelian principles

Unit II: Classical genetics & Non-mendelian inheritance (18 Hours)

Principles of Multiple alleles – Co-dominance – Incomplete dominance – Epistasis – Polygenic inheritance – Genetic linkage – Morgan's experiments on drosophila – Crossing over and genetic recombination – Alfred Sturtevant's linkage mapping based on recombination Frequency

Unit III: Molecular Genetics (18 Hours)

Discovery of chromosomes - Chromosome theory of inheritance – Structural organization of chromosomes in prokaryotes and eukaryotes – Structure of chromosomes - Human karyotyping - Types of chromosomes (Autosomes and Sex chromosomes) – Classification of chromosomes based on centromere - Discovery of DNA as the genetic material: Griffith's Experiment, Avery's experiment and Hershey – Chase Experiment

Unit IV: Population Genetics **(18 Hours)**

Allelic polymorphism - Principles and importance of genetic variation and natural selection - Mutations (types and factors) - Genetic drift (Bottleneck effect and Founder's Principle) – Speciation - Hardy-Weinberg's law (Goon pool and gene frequency) – Pedigree analysis – Overview of Human Genome Project.

Unit V: Genetic disorders **(18 Hours)**

Monogenic inheritance – Sex linked inheritance – X-linked dominant inheritance –X- linked recessive inheritance – Y-linked inheritance – Polygenic inheritance – Chromosomal abnormalities: Autosomal structural abnormalities & Numerical abnormalities – Sex chromosomal abnormalities (XO, XXX, XXY, XYY, XX Male & XY Female Syndromes) – Gender defects and gender defectivephenotypes.

Reference Books:

1. Dr. P.S.Verma and V.K.Agarwal, Genetics, S.Chand Publishers, 2010.
2. Daniel L.Hartl, Bruce J.Cochrane, Genetics, Analysis of Genes and genomes, Jones and Bartlett Publishers, 6th Ed., 2005.
3. Gardner, Simmons and Snutad Principles of Genetics, John Wiley & Sons Ltd., 8 Ed., 2005.
4. R.S.Shukla, R.S.Shukla, Cytogenetics, Evolution, Biostatistics, Plant breeding, S.Chand, 5 Ed., 2016.
5. Richard Dawkins, The Selfish Gene, Oxford University Press, 4 Ed., 2016.
6. Jocelyn E. Krebs (Author), Elliott S. Goldstein (Author), Stephen T.Kilpatrick (Author)Lewin's Genes XII, Jones & Bartlett Learning; 12 Ed., 2017.
7. Steve Olson, Mapping Human History: Genes, Race and our common origins, Mariner Books;First Ed, 2003.
8. Sharma & Chakraborty, A Textbook of Developmental Genetics, Wisdom press. 2013.
9. Narain & Naha, Handbook of Heredity & Genetics, Wisdom Press, 2012.

Useful URL:

1. https://www.youtube.com/watch?v=mBq1ULWJp_M
2. https://www.youtube.com/watch?v=0bfpOhbKEAk&t=8s
3. https://www.youtube.com/watch?v=NWqgZUnJdAY&start_radio=1&list=RDQMA-0RaR5RrOw
4. https://www.youtube.com/watch?v=1ZXkPk9Rr5M
5. https://www.youtube.com/watch?v=Dzt3XdSZ1eI
6. https://www.youtube.com/watch?v=RTo2lRgfluI

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

CORE VI – PRACTICAL – III: GENETICS AND MICROBIOLOGY

(a.) CORE VI– PRACTICAL – III: GENETICS

Subject Code:	**Practical**	**Marks:** 100
Semester: III	**Credits:** 3	**Total Hours:** 45

Course Framework:

- To culture the genetic model organisms on their own and witness the pattern of inheritance and phenotypic expression of genetic traits
- To observe, analyze the structure of chromosomes and karyotypes of chromosomal autosomes and sex chromosomal abnormalities in humans.

Course Outcome:

On completion of the course the students will be able

1. To analyze the karyotypes of human chromosome using photomicrograph
2. To differentiate the male, female, wild and mutant types of drosophila
3. To culture genetic model- drosophila and to observe stages of its life cycle
4. To perform the blood grouping and discuss the mechanism of co-dominance
5. To classify the types of human chromosomes based on their structure

Practical Experiments:

1. Observation of seven characteristics of Pea plant using photomicrographs
2. Identification of human blood groups and demonstration of multiple allelism and co-dominance
3. Preparations of culture medium of *Drosophila melanogaster* (Fruit fly)
4. Maintenance and culture of *Drosophila melanogaster* in lab
5. Preparation of Giant chromosomes from Chironomous larvae/Drosophila larvaesalivary glands.
6. Identification of different types of Human chromosomes (Metacentric, submetacentric, Telocentric and acrocentric) by Photomicrographs.

Demonstration Experiments:

1. Drosophila: Life cycle, male, female, wild type and mutant type differentiation
2. Identification of chromosomal abnormalities using photomicrographs of karyotypes
3. Expression of recombination using *Portulaca grandiflora* (button rose plant).

Reference Books

1. Dr. P.S.Verma and V.K.Agarwal, Genetics, S.Chand Publishers, 2010.
2. Daniel L.Hartl, Bruce J.Cochrane, Genetics, Analysis of Genes and genomes, Jones and Bartlett Publishers, 6th Ed., 2005.
3. Gardner , Simmons and Snutad Principles of Genetics, John Wiley & Sons Ltd., 8th Ed., 2005.
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6. Steve Olson, Mapping Human History: Genes, Race and our common origins, Mariner Books; First Ed, 2003.
7. Sharma & Chakraborty, A Textbook of Developmental Genetics, Wisdom press. 2013.
8. Narain & Naha, Handbook of Heredity & Genetics, Wisdom Press, 2012.

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2. https://www.youtube.com/watch?v=0bfpOhbKEAk&t=8s
3. https://www.youtube.com/watch?v=NWqgZUnJdAY&start_radio=1&list=RDQMA-0RaR5RrOw
4. https://www.youtube.com/watch?v=1ZXkPk9Rr5M
5. https://www.youtube.com/watch?v=Dzt3XdSZ1eI
6. https://www.youtube.com/watch?v=RTo2lRgfluI

CORE VI– PRACTICAL – III: GENETICS AND MICROBIOLOGY
(b) CORE VI: PRACTICAL – III: MICROBIOLOGY

Subject Code:	**Practical**	**Marks:** 100
Semester: III	**Credits**: 3	**Total Hours**: 45

Course Framework:

- To explain the importance of the staining techniques for bacterial identification
- To identify the bacteria based upon the various biochemical properties.
- To isolate the bacteria from different types of samples such as air, water and soil.
- To isolate industrial important microbes.

Course Outcome:

On completion of the course the students will be able

1. To demonstrate the methods involved in the microbial culture identification and the methodologies involved in different microbial cultures.
2. To apply the microbes for agricultural benefits.
3. To discuss about the quality of water.
4. To evaluate the total bacterial count in air.
5. To evaluate the role of antibiotics anti-microbial agent.

Practical Experiments:

1. Staining protocols
   - Simple staining
   - Differential staining (Gram's staining: Gram positive bacteria: Cocci in chains, cocci inclusters, Bacilli spp., Gram negative strain: *E. coli*)
   - Special staining (Spore, Capsular and Metachromatic staining)
2. Isolation and confirmation of *E. coli* from sewage water
3. Isolation of plant growth promoting bacteria from rhizosphere soil sample (confirmphosphatase, siderophore).
4. Isolation of probiotic bacteria (aerobic and anaerobic) from curd sample
5. Screening of enzyme producing bacteria: Starch hydrolysing bacteria
6. Isolation of bacteria from marine sample using Zobell medium.
7. To identify the various colony of bacteria isolated from soil sample.
8. Fungus identification by - Lactophenol cotton blue staining method.
9. Antibiotic sensitivity test: Disc diffusion method.

Demonstration Experiments:

1. Demonstration of Pigment producing and fluorescents bacteria
2. Demonstration of bacteriophage plaques
3. Water quality test-MPN test
4. Open plate technique.

Reference Books:

1. TSR manual
2. Bergey's Manual of Systematic Bacteriology, David Hendricks Bergey, 9th Ed.,
3. Practical Microbiology - A Laboratory Manual, Senthilkumar Balakrishnan, Zothansanga, Senbagam Duraisamy, Guruswami Gurusubramanian, Panima Publishing Corporation, New Delhi, India, 2013.
4. General Microbiology Laboratory Manual, Biology 490, Sam R. Zwenger, Ph.D., 2nd Ed.

ALLIED III: MICROBIOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: IV	**Credits:** 5	**Total Hours: 90**

Course Framework:

- To identify the evolution of microbes and their classification.
- To evaluate the various sterilization techniques.
- To classify the microbes and demonstrate the various biochemical test to identify themicrobes.
- To identify and interpret the microbial interactions.
- To relate the importance of microbes in the field of agriculture and plant growth.
- To evaluate the role of microbes in environmental.

Course Outcome:

On completion of the course the students will be able

1. To determine the evolution of microbes.
2. To describe the sterilization techniques of microbes.
3. To discuss the various biochemical test for the bacterial identifications.
4. To identify the role of microbes in agriculture
5. To interpret the applications of microbes in environment recalcitration.

Unit I: Introduction to Microbes and its classification (18 hrs.)

History of Microbiology and importance of Microbiology; Branches of Microbiology. Whitakaer classification, Bacteria (Ultrastructure of bacteria – functions of subcellular organelles and Bacterial Genomic DNA & plasmids); Classification of Microbes (1.) Based upon their shape (2.)Cell wall (3.) nutritional classification of bacteria (4.) Optimum growth temperature (5.) Basedupon its primitiveness (1.) Archaebacter and Eubacter; General properties of (i) Virus (iii.) fungi, (iii.) protozoa, (iv.) algae.

Unit II: Sterilization and culture techniques (18 hrs.)

(i.) Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultra-sonication, filtration. Physical and Chemical methods of sterilization; disinfection sanitization, antisepsis, sterilants and fumigation. (ii.) Media: Properties and types; Bacterial culturing techniques; Bacterial growth, bacterial growth curve determination; calculation of generation time

Unit III: Bacterial identification and microbial interaction (18 hrs.)

Classification of staining techniques (Simple staining, Differential staining and Special staining); Biochemcial test for bacterial identification (principles of Catalase, Hydrolyase, IMViC, growth on differential medium: Mac Conkey, Blood agar, TSI, Nitrate reductase, citrate utilisation, OF- test, motility test, gelatin utilization, growth pattern on selective medium); Microbial interactions Mutualism, Commensalism, symbiotic association, saphrophytic and parasitic: Kotch postulatesto understand the host parasite interaction, Antibiotics: Classes (Cell wall & cell membrane degrading, Inhibition of protein synthesis, disassembly of ribosomal assembly and inhibition of DNA replication).

Unit IV: Role of microbes in agriculture (18 hrs)

Azolla, Azospirillum, Cyanobacteria as biofertilizer, Mycorrhizal fungi as biofertilizers –

- Importance of Ecto, Endormycorrhizae, Calcium and Phosphate solubilisation bacteria.

Unit V: Environmental applications of microbes (18 hrs)

Sewage and wastewater treatment purification, Microbial ore leaching; Microbial bioremediation of pesticides and Xenobiotic compounds; Phytoremediation (Microscopic and macroscopic algae) - concepts and application. Microbes as Biosurfactants.

Reference Books:

1. Pelezar, Chan, "General Microbiology"– Krieg Tata McGraw Hill Publications, 2007.
2. Ananthanarayan and Paniker's Textbook of Microbiology, 10th Ed., UniversitiesPress. 2017.
3. Prescott, Harley and Klein, "Microbiology", McGraw Hill publications, Fifth edition,2003.
4. Jacquelyn G.Black, "Microbiology -Principles and Explorations" Wiley publications2008.
5. VarunShastri, Microbes by Isha Books, Ist Ed., 2006.
6. Microbiology Laboratory by V.R. Ramamurthy, Black Prints India Inc., Ist Ed., 2013.
7. Handbook of Food Technology by NIIR, National Institute of Science publication.
8. Hans-Joachim Jördening, Josef Winter, "Environmental Biotechnology: Concepts and Applications", Wiley, 2006.
9. Chandrawati Jee, Shagufta,"Environmental Biotechnology", APH Publishing, 2007.
10. Bacterial Biotechnology by Bhattacharjee& Sridhar, Wisdom Press.
11. Environmental Toxicology and Biotechnology by S. K. Dubey& S. Ghose, DominantPublishers & Distributors (P) Ltd., 2009.
12. Environmental Biotechnology by Scragg, Oxford.

Useful URL:

1. https://www.youtube.com/watch?v=iDVq2etiknU
2. https://www.youtube.com/watch?v=qZXOILsh9ro
3. https://www.youtube.com/watch?v=zDmP14twN8g&t=77s
4. https://www.youtube.com/watch?v=y_EhCERWzfs
5. https://www.youtube.com/watch?v=Et1v8EQP10U

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

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	Unit – 5	2
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	Unit – 2	1
	Unit – 3	1
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	Unit – 5	2

CORE VII: GENETIC ENGINEERING

Subject Code:	**Theory**	**Marks:** 100
Semester: IV	**Credits:** 4	**Total Hours: 75**

Course Framework:

- To demonstrate the processes of r-DNA technology and discuss the technical aspects ofevery steps.
- To use the tools of genetic engineering in a determined way to reach out their specificstudy.

Course Outcome:

On completion of the course the students will be able

1. To explain the mechanism of enzymes involved in Recombinant technology
2. To select appropriate types of vectors and expression systems for molecular cloning
3. To screen and distinguish the Transformants and Non-Transformants
4. To learn the importance of molecular techniques for analyzing the biomolecules
5. To apply the principles of genetic engineering in the field of agriculture, medicine and research.

Unit I: Natural genetic recombination processes (15 hrs)

Genetic recombination in bacteria (transformation, transduction and conjugation) - Transposable elements in plants - Horizontal (viral) and vertical (sexual reproduction) Gene transfer in animals - Restriction modification system – Basics of rDNA technology & molecular cloning – Ethical concerns of gene cloning.

Unit II: Molecular tools (Enzymes) (15 hrs)

Nucleases: Endo and Exonucleases - Restriction Enzymes (Type I, II, III, IV & V) - RNases (Ribonuclease-H, Ribonuclease-A) - Dam Methylase - Polymerases: DNA Pol I, Klenow Fragments, Taq Polymerases - Terminal Transferase, T4 Polynucleotide Kinase, Alkaline Phosphatases, Reverse Transcriptases, Topoisomerases - Proteases: Endo & exopeptidases - Ligases: T4 Ligases, *E. coli* DNA Ligase

Unit III: Biology of Cloning vectors (15 hrs)

Properties of vectors - Bacterial vectors: pBR322, pUC - BAC vectors - λ phage vector: Charon vector, Cosmid vectors, M13 vectors - Animal viral vectors: Retro viral and Vaccinia vector - Plant

vectors: Ti plasmid vectors (Bipartite vectors), CaMV in combination with TMV vectors - Yeast Vectors: YAC vectors - Expression vectors: Three rules of construct, pBluescript-sk vectors (+/-), pGEM vector.

Unit IV: Gene expression systems **(15 hrs)**

Bacterial expression systems (*E. coli* and *Bacillus*) - Yeast expression systems (*Saccharomyces cerevisiae* and *Pichia pastoris*) - Mammalian expression systems (Chinese hamster ovary cells and mouse myeloma cells) - Methods of gene transfer into the expression system: Chemical, Physical & Viral mediated DNA transfer - Selection & Screening techniques: Lac Z gene & HGPRT selection

Unit V: Core molecular techniques **(15 Hrs)**

Polymerase Chain Reaction - Quantitative Real Time PCR - Gel Electrophoresis: AGE & PAGE - Blotting Techniques: Southern, Western & Northern Construction of Genomic & cDNA Libraries - DNA Sequencing methods - Protein Engineering: Site Directed Mutagenesis. Overview of applications of genetic engineering in medicine and research

Reference Books:

1. Desmond S. T. Nicholl, "An Introduction to Genetic Engineering" 2008.
2. Russ Hodge and Nadia Rosenthal, "Genetic Engineering: Manipulating the Mechanisms ofLife" (Genetics & Evolution) 2009.
3. Howe C. J., "Gene Cloning and Manipulation" 2007
4. Principals of gene manipulation by R.W. Old and S.B. Primrose, Blackwell Scientific Publications, 1985.
5. J. M. Walker and E.B. Gingold, Molecular Biology and Biotechnology, Panima Publishing Corporation; 3rd Ed., 2001.
6. Subodh Saxena, Genetic Engineering, Black Prints India Inc., 2014.
7. Tissue Culture & Non-gene Biotechnology by Harinder Chaddha, 2011.

Useful URL:

1. https://www.youtube.com/watch?v=3IsQ92KiBwM
2. https://www.youtube.com/watch?v=BK12dQq4sJw
3. https://www.youtube.com/watch?v=glt8iAqK8NQ
4. https://www.youtube.com/watch?v=JmveVAYKylk

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
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	Unit – 3	2
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	Unit – 3	1
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	Unit – 5	2
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	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

CORE VIII – PRACTICAL – IV: GENETIC ENGINEERING AND IMMUNOTECHNOLOGY

(a.) CORE VIII – PRACTICAL – IV: GENETIC ENGINEERING

Subject Code:	**Practical**	**Marks: 100**
Semester: IV	**Credits: 3**	**Total Hours: 45**

Course Framework:

- To apply the principles of molecular techniques to examine biological samples
- To isolate, visualize and analyze the biomolecules and determine their properties.

Course Outcome:

On completion of the course the students will be able

1. To extract the biomolecules: Protein, DNA and RNA by centrifugation methods
2. To separate and observe the biomolecules by electrophoretic techniques
3. To estimate the biomolecules using the UV-spectroscopy analyses
4. To maintain the stock bacterial cell used in genetic engineering experiments
5. To demonstrate the amplification of DNA by PCR

Practical Experiments:

1. Isolation of genomic DNA from *E. coli* cell culture and purity check by using UV-spectroscopic analysis.
2. Agarose gel electrophoresis of DNA sample and demonstration of different types of DNA bands.
3. Isolation of plasmid DNA from *E.coli* cell and demonstration by Agarose gel electrophoresis.
4. Determination of molecular weight of the DNA sample by graphical method.
5. Preparation of protein from bacterial cell and demonstration of protein profiling by SDS-PAGE.
6. Restriction digestion experiments and demonstration of bands using agarose gelelectrophoresis

Demonstration Experiments:

1. Extraction of DNA from animal tissues
2. Blue white colony screening
3. Polymerase Chain Reaction

Reference books:

1. T. Maniatis, E. F. Fritsch, J. Sambrook, Molecular cloning, a laboratory manual (Volume-1, volume-2 and volume-3), Cold Spring Harbour, 3rd, Ed., 2001.
2. S. Janarthanan and S. Vincent, Practical Biotechnology: Methods and Protocols by Orient Black Swan and Universities Press, 2007.
3. Stefan Surzycki, Basic techniques in molecular biology, Springer, 2000.
4. Heather Miller, D.Scott Witherow, Molecular biology techniques: A classroomlaboratory manual, Academic Press 3rd Ed., 2011.
5. Basic Laboratory Calculation for Biotechnology by Seidman, Pearson, 2008.

(b.)CORE VI: PRACTICAL – III: IMMUNOTECHNOLOGY

Subject Code:	Practical	Marks: 100
Semester: IV	Credits: 3	Total Hours: 45

Course Framework:

- To identify the immune cells in vertebrate system
- To demonstrate the separation of serum and plasma.
- To discuss about the different types of serum proteins.
- To explain the principles of agglutination reactions and precipitation reactions.

Course Outcome:

On completion of the course the students will be able

1. To demonstrate the different types of human blood cells.
2. To apply the immunoelectrophoresis in serum protein separation.
3. To identify the phagocytic cells and describe the mechanism of microcidal property.
4. To describe the principles of agglutination and precipitation in disease diagnosis.
5. To demonstrate the various advanced immune-technologies

Practical Experiments:

1. Differential staining and identification of WBC.
2. Preparation of serum and plasma from whole blood
3. Serum protein separation by Agarose gel electrophoresis
4. Demonstration of Anti-inflammatory effects of turmeric by using RBC as model.
5. Agglutination reaction: Blood grouping
6. Identification of phagocytic cells

Demonstration experiments:

- Agglutination reactions: WIDLA TEST, ASO, CRP test
- Precipitation reactions: SRID, ODD-Pattern, Counter Immunoelectrophoresis, Immunoelectrophoresis.
- ELISA- To detect Antigens
- Western blotting

Reference Books:

1. Frank C. Hay, Olwyn Westwood, Practical Immunology (4th Ed.,), Blackwell Publications.
2. Christine Dorresteyn Stevens, Clinical Immunology & Serology by A laboratory perspective, 3rd Ed., F. A. Davis.

ALLIED IV: IMMUNOLOGY AND IMMUNOTECHNOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: IV	**Credits:** 5	**Total Hours**: 75

Course Framework:

- To describe the evolution of immunology among various host cells.
- To explain immune responses in various host cells.
- To analyse the acquired responses
- To differentiate the various, the processes involved in clearance of immuno-complex and hypersensitivity reactions.
- To select the various immune technologies in disease diagnosis.

Course Outcome:

On completion of the course the students will be able

1. To discuss the immune responses in host cells.
2. To recognize the innate and acquired immune responses.
3. To explain the acquired immune responses
4. To discuss the clearance of immune responses and hypersensitivity responses.
5. To critically identify immuno- techniques and its application in disease diagnosis.

Unit- I: History of Immunology (15 hrs)

Evolution of Immune system (from bacteria to human- overview); History of Immunology,Immune system: Lymphatic system (Primary and secondary lymphatic organs); Immune cells: Eosinophil, Basophil, Neutrophil, Monocytes, Macrophages, Lymphocytes (1. Tcells & their types, 2. B-cells & their types and activated B-cells) and MHC molecules (types, structure and their significance).

Unit- II: Host Immune Responses and Antigens (15 hrs)

Types of Immune response: Innate Immune response- Physical, Chemical and biological immune response and Acquired Immune response- Introduction to Humoral immune response and Cell mediated immune responses, Types of antigens, haptens, properties of antigens, processing of antigens (Endocytic and Exocytic pathways).

Unit- III: Acquired immune responses (15 hrs)

Acquired Immune response - Humoral immune response mechanism - Antibody structure, types their biological applications and Cell mediate immune responses: Cytotoxic cell responses, natural killer

cells and Macrophage activation; Immune complex formation reaction- (i.) Agglutination: Direct agglutination, Indirect agglutination and Passive agglutination reactions and (ii.) Precipitation reaction: three types- Single diffusion in singledimensions, double diffusion in single dimension, double diffusion in double dimension.

Unit- IV: Immune complex and Hypersensitivity (15 hrs)

Immune complex formation and its removal from host body: Complement pathway (Classical, Alternative, Mannose binding -lectin pathways), opsonization, Phagocytosis; Hypersensitivity types and biological significance of: Type I, Type II, Type III, Type IV; Immunological tolerance

Unit: V- Immunotechnology (15 hrs)

Monoclonal antibodies production (Classical and modern methods) and their applications; Vaccines: Classical vaccination schedule and Recombinant vaccines: Epitope vaccines, synthetic peptide vaccines. Transplantation immunology: HLA Typing and MLR; Western Blotting, ELISA and FACS.

Reference Books:

1. Sudha Gangal and Shubhangi Sontakke, Textbook of basic and clinical Immunology, 2013.
2. B. Annadurai, A textbook of Immunology and Immunotechnology, 2010.
3. Abul. K. Abbas, Andrew Litchman and Shiv Pillai, Cellular and molecular immunology,Elsevier Saunders, 8th Ed., 2014.
4. Kuby Immunology by Owen, Punt and Stranford, W.H.Freeman and Company, 7th Ed., 2009.
5. A handbook practical and clinical immunology (Volume-1 & Volume-2) G.P Talwar andS.K.Gupta, CBs Publishers & Distributors, 2nd Ed., 2006.
6. Janeway, Travers, Walport, Shlomchik, Garland, "Immunobiology" 6th Edition, 2007.

Useful URL:

1. https://www.youtube.com/watch?v=LB9FYAo7SJU
2. https://www.youtube.com/watch?v=G4jobV6-bFA
3. https://www.youtube.com/watch?v=_FLjj_Z7SKA
4. https://www.youtube.com/watch?v=Q3XpZjtciBQ
5. https://www.youtube.com/watch?v=iZYLeIJwe4w
6. https://www.youtube.com/watch?v=jrAw50B3jK0
7. https://www.youtube.com/watch?v=YO244P1e9QM
8. https://www.youtube.com/watch?v=lkoDv6qgRjE
9. https://www.youtube.com/watch?v=quv1oJlbsTc
10. https://www.youtube.com/watch?v=3g246c6Bv58

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

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TOTAL MARKS				**100**

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	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

ENVIRONMENTAL STUDIES

Subject Code:	**Theory**	**Marks: 100**
Semester: IV	**Credits:** 2	**Total Hours:** 30

COURSE FRAMEWORK:

This course introduces the concepts of Environmental Studies.

COURSE OUTCOME:

On completion of the course the students will be able

1. To know the importance of environmental studies and methods of conservation of natural resources.
2. To describe the structure and function of an ecosystem.
3. To identify the values and conservation of bio-diversity.
4. To explain the causes, effects and control measures of various types of pollutions.
5. To select the appropriate methods for waste management.

Unit-1: Importance and Scope of Environmental studies (6 hrs)

The Multidisciplinary nature of environmental studies Definition; Scope and importance, Need for public awareness.

Unit-2: Natural Resources (6 hrs)

Natural Resources: Renewable and non-renewable resources: Natural resources and associated problems.

a) Forest resources: Use and Over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.
b) Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water dams benefits and problems.
c) Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
d) Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
e) Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, Case studies.
f) Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification. - Role of an individual in conservation of natural resources. - Equitable use of resources for sustainable lifestyles.

Unit-3: Ecosystem **(6 hrs)**

Ecosystems - Concept of an ecosystem. - Structure and function of an ecosystem. - Producers, consumers and decomposers. - Energy flow in the ecosystem.

- Ecological succession. - Food chains, food webs and ecological pyramids. - Introduction, types, characteristic features, structure and function of the following ecosystem: -

a. Forest ecosystem
b. Grassland ecosystem
c. Desert ecosystem
d. Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit-4: Biodiversity and its Conservation **(6 hrs)**

- Introduction-Definition: genetic, species and ecosystem diversity.
- Biogeographical classification of India.
- Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.
- Biodiversity at global, National and local levels.
- India as a mega-diversity nation.
- Hot-spots of biodiversity.
- Threats to biodiversity: habital loss, poaching of wildlife, man-wildlife conflicts.
- Endangered and endemic species of India.
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Unit-5: Pollution **(6 hrs)**

Environmental Pollution: Definition - Causes, effects and control measures of: -

a. Air pollution
b. Water pollution
c. Soil pollution
d. Marine pollution
e. Noise pollution
f. Thermal pollution
g. Nuclear hazards

- Solid waste Management: Causes, effects and control measures of urban and industrial wastes. - Role of an individual in prevention of pollution. - Pollution case studies. - Disaster management: floods, earthquake, cyclone and landslides.

SEMESTER-V
CORE IX: MOLECULAR DEVELOPMENTAL BIOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: V	**Credits:** 4	**Total Hours:** 75

Course Framework:

- To recall the various fertilization.
- To demonstrate the various developmental processes
- To justify the specific signaling mechanism involved in embryonic developmental
- To demonstrate the genes involved in development of embryo
- To diagnose the medical disorders related to developmental biology.

Course Outcome:

On completion of the course the students will be able

1. To recall and discuss the various fertilization, cleavage, blastula and gastrulation.
2. To describe the molecular developmental processes.
3. To classify and compile the signaling processes of embryonic development process.
4. To interpret the embryonic development.
5. To diagnoses the medical implication of embryonic development

Unit I: Introduction to Developmental Biology (15 hrs.)

Gametogenesis-process, Types of sperms and eggs (Frog, Chick and human); different types of Fertilization, Mechanism involved in fertilization in humans; Patterns of Cleavage, Blastulation & Gastrulation pertaining to frog, chick & humans.

Unit II: Molecular developmental processes (15 hrs.)

Growth, Differentiation (Stem cell to functional active cells), Development, re-differentiation, dedifferentiation, trans- differentiation, metamorphosis and morphogenesis.

Unit III: Signaling mechanism involved in development (15 hrs.)

Signal transduction that control the organogenesis in Drosophila (GPCR pathway: Wnt, hedgehog pathway and Notch Delta pathway; Tyrosine kinase pathway: MAP-kinase, JAK- STAT, Serine threonine pathway: TGF-β pathway); Neurulation in Drosophila.

Unit IV: Embryonic Development **(15 hrs.)**

Genes that control the embryonic development to fetus: maternal genes, zygotic genes and hometotic genes using Drosophila as study model animal; Pattern formation in Drosophila- axis specification, fatemap; Comparative study of Regional specification among Drosophila and humans.

Unit- V: Medical implications of developmental biology **(15 hrs.)**

Congenital disorders- Neurological disorders (Anencephaly and cyclopia), thalassemia, Deformality disorders (improper digit separation in hand), Teratogenesis- microbial induced disorders- Rubella virusas example.

Reference Books

1. Scott F. Gilbert and Michael J. F. Barresi, Developmental Biology, Oxford University Press,11th Ed., 2016.
2. Lewis Wolpert, Cheryll Tickle, and Alfonso Martinez Arias, Principles of developmentalbiology, Oxford University Press,5th Ed., 2015.
3. T. Subramoniam, Molecular Developmental biology, 2nd Ed., Alpha Science, 2011.
4. Balinsky, An introduction to embryology, Cengage Learning India; 5 Ed., 2012.
5. Ramdass, Animal biotechnology recent concepts and developent, MJP, 2008.

Useful URL:

1. https://www.jove.com/science-education/5328/an-introduction-to-molecular-developmental-biology
2 https://www.youtube.com/watch?v=DsK9R-yfgF4
3. https://www.youtube.com/watch?v=YtvL-LQlPrU
4. https://www.youtube.com/watch?v=YtvL-LQlPrU
5. https://www.youtube.com/watch?v=YtvL-LQlPrU
6. https://www.youtube.com/watch?v=J2DlGtOA3sA
7. https://www.youtube.com/watch?v=J2DlGtOA3sA
8. https://www.youtube.com/watch?v=RDt5ev9Q0Uk

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

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TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

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	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

CORE X: BIOPROCESS TECHNOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: V	**Credits:** 4	**Total Hours:** 60

Course Framework:

- To discuss the traditional and modern fermentation techniques.
- To distinguish the parts of fermenters and the types of fermenters.
- To interpret the media formulation, bacterial growth and kinetics involved.
- To recognize the specific down-stream processes.
- To discuss the bio-products produced by bioprocess technologies.

Course Outcome:

On completion of the course the students will be able

1. To practice the specific fermentation technologies.
2. To differentiate the usage of the different types of fermenters.
3. To formulate the media and microbial concentrations required for up-stream processes.
4. To practice the down-stream processes
5. To determine the bio-based products.

Unit I: Introduction to Bioprocess and Fermentation (10 hrs.)

Scope of bioprocess technology; Difference between Fermentations and bioprocess processes; Industrial Microbes isolation; Strain improvisation, cell bank maintenance and preservation techniques; Types of fermentation process: Based upon gaseous requirements, mode of fermentation: Surface and submerged fermentation, Mechanism: Batch, fed and fed-batch fermentation.

Unit II: Fermenters and media formulation (12 hrs.)

Definition of fermenter, Basic parts of fermenter, Types of fermenters: stirred tank fermenter, airlift fermenter, fluidized bed bioreactor, packed bed fermenter and Photo bioreactor; Control of a fermenter: Pressure controls, temperature, gas flow control; (i.) Media design and sterilization for fermentation processes: Medium requirements for fermentation processes and industrial fermentation.

Unit III: Bacterial cell inoculum and Kinetics (15 hrs.)

Kinetics of microbial growth (simple and unstructured kinetic models); Substrate utilisation kinetics; Mass transfer kinetics (Fick's law and its application, no derivations) and product formation: Metabolic stoichiometry and energetics: Stoichiometry of cell growth, substrate utilisation and product formation- Citric acid production as an example; Leudeking – Piret model.

Unit IV: Downstream process **(12 hrs.)**

Extra cellular products and intra cellular products; Stages of Downstream process: (i) Removal of solids: flotation, flocculation, precipitation, centrifugation; (ii.) Product isolation: Liquid- Liquid Separation, adsorption, ultra-filtration (iii.) Product purification: Chromatography, crystallisation, distillation, (iv.) Concentration: Evaporation, liquid-liquid separation, precipitation (V) Formulation: drying, freeze drying-lyophilisation, crystallisation.

Unit V: Bioprocess Products **(11 hrs.)**

Primary metabolites and secondary metabolites, Industrial important products: cellulase, amylase, lipase, protease- leather industry; Food products: Bread, Dairy product- Cheese, Beverages: Wine, SCP; Recalcitrant products: Biogas, Vermicompost; Antibiotics: Penicillin, recombinant product-Hormones-Insulin from *Saccharomyces cerevisiae* Microbial flavours: Diacetyl, Methyl ketones, Terpenes, Vanillin.

Reference Books:

- Rajiv Dutta, Fundamentals of Biochemical engineering, Springer (India), 2008.
- Michael L. Shuler and FikertKargi, Bioprocess Engineering Basic concepts, Pearson Education India; 2 Ed., 2015.
- James E.Bailey and David F. Ollis, Biochemical Engineering fundamentals, McGrawHill Education; 2 Ed., 2017.
- Pauline M.Doran, Bioprocess Engineering principles, Elsevier, 2nd Ed., 2012.
- Wulf Crueger and Anneliese Crueger, "Biotechnology – textbook of Industrial Microbiology", reprint 2005. Panima publishing corporation, New Delhi.
- A.H.Patel, (2000), "Industrial microbiology", Macmillan Publishers India.
- Peter F. Stanbury, Whitaker.A, Principles of Fermentation Technology, Elsevier, 2nd Ed., 1995.
- JayantoAchrekar, Fermentation Biotechnology, Dominant Publishers & Distributors (P) Ltd., 2006.
- Najafpour, Yesdee, Biochemical Engineering and Biotechnology, Elsevier Science, 1st Ed., 2006.

Useful URL:

https://www.youtube.com/watch?v=-Uua8sfoJ8

https://www.youtube.com/watch?v=5eKdZ0dVCCo

https://www.youtube.com/watch?v=VKpthcW1llU

https://www.youtube.com/watch?v=I0-w3om3rdU

https://www.youtube.com/watch?v=qbXtN-AiThQ

https://www.youtube.com/watch?v=N7vxq948l-U

https://www.youtube.com/watch?v=fQOzHC828aM

https://www.youtube.com/watch?v=Aw2yjoZ_RtY

https://www.youtube.com/watch?v=uN0NwdR_3sI

*Industrial visit to fermentation industries.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum:** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

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TOTAL MARKS				**100**

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	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

CORE XI: BIOINFORMATICS AND BIOSTATISTICS

Subject Code:	**Theory**	**Marks:** 100
Semester: V	**Credits:** 3	Total Hours: 60

Course Framework:

- To understand the molecular biology in a genomic and proteomic knowledge.
- To study the gene expression systems through *in-silico* studies.
- To make the students to understand the mathematical importance in biological research.

Course Outcome:

On completion of the course the students will be able

1. To explain the importance of bioinformatics and its scope
2. To familiarize with different types of biological databases and their importance
3. To understand the various steps involved in the drug discovery pipeline
4. To discuss the importance of biostatistics and its scope
5. To learn to calculate the measures of central tendency and dispersion

UNIT I: Data Analysis (12 hrs.)

Importance and scope of Bioinformatics. Introduction to Human genome project. Biological databases (types based on data type and data source, applications) – Data Bank (GenBank, PDB), Pubchem, pairwise sequence alignment and multiple sequence alignment - analysis of nucleic acid and protein sequence data using web-based tools.

UNIT II: Gene Prediction and Drug Discovery (12 hrs.)

Gene prediction approaches – prokaryotes and eukaryotes - Open Reading Frame (ORF) prediction – Hidden Markov Model - *In-silico* Drug designing: characteristics of a drug compound, drug discovery pipeline: target identification, lead compound identification, serendipity, QSAR, ADME predictions.

UNIT III: Protein structures (12 hrs.)

Types of tertiary structures - (α-α: Collagen, β-α (Rosmann fold), β-β (Jelly roll -Beta barrels-transporter proteins) quaternary structures: hemoglobin structure. Protein secondary structure prediction: First Generation – Chou-Fasman, Garnier- Osguthorpe- Robson (GOR) methods - Homology modelling, phylogenetic analysis.

UNIT IV: Introduction to Biostatistics (12 hrs.)

Introduction, Scope and applications of Biostatistics - Common terms (Population, Sample, Parameter, Data, Constant and variables) - Sampling techniques - Biological data - Collection of data, Processing of data, Presentation of data: Numerical presentation and Graphical representations (Line graph, Frequency polygon and curve, Histogram, Bar chart, Pie chart) - Central tendency- Arithmetic mean, Median and Mode (problems).

Unit-V: Measures of dispersion and Probability (12 hrs.)

Range, Variance, Standard Deviation (problems) - Coefficient of Variation and Probability - Theoretical distributions: Binomial and Poisson distribution, Normal distribution: Skewness and kurtosis - Significance: Hypothesis testing (Type of errors), Student's t-test, Chi square test (no problems).

Reference Books:

1. Arthur Lesk "Introduction to Genomics" 2nd edition. Oxford University Press 2007.
2. Andreas D Baxevanis, B F Francis Oullette "Bioinformatics: A practical guide to the analysis of genes and proteins". 2nd edition. Wiley publishers, 2005.
3. Jin Xiong "Essential Bioinformatics", 1st edition Cambridge University Press, 2006.
4. David Mount "Bioinformatics: sequence and genome analysis" 3rd Edition. Cold Spring Harbor Laboratory Press, 2004.
5. Biotechnology & Bioinformatics by Ranganathan, Narain & Kuppuswamy, WisdomPress, 2011.
6. Basics of Bioinformatics, Springer-Verlag Berlin Heidelberg, 2013.
7. Pevsner, Bioinformatics and Functional Genomics, John Wiley publishers, 3rd Ed.,2015.
8. Higgs and Attwood, Bioinformatics and Molecular Evolution, Blackwell publishers,2005.

Useful URL:

1. https://www.youtube.com/watch?v=w-uk-_TOgR0&list=PLb0WW0k29aHrF8a ZzK17ORTesZsd-lING
2. https://www.youtube.com/watch?v=SAweFv8I8ow&list=PL1ay9ko4A8skYqjhrA4IND Z7IHtebS0l Y
3. https://www.youtube.com/watch?v=IQCbnRafCtM
4. https://www.youtube.com/watch?v=cd6O8FbrVjw
   https://www.youtube.com/watch?v=ZNIQCrCIbL8

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FORTHEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :**40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	**Numbers**	**Question Component**	Marks	**Total**
Section A	**Question 1–12**	**Definition** **Answer ANY 10 out of 12 questions**	3	**30**
Section B	**Question 13–19**	**Short Answer** **Answer ANY 5 out of 7 questions**	6	**30**
Section C	**Question 20–25**	**Detailed Answer** **Answer ANY 4 out of 6 questions**	10	**40**
TOTAL MARKS				**100**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	**Units**	**No. of Questions**
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2 (1 theory and 1 problem)
	Unit – 5	2 (1 theory and 1 problem)
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2 (1 theory and 1 problem)

CORE XII: PHARMACEUTICAL BIOTECHNOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: V	**Credits:** 4	**Total Hours:** 75

Course Framework:

- The aim of the course is to give strong foundation and advanced information on biopharmaceutical aspects in relation to drug development.
- The core responsibilities for the development and monitoring of the drug and the preparation of medicines according to the norms.
- Knowledge in physicochemical properties, pharmacology and the formulation of commonly used biopharmaceuticals.

Course Outcome:

On completion of the course the students will be able

1. To explain the scope of Bio-pharmaceutical industries in India
2. To explain the series of steps involved in drug development process and demonstrate the phase involved in pre-clinical and clinical trials
3. To analyse the various drug formulation, drug administration and drug description methods
4. To understand the Economic and legal considerations in pharmaceutical Biotechnology in achieving drug approval and marketing
5. To discuss about the demand of recombinant products for healthcare and diagnostics in local and global market

UNIT I: Introduction to Pharmaceutical Biotechnology (15 hrs.)

Scope of Bio-pharmaceutical industries in India; Overview of Pharmaceutical products, Classification – Chemical and phytopharmaceuticals – Pharmacognosy.

UNIT II: Drug development process (15 hrs.)

Stages in the drug development process- Drug Discovery, Drug Designing, Pharmacokinetics – Metrics of Pharmacokinetics. Pharmacodynamics – Mechanisms of Drug action. Rate and Target site- specific delivery. Preclinical trials – Patenting and Drug Approval – Post Clinical trials.

UNIT III: Industrial consideration of drugs (15 hrs.)

Production methods, pharmaceutical consideration, drug formulations and quality analyses, Description and labeling of pharmaceutical products: recombinant protein; Biogeneric drugs development; Drug toxicity analysis, Management of side effects.

UNIT IV: Drug regulations (15 hrs.)

Economic and legal considerations in pharmaceutical Biotechnology. National (Indian Pharmacopoeia) and International Drug approval agencies and guidelines for conduct of clinical trials, licensing and drug marketing.

UNIT V: Recombinant products and their applications (15 hrs.)

Human Insulin (Humulin, actrapid), Growth hormones (Humatrope, Serostim), Steriodhormones, Blood coagulating factors, Hematopoietic growth factors, Vaccines (Hepatitis B (Recombivax), Cholera Vaccines, Edible Vaccine), Monoclonal antibody- Infliximab, Rituximab, Rhogam. DNA based vaccines – Overview and mechanism of Gene therapy – *Ex vivo* and *in vivo* gene therapy (ADA).

Reference books:

1. Daniel Fieys (Ed.) 2005. Industrial proteomics: Applications for Biotechnology and Pharmaceuticals. Wiley and Sons, Incorporated.
2. O. Kayser, R.H. Muller. 2004. Pharmaceutical Biotechnology – Drug Discovery and clinical applications. Wiley – VCH.
3. Heonrich Klefenz. 2002. Industrial Pharmaceutical Biotechnology.
4. Leon Shargel, Andrew B. C. Yu, Susanna Wu-Pong and Yu Andrew B.C.2004.Applied Biopharmaceutics and pharmacokinetics. McGraw- Hill Companies.
5. Sefania Spada, Garywalsh. 2004. Directory of approved biopharmaceutical.
6. Garywalsh. 2003. Biopharmaceutical, biochemistry and biotechnology.
7. Thomas Lengauer (Ed) 2002. Bioinformatics – from Genomes to drugs. Vol.I and II.Wiley – VCH.
8. John F. Corpenter (ed.) Mark C. Manning. 2002. Rational design of stable formulation theory and practice (Pharmaceutical Biotechnology). Plenum, US. I Edition.
9. D.I.A. Crommelin et al, 2002. Pharmaceutical biology. Amazon prome publications.
10. Werner kalow, UA Meyer and Rachel F Tyndale. 2001.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum:** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

CORE XIII – PRACTICAL – V: MOLECULAR DEVELOPMENTAL BIOLOGY AND BIOINFORMATICS, BIOPROCESS TECHNOLOGY

(a.) CORE XIII – PRACTICAL – V: MOLECULAR DEVELOPMENTAL BIOLOGY & BIOINFORMATICS

Subject Code:	**Practical**	**Marks: 100**
Semester: V	**Credits:** 3	**Total Hours:** 45

Course Framework:

- To recall the molecular developmental process by using chick as model.
- To discuss the molecular developmental process by using plant seed as model
- To learn about the on-line biological data bases
- To learn the usage of search engines to derive the biological data.

Course Outcome:

On completion of the course the students will be able

1. To gain knowledge about the different stages of development using Fenugreek or Moong Dal
2. To gain knowledge about embryonic development by using chick embryo and the different stages of development of the chick embryo
3. To observe the different stages of development of a frog embryo
4. To access and retrieve the sequences from the nucleotide and protein databases and to retrieve articles from the Literature databases
5. To apply online tools to understand the protein structures and to compare two or more nucleotide or protein sequences

Practical Experiments:

1. To observe and record the different stages of plant development using seeds (Fenugreekor Moong dhal) as study model.
2. Observe the fertilized egg (to detect Growth and position of chick embryo; Day1 to Day-7) by using “Egg Candler”.
3. Using chick embryo as a model to study the following by the wet mount preparation and record the observation (Number of somites and to monitor the organs development at different time period):

A. Identification and description of 24 hrs. chick embryo

B. Identification and description of 48 hrs. chick embryo
C. Identification and description of 72 hrs. chick embryo
D. Identification and description of 96 hrs. chick embryo
4. Flybase tools- Importance to molecular developmental biology
5. Study of Internet resources in Bioinformatics.
6. Searches on MEDLINE, PubMed databases.
7. Introduction to sequence databases: Protein sequence databank – UNIPROT, Nucleic acid sequence databank – Gene bank, EMBL, DDBJ.
8. Sequence alignment - BLAST, FASTA
9. Multiple alignment - CLUSTALW.

Demonstration Experiments:

1. Record the life cycle of frog.
2. Observation of frog embryo (Blastula, Late gastrula stages)
3. To understand Wound healing mechanism using tadpole as specimen.
4. Hormonal induced developmental metamorphosis using tadpole as sample

Reference Books:

1. Laura R. Keller, Experimental Developmental Biology-a laboratory manual, Academic Press, 1st Ed., 1999.
2. James Sharpe and Rachel O. Wong, Imaging in developmental Biology: A laboratory manual, Cold Spring Harbor Laboratory Press, Ist Ed., 2011.
3. P.S.Verma and V.K.Agarwal, Chordate Embryology, S.Chand, 2006.

(b.) CORE XIII – PRACTICAL – V: BIOPROCESS TECHNOLOGY

Subject Code:	**Practical**	**Marks:** 100
Semester: V	**Credits:** 3	**Total Hours:** 45

Course Framework:

- To compare the different types of fermentation processes.
- To discuss about the importance of cell immobilisation techniques in fermentation processes.
- To examine and describe the applications of parts of SS-grade fermenter.
- To produce wine and relate the importance of submerged fermentation processes.
- To produce citric and to discuss the application of surface fermentation processes.
- To discuss the suitable methods applied for down-stream processes.

Course Outcome:

On completion of the course the students will be able

1. To demonstrate the applications of the different types of fermenters and fermentation mechanisms.
2. To explain the parts of the industrial grade fermenters.
3. To outline, evaluate the microbial growth kinetics
4. To apply the principles of fermentation techniques for wine, citric acid and amylase production.
5. To compare and outline steps involved for the downstream processes

Practical Experiments:

1. Cell immobilization by alginate gel method
2. Hydrolysis of starch by free and immobilized yeast
3. Bacterial growth curve estimation by using Yeast cells
4. Detection of Lipase production microbes
5. Wine production by *Saccharomyces cerevisiae*:
   (i) Preparation of grape extract for wine production
   (ii) Estimation of total sugars before and after 14 days
   (iii) Estimation of Initial pH and after 14 days
   (iv) Estimation of initial total anthocyanin before and after 14 days
   (v) Estimation of initial Tartaric acid and after 30 days

(vi) Effect of substrate concentration on biomass yield in wine preparation

6. Citric acid production by *Aspergillus niger*
   (i) Media formulation
   (ii) Determination of total acid by titration (after 2nd day and after 21 days)
   (iii) Product recovery

Demonstration Experiments:

1. To demonstrate the parts of the industrial grade SS-fermenter.
2. Amylase production by *Bacillus subtilis* using a fermenter (Laboratory scale to Pilot scale) and detection of amylase and identify the concentration of product produced.
3. Demonstration of compost production.

Reference Books:

1. H.J. Peppler, D. Perlman, Microbial Rechnology, 2 nd Edition, Vol.(2), 1979.
2. Kirsten K. Shockey and Christopher Shockey, Storey Publications, 2014.
3. Y. H. Hui, Handbook of Plant-based fermented food & Beverage technology, CRC Press, 2012.

Useful URL:

1. http://site.iugaza.edu.ps/mwhindi/files/BIOTECHNOLOGY-PROCEDURES-AND-EXPERIMENTS-HANDBOOK.pdf
2. https://indiabioscience.org/media/articles/DBT-Life-Science-Protocol-Manual.pdf
3. https://indiabioscience.org/media/articles/DBT-Life-Science-Protocol-Manual.pdf

ELECTIVE I: INTERDISCIPLINARY ELECTIVE (IDE- I)
INTELLECTUAL PROPERTY RIGHTS

Subject Code:	**Theory**	**Marks:** 100
Semester: V	**Credits:** 5	**Total Hours:** 75

Course Framework:

- The course is intended to make the students to know about the fundamental concepts ofIntellectual property rights leading to product development and marketing.
- This course also teaches the basics acts associated with IPR.
- This course is designed with multidisciplinary approaches.

Course Outcome:

On completion of the course the students will be able

1. To explain the history and classification of intellectual property rights.
2. To outline the various international treaties gave rise to IPR laws.
3. To assess and discuss the scope of Indian Copyrights Act.
4. To assess and discuss the scope of Indian Patents Act and to evaluate the scope of invention for its eligibility to be patented.
5. To explain industrial designs and Trade Marks.

Unit I: Introduction to Intellectual Property Rights (15 Hrs.)

Origin and Genesis of IPR. Types of Properties – tangible property and intangible property – Types of intellectual property: Patents, Trademarks, Copyrights, Semiconductor Design and Industrial Designs.

Unit II: International Relevance (15 Hrs.)

Internationalization of IP protection – Paris Convention – Berne Convention, Origin and functions of GATT and World Trade Organization (WTO), TRIPS Agreement – basic principles and minimum standards – limits of one-size-fit for all – flexibilities under TRIPS.

Unit III: Copy Right (Indian Copy Right Act 1957) (15 Hrs.)

Definition of Copy Right – Copy Right Literary, Dramatic & Musical works, Copy Right Rules 2013 - Copyright protection with reference to performers' rights and Artist rights, Author and ownership of Copy Right, Term of Copy Right – Transmission and Relinquishment of Copy Right Licenses.

Unit IV: Patents (Indian Patents Act 1970) **(15 Hrs.)**

Definitions – Concepts of Patents – Patentable and Non-Patentable Inventions – Plant Breeders Rights (Basmati rice), Procedure to obtain Patent specifications (Course activity), Patent search- Case study Google patent – Patent Application – Examination and disposal of application for Patent – Power of the Controller – Grant and sealing of Patents – lapse and restoration of Patents Rights and Obligations of Patentee – Revocation and surrender of Patents – Infringement of Patents and the remedies therefore.

Unit V: Industrial Designs and Trade Mark **(15 Hrs.)**

Introduction – Registerable and Non – Registerable design – novelty and originality – Infringement of rights in designs – Civil remedies against piracy defenses, Awareness of false advertisements. Definition and concepts of Trade Marks – Registration of Trade Marks – Defensive Registration Certification – Duration and Effect of Registration – Registered users – Assignment and Transmission - Infringement and remedies – Passing off actions – Offence and Penalties.

Reference Books:

1. W. Cornish & Llewelyn – Intellectual Property: Patent, Copyrights, Trade Marks & Allied Rights", London Sweet & Maxwell.
2. J. P. Mishra – An Introduction to Intellectual Property Rights
3. B.L. Wadehra - Law Relating to Intellectual Property 5th Edition
4. P. Narayanan – Intellectual Property Law

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

ELECTIVE I: INTERDISCIPLINARY ELECTIVE (IDE-II) – Optional paper
HERBS FOR HEALTHY LIVING

Subject Code:	**Theory**	**Marks:** 100
Semester: V	**Credits: 5**	**Total Hours: 75**

Course Framework:

- The interpret the history of the herbal medication in India
- Compare and analyse the compound with medical property which are available.
- To identify and discuss the extraction of various phytochemical present in plants.
- To give examples for the herbal therapies used for various diseases.
- To develop herbal garden and to justify the importance of herbal medicines.

Course Outcome:

On completion of the course the students will be able

1. To compile the herbal plants present in local region.
2. To appreciate the therapeutic approach of the local herbal plants.
3. To interpret the application of herbal plant.
4. To discuss the various detection methods of phytochemical
5. To identify the plants within the local region.

Unit I: History of Herbal Medication (15 hrs.)

History of herbal medicine, Herbal medication in India (Ayurveda, Unnai, Siddha)

Unit II: Regional Herbs with medicinal importance (15 hrs.)

Everyday plants with medicinal properties: *Zingiber officinale* (Ginger), *Allium sativum* (Garlic), *Capsicum annuum* (pepper), *Murraya koenigii* (curry leaf), *Curcuma longa* (Turmeric), *Ocimum tenuiflorum* (Tulasi), *Sesamum indicum* (Sesame Seeds), *Linum usitatissimum* (Flax seeds), *Centella asiatica* (Vallarai), *Trigonella foenum-graecum* (Fenugreek), *Plectranthus amboinicus* (Mexican mint), *Azadirachta indica* (Neem), Amaranthus, *Aloe barbadensis* (Aloe vera), *Piper longum* (Thipilli)

Fruits with medicinal properties: *Phyllanthus emblica* (Amla), *Mangifera indica* (Mango), *Psidium guajava* (Guava), Banana, Jackfruit

Vegetables with medicinal properties: *Momordica charantia* (Bitter guard), *Moringa oleifera* (Drumstick), Onion, Tomato

Plants with insecticidal and pesticidal properties: *Citrullus colocynthis* (Bitter apple), *Nerium oleander* (Aralli), *Ocimum basilicum* (Basil), and *Origanum majorana* (Marikozhundhu), *Vitex negundo* (Nochi), *Acorus calamus* (Vasambu), *Cymbopogon citratus* (Lemon grass), *Cymbopogon nardus* (Citronella)

Unit III: Phytochemical analyses (15 hrs.)

Plant extract preparation (Hot and cold extraction), Phytochemical detection and qualitative analyses of the phytochemicals, purification methods (Column chromatography), Characterization: (FTIR, GC-MS), Formulation: Powder, Tablets, Pills, Liquid and Semisolid forms.

Unit IV: Herbal based therapies for disease (15 hrs.)

Case study of Infectious Out breaks: Jaundice, COVID and Dengue

Fracture: *Ormocarpum sen noides* (Elumbotti), Dengue - *Carica papaya* (Papaya) leaf extract, Cancer: *Vinca rosea*, Diarrhoea, Common Cold, Vitamin Supplements Lycopene – *Lycopersicum esculentum* (Tomato), Health supplements: Astaxanthin – Algae, Probiotics- Spirulina, Lactocbacillus.

Unit V: Field Work (12 hrs.)

Study of medicinal plants present within Guru Nanak College campus.

*Herbarium and Herbal Garden maintenance, Field visit to Herbal Garden

Reference Books:

1. Herbal Drugs Industry, V. Rajpal and DPS Kohli. 2nd Edition, 2009, Business Horizons.
2. Traditional Herbal Medicine Research Methods: Identification, Analysis, Bioassay, and Pharmaceutical, 2011, Willow J.H. Liu Hardcover, Publishers-Wiley.
3. Herbal Medicine in India, Indigenous Knowledge, Practice, Innovation and its Value, **Sen**, Saikat, Chakraborty, Raja, 2020, Springer.
4. The Complete Handbook of Nature Cure 5th edition, by Dr. H.K. Bakhru, Publications by Jaico. The Complete Book Of Ayurvedic Home Remedies: A comprehensive guide to the ancient healing of India, by Vasant Lad, 2006, Publications by Piatkus
5. Secrets of Natural Diet, by Dr. Brij Bhushan Goyal, 2013, Sterling ***Publishers*** Pvt Ltd.
6. Herbs of Siddha Medicine, Volume 1: The First 3D Book on Herbs, J Raamachandran, Publication by DR.J. Raamachandran**.**

Useful URL:

1. https://www.youtube.com/watch?v=efM3_aKO0E0
2. https://www.youtube.com/watch?v=rE-z_0Nt_kA
3. https://www.youtube.com/watch?v=fLIs4Z4xHWQ
4. https://www.youtube.com/watch?v=Kt0Lgy17I78
5. https://www.youtube.com/watch?v=HzTvEK1sVi0

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

VALUE EDUCATION

Subject Code:	**Theory**	**Marks: 100**
Semester: V	**Credits: 2**	**Total Hours: 15**

COURSE FRAMEWORK:

- To teach and inculcate the importance of value based living.
- To give students a deeper understanding about the purpose of life.

COURSE OUTCOME:

On completion of the course the students will be able

1. To inculcate the value system in their real life scenarios.
2. To implement the role of culture and civilization, roles and responsibilities in the society.
3. To effectively follow Salient values for life such as forgiveness, ability to sacrifice, self -esteem, teamwork and creative thinking.
4. To reflect the human rights, social values and welfare of the citizen.
5. To consider the relation between values and personal behavior affecting the achievement of a sustainable future.

UNIT 1: Education and Values (3 hrs)

Definition, Concept, Classification, Theory, Criteria and Sources of values Aims and objectives of value education Role and Need for value education in the contemporary society, Role of education in transformation of values in society Role of parents, teachers, society, peer group and mass media in fostering values

UNIT 2: Value Education and Personal Development (3 hrs)

Human Values: Truthfulness, Sacrifice, Sincerity, Self-Control, Altruism, Scientific Vision, relevancy of human values to good life. Character Formation towards Positive Personality Modern challenges of adolescents: emotions and behavior Self-analysis and introspection: sensitization towards gender equality, differently abled, Respect for - age, experience, maturity, family members, neighbors, strangers, etc.

UNIT 3: Human rights and Marginalized people (3 hrs)

Concept of Human Rights – Principles of human rights – human rights and Indian constitution – Rights of Women and children – violence against women – Rights of marginalized People – like women, children, minorities, transgender, differently abled etc.

Social Issues and Communal Harmony Social issues – causes and magnitude - alcoholism, drug

addiction, poverty, unemployment – communal harmony –concept –religion and its place in public domain –secular civil society

UNIT 4: Value Education Towards National and Global Development (3 hrs)

- Constitutional Values :(Sovereign, Democracy, Socialism, Secularism, Equality, Justice, Liberty, Freedom, Fraternity)
- Social Values: (Pity and Probity, Self-Control, Universal Brotherhood).
- Professional Values :(Knowledge Thirst, Sincerity in Profession, Regularity, Punctuality, Faith). Religious and Moral Values: (Tolerance, Wisdom, character).
- Aesthetic Values: (Love and Appreciation of literature, fine arts) Environmental Ethical Values
- National Integration and international understanding.
- Need of Humanistic value for espousing peace in society. Conflict of cross-cultural influences, cross- border education

UNIT 5: Guru Nanak Devji's Teachings (3 hrs)

- Relevance of Guru Nanak Devji's teachings' relevance to Modern Society
- The Guru Granth sahib
- The five Ks
- Values and beliefs
- Rights and freedom (Right of equality, Right to Education, Right to Justice, Rights of women,
- Freedom of religion, Freedom of culture, Freedom of assembly, Freedom of speech) Empowerment of women
- Concept of Langar
- Eminent Sikh personalities

REFERENCES BOOKS:

1. Dr.AbdulKalam. My Journey-Transforming Dreams into Actions. Rupa Publications, 2013.
2. Steven R Covey, 8th Habit of Effective People (From Effectiveness to Greatness), Free Press, NewYork, 2005.
3. Prem Singh, G.J. (2004). 'Towards Value Based Education', University News. Vol. 42 (45): P.11-12.
4. V.R. Krishna Iyer. Dialectics & Dynamics of Human Rights in India (Tagore Law Lectures) The Yesterday, Today and Tomorrow, Eastern Law Ho use (1999, Reprint 2018)
5. http://www.ncert.nic.in/rightside/links/pdf/framework/english/nf2005.pdf

CORE XIV: PLANT BIOTECHNOLOGY

Subject Code:	Theory	Marks: 100
Semester: VI	**Credits:** 4	**Total Hours:** 75

Course Framework:

- To understand the overview of Plant Biotechnology and Plant Genetic manipulation
- To understand the various methods of gene transfer in plant genetic engineering in the production of transgenic plants and their applications.
- To illustrate the principles of plant tissue culture techniques
- To demonstrate the National and international regulations of genetically modified crop plants.
- To articulate the applications of Plant Biotechnology

Course Outcome:

On completion of the course the students will be able

1. To understand the overview of the Plant Biotechnology, its history and its scope
2. To assess the plant genome and its collective gene family and the organization of chloroplast and mitochondria
3. To associate the different types of gene transfer techniques and their applications.
4. To evaluate the types of plant growth media and to formulate innovative and novel growth media for Plant Tissue Culture
5. To apply the concepts of plant biotechnology for various applications.

Unit I: Overview of Plant Biotechnology (15 hrs.)

Overview of Plant Biotechnology and its scope. History of Plant Biotechnology. Plant and microbes beneficial association: Plant - *Agrobacterium* association, Rhizobium and Nitrogen fixation. Role of soil microbes in the growth of plant (Production of phytohormones and role of siderophore producing microbes).

Unit II: Plant Genome Organization (15 hrs.)

Model plants for genetic engineering: Tobacco, Potato, *Arabidopsis thaliana*. Genomic organization of plant: Chloroplast, Mitochondria and Genomic DNA.

Unit III: Gene Transfer Techniques **(15 hrs.)**

Methods of gene transfer into plant cells: (1.) Biological transfer- Vectors used in the production of transgenic plants: Bacterial vectors system: Ti and Ri plasmid (Bipartite and tripartite vector systems), Viral vector system: Tobacco mosaic viral vector system, Cauliflower mosaic system, Cucumovirus vector system. (2.) Physical transfer Biolistic, (3.) Electroporation, (4.) microinjection.

Unit IV: Plant Tissue Culture **(15 hrs.)**

Phytohormones and its role in organogenesis; Plant tissue culture medium: MS medium, Gamboorg, White's and Nitsch's medium; Types of explants and various methods of surface sterilization; Protoplast isolation and its application in somaclonal variation, Somatic hybridisation; *In vitro* culture of plants: Callus propagation and its various stages and Micropropagation.

Unit V: Applications of Plant Biotechnology **(15 hrs.)**

Insect resistant plants, pesticide resistant plants, plants with longer shelf lives- Pomato. Bioactive compounds from plants: β-Carotene, Plantibodies and edible plant vaccine; Types and labelling of GMO crops: BT-cotton, Salinity resistant rice, Brinjal, Okra; Biofortified plant: Golden rice.

Reference Books:

1. Dr. Ahindra Nag Textbook of Agricultural Biotechnology, PHI Learning Private Ltd.,New Delhi, 2009.
2. J. H. Dodds, Plant Genetic Engineering, Cambridge University Press, 1983.
3. Rangaswami G., Bagyaraj D.J. Agricultural Microbiology PHI; 2 edition, 1992.
4. Arie Altman Paul Hasegawa, Plant Biotechnology and Agriculture, Academic Press,2012.
5. Slater, Plant Biotechnology, Oxford, 2nd Ed., 2008.
6. Pareek L K Trends in Plant tissue culture and biotechnology, Agrobios (India), 2006.
7. Natesh S, Biotechnology in Agriculture, 1 Ed.South Asia Books, 1987.
8. P. Madhusudan Rao, Plant Tissue Culture & Biotechnology, *Black Prints*/ Dominant Publishers & Distributors Pvt Ltd India, 2013.
9. Fruit and Vegetable Biotechnology (2 Vols.) by Raghuraj Chintamani, DominantPublishers & Distributors (P) Ltd., 2008.
10. Plants Genes and Agriculture by Chrispeels, Jones and Bar, 2nd Ed., 2013.

Useful URL:

1. https://www.youtube.com/watch?v=6y13hYGPi8Q
2. https://www.youtube.com/watch?v=TORRxwbz7aY
3. https://www.youtube.com/watch?v=ykKs5icYwq0
4. https://www.youtube.com/watch?v=MiSLo_HvcJc
5. https://www.youtube.com/watch?v=cD9CFtpLL2s
6. https://www.youtube.com/watch?v=7ba-hqLrgf8

   https://www.youtube.com/watch?v=QYBbgs4612o

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

CORE XV: ANIMAL BIOTECHNOLOGY

Subject Code:	**Theory**	**Marks:** 100
Semester: VI	**Credits:** 4	**Total Hours:** 75

Course Framework:

- To describe the application of animal biotechnology in human welfare
- To summarize the scope of stem cell research and production of Bioartificial organs

Course Outcome:

On completion of the course the students will be able

1. To demonstrate animal cell culture techniques
2. To realize the significance of transgenic and cloning technology
3. To use appropriate molecular techniques for disease diagnosis
4. To take a special care on their reproductive health
5. To distinguish the properties of stem cells and can correlate it with tissue engineering

Unit I: Cell culture technology **(15 hrs)**

History of animal cell culture - Adherent cells and suspension cells - Types of cell culture: Primary cell culture, secondary cell culture and cell line culture. Cell culture requirements and conditions: Buffers – Media – Antibiotics – Culture vessels – Equipment. Steps in animal cell culture. Maintenance of animal cell culture – Isolation, separation and analysis of cultured cells - Cell counting and cell viability assays –Passaging of cells – Cell storage, freezing and thawing methods – Applications of animal cell culture.

Unit II: Transgenic and cloning technology **(15 hrs)**

Transgenic technology: Transgenic animals - Time line of key events – Methods of producing transgenic animals: DNA microinjection. Retrovirus-mediated gene transfer (RMGT). Sperm-mediated gene transfer (SMGT). Embryonic stem cell-mediated gene transfer. Applications: Clinical applications & Agricultural applications. Ethics of treating laboratory animals. Cloning technology: History and methods of cloning – Types of cloning: Therapeutic cloning and reproductive cloning -

Pros and cons of cloning.

Unit III: Molecular tools and techniques for disease diagnosis (15 hrs)

Types of human diseases – Modern tools as diagnostics (Probes and monoclonal antibodies) – Modern techniques in diagnosis: PCR, ELISA, FISH, Southern hybridization and Western blotting. Prophylaxis and management of pathogenic diseases

Unit IV: Assisted reproductive technology (15 hrs)

Human Reproductive health – Infertility in humans - Causes and risk factors of male and female infertility - Assisted reproductive technology: Methods, types and steps of AI, IVM, IVF, GIFT, ZIFT, ICSI, & Third-party assisted ARTs. Livestock improvement methods: Introduction, selection and breeding.

Unit V: Stem Cells, Tissue Engineering and Bioethics (15 hrs)

Properties of Stem cells, Types of stem cells, Applications of stem cells for tissue engineering, Overview of Tissue engineering: Steps involved in tissue construct (only overview), Engineered organs: Skin, Overview of Biomimetics and Example: Bat based blind man stick, Gecko foot based adhesive tapes, Ethical concerns of stem cell research.

Reference Books:

1. Ashish Swarup Verma, Modern Animal Biotechnology, Alpha Science, 2014.
2. R. Ian Freshney, Culture of Animal Cell: A Manual of Basic Technique and specialized applications, 6th Ed., Wiley Blackwell, 2011.
3. Sasidhara R, Animal Biotechnology, MJP publishers, 2010.
4. B Singh, S K Gautam and M S Chauhan, A textbook of Animal Biotechnology, TERI-The energy and resources institute, 2015.
5. David Christie Murray, Red Biotechnology, Dominant Publishers & Distributors (P)Ltd., 2011.
6. Butler, Animal Cell Culture & Technology, Taylor & Francis Publications,2nd Ed., 2003.
7. David S. Goodsell, “Bionanotechnology”, John Wiley & Sonsinc., publications, 2004. Niemeyer, C.M. Mirking C.A., “Nanobiotechnology concepts, Applications andPerpectives”, 2004.
8. Shanmugam. S, “Nanotechnology", MJP publishers, 2010.

Useful URL:

1. https://www.youtube.com/watch?v=RzYhcXjksKc
2. https://www.youtube.com/watch?v=qybFQJ4-KEY
3. https://www.youtube.com/watch?v=WGKoJRNKADY
4. https://www.youtube.com/watch?v=f1ZcvAQW64E
5. https://www.youtube.com/watch?v=766QH_qaYN8
6. https://www.youtube.com/watch?v=Op3r_dB3ISk

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

CORE XVI: BIOSAFETY, BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS

Subject Code:	**Theory**	**Marks:** 100
Semester: VI	**Credits:** 3	**Total Hours:** 75

Course Framework:

- To understand the etiquettes of the research conduction.
- To understand human rights.
- To understand the biosafety precautions, to be followed in laboratory

Course Outcome:

1. To assess the risk in biotechnological research and evaluate the different levels of Biosafety.
2. To design and carry out experiments in an ethical manner.
3. To explain research ethics and analyse the importance of plagiarism.
4. To demonstrate the importance of IPR and its types.
5. To discuss the impact of patenting and process of patent application and granting.

Unit I: Biosafety **(15 hrs.)**

Introduction, history, objectives of Biosafety. Risk assessment in biotechnological research and their regulation of GMO's. Field trail and planned introduction of GMO's. Biosafety guidelines in India. Biosafety levels of Plants, animals and microbial research.

Unit II: Bioethics **(15 hrs.)**

Bioethics – Introduction, Ethical issues related to biotechnology. Legal and socio-economic impacts of biotechnology. Ethical concerns of gene cloning and stem cell research.

Unit III: Research Ethics **(15 hrs.)**

Research ethics – Introduction, Validation of research, Confidentiality in research (Collection, Recording, Usage in research and safe guarding the biological, personal information). Plagiarism – Importance and effects of Plagiarism and its identification software (Urkund and Turnitin), Biopiracy.

Unit IV: Intellectual Property Rights **(15 hrs.)**

Intellectual property rights – Introduction, History (WIPO, GATT, TRIPS), Types - Trade mark (Registration, duration, effect, infringement and remedies), Copyright (Registration, Infringement and remedies), Plant Breeder's Rights, Protection of Plant Varieties and Farmers Rights (Basmati Rice).

Unit V: Patents **(15 hrs.)**

Patents – Introduction, scope. International Scenario of patents. Significance of patents in India-Patent Act 1970 and Patent (Amendments) Act 2002. Process Patent and Product Patent – Patent Application, Procedure and Granting. Industrial Designs (Microarray diagnostic kit). Indian guidelines for patents of biotechnological applications.

Reference books:

1. Shaleesha A, Stanley, Bioethics, Wisdom educational service, 2008.
2. Das H.K., Text book of Biotechnology, Wiley Publishers, 2010.

Useful URL:

1. https://www.youtube.com/watch?v=Ew2OmY_Uer4
2. https://www.youtube.com/watch?v=9wgFZuBXKfc
3. https://www.youtube.com/watch?v=CAM6VNDYJ6k
4. https://www.youtube.com/watch?v=KQwVXqoTfVg

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

CORE XVII- PRACTICAL VI: PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY

(a.) CORE XVII - PRACTICAL VI: PLANT BIOTECHNOLOGY

Subject Code:	**Practical**	**Marks:** 100
Semester: VI	**Credits:** 3	**Total Hours:** 45

Course Framework:

- To learn about the medium preparation for plant callus propagation
- To learn about the sterilization of explants.
- To learn about the Micropropagation
- To learn about the protoplast isolation and fusion technique
- To learn to isolate the Plant DNA.

Course Outcome:

On completion of the course the students will be able

1. To design and outline the requisites of a Plant tissue culture laboratory
2. To demonstrate the callus development and Micropropagation of plants.
3. To demonstrate Protoplast isolation and fusion of plants.
4. To isolate beneficial bacteria and bacterial consortium for production of secondary metabolites involved plant growth.
5. To demonstrate the production of single cell protein by *Spirulina* Culture.

Practical Experiments:

1. Specific surface sterilization methods for different types of explants (leaf, nodal tissues,stem, seed, root and embryo).
2. Callus propagation using chickpea/fenugreek and observe the various stages of callus.
3. Callus squash preparation and staining of callus cells using acetocarmine stain
4. Root induction experiment using carrot explants
5. Isolation of protoplast and its viability check by Evans' blue dye.
6. Protoplast cell fusion technique by using PEG fusion buffer.
7. Plant DNA isolation by CTAB method and visualization by Agarose electrophoresis.
8. Static and shake flask culture of Spirullina by suing Zarrouk's medium and its microscopic observation.

Demonstration Experiments:

1. Preparation of MS medium and the hormone stock preparation.
2. Detection of IAA production by rhizosphere bacteria (*Aztobacter* spp.) by Salkowski method on TLC.

Reference Books:

1. H. S. Chawal, Plant Biotechnology: A Practical Approach, Science Publishers, U.S., 2003.

(b.) CORE XVII - PRACTICAL VI: ANIMAL BIOTECHNOLOGY

Subject Code:	**Practical**	**Marks:** 100
Semester: VI	**Credits:** 3	**Total Hours:** 45

Course Framework:

- To examine various types of animal cells and interpret their basic biological properties.
- To culture animal cells in *in-vitro* conditions using sophisticated instrumentation facility.

Course Outcome:

On completion of the course the students will be able

1. To isolate animal cells from various tissues
2. To count the isolated cells and report the observation
3. To demonstrate single cell suspension using animal tissues obtained from slaughter house
4. To demonstrate the establishment of monolayer of animal cells and its Trypsinisation process
5. To observe, analyze and maintain animal cell culture

Practical Experiments:

1. Preparation of animal cell culture buffers and pH correction
2. Preparation of animal cell culture medium and membrane sterilization
3. Isolation of cells from animal tissues by mechanical methods
4. Isolation of cells from animal tissues by enzymatic digestion methods
5. Morphological observation of the isolated cells using various stains
6. Determining the percentage of cell viability using dye exclusion method
7. Counting of the isolated animal cells using Hemocytometer
8. Preparation of single cell suspension for monolayer culture

Demonstration Experiments:

1. Setting up the animal cell culture laboratory
2. Monitory and maintenance of animal cell cultures

Reference Books:

- Sudha Gangal, Principles and Practice of Animal Tissue Culture, UniversitiesPress, Universities Press (India) Limited, 2007.

ELECTIVE II: ENVIRONMENTAL BIOTECHNOLOGY

Subject Code:	Theory	Marks: 100
Semester: VI	**Credits:** 5	**Total Hours:** 60

Course Framework:

- To illustrate the methods contributing to the pollution.
- Familiarize with various molecular techniques involved in wastage mitigation
- To demonstrate the importance of pollution mitigation
- To apply the pollution regulation of both State and National

Course Outcome:

On completion of the course the students will be able

1. To describe the role of Indian Biotechnological Industries.
2. To discuss the types of biotechnological approach in agriculture management.
3. To demonstrate the value added product production.
4. To discuss the Indian Bio-based industries.
5. To demonstrate the Indian Government agencies which monitor the Biotechnology based research.

Unit I: Objective of Environmental Biotechnology (15 hrs.)

The scope of Environmental Biotechnology, Microbial bioindicator of water: Bacteria and algae, air: Bacterial and viral aerosols and soil: Bacterial, Fungus and plants as bioindicators. Solid waste management: Biodegradation of plastics.

Unit II: Biotechnological approach in agriculture management (15 hrs.)

Qualitative and quantitative analysies of soil and air; Removal of pollutions from air and soil, Integrated farming, Vertical agriculture: Methods and benefits, Hydrophonics: Methods and benefits, Rhizospheric and Endophytic Microbes to Provide a Safe and Affordable Means of Crop Biofortification

Unit III: Biotechnological approach in water management (15 hrs.)

Bioremediation: Biotechnology approaches for industrial effluent treatment (Paper, tannery and dye). Grey water (house hold sewage water): treatment methods; Advanced portable water treatment: Water – Softening, Adsorption, Desalination, Reverse Osmosis, Tamil Nadu Water Quality Standards and Guidelines for industrial effluent discharge.

Unit IV: Medical, Radio and e-waste management **(15 hrs.)**

Medical waste disposal methods, treatment and reuse; Biotechnological approaches for management of e-waste and radio- active waste.

Unit V: Hazardous Waste Management **(15 hrs.)**

Biotechnological methods for cyanide, oxalate and urea detoxification; toxic solvents -phenols. Environmental toxicology – Toxicants – Toxicity, Acute, subacute, chronic, dose effect and LD50 Dose response safe limits. Dose response relationship, detoxification of hazardous chemicals.

Reference Books:

1. Devarajan Thangadurai and JeyabalanSangeetha, Industrial Biotechnology: Sustainable Production and Bioresource Utilization, CRC Press.
2. Loveleen Kaur, Rhobinka Khajuria, Industrial Biotechnology: Principles and application, Nova Science Publishers, 2015.
3. Nurhan Turgut Dunford, Food, Industrial bi-products and bioprocessing, Wiley-Blackwell, 2012.
4. Erick J.Vandamme, Jose Luis Revuelta, Industrial Biotechnology of vitamins, biopigments and antioxidants, Wiley-VCH, 1st Ed., 2016.
5. P.K. Chakraborty, Agro & Industrial Biotechnology, Black Prints India Inc., 2014.
6. Naha &Narain, Immuno-Biotechnology, Dominant Publishers & Distributors (P) Ltd., 2004.
7. Susanna, Biopharmaceutical Drug Design and Development, Humana Press, 1st Ed., 1999.

Reference URL:

1. https://www.youtube.com/watch?v=f_wOnmjawiY
2. https://www.youtube.com/watch?v=1tJ2CWvTVGM&t=378s
3. https://www.youtube.com/watch?v=28iRLLXIBfU&t=292s
4. https://www.youtube.com/watch?v=hdpjA0XhYG0
5. https://www.youtube.com/watch?v=8_1Ng3SCvCU

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

Elective- II: FOOD BIOTECHNOLOGY

Subject Code:	**Theory**	**Marks: 100**
Semester: VI	**Credits:** 5	**Total Hours:** 60

Course Framework:

- To understand the impact of Biotechnology in Indian food status.
- To understand the identification of food that is produced based upon Biotechnological methods.
- To understand the GMOs
- To understand the Food safety monitoring system.

Course Outcome:

On completion of the course the students will be able

1. To detail the insight about the importance of food in day-to-day life.
2. To compile and apply Biotechnological methods involved in the production of biofortified food.
3. To recall the role of Indian Food standards authorities.
4. To recall the global and Indian standards about food storage, preservation and sale of food.
5. To correlate Indian and Global food standards.

Unit I: Basics of Food Biotechnology (15 hrs.)

Importance and scope of food biotech and its application. Diseases pertaining to malnutrition in India; Impact of carbon food printing of food; Solution for malnutrition: Factors affecting meal planning, understanding specific considerations for planning meal for different groups of people.

Unit II: Biofortified Foods (15 hrs.)

Definition and importance of Biofortification of crop and animals for food source. Microbes as food source (Pre and Probiotics foods); Methods of Biofortification of crop plants; Impact of biofortificationin health improvement. Microbial based food products: Microbial flavour and fragrances.

Unit III: Food Safety Regulations (15 hrs.)

Food safety and standards: Food and Drug Administration (FDA), Food Standard Agency, HACCP, FSSAI and FCI (Indian Standards); Food labelling practices and needs, Universal and Indian standard codes.

Unit IV: Food Storage and Preservation (15 hrs.)

Role of microbes in Food spoilage and Permissible limits of microbes in food. Principles involved inFood

preservation and storage techniques. Treatment methods for solid and liquid wastes from food process industries.

Unit V: Agriculture and food ethics (1 5 hrs.)

Impact on society and ethical issues. Laws for the production and use of genetically modified foodsand global marketing.

Reference Books

- Byong H. Lee, Fundamentals of Food Biotechnology, John Wiley & Sons, Ltd., (2014).
- S.C. Bhatia, Food Biotechnology, CRC Press (2016).
- Chetan Sharma, Anil K.Sharma and K.R.Aneja, Frontiers in Food Biotechnology, Nova publishers, (2016).

Useful URL:

1. http://www.fao.org/docrep/U3550t/u3550t0h.htm.
2. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3257668/
3. http://www.oecd.org/science/biotrack/41036698.pdf
4. https://www.youtube.com/watch?v=sOzt0D8vLCU
5. https://www.youtube.com/watch?v=BlHL5MxB84Q
6. https://www.youtube.com/watch?v=i610sLycTTs&list=PL_a1TI5CC9RE2S5RoMgcj2kv TmxqHgT gG
7. https://www.youtube.com/watch?v=-6ZY49DDvq4

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :**100 Marks **Passing Minimum :** 40 Marks **Duration :** Three Hours

QUESTION PAPER PATTERN:

Section	Numbers	Question Component	Marks	Total
Section A	**Question 1–12**	**Definition** Answer **ANY 10** out of **12** questions	3	**30**
Section B	**Question 13–19**	**Short Answer** Answer **ANY 5** out of **7** questions	6	**30**
Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

Sections	Units	No. of Questions
Section A	Unit – 1	2
	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
Section B	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	2
	Unit – 5	2
Section C	Unit – 1	1
	Unit – 2	1
	Unit – 3	1
	Unit – 4	1
	Unit – 5	2

ELECTIVE III: PROJECT

Group Project (2/5 Students per group)

Subject Code:	**Project**	**Marks:** 100
Semester: VI	**Credits:** 5	**Total Hours:** 75

	Internal Assessment	**External Assessment**
Project	**20 Marks** • Interaction with Guide - 5 marks • Regularity - 5 marks • Maintenance of project book - 10 marks	**Project Report** – 50 Marks **Marks split for Project report:** • Title- 2 Marks • Introduction & Reviewof literature- 10 Marks • Methodology- 10 Marks • Results- 10 Marks • Discussion & Conclusion -10 Marks • Reference: 3 Marks • Neat presentation and Novelty- 5 **Viva Voce** – 30 Marks (Students can present the project using aspower point presentation)
Total=100 Marks	**20**	**80**

Mode of Group Project Evaluation regulations:

There will be **Three** Review meetings:

(1.) Review-1: Work plan

(2.) Review-2: Work in progress (presentation of 50% of work completion) - Evaluation for 100 marks (Mid Semester exam).

(3.) Review-3: Work in progress (presentation till 90% of work completion) Evaluation for 100 marks (Model examination).

SOFT SKILLS -UG
SYLLABUS FOR UNDER GRADUATES

FIRST SEMESTER: INTRODUCTION TO STUDY SKILLS

Subject Code:	Theory	Marks 100
Semester: I	Credits: 3	Total Hours: 30

COURSE FRAMEWORK:

- To help, develop and improve the vocabulary of the learners
- To help the learners develop the skill of inference
- To help the learners to acquire writing skills in English

Use of Dictionary and Dictation
Speech Sounds in English & Right
Pronunciation Stress & Intonation
Vocabulary Building Exercises
Listening and Reading
Comprehension Paragraph and
Essay Writing

REFERENCE BOOKS:

1. Hewings, Martin. 1999. Advanced English Grammar: A Self- study Reference and Practice Book for South Asian Students. Reprint 2003.Cambridge University Press. New Delhi.
2. Lewis Norman.1991. Word Power Made Easy.
3. Mohan, Krishna &Meenakshi Raman. 2000. Effective English Communication. Tata Mc Graw Hill Publishing Company Ltd.
4. Mohan, Krishna &Meera Banerji. 2001. Developing Communication Skills. Macmillan. Syamala. 2002. Effective English Communication for You. Emerald Publishers, Chennai.
5. Harishankar, Bharathi. Ed. Essentials of Language and Communication. University of Madras.
6. Swan, Michael and Catherine Walter. 1990. The Cambridge English Course-2. Cambridge University Press.

SECOND SEMESTER: LIFE SKILLS

Subject Code:	**Theory**	**Marks 50**
Semester: II	**Credits: 3**	**Total Hours: 30**

COURSE FRAMEWORK:

- To build the confidence of learners to face the challenges of a globalized society
- To sensitize learners' ethical, moral and social values in their work environment
- To help them understand how to overcome stress-related problems
- To train the learners to use their time effectively

SWOC Analysis Etiquette

Stress Management Time Management

Discussion of Success Stories

i. Auto-suggestions
ii. Problem solving
iii. Decision Making
iv. Presentation Skills-Oral/PPT

BOOKS FOR REFERENCE:

1. Pease, Allen. 1998. Body Language: How to read other's thoughts by their gestures. Sudha Publications. New Delhi.
2. Powell. In Company. MacMillan
3. http://www.essentiallifeskills.net//

THIRD SEMESTER: JOB ORIENTED SKILLS

Subject Code:	Theory	Marks 100
Semester: III	Credits: 3	Total Hours: 30

COURSE FRAMEWORK:

- To prepare the students to be job-ready.
- To help learners use English Language appropriately to the role or situation.
- To develop confidence in them to face Interviews.
- To train them to prepare their own CV/Resume

Different kinds of
Interviews Letter of
Application and CV
Technical Writing - Circulars, Memos, Agenda and
Minutes Group Discussion
Review

i. Books
ii. Films

BOOKS FOR REFERENCE:

1. Harishankar, Bharathi. ed. Essentials of Spoken and Presentation Skills. University of Madras.
2. John, Seely. 1998. The Oxford Guide to writing and speaking. Oxford U P, 1998, Delhi.
3. The Princeton Language Institute and Lanny Laskowski.2001. 10 days to more confident Public Speaking. Warner Books.
4. http://jobsearch.about.com/cs/curriculumvitae.html.//
5. http://www.cvtips.com//

QUESTION PAPER PATTERN

Section	Question Component	Numbers	Marks	Total
A	Answer any 5 out of 7	1-7	2	10
B	Answer any 4 out of 6	8-13	5	20
C	Answer Internal Choice	14 & 15	10	20
TOTAL MARKS				**50**