Center for Basic Sciences (CBS)

COURSE STRUCTURE
SCHEME OF EXAMINATION
&
SYLLABUS
Of
Five Year
Integrated M.Sc. (Biology Stream)

UNDER

FACULTY OF LIFE SCIENCE

EFFECTIVE FROM JULY 2022

Center for Basic Sciences
Pt. Ravishankar Shukla University
Raipur (C.G.) 492010
PH: - 0771 – 2262216

Approved by Board of Studies in Bioscience
Pt. Ravishankar Shukla University Raipur (C.G.)

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Course structure for the Integrated M.Sc. Biology stream
Effective from July, 2022

(Abbreviation: B: Biology, C: Chemistry, M: Mathematics, P: Physics, G: General, H: Humanities, BL: Biology Laboratory, CL: Chemistry Laboratory, PL: Physics Laboratory, GL: General Laboratory, BE: Biology Elective, BPr: Biology Project)

- Minimum total credits for Integrated M.Sc. degree is 240.
- Semesters I to VIII will carry 25 credits each.
- Semesters IX and X will carry 20 credits each.

FIRST YEAR

Semester –I

Subject Code	Subject	Contact Hours /Week Theory +Tutorials	Credits
B101	Biology – I	[2 + 1]	3
C101	Chemistry – I	[2 + 1]	3
M101/MB101	Mathematics – I	[2 + 1]	3
P101	Physics – I	[2 + 1]	3
G101	Computer Basics	[2 + 1]	3
H101	Communication Skills	[2]	2
	Contact Hours /Week Laboratory		
PL101	Physics Laboratory – I	[4]	2
CL101	Chemistry Laboratory – I	[4]	2
BL101	Biology Laboratory – I	[4]	2
GL101	Computer Laboratory	[4]	2
	(25 of 240 credits)	**Total**	**25**
Additional Papers			
ES101	Environmental Studies	[2]	**2**

Semester- II

Subject Code	Subject	Contact Hours /Week Theory+Tutorials	Credits
B201	Biology – II	[2 + 1]	3
C201	Chemistry – II	[2 + 1]	3
M201/ MB201	Mathematics – II	[2 + 1]	3
P201	Physics – II	[2 + 1]	3
G201	Electronics and Instrumentation	[2 + 1]	3
	Contact Hours /Week Laboratory		
PL201	Physics Laboratory – II	[4]	2
CL201	Chemistry Laboratory – II	[4]	2
BL201	Biology Laboratory – II	[4]	2
GL201	Electronics Laboratory	[4]	2
H201	Communication Skills Lab	[4]	2
	(50 of 240 credits)	**Total**	**25**
Additional Paper			

ES201	Environmental Studies	[2]	**2**

SECOND YEAR

Semester- III

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
CB301	Essential mathematics for Chemistry and Biology	[3 + 1]	4
CB302	Biochemistry-I	[3 + 1]	4
CB303	Organic Chemistry-I	[3 + 1]	4
B301	Cell Biology – I	[3 + 1]	4
H301	Creative Hindi	[2 + 0]	2
H302	History and Philosophy of Science	[2 + 0]	2
		Contact Hours / Week Laboratory	
BL 301	Biology Laboratory	[6]	3
GL301	Applied Electronics Laboratory	[4]	2
	(75 of 240 credits)	**Total**	**25**

Semester- IV

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
PCB401	Physical and Chemical Kinetics	[3 + 1]	4
CB401	Introductory Spectroscopy (UV-vis, fluorescence, IR, Raman, NMR)	[3 + 1]	4
B 401	Cell Biology – II	[2 + 1]	3
B 402	Biochemistry – II	[2 + 1]	3
G401	Statistical Techniques and Applications	[3 + 1]	4
		Lab hrs	**Credits**
BL 401	Biology Laboratory	[6]	3
GL 401	Computational Laboratory and Numerical Methods	[4]	2
H401	Communication Skills Lab	[4]	2
	(100 of 240 credits)	**Total**	**25**

THIRD YEAR

Semester- V

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
CB501	Analytical Chemistry	[3 + 1]	4
B 501	Genetics	[3 + 1]	4

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B 502	Molecular Biology	[3 + 2]	5
B 503	Biodiversity plants/animals	[3 + 2]	5
H501	Scientific Writing in Hindi	[2]	2
		Lab contact hrs	**Credits**
BL501	Biology Laboratory	[10]	5
	(125 of 240 credits)	**Total**	**25**

Semester- VI

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
CB601	Biophysical Chemistry	[3 + 1]	4
B 601	Immunology	[2 + 1]	3
B 602	Animal Physiology	[2 + 1]	3
B 603	Plant Physiology	[3 + 1]	4
B 604	Microbiology	[3 + 1]	4
H601	Ethics in Science and IPR	[2 + 0]	2
H602	Scientific Writing in English	[2]	2
		Lab contact hrs	**Credits**
BL601	Biology Laboratory	[6]	3
	(150 of 240 credits)	Total	25

FOURTH YEAR

Semester- VII

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
B 701	Evolutionary Biology	[3 + 1]	4
B 702	Immunology – II	[3 + 1]	4
B 703	Developmental Biology	[3 + 1]	4
B 704	Imaging technology in biological research	[3 + 1]	4
BPr 701	Reading Project	[8]	4
		Lab contact hrs	**Credits**
BL 701	Advanced Biology Laboratory-I	[10]	5
	(175 of 240 credits)	Total	25

Semester- VIII

Subject Code	Subject	Contact Hours / Week Theory+Tutorials	Credits
B 801	Virology	[3 + 1]	4
B 802	Biotechnology – I	[3 + 1]	4
B 803	Bioinformatics	[3 + 1]	4

B 804	Biotechnology – II	[3 + 1]	4
		Lab contact hrs	Credits
BL 801	Advanced Biology Laboratory-II	[10]	5
BPr801	Project	[8]	4
	(200 of 240 credits)	Total	25

FIFTH YEAR

Semester- IX

Subject Code	Subject	Contact Hours / Week	Credits
BPr901	Project		20
	(220 of 240 Credits)	Total	20

Semester- X

Subject Code*	Subject	Contact Hours / Week Theory+Tutorials	Credits
BE1	Proteomics and Genomics	[4 + 1]	5
BE2	Nanobiotechnology	[4 + 1]	5
BE3	Plant Genetic Engineering	[4 + 1]	5
BE4	Plant-Microbe Interaction	[4 + 1]	5
BE5	Neurobiology	[4 + 1]	5
BE6	Plants for Human Welfare	[4 + 1]	5
BE7	Animal Tissue Culture	[4 + 1]	5
BE8	Earth Science and Energy & Environmental Sciences	[4 + 1]	5
BE9	Glimpses of Contemporary Sciences	[4 + 1]	5
	(240 of 240 credits)	Total	20

***Four Subjects will be offered according to the availability of instructors and minimum number of interested students taking a course. The chosen four subjects will have codes BE1001, BE1002, BE1003 and BE1004.**

Scheme of Examination (Biology Stream)

Integrated M.Sc. Semester – I

Subject Code	Subject	Internal Marks		External Marks		Total Marks Max	Credit
		Max	Min	Max	Min		
B101	Biology - I	60	24	40	16	100	3
C101	Chemistry - I	60	24	40	16	100	3
M101/MB101	Mathematics - I	60	24	40	16	100	3
P101	Introductory Physics- I	60	24	40	16	100	3
G101	Computer Basics	60	24	40	16	100	3
H101	Communication Skills	60	24	40	16	100	2
Practical							
BL101	Biology Laboratory-I	60	24	40	16	100	2
CL101	Chemistry Laboratory-I	60	24	40	16	100	2
PL101	Physics Laboratory-I	60	24	40	16	100	2
GL101	Computer Laboratory	60	24	40	16	100	2
Additional Papers							
ES101	Environmental Studies	60	24	40	16	100	2

Integrated M.Sc. Semester – II

Subject Code	Subject	Internal Marks		External Marks		Total Marks Max	Credit
		Max	Min	Max	Min		
B201	Biology - II	60	24	40	16	100	3
C201	Chemistry - II	60	24	40	16	100	3
M201/MB201	Mathematics-II	60	24	40	16	100	3
P201	Introductory Physics-II	60	24	40	16	100	3

G201	Electronics and Instrumentation	60	24	40	16	100	3
Practical							
BL201	Biology Laboratory- II	60	24	40	16	100	2
CL201	Chemistry Laboratory-II	60	24	40	16	100	2
PL201	Physics Laboratory- II	60	24	40	16	100	2
GL201	Electronics Laboratory	60	24	40	16	100	2
H201	Communication Skills Lab -I	60	24	40	16	100	2
Additional Papers							
ES201	Environmental Studies	60	24	40	16	100	2

Integrated M.Sc. Semester – III

Subject Code	Subject	Internal Marks		External Marks		Total Marks Max	Credit
		Max	Min	Max	Min		
CB301	Essential mathematics for Chemistry and Biology	60	24	40	16	100	4
CB302	Biochemistry-I	60	24	40	16	100	4
CB303	Organic Chemistry-I	60	24	40	16	100	4
B301	Cell Biology – I	60	24	40	16	100	4
H301	Creative Hindi	60	24	40	16	100	2
H302	History and Philosophy of Science	60	24	40	16	100	2
Practical							
BL301	Biology Laboratory	60	24	40	16	100	3
GL301	Applied Electronics Laboratory	60	24	40	16	100	2

Integrated M.Sc. Semester – IV

Subject Code	Subject	Internal Marks		External Marks		Total Marks Max	Credit
		Max	Min	Max	Min		
PCB401	Physical and Chemical kinetics	60	24	40	16	100	4
CB401	Introductory Spectroscopy (UV-vis, fluorescence, IR, Raman, NMR)	60	24	40	16	100	4
B401	Cell Biology – II	60	24	40	16	100	3
B402	Biochemistry – II	60	24	40	16	100	3
G401	Statistical Techniques and Applications	60	24	40	16	100	4
Practical							
BL401	Biology Laboratory	60	24	40	16	100	3
GL401	Computational Laboratory and Numerical Methods	60	24	40	16	100	2
H401	Communication Skills Lab-II	60	24	40	16	100	2

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Integrated M.Sc. Semester – V

Subject Code	Subject	Internal Marks		External Marks		Total Marks Max	Credit
		Max	Min	Max	Min		
CB501	Analytical Chemistry	60	24	40	16	100	4
B501	Genetics	60	24	40	16	100	4
B502	Molecular Biology	60	24	40	16	100	5
B503	Biodiversity plants/animals	60	24	40	16	100	5
H501	Scientific Writing in Hindi	60	24	40	16	100	2
Practical							
BL501	Biology Laboratory	60	24	40	16	100	5

Integrated M.Sc. Semester – VI

Subject Code	Subject	Internal Marks		External Marks		Total Marks Max	Credit
		Max	Min	Max	Min		
CB601	Biophysical Chemistry	60	24	40	16	100	4
B601	Immunology	60	24	40	16	100	3
CB602	Animal Physiology	60	24	40	16	100	3
B603	Plant Physiology	60	24	40	16	100	4
B604	Microbiology	60	24	40	16	100	4
H601	Ethics of Science and IPR	60	24	40	16	100	2
H602	Scientific Writing in English	60	24	40	16	100	2
Practical							
BL601	Biology Laboratory	60	24	40	16	100	3

Integrated M.Sc. Semester – VII

Subject Code	Subject	Internal Marks		External Marks		Total Marks Max	Credit
		Max	Min	Max	Min		
B701	Evolutionary Biology	60	24	40	16	100	4
B702	Immunology – II	60	24	40	16	100	4
B703	Developmental Biology	60	24	40	16	100	4
B704	Imaging technology inbiological research	60	24	40	16	100	4
BPr701	Reading Project	60	24	40	16	100	4
Practical							
BL701	Advanced Biology Laboratory -I	60	24	40	16	100	5

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Integrated M.Sc. Semester – VIII

Subject Code	Subject	Internal Marks		External Marks		Total Marks Max	Credit
		Max	Min	Max	Min		
B801	Virology	60	24	40	16	100	4
B802	Biotechnology – I	60	24	40	16	100	4
B803	Bioinformatics	60	24	40	16	100	4
B804	Biotechnology – II	60	24	40	16	100	4
Practical							
BL801	Advanced Biology Laboratory- II	60	24	40	16	100	5
BPr801	Project	60	24	40	16	100	4

Integrated M.Sc. Semester – IX

Subject	Project Report/Dissertation		Seminar Based on Project		Viva-Voce Based on Project Report and Seminar		Total Marks Max	Credit
BPr901-Project	Max	Min	Max	Min	Max	Min		
	150	60	150	60	100	40	400	20

Integrated M.Sc. Semester – X

Subject Code	Subject	Internal Marks		External Marks		Total Marks Max	Credit
		Max	Min	Max	Min		
BE1001	Elective subjects will be offered according to the availability of instructors and minimum number of interested students taking a course from the list of elective subjects in the syllabus.	60	24	40	16	100	5
BE1002		60	24	40	16	100	5
BE1003		60	24	40	16	100	5
BE1004		60	24	40	16	100	5

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FIRST YEAR
Semester-1

B 101: Biology I (Introductory Biology-I)

Unit-I

Life: History and origin of life, Concepts of biological evolution, Darwinism, Lamarckism, natural selection, speciation.

Unit-II

Classification of living things: Classification and domains of life, overview of taxonomy of plants, animals and microorganisms.

Unit-III

Cell Biology: Discovery of cell, cell theory, classification of cell types, Prokaryotes and Eukaryotes, cell wall, cell membrane, cytoplasm, structure and functions of cell organelles.

Unit-IV

Cell Division and System Development: cell cycle, mitosis, meiosis, and mechanism of development (stem cells), formation of tissues, cell-cell interactions, respiration.

Unit-V

Morphology and Anatomy of flowering plants, photosynthesis. Major Human Body Systems: Digestive, Circulatory, Lymphatic, Respiratory system.

Books Recommended:

S.No.	Author	Book
1	Neil A Campbell and JB Reece (2007)	Biology with Mastering Biology (8th Edition)
2	NA Campbell, JB Reece, MR Taylor and EJ Simon (2008)	Biology: Concepts & Connections with biology (6th Edition)
3	Charles Darwin (2008)	On the Origin of Species
4	B Alberts, D Bray, K Hopkin and AD Johnson (2009)	Essential Cell Biology
5	Rene Fester Kratz (2009)	Molecular and Cell Biology For Dummies
6	MJ Behe (2006)	Darwin's Black Box: The Biochemical Challenge to Evolution
7	SD Garber (2002)	Biology: A Self- Teaching Guide, (2nd Edition)

ES101-ENVIRONMENTAL STUDIES

UNIT – I

THE MULTI DISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES :

Definition ,scope and importance

Need for publish awareness.

UNIT-II

Natural Resources :

Renewable and non-renewable resources:

Natural resources and associated problems .

(a) Forest resources: use and over – exploitation, deforestation, case studies, timber extraction,Mining dams and their effects on forests and tribal people .

(b) Water resources : use and over-utilization of surface and ground water,floods, drought,Conflicts ove water , dams benefits and problems .

(c) Mineral resources : use and explotation, environmental effects of extracting and using Minera resources, case studies .

(d) Food resources : World food problems , changes caused by agriculture and overgrazing, Effects o modern agriculture , fertilizer –pesticide problems , water logging , salinity Case studies.

(e) Energy resources : Growing energy needs , renewable and non renewable energy sources Use o alternate energy sources ,case studies.

(f) Land resources : land as a resources , land degradation, man induced landslides , soil erosion & desertification.

Role of an individual in consertification of natural resources.

Equitable use of resources for sustainable life –styles.

UNIT- III

Concept of an ecosystems.

Structure and function of an ecosystem.

- Producers , consumers and decomposers .
- Energy flow in the ecosystem .
- Ecological succession.
- Food chains, food webs and ecological pyramids

UNIT-IV Introduction , types ,characteristic features , structure and function of the following Ecosystem:

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

UNIT- V

SOCIAL ISSUES AND THE ENVIRONMENT

Environment Protection Act.

- Air (prevention and control of pollution) Act.
- Wildlife protection Act.
- Forest conservation Act.
- Issues involved in enforcement of environmental legislation .
- Public awareness.
- Value Education
- HIV/ADIS
- Women and child welfare.
- Role of information technology in Environment and Human Health.
- Case studies.

Field work

- Visit to a local area to document environment assets – river / forest/grassland/hill/ Mountain.
- Visit to local polluted site: Urban/Rural/Industrial/Agriculture.

Sr.No.	Author	Title	Publisher
1.	Agarwal K.C.	Environmental Biology 2001	Nidi Publ. Ltd.Bikaner
2.	Bharucha Erach	The Biodiversity of India	Mapin Publishing Pvt. Ltd. Ahmedabad 380013, lia .
3.	Bruinner R.C.	Hazardous Waste Incineration, 1989	Mc Graw Hill Inc. 480p.
4.	Bharucha E.	Textbook for Environmental Studies for undergraduate Cources.	JGC, New Delhi & Bharti Vidyapeeth Inst.)f Environment edu. & esearch ,Pune.
5.	Begon M.,Town send C.R. ,Harper J.L.	Ecology From Individuals to Ecosystems	th edition , Blackwell ublishing (TB)

BL 101 Biology laboratory

1. Introduction to Biology laboratory
2. Taxonomy
3. Methods of Classification
   Dichotomous key; Hierarchical Classification; Phylogenetic Classification
4. Introduction to Light Microscopy:
   a) Observing cells in a leaf peel using a compound microscope
   b) Observing plant cells in onion peel
   b) To study the morphological characteristics of Saccharomyces cerevesiae.
5. Staining and Observing human cheek cells: To carry out staining of epithelial cells from the mouth using acetocarmine and methylene blue stains.
6. Dye exclusion method of differentiating dead v/s live cells: To use a vital stain to distinguish dead and live yeast cells.
7. Staining human blood cells: To observe human blood cell types by differential staining.
8. Plant anatomy: Relationship between plant anatomy and habitat.
   a) Preparing and observing transverse section of dicot & monocot stem.
   b) Preparing and observing transverse section of dicot &monocot root.
   c) Preparing and observing transverse section of dicot &monocot leaf.
   d) Performing flower dissection and observing different parts of flower.
   e) Observing and understanding types shapes and patterns of leaves.
9. Micrometry: Measuring size of a microscopic specimen.
10. Haemocytometer

FIRST YEAR
Semester-II

B 201: Biology –II [Introductory Biology-II]

Unit-I

Nucleic acids: DNA as the carrier of genetic information, Building blocks- nucleosides, nucleotides,DNA andRNA structure,types and function, chromatin structure, genes, repetitive DNA sequences.

Unit-II

Gene expression: Overview, genes's regulatory elements, transcription mechanism in prokaryotes and eukaryotes (a comparison), Reverse transcription, genetic code.

Unit-III

Protein Structure and Function: Building blocks- amino acids, peptides, secondary structure, three dimensional structure, membrane proteins, miscellaneous proteins, enzymes.

Unit-IV

Cell Signaling: Overview, signaling via hydrophobic molecules, signaling via ion channels, Signaling via G-protein coupled receptors, signaling via cell surface enzymes, intracellular signalling.

Unit-V

Biotechnology:DNA cloning, Uses of recombinant DNA technology, Polymerase chain reaction (PCR), Production of recombinant proteins and SDS-PAGE.

Books Recommended:

Sr.no	Author	Book
1.	B Alberts, A Johnson, J Lewis, and M R aff	Molecular Biology of the Cell
2.	J D. Watson, T A.Baker, S P. Bell, & A Gann	Molecular Biology of the Gene (6th Edition)
3.	John Wilson and Tim Hunt (2007)	Molecular Biology of the Cell:The Proble ms
4.	Benjamin Lewin (2007)	Genes IX (Lewin, Genes XI)

ES201: Environmental Studies

Unit-I: Biodiversity and its Conservation: Introduction- Definition: genetics, species and ecosystem diversity. Bio geographical classification of India. Value of biodiversity: consumptive use productive use, social, ethical, aesthetical and option value. Biodiversity at global, National and local levels. India as mega-diversity nation. Hot-spots of biodiversity. Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts. Endangered and endemic species of India. Conservation of biodiversity: in situ and ex-situ conservation of biodiversity.

Unit-II: Environmental pollution. Definition Causes, effects and control measures of- a. Air pollution b. Water pollution c. Soil pollution d. Marine pollution e. Noise pollution f. Nuclear hazards.

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

Unit-IV: Human population and the Environment: Population growth, variation among nation. Population explosion- Family welfare programme. Environment and human health. Human Rights.

Unit-V: Social Issues and the Environment: From unsustainable to Sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people, its problems and concerns. Case studies. Environment ethies: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies. Wasteland reclamation. Consumerism and waste products.

BL 201: Biology Practical

1. Observing instruments to be used in semester II, their use and maintenance: (a) micro-pipettes, (b) tissue homogenizer, (c) electrophoresis apparatus, (d) centrifuges, (e) colorimeter & ultraviolet and visible (uv-vis) absorption spectrophotometer
2. Introduction to Research Laboratory: Different kinds of microbial plates, liquid growth media for microbes, Laminar air flow system, Centrifuges, Spectrophotometer, Sonicator, PCR and Real-time PCR, Gel Documentation system and various Incubators
3. Gram Staining: To differentiate bacteria cells by Gram staining.
4. Centrifugation of the cell contents at varying speeds such that the subcellular fractions separate out based on their density differences
5. To understand the principle of colorimeter and spectrophotometer-to determine the wavelength of maximum absorbance of a solution using colorimeter.
6. To verify Beer-Lamberts law using colored solutions.
7. Bacterial cell counting using Neubauer chamber.
8. To observe mitosis in onion root tips.
9. Carbohydrate extraction & estimation - extraction of sugars from grapes & estimation of the same by DNSA method
10. Protein extraction & estimation determination of total protein content in microorganisms by folin-ciocaltaeu method
11. Lipid extraction & separation - Extraction of total lipids from liver tissue & separation by thin layer chromatography
12. Separation of biomolecules using:
    Adsorption chromatography; Partitioning of indicators in various solvent systems. ;
    Separation of a mixture of solutes by partitioning; Separation of leaf pigments by paper chromatograhy
    Separation of flower pigments by paper chromatography ; Reverse phase thin layer chromatography (PRTLC) - Separation of photosynthetic pigment.

SECOND YEAR
Semester-III

CB 302: Biochemistry-I

Unit-I

General biochemistry concepts: The concept of pH, dissociation and ionization of acids and bases, pKa, buffers and buffering mechanism, Henderson Hasselbalch equation, dissociation of amino acids and determination of pKa.

Unit-II

Chemical structure of: carbohydrate, lipids, nucleic acids, proteins. Properties and classification of carbohydrates-monosaccharides, di-, oligo- and polysaccharides, cellulose, lignin, cell wall, Sugar derivatives, Glycosidic Bonds.

Unit-III

Enzymes: characteristics, nomenclature and classification. Mechanism of enzyme action, enzyme kinetics, enzyme inhibition and regulation.

Unit-IV

Structure and Functions of Lipid: General properties; Classifications: fatty acid, fats, oils, waxes, cholesterol, phospholipids, glycolipid, glycocalyx, Vitamins, Hormones

Unit-V

Protein structure and function: levels of structure of protein, Classification of proteins-globular and fibrous, Protein folding and modification, proteolysis, ubiquitin- proteasome.

Books Recommended:

S.No.	Author	Book
1	D. L. Nelson & M. M. Cox	Lehninger Principles of Biochemistry
2	Stryer L (1995)	Biochemistry, 4 th edition,
3	Starzak, Michael E.	Energy and Entropy equilibrium to stationary states
4	J. McMurry (1999)	Fundamentals of General Organic & Biological Chemistry

B 301: Cell Biology -I

Unit-I

Visualization of cell- History of cellular imaging; principles and applications of light microscopy, Different microscopic techniques for imaging cells-phase contrast, confocal, SEM, TEM.

Unit-II

Membrane system: The cell membrane and its structure, Models of the biomembrane: Charles Overton's "Lipid Membrane", Lipid monolayer model of Irwing Langmuir, Lipid bilayer model by Gorter and Grendel, Protein-containing lipid bilayer model of Daveson and Danielly, David Robertson's direct observation of the membrane, Fluid Mosaic model of Singer and Nicholson, Constituents and fluidity of plasma membrane, Transport across membrane, Ion channels.

Unit-III

Cellular organelles and their functions: Mitochondria: Structure of mitochondria, Different enzymes and their location, Electron transport complexes, ATP synthase, Mitochondrial DNA, Structure of chloroplast, Protein complexes and photosynthetic electron transport chain, DNA of the chloroplast, Structure and functions of the ribosomes, Endoplasmic reticulum, Golgi body, Lysosomes and Nucleus.

Unit-IV

Cytoskeleton, cilia and flagella: Structure and functions of Microtubules, microfilaments, and Intermediate filaments. Structure and function of tubulin, actin Molecular motors-structure and mechanisms of kinesins and dyneins. Myosin motor protein. Cilia and flagella: structure and functions and mechanism of movement.

Unit-V

Replication and Maintenance of the genome: DNA replication, DNA damage and repair, DNA rearrangements.

Books Recommended:

S.No.	Author	Book
1	D. L. Nelson & M. M. Cox	Lehninger Principles of Biochemistry,
2	Stryer L (1995	Biochemistry,
3	Gerald Karp	Cell and Molecular Biology

BL 301: Biology Laboratory (Biochemistry + Cell Biology)

1. Biochemical calculation: Concept of pH & Buffers:Hydrogen ion concentration in solution; Inorganic ion concentration in solutions Inorganic Buffers and Biological fluids; Henderson-Hesselbach equation
2. Strong acid strong base titration, weak acid strong base titration
3. Amino acid titration:
   Determine the pka value of the provided amino acid solutions using titration curve.
   Identify the amino acids using the reference table on the basis of pka values obtained
4. Carbohydrate identification & estimation by anthrone method

Extraction of carbohydrates from various sources.

5. Qualitative tests of carbohydrates.
6. Estimation of total free amino acids-Extraction of total free amino acids from plant sample estimation by ninhydrin reagent
7. Acid value - Acid number is a measure of the amount of carboxylic acid groups a fatty acid
8. Iodine number
   Iodine numbers are often used to determine the amount of unsaturation in fatty acids
9. Saponification value
   Measure of the average molecular weight (or chain length) of all the fatty acids present
10. Peroxide value - Gives the evidence of rancidity in unsaturated fats and oils
11. Potato starch - isolation of starch
12. Enzyme kinetics
    Enzymatic reaction using potato starch and salivary amylase. Determine Vmax and Km for individuals salivary amylase.
13. pH and temperature effect on enzyme kinetics
    Effect of pH and temperature on salivary amylase action on starch
14. Effect of inhibitors on enzyme kinetics
15. Enzyme Kinetics: To study an enzyme catalyzed reaction using hydroquinone as a substrate and peroxidase extracted from cabbage.
16. Carbohydrate identification by thin layer chromatography
    Extraction of carbohydrates from various fruit sample and identification by separating using TLC
17. Cell biology
    Cell staining – i (capsule, cell wall, lipid granules)
    Cell staining – ii (metachromatic granules, endospores) Cell motility
    Subcellular fractionation of mouse liver tissue, page & western blotting Immunoflourescence of cytoskeleton & nuclear proteins, Meiosis using lily anthers

SECOND YEAR
Semester-IV

B401: Cell Biology - II

Unit-I

Cell Junctions, Cell Adhesion, and the Extracellular Matrix: Introduction, Cell Junctions, Cell-C ell Adhesion, The Extracellular Matrix of Animals, Extracellular Matrix Receptors on Animal Ce lls. Integrins, Selectins, and other proteins involved in intercellular contacts. The Plant Cell Wall

Unit-II

Cell signaling: 1. Introduction: Components involved in signaling, Types of signaling, Three Maj or Classes of Signaling Receptors: Ion Channel-linked, G protein-coupled receptors (GPRs), Enz yme-Linked receptors: Tyrosine-Kinase Receptors, other enzyme-linked receptors,
Second Messengers: cAMP, cGMP, IP3 and DAG, Ca+2, PIP3. Signaling Cascades.

Unit-III

Cell cycle and Cell division: Mechanisms and regulations of cell division, Cyclins and CDKs, Key events in G1 Phase, S-Phase, G2 Phase and Mitosis.Cell cycle checkpoints, Molecular mechanism of cytokinesis,uncontrolled cell division and cancer.

Unit-IV

Types of cell death: Apoptosis-Molecular mechanisms of apoptosis; Key proteins involved in apoptosis: Pro- and anti-apoptotic proteins. Necrosis, Anoikis, Oncosis, autophagy.

Unit-V

Techniques in Cell biology: Cell fractionation, DNA libraries, DNA transfer into eukaryotic cells

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and Mammalian embryos, Nucleic acid hybridization, Purification of nucleic acid, Isolation and fractionation of proteins.

Books Recommended:

S.No.	Author	Book
1	Alberts et al.	Molecular biology of the Cell
2	Alberts, Bray et al	Essential Cell Biology Garland, Publication New York 1997
3	James E. Darnell, Harvey F. L odish, and David Baltimore	Molecular Cell Biology
4	Geoffrey M Cooper	The Cell, 2nd edition, A Molecular Approach
5	Gerald Karp	Cell and Molecular Biology

B 402: Biochemistry-II

Unit-I

Bioenergetics, and Basic concepts of Metabolism: catabolism and anabolism. Carbohydrate metabolism: Glycolysis and regulation, Feeder pathways of glycolysis, cori cycle, oxygen debt, Pasteur effect, Fates of pyruvate, ATP, NADH

Unit-II

TCA cycle, regulation, Gluconeogenesis, Glycogenolysis, Pentose phosphate pathway, Glyoxalate cycle. ETC, inhibitors of ETC, Oxidative Phosphorylation, chemiosmotic theory

Unit-III

Lipid metabolism: B oxidation of unsaturated and saturated fatty acids, propionyl Co A metabolism, significance of ketone bodies, biosynthesis of palmitate , Absorption and transport of fats.

Unit-IV Amino acid Metabolism: Transamination, Deamination, Fate of amino acid skeleton, urea cycle, precursors of compounds other than proteins.

Unit-V

Nucleotide Metabolism: Salvage and De novo pathways of purines and pyrimidines, formation of deoxyribonucleotides, origin of thymine

Books Recommended:

S.No.	Author	Book
1	D.L. Nelson, M.Cox	Lehninger Principles of Biochemistry
2	Stryer L	Biochemistry
3	Starzak Michael E.	Energy and Entropy equilibrium to stationary states
4	J McMurry	Fundamentals of General Organic and Biological Chemistry (Study Guide)

BL401: Biology Laboratory (Biochemistry + Cell Biology)

1. Isolation and Analysis of Biomolecules -
   a) Carbohydrate estimation by DNSA
   b) Protein estimation by Peterson method

c) RNA estimation by Orcinol method
d) DNA estimation by DPA method
e) Qualitative tests for protein.
f) Nucleic acid extraction - from plant & animal tissue using ethanol precipitation
g) Agarose gel electrophoresis
h) Analysis of DNA under various conditions – pH and Temperature

2. Chromatography
a) Paper chromatography-chromatography of a mixture of amino acids
b) TLC, Gel filtration
c) Ion-exchange chromatography, affinity chromatography

3. Cell Biology
a) Programmed Cell Death DNA Laddering and Cell death assay (quantification by Evans Blue)
b) To detect blood group and Rh factor in the blood sample.
c) To study and observe Barr bodies by slide preparation.
d) To study Meiosis using lily anthers
e) Introducing undergraduate students to real-time PCR, D. Hancock et al., *Biochem. Mol. Biol. Educ.*38, 309-316 (2010).

THIRD YEAR
Semester-V

B501: Genetics

Unit I

Overview and Introduction of Genetics: Central Dogma, Genotype and Phenotype, Eukaryotic and Prokaryotic Genes, Forward and Reverse Genetics, Mendelian Inheritance: Law of Dominance, Law of Segregation, Law of Independent Assortment, Deviation from Mendelism: Incomplete dominance, Co-dominance.

Unit II

Epistasis, Polygeneic Inheritance, Cytoplasmic Inheritance,Linkage and Recombination, Sex Linkage and Sex-Linked Inheritance, Pedigree Analysis

Unit III

Bacterial Genetics: Transformation, Conjugation, Transduction (Lambda Phage)
Human genome and genetics: Elements of human genetics & genetic disorders, Examples from *Drosophila*,yeast, maize and mouse, Immunogenetics.

Unit IV

Genes and Evolution: The law of DNA constancy and C-value paradox: Numerical and structural changes in chromosomes; Molecular basis of spontaneous and induced mutations and their role in evolution;Environmental mutagenesis and toxicity testing; Population genetics

Unit V

Biostatistics: Principles and practice of statistical methods in biological research; samples and populations; Basic statistics – average, statistics of dispersion, coefficient of variation; Standard error;Confidence limits; Probability distributions binomial, Poisson and normal; Tests of statistical significance; Simple correlation of regression; Analysis of variance.

Books Recommended:

S.No.	Author	Book
1	E. J. Gardner, D.P Snustad and M. J. Simmons	Principles of Genetics

2	Leland Hartwell, Leroy Hood, Michael Goldberg, Ann Reynolds, Lee Silver, Ruth Veres.	Genetics: From genes to genomes
3	Anthony J. F. Griffiths. 2010	Introduction to genetic analysis
4	Harvey Motulsky, 2010	Intuitive Biostatistics: A Nonmathematical Guide to Statistical Thinking
5	Marcello Pagano, 2000	Principles of Biostatistics
6	Peter J. Russell	Genetics:A Molecular Approach

B 502: Molecular Biology

Unit I

Molecular biology an overview: Concept and definition of the gene, complexity of the eukaryotic gene. Structural organization of the DNA in the nuclear material- General properties of histones, nucleosomes and solenoid structure, RNAs and their structure & function.

Unit II

DNA synthesis: The enzymes of DNA replication in prokaryotes and eukaryotes, mechanism of replication in bacteria and viruses, reverse transcriptase, salient features of eukaryotic nuclear and mitochondrial DNA replication.RNA synthesis: The enzymes of transcription in prokaryotes and eukaryotes, mechanism of transcription in bacteria, heteronuclear RNA, post transcriptional processing of RNA, role of ribozymes.

Unit III

Protein synthesis: Concept of the genetic code, structure of t RNA and r RNA, enzymes of translation in prokaryotes and eukaryotes, mechanism of protein synthesis, post translational processing of proteins, translational inhibitors. Protein sorting, Vesicular traffic inside the cells, targeting & degradation

Unit IV

Gene expression and its characterization: Regulation of gene expression in prokaryotes, eukaryotes, λ phage, structure and mechanism of different operons, Gene regulation during development, Gene function and phenotype loss of function & gain of function, Gene interaction, suppressors & enhancers.

Unit V

Mutations and their consequences: Definition of mutation, mutagenesis & mutant selection, Alleles, Complementation, Recombination, recombination mapping and mechanism of recombination, Repair of DNA, Transposons & retroposons.

Books Recommended:

S.No.	Author	Book
1	Stryer L	Biochemistry, 4 th edition,
2	Watson J. D., Hopkins, N. H., Roberts, J. W., Steitz, J. A. and Weiner, A. M.	Molecular biology of the gene, 4th edition, The Benjamin/Cummings publishing companies
3	Benjamin Lewin	Genes VII, oxford University Press, Oxford
4	Weaver R. F.	Molecular biology,

		approach, IRL press, Oxford.28
6	Cox Lynne S	Molecular Themes in DNA Replication
7	Gerald Karp	Cell and Molecular Biology

B 503: Biodiversity of plants/animals

Unit I

Principles of taxonomy: Concept of species and hierarchical taxa, Biological nomenclature,Taxonomical structure, Outline classification of animals, important criteria used for classification in each Taxon, Classification of animals Levels of Structural organizations: Larval forms and their evolutionary significance, Unicellular, colonial, and multicellular forms, Levels of organization of tissues, organs, and systems, Comparative anatomy.

Unit II

Classical and quantitative methods in taxonomy: Biosystematics, Interrelationship among major invertebrate phyla and minor invertebrate phyla; Evolutionary relationship among taxa, Natural History of Indian subcontinent: Major habitat types, Geographical origin and migration of species, Common Indian flora and fauna.

Unit III

Taxonomy of plants: Plant identification, nomenclature, collecting and documentation, plant phylogeny and systematics. Gymnosperms: Characteristic features, outline classification, morphology and anatomy of ovules and female gametophyte, microspore and male gametophyte, seeds, stem and leaves.

Unit IV

Angiosperms: Characteristic features, outline classification, comparison of monocotyledons and dicotyledons, vascular anatomy, leaves, flower, fruits and seeds. Comparative anatomy and morphology of angiosperms and gymnosperms.

Unit V

Concepts and characteristics of biodiversity: The concepts of biodiversity, Different strategies for conserving biodiversity. a. Conservation Strategies, b. Laws and Legal Actions, c. Grassroots Action Program Comparison of historical and current rate of species extinction, Importance of preserving biodiversity, Genetic diversity, Causes and consequences of biodiversity loss: Address the major threats to biodiversity- a. Habitat Loss & Alteration b. Exotic Species c. Chemical Pollutants d. Loss of Genetic Diversity in Crops.

Books Recommended:

S.No.	Author	Book
1	Cecie Starr, Ralph Taggart, Christine Evers, and Lisa Starr	Biology: The Unity and Diversity of Life
2	Hawksworth, D. L. & Bull Alan T.	Plant Conservation and Biodiversity. Series: Topics in Biodiversity and Conservation, Vol. 6 (Eds.) Reprinted from Biodiversity and Conservation, 16:6, 2007, VIII, 424 p.

3	M P Singh	Plant Biodiversity & Taxonomy
4	E.O.Wilson, Editor. Frances M. Peter	Biodiversity
5	Peter H. Raven, Ray F. Evert, and Susan E. Eichhorn	Biology of Plants

BL 501: Biology Laboratory

1. Bacterial Genetics

a) *E. coli* Transformation
b) *E. coli* Conjugation
c) *E. coli* Transduction
d) Phage Titration
e) Transposition
f) α- Complementation
g)Karyotyping

2. Biodiversity

h) Biodiversity in soil, air & Winogradsky's Column – Plating , Colony Characterization & Gram Staining

3. Molecular Biology

a) General Laboratory Procedures
b) Extraction and Isolation of genomic DNA Using Kit method & By conventional Ethanol Precipitation method
c) Detection of Nucleic acids (AGE)
d) Polymerase Chain Reaction (PCR) & Detection of the PCR product and its purification
e) Blunt-end cloning (after Ligation)
f) Preparation of competent cells & Transformation of E. coli cells with plasmid
g) Plasmid Purification, RE Digestion & Detection of the RE-digested product
h) Protein extraction & separation using polyacrylamide gel electrophoresis SDS-PAGE
i) Using restriction mapping to teach basic skills in the molecular biology lab, L. Walsh et al., *Biochem. Mol. Biol. Educ.* **35**, 199-205 (2007).
j) Western blot analysis to illustrate relative control levels of the *lac* and *ara* promoters in *E. coli*, B. Nielsen et al., *Biochem. Mol. Biol. Educ.* **35**, 133- 137 (2007).

THIRD YEAR
Semester-VI

B 601: Immunology

Unit-I

Overview of the Immune system: Types of immunity, innate, acquired, passive and active, self vs nonself discrimination, Adaptive immune response, Autoimmunity

Unit-II

Cells and organs of the immune system: T cell receptors, T cell receptor genes & gene rearrangements, T cell maturation, activation & differentiation, B cell generation, activation & development

Unit-III

Antigens and Antibodies: Immunoglobulins- structure and function, Immunoglobulin genes- Organization and rearrangement, Antibody diversity, Antigen antibody reactions, MHC (antigens and genes), Antigen processing & presentation

Unit-IV

Immune response: Self Non-self discrimination (mechanism), Clonal selection theory & idiotypic network hypothesis, Cytokines, The complement system, Cell mediated effector

response, Leukocyte migration and inflammation, Hypersensitive reactions, Immune regulation, Immune response to infectious organisms, Vaccines, Immunodeficiency diseases (AIDS)

Unit-V

Immunology & applications: Transplantation immunology, Tumour immunology, Immunotechnology, Animal models. Plant immunity

Books Recommended:

S.No.	Author	Book
1	Goldsby, Kindt, and Osborne	Immunology
2	Janice Kuby	Immunology
3	Ivan Roitt	Essential Immunology, 8th Edition
4	Cellular and Molecular Immunology	Kathyrn Austyn
5	David	Biology of Immunological Diseases
6	Richard Burry	Immunocytochemistry: A practical guide for Biomedical Research

B 602: Animal Physiology

Unit-I

Cell Structure & Metabolism: Homeostasis, Mechanisms of Cellular Control, Membrane Transport, Membrane Potentials (a review). Body Control: Hypothalamic/Pituitary Axis, Mystic Rhythms

Unit II

Neurons and the Nervous system: Synapses, Sense Perception, Special Senses, CNS Design: Autonomic Nervous System, Action Potential, - Basic structures of neurons and glia, Neurotransmission:Ion channels, Membrane potentials, Resting potential – Depolarization, repolarization and hyperpolarization. Electrotonic and Action potential, Mechanism of neurotransmission. Membrane channels –voltage gated, ligand gated, mechanically gated. Basics of a synapse (electrical and chemical).

Introduction to central nervous system design: Structural and functional outline of the brain and the spinal cord, Hypothalamus: Osmoregulation, temperature control, and role in neuroendocrine system: Hypothalamo-hypophyseal portal system, Autonomic Nervous System (sympathetic and parasympathetic pathways). Reflex action.

Unit III

Muscular system: Skeletal Muscle, Muscle Characteristics, Muscle Control, Muscle Exercise, Smooth Muscle. Cardiovascular Systems: Cardiac Muscle, Heartbeat, Cardiac Control, Blood: Hemostasis, Temperature Control, Vessels, Tissue Exchange, EKGs and Blood Pressure. Digestion: Absorption

Unit IV

Respiratory Systems: Respiration, Respiratory Control. Energy Balance and Metabolism: Fuel Metabolism (both plants and Animals)

Unit V

Processes: Excretion Control Salt & Water Balance, An example of a process going wrong: Diabetes. Comparative Physiology

Books Recommended:

S.No.	Author	Book
1	Linda S. Costanzo	Physiology: Board Review Series
2	William Ganong	Review of Medical Physiology (Lange Basic Science)
3	Guyton and Hall	Physiology Review
4	Appleton and Lange	Review of Physiology
5	Linardakis	Illustrated review of Physiology
6	C Guyton	Textbook of Medical Physiology

B 603: Plant Physiology

Unit 1

Plant Cells - Model Organisms, The Plant Kingdom, Flower Structure and the Angiosperm Life Cycle, Plant Tissue Systems: Dermal, Ground, and Vascular, Structure of Chloroplast Glycosylglycerides, Specialized Vacuoles in Plant Cells

Water and Plant Cells- Water transport process, Diffusion, Osmosis, Diffusion pressure deficit, Concept of water potential, measuring of water potential, The Matric Potential, Wilting and Plasmolysis

Water Balance of Plants- Water absorption by roots, Water transport through xylem, The Cohesion-Tension theory, Water movement from leaf to the atmosphere,

Mineral nutrition: Essential nutrients, Deficiencies and Plant disorders, Soil, roots and microbes: Mycorrhizal fungi and its significance.

Solute Transport- Passive and active transport, membrane transport process, membrane transport protein, ion transport in roots, Apoplastic and symplastic movement of solutes. Goldman Equation, Patch Clamp Studies in Plant Cells

Unit 2

Photosynthesis- The Light reactions; Photosynthetic pigments, Key experiments in understanding photosynthesis, Action spectrum and absorption spectrum, Photochemical reaction centres, Red drop effect, Enhancement effect, Midpoint Potentials

Photosynthesis- The Carbon Reactions

Organization of the photosynthetic apparatus, Photosystem I and II, Oxygenic and Anoxygenic photosynthesis. Organization of light absorbing antenna systems, mechanism of electron transport, Z-scheme, proton transport and ATP synthesis in chloroplast, Repair and regulation of photosynthetic machinery, genetic, assembly and evolution of photosynthetic systems. Photosynthesis: Carbon reactions; The Calvin cycle, regulation of the Calvin cycle, The C2 oxidative photosynthetic carbon cycle, C_4 cycle, Crassulacean acid metabolism (CAM CYCLE), synthesis of starch and sucrose. Rubisco: A Model Enzyme for Studying Structure and Function

Photosynthesis- Physiological and Ecological Considerations

Working with Light, Heat Dissipation from Leaves: The Bowen Ratio

The Geographic Distributions of C3 and C4 Plants

Translocation in the Phloem

Translocation in the phloem, pathways of translocation, patterns of translocation: source to sink; Materials translocated in the phloem, rates of movement, The mechanism of translocation in the phloem: The pressure flow model, Phloem loading and unloading.

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Unit 3

Respiration and lipid metabolism- Glycolysis, citric acid cycle, electron transport Multiple Energy Conservation Bypasses in Oxidative Phosphorylation of Plant Mitochondria, and ATP synthesis.

Lipid metabolism- biosynthesis of triacylglycerols and polar glycerolipids.

Assimilation of mineral nutrients, Nitrate assimilation, Ammonium assimilation, Biological nitrogen fixation, Development of root nodule, Sulphur assimilation, Phosphate assimilation, Oxygen assimilation.

Secondary metabolites and Plant defense- Cutin, waxes and suberin, Biosynthesis of Terpenes, The Shikimic Acid Pathway, Detailed Chemical Structure of a Portion of a Lignin Molecules, Phenolic compounds, Flavonoids, Alkaloids, Cynogenic glycosides, Glucosinolates and their functions. Plant defence against pathogens, synthesis of antimicrobial compounds against pathogens, hypersensitive response by plants, Systemic acquired resistance, Phytoalexins.

Cell walls: Structure, Biogenesis, and Expansion, rate of cell elongation, wall degradation and plant defense.

Unit 4

Growth and Development- Embryogenesis, Meristems in plant development, Cell differentiation.

Phytochrome and light control of plant development-The photochemical and biochemical properties of phytochrome. Localization of phytochrome in tissues and cells. Characteristics of phytochrome induced whole plant responses. Ecological functions: Shade avoidance, circadian rhythms, phytochrome specialization.

Blue light responses- Stomatal movements and morphogenesis, blue light photoreceptors: cryptochrome, phototropins, carotenoid and zeaxanthin.

Plant hormones: Biosynthesis, metabolism, transport, physiological effects and signal transduction pathways of auxins, gibberellins, cytokinins, abscisic acid and ethylene.

Gibberellins- Regulators of Plant Height and Seed Germination,Structures of Some Important Gibberellins, Gibberellin Biosynthesis, Effects of GAs on Flowering

Cytokinins- Regulators of Cell Division, Structures of Some Naturally Occurring Cytokinins, Cytokinin Can Promote Light-Mediated Development, Cell Expansion and Greening in Cotyledons, Interact with Elements of the Circadian Clock

Ethylene- The Gaseous Hormone, Ethylene in the Environment Arises Biotically and Abiotically, ACC Synthase Gene Expression and Biotechnology, The *hookless* Mutation Alters the Pattern of Auxin Gene Expression, Ethylene Inhibits the Formation of Nitrogen-Fixing Root Nodules in Legumes, Ethylene Biosynthesis Can Be Blocked with Anti-Sense DNA, Abscission and the Dawn of Agriculture, Specific Inhibitors of Ethylene Biosynthesis Are Used Commercially to Preserve Cut Flowers

Abscisic Acid- A Seed Maturation and Stress-Response Hormone, The Structure of Lunularic Acid from Liverworts, ABA May Be an Ancient Stress Signal, Structural Requirements for Biological Activity of Abscisic Acid, Yellow Cameleon: A Noninvasive Tool for Measuring Intracellular Calcium, Phosphatidic Acid May Stimulate Sphingosine-1-Phosphate Production, The ABA Signal Transduction Pathway Includes Several Protein Kinases, The *ERA*1 and *ABH* Genes Code for Negative Regulators of ABA Response, ABA may play a Role in Plant Pathogen Responses, Proteins Required for Desiccation Tolerance, The Types of Coat-Imposed Seed Dormancy, Types of Seed Dormancy and the Roles of Environmental Factors, The Longevity of Seeds, Genetic Mapping Of Dormancy: Quantitative Trait Locus (QTL), Scoring of Vegetative

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Dormancy Combined with a Candidate Gene Approach ABA-Induced Senescence and Ethylene.

Unit 5

The control of flowering- Floral meristems and floral organ development, the characteristics of shoot meristems in Arabidopsis change with the development, The four different types of floral organs are initiated as separate whorls, Three types of gene regulate floral development, Meristem identity genes regulate meristem function, Homeotic genes control floral organ identity, The ABC model for determination of floral organ identity.

Floral evocation- Internal and external cues, the shoot apex and phase changes, Combinatorial model of shoot development in maize, Phase changes can be influenced by Nutrients, Gibberellins and other chemical signals, Competence and determination are two stages of floral evocation, Circadian rhythms: The Clock within, Phase Shifting Adjusts Circadian Rhythms to different Day-Night Cycles, Phytochrome and Crptochromes entrain clock.

Stress physiology- Response and adaptation to stress, water deficit and draught Resistance, drought stress, flood stress, salt stress, heat stress, chilling stress and freezing stress.

Books Recommended:

S.No.	Author	Book
1	Hans Mohr, Peter Schopfer	Plant Physiology; Springer, 629 pages
2	Taiz and Zeiger	Plant Physiology; 4th Edition. Sinauer
3	Hopkins WG	Introduction to Plant Physiology. 2nd or 3rd Edition
4	Stern KR	Introductory Plant Biology. 7th Ed. Wm C Brown Publishers
5	Fosket	Plant Growth and Development: A molecular approach. Acad. Press. More details on how plants grow and develop.
6	Buchanan R, Gruissem W and	Biochemistry and Molecular Biology of

B 604: Microbiology

Unit I

General Microbiology - History of Development of Microbiology, Bacterial classification, Gram Negative Bacteria, Gram Positive Bacteria, & Archaea, Prokaryotic Structure & Function, Microbial Nutrition, Microbial Growth, Control of Microbes.

Fundamentals of General Microbiology – Isolation of a broad range of non-pathogenic bacteria from natural sources, Selective and Enrichment techniques, Microscopic, biochemical, and molecular identification.

Unit II

Bacterial Genetics -description of fundamental genetic processes such as mutation, repair, genetic exchange, recombination, and gene expression. Signal transduction in bacteria (Quorum Sensing in Gram positive & Gram-Negative Bacteria), Metagenomics.

Unit-III

Prokaryotic Diversity - Structure, biochemical properties, and genetics of the major groups of prokaryotes.

Microbial Ecology - various roles of microorganisms particularly bacteria and cyanobacteria in environmental processes, Microbial interactions, Aquatic Ecology, Terrestrial Ecology; food, industrial microbiology.

Unit IV

Medical Bacteriology- Medically important bacterial pathogens in terms of the clinical, therapeutic, and epidemiological aspects of diseases caused by them, molecular mechanisms of pathogenesis, procedures for isolation and identification of pathogenic bacteria, testing their susceptibility to antibiotics. Bacterial cell-cell communications and biofilm formation, Strategies for bacterial adhesion and invasion, bioterrorism.

Unit V

Medical Mycology and Parasitology- Consideration of medically important fungi and parasites,with emphasis on their biology in relation to disease and its laboratory diagnosis.

Protozoan infections: Introduction to protozoa, major protozoan infections of humans, Biology and pathogenesis of Plasmodium, pathology of human malaria, biochemical and cell biological similarities and differences with other apicomplexa (Babesia,Cryptosporidium, Toxoplasma, etc.), Biology and pathogenesis of Toxoplasma, Leishmania, Trypanosoma

Books Recommended:

S.No.	Author	Book
1	Thomas D Brock	Brock's Biology of Microorganisms
2	Patrick R Murray	Medical Microbiology: with STUDENT CONSULT Access
3	Willey, Joanne, Sherwood, Linda, Woolverton, Christopher J.	Presscotts Microbiology
4	Alfred E Brown	Benson's Microbiological Applications: Laboratory Manual in General Microbiology (Spiral-bound)
5	Ananthanarayan and Paniker Orient Blackswan	Textbook of Microbiology: Medical microbiology

H 601: Ethics of Science and IPR

Unit I

Introduction to Ethics– causes of unethical acts, Definition – moral, values, ethics; Role and importance of ethics in science; Professional ethics – professional conduct, Teaching ethical values to scientists, good laboratory practices, good manufacturing practices, Basic Approaches to Ethics; Posthumanism and Anti-Posthumanism.

Unit II

Medical Ethics: Different themes pertaining to medical ethics including ethical issues in public health. Environmental Ethics, Bioethics, Journals and Publishers: Monopolistic practices by Academic Publishers. Plagiarism, softwares for plagiarism detection.

Unit III

Introduction to IPR; Types of Intellectual property – Patents, Trademarks, Copyrights and related rights; Traditional vs. Novelty; Importance of intellectual property rights in the modern global economic environment, Importance of intellectual property rights in India.

Unit IV

Patents: Definition, patentable and non patentable inventions; types of patent application – Ordinary, Conventional, PCT, Divisional, and Patent of addition; Concept of Prior Art; Precautions while patenting disclosure / nondisclosure;

Unit V

Case studies and agreements - Evolution of GATT and WTO and IPR provisions under TRIPS; Madrid agreement; Hague agreement; WIPO treaties; Budapest treaty; Indian Patent Act (1970)

Books Recommended:

S.No.	Author	Book
1	David B. Resnik	The Ethics of Science: An Introduction', Routledge, New York, 1998
2	V. K. Ahuja	Intellectual Property Rights in India', 2015
3	V. K. Ahuja	Law Relating to Intellectual Property Rights', 2017.

BL 601: Biology Laboratory

1. Animal Physiology

a) Animal cell culture and microscopy
b) Gross anatomy of the animal brain & Staining of mouse brain sections
c) Wound Healing Assay

2. Immunology

d) Differential Leucocyte count
a) Ag detection & Ab detection
b) Double diffusion
c) Radial Immunodiffusion
d) Total serum protein estimation
e) Estimation of glammaglobulins in serum
f) Determination of A:G ratio in serum sample

3. Plant Physiology

a) *Arabidopsis thaliana* - model organism and its development

b) Estimation of catalase activity in plant sample
c) Estimation of peroxidase activity in plant sample
d) Estimation of Indole Acetic Acid oxidase activity in plants
e) Photosynthesis - floating leaf disc experiment under various conditions (light, dark & light - dark)
f) Isolation and spectrophotometric characterization of photosynthetic pigments, R. Boyer, *Biochem. Educ.* **18**, 203-206 (1990), and *Modern Experimental Biochemistry*, 3rd ed., p. 333-344, (2000) Benjamin Cummings.
g) An improved method for the extraction and thin-layer chromatography of chlorophyll a and b from spinach. H. Quach, R. Steeper, and G. Griffin, *J. Chem. Educ.* **81**, 385-387 (2004).

4. Microbiology

a) Media Preparation: Preparing and inoculating solid and liquid nutrient media for culturing microorganisms: Preparing nutrient media, Pouring nutrient agar plates and streaking bacterial culture on solid media, Inoculating nutrient broth with bacterial culture
b) Growth Curve:Generating a bacterial growth curve under various pH and environmental conditions (steady and shaking); Calculations of Growth rate constant (μ); Calculation of generation time
c) Antibacterial activity testing
d) Bacterial Fermentation test
e) Isolation & Detection of coliform bacteria
f) Catalase activity
g) Amylase activity

FOURTH YEAR
Semester-VII

B 701: Evolutionary Biology

Unit- I

Origin of life: Historical theories and background information, Experimental approaches, Chemogeny, Biogeny, RNA and DNA world, evolution of proteins, origin of photosynthesis, evolution of eukaryotes. Lamarckism, Darwinism, pre-Darwinian and post-Darwinian period, Neo-Darwinism. Theories of organic evolution. Evidences of evolution.

Unit- II

Sources of variations: Heritable variations and their role in evolution. Natural selection: types of natural selection (Directional, stabilizing and disruptive) and examples (Industrial melanism, Australian rabbits, resistant to pesticides, heavy metal resistance in plants), Sexual selection, group and kin selection.

Unit- III

Polpulation genetics and evolution: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium. Genetic Drift (mechanism, founder's effect, bottleneck phenomenon); Role of Migration and Mutation in changing allele frequencies

Unit-IV

Evolution above species level: Adaptation, adaptive radiation, microevolution, macroevolution, megaevolution, punctuated equilibria and related phenomenon. Isolation: Introduction and types of isolation. Speciation: species concept, modes of speciation: allopatric, sympatric

Unit-V

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees.

Suggested readings:

1. S. Freeman and J. C. Herron, Evolutionary Analysis, 4th Edn., Benjamin-Cummings (2007).
2. D. J. Futuyma, Evolution, 2nd Edn., Sinauer Associates Inc. (2009)

B 702: Immunology-II (Immunity and Disease)

Unit I

Host-Pathogen relationship Diseases caused by Viruses and the immune response to them- HIV and AIDS-immune responses

Unit II

Bacterial diseases – and the immune response to bacteria Vaccines- mechanisms, types of vaccines

Unit III

Parasites – protozoan parasites, parasitic worms and the immune response to them- eg malaria, leishmaniasis, worm infestations

Unit IV

Immediate Hypersensitivity and allergy, anaphylaxis Hypersensitivity and chronic inflammatory diseases- tuberculosis and leprosy Cancer immunology

Unit V

Autoimmune diseases- generalized- SLE, Rheumatoid arthritis; localized- multiple sclerosis, Diseases due to immune cross reactivity- Rh incompatibility, transfusion, transplantation, Inherited immune diseases

Books Recommended:

S.No.	Author	Book
1.	Charles A Janeway, JP Travers, Mark Walport and Mark J Shlomchik	Immunobiology, 5th edition; The Immune System in Health and Disease
2.	Baron S, Galveston	Medical Microbiology; 4th Edition; University of Texas Medical Branch at Galveston
3.	RA Goldsby *et al.*	Kuby's Immunology
4.	E Benjamini, R Coico and G Sunshine	Immunology- A short Course
5.	Roitt, Brostoff and Male	Immunology

B 703: Developmental Biology

Unit I

Basic concepts of molecular regulation of development: Transcription factors in differential gene expression; morphogens and axis formation; autocrine and paracrine regulation. How cell proliferation, apoptosis, and fate specification determine developmental processes.
Fertilization: Structure of oocytes and spermatocytes. The process of fertilization.

Unit II

Comparative study of early embryonic development: (*Caenorhabditis elegans*, amphibians, birds, and mammals), Cleavage formation, Gastrulation, Axis formation: Signaling cascades and

molecular understanding of anteroposterior, mediolateral, and dorsoventral axes development.

Unit III

Organogenesis in vertebrates: Germ layer formation. Regulation of formation of the somites, heart, kidney, blood vessels, and limb. Changes in circulation pattern between fetus and newborn.Metamorphosis and regeneration process: Hormonal control of metamorphosis in amphibians and insects; wing imaginal disc formation in *drosophila*. Regeneration in planeria and that of vertebrate limb.

Unit IV

Stem cells: Concepts of totipotent, pluripotent, and multipotent cells. Factors regulating "stemness" of a cell. Embryonic vs. adult stem cells. Sources of stem cells in vertebrates and their applications. Developmental disorders and aging: Regulatory role of genetic and environmental factors. Role of carcinogens and teratogens.

Unit V

Development processes in plants: How are the mechanisms different from that of animal development? Gametogenesis, pollination, and fertilization processes in angiosperms. Plant embryogenesis, tissue differentiation, Hormonal regulation of seed dormancy and the process of germination. Meristems in plant development, Root and shoot development mechanisms. Reproductive phase: photoperiod sensitivity and molecular regulation of flowering process.

Books Recommended:

S.No.	Author	Book
1.	Alberts *et al.*	Molecular Biology of the Cell
2.	SF Gilbert	Developmental Biology
3.	Lewin Benjamin	Gene VIII
4.	PO Moody	Introduction to Evolution, 1970
5.	Dobzhansky et al.	Evolution, W. H. Freeman. New York

B 704: Imaging Technology in Biological Research

Unit I

The power of ten (understanding how small cells and the sub-cellular contents are)

An introduction to light and optics, exploring with lenses (what are lenses, looking through them, understanding the concept of magnification, mirrors, angles of reflection, refraction, prisms and colors)

Unit II

Fundamentals of illumination (ray diagrams, types of light sources, LEDs, power levels, coherence of light, elliptical reflectors)

Exploring microscopes (short history, magnifying glass, simple and compound microscopes, electron Microscopes, stereomicroscope)

Unit III

Fluorescence microscopy (Understanding fluorescence, Fluorescence protein technology, GFP, YFP), two-photon fluorescence microscopy, matrix-assisted laser desorption/ionization mass spectrometry (MALDIMS) imaging

Unit IV

Live cell imaging (confocal microscopes), Differential interference contrast (DIC) images

Comparing Confocal and Widefield Fluorescence Micro scopy, Atomic force microscopy and

optical tweezers force spectroscopy

Unit V

NMR Imaging Spatially nonresolved NMR spectroscopy; low-field NMR instruments; 1H-nuclear magnetic resonance (NMR) microimaging ; 1H-magic angle spinning NMR spectroscopy; MAS-13C NMR spectroscopy, Spectral-resolution enhancement using magic angle spinning.

Books Recommended:

S.No.	Author	Book
1.	Ulf Grenander, Y Chow and Daniel M Keenan	Hands: A Pattern Theoretic Study of Biological Shapes (Research Notes in Neural Computing) (Volume-2) Alberts *et al.*
2.	Valery V Tuchin, Lihong Wang and Dmitry A Zimnyakov	Optical Polarization in Biomedical Applications (Biological and Medical Physics, Biomedical Engineering)
3.	RM Lambrecht	Biological Models in Radiopharmaceutical Development (Developments in Nuclear Medicine)
4.	Philippe Sansonetti	Bacterial Virulence: Basic Principles, Models and Global Approaches (Infection Biology (VCH)
5.	Richard Nuccitelli, Leslie Wilson and Paul T Matsudaira	A Practical Guide to the Study of Calcium in Living Cells, Volume 40 (Methods in Cell Biology)

BL 701: Advanced Biology Laboratory-I

1. Immunology
a) Serum Electrophoresis
b) ELISA - direct & indirect
c) Widal – Tube & Slide
d) Immunoelectrophoresis
e) Rocket immunoelectrophoresis
f) VDRL

2. Developmental Biology

a) Preparation of MS media
b) Callus formation from carrot cells
c) Study of effects of phytohormones on plant growth development
d) Study of germination patterns under stress and normal conditions
3. Synthetic seed preparation
4. Silver Nanoparticle synthesis from plant extract
5. Silver Nanoparticle synthesis from tea extract
6. Preparation of plant extracts using soxhlet method
7. Phytochemical tests

8. Bioinformatics:

DNA sequence analysis using BLAST; sequence pattern, motifs and profiles.
Prediction of secondary structure of proteins
Prediction of tertiary structure of (fold recognition, homology search)
Molecular modeling and dynamics: using small oligonucleotides and small protein with known crystal

structure (available from data bank), Drug designing – using available data Applications of bio informatics, Primer designing.

FOURTH YEAR
Semester-VIII

B 801: Virology

Unit I

Introduction to Virology: definition, properties and origin of viruses
Virus architecture and nomenclature
Virus replication cycle
Basic virological methods
Basics of virus entry, spread and transmission

Unit II

Host resistance to viral infection: immune responses
Vaccines and antiviral chemotherapy: the prevention and treatment of viral diseases
Epidemiology
Exploiting viruses as gene therapy and vaccine vectors

Unit III

Viruses and cancer: oncoviruses and oncolytic viruses
Polioviruses and other single-stranded positive-strand RNA viruses
Rabies and other single-stranded nonsegmented negative-strand
Influenza viruse and ther single-stranded segmented negative-strand RNA viruses.

Unit IV

Evolution of viruses: new and reemerging viruses
Herpesviruses (nuclear large double-stranded DNA viruses)
Poxviruses (cytoplasmic large double-stranded DNA viruses)
HIV and other retroviruses

Unit V

Hepatitis B virus (reverse-transcribing DNA virus) and other viruses causing hepatitis
Prion diseases
Plant viruses
Bacteriophages

Books Recommended:

S.No.	Author	Book
1	L Collier, J Oxford and Paul Kellam	Human Virology (4th edition),
2	SJ Flint, LW Enquist, VR Racaniello and AM Skalka	Principles of Virology (3rd edition) · 2009
3	AJ Cann	Principles of Molecular Virology,
4	Teri Shors. Jones and Bartlett	Understanding Viruses
5	NJ Dimmock, A Easton, K Leppard	Introduction to Modern Virology 6th edition,

6	David M Knipe, Peter M Howley, MD Diane E Griffin, Robert A Lamb, Malcolm A Martin, Bernard Roizman, Stephen E Straus	Field's Virology. 6th edition

B 802: Biotechnology-I

Unit I

Basic concept of genetic engineering, Methods for creating recombinant DNA molecule, properties of restriction endonucleases and their mode of action, Cloning **Vectors**-Lambda phage, Plasmid, M13 phage, cosmid, yeast, viral and Expression vectors, YACs, BACs, PACs. Introduction of DNA into living cells and selection of recombinants.

Unit II Construction of DNA library:Genomic libraries: Partial digest, choice of vectors, construction and evaluation of a genomic library, growing and storing libraries, cDNA Library: methods of generating cDNA library, Genomic vs cDNA library, Expression libraries

Unit III

Selection/screening: Analysis of genomic DNA by Southern hybridization, Northern and Western blotting techniques, Restriction mapping, DNA sequencing and analyses techniques, next gen sequencing, microarray technology.

DNA manipulation techniques:

Preparation of radiolabelled and synthetic probes, Amplification of DNA by polymerase chain reaction, Site directed mutagenesis, Gene transfer methods for animals and plants

Unit IV

Transgenic animals/plants- Selectable markers, Reporter genes for promoter analysis, Embryonic stem cells, Super mouse,Pronuclear Transgenic Goats, Whole animal cloning e.g. Do lly, gene Knock-out, knock-down, knock-in technology, Gene therapy e.g. SCID] Agrobacterium mediated transformation in plants, Ti plasmid.

Unit V

Cell and tissue culture in plants and animals: Primary culture; Cell line; Cell clones; Callus cultures; Somaclonal variation; Micropropagation; Somatic embryogenesis; Haploidy; Protoplast fusion and somatic hydridization; Cybrides; Artificial seeds; Hybridoma technology.

Books Recommended:

S.No.	Author	Book
1	Benjamin Lewin	Gene VII, Oxford Publishers
2	T A Brown	Genome, Second edition,
3	Old and Primrose	Principles of Gene Manipulation;
4	Simmons and Gardner	Principles of genetics;
5	Donald Voet and Judith Voet	Biochemistry 3rd Edition,
6	T D.Watson and others	Molecular Biology of the Gene , 6th Edition
7	GM Cooper	The Cell: A molecular approach: Library of Congress cataloging in publication data.
8	Griffiths A and Miller J	An introduction to genetic analysis; Freeman
9	Lodish H and Berk	A Molecular cell biology;
10	Sambrook J, Russell	Molecular cloning:- Vol I, II , III; CSHL Press

11	TA Brown	Gene cloning and DNA analysis;
12	B Glick, J Pasternak & C Patten	Molecular Biotechnology- principles and applications of Recombinant DNA, 4th
13	K. Deb and Satish Totey	Stem Cells Basics and Applications;
14	Gary Stein and Maria B et al.	Human Stem Cell Technology and Biology;

B 804: Biotechnology-II

Unit I

Principles of plant breeding: Important conventional methods of breeding self and cross pollinated and vegetatively propagated crops; Non-conventional methods; Polyploidy: Genetic variability; Plant diseases and defensive mechanisms. Ethics of GM crops and animal cloning. Model organisms - S. cereviceae, Dictostylium, Caenorhabditis elegans, Arabidopsis, Zebra Fish, Mouse, Drosophila

Unit II

Industrial Biotechnology-I

Bioprocess Technology [basics of bioreactor kinetics and mathematical equations regarding bioreactors, scale-up and aeration of bioreactors in detail, Kinetics of microbial growth, substrate utilization and product formation: Batch, Fed- Batch and continuous processes, Scale up concepts with respect to fermenter design and product formation, Gas exchange and mass transfer: O2 transfer, critical oxygen concentration, determining the oxygen uptake rate, Solid state fermentation.

Unit III

Industrial Biotechnology-II

Downstream Processing - Flocculation and floatation, Filtration, Centrifugation, Cell disruption, Liquid extraction, Precipitation, Adsorption, Dialysis, Reverse osmosis, Chromatography, Crystallization and drying, Common examples: Biopolymers

Unit IV

Remediation and Biotechnology- Biodegradation of xenobiotic compound. Priority pollutants and their health effects, Microbial basis of biodegradation, Bioremediation (phyto and metal), Environmental and industrial pollution control, Biopesticides, Microbial plastics, Solid waste management

Unit V

Medical Biotechnology- a.Production of small biological molecules, Tissue Engineering - Growth Factors and morphogens: signals for tissue engineering and whole organ development, extracellular Matrix: structure, function and applications to tissue engineering, Cell adhesion and migration, Inflammatory and Immune responses to tissue engineered devices b. Biomaterials - Polymeric scaffolds, Bio mimetic materials, Nanocomposite scaffolds

Introduction to nanotechnology and nano-biotechnology, Nanomaterials and their uses.

Books Recommended:

1	R. Ian Freshney, Glyn N. Stacey, Jonathan M. Auerbach	Culture of Human Stem Cells. John Wiley & Sons
2	Bernard R Glick, Jack J Pasternak, Cheryl L Patten	Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press

3	Robert Lanza, Robert Langer, Joseph P Vacanti	Principles of Tissue Engineering
4	F Gilbert	Developmental Biology; 6th Edition;
5	Gordana Vunjak-Novakovic, R Ian Freshney	Culture of Cells for Tissue Engineering;
6	SB Primrose and Twyman	Principles of gene manipulation
7	RW Old and SB Primrose	Principles of gene manipulation
8	Watson	Recombinant DNA
9	TA Brown	Gene cloning and DNA analysis
10	D Clark, N Pazdernik	Bioprocess Technology- Biotechnology- Applying the genetics to revolution
11	Wulf Crueger and Anneliese Crueger	Biotechnology: A Textbook of Industrial Microbiology; Panima Publishers, New Delhi
12	Michael L Shuler, Fikret Kargi	Bioprocess Engineering: Basic concepts
13	StanburyPF,WhitakerA,HallSJ	Principles of Fermentation Technology; Butterworth-Heinemann
	Glazer AN and Nikaido H	Microbial Biotechnology: Fundamentals of Applied Microbiology
14	Sulabha Kulkarni	Nanotechnology principles and practices;
15	David S Goodsell	Bionanotechnology: Lessons from Nature;
16	James A Schwarz, Cristian I Contescu and Karol Putyera	Dekker Encyclopaedia of Nanoscience and nanotechnology;

B 803: Bioinformatics

Unit I

Introduction to Bioinformatics: Bioinformatics - History, definition, importance and applications of Bioinformatics, Bioinformatics and computational Biology opportunities in India. Major Bioinformatics Resources: NCBI, EBI, ExPaSy

Unit II

Biological databases- Introduction of Biological Databases; (a) Nucleic acid databases (NCBI, DDBJ, and EMBL). (b) Protein databases (Primary, Composite, and Secondary)(c) Specialized Genome databases: (SGD, TIGR, and ACeDB) (d) Structure databases (CATH, SCOP, & PDBsum)

Unit III

Alignment: Basics and techniques, Local alignment and Global alignment, Pairwise sequence alignment:NEEDLEMAN and Wunsch algorithm, Smith and Waterman algorithm, The Dot Plot.Multiple Sequence Alignment (MSA): Definition, Objective, Methods for MSA: Heuristic approach, Dynamic programming approach and their combinations. database similarity searches-BLAST/FASTA algorithms,

Phylogenetic Analysis: Phylogenetic-trees, Terminology of tree-reconstruction, rooted and un-rooted trees, gene vs species trees and their properties. Algorithms /methods of phylogenetic analysis: UPGMA, Neighbor-Joining Method.

Unit IV

Protein structure analysis and prediction: Identification/assignment of secondary structural elements from the knowledge of 3-D structure of macromolecule using DSSP and STRIDE

methods , Prediction of secondary structure: PHD and PSI-PRED method Tertiary (3-D) 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.)

Unit-V

Genomics and Functional Analysis Methodologies for high throughput analysis including NGS, application of bioinformatics in genomics. Comparative genomics.

Drug discovery and Development : Introduction to Drug Design and Development, Drug targets, Lead Identification and Modification, Computer-Aided Drug Design, Drug Delivery, Applications of Bioinformatics: Pharmaceutical industries, immunology, agriculture, forestry; Legal, ethical and commercial ramifications of bioinformatics.

Books Recommended:

S.No.	Author	Book
1	E Wayne W Daniel	Biostatistics: A foundation for Analysis in the Health Sciences
2	Prem S Mann	Introductory Statistics. 5th Edition;
3	Olive Jean Dunn	Basic Statistics: A primer for Biomedical Sciences
4	C Stan Tsai	Computational Biochemistry;
5	SC Rastogi *et al.,*	Bioinformatics-Methods and Applications
6	A Caldwell et al.,	Integrated Genomics; Wiley Publishers

BL 801: Advanced Biology Laboratory-II

Electives for X Semester-Biology Stream

BE-1: Proteomics and Genomics

Unit-I

Introduction and scope of proteomics; Protein separation techniques: ion exchange, size-exclusion and affinity chromatography techniques; Polyacrylamide gel electrophoresis; Isoelectric focusing (IEF); Two dimensional PAGE for proteome analysis; Image analysis of 2D gels.

Unit-II

Introduction to mass spectrometry; Strategies for protein identification; Protein sequencing; Protein modifications and proteomics; Applications of proteome analysis to drug.

Unit-III

Protein-protein interaction (Two hybrid interaction screening); Protein engineering; Protein chips and functional proteomics; Clinical and biomedical application of proteomics; Proteome database; Proteomics industry.

Unit-IV

Introduction and Classification of genomics; Methods of preparing genomic DNA; Genome sequencing methods (next-generation sequencing); Databases of genomes; Genetic mapping; Mapping of human genome; Human genome project; Hap Map Project, The 1000 genome project, and The ENCODE Project.

Unit-V

Gene variation and Single Nucleotide Polymorphisms (SNPs); Expressed sequenced tags (ESTs); Gene disease association; DNA fingerprinting; Microarray based techniques for RNA analysis; metagenomics.

Suggested readings:

1. Cantor and Smith, Genomics. John Wiley & Sons, 1999.
2. Introduction to Genomics - Arthur M Lesk, Oxford University Press, 2007.
3. R.M.Twyman, Principles of Proteomics, BIOS Scientific Publishers, 2004.
4. P.Michael Conn, Handbook of Proteomic Method. Humana Press, Totowa, New Jersay, USA, 2003.
5. L.Stryer, Biochemistry, W. H. Freeman and Co., New York, 2007

BE-2: Nanobiotechnology

Unit-I

The nanoscale dimension and paradigm, various definitions and Concept of Nano-biotechnology, Historical background, Development. Fundamental sciences and broad areas of Nanobiotechnology.

Unit-II

Nanomaterial in biotechnology - nanoparticles, quantum dots, nanotubes and nanowires etc. Cell – Nanostructure interactions. Protein-based Nanostructures, Cell as Nanobio-machine, DNA-Protein Nanostructures-Overview and introduction, DNA- Protein conjugates in microarray technology.

Unit-III

Biosensors; molecular recognition elements, transducing elements. Applications of molecular recognition elements in nanosensing of different analytes, Application of various transducing elements as part of nanobiosensors.

Unit-IV

Miniaturized devices in nanobiotechnology - types and applications, lab on a chip concept. Biological nanoparticles production - plants and microbial, methods, Properties, Characterization and applications.

Unit-V

Nanobiotechnological applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.

Suggested readings:

1. Nanobiotechnology: Concepts,Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
2. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
3. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications

BE-3: Plant Genetic Engineering

Unit-I

Plant transformation vectors and methods: T-DNA and viral vectors; Selectable marker and reporter genes, Plant transformation by Agrobacterium sp., Molecular mechanism of T-DNA transfer; in planta transformation; Direct gene transfer methods in plants.

Unit-II

Genetic engineering for increasing crop productivity by manipulation of Photosynthesis, Nitrogen fixation, Nutrient uptake efficiency. Genetic engineering for biotic stress tolerance (Insects, fungi, bacteria, viruses, weeds). Genetic engineering for abiotic stress (drought, flooding, salt, metal and temperature)

Unit-III

Genetic engineering for quality improvement of Protein, lipids, carbohydrates, vitamins & mineral nutrients, Plants as bioreactor, Marker-assisted selection of qualitative and quantitative traits. Concept of gene synteny, Concept of map-based cloning and their use in transgenics.

Unit-IV

Chloroplast transformation; Transgene analysis, silencing and targeting; Marker-free and novel selection strategies; Multigene engineering; Gene knock-down by ribozymes, antisense RNA and RNA interference.

Unit-V

Plant Metabolic Engineering. The concept of secondary metabolites, Historical and current views, Importance of secondary metabolites in medicine and agriculture, Introduction to various pathways, Flavanoid pathway, Terpenoid pathway, Polyketoid pathway, Plant vaccine.

Suggested readings:

1. Plant Tissue Culture: Theory and Practice Bhojwani S. S. & Razdan M. K. Elsevier
2. Plant Biotechnology: The Genetic Manipulation of Plants Slater A. Scott N. & Fowler M. Oxford University Press Inc.
3. Plants, Genes and Crop Biotechnology Chrispeels M. J. & Sadava D. E. Jones and Barlett Publishers
4. Principles of Gene Manipulation and Genomics Primrose S. B. & Twyman R. M. Blackwell Publishing.
5. Plant Cell, Tissue and Organ Culture: Fundamental Methods. (Eds). Gamborg O. L & Phillips G. C. Springer-Verlag.

BE-4: Plant-Microbe Interaction

Unit-I

History of Plant pathology and recent developments: Significance of plant diseases, and pathology, types of plant-microbe associations (pathogenic– bacteria, virus, fungi, and symbiotic).

Unit-II

Beneficial Plant - Microbe interactions (molecular aspects): a. Nitrogen fixing bacteria and blue green algae b. Mycorrhizal association c. Phytohormones and Biocontrol antibiotics

Unit-III

Parasitism and disease development: Pathogenecity, host range of pathogens, disease cycle and epidemics.

Unit-IV

Molecular biology of pathogenicity: Mechanisms of variability in pathogens, pathogenicity genes and mechanisms in pathogenic bacteria, biotrophic and necrotrophic fungi, Virus and Viroid genes involved in pathogenicity, Agrobacterium and plant interaction-a model system.

Unit-V

Molecular genetics of plant disease susceptibility and resistance: Types of plant resistance to pathogens (R gene resistance, quantitative and monogenic), basal and induced defense mechanisms, pre-formed inhibitors of pathogens, gene for gene interaction in plant defense, Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR), Recognition mechanism and signal transduction during plant - pathogen interaction.

Suggested readings:

1. Plant Pathology Agrios G. N. Academic Press
2. Molecular Plant pathology Dickinson M. BIOS Scientific Press
3. Plant Pathogenesis and Resistance: Biochemistry and Physiology of Plant- Microbe Interactions Jeng-Sheng H. T Kluwer Academic Pubs.T Gen 904(ii)- MEDICA

BE-5: Neurobiology

Unit-I

The glial system: Generation of Astrocytes, Oligodendrocytes, and Schwan cells. Function of glia in normal brain and in neuroprotection.

Chemical composition of the brain: metabolism (utilization and uptake of glucose and amino acids). Blood-Brain barrier.

Unit-II

Neurotransmitters: Synthesis, storage, release, uptake, degradation and action of neurotransmitters, Acetyl choline, GABA, Serotonin, Dopamine, Glutamate, Nitrous oxide, etc. Receptors: different subtypes (cholinergic, dopaminergic, adrenergic, and glutamatergic), mechanism of action, Agonists and Antagonists – their mode of action and effects. Exocytosis of neurotransmitter – Role of synapsins, synaptogamins, SNAP, SNARE and other proteins in docking, exocyotosis and recycling of vesicles.

Unit-III

Sleep and Learning and memory: Mechanism of short-term memory and Long-term memory (longterm potentiation). Role of sleep in memory consolidation. Electroencephalogram. Role of second messenger pathways in learning and memory process. Role of synaptic plasticity.

Unit-IV

Sensory organs:Vision: Biochemistry of vision: Rod and cone cells, mechanism and regulation of vision, color vision, visual field, visual acuity. Visual pathway and topographic mapping. Audition: functional anatomy of the middle and inner ear. Amplification of sound. Functional anatomy and mechanism of detection of specific sound frequency in the inner ear. Mechanism of action of the mechanosensory receptors in the inner ear.

Unit-V

Chemical senses: Olfaction: The olfactory pathway, mechanism and the combinatorial code of

detecting a smell. Taste: Mechanism of taste perception.
Touch/pain: The touch/pain/temperature pathway (ascending and descending). Higher order integration in the brain.
Pathologies of the nervous system: Molecular basis of Parkinson's disease, Alzheimer's disease, Schizophrenia. Myasthenia gravis and Multiple sclerosis, stress and antidepressants.

Suggested Reading:

S.No.	Author	Book
1.	Ferdinand Hucho	Neurochemistry
2.	MP Spiegel	Basic Neurochemistry
3.	Koenig and Edward	Cell Biology of the Axon, Series: Results & Problems in Cell Differentiation, Vol. 48
4.	Eric Kendel, JH Schwartz, T Jessel	Principles of neural Sciences
5.	A Guyton and J Hall	Textbook of medical Medical physiolog

BE-6: Plants for Human Welfare

Unit-I

A general overview of economically important plants and their role in human welfare as food, oil, drugs, nutraceuticals, fuel. Food crops: Cereals; Spices and condiments; Alcoholic and non-alcoholic beverages.

Unit-II

Medicinal: Traditional plants as source of drugs against several diseases such as cancer, diabetes, malaria, dengue, psoriasis, etc. Plant secondary metabolites; classification, knowledge of extraction, isolation, characterization and elicitation of bioactive metabolites.

Unit-III

Nutraceuticals and functional foods; Important plants such as Aloe vera, Piper, Withania, Ginseng. Amaranthus etc. yielding antioxidants and nutraceutical compounds. Edible and non-edible oils: Oil yielding plants, transgenic approaches and constraints for improvement in different oils. Essential oils.

Unit-IV

Plant-based biofuels e.g., Difference between first and 2nd generation biofuels, Jatropha, Pongamia. Zea mays, Madhuca, etc. Extraction and economic viability; application as alternate source of diesels, Bioelectricity.

Unit-V

Plants as a source of timber: e.g., Tectona grandis, Salix sp., Dalbergia sisso, Fibre yielding plants: Cotton (Gossypium sp.), Jute (Corchorus sp.) with special reference to their improvement through breeding and genetic transformation e.g., Bt cotton.

Suggested readings:

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.

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3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Acharya, Deepak; Anshu, Shrivastava (2008). Indigenous Herbal Medicines: Tribal Formulations and Traditional Herbal Practices. Jaipur, India: Aavishkar Publishers
5. Raven, Peter H.; Evert, Ray F.; Eichhorn, Susan E. (2005). Biology of Plants (7th ed.). New York: W. H. Freeman and Company

BE-7: Animal Tissue Culture

Unit-I

Introduction and significance of Animal cell culture, historical background of cell culture. Types of cell culture: Primary and secondary cell culture.

Laboratory requirements for animal cell culture: Sterile handling area. Sterilization of different materials used in animal cell culture, Aseptic concepts. Instrumentation and equipments for animal cell culture.

Unit-II

Culture requirements and reagents: Culture media, properties of media, Types of cell culture media, Ingredients of media, Physiochemical properties, Antibiotics, growth supplements, Foetal bovine serum; Serum free media, Trypsin solution, Selection of medium and serum, Conditioned media, Other cell culture reagents, Preparation and sterilization of cell culture media, different types of serum and other reagents.

Unit-III

Types of cell culture: Different types of cell cultures, Trypsinization, Cell separation, Continuous cell lines, Suspension culture, Organ culture.

Cell lines: Introduction, development of cell lines, Characterization and maintenance of cell lines, stem cells, Cryopreservation, Common cell culture contaminants.

Unit-IV

Stem cell research: Stem cell types, properties and biological significance, Current status and application in medicine. Application of animal cell culture for in vitro testing of drugs; Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins. Production of different recombinant proteins. General account of in vitro regulation of blood cells production.

Unit-V

Gene transfer technology in animals: Different method in gene transfer technology in animals, viral and non-viral methods, Production of transgenic animals, current status in the field of transgenic animals. Animal cloning: Techniques, relevance and ethical issues.

Suggested readings:

1. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005
2. Ed. John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.
3. Ed. Martin Clynes, Animal Cell Culture Techniques, Springer, 1998.
4. B.Hafez, E.S.E Hafez, Reproduction in Farm Animals, 7th Edition, Wiley- Blackwell, 2000.
5. Louis-Marie Houdebine, Transgenic Animals: Generation and Use, 1st Edition, CRC Press, 19.

BE9- Glimpses of Contemporary Science

Unit-I

Physics in life systems: size and scale, diffusion, cell locomotion, force generated by actin growth and flagellum rotatory motion, ion channels, resting potential across the membrane, nerve conduction velocity, action potential, macromoleculaes of life, random walk model of polymer, single molecular experiments, optical tweezers, magnetic tweezers.

Unit-II

Complex systems: dynamical chaos, logistic map, bifurcation, Universality, Feigenbaum constants, Mechanical demonstrations of chaos, Nanomechanical oscillators, Patterns, Reaction-diffusion systems, Nodal patterns, thermodynamics and human population, Falling leaves, Smoke ring physics.

Unit-III

At the turn of 1900: Silver threads, Discovery of the electron, Rutherford's nuclear atom Wien's law, Blackbody radiation and Max Planck's action.

Unit-IV

Astrophysics, Astrochemistry and Astrobiology

Unit-V

Quantum mechanics, atoms : Entanglement Light-atom interaction, Bringing atoms to rest, Laser tweezers, How bright is laser, Quantum computing.

Books Recommended:

S.No.	Author	Book
1	Darcy Wentworth Thompson	Growth and Forms
2	Rob Phillips	Physical biology of the cell
3	Harward Berg	Random walks in biology
4	L. Cooper	Physics: Structure and Meaning
5	R. P. Feynman, R. B. Leighton, and M. Sands	The Feynman Lectures on Physics vol. 3

BE8: Earth Science and Energy & Environmental Sciences

Unit –I

Origin of the earth, type of rocks in different layers, their physical and chemical properties. Mechanism of their formation and destruction. Radioactivity and its role in geochronology, Plate tectonics and geodynamics and the role of mantle plumes in sustaining these processes.

Gravity, electrical, seismic and magnetic properties of the different layers in the earth. Their variations in different geological terrains. Instrumentation, field procedures used in these studies. Response of the earth to the elastic (Seismic) and electromagnetic waves, use of this phenomena to study the earth's interior.

Unit-II

Geodynamo and the internal magnetic field of the earth.
Paleomagnetic studies, Polar wandering and reversal, possible theoretical arguments for understanding the phenomena.
Seismology and its use in understanding of the different layers in the earth's interior.
Utility of the different geophysical techniques (discussed above) in exploration for academic as well as for harnessing resources.

Unit-III

Introduction to Environmental Science. Natural Environments: Ecosystems and ecology, biodiversity. Socio-cultural environments: demography, population density, human organizations.
Land use and its planning.
Global climate change and effects on environment.
Carbon cycle from human activity, calculation of carbon budgets.

Unit-IV

Water harvesting, storage and treatment.
Natural calamities, hazards, and effects of human activity: Chemical and other technological hazards. Introduction to energy Sources - evolution of energy sources with time. Power production, per capita consumption in the world, and relation to development index.
Energy scenario in India:
Various issues related to consumption and demands -energy crisis issues in India.
Renewable and non-renewable energy sources - technology and commercialization of energy sources, local (decentralized) versus centralized energy production, constraints and opportunities of renewable energy (hydrocarbon and coal based energy sources).

Unit-V

Energy conservation – calculation of energy requirements for typical and home and industrial applications. Alternative to fossil fuels - solar, wind, tidal, geothermal.
Bio-based fuels. Hydrogen as a fuel.
Energy transport and storages, comparison of energy sources - passage from source to delivery (source, production, transport, delivery) - efficiencies, losses and wastes.
Nuclear energy: Power production: Components of a reactor and its working, types of reactors and comparison. India's three stage nuclear program. Nuclear fuel cycle. Thorium based reactors. Regulations on nuclear energy.

Books Recommended:

S.No.	Author	Book
1	Merill RT, McElhinny MW and McFadden PL	The magnetic field of the Earth: International Geophysical Series
2	Edward J, Tarbuck EJ and Lutgens FK	Earth Science
3	HR Sheehan *et al.*,	Introduction to Applied Geophysics: Exploring the Shallow Subsurface Burger

(44)

Center for Basic Sciences (CBS)

Learning Outcome
Of
Five Year
Integrated M.Sc. (Biology Stream)

UNDER

FACULTY OF LIFE SCIENCE
EFFECTIVE FROM JULY 2022

Center for Basic Sciences
Pt. Ravishankar Shukla University
Raipur (C.G.) 492010
PH: - 0771 – 2262216

Approved by Board of Studies in Bioscience
Pt. Ravishankar Shukla University Raipur (C.G.)

Integrated M.Sc. in Biology

Center for Basic Sciences
Pt. Ravishankar Shukla University Raipur (C.G.) 492010

Program Educational Objectives:

PEO1: To have fundamental as well as applied knowledge of the various fields of biology.

PEO2: To develop good practical handling of various basic as well as advanced instruments used in biological research.

PEO3: To orient the students to be able to work in research organizations of national and international repute and become the top future scientists of the country.

PEO3: To promote the students to explore and foster connections with other fields for interdisciplinary knowledge.

PEO4: To develop world class biology teachers who can understand their responsibilities in solving social and ethical issues with a scientific approach for the betterment of society.

Program Learning Outcomes:

PLO1: Students will have knowledge of fundamental as well as applied aspects of various fields of biology along with the foundation of Physics Chemistry and Mathematics.

PLO2: Students will have the knowledge of Biochemistry, Microbiology, Immunology, Molecular Biology, Genetics along with the applied areas of Biotechnology, Bioinformatics as well as emerging areas of Nanobiotechnology, Biomaterials, Synthetic Biology etc.

PLO3: Students will develop skills for interdisciplinary research, critical thinking and problem solving ability.

PLO4: Students will be able to not only design and perform experiments but analyze and interpret data independently.

PLO5: Activities like reading project, review writing, presentations will inculcate the abilities of better written as well as oral expression of the scientific work.

PAPER WISE LEARNING OUTCOMES:

SEMESTER-I

B 101: Biology I (Introductory to Biology)

With this introductory paper students will be able to comprehend

- General biological processes which are essential for students of all the streams Physics, Chemistry or mathematics.
- Theories of origin of life, evolution and process of development on earth.
- Identification of the levels of biological organization.
- Cellular mechanism which will further improve the understanding of processes of living beings.
- Physiology of different organ systems of the human body.

ES101: Environmental Science

Students will have knowledge of

- Concepts of ecology and environment which are important for the student of any stream.
- Environmental issues, measures to deal with them.
- Owns' role as a responsible citizen.

SEMESTER-II

B201: Biology II (Introduction to Macromolecules)

Students will be able to exhibit a knowledge base in

- Cell structure, function and role of biological molecules in regulating the basic mechanism of a cell.
- Process of Cell Signaling.
- Fundamentals of biotechnology and recombinant DNA technology.

B301: Cell Biology – I

Students will gain clear understanding of

- Cell structure, organelles and their roles.
- Biomolecules, and different imaging techniques.
- Organization of DNA, its replication, damage and repair processes.

SEMESTER-III

CB302 Biochemistry – I

This Paper is common for biology and chemistry students. It will be able to exhibit a knowledge base of

- Concepts of biochemistry
- Concepts of enzymes and enzyme kinetics
- Protein structure, folding, and modification processes.

SEMESTER-IV

CB402 Biochemistry – II
Students will have a knowledge base of • Different metabolic pathways related to synthesis and degradation of the major macromolecules. • Structure and role of different pigments and electron carriers. • Basics of photosynthesis process and electron carriers involved.
B401: Cell Biology – II
Students will gain in- depth understanding of • Cell-Cell communication and cell junctions present between the cells. • Cell division and regulation mechanisms. • Process of apoptosis and other types of cell death. • Concepts of techniques used in the study of cell biology.
SEMESTER-V
B501: Genetics
Students will be able to exhibit a knowledge base of • General principle, importance of genetics and interpretation of the various laws of genetic • Hereditary nature of the gene and how it codes different proteins of the cells. • Genetic diseases linked to gene/DNA. • Relationship between gene and evolution. • Biostatics and its significance in biology.
B502: Molecular Biology
Students will gain in-depth understanding of • Basic concept of molecular biology. • Central dogma and molecular mechanism in prokaryotes and eukaryotes. • Synthesis and control the proteins synthesis, • Gene expression in prokaryotes and eukaryotes. • Mutation, its types, causes, and consequences.
B503: Biodiversity
Students will have a knowledge base in • Taxonomy of plants and animals. • Distribution and diversity of plants and animals. • Biodiversity, threats and conservation need.
SEMESTER-VI
B601: Immunology
Students will develop knowledge base in • Concepts of immune system and types of immunity. • Mechanism of activation of immune system components.

- Concepts of immunodeficiency, allergies, autoimmune disorders, transplant immunology, immunotherapy, development of vaccines etc.

B 602: Animal Physiology

Students will be able to comprehend the basics of

- Organization and mechanism of working of various organ systems of the human body like nervous system, muscular system, and respiratory system.
- Process of nerve stimulation, neurotransmission, cardiac control, temperature control, blood pressure etc.

B603: Plant Physiology

Students will gain in-depth understanding of

- Fundamentals of Plant morphology, plant ecology
- Phytochemistry including the plant growth regulators
- Phenomenon like photoperiodism, photomorphogenesis, circadian rhythms.

B604 Microbiology

Students will able to gain in –depth understanding of

- Microscopic organisms unicellular, multicellular or acellular.
- Concepts of mycology, parasitology and bacteriology.
- Diseases mechanism associated with these microorganisms.

H 601: Ethics of Science and IPR

Students will gain understanding of

- Ethics, Bioethics and its approaches
- Bioethics in modern biology
- Ethical issues related to Synthetic biology
- Intellectual property rights
- Patents and emerging issues

SEMESTER-VII

B701: Evolutionary Biology

Students will be able to comprehend various concepts

- Theories and evidences of organic evolution.
- Sources of variations and role in evolution.
- Population genetics, Evolution of man.
- Construction of phylogenetic trees, Multiple sequence alignment.

B702: Immunology

Students will able to gain in –depth understanding of

- Concepts of host-pathogen relationships and hypersensitivity.
- Application of concepts of immunology for the disease prevention.

- Mechanism of vaccines action.
- Concepts of various autoimmune diseases.

B703: Developmental Biology

Students will be able to comprehend

- Developmental procesess in animals and plants.
- Biochemical and molecular regulation of development.
- Concepts of epigenetics and how environmental factors influence the development of plants and animals.

B704: Imaging Technology in Biological Research

This is a very crucial paper which will be going to benefit students in further research in biological sciences. It will give in –depth understanding and knowledge base of

- Imaging techniques and instruments sample preparation procedure, operation of instruments, and data interpretation of different instruments in biological research.
- Concept of the lights, different types of microscopes including confocal and atomic force microscopy, optical tweezers.
- Advanced and sophisticated instruments NMR technique.

BPr701: Reading project

- Project is kept in curriculum to give training to students and motivate to pursue research as a career.
- This is the first phase where the students are made familiar to preliminary aspect of research which starts with reading and understanding a research problem through review articles / research articles.

SEMESTER-VIII

B801: Virology

Students will be able to comprehend the various concepts regarding

- Structure and classification of animal, plant viruses and bacteriophages.
- Replication mechanism and diseases caused by them.
- Development of vaccines for the viral epidemics and also about antiviral chemotherapy.

B802: Biotechnology I

Students will have in –depth understanding of

- Basic principles of genetic engineering.
- Transgenic animals, cloning and applications
- Development of transgenic plants and their applications.

B803: Bioinformatics

Students will have in –depth understanding of

- Biological databases and alignment techniques.
- Construction of phylogenetic tree and 3D structure of proteins.
- Various bioinformatics tools for the study of whole genome sequencing and making phylogenetic tree.

B804: Biotechnology II

Students will have in –depth understanding of

- Principles of plant breeding
- Bioprocess technology and industrial application of biotechnology in the production of various biopolymers.
- Biotechnological ways for environmental and industrial pollution control.
- Medical biotechnology applications like tissue engineering.
- Synthesis and application of nanoparticles.

BPr801: Project

- The main objective of such projects is to develop research aptitude in students at early stage.
- This is the second phase where the students will undertake some research problem and solve it through experiments.
- Further a report is submitted and presented for discussion.

SEMESTER-IX

BPr901: Six-Months Project

- This whole semester is fully dedicated to research.
- Students will undertake six month research training from any of the recognized premier institute or university.
- The course aims to provide a full fledged exposure to students to experience fully devoted research environment, learn techniques and develop writing skills too.

SEMESTER-X

BE01: Proteomics and Genomics

Students will have in –depth understanding of

- Protein separation and identification techniques.
- Protein and Genome sequencing methods.
- Functional proteomics and its applications.
- Human genome, Gene disease association and metagenomics.

BE02: Nanotechnology

Students will be able to comprehend various concepts

- Nanotechnology in biology
- Nanomaterial and Nanostructures
- Biosensors and nanobiosensors.
- Nanobiotechnological applications in health and disease and environment.

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BE03: Plant Genetic Engineering
Students will have in –depth understanding of • Plant transformation techniques. • Transgenics for increasing crop productivity. • Transgenics for quality improvement. • Chloroplast transformation. • Plant Metabolic Engineering, Plant vaccines.
BE04: Plant- Microbe Interactions
Students will have in –depth understanding of • Plant pathology and plant-microbe associations. • Molecular biology of pathogenicity. • Systemic Acquired Resistance and Induced Systemic Resistance.
BE05: Neurobiology
Students will be able to comprehend the basics of • Neurobiology, brain and its components. • Biochemical mechanism, neurotransmitters, mechanism of sleep, learning, and memory. • Sensory organs of the body and neurobiology related diseases.
BE06: Plants for Human Welfare
Students will develop understanding about • Economically important plants and their role in human. • Food crops Medicinal: Plant secondary metabolites. • Knowledge of extraction, isolation, characterization and elicitation of bioactive metabolites. • Nutraceuticals and functional foods. • Plant-based biofuels.
BE07: Animal Tissue Culture
Students will have in –depth understanding • Animal cell culture. • Types of cell culture media. • Cell lines, Stem cell research and gene transfer technology in animals