GURU NANAK COLLEGE

(Autonomous)

VELACHERY ROAD, CHENNAI – 600042

Re-accredited 'A' grade by NAAC

(Affiliated to the University of Madras)

BACHELOR OF SCIENCE

B.Sc. (BIOTECHNOLOGY)

(SEMESTER PATTERN WITH CHOICE BASED CREDIT SYSTEM)

Syllabus

(For the candidates admitted for the Academic year 2020- 2023 batch)

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

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

Programme Outcomes

PO 1: Dissipate knowledge of fundamental conceptual approach in the fields of Biotechnology.

PO 2: Familiarize the mechanisms involved in the specific fields of Biotechnology.

PO 3: Opportunities and challenges discussions pertaining to the field of Biotechnology.

PO 4: Analysis and apply the new cut edge technologies in the field of Biotechnology.

PO 5: Demonstration of sustainable development through the skills acquired through Biotechnology.

Programme Specific Outcomes

PSO 1: 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 product development 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, Bioentrepreneurs to support the biobased industries, Science communicators which are the need of the hour in today's world.

B.Sc. Biotechnology

Academic Year: 2020- 2023 batch

Semester	Part	Course Component	Subject Code	Subject Name	Credit	Hours	CIA	ESE	Total
Semester- I	I	Language	19UTAM141/ 19UFRE141/ 19UHIN141/ 19USAN141	Tamil-I/Hindi-I/ French- I / Sanskrit-I	3	6	50	50	100
	II	English	19UENG241	English-I	3	4	50	50	100
	III	Core-I	20UBIO301	Cell Biology	4	5	50	50	100
	III	Core-II	20UBIO302P	Practical I-Cell Biology and Chemistry	3	6	50	50	100
	III	Allied-I	20UCHEM333	Chemistry	4	5	50	50	100
	IV	NME/ Basic Tamil/ Adv. Tamil/ Basic Hindi	20UNME401C/ 20UNME401D/ 19UBAT401/ 19UADT401	Biotechnology for society welfare/ Human Physiology/ Basic Tamil/ Adv. Tamil/ Basic Hindi	2	2	-	100	100
	IV	Skill based subjects	19UGSL401	Soft skill I: Introduction to Study skills	3	2	-	100	100
Total Credit: 22 / Total Hours per week: 30									
Semester- II	I	Language	19UTAM142/ 19UFRE142/ 19UHIN142/ 19USAN142	Tamil-II/Hindi-II/ French-II/ Sanskrit-II	3	6	50	50	100
	II	English	19UENG242	English II	3	4	50	50	100
	III	Core-III	20UBIO303	Biochemistry	4	5	50	50	100
	III	Core-IV	20UBIO304P	Practical II-Biochemistry and Bioinstrumentation	3	6	50	50	100
	III	Allied-II	20UBIO305	Biotechniques and Bioinstrumentation	5	5	50	50	100
	IV	NME/ Basic Tamil	20UNME402C/20UNME402E/ 19UBAT401/ 19UADT401/ 19BAH402	Marine Biotechnology/ Herbal Science/ Basic Tamil/ Adv. Tamil/ Basic Hindi	2	2	---	100	100
	IV	Skill based subjects	19UGSL402	Soft skill II: Life Skills	3	2	---	100	100
Total Credit: 23 / Total Hours per week: 30									

Semester	Part	Course Component	Subject Code	Subject Name	Credit	Hours	CIA	ESE	Total
Semester- III	I	Language	19UTAM143/ 19UFRE143/ 19UHIN143/ 19USAN143	Tamil-III/Hindi-III/ French-III/ Sanskrit-III	3	6	50	50	100
	II	English	19UENG243	English III	3	4	50	50	100
	III	Core-V	19UBIO306	Genetics	4	6	50	50	100
	III	Core-VI	19UBIO307P	Practical III – Genetics and Immunotechnology	3	6	50	50	100
	III	Allied-III	19UBIO308	Immunology and Immunotechnology	5	6	50	50	100
	IV	Skill based subjects	19UGSL403	Soft skill III	3	2	---	100	100
Total Credit: 21 / Total Hours per week: 30									
Semester- IV	I	Language	19UTAM144/ 19UFRE144/ 19UHIN144/ 19USAN144	Tamil-IV/Hindi-IV/ French-IV/ Sanskrit-IV	3	6	50	50	100
	II	English	19UENG244	English IV	3	4	50	50	100
	III	Core-VIII	19UBIO309	Genetic Engineering	4	5	50	50	100
	III	Core-VI	19UBIO3010P	Practical III – Genetic Engineering and Microbiology	3	6	50	50	100
	III	Allied-IV	19UBIO311	Microbiology	5	5	50	50	100
	IV	Skill based subjects	19UGSL404	Soft skill III	3	2	-	100	100
	IV	EVS	19UEVS401	Environmental Studies	2	2	-	100	100
Total Credit: 23 / Total Hours per week: 30									
Semester- V	III	Core -IX	19UBIO312	Molecular Developmental Biology	4	4	50	50	100
	III	Core- X	19UBIO313	Bioprocess Technology	4	4	50	50	100
	III	Core - XI	19UBIO314	Bioinformatics and Biostatistics	3	5	50	50	100
	III	Core XII	19UBIO315	Pharmaceutical Biotechnology	4	5	50	50	100
	III	Core XIII	19UBIO316P	Practical III - Molecular Developmental Biology, Bioinformatics & Bioprocess Technology	3	6	50	50	100
	III	Elective-I (IDE)	19UIDE321	Intellectual Property Rights	5	5	50	50	100
	IV	Value Education	19UVED401	Value education	2	1	*	100	100
	V	Internship		Internship	2				
Total Credit: 27 / Total Hours per week: 30									

Semester	Part	Course Component	Subject Code	Subject Name	Credit	Hours	CIA	ESE	Total
Semester- VI	III	Core XIV	19UBIO317	Plant Biotechnology	4	5	50	50	100
	III	Core XV	19UBIO318	Animal Biotechnology	4	5	50	50	100
	III	Core XVI	19UBIO319	Biosafety, Bioethics and Intellectual Property Rights	3	5	50	50	100
	III	Core XVII Practical-VI	19UBIO320P	Plant Biotechnology and Animal Biotechnology	3	6	50	50	100
	III	Elective II	19UBIO321/ 19UBIO323	Microbial Biotechnology/ Environmental Biotechnology	5	4	50	50	100
	III	Elective III	19UBIO322	Project	5	5	50	50	100
	IV	Extension Activities		Extension Activities	1	-	-	-	-
Total Credit: 25 / Total Hours per week: 30									
Grand Total Credit: 142 / Total Hours per week: 180									

SEMESTER-I

CORE I: CELL BIOLOGY

Subject Code: 20UBIO301	**Theory**	**Marks:** 100
Semester: I	**Credits:** 4	**Total Hours:** 60

Course Objectives:

- 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.

Unit I: Basic Biology of Cells (10 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 (14 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 (12 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 (12 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 (12 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:

- Devasena, Cell biology by, Oxford University Press, I Ed., 2012.
- Geoffrey M. Cooper and Robert E. Hausman, Molecular approach to cell by, Oxford University Press, 7th Ed., 2018.
- Channarayappa, Molecular Biology, Universities Press, 2010.
- 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).
- The lives of a cell –A practical –Experimental Biology-A laboratory manual by Lewis Thomas.

Useful URL:

https://www.youtube.com/watch?v=dMPXu6GF18M&list=PLSy2IqrL3nn9etf2mmBU 3OOGY xlR H1BNN
https://www.youtube.com/watch?v=y623clAREHI&list=PL3993356C72C83C
https://www.youtube.com/watch?v=qOVkedxDqQo
https://www.youtube.com/watch?v=4qf1BSXn_tk
https://www.youtube.com/watch?v=89W6uACEb7M
https://www.youtube.com/watch?v=KIvBn6gfRgY
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:20UBIO302P	**Theory**	**Marks:** 100
Semester: I	**Credits:** 3	**Total Hours:** 30

Course Objective:

- 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.

Unit-1: 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

Unit-2: 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

Unit-3: Spotters: (Identification using photomicrographs and microscopes)

- Prokaryotic and eukaryotic cells
- Plant and animal cells
- Types of the chromosomes based on the centromere
- Mitotic stages: Prophase, Metaphase, Anaphase & telophase
- Meiosis stages Prophase I: (Leptotene, Zygotene, Pachytene, Diplotene & Diakinesis)
- Male and female grasshopper
- Double helical structure of DNA
- Fluid mosaic model of the cell membrane
- Components of the compound microscope
- Hemocytometer

(b.)CORE II - PRACTICAL - I: CHEMISTRY

Subject Code: 20UBIO302P	**Practical**	**Marks:** 100
Semester: I	**Credits:** 3	**Total Hours:** 30

Course Objectives:

- To learn about the basic preparation of samples, solutions.
- To learn about the principles of volumetric analysis
- To learn about the working principles and handling of laboratory instruments.

Unit-1: Preparation of Standard Solutions

1. Preparations of solutions based on normality
2. Preparations of solutions based on molarity
3. Preparations of solutions based on percentage
4. Preparation of Buffer solutions with determined pH
5. Preparation of standard solution

Unit-2: Volumetric Analysis

1. Estimation of Sodium hydroxide using standard Sodium Carbonate.
2. Estimation of Hydrochloric acid using standard Oxalic acid.
3. Estimation of Ferrous sulphate using standard Mohr's salt
4. Estimation oxalic acid using standard Ferrous Sulphate.

Unit-3: Demonstration Experiment:

1. Estimation of hardness of water using EDTA (Demo)

ALLIED I: CHEMISTRY

Subject Code:20UCHE333	Theory	Marks: 100
Semester: I	**Credits:** 4	**Total Hours:** 75

Course Objectives:

- To understand the basics of atomic arrangement, theories involved in the sub atomic particle.
- To understand the chemical bonding
- To understand the importance of functional groups

Unit I: FUNDAMENTAL CONCEPTS IN ORGANIC CHEMISTRY (15 hrs.)

Concept of hybridization: Orbital overlap hybridization and geometry of CH_4, C_2H_4, C_2H_4 and C_6H_6; Polar effects: Inductive, Mesomeric, Hyperconjugation, Steric effect; Intermediate and Types of organic reactions: Nucleophile, Electrophile, Free radicals- Substitution and Elimination (S^N1, S^N2, E^1, E^2).

Unit II: NANOCHEMISTRY (15 hrs.)

Introduction to nanochemistry – molecules, bulk materials and nanoparticles – classification with examples – preparation methods- top-down and bottom-up approach, ball milling, laser ablation, solgel, thermolysis, electrodeposition, chemical vapour deposition. Therapeutic and catalytic applications of nanomaterials.

Unit III: PHOTOCHEMISTRY (15 hrs.)

Photochemistry: Grothus-Drapper's law and Stark-Einstein's law of photochemical equivalence. Quantum yield – Hydrogen-chlorine reaction. Phosphorescence, fluorescence, chemiluminescence, photosensitization and photosynthesis (definition with examples).

Unit IV: KINETICS AND CATALYSIS: (15 hrs.)

Order and Molecularity – Integrated rate expression for first order reaction. Second order, zero order and pseudo unimolecular reactions (no derivation); Catalysis: Homogenous and heterogeneous, catalyst used in contact and Haber's processes.

Unit V: ELECTROCHEMISTRY (15 hrs.)

Galvanic cell- Standard hydrogen electrode- Calomel electrode- standard electrode potentials- electrochemical series. Strong and weak electrolytes – ionic product of water – pH, pKa, pKb.

Conductometric titrations- pH determination by colorimetric method – buffer solutions and its biological applications. Corrosion and its prevention.

Reference Books:

- V. Veeraiyan, Text book of Ancillary Chemistry; High mount publishing house, Chennai, first edition, 2009.
- S. Vaithyanathan, Text book of Ancillary Chemistry; Priya publications, Karur, 2006.
- ArunBahl, B. S. Bahl. Advanced organic chemistry; S. Chand and Company, New Delhi, twenty third edition, 2012.
- P.L. Soni, H. M. Chawla, Text Book of Organic chemistry; S. Chand & Company, New Delhi, twenty ninth edition, 2007.
- P. L. Soni, Mohan Katyal, Text book of Inorganic chemistry; S. Chand & Company, New Delhi, twentieth edition, 2007.
- R. Puri, L. R. Sharma, M. S. Pathania, Text book Physical chemistry; Vishal Publishing Co., New Delhi, forty fourth edition, 2010.

Useful URL:

https://www.youtube.com/watch?v=9QZj-F-5PV4
https://www.youtube.com/watch?v=XG5HvU47Ky4
https://www.youtube.com/watch?v=DC4J0t1z3e8
https://www.youtube.com/watch?v=Sa0WfA9UGG0

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-1): BIOTECHNOLOGY FOR SOCIETY WELFARE

Subject Code:20UNME401C	**Theory**	**Marks: 100**
Semester: I	Credits: 2	Total Hours: 30

Course Objective:

- 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

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

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

Unit-II: Biobased industries **(6 hrs.)**

Biobased cottage industries; Sericulture, Aquaculture, Apiculture, Vermicompost 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:

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

Useful URL:

https://youtu.be/g_ZswrLFSdo
https://youtu.be/CVa_IZVzUoc
https://youtu.be/N2vXsnlHxcA

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

Subject Code: 20UNME401D	**Theory**	**Marks:** 100
Semester: I	**Credits:** 2	**Total Hours:** 30

Course Objectives:

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

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:

- G. K. Pal, 'Text Book of Medical Physiology', Second Edition, 2014.
- T. S. Ranganathan,Text Book of Human Anatomy , S.Chand&Co. Ltd.,5th,1996
- Arthur.C.Guyton, John E Hall, 'Textbook of Medical Physiology', W.B. Saunders Company, Twelfth edition, 2006
- Kim E. Barrett, Susan M. Barman, Scott Boitano, Ganong's Review of Medical Physiology', 24th Edition, 1 May 2012.

- Sylvia Mader (Author), Michael Windelspecht, Human Biology by, McGraw Hill publications, 14th Ed., 2015.
- K. Sembulingam, Essentials of Medical Physiology, 6th Edition

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

SEMESTER-II

CORE III: BIOCHEMISTRY

Subject Code:20UBIO303	Theory	Marks: 100
Semester: I	**Credits:** 4	**Total Hours**: 60

Course Objective:

- To demonstrate various metabolic cycles.
- To explain the properties and significance of biomolecules.
- To describe the role of vitamins in metabolism.
- To relate the complications of metabolic disorders.

Unit- I: Carbohydrates and its metabolism (12 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 (12 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 (12 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 (12hrs)

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

Unit- V: Metabolic disorders: (12 hrs)

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

Reference Books:

- Albert Lehninger, David Nelson, Michael Cox, Principles of Biochemistry; W.H.Freeman, 2000.
- Donald Voet, Judith G.Voet, Charlotte W.Pratt, Fundamentals of Biochemistry: Life at the molecular level, Wiley, 5th Ed., 2016.
- J.L.Jain, Sunjay Jain, Nitin Jain, Fundamentals of Biochemistry, S.Chand Publishers, 7th Ed., 2006.
- Satyanaryana.U, Essentials of Biochemsitry, New India Book Agency, 2nd, 2008.

- T.Devasena, Biomolecules, MJP Publishers, Ist Ed., 2010.
- Donald Voet, Judith G.Voet, Biochemistry, Vol. 1: Biomolecules, Mechanisms of Enzyme Action, and Metabolism, Wiley Publishers, Ist Ed., 2003.
- V.K. Ahluwalia, Biomolecules Chemistry of Living System, Manakin Press, 2015.
- MN Chatterjea, Textbook of Medical Biochemistry, 8th Edition

Useful URL:

https://www.youtube.com/watch?v=8qij1m7XUhk
https://www.youtube.com/watch?v=rdF3mnyS1p0
https://www.youtube.com/watch?v=FmafhSMv0e0
https://www.youtube.com/watch?v=wQ1QGZ6gJ8w
https://www.youtube.com/watch?v=KwNe9x0eChs
https://youtu.be/9dMsDgWMq1w
https://youtu.be/8qij1m7XUhk
https://youtu.be/ubzw64PQPqM
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**

UESTION 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:20UBIO304P	**Theory**	**Marks: 100**
Semester: II	**Credits:** 3	**Total Hours:** 30

Course Objectives:

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

Unit-1: Volumetric analysis:

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

Unit-2: 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.

Unit-3: 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.

Unit-4: Biochemical preparations: a. Preparation of casein from milk.

b. Preparation of starch from potato.

Unit-5: 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.

Unit-6: Spotters:

- Osazone crystals of glucose, fructose, lactose, maltose, galactose
- Albumin-BSA
- Diabetes mellitus
- Structure of starch
- Centrifugation apparatus.

- Liver cirrhosis
- Night blindness
- pH meter
- Spectroscopy
- Colorimetry

Reference Books:

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

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

Subject Code:20UBIO304P	Theory	Marks: 100
Semester: II	Credits: 3	Total Hours: 30

Course Objectives:

- 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.

Unit-1: 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).

Unit-2: Demonstration Experiments:

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

Unit-3: Spotters:

1. Water bath
2. Homogenizer
3. Electronic Weighing Balance
4. Orbital Shaker
5. Micropipette
6. UV-Trans illuminator
7. Biosafety Cabinet 8. Vortex Mixture
9. Soxhlet apparatus
10. Silica gel

ALLIED II: BIOTECHNIQUES AND BIOINSTRUMENTATION

Subject Code:20UBIO305	**Theory**	**Marks: 100**
Semester: II	**Credits:** 5	**Total Hours:** 75

Course Objectives:

- 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.

Unit – 1: Microscopy **(15 hrs.)**

Microscopes – Micrographs – Microscope lenses and types - Simple microscopes – Compound microscopes – Principles of microscopy: Magnification and resolution power – 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 – Distribution coefficient – Principle and Applications of different types of chromatography: Paper chromatography – Thin layer chromatography – Capillary action - Rf Value - 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: Basics of classification of the types – Principles, instrumentation and applications of UV-Visible spectroscopy – Principle and uses of Fluorescence spectroscopy – Differences between spectroscopy and spectrometry - Applications of 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:

- Keith Wilson, John Walker (2010) Principles and Techniques of Biochemistry and Molecular Biology (7th Ed) Cambridge University Press
- David Sheehan (2009), Physical Biochemistry: Principles and Applications (2nd Ed), Wiley- Blackwell
- David M. Freifelder (1982) Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W.H.Freeman
- Rodney F. Boyer (2012), Biochemistry Laboratory: Modern Theory and techniques, (2nd Ed),

  Prentice Hall
- Kaloch Rajan (2011), Analytical techniques in Biochemistry and Molecular Biology, Springer.

Useful URL:

https://www.youtube.com/watch?v=VpiqscrcbME
https://www.youtube.com/watch?v=U5N2uxHNzxg
https://www.youtube.com/watch?v=Dq5JgsxJpTY
https://www.youtube.com/watch?v=W0oacysFTko
https://www.youtube.com/watch?v=1uPyq63aRvg
https://www.youtube.com/watch?v=SsIYDEma_cU
https://www.youtube.com/watch?v=2rYmUxqz3jo&list=PLFD540BF4995B4469
https://www.youtube.com/watch?v=x8one-B_Y1w
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: 20UNME402C	**Theory**	**Marks: 100**
Semester: II	**Credits:** 2	**Total Hours:** 30

Course Objectives:

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

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); Aquaculture farm: Set-up & management (Fin-fishes farm, crustacean farms, Shell fishes); Feed formulation; Health management of commercially important animals

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

Indian marine research institutes and marine products based Indian industries; Bioproducts from marine organisms: (i.) Molluscan Derived Compounds (ii.) Vertebrate-Derived Compounds, (iii.) Cnidarian Derived Compounds, (iv.) Ascidian Derived Compounds, (v.) Bryozoans Derived Compounds, (vi.) Helminth Derived Compounds, (vii.) fish derived compounds, (viii.) Marine algae based compound

Unit-V Marine Bacteria and Indian Research Institutes **(6 hrs.)**

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

Reference books:

- Garth L. Fletcher, Matthew L. Rise, Aquaculture Biotechnology, Wiley Blackwell, 2012.
- Marine Biotechnology: enabling solutions for ocean productivity and sustainability, Organisation for Economic Co-Operation and Development, OECD, 2013
- V. Ramachandran, Aquaculture Biotechnology, Black Prints India Inc., 2013.

- Manjushree Acharya, Aquatic and Marine Biology, Mittal Publishers, 2011.

Useful URL:

https://www.youtube.com/watch?v=hv1U19J3yfw
https://www.youtube.com/watch?v=KTy_0dzLiu8
https://www.youtube.com/watch?v=8_1Ng3SCvCU
https://www.youtube.com/watch?v=pnjFfxj9FHE
https://www.youtube.com/watch?v=EXb2hK7odd4

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

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

Subject Code: 20UNME402E	Theory	Marks: 100
Semester: II	**Credits:** 2	**Total Hours:** 30

Course Objective:

- 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.

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:

- Herbal Drugs Industry, V. Rajpal and DPS Kohli. 2nd Edition, 2009, Business Horizons.
- Traditional Herbal Medicine Research Methods: Identification, Analysis, Bioassay, and Pharmaceutical, 2011, Willow J.H. Liu Hardcover, Publishers-Wiley.
- Herbal Medicine in India, Indigenous Knowledge, Practice, Innovation and its Value, **Sen**, Saikat, Chakraborty, Raja, 2020, Springer.
- 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
- Secrets of Natural Diet, by Dr. Brij Bhushan Goyal, 2013, Sterling ***Publishers*** Pvt Ltd.
- Herbs of Siddha Medicine, Volume 1: The First 3D Book on Herbs, J Raamachandran, Publication by DR.J. Raamachandran**.**

Useful URL:

https://www.youtube.com/watch?v=efM3_aKO0E0
https://www.youtube.com/watch?v=rE-z_0Nt_kA
https://www.youtube.com/watch?v=fLIs4Z4xHWQ
https://www.youtube.com/watch?v=Kt0Lgy17I78
https://www.youtube.com/watch?v=HzTvEK1sVi0

SEMESTER-III
CORE V: GENETICS

Subject Code:19UBIO306	**Theory**	**Marks:** 100
Semester: III	**Credits:** 4	**Total Hours:** 60

Course Objective:

- 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.

UNIT I: Classical Genetics & Mendelian inheritance (12 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 (12 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 (12 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 (12 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 (12 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:

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

Useful URL:

https://www.youtube.com/watch?v=mBq1ULWJp_M

https://www.youtube.com/watch?v=0bfpOhbKEAk&t=8s

https://www.youtube.com/watch?v=NWqgZUnJdAY&start_radio=1&list=RDQMA- 0RaR5RrOw

https://www.youtube.com/watch?v=1ZXkPk9Rr5M

https://www.youtube.com/watch?v=Dzt3XdSZ1eI

https://www.youtube.com/watch?v=RTo2lRgfluI

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

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

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TOTAL MARKS				**100**

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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 VI – PRACTICAL – III: GENETICS AND IMMUNOTECHNOLOGY

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

Subject Code:19UBIO307P	**Practical**	**Marks:** 100
Semester: III	**Credits:** 3	**Total Hours:** 30

Course Objective:

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

Unit-1: 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 larvae salivary glands.
6. Identification of different types of Human chromosomes (Metacentric, submetacentric, Telocentric and acrocentric) by Photomicrographs.

Unit-2: 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).

Unit-3: Spotters:

1. Drosophila mutant type and wild type
2. Drosophila eye color (Red eyes & White eyes)
3. Dominant and recessive traits of maize
4. Down syndrome
5. Klinefelter syndrome
6. Polytene chromosome
7. Crossing over - Chiasma
8. Pedigree analysis
9. Punnett square
10. Bottle neck effect

Reference Books

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

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https://www.youtube.com/watch?v=mBq1ULWJp_M

https://www.youtube.com/watch?v=0bfpOhbKEAk&t=8s

https://www.youtube.com/watch?v=NWqgZUnJdAY&start_radio=1&list=RDQMA-0RaR5RrOw

https://www.youtube.com/watch?v=1ZXkPk9Rr5M

https://www.youtube.com/watch?v=Dzt3XdSZ1eI

https://www.youtube.com/watch?v=RTo2lRgfluI

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

Subject Code:19UBIO307P	**Practical**	**Marks:** 100
Semester: III	**Credits**: 3	**Total Hours**: 30

Course Objectives:

- 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.

Unit-1: 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

Unit-2: Demonstration experiments:

- Agglutination reactions: WIDLA TEST, ASO, CRP test
- Precipitation reactions: SRID, OD-Patterns, Counter immunoelectrophoresis, immunoelectrophoresis.
- ELISA- To detect Antigens
- Western blotting

Unit-3: Spotters:

- Granulocytes
- Agranulocytes
- ELISA test
- Western blot
- T.S of Spleen
- T.S. of Lymph node
- T.S. of Thymus
- Elie Metchnikoff
- Kohler and Milstein
- Edward Jenner

Reference Books:

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

ALLIED III: IMMUNOLOGY AND IMMUNOTECHNOLOGY

Subject Code:19UBIO308	**Theory**	**Marks:** 100
Semester: III	**Credits:** 5	**Total Hours**: 60

Course Objectives:

- 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 immnotechnologies in disease diagnosis.

Unit- I: History of Immunology (12 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 (12 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 (12 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 (12 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 (12 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:

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

Useful URL:

https://www.youtube.com/watch?v=LB9FYAo7SJU

https://www.youtube.com/watch?v=G4jobV6-bFA

https://www.youtube.com/watch?v=_FLjj_Z7SKA

https://www.youtube.com/watch?v=Q3XpZjtciBQ

https://www.youtube.com/watch?v=iZYLeIJwe4w

https://www.youtube.com/watch?v=jrAw50B3jK0

https://www.youtube.com/watch?v=YO244P1e9QM

https://www.youtube.com/watch?v=lkoDv6qgRjE

https://www.youtube.com/watch?v=quv1oJlbsTc

https://www.youtube.com/watch?v=3g246c6Bv58

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FORTHEORY PAPERS

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

QUESTION PAPER PATTERN:

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	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 VII: GENETIC ENGINEERING

Subject Code:19UBIO309	**Theory**	**Marks:** 100
Semester: IV	**Credits:** 4	**Total Hours:** 60

Course Objective:

- 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.

Unit I: Natural genetic recombination processes (12 Hours)

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 r-DNA technology & molecular cloning.

Unit II: Molecular tools (Enzymes) (12 Hours)

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 (12Hours)

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 (12 Hours)

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

Unit V: Core molecular techniques (12 Hours)

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:

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

Useful URL:

https://www.youtube.com/watch?v=3IsQ92KiBwM

https://www.youtube.com/watch?v=BK12dQq4sJw

https://www.youtube.com/watch?v=glt8iAqK8NQ

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

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**

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
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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

CORE VIII – PRACTICAL – IV: GENETIC ENGINEERING AND MICROBIOLOGY

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

Subject Code:19UBIO310P	**Practical**	**Marks:** 100
Semester: IV	**Credits:** 3	**Total Hours**: 30

Course Objective:

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

Unit-1: 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. Extraction of DNA from animal tissues
5. Determination of molecular weight of the DNA sample by graphical method.
6. Preparation of protein from bacterial cell and demonstration of protein profiling by SDS-PAGE.
7. Restriction digestion experiments and demonstration of bands using agarose gel electrophoresis

Unit-2: Demonstration Experiments:

1. Blue white colony screening
2. Polymerase Chain Reaction

Unit-3: Spotters:

1. DNA patterns of linear DNA, circular DNA, Nicked DNA and Apoptotic DNA
2. ECORI enzyme action
3. pBR322 Vector
4. TAE buffer
5. DNA gel loading dye
6. Southern blotting and hydridisation
7. Submarine gel electrophoresis unit
8. Slab gel electrophoresis unit
9. Blue white screening
10. Kary Mullis

Reference books:

- 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.
- S. Janarthanan and S. Vincent, Practical Biotechnology: Methods and Protocols by Orient Black Swan and Universities Press, 2007.
- Stefan Surzycki, Basic techniques in molecular biology, Springer, 2000.
- Heather Miller, D.Scott Witherow, Molecular biology techniques: A classroom laboratory manual, Academic Press 3rd Ed., 2011.
- Basic Laboratory Calculation for Biotechnology by Seidman, Pearson, 2008.

(b.)CORE VIII – PRACTICAL – IV: MICROBIOLOGY

Subject Code:19UBIO310P	**Practical**	**Marks:** 100
Semester: IV	**Credits:** 3	**Total Hours**: 30

Course Objectives:

- 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.

Unit-1: 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.

Unit-2: 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.

Unit-3: Spotters:

1. *Staphylococcos aureus*
2. *Bacillus subtilis*
3. *E.coli*

4. *Lactobacillus* spp.
5. EMB agar
6. Mannitol salt agar
7. *Aspergillus niger*
8. *Penicillium chrysogenum*
9. Gram's Iodine
10. Lactophenol cotton stain
11. Colony counter
12. Autoclave and Hot air oven
13. Alexander Fleming

Reference Books:

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

ALLIED IV: MICROBIOLOGY

Subject Code:19UBIO311	**Theory**	**Marks:** 100
Semester: IV	**Credits:** 5	**Total Hours:**60

Course Objectives:

- To identify the evolution of microbes and their classification.
- To evaluate the various sterilisation 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.

Unit I: Introduction to Microbes and its classification (12 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 (12 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 growthcurve determination; calculation of generation time

Unit III: Bacterial identification and microbial interaction (12 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: MacConkey, 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, disammebly of ribosomal assembly and inhibition of DNA replication).

Unit IV: Role of microbes in agriculture (12 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 **(12 hrs)**

Sewage and waste water 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:

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

Useful URL:

https://www.youtube.com/watch?v=iDVq2etiknU

https://www.youtube.com/watch?v=qZXOILsh9ro

https://www.youtube.com/watch?v=zDmP14twN8g&t=77s

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

https://www.youtube.com/watch?v=Et1v8EQP10U

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

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

QUESTION PAPER PATTERN:

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Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

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	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
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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

SEMESTER-V

CORE IX: MOLECULAR DEVELOPMENTAL BIOLOGY

Subject Code: 19UBIO312	**Theory**	**Marks:** 100
Semester: V	**Credits:** 4	**Total Hours:** 60

Course objective:

- 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.

Unit I: Introduction to Developmental Biology (12 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 (8 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 Developmen (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 (10 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

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

Useful URL:

https://www.jove.com/science-education/5328/an-introduction-to-molecular- developmental-biology.

https://www.youtube.com/watch?v=DsK9R-yfgF4

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

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

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

https://www.youtube.com/watch?v=J2DlGtOA3sA

https://www.youtube.com/watch?v=J2DlGtOA3sA

https://www.youtube.com/watch?v=RDt5ev9Q0Uk

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FORTHEORY PAPERS

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

QUESTION PAPER PATTERN:

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Section C	**Question 20–25**	**Detailed Answer** Answer **ANY 4** out of **6** questions	10	**40**
TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

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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 X: BIOPROCESS TECHNOLOGY

Subject Code:19UBIO313	**Theory**	**Marks:** 100
Semester: V	Credits: 4	Total Hours: 60

Course Objective:

- 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.

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 Up-stream process- media formulation (12 hrs.)

Definition of fermenter, Basic parts of fermenter, Types of fermenters: stirred tank fermenter, airlift fermenter, fluidised 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: Up-stream processes - Bacterial cell inoculum and Kinetics (15 hrs.)

(i.) 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: (1) 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, 2ndEd., 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** **MarksDuration : Three** **Hours**

QUESTION PAPER PATTERN:

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TOTAL MARKS				**100**

DISTRIBUTION OF QUESTIONS:

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	Unit – 2	2
	Unit – 3	2
	Unit – 4	3
	Unit – 5	3
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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

CORE XI: BIOINFORMATICS AND BIOSTATISTICS

Subject Code:19UBIO314	**Theory**	**Marks:** 100
Semester: V	Credits: 3	Total Hours: 60

Course Objectives:

- 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.

UNIT I: Data Analysis (16 hrs.)

Importance and scope of Bioinformatics. Introduction to Human genome project. Biological databases – Data Bank (GenBank, PDB), 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 (18 hrs.)

Gene prediction approaches – prokaryotes and eukaryotes - Open Reading Frame (ORF) prediction – Hidden Markov Model – Discriminant analysis. *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 (20 hrs.)

Introduction to Isomer (Optical, geometric and stereo isomers); Protein structures - Definition and Types - Primary structure, Secondary structures (Ramachandran Plot), Tertiary structure (α-α: Collagen, β-α (Rosmann fold), β-β (Jelly roll -Beta barrels- transporter proteins) and quaternary structures: hemoglobin structure). Protein secondary structure prediction: First Generation – Chou-Fasman, Garnier- Osguthorpe- Robson (GOR) methods – Neural network concepts and Second Generation - Homology modeling (hom and hox box genes).

UNIT IV: Introduction to Biostatistics (18 hrs.)

Introduction, Scope and application of Biostatistics; Common terms (Data, Constant and variables: Dependent and independent data); Collection of biological data- sampling techniques, 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, Mode and Median (problems).

Unit-V: Measures of dispersion and Probability (18 hrs.)

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

Reference Books:

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

Useful URL:

https://www.youtube.com/watch?v=w-uk-_TOgR0&list=PLb0WW0k29aHrF8a ZzK17ORTesZsd-lING

https://www.youtube.com/watch?v=SAweFv8I8ow&list=PL1ay9ko4A8skYqjhrA4IND Z7IHtebS0lY

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

https://www.youtube.com/watch?v=cd6O8FbrVjw

https://www.youtube.com/watch?v=ZNIQCrCIbL8

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

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

QUESTION PAPER PATTERN:

Section	**Numbers**	**Question Component**	Marks	**Total**
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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**

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Sections	**Units**	**No. of Questions**
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	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:19UBIO315	**Theory**	**Marks:** 100
Semester: V	**Credits:** 4	**Total Hours:** 60

Course Objectives:

- 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 ofcommonly used biopharmaceuticals.

UNIT I: Introduction to Pharmaceutical Biotechnology (10 hrs.)

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

UNIT II: Drug development process (14 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 (12 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 (12 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 (12 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:

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

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**

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, BIOPROCESS TECHNOLOGY AND BIOINFORMATICS

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

Subject Code:19UBIO316P	**Practical**	**Marks:** 100
Semester: V	**Credits:** 3	**Total Hours:** 30

Course Objective:

- 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.

Unit-1: 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

Unit-1: Experiments: Bioinformatics

1. Study of Internet resources in Bioinformatics.
2. Searches on MEDLINE, PubMed databases.
3. Introduction to sequence databases: Protein sequence databank – UNIPROT, Nucleic acid sequence databank – Gene bank, EMBL, DDBJ.
4. Sequence alignment - BLAST, FASTA
5. Multiple alignment - CLUSTALW.

Unit-2: 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

Unit-3: Spotters:

1. Human ovum and sperm
2. Frog ovum and sperm
3. Blastophore in frog
4. Different developmental stages of Drosophila
5. Drosophila imaginal bud and Neural tube
6. Egg Candler
7. Safranin stain
8. Ringer solution
9. Edward B.Lewis
10. Scott Gilbert

Reference Books:

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

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

Subject Code:19UBIO316P	**Practical**	**Marks:** 100
Semester: V	**Credits:** 3	**Total Hours:** 30

Course Objectives:

- 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.

Unit-1: 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

Unit-2: 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

Unit-3: Citric acid production by *Aspergillus niger*

(i) Media formulation
(ii.) Determination of total acid by titration (after 2^{nd} day and after 21 days)
(iii) Product recovery

Unit-4: 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.

ELECTIVE I: INTERDISCIPLINARY ELECTIVE (IDE)
INTELLECTUAL PROPERTY RIGHTS

Subject Code:19UIDE321	**Theory**	**Marks:** 100
Semester: V	Credits: 5	Total Hours: 60

Course Objectives:

- The course is intended to make the students to know about the fundamental concepts of Intellectual 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.

Unit I: Introduction to Intellectual Property Rights (12 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 (12 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) (12 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) (12 Hrs.)

Definitions – Concepts of Patents – Patentable and Unpatentable Inventions – Plant Breeders Rights (Basmati rice), Procedure to obtain Patent specifications (Course activity) – 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 **(12 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:

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

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FORTHEORY PAPERS

Question Allotment	**Maximum :100 Marks** **Passing Minimum :40 MarksDuration : 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 XIV: PLANT BIOTECHNOLOGY

Subject Code:19UBIO317	**Theory**	**Marks:** 100
Semester: VI	**Credits:** 4	**Total Hours:** 60

Course Objective:

- To understand the basic properties, classification of plants
- To understand the application of genetic engineering in the generation of transgenic plants and their applications.

Unit I: Overview of Plant Biotechnology (18 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 (16 hrs.)

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

Unit III: Gene Transfer Techniques (19 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 (18 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 (19 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:

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

Useful URL:

https://www.youtube.com/watch?v=6y13hYGPi8Q

https://www.youtube.com/watch?v=TORRxwbz7aY

https://www.youtube.com/watch?v=ykKs5icYwq0

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

https://www.youtube.com/watch?v=cD9CFtpLL2s 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** **MarksDuration : Three** **Hours**

QUESTION PAPER PATTERN:

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

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 XV: ANIMAL BIOTECHNOLOGY

Subject Code:19UBIO318	Theory	Marks: 100
Semester: VI	Credits: 4	Total Hours: 60

Course Objective:

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

Unit I: Cell culture technology (12 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 – Equipments. 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 (12 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 (12 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 (12 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: Overview of Stem cell biology and tissue engineering (12 hrs)

Stem cells: Stem cell potency - Types of stem cells - Embryonic stem cells, tissue specific stem cells, mesenchymal stem cells and induced pluripotent stem cells – Applications of stem cells in medicine and research. Tissue engineering: Basic principles – Types of cells – Scaffold and biomaterials – Tissue assembly – Bioartificial organs – Biomimetics.

Reference Books:

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

Useful URL:

https://www.youtube.com/watch?v=RzYhcXjksKc https://www.youtube.com/watch?v=qybFQJ4-KEY
https://www.youtube.com/watch?v=WGKoJRNKAD Y
https://www.youtube.com/watch?v=f1ZcvAQW64E
https://www.youtube.com/watch?v=766QH_qaYN8
https://www.youtube.com/watch?v=Op3r_dB3ISk

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**

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:19UBIO319	**Theory**	**Marks:** 100
Semester: VI	**Credits:** 3	**Total Hours:** 60

Course Objective:

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

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:

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

Useful URL:

https://www.youtube.com/watch?v=Ew2OmY_Uer4

https://www.youtube.com/watch?v=9wgFZuBXKfc

https://www.youtube.com/watch?v=CAM6VNDYJ6k

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:19UBIO320P	**Practical**	**Marks:** 100
Semester: VI	**Credits:** 3	**Total Hours:** 30

Course Objectives:

- 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.

Unit-1: 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.

Unit-2: 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.

Unit-3: Spotters

1. Protoplast
2. Agrobacterium mediated gene transfer
3. Microinjection and Biolistic method
4. IAA
5. Embryo
6. Steps in Plant Tissue Culture
7. Tween 20

8. Different stages of callus
9. M.S.Swaminathan
10. Murashige Skoog medium

Reference Books:

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

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

Subject Code:19UBIO320P	**Practical**	**Marks:** 100
Semester: VI	**Credits:** 3	**Total Hours:** 30

Course Objective:

- 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.

Unit-1: 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

Unit-2: Demonstration Experiments:

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

Unit-3: Spotters:

1. Membrane filter
2. Dulbeccos's Modified Eagle's Medium
3. RPMI Medium
4. T - Flasks
5. CO2 Incubator
6. Inverted microscope
7. Tryphan blue
8. Phosphate buffer
9. Hank's buffer
10. Animal tissues (Spleen and liver)

Reference Books:

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

ELECTIVE II: ENVIRONMENTAL BIOTECHNOLOGY

Subject Code:19UBIO321	**Theory**	**Marks: 100**
Semester: VI	**Credits:** 5	**Total Hours:** 60

Course Objective

- Familiarize with various molecular techniques involved in wastage mitigation
- To demonstrate the importance of pollution mitigation

Unit I: Objective of Environmental Biotechnology (12 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 (12 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 (12 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 (12 hrs.)

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

Unit V: Hazardous Waste Management (12 hrs.)

Biotechnological methods for cyanide, oxalate and urea detoxification; toxic solvents -phenols. Environmental toxicology – Toxicants – Toxicity, Acute, subacute, chronic, dose effect and LD_{50} Doseresponse safe limits. Dose response relationship, detoxification of hazardous chemicals.

Reference Books:

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

USEFUL URL:

https://www.youtube.com/watch?v=f_wOnmjawiY
https://www.youtube.com/watch?v=1tJ2CWvTVGM&t=378s
https://www.youtube.com/watch?v=28iRLLXIBfU&t=292s
https://www.youtube.com/watch?v=hdpjA0XhYG0
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** **MarksDuration : 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:19UBIO323	**Theory**	**Marks:** 100
Semester: VI	**Credits:** 5	**Total Hours:** 60

Course Objectives:

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

Unit I: Basics of Food Biotechnology **(12 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 **(12 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 biofortification in health improvement. Microbial based food products: Microbial flavour and fragrances.

Unit III: Food Safety Regulations **(12 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 **(12 hrs.)**

Role of microbes in Food spoilage and Permissible limits of microbes in food. Principles involved in Food preservation and storage techniques. Treatment methods for solid and liquid wastes from food process industries.

Unit V: Agriculture and food ethics **(12 hrs.)**

Impact on society and ethical issues. Laws for the production and use of genetically modified foods and 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, Novapublishers, (2016).

Useful URL:

http://www.fao.org/docrep/U3550t/u3550t0h.htm.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3257668/

http://www.oecd.org/science/biotrack/41036698.pdf

https://www.youtube.com/watch?v=sOzt0D8vLCU

https://www.youtube.com/watch?v=BlHL5MxB84Q

https://www.youtube.com/watch?v=i610sLycTTs&list=PL_a1TI5CC9RE2S5RoMgcj2kv TmxqHgTgG

https://www.youtube.com/watch?v=-6ZY49DDvq4

*Visit to Food industries.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN FOR THEORY PAPERS

Question Allotment	**Maximum :100 Marks** **Passing Minimum :40** **MarksDuration : 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)

Subject Code:19UBIO322	**Project**	**Marks:** 100
Semester: VI	**Credits:** 5	**Total Hours:** 60

	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**