Scheme of Semester Examination & Syllabus
Academic Session: 2014-2016
M. Sc. Bioscience (Semester I to IV)

School of Life Sciences
Pt. Ravishankar Shukla University, Raipur

First Semester [July 2014 – December 2014]				
Paper	**Title of Paper**	**Marks**		
		(External)	**(Internal*)**	**Credit**
I	Cell Biology	**80**	**20**	**4**
II	Biomolecules and Enzymology	**80**	**20**	**4**
III	Microbiology	**80**	**20**	**4**
IV	Biology of Immune System	**80**	**20**	**4**
LC-I	Lab Course I (Based on Theory papers I & II)	**80**	**20**	**2**
LC-II	Lab Course II (Based on Theory papers III & IV)	**80**	**20**	**2**
	Total		**600**	**20**
Second Semester [January 2015 – June 2015]				
Paper	**Title of Paper**	**(External)**	**(Internal)**	**Credit**
I	Molecular Biology	**80**	**20**	**4**
II	Bioenergetics & Metabolism	**80**	**20**	**4**
III	Instrumentation	**80**	**20**	**4**
IV	Biostatistics and Computer Application	**80**	**20**	**4**
LC-I	Lab Course I (Based on Theory papers I & II)	**80**	**20**	**2**
LC-II	Lab Course II (Based on Theory papers III & IV)	**80**	**20**	**2**
	Total		**600**	**20**
Third Semester [July 2015 – December 2015]				
Paper	**Title of Paper**	**(External)**	**(Internal)**	**Credit**
I	Molecular Plant Physiology	**80**	**20**	**4**
II	Environmental Biology	**80**	**20**	**4**
III	Animal Physiology	**80**	**20**	**4**
IV	Developmental Biology and Evolution	**80**	**20**	**4**
LC-I	Lab Course I (Based on Theory papers I & II)	**80**	**20**	**2**
LC-II	Lab Course I (Based on Theory papers III & IV)	**80**	**20**	**2**
			600	**20**
Fourth Semester [January 2016 – June 2016]				
Paper	**Title of Paper**	**(External)**	**(Internal)**	**Credit**
I	Seed Science	**80**	**20**	**4**
II	Plant Biotechnology	**80**	**20**	**4**
III	Special Paper A: Parasitology/ Special Paper B: Basic Chronobiology	**80**	**20**	**4**
IV	Special Paper A: Immunology/ Special Paper B: Applied Chronobiology	**80**	**20**	**4**

LC-I	Lab Course I (Based on Theory papers I & II)		**80**	**20**	**2**
LC-II	Lab Course II (Based on Theory papers III & IV)		**80**	**20**	**2**
		Total		**600**	**20**
	OR				
	Project Work**			**600**	
	Distribution of Marks	Dissertation	**240**	**60**	**11**
		Seminar based on project	**160**	**40**	**6**
		Viva-voce	**80**	**20**	**3**
				600	**20**
		Grand total [Semester I + II + III + IV]		**2400**	**80**

Important Note:

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Continuous evaluation of Performance*

Each student will be evaluated continuously throughout the semester.

There will be a class test based on each theory paper. The full marks will be 10 for each paper.

There will be a poster/oral presentation based on each theory paper. The full marks will be 10 for each presentation.

Each student will be required to submit a brief write-up (not more than 15-20 pages) on his/her poster/oral presentation.

Project Work**

A student of IV semester will have the choice to opt for project work in lieu of four theory papers and two lab courses provided he/she secures at least 75% or more marks in aggregate in semester I and II.

The project has to be carried out in recognized national Institutes/Laboratories or UGC-recognized universities. No student will be allowed to carry out project work in private laboratories/ college/ institutions, excluding the colleges recognized as research centers by the RDC of Pt. Ravishankar Shukla University, Raipur.

The valuation of all the projects will be carried out by an external examiner and HoD of UTD or its nominee at the UTD Centre.

Scheme for Lab Course (LC) Examination (Applicable for each LC in each Semester)

1.	Major exercise based on paper I	**20**
2.	Minor exercise based on paper I	**10**
3.	Major exercise based on paper II	**20**
4.	Minor exercise based on paper II	**10**
5.	Spotting/ Interpretation***	**10**
6.	Viva-voce	**10**
7.	Sessional [Internal]	**20**
	Total	**100**

***A student will be required to interpret on the displayed item/material

July 2014 – December 2014

M.Sc. Bioscience

First Semester

Paper I: Cell Biology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Molecular organization of membranes- asymmetrical organization of lipids, proteins and carbohydrates.
Transport of small molecules across membranes: Types and mechanism.
Active transport by ATP-powered pumps: types, properties and mechanisms.
Transport of proteins into mitochondria and chloroplast.

Unit-II Transport of proteins into and out of nucleus.
Transport of proteins into endoplasmic reticulum.
Transport by vesicle formation: endocytosis and exocytosis.
Molecular mechanism of vesicular transport.

Unit-III Cell signaling: Signaling via G-protein linked and enzyme linked cell surface. Receptors, MAP kinase pathways, interaction and regulation of signaling pathways.
Eukaryotic cell division cycle: different phases and molecular events.
Cell cycle and apoptosis: control mechanisms: role of cyclins and cyclin dependent kinases, retinoblastoma and E2F proteins, cytokinesis and cell plate formation, mechanisms of programmed cell death.
Oncogenes and tumor suppressor genes: viral and cellular Oncogenes, tumor suppressor genes from humans, structure, function and action of pRB, and p53 tumor suppressor proteins.

Unit-IV DNA content, banding pattern, C– value complexity, C- value paradox, euchromatin & heterochromatin.
Structure of centromere, nucleolar organizer and telomere.
Structure of nucleosomes, DNA, histone interaction, histones and non-histones, DNA packaging, 10 nm fibril, 30nm fibril, solenoid structure.
Classes of DNA, reassociation kinetics, Cot curve, Rot curve analysis

Lab Course:

1. Mitosis and meiosis (Onion root tip, human lymphocytes)
2. Chromosome Preparation (*Allium cepa*,/ rat testis /grass hopper testis)
   Polytene chromosome
3. Estimation of DNA
4. Estimation of RNA
5. Sub-cellular fractionation and marker enzymes
6. Identification of different biomolecules in different tissues by histochemical techniques

Recommended Books

H Lodish *et al.*	Molecular Cell Biology
B Alberts *et al.*	Essential Cell Biology
H Lodish *et al.*	Molecular Cell Biology (Lodish, Molecular Cell Biology)
B Alberts *et al.*	Molecular Biology of the Cell
G Karp	Cell and Molecular Biology: Concepts and experiments

July 2014 – December 2014

M.Sc. Bioscience
First Semester
Paper II: Biomolecules and Enzymology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Carbohydrates: Structure, classification, properties and function; derivatives of monosaccharides, homo and hetero-polysaccharides, Peptidoglycan glycoproteins and liposaccharide.
Lipids: Classification, structure and function.
Nucleic Acid: Structure of purine and pyrimidine bases, nucleoside and nucleotide; DNA- structure and conformation; RNA - Structure, types and functions.

Unit-II Amino acids: Structure, classification and functions; Synthesis of peptides and protein sequencing; Proteins- properties, covalent structure; secondary, tertiary and quaternary structure of proteins, Ramchandran plot

Unit-III Enzyme classification, coenzymes, active site of enzyme, factors contributing to the catalytic efficiency of enzyme; enzyme kinetics- Michaelis-Menten equation, determination of Km, enzyme inhibition, allosteric enzymes, isoenzymes, ribozyme, multienzyme complexes

Unit-IV Chemistry of porphyrins: Importance of porphyrins in biology; structure of hemoglobin and chlorophyll porphyrins, structure and biological role of animal hormones, structure and biological role of water soluble and fat soluble vitamins.

Lab Course:

1. Specific tests for sugars, amino acids and lipids
2. Formal titration of amino acids
3. Estimation of proteins using ninhydrin and biuret method
4. Estimation of sugar by Anthrone and Folin-Wu method
5. Saponification value and iodine number of fat.
6. Estimation of ascorbic acid
7. Achromic point determination using salivary amylase
8. Effect of ions on salivary amylase activity
9. Enzyme assay and kinetics (ex. Amylase, Protease)

Recommended Books:

Nelson, Cox and Lehninger	Principles of Biochemistry
G Zubay	Biochemistry
Stryer	Biochemistry
Garrett and Grosham	Biochemistry
West, Tood, Mason and Bbruglen	Text book of biochemistry
White, Handler and Smith	Biochemistry
D Voet and JC Voet	Biochemistry

July 2014 – December 2014

M.Sc. Bioscience
First Semester
Paper III: Microbiology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I General characteristics of fungi, classification of fungi, life cycle of selected fungal genus (Aspergillus, Pencillium, Fusarium and Mucor). Economic importance of fungi.
Fungi and bioremediation, parasitism, mutualism and symbiosis with plants and animals. Heterothallism, sex hormone in fungi, Mycorrhiza, VAM.
Algae: Distribution, classification, reproduction, ecology and importance.

Unit-II Morphology and ultra structure of bacteria, morphological types, cell wall of archaebacteria, gram negative, gram positive eubacteria, eukaryotes.
Cell membranes – structure, composition and properties. Structure and function of flagella, cilia, pili, gas vesicles. Cyanobacteria, protozoa, mycoplasma and Rickettsia.
Gene transfer mechanisms, transformation, transduction, conjugation and transfection. Plasmids F: factors colicins and col factors, plasmids as a vector for gene cloning.

Unit-III Nutritional types (autotrophs, heterotrophs, phototrophs, chemotrophs), growth curves, measurement of growth, factors affecting growth, generation time, growth kinetics. Batch and continuous culture, asynchronous, synchronous culture.
Basis of microbial classification, classification and salient feature of bacteria according to Bergey's manual of determinative bacteriology, cyanobacteria, prochlorons and cyanelles.

Unit-IV Viruses: Structure and classification of viruses; morphology and ultra structure; capsids and their arrangements, types of envelopes, viral genome, their types and structure, virus related agents (viroids, prions).
General feature of virus reproductions, early events in virus multiplication, virus restriction and modification of host, virus mRNA.
General overview of bacterial viruses, RNA and DNA bacteriophages (MS2, ϕX174, M13, T3, T4). Lysogeny and Lytic phase.

General account of plant and animal viruses (TMV, HIV and other oncogenic virus, Hepatitis virus).

Lab Course:

1. Glassware preparation and sterilization techniques- wet heat- dry heat- filter types- laminar flow chamber types- CDC- safety levels
2. Preparation of liquid & solid media, plating, pouring, inoculation and incubation for growth of microorganism
3. Methods of obtaining pure culture of microorganisms (a) streak plate (b) Pour plate, and (c) spread plate methods
4. Microscopic examination of the microorganisms, identification and staining methods
5. Micrometery and camera lucida drawings
6. Study of bacterial growth by turbiditimetry/ spectrophotometry
7. Biomass measurement for fungi
8. Isolation and enumeration of microorganisms from soil by serial dilution agar plating method
9. Enumeration of viruses by plaque assay technique
10. Motility of bacteria by hanging drop technique

Recommended Books:

LM Prescott, JP Harley and DA Klein	Microbiology, McGraw Hill Publication
RY Stanier et al.	General Microbiology, Mac Millian Press
RM Atlas	Principles of Microbiology
Peleczar, Chan and Krieg	Microbiology
Luria, Darnell, Baltimore and Campbell	General Virology
CJ Alexopoulos and CW Mims	Introduction to Mycology, Wiley Eastern Ltd, New Delhi

July 2014 – December 2014

M.Sc. Bioscience

First Semester

Paper IV: Biology of Immune System

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Innate immune mechanism and characteristics of adaptive immune response; Cells of immune system: Hematopoiesis and differentiation, mononuclear cells and granulocytes; Antigen presenting cells; Primary and Secondary lymphoid organs and tissues; Ontogeny and phylogeny of lymphocytes; Lymphocyte traffic

Unit-II Antigen receptor molecules: B-cell receptor complex, Immunoglobulin - structure, types and function; T-cell receptor complex; Major Histocompatibility Complex- types, structural organization, function and distribution; Transplantation and Rejection; Complements in immune function

Unit-III Antigens: nature of antigens, factor affecting immunogenicity, Haptens and super antigens; Antigenic determinants; Recognition of antigens by T and B cell; Antigen processing; Role of MHC molecules in antigen presentation and co-stimulatory signals; Antigen and antibody interaction.

Unit-IV Cell mediated immune response; Cytokines and interleukins- structure and function; Immunity to infections; Hypersensitive reactions and their types; Immunodeficiency disorders; Autoimmunity

Lab Course:

1. Identification of cells of immune system
2. Separation of mononuclear cells by Ficoll-Hypaque
3. Identification of Lymphocytes and their subsets
4. Lymphoid organs and their microscopic organization
5. Isolation and purification of Antigens
6. Purification of IgG from serum
7. Estimation of Levels of gamma globulins and A/G ratio in blood
8. Antigen antibody interaction

Recommended Books:

RA Goldsby *et al.*	Kuby's Immunology
E Benjamini, R Coico and G Sunshine	Immunology- A short Course
Roitt, Brostoff and Male	Immunology
William Paul	Fundamentals of Immunology
Tizard	Immunology
Abbas *et al*.	Immunology

January 2015 – June 2015

M.Sc. Bioscience

Second Semester

Paper I: Molecular Biology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I **DNA and Chromosomes:**

Structure and function of DNA: Packaging of DNA into a set of eukaryotic chromosomes. Chromosomes contain a long string of genes, Organization of genes in chromosomes, Conserved and non-conserved regions of DNA sequence, States of chromosomes during cell cycle. Centromere, telomere and replication origin sequences of DNA in chromosomes.

Packaging of DNA into chromosomes: Structure of nucleosomes, packaging of nucleosomes in chromatin fibers, ATP-driven chromatin remodeling, modification of histone tails.

Structure of chromosomes: Structure of Lampbrush and Polytene chromosomes, Heterochromatin and euchromatin, Heterochromatin at the end of chromosomes and centromeres, role of heterochromatin, mitotic chromosome, banding pattern of chromosomes, territories of chromosomes in interphase nucleus.

DNA Replication: DNA template, DNA polymerases, Leading and lagging strands, DNA helicase, DNA primase, primosome, clamp protein, proteins at replication fork, DNA topoisomerases, replication origin in bacteria and yeast, replication at different regions on eukaryotic chromosomes, origin of replication in humans, assembly of nucleosomes behind replication fork, telomere replication, telomerase, telomere length.

Unit-II **Mutation, Recombination, Transposons and DNA Repair:**

Mutation: Mutation, Molecular basis of spontaneous and induced mutations, Intragenic suppression and intergenic suppression, Ames test.

Recombination: Copy – choice hypothesis, breakage and reunion hypothesis, Homologous recombination, Holliday model, RecA protein, gene conversion.

Transposons and retropoviruses: Insertion sequences, composite transoposons, replicative and non-replicative mechanisms of transposition, Controlling elements in maize. Life cycle of retrovirus, retroviral gens, reverse transcription, DNA integration.

DNA repair: Photo reactivation, Strand-directed mismatch repair, Base excision repair, Nucleotide excision repair, Error-prone repair, Replication repair, Inherited syndromes with defects in DNA repair.

Unit-III **DNA to RNA to Protein:**

Transcription: Types of RNA, RNA polymerases, Start and stop signals, RNA polymerases in eukaryotes, RNA polymerase II and its transcription factors, Activator, mediator and chromatin modifying proteins, transcriptional elongation.

RNA splicing: Spliceosome, RNA splicing mechanisms, trans-splicing, self-splicing mechanisms.

Translation: Genetic code, aminoacyl – tRNA synthetase, initiator tRNA, eukaryotic initiation factors, stop codons, elongation factors, molecular chaperons.

Unit-IV **Control of gene expression:**

Introduction: Different cell types of multicellular organisms contain same DNA, Different cell types synthesize different sets of proteins, Cell can change gene expression in response to external signals, Points of gene control in pathway from DNA to RNA to protein.

Basic components of gene regulatory switches: Gene regulatory proteins and specific sequences, short DNA sequences are fundamental components of genetic switches, gene regulatory proteins contain structural motifs that can read DNA sequences, Helix-turn-helix motifs, Zinc finger motif, Leucine-zipper motifs, helix-loop-helix motif.

Regulation of transcription in prokaryotes: Tryptophan operon, *lac*-operon.

Regulation of transcription in eukaryotic cells: Gene regulatory proteins control gene expression from a distance, control region consists of promoter plus regulatory DNA sequences, gene activator proteins promote assembly of RNA polymerase and general transcription factors at start point of transcription, gene activator proteins modify local chromatin structure, Insulator DNA sequences prevent gene regulatory protein from influencing distal genes, control of cell types in yeast, role of cro and repressor proteins in bacteriophage lambda. RNA editing, RNA interference.

Lab Course:

1. Isolation, purification and estimation of RNA
2. Isolation, purification and estimation of DNA
3. Determination of Tm of nucleic acid
4. Fraction of poly (A) RNA

Recommended Books

H Lodish *et al.*	Molecular Cell Biology
B Alberts *et al.*	Essential Cell Biology
B Alberts *et al.*	Molecular Biology of the Cell
G Karp	Cell and Molecular Biology: Concepts and experiments
JD Watson *et al.*	Molecular Biology of the Gene
J Wilson and T Hunt	Molecular Biology of the Cell: The Problems
B Lewin	Genes VIII
JE Krebs *et al*. (Ed.)	Genes X (Lewin's), Jones and Bartlett Publishers, Sudbury, Massachusetts, (2011)

January 2015 – June 2015

M.Sc. Bioscience
Second Semester
Paper II: Bioenergetics and Metabolism

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Energy transformation and laws of thermodynamics; Concept of free energy, Determination of free energy change by different methods; Structural basis of free energy change during hydrolysis of ATP; High energy compounds, Other high energy biological compounds; ATP cycle

Unit-II Basic concepts of intermediary metabolism: Carbohydrate metabolism - Glycolysis, Kreb's cycle, glycogenolysis, glycogenesis, pentose phosphate pathway, gluconeogenesis, and glyoxylate pathway, inborn errors of carbohydrate metabolism; Regulation of carbohydrate metabolism

Unit-III Electron transport and oxidative phosphorylation: electron carriers, Complexes I to IV, Shuttle system for entry of electron substrate level phosphorylation, mechanism of oxidative phosphorylation; Biosynthesis and degradation of Lipids; Regulation of lipid metabolism, inborn errors of lipid metabolism

Unit-IV Nitrogen Assimilation; Biosynthesis and degradation of amino acids; Regulation of amino acid metabolism; Biosynthesis and degradation of purine and pyrimidine nucleotides

Lab Course:

1. Protein estimation by Lowry, Bradford and Spectrophotometric method
2. Estimation blood cholesterol
3. Estimation of sugar by Nelson-Sompgy and Benedict's reagent
4. Isolation and estimation of lipid from seeds and egg
5. Estimation of inorganic and total phosphorus by Fiske-Subba Rao method
6. Assay of phosphatases in blood and seeds
7. Urease estimation in plant tissues

Recommended Books:

Nelson, Cox and Lehninger	Principles of Biochemistry
G Zubay	Biochemistry
Stryer	Biochemistry
Garrett and Grosham	Biochemistry

West, Tood, Mason and Bbruglen	Text book of biochemistry
White, Handler and Smith	Biochemistry
D.Voet and J C Voet	Biochemistry
Dixon and Webb	Enzymes
Price and Steven	Fundamentals of Enzymology
Plummer	Practical biochemistry
G Tripathi	Enzyme biotechnology
Walsh	Enzyme Reaction Mechanism
Hammes	Enzyme catalysis and regulation

January 2015 – June 2015

M.Sc. Bioscience
Second Semester
Paper III: Instrumentation

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Centrifugation: Principle, techniques. Preparative, analytical and ultracentrifuges, sedimentation coefficient and factors affecting sedimentation coefficient. Application of centrifugation; Photometry: Basic principles of colorimetry, UV-visible spectrophotometry & IR-spectrophotometry; Spectroflurometry; Atomic absorption spectroscopy: Principle, Instrumentation and applications

Unit-II Theory, principle and applications of Paper and Thin Layer Chromatography; Gel filtration, Ion exchange chromatography and Affinity chromatography; Gas-liquid chromatography and HPLC; Microtomy: types, principle and application; Microscopy: light, phase-contrast, fluorescence and electron microscope

Unit-III Electrophoresis, Moving boundary and Zonal; Paper electrophoresis, Starch gel, agarose, PAGE-type, 2D-E; Isoelectric focusing and isotachophoresis; *Lyophilization*: Principle, instrumentation and applications

Unit-IV ORD and CD: Principles, instrumentation and applications; NMR, GC-Mass: Principles, instrumentation and applications; Radioactivity: Concepts & Principles; Radioactive decay, GM counter, Gamma counters, Scintillation counters; RIA and Autoradiography – Concepts, Principles, and applications

Lab Course:

1. Verification of Beers Law
2. Determination of absorption maxima
3. Quantitative determination, Enzyme kinetics
4. Amino acid and carbohydrate separation by paper and TLC
5. Ion exchange and gel filtration chromatography
6. SDS *Polyacrylamide* Gel Electrophoresis
7. Separation of sub-cellular organelles by differential centrifugation

Recommended Books:

BK Sharma	Instrumental methods of analysis
Chatwal and Chatwal	Instrumentation

Upadhyaya and Upadhyaya	Instrumentation
AI Vogel	Analytical chemistry

January 2015 – June 2015

M.Sc. Bioscience

Second Semester

Paper IV: Biostatistics and Computer Application

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Introduction to biostatistics. Types of biological data: data on different scales. Frequency distributions. Cumulative frequency distributions. Random sampling. Parameters and statistics. Measures of central tendency and dispersion: Mean, Median, Mode, Range, Variance and Standard deviation. Coefficient of variation. The effects of coding data. Data transformations: Log-transformation, Square-root transformation and Arcsine transformation. Distribution: normal and binomial. Probability: Basic laws of probability, addition law, multiplication law. Probability and frequency.

Unit-II Statistical errors in hypothesis testing. Testing goodness of fit: Chi-square goodness of fit. Heterogeneity Chi-square. The 2 x 2 contingency table. One sample hypothesis. Two-sample hypothesis. Testing for difference between two means (*t*-test). Testing for difference between two variances (*F*-test). The paired sample *t*-test. Multiple-sample hypothesis (ANOVA): Single factor and two factors ANOVA. Multiple comparisons: Duncan's multiple-range tests. Simple linear regression. Regression *vs.* Correlation. Regression equation. Interpretations of regression functions. Simple linear correlation. The correlation coefficient.

Unit-III Introduction to MS-Office software: Word processing; Creating new document, Editing documents, Adding graphics to documents, Word tables. Management of Workbook & Worksheets; Applications, Features, Using formulas and functions, Features for Statistical data analysis, Generating charts/ graph. Presentation software; Working in PowerPoint, Creating new presentation, Working with slides.

Unit-IV Introduction to Internet and Applications. Basics of internet, e-mailing, Search engine – Google, Yahoo, MSN, Entrez including Pubmed, Web of Science, Citation Index: Science Citation Index (SCI), h-index, i-10-index. Journal Impact Factor (JIF). Introduction to Plagiarism and Cyber laws.

Lab Course

1. Exercises for data distribution
2. Exercises for computation of measures of central tendency
3. Exercises for computation of measures of variability
4. Computation of correlation coefficient, r, and regression constants
5. Data analysis by ANOVA and multiple-range tests
6. Hypothesis testing by *t*-test, F-test, and Chi-square test
7. Graphical presentation of data using a suitable package

8. Statistical analysis of a data using a suitable package
9. Preparation of document using a suitable package
10. Preparation of slides using a suitable package

Books Recommended

Campbell RC	Statistics for biologists
Zar JH	Biostatistical Analysis
Wardlaw AC	Practical Statistics for Experimental Biologists
Snedecor GW & Cochran WG	Statistical Methods
Sokal RR & Rohlf FJ	Introduction to Biostatistics
Sumner M	Computers: Concepts & Uses
White R	How Computers Work
Cassel P *et al.*	Inside Microsoft Office Professional
Coleman P and Dyson P	Mastering Internets
Gralla P	How the Internet Works
Shelly GB, Vermaat ME, Cashman TJ	Microsoft® 2007: Introductory Concepts and Techniques
Habraken J	Microsoft® Office 2003 All in One Microsoft® Office 2010 In Depth
Gilmore B	Plagiarism: Why it happens, How to prevent it?
Buranen L and Roy AM	Perspectives on Plagiarism and Intellectual Property in a Post-Modern World
Kumar Anupa P	Cyber Law
Sood V	Cyber Law Simplified

July 2015 – December 2015

M.Sc. Bioscience
Third Semester
Paper I: Molecular Plant Physiology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Physiology of Mineral Nutrition: Ionic relations; K and P, Molecular mechanism of micronutrient acquisition; Fe and Zn, Translocation of nutrients, Phytoremediation.

Unit-II Photosynthesis: Light absorption and energy conversion, photosystems I and II, ATP synthesis, Assimilation of carbon in C_3, C_4 and CAM pathways, Photorespiration.

Unit-III Phytochromes: Phytohormones: Structure, biosynthesis, molecular mechanisms of Auxin, Gibberellins, Cytokinin, Abscisic acid and Ethylene, Brassinosteroids.

Unit-IV Senescence and Programmed cell death: Senescence; Metabolism and regulation of pigment and nucleic acid, PGR regulation, SAG. PCD; Formation of TE and mobilization of cereal endosperm, Formation of aerenchyma. Signal transduction and PCD.

Lab Course:

1. Spectrophotometric determination of chlorophyll-a, chlorophyll-b and total chlorophyll in young, mature and senescent leaves

2. Kinetin estimation by cucumber cotyledons expansion bioassay
3. Auxin bioassay using wheat coleoptiles
4. GA bioassay by inducing *de-novo* synthesis of Amylase in de-embryonated seeds of wheat
5. Estimation of mono, di and total phenols in the young and aged leaves
6. Estimation of Guaiacol peroxidase activity in fresh and aged seeds
7. Determination of Superoxide dismutase levels in the healthy and deteriorated seeds
8. Estimation of metal toxicity induced changes in the AOS levels in leaf tissues
9. Determination of Nitrate reductase activity in leaf tissues
10. Separation of isozymes of SOD and GPX

Recommended Books:

Fosket DF	Plant Growth & Development
Foyer CH	Photosynthesis
Bacon Ke	Photosynthesis: Photobiochemistry & Photobiophysics
Leopold AC & Kriedemann PE	Plant Growth & Development
Moore TC	Biochemistry & Physiology of Hormones
L Taiz & E Zeiger	Plant Physiology
BB Buchanan, W Gruissem & RL Jones	Biochemistry & Molecular Biology of Plants
MB Wilkins	Advanced Plant Physiology
JA Hopkins	Introduction to Plant Physiology
FB Salisburry & CW Ross	Plant Physiology
Hans-Walter Heldt	Plant biochemistry & Molecular Biology

July 2015 – December 2015

M.Sc. Bioscience
Third Semester
Paper II: Environmental Biology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Ecosystem: Concept, Components and types. Productivity, Ecological energetics, Energy flow in ecosystem, Energy flow models, Ecological pyramids, Food chain, Food web. Ecological succession, Ecological niche.

Unit-II Aquatic ecosystem: Structure and properties of water, water cycle, Abiotic components: temperature, carbon- dioxide and oxygen, Biotic components, lentic and lotic ecosystems, wetlands.

Unit-III Terrestrial ecosystems: Forest types of India with special reference to Chhattisgarh. Productivity pattern and measurements. Natural and plantation (artificial) forests, Agroforestry, Social forestry, National parks and Sanctuaries in Chhattisgarh.

Unit-IV Biodiversity, ex-situ and in- situ conservation. Intellectual property right (IPR) with special reference to India. Natural resources: Water, Forest and Medicinal plants.

Lab Course:

1. To determine the minimum size of the quadrate by 'Specis –Area-Curve' method
2. To study the community by quadrate method by determining frequency, density and abundance of different species present in the community
3. Chromatographic separation of chlorophyll pigments in leaf
4. Measurement of pH and Total alkalinity in water

5. Measurement of Free carbon dioxide and dissolved oxygen in given water
6. Identification and drawing of at least 15 medicinal plants

Recommended Books:

A Beattie and PR Ehrlich	Biodiversity, 2001
EP Odum	Fundamentals of Ecology, 2nd ed., 494-496
EP Odum	Basic Ecology (Philadelphia: Saunders, 1983), 518.
PD Sharma	Ecology and Environment, 2009, Rastogi Publications
M Calver	Environmental Biology, Murdoch University, Western Australia
Aggarwal	Concept of Ecology
NS Subrahmanyam	Ecology, Narosa Publications

July 2015 – December 2015

M.Sc. Bioscience
Third Semester
Paper III: Animal Physiology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I **Circulation**: Composition of blood, Cell types, Hemopoiesis, Structure and function of hemoglobin - Oxygen and carbon dioxide transport, Cardiac cycle and its regulation. Blood pressure, Blood Coagulation,
Respiration: Mechanism and regulation of breathing, Factors influencing oxygen uptake, Diving and high altitude adaptations. Measurement of metabolic rate and Q_{10}

Unit-II **Nervous system**: Mechanisms of conduction along axon and across synapses, Nernst equation and measurement of action potential, Neurotransmitters, Types and physiology of reflexes.
Myology: Types of muscles, Ultrastructure, mechanism and regulation of contraction of skeletal muscle.

Unit-III **Endocrinology**: Communication (autocrine, paracrine, neuroendocrine and endocrine) between cells and within the cells, Classification of hormones, General principles of nature of hormone action, Hormone receptors, Structure and physiology of following endocrine glands: hypothalamus, pituitary, thyroid and parathyroid, pancreas, adrenal, and pineal.

Unit-IV **Hormones, Reproduction and Pheromones**: Hormones in reproduction, Structure and function of testis and ovary, sexual cycles, Mechanism of action of gonadotropins; Types of pheromones, primer pheromone, releaser pheromone, imprinting pheromone, Lee-Boot effect, Bruce effect, Whitten effect, Human pheromones, Sex pheromones in insect control.

Lab Course (8-10 out of the following):

1. Examination of RBC in Piscine/Avian/Human blood.
2. Examination of WBC in Piscine/Avian/Human blood.
3. Differential leukocyte counts in Human blood.
4. Determination of Hb/Hct/ Absolute values in Piscine/Avian/Human blood.

5. To determine prevalence of different types of polymorphs in human blood (Based on Arneth's classification).
6. Demonstration of hemin crystal.
7. Determination of osmotic resistance in Piscine/Avian/Human blood.
8. Determination of specific gravity of Piscine/Avian/Human blood
9. Study of histological preparation of endocrine glands & Microtomy
10. ELISA/ RIA for T4, T3 & TSH
11. ELISA/ RIA for Cortisol and Melatonin
12. Androgen bioassay (chick comb method).
13. Study of vaginal smears in rat/mouse.
14. Effects of surfacing prevention on opercular activity in *C. batrachus*/ *H. fossilis*
15. Determination of rate of oxygen consumption (Whole body and tissue)

Books Recommended:

PJ Bentley	Comparative vertebrate endocrinology
WF Ganong	Review of medical physiology
A Gorbman & HA Bern	A textbook of endocrinology
AC Guyton	Textbook of medical physiology
WS Hoar & DJ Randall	Fish physiology [Series]
CR Martin	Endocrine physiology
D McFarland	Animal behaviour, psychobiology, ethology & evolution
CL Prosser	Adaptational biology: molecules to organisms
CL Prosser & FA Brown	Comparative animal physiology
K Schmidt-Nielsen	Animal physiology: Adaptation & environment
CD Turner & JT Bagnara	General endocrinology
JD Wilson & DW Foster	Textbook of endocrinology
D Randall, W Burggren & K French	Animal Physiology: Mechanisms and adaptations
TD Wyatt	Pheromones and animal behavior: Communication by smell and taste
G Litwack	Pheromones

July 2015 – December 2015

M.Sc. Bioscience
Third Semester
Paper IV: Developmental Biology and Evolution

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Gametogenesis in animals. Molecular events during fertilization. Activation of egg metabolism. Cleavage patterns and fat maps. Regulation of Cleavage cycle. Cleavage and nuclear activity.

Unit-II Concepts of determination, competence, induction and differentiation. Determination in *Caenorhabditis elegans*. Germ cell determination, migration and differentiation. Totipotency and nuclear transfer experiments. Embryonic induction. Formation of vulva in *C. elegans*. Mechanism of differentiation in *Dictyostelium*.

Unit-III Morphogenetic determinants in egg cytoplasm. Role of maternal contributions in early embryonic development. Genetic regulation of early embryonic development in Drosophila. Homeotic genes. Genetic interaction during differentiation. Hox

genes and limb patterning.

Unit-IV Concepts and theories of organic evolution. The processes of Evolutionary change-Genetic drift Natural selection and the Hardy-Weinberg equilibrium. Speciation. Molecular evolution and origin of life. Evolution of Prokaryotes and Eukaryotes. A brief outline of the evolutionary history of Metazoans including-Evolution of tissue grade, coelomic body plans and Chordates. Evolution of Mankind.

Lab Course:

1. Study of developmental stages in Snail/Amphibian/Chick
2. Study on Drosophila development
3. Role of hormones in metamorphosis and development
4. Effect of Vitamin A on tail regeneration in frog
5. Biochemical estimations in developing embryos
6. Structure of hen's egg and its vital staining
7. Demonstration of cell death by vital staining
8. Study of permanent slides of chick embryos
9. Histological studies of Gametogenesis
10. Induced breeding in fishes

Recommended Books

Alberts *et al*.	Molecular Biology of the Cell
SF Gilbert	Developmental Biology
Lewin Benjamin	Gene VIII
	Developmental Genetics
PO Moody	Introduction to Evolution, 1970, Harper and Row
Dobzhansky et al.	Evolution, W. H. Freeman. New York
SW Fox and K Dose	Molecular Evolution and the Origin of Life, 1972, W.H. Freeman & Co Ltd.
FJ Ayala and JW Valentine	Evolving: The theory and processes of Organic evolution, 1979, Benjamin/Cummings Pub. Co.
EO Dodson	Evolution: Process and Product
MW Strickberger	Evolution, 1979, James and Barlett International

January 2016 – June 2016

M.Sc. Bioscience
Fourth Semester
Paper I: Seed Science

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Seed Dormancy: Physiological and molecular basis, Testa, Endosperm, Aleurone layers & Hormonal cross talk in dormancy, Genomics and proteomics. Alleviation of dormancy; Protein oxidation. Dormancy breaking chemicals and mechanism.

Unit-II Seed Germination: Water kinetics, Pregermination, Germination and post germination metabolism. Reactivation of the metabolic pathway and energy production. Cellular repair. Hormonal regulation and metabolism; GA & ABA, ROS metabolism,

Unit-III Seed Ageing: Seed storage physiology: Orthodox & Recalcitrant; Natural and accelerated ageing; Transcriptome and proteome profiling of ageing. ROS

metabolism, Mechanism of desiccation tolerance, dehydrins/LEA/peroxiredoxin, HSPs, sugars, flavonoids, vitamin E and GABA. Longevity markers; β-mercaptopyruvate sulfurtransferase (MST), L -isoaspartyl O-methyltransferase (PIMT)

Unit-IV Seed Technology: Test for seed germination, viability and vigour. Priming technology; biochemical and molecular aspects. Cryobanks, Cryopreservation of seed and embryo; Cryoprotective molecules, Vitrification, Encapsulation and Drying. Marker for Seed and seedling quality and vigour; Genomics, proteomics approach.

Lab Course:

1. Hydro and chemical priming effect on seed germination.
2. To perform accelerated ageing in seeds and its comparison with the control.
3. Testing seed viability and vigour by :
   (a) germination
   (b) triphenyl tetrazolium test
   (c) Specific conductance of leachates and
   (d) Germination Index
4. Lipid peroxidation in ageing seeds.
5. Extraction and estimation of seed proteins, carbohydrates and lipids.
6. Quantitative and qualitative estimation of antioxidant enzymes in seeds:
   (a) SOD
   (b) Peroxidase and
   (c) catalase
7. Peroxidase assay by tissue printing method.
8. Seed cryopreservation technique and post-cryopreservation recovery.
9. Separation and determination of Molecular weight of seed proteins by SDS-PAGE.

Recommended Books

JD Bewley & M Black	Physiology & Biochemistry of Seeds, Vol. I & II
JD Bewley & M Black	Seeds : Physiology of Development & Germination
Black *et al*.	Desiccation and Survival of Plants : Dying without Drying
PK Agrawal & M Dadlani	Techniques in Seed Science & Technology
FAO Report 113	Ex-situ storage of seeds, pollen & *in vitro* cultures
Copeland & McDonald	Seed Science & Technology
RL Agrawal	Seed Technology
J Kigel & G Galili	Seed Development & Germination
W Ayad *et al*.	Molecular Genetic Techniques for Plant Genetic resources
EE Benson	Plant Conservation Biotechnology
DE Fosket	Plant Growth & Development
RB Taylorson	Recent Advances in the Development & Germination of Seeds
McDonald & Copeland	Seed Technology Laboratory Manual
Khullar & RC Thapliyal	Forest Seed
L Schmidt	Guide to Handling of Tropical & Sub-tropical Forest Seed

January 2016 – June 2016

M.Sc. Bioscience

Fourth Semester

Paper II: Plant Biotechnology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids
Tissue culture media (composition and preparation)
Initiation and maintenance of callus and suspension culture; single cell clones
Organogenesis; somatic embryogenesis; transfer and establishment of whole plants in soil
Shoot tip culture: Rapid clonal propagation and production of virus free plant

Unit-II Embryo culture and embryo rescue
Anther, pollen and ovary culture for production of haploid plants and homozygous lines
Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids
Germplasm conservation: Cryopreservation and slow growth cultures
Chloroplast Transformation: Advantages, vectors, success with tobacco and potato

Unit-III Plant transformation technology: Basis of tumor formation, Mechanism of DNA transfer, Features of Ti and Ri plasmids, role of virulence genes, use of Ti and Ri as vectors, binary vectors, markers, use of reporter genes, 35S and other promoters, use of scaffold attachment regions, multiple gene transfers, particle bombardment, electroporation, microinjection

Applications of plant transformation for productivity and performance: herbicide resistance, insect resistance, Bt genes, Non–Bt like protease inhibitors & amylase inhibitors, virus resistance, nucleocapsid gene, disease resistance, PR (Pathogenesis Related) proteins, nematode resistance, abiotic stress, male sterile lines

Unit-IV Metabolic Engineering and Industrial Products: plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway, biodegradable plastics, therapeutic proteins, antibodies, edible vaccines
Molecular Markers– RFLP maps, linkage analysis, RAPD markers, STS (Sequence Tagged Strands), microsatellites, SCAR (Sequence characterized amplified regions), SSCP (Single strand conformational polymorphism), AFLP, map based cloning, molecular marker assisted selection

Lab Course:

1. Preparation of culture media
2. To performe meristem/ bud culture, shoot multiplication & rooting phenomenon
3. To study organogenesis
4. To perform somatic embryogenesis
5. To study the process of plantlet acclimatization
6. To perform embryo culture
7. To study the process of anther culture development
8. Study of molecular markers
9. Extraction of DNA from plant cultures
10. Estimation and separation of DNA using agarose gel electrophoresis and spectrophotometer

Recommended Books:

MK Razdan	Introduction to Plant Tissue Culture, 2nd Edition, Oxford & IBH Publishing Co. Pvt Ltd, 2010
IK Vasil	Plant Cell and Tissue Culture; Springer Publication, 1994
SS Bhojwani and MK Razdan	Plant Tissue Culture; Elsevier
TJ Fu, G Singh and WR Curtis	Plant Cell and Tissue Culture for the production of Food Ingredients. Kluwer Academic/ Plenum Press, 1999
J Hammond, P McGarvey and V Yusibov	Plant Biotechnology, Springer Verlag, 2000
HS Chawla	Biotechnology in Crop Improvement, International Book Distributing Co., 1998
HS Chawla	Introduction to plant biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd., 2000
BD Singh	Biotechnology- Expending Horizons. 1st Edition, Kalyani Publisher, Ludhiana, 2004
Roberta H Smith	Plant Tissue Culture: Techniques and Experiments, 2nd Edition: Academic Press, 2000
Kyte L and Kleyn J	Plants from Test Tubes: An Introduction to Micropropagation, 3rd Edition, Timber Press, 1996
M Smith	Plant Propagator's Bible, 1st Edition, Rodale Books, 2007
MR Ahuja	Micropropagation of Woody Plants, Springer, 1993
YPS Bajaj	Trees III, Springer, 1991
YPS Bajaj	Trees IV, Springer, 1996

January 2016 – June 2016

M.Sc. Bioscience
Fourth Semester
Paper III (Special Paper-A) Parasitology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Parasites and parasitism. The Infection process: Modes of Parasite transmission, invasion, migration within host, maintaining station, obtaining nutrients and resisting host attack. Concept of Disease: Inflammation and Repair, Degeneration, Necrosis. Mechanism of Disease transmission with particular reference to vectors. Vector control measures.

Unit-II General organization and life cycle patterns of Protozoa; Epidemiology, pathogenesis, diagnosis and control of major human diseases, such as- Malaria, Leishmaniasis and Trypanosomiasis.

Unit-III General organization and life cycle patterns of Trematodes and Cestodes; Epidemiology, pathogenesis, diagnosis and control of major human diseases, such as- Schistosomiasis and Hydatidosis. Arthopod- related ectoparasitic diseases: Ticks, mites and flies.

Unit-IV General Organization and life cycle patterns of Acanthocephala and Nematoda; Epidemiology, pathogenesis, diagnosis and control of major nematode diseases, such as- Ascariasis, Ancylostomiasis and Filariasis. Biology of plant parasitic nematodes.

Lab Course:

1. Identification and comments on permanent mounts of parasitic organisms
2. Host examination for parasites; preparation of permanent slides and identification
3. Histology/Histopathology/Histochemistry by routine and differential staining
4. Biochemistry of parasites and pathophysiology of the hosts
5. Root knot nematodes: Extraction and isolation (Cobb's sieving and decantation method and Baerman's Funnel technique), preparation of perennial pattern mounts
6. Detection of blood parasites: Malarial parasite
7. Macroscopic and microscopic examination of stool samples, concentration methods

Recommended Books:

KD Chatterjee	Parasitology (Protozoology and Helminthology) in Relation to Clinical Medicine. 9th Ed. KD Chatterjee, 236 pages, 1973
TC Cheng	General Parasitology. Second Ed., Academic Press College Division, University of California, 827 pages, 1986
CKJ Panicker	Textbook of Medical Parasitology. Jaypee Brothers, Medical Publishers, 248 pages, 2007
TV Rajan	Textbook of Medical Parasitology. BI Publications, New Delhi, 2009
D Rollinson, and SI Hay, Ed.	Advances in Parasitology; Volumes 1 to 78, Elsevier, 1963-2012.
JD Smyth and DW Halton	The Physiology of Trematodes. Academic Press, Second Edition, 446 pages, 1983
DJ Wyler, Ed.	Modern Parasite Biology: Cellular, Immunological and Molecular Aspects. WH Freeman and Company, New York, 2003

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M.Sc. Bioscience

Fourth Semester

Paper III (Special Paper-B) Basic Chronobiology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Historical developments in chronobiology. Different types of geophysical and biological cycles with examples of circadian rhythms. Quantification of biological rhythms - Average, amplitude, phase, and period. Brief introduction to time series analysis. Methods of time series analyses: COSINOR, AUTOCORRELATION, FOURIER, MESA, CHI-SQUARE PERIODOGRAM.

Unit-II Characteristics of circadian rhythm: Free-run, Temperature and nutrition compensation, and Entrainment. Zeitgeber Time (ZT) and Circadian Time (CT). After-effects and Aschoff's rule. Aging and circadian clocks. Photoperiodism.

Unit-III Synchronization (=Entrainment) and masking. Entrainment by single light pulse, complete and skeleton photoperiods. Zeitgebers for circadian clocks. Key properties of a Zeitgeber. Photic and non-photic zeitgebers. Mechanisms of entrainment. Phase response curves (PRC), phase transition curves, strong and weak PRC.

Unit-IV Circadian pacemakers in insects with special reference to *Drosophila*. Suprachaismatic nucleus as mammalian circadian clock. Multi-oscillatory organization: master and slave oscillators, morning and evening oscillators, pacemaker and peripheral oscillators. Adaptive significance of circadian rhythms. Social consequence of circadian rhythms.

Lab Course:

1. Study of locomotor activity rhythm in suitable animal models
2. Actogram construction of locomotor activity of suitable animal models
3. Study of phase shift in circadian rhythm
4. Computation of period (τ), phase angle (Ψ), Mesor (M), amplitude (A) and acrophase/ peak (∅) of circadian, and other low and high frequency rhythms
5. Circadian changes in volume of nuclei in onion peel (*Allium cepa*) cells (microscopic observation)
6. Periodogram, amount of activity and spectral analysis of rhythm data

Recommended Books:

MJ Berridge	Biochemical oscillations and cellular rhythms. The molecular bases of periodic and chaotic behaviour
E Bunning	The physiological clock
FH Columbus	Trends in chronobiology
G Cornelissen & F Halberg	Introduction to chronobiology
JC Dunlap, JJ Loros & PJ DeCoursey	Chronobiology: Biological timekeeping
JC Hall	Genetics and molecular biology of rhythms in *Drosophila* and other insects
PJ Lumsden & AJ Millar	Biological rhythms and photoperiodism in plants
JD Palmer	The living clock
AK Pati	Chronobiology: The dimension of time in biology and medicine; PINSA (Biological Sciences), December 2001
AK Pati (Ed.)	Chronobiology
DS Saunders	An introduction to biological rhythms
B Thomas & D Vince-Prue	Photoperiodism in plants
V Kumar (Ed.)	Biological rhythms
MK Chandrashekaran	Time in the Living World
AT Winfree	The Geometry of Biological Time
MC Moore-Ede, FM Sulzman, & CA Fuller	The clocks that time us, Harvard University Press,1982
DS Saunders	Insect clocks, Pergamon, 2002

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Fourth Semester

Paper IV (Special Paper-A) Immunology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Generation of diversity in BCR and TCR. Light and heavy chain gene recombination. Recombination Signal sequences. Heavy chain constant region genes. Class switching. Membrane and secreted immunoglobulins. Organization and arrangement of T-cell receptor genes.

Unit-II Synthesis and production of immunoglobulins. Monoclonal antibody. Designer antibody. Regulation of immune response by antigen, antibody, immune complex, MHC and cytokines. Immunity to infections. Immunological tolerance. Nutrition and Immune response.

Unit-III Principles of Immunodiagnosis. Antigen-antibody interactions. Precipitation reactions. Haemagglutination. Complement fixation test. Direct and Indirect immunofluorescence. Radio labeled and Enzyme linked assays. Immunoblotting. Isolation of pure antibodies. Assay for complement. Isolation of lymphocyte population. Effector cell assays. Flow cytometry. Plaque forming cell asassay, ELISPOT assay, lymphocyte stimulation test, migration inhibition assays, cytotoxic assay. Immunodiagnosis of parasitic diseases.

Unit-IV Immunoprophylaxis: Principles of vaccination. Immunization practices. Vaccines against important bacterial, protozoan and parasitic diseases. DNA vaccines; passive prophylactic measures. Viral vaccines and antiviral agents. Parasite vaccines.

Lab Course:

1. Preparation of Parasite Antigen and analysis by PAGE
2. Immunizations and production of antibody
3. Antigen antibody reaction by Double Diffusion, Counter current and IEP, RID and EIA
4. Western Blot Analysis
5. Immunodiagnosis using commercial kits

Recommended Books:

RA Goldsby, TJ Kindt and BA Osborne	Kuby's Immunology
E Benjamini, R Coico and G Sunshine	Immunology-A short Course
Roitt, Brostoff and Male	Immunology
William Paul	Fundamentals of Immunology
Stewart Snell	Immunology, Immunopathology and Immunity
Elgert	Understanding Immune System

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M.Sc. Bioscience

Fourth Semester

Paper IV (Special Paper-B) Applied Chronobiology

Each theory paper will have **5 questions** of equal marks. First question [Multiple choice type or short answer type] will be based on all units [complete syllabus] with no internal choice, whereas remaining questions will be unit wise having internal choice within each unit.

Unit-I Molecular mechanisms underlying clock functions in organisms: Autoregulatory transcriptional feedback loops; Circadian clock mutant types in *Drosophila* (*per*, *tim*, *dbt*, *dclock*, *cycle*, *vrille*, *pdf*, *lark*, *takeout*), *Neurospora*, cyanobacteria, mouse, and humans. Temporal expression pattern of clock genes, Regulation of expression of clock genes, Expression patterns under constant light and darkness; Autonomous functions of clock genes in peripheral tissues.

Unit-II Human circadian organization: Methods to study human circadian rhythm; Free-running rhythms in humans, Constant routine protocol, and Forced desynchronization protocol. Circadian pacemaker in humans. Marker rhythms in humans: Core body temperature (CBT), melatonin, and cortisol.

Unit-III Circadian rhythms and human health: Chronopharmacology; Basics of chronopharmacology – clinical chronopharmacology – circadian dependence of drug pharmacokinetics. Chronotherapy; Application of chronotherapy in treatment of different types of cancer, chronopump, cardiovascular diseases, allergies and asthma, DSPS, ASPS and SAD; Sleep-wake rhythms in humans; alertness and performance rhythms; circadian rhythm sleep disorders, and mood disorders.

Unit-IV Circadian rhythms in occupational and travel stresses: Shift work; Types of shift system, direction and frequency of shift rotation, Effect on rhythm parameters, Desynchronization of circadian rhythm, Consequences on sleep, Psychosocial problems, Clinical and non-clinical problems. Shift work tolerance/ intolerance. Shift optimization: Nap, Bright light therapy, Melatonin therapy.
Jet lag: Consequences of jet lag; direction asymmetry & variable asymmetry; Approaches to jet lag alleviation.

Lab Course:

1. Study of circadian rhythms in objective/subjective variables in human subjects.
2. Chronotyping in human population.
3. Study of circadian rhythm in the rest-activity of humans by using wrist actigraphy.
4. Study of circadian rhythm in blood pressure of humans by using Ambulatory Blood Pressure Monitor.
5. Circadian variations in RBC and WBC in suitable animal models.
6. Circadian rhythm in cortisol and melatonin by ELISA

Recommended Books:

JC Dunlap, JJ Loros & PJ DeCoursey	Chronobiology: Biological timekeeping
JC Hall	Genetics and molecular biology of rhythms in *Drosophila* and other insects
WJM Hrushesky	Circadian cancer therapy
BG Katzung	Basic and clinical pharmacology
G Klein and P Becker	Farewell to the internal clock: a contribution in the field of Chronobiology

AK Pati	Chronobiology: The dimension of time in biology and medicine; PINSA (Biological Sciences), December 2001
AK Pati, Ed.	Chronobiology
TT Postolache	Sports Chronobiology: An issue of clinics in sports medicine
D Purves *et al.*	Molecular mechanisms of biological clocks
PH Redfern and B Lemmer	Physiology and pharmacology of biological rhythms
R Refinetti	Circadian Physiology
A Reinberg	Clinical chronopharmacology: Concepts, kinetics, applications
A Sehgal	Molecular biology of circadian rhythms
LE Scheving	Chronobiotechnology and chronobiological engineering
Y Touitou *et al.*	Handbook of medical chronobiology