GURU NANAK COLLEGE (AUTONOMOUS)

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

Guru Nanak Salai, Velachery, Chennai – 600042.

B.Sc. Biotechnology

(SEMESTER PATTERN WITH CHOICE BASED CREDIT SYSTEM)

Syllabus

(For the candidates admitted in the Academic year 2019-20 and thereafter)

Vision

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

Mission

- 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: 2019-2022 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	19UBIO301	Cell Biology	4	5	50	50	100
	III	Core-II	19UBIO303P	*Practical I-Cell Biology and Biochemistry	--	3	---	--	--
	III	Core-IV	19UBIO305P	*Practical II-Chemistry and Bioinstrumentation	--	3	--	--	--
	III	Allied-I	19UCHEM333	Chemistry	4	5	50	50	100
	IV	NME/ Basic Tamil/ Advanced Tamil/ Basic Hindi	19UNME401O/ 19UBAT401/ 19UADT401	Human Physiology/ Basic Tamil/ Advanced 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: 19 / 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	19UBIO302	Biochemistry	4	5	50	50	100
	III	Core-II	19UBIO303P	Practical I-Cell Biology and Biochemistry	4	3	50	50	100
	III	Core-IV	19UBIO305P	Practical II-Chemistry and Bioinstrumentation	3	3	50	50	100
	III	Allied-II	19UBIO304	Biotechniques and Bioinstrumentation	5	5	50	50	100
	IV	NME/ Basic Tamil	19UNME402O	Behavioural studies of flora and fauna	2	2	---	100	100
	IV	Skill based subjects	19UGSL402	Soft skill II: Life Skills	3	2	---	100	100
Total Credit: 27 / Total Hours per week: 30									
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	Part	Course Component	Subject Code	Subject Name	Credit	Hours	CIA	ESE	Total
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 and 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- 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									

*Practical's to be conducted at the end of II Semester

GURU NANAK COLLEGE (AUTONOMOUS), CHENNAI – 600 042
(Effective for the batch of candidates admitted in 2019 – 20)

Core Paper: CELL BIOLOGY

Subject Code: 19UBIO301	**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 of subcellular organization and their importance.
- To learn about the various, inter and intra-cellular communication mechanisms.

Unit I: Introduction to Biotechnology (12 hrs.)

Biotechnology as an interdisciplinary field and its scope; Various fields of Biotechnology: Red Biotechnology (Health, Medical and Diagnosis), White Biotechnology (Gene based bio- industries), Green Biotechnology (Agriculture, Environmental Biotechnology- biofuels, biofertilizers, bioremediation, Geomicrobiology), Yellow biotechnology (food and nutritional Biotechnology), Blue biotechnology (Aqua, coastal and marine biotechnology), Brown Biotechnology (Arid zone and Dessert Biotechnology), Purple Biotechnology (Patents, publications, inventions, publications and IPRs), Gold Biotechnology (Bioinformatics and Nanotechnology), Grey Biotechnology (Classical Fermentation and Bioprocess technology; List of Indian Biotechnology sectors.

Unit II: FUNDAMENTALS OF CELL (12 hrs.)

Organization of living organism (Cells, Tissues [both animal & plant tissues], Organs, Organ system) – Evolution of Unicellular to higher organisms (*Chlamydomonas to Volvocine* algae); Cell theory; Different types of cells; Structural comparison of microbes, plant and animal cells. Plasmamembrane – Model, structure and function; Biomembrane Transportation - Active: Symport, Uniport, Antiport and Passive; Extracellular matrix: Properties and function; Cytoskeleton - Microfilaments, Microtubules and Intermediate filaments; Cellular Junctions -Adherent, Tight and Gap junctions; Molecular Levels of organization – Epithelial Cell to skintissue and skin tissue to integumentary system.

Unit III: Structure and functions of Subcellular organelles (15 hrs)

Mitochondria and its function; Chloroplast and its function; Morphology and functions of Lysosome, Peroxisomes and glyoxysomes; Centrioles; Eukaryotic Nucleus: Nuclear membrane, Karyoplasm, Chromatin reticulum, Condensation of chromatin reticulum to chromosome; DNA

replication in eukaryotic cells; Transposable elements: Transposons and Retroposons; Structure and function; Ribosomes

Unit IV: Structure and functions of Subcellular organelles (16hrs)

Overview of Transcription and Translation of eukaryotic cells and its regulator mechanism (RNA editing, Post transcriptional regulation & Post translation regulation- Protein modification and its importance); Protein degradation mechanism; Endoplasmic reticulum (smooth and rough)& Golgi apparatus and their functions (Protein folding); Protein sorting (Extracellular mechanism & intracellular mechanism- to Mitochondria and nuclear transport mechanism).

Unit V: CELL SIGNALING AND CELL DIVISION (20 hrs.)

Cellular communication - Types of cellular receptors and Cytokines; Inter cellular communication (Autocrine, paracrine, juxtacrine and endocrine) and Intracellular signaling mechanism (G-Protein Coupled Receptor pathway, Receptor kinase pathway: Tyrosine kinase pathway); Phases of Cell cycle and the check point proteins; Mitosis and Meiosis; Mechanism of Apoptosis, Overview of Cancer biology (Definition and types of protooncogens, oncogens and overview of normal cell into abnormal cell).

Reference Books:

- Devasena, Cell biology by, Oxford University Press, Ist 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", Wiley6th Edition, 2010.
- Harvey Lodish (Author), David Baltimore (Author), Arnold Berk,, MolecularCell Biology 3rd Ed., W H Freeman & Co (Sd).
- The lives of a cell –A practical –Experimental Biology-A laboratory manual byLewis Thomas.

Useful URL:
https://www.youtube.com/watch?v=dMPXu6GF18M&list=PLSy2IqrL3nn9etf2m mBU3OOGYxlR 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 PAPER PATTERN

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

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 BIOCHEMISTRY \

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

Subject Code: 19UBIO303P	**Practical**	**Marks:** 100
Semester: I	**Credits:** 3	**Total Hours:** 60

Course Objective:

- To teach the handling of microscope
- To differentiate different types of human cells
- To enumerate the cell count

Unit-1: Experiments:

1. Description about the Compound Microscope: Principle, construction.
2. Preparation of buccal smear and examination of cells and preparation of permanent slide.
3. Yeast cell size measurement using the ocular and micrometer.
4. Preparation of blood smear and examination of cells using Leishman staining.
5. WBC Cells count using Hemocytometer
6. Yeast cell count using Hemocytometer
7. Preparation of temporary mount of onion peel, to observe and study epidermal cells.
8. To perform and identify Mitosis stages by root squash method of *Allium cepa*
9. Animal Cell viability assay using trypan blue
10. Examination of cells under dark field and phase contrast field of microscope.
11. Temporary mount stained preparation and study of striated muscles fiber in cockroach.
12. Examine of biomolecules (Proteins, carbohydrates, lipids) in hand free sections of *Plectranthus amboinicus (*Mexican mint- Karpuravalli) succulent stem.

Unit-2: Demonstration Experiments:

1. Demonstration of using microtome and examination of Hematoxylin and eosin staining.
2. Demonstration of mitochondria isolation by differential centrifugation and its confirmation by methylene blue method.
3. Demonstration of difference between normal skin epithelial cell and a cancerousskin epithelial cell by using photomicrograph.

Unit-3: Spotters:

1. Cell organelles structures (Plant Cell wall, Vacuoles, Cell membrane, Mitochondria, Nucleus, Golgi complex, Chromatin reticulum, Chromosomes)
2. Skin epithelial cells
3. Plant parenchymatous cells
4. Human Nerve cells
5. Human Muscles (striated and non-striated cells)
6. Human Blood smear (demonstration of blood cells)
7. Animal Cell line: Vero
8. Polytene chromosome
9. Mitosis stages: Prophase, Metaphase, Anaphase and telophase
10. Nuclear stain
11. Histochemical stain
12. Cytoplasmic stain
13. Formalin

14. Hemocytometer
15. Onion peel
16. Skin Normal epithelial cell vs Skin epithelial Cancer cell
17. Robert Hooke
18. Theodore Schwann
19. Geoffery M.Cooper
20. Yoshinori Ohsumi

ALLIED I: CHEMISTRY

Subject Code:19UCHE333	**Theory**	**Marks:** 100
Semester: I	Credits: 4	Total Hours: 60

Course Objectives:

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

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_2 and C_6H_6; Polar effects: Inductive, Mesomeric, Hyperconjugation, Steric effect; Intermediateand Types of organic reactions: Nucleophile, Electrophile, Free radicals-Substitution and Elimination (S_N1, S_N2, E_1, E_2)

Unit II: Co-ordination chemistry and water technology (15 hrs.)

Co-ordination chemistry: Definition of terms – IUPAC nomenclature – Werner's theory. Chelation – EDTA, its importance and biological applications; Water technology: Hardnessof water, determination of hardness of water using EDTA method, zeolite method.

Unit III: Basics of physical chemistry (15 hrs.)

Photochemistry: Grothus-Drapper's law and Stark-Einstein's law of photochemical equivalence. Quantum yield, Phosphorescence, fluorescence, chemiluminescence, photosensitization and photosynthesis; Kinetics: Order and Molecularity - First order, secondorder, zero order and pseudo unimolecular reactions (no derivation); Catalysis: Homogenousand heterogeneous.

Unit IV: 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.

Unit V: Special topics (15 hrs.)

Basic principles of stereochemistry: Chirality- Elements of symmetry (simple approach). Enantiomers, diastereomers and racemic mixture (definition with one example). Resolution (biochemical method). Configuration- R / S (amino acids, tartaric acid, lactic acid), E / Z (Maleic and

fumaric acid, butene). Conformation – Conformers of n-butane and cyclohexane; Essentials of trace metals in biological systems- Na, Cu, K, Zn, Mg and Fe; Surfactants- Ionic, Non-ionic and its application. Surface tension, viscosity and their determination (one method).

Reference:

1. V. Veeraiyan, Text book of Ancillary Chemistry; Highmount publishing house,Chennai, first edition, 2009.
2. S. Vaithyanathan, Text book of Ancillary Chemistry; Priya publications, Karur,2006.
3. ArunBahl, B. S. Bahl. Advanced organic chemistry; S. Chand and Company,New Delhi, twenty third edition, 2012.
4. P.L. Soni, H. M. Chawla, Text Book of Organic chemistry; S. Chand &Company, New Delhi, twenty ninth edition, 2007.
5. P. L. Soni, Mohan Katyal, Text book of Inorganic chemistry; S. Chand &Company, New Delhi, twentieth edition, 2007.
6. B. R. Puri, L. R. Sharma, M. S. Pathania, Text book Physical chemistry; VishalPublishing 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:

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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 PRACTICAL-III: PRACTICAL- CHEMISTRY AND BIOINSTRUMENTATION

(a.) ALLIED PRACTICAL-I: CHEMISTRY

Subject Code:19UBIO305P	**Theory**	**Marks:** 100
Semester: I	**Credits:** 3	**Total Hours:** 60

Course Objectives:

- To learn about the estimation of inorganic and organic compounds.
- To learn to identify the organic functional groups

Unit-1: (A) VOLUMETRIC ANALYSIS

- Estimation of Sodium hydroxide using standard Sodium Carbonate.
- Estimation of Hydrochloric acid using standard Oxalic acid.
- Estimation of Ferrous sulphate using standard Mohr's salt
- Estimation oxalic acid using standard Ferrous Sulphate.

Unit-2: (B) ORGANIC ANALYSIS

(1) Detection of Elements (N, S, Halogens)

(2) To distinguish between aliphatic and aromatic Saturated and unsaturated compounds. Functional group tests for phenol, acids (mono, di) aromatic primary amine, amide & aldehyde. Systematic analysis of organic compounds containing one functional group andcharacterization by confirmatory test.(Phenol, cinnamic acid, benzoic acid, phthalic acid, benzamide, urea, benzaldehyde & aniline).

Unit-3: Demonstration Experiment:

- Estimation of hardness of water using EDTA (Demo)

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

Subject Code: 19UNME401O	**Theory**	**Marks:** 100
Semester: I	**Credits:** 2	**Total Hours:** 30

Course Objectives:

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

Unit-I: Skeletal and muscular system (6 hrs.)

Skeletal system: Bones and properties, Types of skeletal system: Hydrostatic skeletal system, exoskeleton and endoskeleton system; Muscles- Smooth and striated muscles, Neuro- Muscular junction and muscular contraction and relaxation.

Unit-II: Nervous system (6 hrs.)

Nervous system- Nerve cells, glial cells, aster cells, Different types of nerves, functions of nervous system, Brain: parts, functions, Spinal cord and its functions.

Unit-III: Circulatory System (6 hrs.)

Circulatory system- Blood composition and lymph composition, Functional anatomy of the heart, Conducting system of the heart, Capillary circulation (Blood and lymph), Arterial and venous system.

Unit-IV: Digestive and Excretory system (6hrs.)

Gastro intestinal system- General structure of alimentary canal, Gastric secretion, pancreatic secretion, mechanism of digestion, gastrointestinal hormones. Renal physiology- Structure of kidney,structure of Nephrons, Glomerular filtrate, Reabsorption, Secretion-mechanism of secretion, Concentrating and diluting mechanism of urine.

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

Respiratory system-Mechanism of breathing, Ventilation, Regulation of respiration, Transport of gases, Hypoxia, Artificial ventilation, 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 MedicalPhysiology', 24th Edition, 1 May 2012.
- Sylvia Mader (Author), Michael Windelspecht, Human Biology by, McGraw Hillpublications, 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-1h4870https://youtu.be/hn6YDo39tx4

SEMESTER-II

CORE IV: BIOCHEMISTRY

Subject Code:19UBIO302	**Theory**	**Marks:** 100
Semester: II	**Credits:** 4	**Total Hours:** 75

Course Objective:

- To understand metabolic cycles
- To understand the properties and mechanism of enzymes
- To understand the role of hormones and vitamins in metabolism

Unit- I: Biomolecules and Carbohydrates **(15 hrs.)**

Characters of Early earth's atmosphere and lithosphere; Theories related to the formation of Biomolecules on Erath: Urey-Miller experiment; Titan's atmosphere as a case study; Overviewof Classification of biomolecules. Carbohydrates (Structures and biological importance of animal& plant polymers- Cellulose, Starch, Lignin, Pectin, Cyanophycin). Glycolysis (aerobic and anaerobic), TCA cycle, oxidative phosphorylation, EM pathway, HMP shunt, Cori cycle.

Unit- II: Amino acid and Proteins **(15 hrs.)**

Classification, properties and Biological significance of (i.) Amino acid; (ii.) Proteins; Amino acid synthesis pathway and Urea Cycle. Introduction to Biochemistry of Enzymes: Nomenclature, Classification and Properties.

Unit- III: Fatty acid and Nucleotides **(15 hrs.)**

Classification, properties and Biological significance (i.) triglycerols, Lipids, Cholesterol, Sterols, essential fatty acids (Omega-3 fatty acid and Docosahexenoic acid [DHA]), eicosanoids,membrane lipids (phospholipids and sphingolipids) and their fluidity, and polyhydroxyalkanoates (PHA). ; Fatty acid synthesis (saturated and unsaturated) and degradation (β, ω oxidation). Types and Structures of Nucleotides.

Unit- IV: Vitamins & Hormones **(15 hrs.)**

Classification and their importance: Vitamins; Roles of vitamins as cofactors in metabolic reaction and their related diseases- (a.) Thiamine (Vitamin B_1) in Glucose metabolism, (b.)Riboflavin (Vitamin B_2) importance in metabolic reactions; Classification of hormones, Metabolic orders: Diabetics, Obesity, thyroid; Fatty Acid Oxidation disorders, Glycogen Storage diseases, Night blindness.

Unit- V: Porphyrin and Pigments (15 hrs.)

Classification and applications: (i.) Porphyrin compounds: of Hemoglobin, chlorophyll, VitaminB12; (ii.)Alkaloids; (iii.)Pigments: Carotenes, Xanthophylls- Astaxanthin, flavonoids (Anthocyanidins, flavan-3-ols and poly phenols), Betalains (Betacyanins) and animal pigments (Melanin, Luciferin, hemocyanin, myoglobin) and iridescences mechanism; Biopotenial properties of Microbial Pigments: Pycocyanin: *Pseudomonas aeruginosa*.

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 EnzymeAction, and Metabolism, Wiley Publishers, Ist Ed., 2003.
- Biomolecules Chemistry of Living System by V.K. Ahluwalia, Manakin Press, 2015.

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

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 II - PRACTICAL - I: CELL BIOLOGY and BIOCHEMISTRY
(b.)CORE II - PRACTICAL – I: BIOCHEMISTRY

Subject Code:19UBIO303P	**Practical**	**Marks:** 100
Semester: I	**Credit:** 3	**Total Hours:** 30

Course Objectives:

- To learn about the types and estimation of biomolecules.
- To learn about the various separation, elution techniques to identify the biomolecules.

Unit-1: Experiments:

1. Estimation of protein by Lowry method
2. Estimation of Carbohydrate by Orthotolidine and Glucose oxidase method
3. Estimation of DNA by Diphenyl amine method.
4. Estimation of RNA by Orcinol method.
5. Estimation of Cholesterol by Zak's method.
6. Preparation of starch from potato
7. Preparation of albumin from eggs
8. Qualitative Analysis:

(i.) Analysis of sugars:

a) Monosaccharides-Glucose, Fructose, Galactose,

b) Disaccharides - Sucrose, Maltose and Lactose.

c) Polysaccharides - Starch.

(ii.)Analysis of amino acids a) Tyrosine b) Tryptophan c) Cysteine d) Arginine

9. Detection of Phytochemicals in Tulasi leaf extract

(a.)Preparation of Tulasi leaf extract using solvents like methanol, Hot water and coldwater and detection of phytochemicals.

(b.)Confirmation of Alkaloids by Mayer's test, Wanger's test, Hagger's test, Dragendroff test

(c.)Confirmation of phenolic compounds and tannins by ferric chloride test

(d.)Antioxidative test of plant extract by using DPPH method

(e.)TLC separation of plant pigments

Unit-2: Demonstration:

1. Demonstration of density gradient centrifugation by separating of Blood cell byusing sucrose density.
2. Demonstration of phase separation of organic and aqueous phase in plant pigmentseparation and silica gel column chromatography.

3. TLC separation of Carbohydrates (glucose and fructose) and amino acid (Glycineand proline).

4. Demonstration of the usage of semi auto-analyser for blood, serum and urinebiochemical parameters.

Unit-3: Spotters:

1. Osazone crystals of glucose, fructose, lactose, maltose, galactose
2. Albumin
3. Glucose
4. Starch
5. Silica Gel for TLC
6. Structure of starch
7. Silica gel for Column chromatography
8. TEMED
9. Diphenyl amine reagent
10. Methanol as solvent
11. PBS buffer
12. Vitamin C
13. Liver cirrhosis
14. Night blindness
15. Oliver H. Lowry
16. Ulrich Laemmli
17. Peggy Annette Whitson
18. pH meter
19. Spectroscopy
20. Colorimetry

Reference Books:

- David Plummer, An introduction to practical Biochemistry, Tata McGraw-HillEducation, 1998
- Sowbhagya Lakshmi and Divya ShanthiD'Sa, An easy guide for practicalBiochemistry 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) PvtLtd., 2015.

Core Practical -II CHEMISTRY AND BIOINSTRUMENTATION

(b.) Allied Practical -I BIOINSTRUMENTATION

Subject Code:19UBIO305P	**Practical**	**Marks:** 100
Semester: I	**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

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
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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

ALLIED II: BIOTECHNIQUES AND BIOINSTRUMENTATION

Subject Code:19UBIO304	**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 chromatographyHigh pressure liquid chromatography – Gas liquid chromatography.

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

Colorimeter: Principles, types and application. Spectroscopy: Basics of classification of thetypes – 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 MolecularBiology (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=PLFD540B F4995B4469 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 FORTHEORY PAPERS

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

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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

NME-II: BEHAVIORAL STUDIES OF FLORA AND FAUNA

Subject Code:19UNME402O	**Theory**	**Marks:** 100
Semester: II	**Credits:** 2	**Total Hours:** 30

Course Objective:

- To understand the importance of Behavioral adaptations among plants and animals
- To understand the role of genetic adaptations mechanism.
- To understand the survival of species.

Unit- I: Behavioral study **(6 hrs.)**

Scope and importance; Behavioral phenotypic plasticity: Case study for microbes (*Dienococcus* spp.), Animals- (Evolution of Elephants from Mammoth and *Pristimantis mutabilis*, Crabs- immune responses in *Scylla serrata*), Plants- (Origin of cactus in desserts and in Dandelions); Types of plasticity with definition and examples: Assimilated Gene Expression Plasticity, Accommodated Gene Expression Plasticity, Novel Constitutive Gene Expression, Conserved Gene Expression Plasticity, Evolved Gene Expression Plasticity, Reversed Gene Expression Plasticity.

Unit- II: Adaptations **(6 hrs.)**

Types: (i.)Structural adaptation: Bill of a bird, tooth of beavers, Plants: Small leaves in desertplants; (ii.)Behavioral adaptation: Hunting patterns among predatory animals, Plants: Survival of weak stemmed plants (Creepers, climbers, vines, twiners); (iii.)Physiological adaptations: Examples- body temperature maintenance among animals (Endothermic, poikilotherms and homothermic animals), Plants: aquatic plants; Effects arising from changes according to the availability of food among animals and changes according to their habitat among animals and plants; Behavioral responses and the evolutionary process.

Unit- III: Ecological traps **(6 hrs.)**

Definition, ecological significance; Adaptive versus maladaptive plasticity: *Cardinalis cardinalis* attraction towards carotenoid rich berries, Insect attraction towards shiny surfaces for laying eggs; Behavioral ecology based upon color vision among animals and Photosynthesis among plants (in evergreen forest and tropical contours).

Unit- IV: Interactions **(6hrs.)**

Parasitism and mutualism interaction (i.) plants only, (ii.) animals only (iii.) their inter relationship; Plants and animals behavioral effects of stability of population and ecosystem; Consequences for

species interaction networks and communities.

Unit- V: Hybridization, Speciation and Development (6 hrs.)

Introduction and Speciation: Monkey to humans; Role and effect of environment on Genetic and cognitive development.

Reference Books:

- Michael D. Breed, Conceptual breakthroughs in Ethology and animal behavior,Academic press, 2017.
- Anthony Trewavas, Plant behavior and intelligence, Oxford University Press, 2014.

Useful URL:

http://www.reed.edu/biology/courses/BIO431S05_2015/student_selected_papers/topic2/renn_schumer_2013.pdf)

https://www.youtube.com/watch?v=SELV4pnyBAw

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

https://www.youtube.com/watch?v=vnmPdHmRv9o

https://www.youtube.com/watch?v=S3X-NkvE49o

https://www.youtube.com/watch?v=9YGLYz0iCLw

https://www.youtube.com/watch?v=LoGnYmNp2Y 0

https://www.youtube.com/watch?v=uO_mFuNpy8c

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

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TOTAL MARKS				**100**

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

CORE 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 laboratoryperspective, 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

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TOTAL MARKS				**100**

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

CORE 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
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 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.) Based upon 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

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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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	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 Development **(15 hrs.)**

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

Unit- V: Medical implications of developmental biology **(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 Marks** **Duration : Three Hours**

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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 Marks** **Duration : Three Hours**

QUESTION PAPER PATTERN:

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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 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 FORTHEORY PAPERS

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

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QUESTION PAPER PATTERN:

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	Unit – 3	2
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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 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 concen tration 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 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 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 FORTHEORY PAPERS

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

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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 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**
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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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	Unit – 3	2
	Unit – 4	3
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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
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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 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} Dose response 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 Marks** **Duration : Three Hours**

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

ELECTIVE II: FOOD BIOTECHNOLOGY

Subject Code: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 Marks** **Duration : Three Hours**

QUESTION PAPER PATTERN:

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

DISTRIBUTION OF QUESTIONS:

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

ELECTIVE III: PROJECT

Group Project (2/5 Students)

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 & Review of 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 as power point presentation)
Total=100 Marks	**20**	**80**