Re-Accredited by NAAC with 'A' Grade
VEER NARMAD SOUTH GUJARAT UNIVERSITY
University Campus, Udhna-Magdalla Road, SURAT - 395 007, Gujarat, India.
વીર નર્મદ દક્ષિણ ગુજરાત યુનિવર્સિટી
યુનિવર્સિટી કેમ્પસ, ઉધના-મગદલ્લા રોડ, સુરત - ૩૯૫ ૦૦૭, ગુજરાત, ભારત.
Tel : +91 - 261 - 2227141 to 2227146, Toll Free : 1800 2333 011, Fax : +91 - 261 - 2227334
E-mail : info@vnsgu.ac.in, Website : www.vnsgu.ac.in

-: પરિપત્ર :-

વિજ્ઞાન વિદ્યાશાખા હેઠળની સંલગ્ન બાયોસાયન્સ વિષય ચલાવતી અનુસ્નાતક કોલેજોના આચાર્યશ્રીઓ તથા ડિપાર્ટમેન્ટનાં વડાશ્રીઓને જણાવવાનું કે, શૈક્ષણિક વર્ષ ૨૦૧૯-૨૦ થી અમલમાં આવનાર M.Sc. Bio-Science Sem-1 & Sem-II નાં અભ્યાસક્રમ અંગે વિચારણા કરતા બાયોસાયન્સ વિષયની અભ્યાસસમિતિની તા.૦૫/૦૪/૨૦૧૯ ની સભાનાં ઠરાવ ક્રમાંકઃ ૨ અન્વયે કરેલ નીચેની ભલામણ વિજ્ઞાન વિદ્યાશાખાની તા.૦૨/૦૫/૨૦૧૯ ની સભાનાં ઠરાવ ક્રમાંકઃ૧૯ અન્વયે સ્વીકારી એકેડેમિક કાઉન્સિલને કરેલ ભલામણ એકેડેમિક કાઉન્સિલએ તેની તા.૦૭/૦૬/૨૦૧૯ ની સભાના ઠરાવક્રમાંકઃ ૬૩ અન્વયે સ્વીકારી મંજૂર કરેલ છે. તેની જાણ સંબંધકર્તા શિક્ષકો અને વિદ્યાર્થીઓને કરવી, તદ્ઉપરાંત તેનો અમલ કરવો.

બાયોસાયન્સ વિષયની અભ્યાસસમિતિની તા.૦૫/૦૪/૨૦૧૯ ની સભાનાં ઠરાવ ક્રમાંકઃ ૨

:: આથી ઠરાવવામાં આવે છે કે, M.Sc. Bio-Science Sem-1 & Sem-II નાં અભ્યાસક્રમને જરૂરી સુધારા વધારા સાથે જૂન-૨૦૧૯ થી અમલમાં આવે તે રીતે મંજૂર કરવામાં આવે છે અને તે મંજૂર કરવા વિજ્ઞાન વિદ્યાશાખાને ભલામણ કરવામાં આવે છે.

વિજ્ઞાન વિદ્યાશાખાની તા.૦૨/૦૫/૨૦૧૯ ની સભાનાં ઠરાવ ક્રમાંકઃ ૧૯

:: આથી ઠરાવવામાં આવે છે કે, M.Sc. Bio-Science Sem-1 & Sem-II નાં અભ્યાસક્રમને જરૂરી સુધારા વધારા સાથે જૂન-૨૦૧૯ થી અમલમાં આવે તે રીતે સ્વીકારી તે મંજૂર કરવા એકેડેમિક કાઉન્સિલને ભલામણ કરવામાં આવે છે.

એકેડેમિક કાઉન્સિલની તા.૦૭/૦૬/૨૦૧૯ની સભાનાં ઠરાવ ક્રમાંકઃ ૬૩

:: આથી ઠરાવવામાં આવે છે કે, વિજ્ઞાન વિદ્યાશાખાએ તેની તા. ૦૨/૦૫/૨૦૧૯ ની સભાના ઠરાવ ક્રમાંક : ૧૯ અન્વયે ભલામણ કરેલ શૈક્ષણિક વર્ષ ૨૦૧૯-૨૦ થી અમલમાં આવનાર M.Sc. Bio-Science Sem-1 & Sem-II નો અભ્યાસક્રમ સ્વીકારી મંજૂર કરવામાં આવે છે.

બિડાણઃ ઉપર મુજબ

ક્રમાંક : એકે./પરિપત્ર/૧૦૪૫૪/૧૯
તા. ૨૧-૦૬-૨૦૧૯

ઈ.ચા. કુલસચિવ

પ્રતિ,

૧) વિજ્ઞાન વિદ્યાશાખા હેઠળની બાયોસાયન્સ વિષય ચલાવતી અનુસ્નાતક કોલેજોના આચાર્યશ્રીઓ તથા ડિપાર્ટમેન્ટનાં વડાશ્રીઓ.
૨) અધ્યક્ષશ્રી, વિજ્ઞાન વિદ્યાશાખા.
૩) પરીક્ષા નિયામકશ્રી, પરીક્ષા વિભાગ, વી. ન. દ. ગુ. યુનિવર્સિટી, સુરત.
૪) પી.જી. વિભાગ, વી. ન. દ. ગુ. યુનિવર્સિટી, સુરત.

...તરફ જાણ તેમજ અમલ સારૂ.

Proposed Syllabus

એકેડેમિક કાઉન્સિલ તા. -20
બાબત.....વિદ્યાશાખા/વિષય.....

M. Sc. Bioscience Semester I & II

CHOICE BASED CREDIT SYSTEM (CBCS)

w.e.f. June 2019

Department of Biosciences
Veer Narmad South Gujarat University, Surat

THE COURSE

The M.Sc. Bioscience (Botany), M.Sc. Bioscience (Microbiology), M.Sc. Bioscience (Zoology), is a full time curriculum, run for 2 years, spread over 4 semesters, with four theory Papers (three core and one elective / interdisciplinary / multidisciplinary) and one combined practical in first two semesters.

ADMISSION

Academic year of the University begins from June. The lectures and practical's of the third semester starts immediately. The same for the first semester usually commences immediately after admissions. The admission process is as per the criteria laid down by the university

ELIGIBILITY

A candidate shall be admitted to M.Sc. Bioscience (Botany) / M.Sc. Bioscience (Zoology) / M.Sc. Bioscience (Microbiology) based on subject which he/she has taken as the Core –I (Principal) subject at the B.Sc. Degree examination. If seats are vacant than admission can be given to students who have taken the Core –II (Subsidiary subject/ Second subject / subject taken up to S.Y. B.Sc. at least).

ATTENDANCE

The M.Sc. courses run by this Department are full time studies and as such, a student admitted to the Department is not allowed to join any other courses or study, or take up any paid service.

Admitted students have to attend all the Lectures, Practical and Seminars. A minimum prescribed attendance as per University rules is required to sanction a term grant. Students whose term is not granted will not be allowed to appear in the examination, and will have to join the same semester in the following year.

EVALUATION AND EXAMINATION

- There shall be University examination for every core and elective/interdisciplinary/ multidisciplinary course at the end of each semester.
- There shall be continuous evaluation of every student for 30% of internal weightage during the semester as shown below:

Theory Examination

Internal Assessment

Continuous Internal assessment will based upon

1. Attendance/regularity/punctuality
2. Written Assignments
3. Internal test
4. Any one option selected by students from: Seminars, Poster presentations, Viva-voce, field work, academic tour, MCQ's tests, quiz competitions, group discussion etc.

External Theory Question Paper format

1. Question paper shall consist of 2 sections.
2. Section-I covers first 2 units of the course.
3. Section-II covers remaining 2 units of the course.
4. Both sections of question paper comprise two questions with internal option of 14 marks each from each unit.
5. Third question shall be short answer type of (07) marks which will cover respective both units.

Practical examination

External practical examination paper format

Exercise 1:	Based on paper I	[25 Marks]
Exercise 2:	Based on paper II	[25 Marks]
Exercise 3:	Based on paper III	[25 Marks]
Exercise 4:	Based on paper IV	[25 Marks]
Exercise 5:	Spotting	[20 Marks]
Exercise 6:	Viva	[15 Marks]
Exercise 7:	Journal/Lab record	[05 Marks]

TEACHING AND LEARNING STRATEGIES

Along with Classroom teaching and laboratory practical on need based modern pedagogical techniques from following can be adapted

Hands on Learning, Story Telling, Role Play, Visual clues, Instructional Conversations, Science Text Cards, Word Games, Graphic Organizers, Word Parts, Social media, Virtual science labs, Thinking Maps, Crossover Learning, Argue with Science, Brain storming, Context-Based Learning, Computational thinking, Multimedia Approach, Projects, Science museums, ICT Enabled Learning, Video clips, Power Points, Documented Problem Solving, Peer-to-Peer Teaching, Science movies, Science games, Mobile apps for Science, Field trips, Science clubs, Flipped Classroom, Guided Discovery Problems, Science Quiz, Learning By Doing Science etc.

M. Sc. Bioscience Sem. I							
Subject Code	Subject Title	Theory Hours/ week	Practical Hours/week	External Marks	Internal Marks	Total Marks	Credit
Bios-101	Biochemistry	4	-	70	30	100	4
Bios-102	Cell Biology and Immunology	4	-	70	30	100	4
Bios-103	Instrumentations and Biostatistics	4	-	70	30	100	4
Bios-104	Fundamentals of Developmental Biology and Physiology	4	-	70	30	100	4
Bios- 105	Practical Based on Bios-101 to 104	-	16	140	60	200	8
Total		**16**	**16**	**420**	**180**	**600**	**24**

M. Sc. Bioscience Sem. II							
Subject Code	Subject Title	Theory Hours/ week	Practical Hours/week	External Marks	Internal Marks	Total Marks	Credit
Bios-201	Evolution and Genetics	4	-	70	30	100	4
Bios-202	Molecular Biology and Recombinant DNA methods	4	-	70	30	100	4
Bios-203	Diversity and ecology	4	-	70	30	100	4
Bios-204	Bioinformatics, IPR, Biosafety & Bioethics	4	-	70	30	100	4
Bios- 205	Practical Based on Bios-201 to 204	-	16	140	60	200	8
Total		**16**	**16**	**420**	**180**	**600**	**24**

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT			
Programme Code		Programme Name	M.Sc. Bioscience
Course Code	BIOS-101	Semester	I
Biochemistry			
Course type	Core Compulsory	Total Credit	04
Teaching time	Examination Marking Scheme		
Theory (hrs)	Internal Marks	External Marks	Total Marks
4/week	30	70 (Paper of 3hrs)	100

BIOS-101: BIOCHEMISTRY

Learning Objective and Outcomes: *This Course will focuses on the synthesis, structure and functions of biomolecules in the living organisms. After learning this unit the students will be able to*

- *Understand the process of synthesis of proteins, lipids, nucleic acids, and carbohydrates and their role in metabolic pathways along with their regulation at the epigenetic, transcriptional, translational, and post-translational levels including RNA and protein folding, modification, and degradation.*
- *Explain reaction kinetics, thermodynamics of the molecules. They will be able to understand principles of catalysis and enzyme kinetics.*

Unit I

1.1 **Chemical fundamentals:** Structure of atoms, molecules and chemical bonds.

1.2 **Stabilizing interactions:** Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.

1.3 **Water:** weak interactions in aqueous systems, ionization of water, weak acids, and weak bases, buffering against pH changes in biological systems, water as a reactant, the fitness of the aqueous environment for living organisms; Acid, Base pH and buffer

1.4 **Kinetics:** Reaction kinetics, thermodynamics, colligative properties

Reference Books

1. *Foundation of General, Organic and Biochemistry, Katherine and Joseph, McGraw Hill*
2. *Biochemistry Demystified, Sharon Walker and David McMohan, McGraw Hill,*
3. *Lehninger Principles of Biochemistry, Nelson, WH free Man*
4. *Fundamentals of Biochemistry: Life at the Molecular Level, Donald Voet, Judith G. Voet, Charlotte W. Pratt, Wiley*
5. *Fundamentals of biochemistry, Jain, S. Chand publication*

Unit II

2.1 **Composition, structure and function of biomolecules:** Carbohydrates, lipids, proteins, nucleic acids and vitamins.

2.2 **Conformation of proteins**: Ramachandran plot, secondary structure, domains, motif and folds.

2.3 **Conformation of nucleic acids:** Helix (A, B, Z), t-RNA, micro-RNA.

2.4 **Stability:** Stability of proteins and nucleic acids

Reference Books

1. *Foundation of General, Organic and Biochemistry, Katherine and Joseph, McGraw Hill*
2. *Lehninger Principles of Biochemistry, Nelson, WH free Man*

3. *Biochemistry: Concepts and Connections, Dean R. Appling, Spencer J. Anthony-Cahill,Christopher K. Mathew, Pearson*
4. *Fundamentals of Biochemistry: Life at the Molecular Level, Donald Voet, Judith G. Voet, Charlotte W. Pratt, Wiley*
5. *Biochemistry for life sciences by Uma Bhardwaj, Pearson Education*
6. *Fundamentals of biochemistry, Jain, S. Chand publication*
7. *Biochemistry Dr. C. B. Powar Dr. G.R. Chatwal, Himlaya Publishing House*

Unit III

3.1 **Introduction to enzymes:** Principles of catalysis, Enzyme Specificity, Types of enzyme

3.2 **Enzyme kinetics:** factor affecting enzyme activity, Michaelis-Menten Equation and its Transformations

3.3 **Enzyme inhibition:** Reversible and irreversible inhibition

3.4 **Enzyme regulation:** Allosteric enzyme regulation, Covenant modification, enzyme synthesis

Reference Books

1. *Understanding Enzyme, Trevor Palmer, Ellis Horwood Ltd.*
2. *Enzymology T. Devasena, Oxford University Press*
3. *Fundamentals of Enzymology,by Nicholas C. Price,Oxford University Press*
4. *Fundamentals of Biochemistry: Life at the Molecular Level, Donald Voet, Judith G. Voet, Charlotte W. Pratt, Wiley*
5. *Lehninger Principles of Biochemistry, Nelson, WH free Man*
6. *Fundamentals of biochemistry, Jain, S. Chand publication*

Unit IV

4.1 **Bioenergetics:** Principles of Bioenergetics, Glycolysis, Gluconeogenesis, and the Pentose Phosphate Pathway, The Metabolism of Glycogen in Animals, The Citric Acid Cycle, Oxidative Phosphorylation and Photophosphorylation, Carbohydrate Biosynthesis in Plants and Bacteria

4.2 **Lipid Biosynthesis:** Biosynthesis of Fatty Acids and Eicosanoids, Biosynthesis of Triacylglycerols, Biosynthesis of Membrane Phospholipids, Biosynthesis of Cholesterol, Steroids, and Isoprenoids, Fatty Acid Catabolism: Digestion, Mobilization, and Transport of Fats, Oxidation of Fatty Acids, Ketone Bodies

4.3 **Nitrogen Metabolism:** Overview of Nitrogen Metabolism, Biosynthesis of Amino Acids, Molecules Derived from Amino Acids, Biosynthesis and Degradation of Nucleotides, Amino Acid Oxidation and the Production of Urea : Metabolic Fates of Amino Groups, Nitrogen Excretion and the Urea Cycle, Pathways of Amino Acid Degradation, symbiotic and non-symbiotic nitrogen fixation by microorganisms

4.4 **Integration and Hormonal Regulation of Mammalian Metabolism:** Tissue-Specific Metabolism: The Division of Labor, Hormonal Regulation of Fuel Metabolism, Long Term Regulation of Body Mass, Hormones: Diverse Structures for Diverse Functions

Reference Books

1. *Lehninger Principles of Biochemistry, Nelson, WH free Man*
2. *Fundamentals of Biochemistry: Life at the Molecular Level, Donald Voet, Judith G. Voet, Charlotte W. Pratt, Wiley*
3. *Lippincott Illustrated Reviews Biochemistry, Denise R.Ferrier, Wolters Kluwer India Pvt. Ltd*
4. *Biochemistry: Concepts and Connections, Dean R. Appling, Spencer J. Anthony-Cahill, Christopher K. Mathew, Pearson*
5. *The Physiology and Biochemistry of Prokaryotes by David White, OUP USA*
6. *Introduction to Plant physiology, William G. Hopkins and Norman P.A. Huner, Wiley India Pvt Ltd*
7. *Introduction to biochemistry and Metabolism by D Anandhi Pearson Education*
8. *Plant Biochemistry, Hans-Walter Heldt, Elsevier*
9. *Plant physiology by by Lincoln Taiz and Eduardo Zeiger, Sinauer Associates Inc., U.S*
10. *Fundamentals of biochemistry, Jain, S. Chand publication*
11. *Bios Instant Notes In Biochemistry, by David & Hooper, Nigel Hames,Taylor & Francis*

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT			
Programme Code		**Programme Name**	**M.Sc. Bioscience**
Course Code	**BIOS-102**	**Semester**	**I**
Cell Biology and Immunology			
Course type	**Core Compulsory**	**Total Credit**	**04**
Teaching time	**Examination Marking Scheme**		
Theory (hrs)	**Internal Marks**	**External Marks**	**Total Marks**
4/week	**30**	**70 (Paper of 3hrs)**	**100**

BIOS-102: CELL BIOLOGY AND IMMUNOLOGY

***Learning Objective and Outcomes**: The course mainly emphasize on study of ultra-structure of various cell types, cell division and its regulation. The course also deals with molecules involve in immune system and their role in immune system. After learning this course students will be able to understand*

- *Basic structure and chemical properties of plant, animal and bacterial cells*
- *Phases, mechanism and regulation of cell cycle, cell signaling pathways and cancer biology*
- *Students will be also able to explain molecules involved in innate and adaptive immunity and response of immune system in various pathogenic condition*

Unit I

1.1 **Membrane structure and function:** Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

1.2 **Ultra-structure and function of Bacteria:** Bacterial Nucleoids, Plasmid, Microbial Cell Surfaces, Cytoplasmic Membranes, Capsules, Organs of Locomotion, Pili or Fimbriae

1.3 **Major structural and functional features of eukaryotic cell:** Cell membrane and transport across the cell membrane, Plasma membrane, Cell wall, Extracellular matrix and cell interaction, Nucleus, Endoplasmic reticulum, Golgi complex, Lysosome,

Mitochondria, Chloroplast, Peroxisome, Plastids, Vacuoles, Cytoskeleton and Cell movement

1.4 **Organization of genes and chromosomes:** Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons.

Reference Books

1. *The Cell – A molecular Approach, Cooper and Hausman*
2. *Cell and Molecular Biology Concepts 6th ed, Gerald Karp,Wiley*
3. *Molecular cell biology, Lodish, WH freeman*
4. *Cell Biology, Devasena, Oxford*
5. *The Physiology and Biochemistry of Prokaryotes by David White,OUP USA*
6. *Cells, Benjamin Lewin, Jones and Bartlett Publishers, Inc*
7. *The Cell, A visual tour of building blocks of life, Jack Challoner, Ivy press*

Unit II

2.1 **Cell division and cell cycle:** Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle

2.2 **Cell Signaling :** Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways,

2.3 **Cell sensing:** Bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

2.4 **Cellular communication:** General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, regulation of hematopoiesis, neurotransmission and its regulation,

Reference Books

1. *The Cell – A molecular Approach, Cooper and Hausman*
2. *Cell Biologyby Gerald Karp, Wiley*
3. *Molecular cell biology, Lodish, WH freeman*
4. *Cells, Benjamin Lewin, Jones and Bartlett Publishers, Inc*
5. *Cell Biology, Devasena, Oxford*
6. *The Physiology and Biochemistry of Prokaryotes by David White,OUP USA*
7. *Cell Biology, Genetics, Molecular Biology, Evolution &EcologybyVerma P.S. (Author), Agarwal V.K.*
8. *Biology by Peter Raven, George Johnson, Kenneth Mason, Jonathan Losos, Susan Singer, McGraw Hill Education*

Unit III

3.1 **Host parasite interaction:** Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.

3.2 **Cancer development:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer.

3.3 **Cancer propagation:** Metastasis, interaction of cancer cells with normal cells, apoptosis.

3.4 **Cancer treatment:** Therapeutic interventions of uncontrolled cell growth.

Reference Books

1. *Prescott's Microbiology, Joanne Willey, McGraw-Hill Education*
2. *Immunology, Raj Khanna, Oxford*
3. *The Short Textbook of Medical Microbiology, SatishGupte, jaypee*
4. *Cellular and Molecular Immunology, by Abul K. Abbas, Andrew H Lichtman, Shiv Pillai, Elsevier*
5. *Genes IX by Benjamin Lewin, Jones and Bartlett Publishers*
6. *BIOS Instant notes of immunology, by Peter Lydyard, Alex Whelan, Michael Fanger*

Unit IV

4.1 **Innate and adaptive immune system:** Cells and molecules involved in innate and adaptive immunity

4.2 **Immune cells**: Antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. Generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors.

4.3 **Immune response:** Humoral and cell mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation,

4.4 **Immune disorder:** Hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

Reference Books

1. *Roitt's Essential Immunology Peter J. Delves, Seamus, Wiley-Blackwell*
2. *Kuby Immunology, Jenni Punt, WH Freeman*
3. *Cellular and Molecular Immunology, by Abul K. Abbas, Andrew H Lichtman, Shiv Pillai, Elsevier*
4. *The Elements of Immunology by Khan, Pearson Education India*
5. *Immunology by Ramesh, McGraw Hill Education India*
6. *Immunology, Raj Khanna, Oxford*
7. *The Short Textbook of Medical Microbiology, SatishGupte, jaypee*
8. *BIOS Instant notes of immunology, by Peter Lydyard, Alex Whelan, Michael Fanger*

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT			
Programme Code		**Programme Name**	**M.Sc. Bioscience**
Course Code	**BIOS-103**	**Semester**	**I**
Instrumentations and Biostatistics			
Course type	**Core Compulsory**	**Total Credit**	**04**
Teaching time	**Examination Marking Scheme**		
Theory (hrs)	**Internal Marks**	**External Marks**	**Total Marks**
4/week	**30**	**70 (Paper of 3hrs)**	**100**

BIOS-103: INSTRUMENTATIONS AND BIOSTATISTICS

Learning Objective and Outcomes: *The course is designed to develop the experimental techniques and bio statistical skill for student. At the end of this course the students will be able to explain the principle, construction and working of various analytical instruments. Students will get detailed information about the applications of analytical techniques in Biological sciences. They will be able to*

- *Understand and use various qualitative and quantitative techniques i.e. microscopic, spectroscopic, chromatographic, etc.*
- *They will be able to explain various histochemical and immunotechniques for the detection of molecules in living cells. They will learn detection and measurements of different types of radioisotopes as well as electrophysiological methods*
- *Students will be able to analyse the biological data by manual and computational methods*

Unit I

1.1 **Centrifugation and basic colorimetery :** Basic concepts of centrifugation. Calculation of g value from RPM. Density gradient centrifugation. Sedimentation velocity and Sedimentation equilibrium. Separation of sub-cellular components and macromolecules using high speed and ultracentrifugation; UV/Vis spectrophotometry. Beer-Lambert's law and its use in determination of protein/ nucleic acid concentration, Turbidimetry and Nephelometry

1.2 **Microscopic techniques:** Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze fracture methods for EM, image processing methods in microscopy. Other microscopy techniques (Bright-field, Dark-filed, Phase-contrast, Differential interference contrast Microscope, Fluorescence, Polarization, Confocal Scanning, stereomicroscope), Scanning Probe Microscopes (Scanning Tunnelling, Atomic Force, Near-field Scanning Optical, Magnetic Force etc)

1.3 **Atomic spectroscopy:** Flame photometer, Atomic absorption spectroscopy, Mass spectroscopy

1.4 **Chromatography:** Ion exchange, Gel Filtration and Affinity chromatography, HPLC, GC, LC

Reference Books

1. *Modern Experimental Biochemistry, Rodney Boyer, Pearson Education*
2. *Instrumental methods of chemical analysis by Chatwal and Anand, Himalaya Publishing house*
3. *Biochemistry and Molecular biology, Wilson walker, Cambridge*
4. *Handbook of instrumental techniques for analytical chemistry, Frank Settle, Prentice Hall*
5. *Fundamentals and Techniques of Biophysics and Molecular Biology, Pranav Kumar, Pathfinder Publication.*
6. *Research Methodology for biological Sciences by N Gurumani,*

Unit II

2.1 **Fluorescence Spectroscopy:** Basic concepts of excitation and emission. Quenching, Stern-Volmer Plots. Theory and applications of FRET and fluorescence lifetime measurements.

2.2 **Structure determination I:** Fundamentals of CD, IR and Raman spectroscopy and their use in the study of biomolecular conformation.

2.3 **Structure determination II:** Fundamentals of X-ray, NMR and cryo-electron microscopy for determination of biomolecular structure.

2.4 **Sequencing technology:** DNA and Protein Sequencing technology

Reference Books

1. *Biochemistry and Molecular biology, Wilson walker, Cambridge*

2. *Fundamentals and Techniques of Biophysics and Molecular Biology, Pranav Kumar, Pathfinder Publication*
3. *Tools and Techniques of Biotechnology, MousumiDebnath, Pointer Publishers*

Unit III

3.1 **Histochemical and Immunotechniques:** Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH; Biosensors

3.2 **Radiolabeling techniques:** Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

3.3 **Electrophysiological methods:** Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.

3.4 **Electrophoresis:** Agarose gel, Native and SDS-PAGE. Isoelectric focusing, 2D-PAGE and its applications; characterization of nucleic acids/protein including Southern, northern and western hybridizations.

Reference Books

1. *Analytical Biochemistry, David Holme and Hazel Peck, Prentice Hall*
2. *Tools and Techniques of Biotechnology, Mousumi Debnath, Pointer Publishers*
3. *Fundamentals and Techniques of Biophysics and Molecular Biology, Pranav Kumar, Pathfinder Publication*
4. *Biochemistry and Molecular biology, Wilson walker, Cambridge*
5. *UGC NET Life Science, by Ashish Nagesh, Quaisher J. Hossain, Prashant Kumar,Arihant Publications*

Unit IV

4.1 **Fundamental of statistical analysis:** Basic concepts of design of Experiments, Concepts of precision and accuracy in experimental measurements. Introduction to computational resources for statistical analysis

4.2 **Descriptive Statistics**: Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal), Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance;

4.3 **Test of significance:** Student t-test, Analysis of variance, X^2 test,

4.4 **Other statistical techniques:** Regression and Correlation, Basic introduction to Multivariate statistics

Reference Books

1. *Introduction to Bio-Statistics, Banerjee Pranab Kumar, S Chand & Company*
2. *Biostatistics, Veer Bala Rastogi, Medtech*
3. *Biostatistics Analysis, Zar, Pearson*
4. *Biostatistics for health and life sciences, Rao K Surya, Himalaya Publishing house*
5. *Research methodology, C R Kothari, New Age Publishers*
6. *Principles of Biostatistics by Marcello Pagano, Duxbury Thomson Learning*

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT			
Programme Code		Programme Name	M.Sc. Bioscience
Course Code	BIOS-104	Semester	I
Fundamentals of Developmental Biology and Physiology			
Course type	Core Compulsory	Total Credit	04
Teaching time	Examination Marking Scheme		
Theory (hrs)	Internal Marks	External Marks	Total Marks
4/week	30	70 (Paper of 3hrs)	100

BIOS-104: FUNDAMENTALS OF DEVELOPMENTAL BIOLOGY AND PHYSIOLOGY

Learning Objective and Outcomes:

The course has created to exposed student with the fundamental of developmental biology and physiology of the different life forms. The course explores various topics in plant physiology, and biochemistry including primary and secondary metabolism, photosynthesis, respiration, water relations, mineral nutrition, response to environmental stress, roles of plant hormones. After completing this course,

- *Students will be able to explain important developmental aspects in plants and animal.*
- *The students will understand the relationship between structure, function and its relation to various biological processes.*
- *Student will gain an appreciation of the metabolic and physiological processes for stress adaptation*

Unit I

1.1 **Basic concepts of development**: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenic in analysis of development.

1.2 **Gametogenesis, fertilization and early development**: Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; Embryo sac development and double fertilization in plants, embryogenesis, establishment of symmetry in plants; seed formation and germination.

1.3 **Morphogenesis and organogenesis in animals**: Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, amphibia and chick; organogenesis–vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development andregeneration in vertebrates; differentiation of neurons, post embryonic development- larvalformation, metamorphosis; environmental regulation of normal development; sex determination.

1.4 **Morphogenesis and organogenesis in plants**: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*.

Reference Books

1. *Plant Physiology and Development, Lincoln Taiz, Oxford*
2. *Developmental Biology, Scott F. Gilbert, Sinauer*

3. *BIOS Instant Notes in Developmental Biology, Richard Twyman, Taylor & Francis*
4. *Embryology of Flowering Plants, T.B. BATYGINA, Science Publishers*
5. *Instant Notes, Plant Biology, A.J. Lack & D.E. Evans, Bios*
6. *An introduction to the embryology of angiosperms, Maheswari, McGRAW-HILL*
7. *Biology, Raven and Johnson,2013, McGraw Hill India publication*
8. *Campbell Biology, Jane B. Reece, Pearson Benjamin Cummings*
9. *Chordate Embryology, Verma P.S. and Agarwal V.K., S chand*
10. *Inderbir Singh's Human Embryology, V Subhadra Devi, Jaypee Brothers Medical Publishers*

Unit II

2.1 **Sensory photobiology:** Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks,

2.2 **Solute transport and photoassimilate translocation**: uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.

2.3 **Secondary metabolites**: Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

2.4 **Stress physiology:** Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

Reference Books

1. *Plant Physiology and Development, Lincoln Taiz, Oxford*
2. *Physiology and Molecular Biology of Stress Tolerance in Plants, Rao, Springer*
3. *Introduction to Plant Physiology, William G. Hopkins and Norman P. A., John Wiley & Sons, Inc.*
4. *Campbell Biology, Jane B. Reece, Pearson Benjamin Cummings*
5. *Biology, Raven and Johnson, McGraw Hill India publication*

Unit III

3.1 **Blood and circulation**: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis; Cardiovascular System: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above; Respiratory system - Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.

3.2 **Nervous system**: Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture; Sense organs - Vision, hearing and tactile response.

3.2 **Digestive system**: Digestion, absorption, energy balance, BMR; Excretory system: Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

3.4 **Thermoregulation:** Comfort zone, body temperature: physical, chemical, neural regulation, acclimatization; Stress and adaptation

Reference Books

1. *Vander's Human Physiology: The Mechanisms of Body Function, Eric Widmaier, McGraw-Hill Education*
2. *Guyton & Hall Textbook of Medical Physiology: A South Asian Editionby Mario Dr. Vaz, Tony Dr. Raj, Elsevier India*
3. *Human Physiology: An Integrated Approach, Silverthorn, Pearson Education India*
4. *Campbell Biology, Jane B. Reece, Pearson Benjamin Cummings*
5. *Biology, Raven and Johnson,2013, McGraw Hill India publication*

Unit IV

4.1 **Cell death:** Programmed cell death, aging and senescence.

4.2 **Microbial Physiology**: Growth yield and characteristics, strategies of cell division, stress response; Microbial fermentation and production of small and macro molecules.

4.3 **Plant hormones**: Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

4.4 **Endocrinology and reproduction**: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation.

Reference Books

1. *Developmental Biology, Scott F. Gilbert, Sinauer*
2. *BIOS Instant Notes in Developmental Biology, Richard Twyman, Taylor & Francis*
3. *The Physiology and Biochemistry of Prokaryotes, David white*
4. *Introduction to Plant Physiology, William G. Hopkins and Norman P. A., John Wiley & Sons, Inc.*
5. *Plant Physiology and Development, Lincoln Taiz, Oxford*
6. *Vander's Human Physiology: The Mechanisms of Body Function, Eric Widmaier, McGraw-Hill Education*
7. *Guyton & Hall Textbook of Medical Physiology: A South Asian Editionby Mario Dr. Vaz, Tony Dr. Raj, Elsevier India*
8. *Human Physiology: An Integrated Approach, Silverthorn, Pearson Education India*
9. *Campbell Biology, Jane B. Reece, Pearson Benjamin Cummings*
10. *Biology, Raven and Johnson, 2013, McGraw Hill India publication*

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT			
Programme Code		Programme Name	M.Sc. Bioscience
Course Code	BIOS-105	Semester	I
Practical Based on BIOS-101 to 104			
Course type	Practical	Total Credit	08
Teaching time	Examination Marking Scheme		
Practical (hrs)	Internal Marks	External Marks	Total Marks
16/week	60	140	200

BIOS 105: Practical Based on BIOS-101 to 104

Following are the indicative list of the experiments. Changes can be done depending upon the departmental need and availability of the resources

Biochemistry

1. Preparation of buffer and solution of different concentration, Normality and molarity, Determination of pKa
2. Estimation of protein by biuret method
3. Estimation of protein by Lowry's method
4. Estimation of protein by Bradford method
5. Lambda Max for protein and amino acids
6. Determination of molar absorbance coefficient of l-tyrosine
7. Estimation of sugar by Anthrone method
8. Estimation of sugar by DNSA
9. Estimation of sugar by Cole's method
10. Estimation of glucose in human serum (GOD- POD) (kit)
11. Estimation of Ascorbic acid
12. Estimation of lipid and fatty acid
13. To study the effect of pH, temperature, salt and substrate on enzyme activity
14. Determination of Km and Vmax of enzyme.
15. Enzyme inhibition study-**(1)** competitive inhibition **(2)** Uncompetitive inhibition
16. Estimation of Aspartate aminotransferase (AST) &Alanine aminotransferase (AST) (kit)
17. Estimation of Lactate dehydrogenase (LDH) (Kit)

Reference Books

1. *Introductory Practical Biochemistry, Narosa Publishing House*
2. *Laboratory manual in Biochemistry, New Age International (P) Limited, Publisers*
3. *An Introduction to Practical biochemistry by, David T. Plummer, Tata McGraw-Hill Publishing Company Limited*
4. *Biochemistry Practical Manual by Soundravsally Rajendiran & Pooja Dhiman, ELSEVIER*
5. *Laboratory handbook on Biochemistry by S. Shanmugam, T. SathishKumar,PHI Learning Private Limited, New Delhi*
6. *Laboratory Manual of biochemistry by Joy P P, Surya S. and Aswathy C.Kerala Agricultural University*
7. *Lab Workbook, Ushwantrao Chavan Maharashtra Open University*
8. *Laboratory Protocols in Applied Life Sciences, Bisen, CRC*

Cell Biology and Immunology

1. To study Plant cell, animal cell and bacterial cell
2. To identify the nucleus and nucleolus in onion peel using Toluidine blue
3. Simple staining and negative staining
4. Gram's staining and acid fast staining
5. Special staining: cell wall staining, capsule staining, spore staining
6. To study metachromatic granules in bacteria
7. To study metachromasia by toluidine blue in bone marrow of chicken
8. To isolate liver parenchyma cells and perform viability count (trypan blue exclusion test for cell viability)
9. To isolate chloroplast fraction of the plant cells (spinach) by density gradient centrifugation method
10. To isolate nuclear and mitochondrial fractious of the cells by density gradient centrifugation method and staining by Schiff's reagent & Jenus green-B
11. To perform differential count in human blood smear
12. To perform Total White Blood cell (WBC) and Red Blood Cells (RBC) in human blood
13. To study different phases of mitosis in onion root tip by squash preparation
14. To identify the presence of Barr body in the female buccal epithelial cells
15. Widal test for Typhoid detection/VDRL test for Syphilis (kit)
16. HIV detection test (kit)
17. Malarial parasite detection (kit)

References:

1. *Microbiology A laboratory manual, by James cappuccino and natalie Sherman, Pearson India Education Services Pvt. Ltd.*
2. *Introductory Practical Biochemistry, Narosa Publishing House.*
3. *Life Sciences Protocol manual, DBT Star College Scheme, 2018*
4. *Laboratory manual for Biotechnology By, Ashish Verma, Surjit Das &Anchal Singh, S, Chand*

Instrumentation technique and Biostatistics

1. Validation and Calibration of Balance, pH meter, Centrifuge, Spectrophotometer, laminar air flow, Autoclave, incubator, ion analyser etc. instruments.
2. Exposure to the different imaging techniques
3. Microscopy: Fluorescence, Phase contrast, bright field etc.
4. Flame photometry
5. Atomic absorbance Spectrophotometer (AAS) (Demonstration)
6. Separation of sugar/ fatty acid by Thin Layer Chromatography
7. High performance Thin Layer Chromatography (HPTLC)
8. High performance Liquid Chromatography (HPLC)
9. Gas Chromatography- Mass Spectrometry (GC-MS)
10. Gel-filtration/ Column Chromatography
11. SDS-PAGE analysis of protein
12. ELISA

13. ***Statistical experiments based on the manual and computer:*** Descriptive Statistics, t-test, ANOVA, Chi square, Regression, Correlation
14. Graphical representation

Reference Books

1. *Laboratory manual for Biotechnology By, Ashish Verma, Surjit Das &Anchal Singh, S, Chand*
2. *Introductory Practical Biochemistry, Narosa Publishing House*
3. *Laboratory manual in Biochemistry, New Age International (P) Limited, Publishers*
4. *A manual for Biochemistry Protocol by Marcus R Wenk, World Scientific.*
5. *Biostatistics and Microbiology- A survival Manual by Daryl S. Paulson, Springer*

Developmental Biology and Physiology

1. Renal profile
2. Cardiac profile
3. Liver profile
4. Stress response in animals
5. Stress response in microbes
6. Stress response in plants: rate of photosynthesis under different conditions
7. Observation of various developmental stages in animal
8. Sperm viability test
9. Observation of various developmental stages in plants
10. Artificial pollination by emasculation (bagging method)
11. Pollen germination and viability test
12. Demonstration the phenomenon of osmosis using potato osmoscope.
13. Measurement of diffusion pressure and osmotic pressure in plant cell.
14. To study the evolution of Oxygen by isolated chloroplast using Hill oxidants
15. Qualitative and quantitative determinations of alkaloids, terpenoids, and phenolics in plants
16. To find out stomatal Index in various stress condition
17. To study symbiotic and non-symbiotic bacteria from Rhizosphere.
18. The respiration of mitochondria and oxidative phosphorylation
19. Bacterial growth curve

Reference Books

1. *Biochemistry Practical Manual by Soundravsally Rajendiran & Pooja Dhiman, ELSEVIER*
2. *Experiments in Plant Physiology: A Laboratory Manual, Narosa*
3. *An introduction to practical Biochemistry by David T Plummer, Tata McGraw Hill*

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT			
Programme Code		Programme Name	M.Sc. Bioscience
Course Code	BIOS-201	Semester	II
Evolution and Genetics			
Course type	Core Compulsory	Total Credit	04
Teaching time	Examination Marking Scheme		
Theory (hrs)	Internal Marks	External Marks	Total Marks
4/week	30	70 (Paper of 3hrs)	100

BIOS-201: EVOLUTION AND GENETICS

Learning Objective and Outcomes: *The course concentrate on understanding of origin, evolutionary mechanism and genetics aspects of life. The aim of the course is to provide students with a deeper insight into the evolutionary processes. On completion of the course the students will be able to*

- *Describe the origin, evolutionary mechanism of life forms.*
- *Student will be correlate the evolution processes with behavior biology, palaeontology and molecular biology.*
- *Student will be explain the traditional to modern aspects with practical application in genetics.*

Unit I

1.1 **Emergence of evolutionary thoughts Lamarck:** Darwin-concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.

1.2 **Origin of cells and unicellular evolution:** Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes;

1.3 **Origin of eukaryotic cells**: Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.

1.4 **Paleontology and Evolutionary History:** The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals; Stages in primate evolution including Homo.

Reference Books

1. Evolution third edition, Mark Ridley, Blackwell Publishing
2. Evolution, Strickberger, Monroe W, Jones & Bartlett Publishers, Inc.
3. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Verma and Agarwa, S. Chand
4. Biology, Raven and Johnson, 2013, McGraw Hill India publication
5. Life: The Science of Biology, William, W. H. Freeman
6. Campbell Biology, Jane B. Reece, Pearson Benjamin Cummings

Unit II

2.1 **Molecular Evolution**: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

2.2 **The Mechanisms**: Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

2.3 **Brain and Evolution:** Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Neural basisof learning, memory, cognition, sleep and arousal; Biological clocks;

2.4 **Behavior and Evolution:** Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

Reference Books

1. Evolution third edition, Mark Ridley, Blackwell Publishing
2. Evolution, Strickberger, Monroe W, Jones & Bartlett Publishers, Inc.
3. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Verma and Agarwa, S. Chand
4. Biology, Raven and Johnson,2013, McGraw Hill India publication
5. Life: The Science of Biology, William, W. H. Freeman
6. Campbell Biology, Jane B. Reece, Pearson Benjamin Cummings

Unit III

3.1 **Mendelian principles:** Dominance, segregation, independent assortment, Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests, Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

3.2 **Gene mapping methods:** Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

3.3 **Extra chromosomal inheritance:** Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.

3.4 **Microbial genetics**: Methods of genetic transfers- transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

Reference Books

1. Molecular biology of the Gene, Watson, Person
2. Principle of Genetics, Tamrine, Tata McGraw Hill
3. Genetics A Conceptual Approach, Benjamin A. Pierce, WH Freeman
4. Genetics, Karvita B. Ahluwalia, New Age
5. Concepts of Genetics, Klug, Cummings, Spence, Person
6. Genetics, Strickberger, Person
7. Principles of Genetics, Gardner, Wiley
8. Molecular Genetics of Bacteria, Larry Snyder, Wendy Champness, American Society for Microbiology
9. Microbial Genetics Paperback, Chaudhuri. The Energy and Resources Institute, TERI
10. Genetic analysis: An Integrated Appraoch by Mark F Sanders, Pearson Education

Unit IV

4.1 **Human genetics:** Pedigree analysis, LOD score for linkage testing, karyotypes, genetic disorders.

4.2 **Quantitative genetics:** Polygenic inheritance, heritability and its measurements, QTL mapping.

4.3 **Mutation:** Types, causes and detection, mutant types- lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis; Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

4.4 **Recombination:** Homologous and non-homologous recombination including transposition.

Reference Books

1. Molecular biology of the Gene, Watson, Person
2. Prinviple of Genetics, Tamrine, Tata McGraw Hill
3. Genetics A Conceptual Approach, Benjamin A. Pierce, WH Freeman
4. Genetics, Karvita B. Ahluwalia, New Age
5. Concepts of Genetics, Klug,Cummings, Spence, Person
6. Genetics, Strickberger, Person
7. Principles of Genetics, Gardner, Wiley
8. Molecular Genetics of Bacteria, Larry Snyder, Wendy Champness, American Society for Microbiology
9. Microbial Genetics Paperback, Chaudhuri, The Energy and Resources Institute, TERI
10. Genetic analysis: An Integrated Approach by Mark F Sanders, Pearson Education

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT			
Programme Code		Programme Name	M.Sc. Bioscience
Course Code	BIOS-202	Semester	II
Molecular Biology and Recombinant DNA Methods			
Course type	Core Compulsory	Total Credit	04
Teaching time	Examination Marking Scheme		
Theory (hrs)	Internal Marks	External Marks	Total Marks
4/week	30	70 (Paper of 3hrs)	100

BIOS-202: MOLECULAR BIOLOGY AND RECOMBINANT DNA METHODS

Learning Objective and Outcomes: *The subject offers the in-depth knowledge of the concepts, tools, techniques and process related to Molecular biology and recombinant DNA technology with respect to prokaryotic and eukaryotic cell*

- *Student will able to understand central dogma of life and compare the molecular biological processes among prokaryotic and eukaryotic cell.*
- *Student will able to describe and apply the recombinant DNA technology*
- *Student will able to explain the quantification, decoding, cloning and modification of gene and genome*

Unit I

1.1 **Prokaryotic replication system:** Semiconservative nature of replication; Bacterial Replication

1.2 **Eukaryotic Archaeal replication system** Eukaryotic and Archaeal DNA Replication; Breakage, Alignment, and Repair of DNA Strands

1.3 **Transcription:** An Early RNA World, The Structure of RNA, Classes of RNA, Synthesis of an RNA Molecule from a DNA Template; Bacterial Transcription; Eukaryotic and Archaeal Transcription

1.4 **Translation:** RNA Molecules and RNA Processing: capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation

Reference Books

1. Molecular Biology, Robert F. Weaver, McGraw-Hill Higher Education
2. LIR: Cell and Molecular Biology, Chandar, Wolters Kluwer India Pvt. Ltd.
3. Essentials of Molecular Biology, Malathi, Person
4. Cell and Molecular Biology,S.C. Rastogi, New Age international
5. Genes IX Benjamin Lewin, Jones and Barlett
6. Genetics A Conceptual Approach- 5th Ed. Benjamin A. Pierce
7. Principle of Genetics, Tamrine, Tata McGraw Hill
8. Fundamentals of Molecular Biology – Jayanta K. Pal and Saroj S. Ghaskadbi
9. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Verma &Agarwa, S. Chand
10. Molecular biology of the gene, Watson, Pearson

Unit II

2.1 **Protein synthesis and processing:** Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNAsynthetase, and translational proof-reading, translational inhibitors,

2.2 **Protein modification:** Post- translational modification of proteins.

2.3 **Viral Prokaryotic Gene expression control :** Control of gene expression at transcription and translation level for prokaryotes; regulating the expression of phages, viruses

2.4 **Eukaryotic gene expression control:** Control of gene expression at transcription and translation level for eukaryotes

Reference Books

1. Molecular Biology, Robert F. Weaver, McGraw-Hill Higher Education
2. LIR: Cell and Molecular Biology, Chandar, Wolters Kluwer India Pvt. Ltd.
3. Essentials of Molecular Biology, Malathi, Person
4. Cell and Molecular Biology, S.C. Rastogi, New Age international
5. Genes IX Benjamin Lewin, Jones and Barlett
6. Genetics A Conceptual Approach- 5th Ed. Benjamin A. Pierce
7. Principle of Genetics, Tamrine, Tata McGraw Hill
8. Fundamentals of Molecular Biology – Jayanta K. Pal and Saroj S. Ghaskadbi
9. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology, Verma &Agarwa, S. Chand
10. Molecular biology of the gene, Watson, Pearson

Unit III

3.1 **Gene isolation:** Isolation and amplification of specific nucleic acid sequences, PCR, RT-PCR and qPCR.

3.2 **Enzymes for R DNA technology**: Enzymes used in Recombinant DNA technology; Analysis of DNA polymorphism: RFLP, RAPD and AFLP techniques.

3.2.1 **Vector:** Vector used in Gene cloning: Plasmid, Bacteriophage, M13, Yeast cloning vector, Other Vectors.

3.2.2 **Chimeric DNA and Transformation:** Joining of DNA fragment, Introduction of DNA in host cell.

Reference Books

1. *Principles of Genome Analysis and Genomics, Sandy B. Primrose, Wiley-Blackwell*
2. *Principles of Gene Manipulation, Sandy B. Primrose, Wiley-Blackwell*
3. *Genetic Engineering – Smita Rastogi and Neelam Pathak*
4. *Gene Cloning and DNA Analysis, T. A. Brown, Wiley-Blackwell*
5. *Analysis of Genes and Genomes, Richard J. Reece, John Wiley & Sons, Ltd*
6. *Genetic Engineering, Verma P.S., S Chand & Company*
7. *An Introduction to Genetic Engineering, Nicholl, Cambridge University Press*
8. *Genetic Engineering, Sandhya Mitra, McGraw Hill Education*
9. *Recombinant Dna Technology and Genetic Engineering Paperback, K Rajagopa, McGraw Hill Education*
10. *Recombinant DNA Technology, Keya Chaudhuri, The Energy and Resources Institute, TERI*

Unit IV

4.1 **Library preparation:** Construction of Genomic and cDNA library; Techniques for selection, screening and characterization of transformants.

4.2 **Expression:** Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques.

4.3 **Mutagenesis:** *In vitro* mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms.

4.4 **Application:** Genomics and its application to health and agriculture, including gene therapy.

Reference Books

1. *Principles of Genome Analysis and Genomics, Sandy B. Primrose, Wiley-Blackwell*

2. *Principles of Gene Manipulation, Sandy B. Primrose, Wiley-Blackwell*
3. *Genetic Engineering – Smita Rastogi and Neelam Pathak*
4. *Gene Cloning and DNA Analysis, T. A. Brown, Wiley-Blackwell*
5. *Analysis of Genes and Genomes, Richard J. Reece, John Wiley & Sons, Ltd*
6. *Genetic Engineering, Verma P.S., S Chand & Company*
7. *An Introduction to Genetic Engineering, Nicholl, Cambridge University Press*
8. *Genetic Engineering, Sandhya Mitra,,McGraw Hill Education*
9. *Recombinant DNA Technology and Genetic Engineering Paperback, K Rajagopa, McGraw Hill*
10. *Education*
11. *Recombinant DNA Technology, Keya Chaudhuri, The Energy and Resources Institute, TERI*

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT			
Programme Code		**Programme Name**	**M.Sc. Bioscience**
Course Code	**BIOS-203**	**Semester**	**II**
Diversity and Ecology			
Course type	**Core Compulsory**	**Total Credit**	**04**
Teaching time	**Examination Marking Scheme**		
Theory (hrs)	**Internal Marks**	**External Marks**	**Total Marks**
4/week	**30**	**70 (Paper of 3hrs)**	**100**

BIOS-203: DIVERSITY AND ECOLOGY

Learning Objective and Outcomes: *The course provides the Biodiversity concept and details information of ecology, taxonomy and natural history of Indian subcontinent. The subject elicit the interest of student regarding the nature conservation, natural biodiversity and environmental legislation of India*

- *Student shall get the information of natural flora, fauna of the world and India with current status of the population dynamics, the human intervention on ecosystem and community.*
- *Student will get the fundamental knowledge about the applied ecology and its application in conservation biology and sustainable development.*

Unit I

1.1 **Principles & methods of taxonomy**: Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals and microorganisms.

1.2 **Levels of structural organization:** Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications.

1.3 **Outline classification of plants, animals & microorganisms:** Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa.

1.4 **Natural history of Indian subcontinent:** Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent.

Reference Books

1. *Biodiversity: Perception, Peril and Preservation Prabodh K. Maiti, PHI Learning Private Limited*
2. *The Bio-Diversity of India, Erach Bharucha, Grantha Corporation*
3. *Biogeography and Biodiversity, R. B. Singh, Rawat Pubns*
4. *An Introduction to Biodiversity, Prithipalsingh, Ane books*
5. *An Advanced Textbook on Biodiversity, K. V. Krishnamurthy*
6. *Biodiversity Measurement and estimation, Hawksworth, Chapman*

Unit II

2.1 **Organisms of health & agricultural importance:** Common parasites and pathogens of humans, domestic animals and crops.

2.2 **Organisms of conservation concern:** Rare, endangered species. Conservation strategies.

2.3 Methods in field biology: Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization: ground and remote sensing methods.

2.4 **Biodiversity:** Bioresource and uses of biodiversity, pollution and environment related law, EIA

Reference Books

1. *Biodiversity: Perception, Peril and Preservation Prabodh K. Maiti, PHI Learning Private Limited*
2. *The Bio-Diversity of India, Erach Bharucha, Grantha Corporation*
3. *Biogeography and Biodiversity, R. B. Singh, Rawat Pubns*
4. *An Introduction to Biodiversity, Prithipalsingh, Ane books*
5. *An Advanced Textbook on Biodiversity, K. V. Krishnamurthy*
6. *Biodiversity Measurement and estimation, Hawksworth, Chapman*
7. *Environmental Sciences C Santra*

Unit III

3.1 **The Environment:** Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

3.2 **Population Ecology**: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

3.3 **Species Interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

3.4 **Community Ecology**: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

Reference Books

1. *Fundamentals of Ecology, Eugene Odum, Cengage*
2. *Concepts of Ecology, Kormondy Edward, Pearson Education*
3. *Elements of Ecology, Smith, Pearson Education*
4. *Fundamentals of Ecology and Environmental Biology, S. C. Santra*
5. *Essentials of Ecology and Environmental Science, Rana, PHI*
6. *Ecology: he Experimental Analysis of Distribution and Abundance, Person*
7. *The Ecology Book (Big Ideas Simply Explained),DK, DK publication*
8. *Fundamentals of Ecology, M. Dash, McGraw Hill Education*
9. *Ecology: Concepts and Applications, Manuel C Molles, McGraw-Hill Higher Education*
10. *First Ecology, Alan, Oxford*
11. *Ecology and Environment, PD Sharma, Rastogi Publications*

Unit IV

4.1 **Ecological Succession:** Types; mechanisms; changes involved in succession; concept of climax.

4.2 **Ecosystem Ecology:** Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, and P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).

4.3 **Biogeography:** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

4.4 **Applied Ecology:** Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches; Conservation Biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves). Bioremediation and phytoremediation

Reference Books

1. *Fundamentals of Ecology, Eugene Odum, Cengage*
2. *Concepts of Ecology, Kormondy Edward, Pearson Education*
3. *Elements of Ecology, Smith, Pearson Education*
4. *Fundamentals of Ecology and Environmental Biology, S. C. Santra*
5. *Essentials of Ecology and Environmental Science, Rana, PHI*
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9. *Ecology: Concepts and Applications, Manuel C Molles, McGraw-Hill Higher Education*
10. *First Ecology, Alan, Oxford*
11. *Ecology and Environment, PD Sharma, Rastogi Publications*

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT			
Programme Code		**Programme Name**	**M.Sc. Bioscience**
Course Code	**BIOS-204**	**Semester**	**II**
Bioinformatics, IPR, Biosafety & Bioethics			
Course type	**Core Compulsory**	**Total Credit**	**04**
Teaching time	**Examination Marking Scheme**		
Theory (hrs)	**Internal Marks**	**External Marks**	**Total Marks**
4/week	**30**	**70 (Paper of 3hrs)**	**100**

BIOS-204: BIOINFORMATICS, IPR, BIOSAFETY & BIOETHICS

Learning Objective and Outcomes: *The most valuable knowledge need to learn the student is the moral values and ethics along with the gaining of the knowledge of the interdisciplinary subject. The course provide the information and knowledge of the IPR, Biosafety and B*

- *Student will be utilized the available biological database, online resources and tools.*
- *Student will be able to understand and perform the bimolecular structure visualization, sequences alignment, modelling and drug discovery*
- *Student will be able to understand the regulation and importance of IPR and patent along with the ethical concern*
- *Student will be able to understand the Biosafety requirement and practice it during his/her practical and research work*

Unit I

1.1 **Major Bioinformatics Resources**: Sequence databases, Gene Expression database: GEO, SAGE, 3D Structure Database: PDB, NDB, Knowledge driven Databases & utility, Pattern Sequence: InterPro, Prosite, Pfam, ProDom, Gene Ontology.

1.2 **Database Searches:** Keyword-based searches using tools like ENTREZ and SRS Sequence-based searches: BLAST and FASTA.

1.3 **Sequence Analysis, Basic concepts:** Sequence similarity, identity and similarity, definitions of homologues, orthologues, paralogues, Tandem and Interspersed repeats, repeat finding, Scoring Matrix, Pairwise sequence alignments

1.4 **Multiple alignment**: Multiple sequence alignments (MSA), Application in Taxonomy and phylogeny, Comparative genomics.

Reference Books

1. Bioinformatics: Principles and Applications, Zhumur Ghosh, Oxforrd
2. Bioinformatics, Orengo, Advanced Text
3. Introduction to genomics, Arthur lesk, Oxford
4. Bioinformatics, Ratogi, PHI
5. Bioinformatics Bosu, Oxford
6. Introduction to Bioinformatics Paperback, Lesk, Oxford
7. Introduction to Bioinformatics, Teresa Attwood, Pearson Education
8. Essential bioinformaics, Jin Xiong, Cambridge University Press
9. Bioinformatics: Sequence and Genome Analysis, Mount, CBS

Unit II

2.1 **Structural Biology:** 3-D structure visualization and simulation, Basic concepts in molecular modeling: different types of computer representations of molecules. External coordinates and Internal Coordinates, Molecular Mechanics, Force fields etc.

2.2 **Proteins:** Secondary structure elucidation using Peptide bond, phi, psi and chi torsion angles, Ramachandran map, anatomy of proteins – Hierarchical organization of protein structure –like CATH, SCOP, FSSP; DNA & RNA secondary and tertiary structures, t-RNA tertiary structure.

2.3 **Classification and comparison of protein 3D structures:** Secondary structure prediction: Algorithms viz. Chou Fasman, GOR methods, Tertiary Structure prediction: Fundamentals of the methods for 3D structure prediction (sequence similarity/identity of target proteins of known structure, fundamental principles of protein folding etc.) Homology/comparative modeling, fold recognition, threading approaches, and *ab initio* structure prediction methods. CASP. Computational design of Promoters, Proteins & Enzymes

2.4 **Application in drug design:** Chemical databases like NCI/PUBCHEM. Fundamentals of Receptor-ligand interactions. Structure-based drug design:

Identification and Analysis of Binding sites and virtual screening. Ligand based drug design: Structure Activity Relationship – QSARs & Pharmacophore etc. *In silico* predictions of drug activity and ADMET.

Reference Books

1. *Bioinformatics: Principles and Applications, Zhumur Ghosh, Oxforrd*
2. *Bioinformatics, Orengo, Advanced Text*
3. *Introduction to genomics, Arthur lesk, Oxford*
4. *Bioinformatics, Ratogi, PHI*
5. *Bioinformatics Bosu, Oxford*
6. *Introduction to Bioinformatics Paperback, Lesk, Oxford*
7. *Introduction to Bioinformatics, Teresa Attwood, Pearson Education*
8. *Essential bioinformaics, Jin Xiong, Cambridge University Press*
9. *Bioinformatics: Sequence and Genome Analysis, Mount, CBS*

Unit III

3.1 **IP:** Types of IP Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP. IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS.

3.2 **Patent Databases:** Invention in context of "prior art"; Patent databases; Searching International
Databases; Country-wise patent searches (USPTO, EPO, India etc.); Analysis and report formation.

3.3 **Patent Types:** Types of patents; Indian Patent Act 1970; Recent Amendments; Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; WIPO Treaties; Budapest Treaty; PCT and Implications; Role of a Country Patent Office; Procedure for filing a PCT application.

3.4 **Patent Application:** Patent application- forms and guidelines, fee structure, time frames; Types of patent applications: provisional and complete specifications; PCT and convention patent applications; International patenting-requirement, procedures and costs; Financial assistance for patenting-introduction to existing schemes; Publication of patents-gazette of India, status in Europe and US Patenting by research students, lecturers and scientists-University/organizational rules in India and abroad, credit sharing by workers, financial incentives, Patent infringement- meaning, scope, litigation, case studies and examples.

Reference Books

1. *IPR, Biosafety and Bioethics, Goel and Parashar, Person*
2. *A Book on Indian Patenting System and Patent Agent Examination, Sheetal Chopra, Notion Press*
3. *A Book on Indian Patenting System and Patent Agent Examination, Sheetal Chopra, Notion Press*
4. *Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers, Anil Kumar, Ramakrishna, Notion Press*
5. *Intellectual Property Rights (IPRs): TRIPS Agreement & Indian Laws, E. T. Lokganathan, New Century Publications*

6. How to Patent an Idea in India, Prasad Karhad
7. Building Biotechnology: Biotechnology Business. Regulations, Patents, Law, Policy and Science Paperback, Yali Friedman, Logos Press

Unit IV

4.1 **Biosafety fundamentals**: Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals;

4.2 **Biosafety regulation :** Biosafety guidelines-Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.

4.3 **Bioethics:** Concepts; Philosophical considerations; Epistemology of Science; Ethical Terms; Principles & Theories; Relevance to Biotechnology; Ethics and the Law Issues: Genetic Engineering, Stem Cells, Cloning, Medical techniques, Trans-humanism, Bioweapons; Research concerns - Animal Rights, Ethics of Human Cloning, Reproduction and Stem Cell Research;

4.4 **Emerging issues:** Biotechnology's Impact onSociety; DNA on the Witness Stand - Use of genetic evidence in civil and criminal court cases; Challenges to Public Policy – To Regulate or Not to Regulate; Improving public understanding of biotechnology products to correct misconceptions.

Reference Books

1. *IPR, Biosafety and Bioethics, Goel And Parashar, Person*
2. *Bioethics and Biosafety M.K. Sateesh, I K International Publishing House*
3. *Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers, Anil Kumar, Ramakrishna, Notion Press*
4. *Biosafety and Regulation for Genetically Modified Organisms, Xue, lpha Science International Ltd*
5. *Building Biotechnology: Biotechnology Business, Regulations, Patents, Law, Policy and Science Paperback, Yali Friedman, Logos Press*

VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT			
Programme Code		Programme Name	M.Sc. Bioscience
Course Code	BIOS-205	Semester	II
Practical Based on BIOS-201 to 204			
Course type	Practical	Total Credit	08
Teaching time	Examination Marking Scheme		
Practical (hrs)	Internal Marks	External Marks	Total Marks
16/week	60	140	200

BIOS 205: Practical based on paper 201 to 204

Following are the indicative list of the experiments. Changes can be done depending upon the departmental need and availability of the resources

Evolution and Genetics

1. Fossils study
2. Mendelian genetics
3. Chromosome banding techniques
4. Study of polytene chromosome in larva
5. A study of Lampbrush chromosome
6. To perform Peripheral Blood Lymphocyte Culture (PBLC) and to observe metaphase chromosomes by wet-dry preparation
7. To perform Micronucleus Assay
8. MTT Assay .
9. Petite mutant in yeast
10. Fluctuation test
11. Conditional mutation
12. UV Mutagenesis in *E. coli*
13. Ames test
14. Isolation of a streptomycin-resistant mutant by gradient plate technique
15. Molecular Phylogenetic analysis

Reference Books

1. *Laboratory manual for Genetic Engineering by S. John venison, PHI learning Private Ltd.*
2. *Life Science Protocol manual DBT, Star College Scheme 2018*
3. *Microbiology – A laboratory Manual by James Cappuccino and Natalie Sheman, Pearson*
4. *Laboratory Protocols in Applied Life Sciences, Bisen, CRC*

Molecular Biology and Recombinant DNA methods

16. Isolation of DNA from Plant
17. Agarose gel electrophoresis
18. RAPD
19. Isolation of DNA from blood
20. Isolation of Bacterial Genomic DNA
21. PCR
22. Amplified rDNA Restriction Analysis (ARDRA)/RFLP
23. Isolation of plasmid vector pUC19 by alkaline lysis method
24. Metagenome isolation

25. Primer design
26. T-A Cloning in bacteria
27. Transformation of vector pUC19 into *E. coli* DH5 alpha and Demonstration of blue-white selection for DH5 alpha and pUC19 vector

Reference Books

1. *Laboratory manual for Genetic Engineering by S. John venison, PHI learning Private Ltd.*
2. *Life Science Protocol manual DBT, Star College Scheme 2018*
3. *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications by R. Ian Freshney*
4. *Microbiology – A laboratory Manual by James Cappuccino and Natalie Sheman, Pearson*

Diversity and Ecology

28. Study of biodiversity by Quadrant analysis
29. Primary productivity in fresh water bodies
30. Construction of Winogradsky column
31. Soil Biofilms by the Buried Slide Technique
32. Biological analysis of water (MNP, BOD, SPC)
33. Biological analysis of Soil i.e. total viable count
34. Physico-chemical analysis of water
35. Physico-chemical analysis of Soil
36. Air quality study
37. Cultivation and isolation of Microorganisms (Bacteria, fungi, Mushroom etc.)
38. Carbon Credit and foot print

Reference Books

1. *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology by Jyoti Saxena et al, Scientific publication India*
2. *Microbiology – A laboratory Manual by James Cappuccino and Natalie Sheman, Pearson*
3. *IS manuals*
4. *Guide manual water and wastewater analysis, Central Pollution Control Board*
5. *American Public Health Association*
6. *Handbook of soil analysis by Marc Pansu, Jacques Gautheyrou, Springer*
7. *Hand Book of Water, Air and Soil Analysis, Anand Dev Gupta, International E - Publication*

Bioinformatics, IPR, Biosafety and Bioethics

39. Biological databases search
40. Sequence alignments
41. Protein structure prediction
42. Molecular Docking
43. QSAR study
44. Genomes annotation
45. Proteomics database search
46. Patent database search
47. Diversity indices calculation by PAST
48. GMO detection using cotton seeds

Reference Books

1. *Practicals in Bioinformatics, P. Shanmughavel, Pointer Publishers*
2. *Bioinformatics: A Practical Manual Kasturi K (Author), K. Sri Lakshmi, PharmaMed Press*
3. *Current protocol, wiley.com*
4. *Cold Spring Harbor Protocols*