MSc – Biochemistry

Program Outcomes (POs)

- Understand biochemistry at the atomic level, draw molecules and reaction mechanisms perfectly.
- Understand in detail about amino acid structures, types of amino acids, classifications, structure of proteins and types of proteins.
- Learn the molecular structures of 20 amino acids, differentiating essential and non-essential amino acids, biologically

Course outcomes (COs)

- Student repeat all the tests of UG and following additional tests and skills are also learnt
- DNA and RNA isolation and estimation from blood, plant and bacteria.
- Students are able to analyze to microbial contamination in blood, water, urine etc
- Students are able to handle cell culture labs
- Students are able to analyze molecular disease.
- Learn the significance of structural and storage polysaccharides in nature.
- To study the structures of PG, GAG and other complex Polysaccharides.
- Describe the physiology of the carbohydrate Digestion in mammals.
- Illustrate the metabolism of carbohydrates through various anabolic and catabolic pathways like glycolysis, Kreb's cycle,
- Glycogen metabolism, glucuronic acid cycle etc.
- Relate the structure of DNA with its function in Replication and gene expression that include both transcription and translation.

Pt. Ravishankar Shukla University, Raipur

M. Sc. BIOCHEMISTRY

Scheme and Syllabi of Examination for SESSION 2017-19

July 2017-December 2017				
	First Semester	**Marks**		
Paper	**Title of Paper**	**(External)**	**(Internal)***	**Credit**
I	Cell Biology	80	20	4
II	Biomolecules	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 2018-June 2018				
	Second Semester	**Marks**		
Paper	**Title of Paper**	**(External)**	**(Internal)***	**Credit**
I	Genetics and Molecular Biology	80	20	4
II	Bioenergetics & Metabolism	80	20	4
III	Instrumentation and Molecular Techniques	80	20	4
IV	Biometry, Computer and Scientometry	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 2018-December 2018				
	Third Semester	**Marks**		
Paper No.	**Title of Paper**	**(External)**	**(Internal)***	**Credit**
I	Genetic Engineering	80	20	4
II	Plant Physiology and Biochemistry	80	20	4
III	Nutritional and Environmental Biochemistry	80	20	4
IV	Enzymology	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 2019-June 2019				
	Fourth Semester	**Marks**		
Paper No.	**Title of Paper**	**(External)**	**(Internal)***	**Credit**
I	Plant Biotechnology	80	20	4
II	Seed Science Technology	80	20	4
III	**Special Paper-A:** Clinical Biochemistry and Endocrinology **Special Paper-B:** Nutraceuticals and Functional Foods	80	20	4
IV	**Special Paper-A:** Advanced Immunology, diagnostics and prophylaxis **Special Paper-B:** Bioinformatics	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 questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words.

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 secure 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 I I	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 2017 – December 2017)

PAPER - I: CELL BIOLOGY **[Credit: 4 and Maximum Marks: 80]**

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

UNIT-I Molecular organization of membranes - asymmetrical organization of lipids, proteins and carbohydrates. Osmosis, ion channels, membrane pumps and electrical properties of membranes. Active transport by ATP-powered pumps: types, properties and mechanisms.

UNIT-II Transport of proteins into mitochondria, chloroplast and endoplasmic reticulum. Transport of proteins into and out of nucleus. Transport by vesicle formation: exocytosis, endocytosis and its molecular mechanism.

UNIT-III Cell signaling: Signaling via G-protein linked and enzyme linked cell surface receptors, MAP kinase pathways. Eukaryotic cell division cycle: different phases and molecular events, regulation and control of cell cycle. Apoptosis. Oncogenes and tumor suppressor genes: viral and cellular Oncogenes, retinoblastoma, E2F and p53 proteins.

UNIT-IV Organization of chromosomes: Structure of chromosomes, centromere and telomere. States of chromosomes during cell cycle. Mitotic chromosome. Organization of genes in chromosomes. Banding pattern of chromosomes. Lampbrush and Polytene chromosomes. Chromatin, nucleosomes, DNA packaging, heterochromatin and euchromatin.

Lab Course:

1. Study of chromosome behaviour during Mitosis and meiosis (Onion / Garlic root tips, Onion buds, human lymphocytes, rat or bird testis /grass hopper testis or any other materials).
2. Calculation of mitotic index in growing Onion / Garlic root tips
3. Squash preparation: Polytene chromosome (in chironomus / Drosophila or other insect salivary gland) and Barr body (in buccal epithelial cells).
4. Demonstration of secretory granules in the salivary gland cells of insect.
5. Demonstration of mitochondria by vital staining.
6. Study of permanent slides.
7. Estimation of DNA
8. Estimation of RNA
9. Sub-cellular fractionation and marker enzymes
10. Identification of biomolecules in different tissues by histochemical techniques
11. Preparation of mitotic plate by carmine squashing method and phase identification.
12. Demonstration of the nuclear matrix networks in onion cells.

13. Study of the effect of chemical agents on chromosomes plant cells.
14. Isolation of protoplast, measurement of cell density plating efficiency.
15. Preparation of Karyotype of metaphase plate.
16. Preparation of Meiotic plate and determination of phases.
17. Computation of Chaisma frequency and Terminalization of phases.
18. Micrometry and Camera Lucida drawings.

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
B. Alberts, A. Johnson, J. Lewis and M. Raff	Molecular Biology of the Cell
Gerald Karp	Cell and Molecular Biology Concepts and experiments

M. Sc. Biochemistry

FIRST SEMESTER (July 2017 – December 2017)

PAPER – II: Biomolecules **[Credit: 4 and Maximum Marks: 80]**

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

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

M. Sc. Biochemistry

FIRST SEMESTER (July 2017 – December 2017)

PAPER – III: Microbiology [Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

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, X174, 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 General	L.M. Prescott, J.P. Harley and D.A. Klein
Microbiology Principles of Microbiology	RY Stanier, J L Ingrahamana, ML Wheelis & P. R. Painter
Microbiology General	R.M. Atlas
Virology Introduction to	Peleczar, Chan & Krieg.
Mycology	Luria, Darnell, Baltimore and Campell.
	CJ Alexopoulos and CW Mims

M. Sc. Biochemistry

FIRST SEMESTER (July 2017 – December 2017)

PAPER – IV: Biology of Immune System [Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

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 2018 – June 2018)

PAPER – I: Genetics and Molecular Biology [Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

UNIT- I Mendelian principles: Dominance, segregation, independent assortment. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions.

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

Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis

UNIT-II DNA replication, repair and recombination: Mechanism of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms; Repair of Base-excision, Nucleotide excisions, Mismatch and Double Strand. Guardian of DNA; p_{53} and p_{21}. Homologous and site-specific recombination.

UNIT-III RNA synthesis and processing: transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, elongation, and termination, RNA processing, capping, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport.

UNIT-IV Protein synthesis and processing: Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post Translational modification of proteins. Protein targeting.

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
5. Restriction Mapping
6. Restriction Digestion
7. Ligation
8. DNA molecular size determination

Books Recommended:

Molecular Cell Biology

Essential Cell Biology

Molecular Biology of the Cell Cell and Molecular Biology

: Concepts and experiments

Molecular Biology of the Gene Molecular Biology of the Cell

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

M. Sc. Biochemistry

SECOND SEMESTER (January 2018 – June 2018)

PAPER – II: Bioenergetics & Metabolism [Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

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- Somagy 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

M. Sc. Biochemistry

SECOND SEMESTER (January 2018 – June 2018)

PAPER- III: Instrumentation and Molecular Techniques

[Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

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

Electrophoresis: Paper electrophoresis, Starch gel, agarose, PAGE-type, 2D-E.

UNIT-II Microscopic techniques: light microscopy, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy

Microtomy: types, principle and applications

Lyophilization: Principle, instrumentation and applications

UNIT-III Chromatography: Paper and Thin Layer Chromatography. Gel filtration, Ion exchange chromatography and Affinity chromatography. Gas-liquid chromatography and HPLC. Histochemical and immunotechniques: Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, *In situ* localization; FISH and GISH.

Radioactivity: GM counter, liquid Scintillation counter, solid Scintillation counter, gamma counters

UNIT-IV Molecular techniques: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, separation methods; RNA, DNA and proteins; 1-D and 2-D, isoelectric focusing gels; Molecular cloning of DNA and RNA fragments in bacterial systems; Expression of recombinant DNA; DNA sequencing. Gene expression; mRNA, cDNA using PCR and qRT-PCR. Micro array based techniques.

Molecular Markers for diversity analysis: RFLP, RAPD, AFLP, VNTR, SSR, ISSR, SNP, DArT.

Lab Course:

Verification of Beers Law

Determination of absorption maxima

Quantitative determination, Enzyme kinetics

Amino acid and carbohydrate separation by paper and TLC Ion exchange and gel filtration chromatography

SDS Polyacralamide Gel Electrophoresis

DNA electrophoresis
Isoenzymes
Separation of sub-cellular organelles by differential centrifugation. Isolation of DNA and Agarose gel Electrophoresis
Amplification of RAPD and AFLP markers.
Isolation of RNA and Electrophoresis of RNA on denaturing gels. cDNA synthesis and cloning
Isolation of Protein and SDS-PAGE
In vitro DNA ligation, transformation of E. coli
Characterization of transformants: DNA gel electrophoresis, Restriction map analysis

Books Recommended:

K Wilson and John Walker	Practical Biochemistry: Principles & Techniques
RF Boyer	Biochemistry Laboratory: Modern Theory & Techniques
S Carson, H Miller and D Scott	Molecular Biology Techniques: A Classroom Laboratory Manual
TC Ford and J. M. Graham	An Introduction to Centrifugation
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
BA Wallace and R William	Modern Techniques for Circular Dichroism and Synchrotron Radiation, Volume 1
J Sambrook, EF Rritsch and I Maniatis	Molecular cloning: A Laboratory Manual
PD Dabre	Introduction to Practical Molecular Biology
JD Watson, NH Hopkins, JW Roberts, JA Steitz and AM Weiner	Molecular Biology of Gene (4^{th} Edition)
J Darnell, H Lodish and D Baltimore	Molecular Cell Biology (2^{nd} Edition)
B Alberts, D Bray, J Lewis, M Raff, K Roberts and JD Watson	Molecular Biology of the Cell (2^{nd} Edition)
Benjamin Lewin	Gene VII
JM Walker and R Rapley	Molecular Biology and Biotechnology
SB Primrose	Molecular Biotechnology

M. Sc. Biochemistry

SECOND SEMESTER (January 2018 – June 2018)

PAPER- IV: BIOMETRY, COMPUTER AND SCIENTOMETRY

[Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

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 and Yahoo; Pub med, Scopus, Web of Science, Google Scholar, Indian 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
Zar JH
Wardlaw AC
Snedecor GW & Cochran WG Sokal RR & Rohlf FJ
Sumner M White R Cassel P et al.
Coleman P and Dyson P Gralla P

Shelly GB, Vermaat ME, Cashman TJ

Statistics for biologists
Biostatistical Analysis
Practical Statistics for Experimental Biologists
Statistical Methods
Introduction to Biostatistics
Computers: Concepts & Uses
How Computers Work
Inside Microsoft Office Professional
Mastering Internets
How the Internet Works
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 2018 – December 2018)

PAPER – I: Genetic Engineering [Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

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.

Vector-less 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

M. Sc. Biochemistry

THIRD SEMESTER (July 2018 – December 2018)

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

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

UNIT- I Membrane transport: Pumps; F-type H^+-ATPase mitochondria, P-type PM H^+ - ATPase, V-Type H^+ -ATPase, and ABC type. Ion Channels; Voltage gated channels of K and Ca. Water transport through Aquaporins.

Physiology of Mineral Nutrition: Molecular mechanism and regulation of K, Fe and Zn transport. Phosphorous nutrition and transport. Phytoremediation. Mineral toxicity

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

M. Sc. Biochemistry

THIRD SEMESTER (July 2018 – December 2018)

PAPER- III: Nutritional and Environmental Biochemistry

[Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

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. Separation and purification of sub-cellular organelles and assay of marker enzymes.
2. Protein fractionation - salt, solvent and isoelectric precipitation.
3. Identification and assay of certain toxicants.
4. Effect of various toxicants on serum enzymes and proteins
5. Effect of various toxicants on liver and kidney metabolism
6. Estimation of carbohydrate, protein and fat in food materials.
7. Titrimetric method of ascorbic acid estimation in fruit.
8. Separation of casein protein from milk

Books Recommended:

LG Corkerhem and BSS Shane	Basic Environmental Toxicology
T Shibamato & L F Bzeidanes	Introduction to Food Technology
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

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THIRD SEMESTER (July 2018 – December 2018)

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

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

UNIT-I Isolation and purification of enzymes. General properties and effects of pH, substrate and temperature on enzyme catalyzed reactions.

Kinetics of catalyzed 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 Enzymes of Industrial Importance; their source, characteristic properties, functions and uses.

Enzymes used in leather, paper, textile industries.

Enzymes in baking, brewing, Alcohol products; enzymes in detergents, starch and animal feeds.

Amylases, cellulases, catalase, pectinase, lipase, protease, xylanase, laccase, beta glucanase

Lab Course:

1. Estimation of enzymes
2. Separation, purification of sub-cellular organelles & assay of marker enzymes.
3. Methods of purification of an enzyme - ion-exchange, gel filtration
4. Test of homogeneity by SDS-PAG E
5. Kinetics of an enzymatic reaction

6. Effect of various toxicants on serum enzymes and proteins
7. Enzyme modeling: Validation Criteria by WHATIF, Verify3d, PROSA and DOPE score
8. Verification of Ramachandran Plot: Estimation of interaction energy per residue by PROSA and Verify3D.
9. 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 Protein Architecture
Mcpherson, A.	Introduction of Molecular Crystallography
Pennington	Proteomics from Protein Sequence to Function
Durbin, Eddy, Anders & Graeme	Biological Seq. Analysis: Probabilistic Models of Proteins & Nucleic Acids
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
Eisenthal and Danson	Enzyme Assay: A Practical Approach
M. Stipanuk	Biochemical, Phys. & Mol. Aspects of Human Nutrition
G.P. Talwar	Text book of Biochemistry and Human Biology

M. Sc. Biochemistry

FOURTH SEMESTER (January 2019 – June 2019)

PAPER – I: Plant Biotechnology **[Credit: 4 and Maximum Marks: 80]**

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

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

M. Sc. Biochemistry

FOURTH SEMESTER (January 2019 – June 2019)

PAPER- II: Seed Science Technology **[Credit: 4 and Maximum Marks: 80]**

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UNIT- I Seed development: Phases of development, Maturation; accumulation of desiccation related compounds, ABA regulation. Seed Dormancy: Physiological and molecular basis, Testa, Endosperm, Aleurone layers & Hormonal cross talk in dormancy. Alleviation of dormancy; Protein oxidation. Dormancy breaking chemicals and mechanism.

UNIT-II Seed Germination: Pre-germination, Germination and post germination Metabolism. Reactivation of the metabolic pathway. Cellular repair. Hormonal regulation and metabolism; GA & ABA, ROS metabolism.

UNIT-III Seed Ageing: Seed storage physiology: Orthodox & Recalcitrant; ROS metabolism, Mechanism of desiccation tolerance, dehydrins/LEA/peroxiredoxin, HSPs, Sugars. Longevity markers; β- mercaptopyruvate sulfurtransferase (MST), L –isoaspartyl O-methyltransferase (PIMT).

UNIT-IV Seed Technology: Priming technology; biochemical and molecular aspects. Cryobanks, Cryopreservation of seed and embryo; Cryoprotective molecules, Vitrification, Encapsulation and Drying. Synthetic seeds.

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

M. Sc. Biochemistry

FOURTH SEMESTER (January 2019 – June 2019)

Special Paper PAPER - III (A): Clinical Biochemistry and Endocrinology

[Credit: 4 and Maximum Marks: 80]

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UNIT-I Plasma proteins – Properties, functions and their variations in diseases, Plasma lipids and lipoproteins, Interrelationship of lipids, lipoproteins and apolipoproteins. Erythropoiesis, abnormalities in blood formation. Anemias. Heamoglobinopathies. Cerebrospinal fluid – composition in health and diseases.

Clinical enzymology - Plasma enzymes in diagnosis and prognosis, Isoenzymes in health and diseases (Liver, cardiac and skeletal muscle enzymes)

UNIT-II Liver function tests, their significance, Liver diseases – Jaundice, hepatitis, gall stones, cirrhosis and fatty liver. Free radical mechanism and role of reactive oxygen species in diseases. Role of liver in metabolic regulation and drug metabolism. Clinical chemistry of new born.

Kidney – Renal hormones –Renin, erythropoietin and angiotensin. Investigations of renal functions, biochemical investigation of renal disorders. Nephritis, nephrotic syndrome and urolithiasis. Compensatory mechanism for acidosis and alkalosis.

Gastrointestinal hormones - Gastrin, secretin and cholecystokinin. Disorders of gastric function, methods of evaluation. Pancreatic exocrine secretions, pancreatic diseases, steatorrhoea. Malabsorption syndrome – tests for their evaluation and significance.

UNIT-III Pancreatic hormones – Biosynthesis of insulin, regulation of secretion of insulin and glucagon, their role in carbohydrate ,lipid and protein metabolism. Endocrine disorders of pancreas – Diabetes mellitus, melliturias, hypoglycemia. Glucose tolerance test.

Thyroidal hormones – Chemistry, function and metabolism. Hypo and hyper thyroidism, tests for thyroid function. Parathyroid hormones – Parathormone and calcitonin, their role in calcium and phosphate metabolism, abnormalities of parathyroid functions and methods of evaluation.

Adrenals - Chemistry and biosynthesis of adrenal medullary and adrenal cortical hormones . Disorders of adrenal cortex and adrenal medulla, tests for the evaluation of adrenal functions. Biochemical effects of tumours.

UNIT-IV Synthesis, secretion, transport and biological actions of hypothalamic, adenohypophysial and neurohypophysial hormones. Hypothalamic disorders. Pituitary - Clinical syndromes and their evaluation. Penial hormones – Melatonin and serotonin. Chemistry, biosynthesis and role of androgens, estrogens and progesterone. Hormonal regulation of menstrual cycle, Hormonal contraception. Placental hormones. Biochemistry of reproductive disorders, pregnancy toxemia, pregnancy tests.

Lab Course:

1. Assay of Alkaline and Acid Phosphates
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 urine and blood billurubin.
8. Effect of various toxicants on serum enzymes and proteins
9. Effect of various toxicants on liver and kidney metabolism
10. Purification of protein hormones
11. Assay of steroid dehydrogenase
12. Isolation and characterization of steroid
13. Sperm count
14. Demonstration of estrus cycle study by vaginal smear technique
15. Histological / Histochemical / Cytological study of Endocrine gland

Books Recommended:

Experimental Endocrinology: Zarrow, M.X; Yochin, J.M and Machrth, J.I

Essential techniques in reproductive physiology and Endocrinology: Chinoy, N.J, Rao, M.V, Desarai, K.J and High land, H.N

Biochemistry: L. Stryer

Textbook of Biochemistry with Clinical Correlations: T.M. Devlin

Lippincott's Illustrated Reviews in Biochemistry: P.C.Champe, R.A.Harvey and D.R.Ferrier

Harper's Biochemistry: R.K.Murray, D.K.Granner, P.A. Mayes and V.W.Rodwell.

Clinical Laboratory Science Review: Robert R. Harr

Fundamentals of Clinical Chemistry: C.A. Burtis, E.R. Ashwood Tietz

Notes on Clinical Chemistry- Principles of Internal Medicines: Whitby, Smith, Beckett, Walker, Harrison

The structure and function of enzymes: S.A. Bbernhard

Enzymes- biochemistry, Biotechnology, Clinical chemistry: J. Palmer

Enzymes: Dixon, Webb, Thorne & Tipton

Enzyme structure and Mechanism: Alan Fersht

Enzymatic reaction mechanism: C. Walsh, F. Pub

Basic Environmental Toxicology: Basic Environmental Toxicology: L. G Corkerhem and B.SS Shane

Introduction to Food Technology: T. Shibamato & L F Bzeidanes

Enzyme Assay: A Practical Approach: Eisenthal and Danson

Biochemical, Physiological & Molecular Aspects of Human Nutrition: M. Stipa

M. Sc. Biochemistry

FOURTH SEMESTER (January 2019 – June 2019)

Special Paper: PAPER- III (B): Nutraceutical Biochemistry and Functional Foods

[Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

Unit-I: Introduction to Nutraceuticals as Science:

Historical perspective, classification, scope and future prospects. Scrutinising the term 'nutraceutical', Regulation of various countries. Medicinal Plants: Ethnomedicine in India, Applied aspects of the Nutraceutical Science. Sources of Nutraceuticals. Relation of Nutraceutical Science with other Sciences: Medicine, Human physiology, genetics, food technology, chemistry and nutrition

Unit-II: Properties, structure and functions of various Nutraceuticals:

Glucosamine, Octacosanol, Lycopene, Falvanoids, Carnitine, Melatonin and Ornithine alpha, ketoglutarate. Use of proanthocyanidins, grape products, flaxseed oil as Nutraceuticals.

Nutraceutical Industry and Market Information, New technologies in development of Nutraceuticals and functional foods

Functional Foods, Scope of Genetic engineering, Nutritional Genomics

Unit-III: Food as remedies

Nutraceuticals bridging the gap between food and drug, Special Dietary Needs, Disease and Nutrition; Nutraceuticals in treatment for cognitive decline, Nutraceutical remedies for common disorders like Arthritis, Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis,

Psoriasis and Ulcers etc. Brief idea about some Nutraceutical rich supplements e.g. Bee pollen, Caffeine, Green tea, Lecithin, Mushroom extract, Chlorophyll, Kelp and Spirulina etc.

Unit-IV: Anti-nutritional Factors present in Foods

Types of inhibitors present in various foods and how they can be inactivated. General idea about role of Probiotics and Prebiotics as nutraceuticals. Recent advances in techniques & feeding of substrates. Assessment of nutritional status and Recommended Daily allowances.

Lab Course:

Identification using characteristic features of nutracuetically important plants like; *Phyllanthus emblica, Curcuma longa, Zinziber officinalis*, Solanaceae (*Withania somnifera)*, *Aloe vera*, Lilliaceae (*Alium sativum*), Lamiaceae (*Ocimum sanctum*), Apiaceae (*Coriandrum sps*) and Liliaceae (*Asparagus sps.*), *Centella asiatica*.

Study of following Parasites/ Vectors/ pests: Identification, Habits and control measures (museum Specimens / slides): *Entamoeba histolytica, Taenia sps, Ascaris lumbricoides, Ancylostoma dueodenaei, Trichinella spiralis, Trichura trichuris,* Mosquito (*Culex and Anopheles*), House fly, Green bottle fly, Head Louse, Cockroach (*Periplanata & Blatta*), bed bug, *Mus* sps. (Mouse) and *Rattus* sps. (House rat)

Reactions of mono, di and polysaccharides and their identification in unknown mixtures

Determination of Acid value, Saponification and Iodine number of natural fats & oils.

Estimation of proteins with Bradford's and other methods.

Extraction and estimation of total sugars from food products (dairy product, fruit juices, bread).

TLC separation of Plant pigments – Curcumin and carotene.

To isolate DNA and RNA from given plant/ animal material and estimate DNA by Diphenylamine (DPA) method and RNA by Orcinol reagent

Extraction, purification and evaluation of activity of any one digestive enzyme (e.g. Beta amylase from sweet potato)

Estimation of ascorbic acid from lemon & amla juice by titration method

Estimation of crude fat contents of foods by Soxhlet's method (Butter, Margarine, edible oil).

Estimation of total Nitrogen of foods by Kjeldahl and Micro Kjeldahl methods.

Chromatography: Paper, TLC, adsorption, ion exchange, gel filtration, affinity, GC & HPLC.

Separation of Milk proteins on Native and SDS gels.

Preparation of plasmid DNA from given sample and its digestion by restriction enzymes and separation of DNA fragments by gel electrophoresis

Books Recommended:

01. Stryer E.A., Biochemistry
02. Zubay, Geoffrey L. Biochemistry,
03. Greenberg David M. Metabolic Pathways, Vol 3
04. Todd and others, Clinical Diagnosis and Management, 17th Ed,
05. Gopalan C., et al Dietary Allowances for Indians, NIH, Hyderabad.
06. Anita F.P. Clinical Dietetics and Nutrition, 4th Ed, 1997,
07. Devlin, T.M. Text Book of Biochemistry with Clinical Correlation,
08. Mahan, L.K. & Ecott- Stump, S. [Ed.] Krause's Food, Nutrition and Diet Therapy
09. Lehninger Nutrition Concepts & Controversies,
10. Davidson, S. Passmore, & Turswell Nutrition and dietetics by
10. Goodhearth R., S. Shills Modern Nutrition in health and disease by.
12. Nelson and Cox, 2000, Lehninger's Principles of Biochemistry,
13. Robert E.C. Wildman, Handbook of Nutraceuticals and Functional Foods
16. Rapport and B. Lockwood Nutraceuticals
15. W. Jeffrey, Hursts Methods of Analysis for Functional Foods and Nutraceuticals
16. M. Maffei (Ed.) Dietary Supplements of Plant Origin
17. Gunzler and Williams Handbook of Analytical Techniques Vol. I,II ,
18. Thomson Herbal Medicines PDR 3rd ed. -
19. Gary, M & Giintert, E.Active Compounds in Foods Chemistry and Sensory Properties - l
20. Israel Goldberg Functional foods, designer foods, pharma foods,

Nutraceuticals,
21. P.D. Dabre — Introduction to Practical Molecular Biology,
22. Ellyn Daugherty — Biotechnology Science for the new Millennium,
23. T K Attwood, D J PSmith — Bioinformatics Introduction -.
24. Primrose and RM Twyman — Principals of Gene Manipulation and Genomics.
25. Massimo Maffei — Dietary Supplements of Plant origin: a nutrition and health approach
27. CCRUM — Herbal Drugs: Potential Antimalarial Herbal Drugs from South Asia.

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FOURTH SEMESTER (January 2019 – June 2019)

Special Paper: PAPER- IV (A): Advanced Immunology, diagnostics and prophylaxis

[Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

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

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FOURTH SEMESTER (January 2019 – June 2019)

Special Paper: PAPER- IV (B): Bioinformatics

[Credit: 4 and Maximum Marks: 80]

(Each theory paper will have questions divided into four sections, A, B, C & D. Section A will have 20 MCQ of 1 mark each covering whole syllabus. Section B will have 8 very short answer questions, two from each unit, of 2 marks each to be answered in two to three lines. Section C will have 8 questions, two from each unit, of 3 marks each. The question has to be answered in about 75 words. Section D will have 4 questions, one from each unit with internal choice, of 5 marks each. The question has to be answered in about 150 words).

Unit I Introduction to bioinformatics and data generation

Bioinformatics and its relation with molecular biology. Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pub med, PDB) and software (RASMOL, Ligand Explorer).

Data generation; Generation of large scale molecular biology data. (Through Genome sequencing, Protein sequencing, Gel electrophoresis, NMR Spectroscopy, X-Ray Diffraction, and microarray). Applications of Bioinformatics.

Unit II Biological Database and its Types

Introduction to data types and Source. Population and sample. Classification and Presentation of Data. Quality of data, private and public data sources. General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDB sum)

Unit III Data storage and retrieval and Interoperability

Flat files, relational, object oriented databases and controlled vocabularies. File Format

(Genbank, DDBJ, FASTA, PDB, SwissProt). Introduction to Metadata and search; Indices, Boolean, Fuzzy, Neighboring search. Data exchange and integration. Ontologies, interchange languages and standardization efforts. General Introduction to XML, UMLS, CORBA, PYTHON and OMG/LIFESCIENCE.

Unit IV Gene Expression and Representation of patterns and relationship

General introduction to Gene expression in prokaryotes and eukaryotes, transcription factors binding sites. SNP, EST, STS.

Regular Expression, Hierarchies, and Graphical models (including Marcov chain and Bayes notes). Genetic variability and connections to clinical data.

Lab Course:

01. Retrieval of sequences from NCBI, EBI and EMBL databases.
2. Retrieval of sequences from NBRF-PIR, SWISSPROT and P databases.
3. Transition and Translation of sequences.
4. Retrieval of genome from genome databases.
5. Exploring DIP and PPI.
6. Exploring BIND and PIM.
7. Exploring MINT and GRID.
8. Analysis of phylogenetic tree
9. Exploring PDB file.
10. Analysis of active site by pymol

Books Recommended:

BAXEVANIS, AD & OUELLETTE, BFF : Bioinformatics: a practical guide to the analysis of genes and proteins. 2nd Ed.. 2002.

BAXEVANIS, AD, DAVISON, DB, PAGE RDM & PETSKO, GA : Current protocols in bioinformatics. 2004.

ORENGO, C, JONES, D & THORNTON, J : Bioinformatics: genes, proteins and computers. 2003

Ingvar Eidhammer, Inge Jonassen, William R Taylor : Protein Bioinformatics. 2003

HIGGINS, D & TAYLOR,
W David Mount

: Bioinformatics: sequence, structure, and databank. 2000.
: Bioinformatics: sequence and genome analysis. 2004