PT. RAVISHANKAR SHUKLA UNIVERSITY

School of Life Sciences

Syllabus of

M. Sc. Biochemistry

[Credit Based System]

Semester Examination

SESSION 2014-16

M. Sc. BIOCHEMISTRY [Credit Based System]
Scheme of Examination for SESSION 2014-16

July 2014-December 2014					
			Marks		Credit
Paper No.	Title of Paper		(External)	(Internal)* *	
	First Semester				
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 paper I & II)		80	20	2
LC-II	Lab Course II (Based on paper III & IV)		80	20	2
			Total	**600**	**20**
January 2015-June 2015					
			Marks		Credit
Paper No.	Title of Paper		(External)	(Internal)* *	
	Second Semester				
I*	Molecular Biology		80	20	4
II*	Bioenergetics & Metabolism		80	20	4
III*	Instrumentation		80	20	4
IV*	Biostatistics and Computer Applications		80	20	4
LC-I	Lab Course I (Based on paper I & II)		80	20	2
LC-II	Lab Course II (Based on paper III & IV)		80	20	2
			Total	**600**	**20**
July 2015-December 2015					
			Marks		Credit
Paper No.	Title of Paper		(External)	(Internal)* *	
	Third Semester				
I*	Genetic Engineering		80	20	4
II*	Plant Physiology and Biochemistry		80	20	4
III*	Environmental and Nutritional Biochemistry		80	20	4
IV*	Advanced Enzymology and Bioinformatics		80	20	4
LC-I	Lab Course I (Based on paper I & II)		80	20	2
LC-II	Lab Course II (Based on paper III & IV)		80	20	2
			Total	**600**	**20**
January 2016-June 2016					
			Marks		Credit
Paper No.	Title of Paper		(External)	(Internal)* *	
	Fourth Semester				
I*	Plant Biotechnology		80	20	4
II*	Seed Science Technology		80	20	4
III*	Clinical Biochemistry		80	20	4
IV*	Advanced Immunology		80	20	4
LC-I	Lab Course I (Based on paper I & II)		80	20	2
LC-II	Lab Course I (Based on paper III & IV)		80	20	2
			Total	**600**	**20**
	OR				
	Project Work***	Dissertation	240	60	11
		Seminar based on Projects	160	40	6
		Viva-voce	80	20	3
		Total		**600**	**20**
		Grand Total		2400	**Credit**: 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 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 (for each Semester)	**Maximum Marks 100**
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

M. Sc. Biochemistry

FIRST SEMESTER

(July 2014 – December 2014)

PAPER- I

CELL BIOLOGY

[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

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)
3. Polytene chromosome
4. Estimation of DNA
5. Estimation of RNA
6. Sub-cellular fractionation and marker enzymes
7. Identification of different biomolecules in different tissues by histochemical techniques

Books Recommended:

H. Lodish, A. Berk, S L Zipursky, P. Matsudaira, D. Baltimore, and James Darnell.	Molecular Cell Biology
B. Alberts, D. Bray, K. Hopkin, A. Johnson	Essential of Cell Biology
H. Lodish, A. Berk, C. A. Kaiser & M. Krieger	Molecular cell Biology [Lodish, Molecular Cell Biology]
B. Alberts, A. Johnson, J. Lewis and M. Raff	Molecular Biology of the Cell
Gerald Karp	Cell and Molecular Biology Concepts and experiments

PAPER- I I

Biomolecules and Enzymology

[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

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)

Books Recommended:

Nelson, Cox and Lehninger	Principles of Biochemistry
G. Zubay	Biochemistry
Stryer	Biochemistry
Garrett and Grosham	Biochemistry
West, Tood, Mason & Bbruglen	Text book of biochemistry
White, Handler & Smith	Biochemistry-clinical application
D. Voet and J C Voet	Biochemistry

PAPER- III

Microbiology

[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

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.

Books Recommended:

Microbiology	L.M. Prescott, J.P. Harley and D.A. Klein
General Microbiology	RY Stanier, J L Ingrahamana, ML Wheelis & P. R. Painter
Principles of Microbiology	R.M. Atlas
Microbiology	Peleczar, Chan & Krieg.
General Virology	Luria, Darnell, Baltimore and Campell.
Introduction to Mycology	CJ Alexopoulos and CW Mims

PAPER- IV

Biology of Immune System

[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT-I Innate immune mechanism and characteristics of adaptive immune response. Cells of immune system: Hematopoisis 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

Books Recommended:

Kuby's Immunology	R.A. Goldsby, T. J Kindt and B. A. Osborne
Immunology- A short Course	E. Benjamini, R. Coico and G. Sunshine
Immunology	Roitt, Brostoff and Male
Fundamentals of Immunology	William Paul
Immunology	Tizard
Immunology	Abbas et al

M. Sc. Biochemistry

SECOND SEMESTER

(January 2015 – June 2015)

PAPER- I

Molecular Biology

[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.)

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: Photoreactivation, 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 plusregulatory DNA sequences, gene activator proteins promote assembly of RNA polymerase and general transcription factors at start point of transcription, gene activator proteinsmodify 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

Books Recommended:

Molecular Cell Biology	H. Lodish, A. Berk, SL Zipursky, P. Matsudaira, D. Baltimore, and James Darnell.
Essential Cell Biology	B. Alberts, D. Bray, K. Hopkin and A. Johnson
Molecular Biology of the Cell	B. Alberts, A. Johnson, J. Lewis and M. Raff
Cell and Molecular Biology Concepts and experiments	Gerald Karp
Molecular Biology of the Gene	JD Watson et al.
Molecular Biology of the Cell The Problems	John Wilson, Tim Hunt
Molecular Biology of the Cell	Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter
Genes VIII	Benjamin Lewin

PAPER- II

Bioenergetics & Metabolism

[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

UNIT-I First and second laws of thermodynamics.Concept of free energy.High – energy compounds, ATP cycle, structural basis of free energy change during hydrolysis of ATP.Other high – energy biological compounds

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 oxidation phosphorylation: electron carriers, complexes I to IV, substrate level phosphorylation, mechanism of oxidative phosphorylation. Shuttle system for entry of electron.
Biosynthesis and degradation of Lipids. Regulation of lipid metabolism

UNIT-IV Nitrogen Assimilation
Biosynthesis of amino acids
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

Books Recommended:

Principles of Biochemistry	Nelson, Cox and Lehninger
Biochemistry	G. Zubay
Biochemistry	Stryer
Biochemistry	Garrett and Grosham
Text book of biochemistry	West, Tood, Mason & Bbruglen
Biochemistry	White,Handler & Smith
Biochemistry with clinical application	D.Voet and J C Voet
Enzymes	Dixon and Webb
Fundamentals of Enzymology	Price and Steven
Practical biochemistry	Plummer
Enzyme biotechnology	G. Tripathi
Enzyme Reaction Mechanism	Walsh
Enzyme catalysis and regulation	Hammes

PAPER- III

Instrumentation

[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

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 applications.
Microscopy: light, phase-contrast, fluorescence and electron microscopy.

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: GM counter, liquid Scintillation counter, solid Scintillation counter, gamma counters.
RIA and Autoradiography: 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 Polyacralamide Gel Electrophoresis
7. DNA electrophoresis
8. Isoenzymes
9. Separation of sub-cellular organelles by differential centrifugation

Books Recommended:

K Wilson and John Walker	Practical Biochemistry: Principles & Techniques
GR Chatwal and SK Anand	Instrumental methods of Chemical Analysis
S. K. Sawhney	Introductory Practical Biochemistry
RF Boyer	Biochemistry Laboratory: Modern Theory & Techniques
S Carson, H Miller and D Scott	Molecular Biology Techniques: A Classroom Laboratory Manual
T C Ford and J M Graham	An Introduction to Centrifugation
TS Work and E Work	Density Gradient Centrifugation, Vol. 6
David Rickwood	Centrifugation Techniques
A Braithwaite and FG Smith	Chromatographic Methods
LR Snyder, JJ Kirkland & JW Dolan	Introduction to Modern Liquid Chromatography
S J Pennycook and PD Nellist	Scanning Transmission Electron Microscopy
DJ Rawlins	Light microscopy
M Hoppert	Microscopic Techniques in Biotechnology
M Hoppert and A Holzenburg	Electron microscopy in microbiology
T Peng, D L Horrocks and E L Alpen	Liquid Scintillation Counting: Recent Applications and Development, Volume I
R Baserga and D Malamud	Autoradiography: techniques and application
T Chard	An Introduction to Radioimmunoassay and Related Techniques , Volume 6,
MD Bruch	NMR Spectroscopy Techniques
B A Wallace and R. William	Modern Techniques for Circular Dichroism and Synchrotron Radiation ..., Volume 1

PAPER- IV
Biostatistics and Computer Applications
[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise).

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 & 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 & 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 & Roy AM	Perspectives on Plagiarism & Intellectual Property in a Post-Modern World

Kumar Anupa P Cyber Law
Sood V Cyber Law Simplified

M. Sc. Biochemistry

THIRD SEMESTER

(July 2015 – December 2015)

PAPER- I

Genetic Engineering

[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.)

UNIT- I Milestones of genetic engineering: isolation of enzymes, DNA sequencing, synthesis and mutation, detection and separation of clones, cloning and patenting of life forms, genetic engineering guide lines.

Molecular tools and their applications: restriction enzymes, modification enzymes.

Molecular techniques: gel electrophoresis, polymerase chain reaction, DNA sequencing, DNA microarray.

UNIT-II Gene cloning vectors: plasmids and transformation, bacteriophages and in vitro packaging, cosmids, artificial chromosomes.

Genomic library: strategies of genomic DNA library construction, transformation, construction of eukaryotic genomic library, screening methods.

cDNA library: isolation and purification of mRNA, first strand synthesis, second strand synthesis, cDNA library construction.

Study of gene regulation: reporter assays

Expression strategies for heterologous genes: vector engineering and codon optimization, host engineering, in vitro transcription and translation.

UNIT-III Processing of recombinant proteins: recombinant proteins purification, refolding, characterization and stabilization

Site directed mutagenesis, protein engineering

Gene knockout technique

UNIT-IV Plant transformation technology: basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanism of DNA transfer, role of virulence genes, use Ti and Ri as vectors, binary vectors, use of 35S and other promoters, genetic markers, use of reporter genes.

Vectorless or direct DNA transfer: particle bombardment, electroporation, microinjection.

Application of plant transformation for productivity and performance, herbicide resistance, insect resistance, virus resistance, long shelf-life of fruits

Lab Course:

1. Bacterial culture and antibiotic selection media. Preparation of competent cells.
2. Isolation of plasmid DNA.
3. Isolation of Lambda phage DNA.
4. Quantitation of nucleic acids.
5. Agarose gel electrophoresis and restriction mapping of DNA.
6. Construction of restriction map of plasmid DNA.
7. Cloning in plasmid/phagemid vectors.
8. Isolation of RNA.
9. Synthesis of cDNA.
10. RAPD analysis by PCR.

Books Recommended:

Genes VIII	Benjamin Lewin
An Introduction to Genetic Engineering	DST Nicholl
Principles of Gene Manipulation and Genomics	SB Primrose and Richard
Gene Cloning and Manipulation	CJ Howe
Genetic Engineering (Genetics and Evolution)	R Hodge
Introduction to Biotechnology & Genetic Engineering	AJ Nair
Genetic Engineering	A Kumar & N Garg
Biotechnology & Genetic Engineering	L Yount
DNA Microarrays & Gene Expression: from Experiments to Data Analysis and Modeling	P Baldi & G Wesley
DNA Sequencing (Intro. to Biotechniques)	L Alphey
Plant transformation Technologies	CN Stewart, A Touraev, V Citovsky & T Tzfira
Application of Plant Biotechnology: In vitro Propagation, Pant Transformation and secondary Metabolite Production	A Kumar and SK Sopory
Genetic Transformation of Plants	JF Jackson & HF Linskens
Transgenic Plants: Methods & Protocols	L Pena

PAPER- II
Plant Physiology and Biochemistry
[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.)

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 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.

Books Recommended:

Fosket DF	Plant Growth & Development
Foyer CH	Photosynthesis
Bacon KE	Photosynthesis: Photobiochem. & 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 and 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

PAPER- III
Environmental and Nutritional Biochemistry
[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.)

UNIT-I Composition of balanced vegetarian and non-vegetarian diets; recommended dietary allowance (RDA) for different categories of the human beings.
Food preservation standards, food adulterations and precautions, government regulations on preservation and quality of food.
Food processing and loss of nutrients during processing and cooking.
Basal metabolism and methods of measuring basal metabolic rate (BMR); energy requirements during growth, pregnancy, lactation and various physical activities.

UNIT- II Nutritional aspects of the carbohydrates, lipids and protein: nutritive value, requirements, and functions.
Nutritional aspects of the vitamins and minerals: requirement and functions
Malnutrition, its implications, relationship with dietary habits and prevention.
Disorders related to the nutrition: Protein energy malnutrition, Starvation, Obesity.

UNIT- III

Environmental Pollution: Types, Outdoor and indoor Air pollution, sources, structure and control strategies. Water and Soil Pollution.
Eco–toxicology and its environmental significance.
Xenobiotic metabolism, Phase I reaction – oxidation – reduction, hydrolysis and hydration. Phase II reaction – conjugation and methylation.

UNIT- IV

Pesticide toxicity – insecticides, fungicides, herbicides and biopesticides.
Toxicology of food additives.
Metal toxicity – arsenic, mercury, lead and cadmium.
Toxicity testing – Test control, genetic toxicity testing.
Occupational toxicology: Occupational hazards and their assessment.

Lab Course:

1. Methods of protein estimation
2. Separation and purification of sub-cellular organelles and assay of marker enzymes.
3. Protein fractionation - salt, solvent and isoelectric precipitation.
4. Methods of purification of an enzyme - ion-exchange, gel filtration
5. Homogeneity test of protein by SDS-PAGE
6. Kinetics of an enzymatic reaction
7. Identification and assay of certain toxicants.
8. Effect of various toxicants on serum enzymes and proteins
9. Effect of various toxicants on liver and kidney metabolism
10. Estimation of carbohydrate, protein and fat in food materials.
11. Titrimetric method of ascorbic acid in fruit.
12. Separation of casein protein from milk

Books Recommended:

S.A. Bbernhard	The structure and function of enzymes
J. Palmer	Enzymes: biochemistry, Biotechnology, Clinical chemistry
M Dixon, EC Webb, CJR Thorne & KF Tipton	Enzymes
Alan Fersht	Enzyme structure and Mechanism
Christopher Walsh	Enzymatic reaction mechanism
LG Corkerhem and BSS Shane	Basic Environmental Toxicology
T Shibamato & L F Bzeidanes	Introduction to Food Technology
Eisenthal and Danson	Enzyme Assay: A Practical Approach
M. Stipanuk	Biochemical, Phys. & Mol. Aspects of Human Nutrition
Tom Brody	Nutritional Biochemistry
DA Bender	Nutritional Biochemistry of the Vitamins
R.L. Pike and M.L. Brown	Nutrition: An integrated approach -
G.P. Talwar	Text book of Biochemistry and Human Biology
DWS Wong	Mechanism and theory in food chemistry
M.S.Banji N P. Rao & V. Reddy	Text book of Human Nutrition
Linten	Nutritional biochemistry and Metabolism

PAPER- IV
Advanced Enzymology and Bioinformatics
[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.)

UNIT-I Isolation and purification of enzymes. General properties and effects of pH, substrate and temperature on enzyme catalysed reactions.
Kinetics of catalysed reaction : Single substrate reactions, bisubstrate reactions, concept of Michaelis - Menten, Briggs Haldane relationship, Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics,
Concept of convergent and divergent evolution of enzyme.
Methods of examining enzyme – substrate complexes

UNIT-II Enzyme Turnover and methods employed to measure turnover of enzymes, significance of enzyme turnover.
Protein – ligand binding, including measurement, analysis of binding isotherms, cooperativity phenomenon, Hill and Scatchard plots.
Multienzyme system : occurrence , isolation & their properties , mechanism of action & regulation;Pyruvate dehydrogenase complex, fatty acid synthetase complexes.
Mechanism of action of lysozyme, chymotrypsin, carboxypeptidase and DNA polymease.

UNIT-III General mechanisms of enzyme regulation.
Allosteric enzymes, sigmoidal kinetics and their physiological significance, symmetrical and sequential modes for action of allosteric enzymes and their significance.
Water soluble enzymes and their coenzymes. Metallo enzymes.
Immobilized enzymes and their industrial applications.
Enzyme modeling; WHATIF, Verify3d, PROSA and DOPE score

UNIT-IV Introduction and Scope of Bioinformatics.
Elementary commands and Protocols, ftp, telnet, http.
Databanks – nucleotide databanks – Genbank, NCBI, EMBL, DDBJ, protein databanks – sequence databanks – PIR, SWISSPROT, TrEMBL, structural databases –PDB, SCOP, CATH, SSEP, CADB, Pfam and GDB.
Search tools.

Lab Course:

1. Methods of protein estimation
2. Separation & purification of sub-cellular organelles & assay of marker enzymes.
3. Protein frationation - salt, solvent and isoelectric precipitation.
4. Methods of purification of an enzyme - ion-exchange, gel filtration
5. Test of homogeneity by SDS-PAG E
6. Kinetics of an enzymatic reaction
7. Identification and assay of certain toxicants.
8. Effect of various toxicants on serum enzymes and proteins
9. Effect of various toxicants on liver and kidney metabolism
10. Enzyme modeling: Validation Criteria by WHATIF, Verify3d, PROSA and DOPE score
11. Verification of Ramachandran Plot: Estimation of interaction energy per residue by PROSA and Verify3D.
12. Enzyme packing quality: Assessed by WHATIF.

Books Recommended:

Brandon and Tooze	Introduction to protein structure
Campell	Discovering Genomics, Proteomics and Bioinformatics,
Dan Gusfield	Algorithms On Strings Trees And Sequences -,
Lesk, A.M	Introduction to Bioinformatics -
Lesk, A.M	Introduction to Protein Architecture
Mcpherson, A.	Introduction of Molecular Crystallography
Mount, D.	Bioinformatics; Sequence and Genome Analysis
Pennington	Proteomics from Protein Sequence to Function
Durbin, Eddy, Anders & Graeme	Biological Seq. Analysis: Probabilistic Models of Proteins & Nucleic Acids
T.K.Attwood & D.P Smith	Introduction to Bioinformatics
S.A. Bbernhard	The structure and function of enzymes
J. Palmer	Enzymes: biochemistry, Biotechnology, Clinical chemistry
M Dixon, EC Webb, CJR Thorne & KF Tipton	Enzymes
Alan Fersht	Enzyme structure and Mechanism
Christopher Walsh	Enzymatic reaction mechanism
LG Corkerhem and BSS Shane	Basic Environmental Toxicology
T Shibamato & L F Bzeidanes	Introduction to Food Technology
Eisenthal and Danson	Enzyme Assay: A Practical Approach
M. Stipanuk	Biochemical, Phys. & Mol. Aspects of Human Nutrition
Tom Brody	Nutritional Biochemistry
DA Bender	Nutritional Biochemistry of the Vitamins
R.L. Pike and M.L. Brown	Nutrition: An integrated approach -
G.P. Talwar	Text book of Biochemistry and Human Biology
DWS Wong	Mechanism and theory in food chemistry
M.S.Banji N P. Rao & V. Reddy	Text book of Human Nutrition
Linten	Nutritional biochemistry and Metabolism

M. Sc. Biochemistry

FOURTH SEMESTER

(January 2016 – June 2016)

PAPER- I

Plant Biotechnology

[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.)

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 & establishment of 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 & homozygous lines.
Protoplast isolation, culture and fusion; selection of hybrid cells and regeneration of hybrid plants; symmetric and asymmetric hybrids, cybrids.
Germplasm conservation: Cryopreservation & slow growth cultures.
Chloroplast Transformation: Advantages, vectors, success; tobacco & 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 & separation of DNA: Agarose gel electrophoresis & spectrophotometer.

Books Recommended:

Razdan MK	Introduction to Plant Tissue Culture
Vasil IK	Plant Cell and Tissue Culture
Bhojwani SS and Razdan MK	Plant Tissue Culture
Fu TJ, Singh G and Curtis WR	Plant Cell & Tissue Culture for the production of Food Ingredients
Hammond, McGarvP & Yusibov	Plant Biotechnology
Singh BD Biotechnology	Expanding Horizons
RH Smith Plant Tissue Culture	Techniques and Experiments
L Kyte and J Kleyn	Plants from Test Tubes: An Introduction to Micropropagation
M Smith	Plant Propagator's Bible
MR Ahuja	Micropropagation of Woody Plants
YPS Bajaj	Trees III
YPS Bajaj	Trees IV

PAPER- II

Seed Science Technology

[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.)

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.

Books Recommended:

J.D. Bewley & M. Black	Physiology & Biochemistry of Seeds
J.D. Bewley & M. Black	Seeds : Physiology of Development & Germination
Black et al.	Desiccation and Survival of Plants : Dying without Drying
P.K. 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

R.L. Agrawal	Seed Technology
J. Kigel & G. Galili	Seed Development & Germination
W. Ayad et al.	Molecular Genetic Techniques for Plant Genetic resources
E.E. Benson	Plant Conservation Biotechnology
D. E. Fosket	Plant Growth & Development
R.B. Taylorson	Recent Adv. in the Development & Germination of Seeds
McDonald & Copeland	Seed Technology Laboratory Manual
Khullar & Thapliyal, R.C.	Forest Seed
L. Schmidt	Guide to Handling of Tropical & Sub-tropical Forest Seed

PAPER- III
Clinical Biochemistry
[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.)

UNIT-I Definition and scope of clinical biochemistry in diagnosis. Units and abbreviations used in expressing concentrations and standard solutions.
Automation in clinical biochemistry, Quality assurance, External and internal quality control measurements.
Collection and preservation of biological fluids (blood, serum, plasma, urine and CSF).

UNIT-II Chemical analysis of biological fluids and normal values for important constituents in blood, plasma/serum urine and CSF.
Electrolyte, blood gases and acid base balance.
Hemoglobinopathies: thalassemias and anaemias, homeostasis and thrombosis, blood clotting mechanism.

UNIT-III Definition of functional and nonfunctional plasma enzymes, isozymes and diagnostic tests.
Enzyme pattern in health and diseases. Clinical significance of plasma lipase, cholinesterase, alkaline and acid phosphatase, SGOT, SGPT, LDH and CPK.
Thyroid functions, diagnostic test for hypo and hyperthyroidism.

UNIT-IV Hypo and hyperglycemia, glycogen storage diseases, Ketone bodies, Glucose tolerance test. Diagnostic tests for apolipoproteins, HDL- cholesterol, LDL- cholesterol and triglycerides disorders.
Evaluation of organ function tests of gastric, pancreas, kidney and liver.
Bilirubin, direct and indirect vanderwaal tests and their clinical significance, fatty liver, jaundice.

Lab Course:

1. Assay of Alkaline and Acid Phosphatase
2. Estimation of blood glucose by GOD and POD method
3. Various types of glucose tolerance tests.
4. Estimation of SGOT, SGPT, LDH and CPK, Serum Amylase enzymes

5. Estimation of HDL- cholesterol, LDL- cholesterol.
6. Estimation of uric acid and creatinine in plasma.
7. Estimation of urin and blood billurubin.
8. Effect of various toxicants on serum enzymes and proteins
9. Effect of various toxicants on liver and kidney metabolism

Books Recommended:

C.A. Burtis, E.R. Ashwood	Tietz fundamentals of clinical chemistry
Whitby, Smith, Beckett, Walker, Harrison	Notes on Clinical Chemistry- Principles of Internal Medicines
S.A. Bbernhard	The structure and function of enzymes
J. Palmer	Enzymes- biochemistry, Biotechnology, Clinical chemistry
Dixon, Webb, Thorne & Tipton	Enzymes
Alan Fersht	Enzyme structure and Mechanism
C. Walsh, F. Pub	Enzymatic reaction mechanism
L. G Corkerhem and B.SS Shane	Basic Environmental Toxicology
T. Shibamato & L F Bzeidanes	Introduction to Food Technology
Eisenthal and Danson	Enzyme Assay: A Practical Approach
M. Stipanuk	Biochemical, Physiological & Molecular Aspects of Human Nutrition

PAPER- IV
Advanced Immunology
[Credit: 4 and Maximum Marks: 80]

(There will be 5 questions of equal marks. First question will be based on complete syllabus with no internal choice, whereas rest questions will be unit wise.)

UNIT- I Clonal selection theory- concept of antigen specific receptor. Organization and expression of immunoglobulin genes. Generation of antibody diversity. Light and heavy chain gene recombination. Recombination Signal Sequences. Heavy chain constant region genes. Class switching. T-cell receptor diversity.

UNIT-II Membrane and secreted immunoglobulins. Production of polyclonal and monoclonal antibodies- principle, technique and applications. Antibody engineering. Regulation of immune response by antigen, antibody, immune complex, MHC and cytokines. Immune response to infectious diseases: viral, bacterial and protozoal. Cancer and immune system. Nutrition and Immune response.

UNIT-III Principles of Immunodiagnosis. Antigen-antibody interactions. Precipitation reactions. Haemagglutination. Complement fixation test. Immunofluorescence assay: Fluorescence activated cell sorter (FACS) technique. Radio Immuno and Enzyme Immuno assays. Immunoblotting. Isolation of pure antibodies. Isolation of leucocyte population on density gradient. Effector cell assays. Plaque forming cell assay, ELISPOT assay, leucocyte migration inhibition technique, cytotoxicity assay.

UNIT-IV Active immunization (immunoprophylaxis): Principles of vaccination. Immunization practices. Passive immunization (immunotherapy). Role of vaccine in prevention of diseases: vaccines against important viral, bacterial, protozoan and parasitic diseases. DNA vaccines; Antiviral, antibacterial agents.

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 & EIA
4. Western Blot Analysis
5. Immunodiagnosis using commercial kits

Books Recommended:

R.A. Goldsby, T.J Kindt & B. A. 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