DEPARTMENT OF BIOCHEMISRTY

Syllabus for Two Years Master Degree Course

(To be implemented from the Academic Year 2020 onwards)

CHOICE BASED CREDIT SYSTEM

M.Sc. – BIOCHEMISTRY

YBNUNIVERSITY

Established by the Act of Government of Jharkhand Act 15, 2017
Gazette Notification No. 505, Dated 17th July 2017
As per Section 2(f) of UGC Act. 1956

Our Vision

The vision of the Biochemistry Dept. is to be a centre of excellence in the discipline of biochemistry by producing:
Quality students trained in the latest tools and technologies and striving to make university a world leader in the area of biochemistry.
To propagate the culture of innovation and creativity in biochemistry and related fields.
To achieve academic excellence in biochemistry of imparting in-depth knowledge to the students, facilitating research activities and cater to the ever changing industrial demand & societal needs.
To develop the sense of responsibility regarding community service and society.

Our Mission

To create, through participatory management, a working environment in which everyone can develop to his or her full potential.
To nurture ample knowledge in concepts and principles of biochemistry to the students.
To identify local and global issues that need intervention by a biochemist and develop intelligent strategies and biochemical approaches in problem solving situations
To provide opportunities to get hands on experience in research oriented education in Biochemistry, Molecular Biology, Immunology and Biotechnology, apprenticeship in industries and service agencies and entrepreneurship in biochemistry-related areas.

Introduction to program

A two years M.Sc. programme is formulated for developing competent Biochemists. The course is based on choice based credit system (CBCS) and interdisciplinary nature of Biochemistry.
M.Sc. in Biochemistry is a 2 Year full time Post graduate course at YBN University, Jharkhand that is dedicated for providing an atmosphere to acquire skills in identifying the link between biological and human resources and transform it to enhance the quality of life. A two-year program will lead to the award of a M.Sc. degree in Biochemistry. Students will be offered advanced level theory and practical courses in subjects like Proteins, Cell biology, Immunology and Immunotechniques, Enzymes and their Biotechnological applications, Molecular biology, Recombinant DNA technology and applications in Biotechnology, Developmental biology, Proteomics and Metabolomics and advanced techniques in genomics.
The course content is designed to cover all aspects of Biochemistry and practical orientation for biochemical methods. The exhaustive training in biochemical methods and sound theoretical background is intended to make the student an appropriate candidate to not only take up either teaching or pursuing doctoral research but also competent enough to work in pharmaceutical, R&D and diagnostic labs, agricultural research intuitions, and various medical and allied institutions and industries.
The program of M.Sc. in Biochemistry I designed to render the basic and advance study for the aspiring students. Students are also required to present critical reviews of various topics in the form of elaborate seminars/ assignments. Several quality improvement events like seminars by external experts, symposiums, poster presentations, scientific essay writing, science quiz, etc are regularly organized. In addition, university provides students job training /project work in industry or Research institutes which helps to get job in respective discipline.

Program Specific Objective

Two years M. Sc. program is formulated for programme objectives:
The foremost objective of the programme is to empower students with clear understanding of the basic concepts of biochemistry and provide them knowledge of the recent advances so that they can independently assess the vast scope in the field.
The programme aims to train students to enable them to apply biochemical principles, theoretically and experimentally, to understand various complex life processes, while providing biotechnological solutions to combat various human diseases.
It is expected that at the time of completion of the programme each student is confident and independent in their thought processes and can make an informed choice about their subsequent career.
The program is expected to motivate students for higher education, especially research and provide trained manpower for biotechnology industry.
They are expected to be ethically sound and ready for the next phase of their development, skilled in the art of self-reading, oration and scientific writing.

Programme outcome

A two years M.Sc. programme is formulated for developing competent Biochemists. The course is based on choice based credit system (CBCS) and interdisciplinary nature of Biochemistry, Chemistry, Quantitative Biology, Genetics and Microbiology.
The programme obliges students to read original publications and envisages significant inputs in Laboratory work, communication skills, creativity, planning, execution and critical evaluation of the scientific data.
The course titles have been carefully chosen to represent the core courses and the specialization introduced in the two years course of Biochemistry are :- Enzymology, Molecular Biology, Biotechnology, Clinical Biochemistry, Nutritional Biochemistry and Immunology inconsonance with the objectives of the University.
The courses formulated have a biochemical slant than biological and are up to date. The course is fine tuned in order to enhance the job opportunities of the students.

Programme Specific Outcomes (PSOs)

A post-graduate student upon completion of the programme is expected to gain the following attributes:

PSO: 1 In-depth knowledge of Biochemistry with inter-disciplinary perspective of other branches of life sciences. Competence for research and innovation in Biochemistry and Biotechnology as a skilled experimentalist.
PSO: 2 Analytical and problem solving skills with regard to biochemical principles of life processes and technologies for combating human diseases.
PSO: 3 Critical thinking about the concepts in Biochemistry and ability to critically review scientific literature for development of new theories and testable hypothesis.
PSO: 4 Capacity for decision making with regard to scientific progress, personal development and career choice.
PSO: 5 Ability to work independently, while still promoting team work and collaboration skills.
PSO: 6 Oratory (public speaking), scientific conversation and writing skills.
PSO: 7 Leadership and organizational skills.
PSO: 8 Demonstration of integrity, honesty, ethical behavior and sense of responsibility.
PSO: 9 Appreciation of diversity in scientific community and responsibility towards society and nation.
PSO: 10 Environmental awareness vis-à-vis bio-waste generation, disposal and management and safety and security issues

COURSES OF STUDY POSTGRADUATE M.Sc. BIOCHEMISTRY PROGRAMME

Subject combination allowed for M.Sc. Programme (80 Credits)

Fundamental Course **FC** **1 Paper**	Core Subject **CC** **11 Papers**	Ability Enhancement Course **AE** **1 Paper**	Discipline Centric Elective/ Generic Elective Course **DC/ GE/ EC/** **3 Papers**

Semester wise Examination Structure for Mid Sem. & End Sem. Examinations:

Sem	Core, AE/ GE/ DC/ EC & Compulsory FC Course				Examination Structure		
	Paper	**Paper Code**	**Credit**	**Name of Paper**	**Mid Semester Evolution (F.M.)**	**End Semester Evolution (F.M.)**	**End Semester Practical Viva (F.M.)**
I	Fundamental Course	1Y2BCH101	5	Physico- Chemical Aspects of Biology	30	70	----
	Core Course	1Y2BCH102	5	Analytical Biochemistry	30	70	----
	Core Course	1Y2BCH103	5	Biomolecules	30	70	----
	Practical's On Core	1Y2BCH104P	5	Practical's on Core	----	----	70 + 30
II	Elective	1Y2BCH201	5	Enzymology/Cell Biology &Endocrinology/ Biological Macromolecules	30	70	----
	Core Course	1Y2BCH202	5	Metabolism of Fuel Molecules	30	70	----
	Core Course	1Y2BCH203	5	Medical Biochemistry	30	70	----
	Practical's On Core	1Y2BCH204P	5	Practical's on Core	----	----	70 + 30
III	Ability Enhancement Course	1Y2BCH301	5	Biostat, Bioinformatics and Drug Discovery	30	70	----
	Core Course	1Y2BCH302	5	Immunology	30	70	----
	Core Course	1Y2BCH303	5	Plant Biochemistry	30	70	----
	Practical's On Core	1Y2BCH304P	5	Practical's on Core	----	----	70 + 30
IV	Elective	1Y2BCH401	5	Molecular Biology/ Clinical Bioche. and Dietics	30	70	----
	Elective	1Y2BCH402	5	Biochemical Genetics and Gene regulation/ Genetic engineering and Biotech	30	70	----
	Practical's On Elective	1Y2BCH403P	5	Molecular Biology & Clinical Bioche/ Genetic engineering & Biotechnology	----	----	70 + 30
	PROJECT	1Y2BCH404PR	5		----	----	70 + 30

Semester Wise Distribution of Course

	COURSE	CREDIT	Hrs/Week
I	**FC (Compulsory) –FC-1)** **Core Course -1 (CC-1)** **Core Course -2 (CC-2)** **Core Course (P) -3 (CC (P)-3)**	**5** **5** **5** **5**	**5 (L) +1 (T)** **5 (L) +1(T)** **5 (L) +1(T)** **10**
II	**Elective Course (SE) (EC-1)** **Core Course -4 (CC-4)** **Core Course -5(CC-5)** **Core Course (P) -6 (CC (P)-6)**	**5** **5** **5** **5**	**5 (L) +1 (T)** **5 (L) +1(T)** **5 (L) +1(T)** **10**
III	**Core Course -7 (CC-7)** **Core Course -8 (CC-8)** **Elective (GE/DC) [EC-2]** **Elective Course (P) -3[EC (P)-3]**	**5** **5** **5** **5**	**5 (L) +1 (T)** **5 (L) +1(T)** **5 (L) +1(T)** **10**
IV	**Core Course -9 (CC-9)** **Elective (GE/DC) [EC-4]** **Elective Course (P) -5[EC (P)-5]** **Project**	**5** **5** **5** **5**	**5 (L) +1 (T)** **5 (L) +1(T)** **5 (L) +1(T)** **10**

YBN UNIVERSITY RANCHI

COURSE STRUCTURE OF M.Sc. BIOCHEMISTRY FIRST SEMESTER													
Course Details				**External Assessment**		**Internal Assessment**				**Credit Distribution**			**Allotted Credits**
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max Marks	Min. Marks	Max. Marks	Min. Marks				
1Y2BCH101	Foundation Course	Physico-Chemical Aspects of Biology	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH102	Core Course-I	Analytical Biochemistry	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH102	Core Course-II	Biomolecules	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH103P	Core Course-III Practical	Practical's on Core	100	50	17	20	07	30	10	-	-	10	5
GrandTotal		**400**											**20**

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End
Theory Exam Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

SEMESTER-I

Fundamental Course - Compulsory (FC-1)

Course Code: 1Y2BCH101

PHYSICO-CHEMICAL ASPECTS OF BIOLOGY

(5 Credits: 70Hrs)

Atoms and Chemical bonds: Electron theory of valence. Hybridization of chemical bonds. Hybrid orbitals and hybrid molecules. Hydrophobic interactions and Van der waals interaction. Covalent bond, coordinate bond, coordinate bond formation in transition metals. Crystal field theory, ligand field theory, valence bond theory. Structure, bonding and special properties of water. Bonding of iron in hemoglobin and cytochromes, cobalt in Vit B12, magnesium in chlorophyll. Chelates: Types of ligands and complexes.
ligands and complexes. 17 Hrs

Stereochemistry: Isomerism, types of isomers. Importance of stereochemistry, position and order of groups around carbon. Geometric and optical isomerism, absolute and relative configuration. Symmetry view of chirality, relation between chirality and optical activity, representation of chiral structures by Fischer. Structure and stereochemistry of glucose; anomer, epimer,enantiomer,
stereoisomer, D and L, + and -, R and S notation and stereochemistry of amino acids. 13 Hrs

Mechanism of organic reactions: Characteristic aspects of ionic, radical and concerted reactions. Classification of rearrangement reactions. Energy profiles of reactions, transition state theory. Mechanisms and stereochemistry of substitution (electrophilic and nucleophilic- SN1 and SN2 reactions), addition, elimination and rearrangement reactions. Mechanisms of ester hydrolysis,
property of aromaticity and resonance. 15 Hrs

Heterocyclic systems: Occurrence in biological systems, structure and properties of Furan, Pyrrole. Indole, Thiazole, Imidazole, Pyridine, Pyrimidine, Purine, Quinine, Pteridine and Isoalloxazine. Chemistry of porphyrins and heme.

8Hr

Secondary metabolites:Structure, properties and importance of phytochemicals; Terpenes, Polyphenols, Procyanidins, Flavonoids, Xanthones, Alkaloids and Pigments. 5Hr

FreeRadicals: Introduction to free radicals. Generation and reaction of free radicals with biological materials and their adverse effects. 5Hrs

Thermodynamics: Basic concepts of entropy, free energy changes, standard free energy change and its relation to equilibrium constant, oxidation-reduction reactions, oxidation reactions in biological systems. 8 Hrs

REFERENCES

1) Physical Biology of the Cell,2nd Edn.Rob Phillips,Jane Kondev, Julie Theriot,HernanGarcia,Garland Publishers(2012).
2) Bioinorganic Chemistry; Ei-Ichiro Ochiai, Elsevier (2008).
3) Physical Biochemistry. Kansal Edward Van Halde. Prentice Hall.
4) Physical Biochemistry. David Frrifielder. 2nd Edn. W.G. Freeman and Co
5) Biochemical Calculations, Irwin H. Segel (1976) 2nd Ed. John Wiley and Sons.
6) Introduction to Biophysical Chemistry, Bruce Martin
7) Organic Chemistry. R.T. Morrison and R.N. Boyd.6thEdn. Prentice Hall, India
8) Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6thEdn. Macmillan Publications (2012).
9) Biochemistry-The Chemical Reactions of Living Cells. David Metzler, 2ndEdition, Academic Press

SEMESTER-I
Core Course-1 (CC-1) Course
Code: 1Y2BCH102
ANALYTICAL BIOCHEMISTRY

(5 Credits:70Hrs)

Preliminary techniques in Biochemistry: Animal models, types of studies, mutant organisms (auxotroph), cultured animal and plant cells and plant as models. 5 Hrs

Cell fractionation techniques: Cell lysis, homogenization, extraction, salting in and salting out. Dialysis and ultrafiltration-Artificial membranes, semipermeable membranes, Donnan membrane equilibrium and biological significance of osmosis.

5Hrs

Centrifugation: Svedberg's constant, sedimentation velocity and sedimentation equilibrium.

Ultracentrifugation: Differential and density gradient centrifugation, construction of preparative and analytical ultracentrifuge. 9 Hrs

Chromatographic techniques: Principles, procedure and applications of paper, TLC, adsorption, ion exchange, gel filtration, affinity, GLC, chromatofocusing, HPLC and FPLC.

Electrophoretic techniques: Polyacrylamide gel electrophoresis, SDS-PAGE, 2D-electrophoresis, agarose gel electrophoresis, isoelectric focusing, pulsed field electrophoresis, high voltage electrophoresis, capillary electrophoresis, isotachophoresis. Separation of proteins, lipoproteins and nucleic acids. Visualizing separated components; staining, fluorescence, PAS staining, zymogram and reverse zymogram.

14 Hrs

Spectroscopic techniques: Principles of colorimeter, spectrophotometer, fluorimeter. Beer- Lambert's Law and its limitations. Extinction coefficient, fluorescent probes and their applications. Principle and applications of NMR, IR, CD/ORD. 11 Hrs

Radioisotope techniques: Radioactivity, stable and radioactive isotopes. Methods of detection of isotopes. GM counters, liquid scintillation counters and autoradiography. Units of radioactivity, half- life of radioisotopes. Radiation monitoring and its hazards. Application of radioactive tracer in biology. 7 Hrs

Radioisotopes in Biology: 3H, 14C, 32P, 131I, 35S, concept of half-life, decay constant, detection and quantitation- GM counter and solid and liquid scintillation counter. Specific activity, autoradiography and their applications. 7 Hrs

Mass spectroscopy: Theory and construction of mass spectrometer. Ionization, fragmentation, m/e, time of flight, MALDI and ESI. 5Hrs

Labelling: Using plant system (monosaccharides and polysaccharides), animal system, chemical (Glucose1-14C) and enzymatic methods (disaccharides). Labelling of ATP (α-P32 and γ-P32), proteins andnucleicacids.

7Hrs

REFERENCES

1) Biophysical Chemistry: Principles andTechniques,2nd edition by A. Upadhyay, K. Upadhyay and N. Nath. Himalaya Publishing House Delhi
2) Analytical techniques in Biochemistry and Molecular Biology; Katoch, Rajan. Springer (2011).
3) Principle and techniques in Biochemistry and Molecular biology; Keith Wilson and John Walker (2005).
4) Biochemistry and Molecular Biology; 5thEdn. D. Papa Christ odoulou, A.Snape, W.H. Elliott, and D.C. Elliott, Oxford University Press(2014)
5) Immuno Assay Hand Book; David Wild, Elsevier(2013).
6) Isoelectric Focusing; Theory, Methodology and Applications; P.G. Righetti, Elsevier (2013).
7) PrinciplesandTechniquesofPracticalBiochemistry-Wilson.K.AndWalker.J.Pub: Cambridge Press.
8) The Tools of Biochemistry, Cooper TG, John Wiley andSons.
9) Biochemistry Laboratory: Modern Theory and Techniques. Rodney F. Boyer.2011,Pearson Education.
10) Physical Biochemistry: Applications to Biochemistry and Molecular Biology. David Freifelder. W. H. Freeman Publishers 1982.

SEMESTER-I
Core Course-2 (CC-2)
Course Code: 1Y2BCH103
BIOMOLECULES

(5 Credits: 70Hrs)

10 Hrs

Carbohydrates: Classification of carbohydrates. Chemistry of monosaccharides: pentoses. Hexoses, deoxyglucose, amino sugars muramic acid, Linkages in sucrose, lactose and maltose, trehalose and glycosides. Isolation of polysaccharides: Homopolysaccharides and heteropolysaccharides, starch, cellulose, glycogen, hyaluronic acid, chondroitin sulphate, chitin, xylans, bacterial cell wall polysaccharides, blood group polysaccharides.Structure elucidation: degradation, graded acid hydrolysis, periodate oxidation, degradation of oxopolysaccharides, methylation, acetylation,. Glycoproteins: N- and O-glycosylation, lectins, carbohydrates in tissue engineering. Proteoglycans; agreecan, syndecan, and decorin. Pectin and pectic polysaccharides.

6 Hr

Amino acids, Peptides and Proteins: Features of the peptide bond, naturally occurring peptides: glutathione enkaphalins and endorphins. Chemical synthesis of peptides; Khorana's solution phase synthesis, Merrifield's solid phase synthesis. 6 Hr

Determination of amino acid compositions: Acid and base catalyzed hydrolysis, separation, quantification, determination of N and C terminal residues, determination of site of glycosylation and type of linkage (o- -glycosylandn- glycosyl) 5 Hr

Elucidation of structure of proteins: Isolation of proteins; overview of purification and criteria of purity. Determination of primary structure: Sequencing strategies; N-terminal and C-terminal, sequencing methods. Automated sequanators. Determination ofs-s-bondposition. 5 Hr

Secondary structure of proteins: α, β sheet, β bend, β turn and super secondary structures. Secondary structure prediction methods: Ramachandran plot, Chou and Fasman algorithm. Tertiary andquaternarystructures. 5 Hr

Factors responsible for protein folding: Anfinsen's experiment. Weak forces of interaction; hydrogen bonding, Vander Waal's forces, London forces, ionic interactions, hydrophobic interactions, S-S bridges, peptide bond, glycosidic bond, phospodiester bond, and allolysine. Denaturation and renaturation of proteins, molten globule. 3D Structure of myoglobin hemoglobin, immunoglobulin, collagen, chymotrypsin and keratin.MolecularChaperons. 8Hr

Lipids: Classification of lipids; oils, fats, and waxes. Occurrence and properties of fatty acids, esters of fatty acids, cholesterol, phosopholipids, glycolipids, sphingolipids, cerebrosidesandgangliosides. 6Hr

Lipid mediators: Eicosanoids, prostaglandins, leukotrienes, prostacyclins, thrombaxanes, DAG, ceramide and PAF. 3 Hr

Nucleic acids: Isolation of RNA and DNA from biological samples. Physico-chemical properties of nucleic acids- melting of DNA, Tm; factors affecting Tm, Cot curve, classification of DNA based on cot curve. Chemical reactions of DNA and RNA.

6Hr

Structure of nucleic acids: Primary, secondary and tertiary structure of DNA; Watson and Crick model; B and Z DNA, other models of DNA structure. palindromic sequences, cruciforms. DNA protein interaction; zincfinger, leucinc zipper,helix-turn-helix,othermotifs,DNAbendingandkinks.SecondarystructureoftRNAandcloverleaf model. Nucleic acid sequencing- Maxam- Gilbert method, dideoxy method. Chargaff 's rule. 9Hr

REFERENCES

1) Lehninger- Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6thEdn.MacmillanPublications (2012).
2) Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, WH Freeman and Co. (2006).
3) Physical Biology of theCell, 2nd Edn. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, Garland Publishers(2012).
4) Biochemistry; Voet, D. and Voet, J.G. [Eds.]. Jhon Wiley and sons,(2010).
5) Biochemistry; David Rawn, J, Neil Patterson Publishers (1989).
6) Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., Blackwell Scientific (1982).
7) Principles of Biochemistry; Smith et al., Mc Garw Hill (1986).
8) Proteins Structures and Molecular Properties 2 Co. 2ndEdn. Thomas E. Creighton, W H Freeman
9) Principles of Protein Structure, Function, & evolution, Dickerson & Geis 2nd Ed. Benjamin- Cummings (1983).
10) Biochemistry-The Chemical Reactions of Living Cells. David Metzler, 2nd Edition, Academic Press

SEMESTER-I
Core Course (P) -3 (CC (P)-3)
Course Code: 1Y2BCH104

Full Marks: 100
Pass Marks: 34
Time: 06 Hrs

PHYSICO-CHEMICAL ASPECTS OF BIOLOGY **(2 Credits:32h)**

1) Measurement of pH by pH meter
2) Titration curve of weak acids and determination of pKa
3) Preparation of buffers
4) Titration curve of amino acids.
5) Polari metric analysis of carbohydrates.
6) Acid hydrolysis of sucrose and starch.
7) Hydrolysis of proteins.

ANALYTICALBIOCHEMISTRY **(2 Credits: 32h)**

1. **pH - metric titrations**: Strong acid against a strong base, Weak acid against a strong base, Poly basic acid against a strong base, Amino acid (Neutral) against a strong base and acid.
2. **Paper chromatography**: Ascending and Descending, Two–dimensional.
3. **Protein isolation**: Isolation and Estimation of Casein from milk, Starch from potato, Lecithin from egg.
4. **Chromatography**: Ion exchange chromatography of proteins, Carbohydrates and nucleic acids. Anion and Cation exchange chromatography. Elution of proteins by linear gradient technique. Molecular sieve chromatography- separation of mixture of proteins and molecular weight determination of proteins. Affinity chromatography - Isolation of glycoproteins, antibodies and double antibodies**.**
5. **Electrophoresis:** Paper electrophoresis - Separation of amino acids and proteins in serum. Polyacrylamide Gel Electrophoresis- Anionic and Cationic PAGE of proteins. SDS-PAGE; Determination of Molecular weight of proteins.

BIOMOLECULES **(2 Credits:32h)**

1) Estimation of reducing sugars by DNS method.
2) Quantitative estimation of sugars by phenol-sulfuric acid method.
3) Hydrolysisofstarchorglycogenandestimationofitspuritybytitrimetricmethod.
4) Determination of Pka value of an amino acid.
5) Analysis of fats: Saponification number, Iodine number and acid value of oil.
6) Estimation of Nitrogen in amino acids, urea and casein by Micro-Kjeldahl Method.
7) Estimation of protein by Lowry's method.
8) Estimation of protein by Biuret method.
9) Isolation of cholesterol and lecithin.
10) Isolation of nucleic acids from plant source.

Practical-1: 45 Marks, Note Book:40 Marks, Viva:15 Marks

COURSE STRUCTURE OF M.Sc. BIOCHEMISTRY SECOND SEMESTER													
Course Details				**External Assessment**		**Internal Assessment**				**Credit Distribution**			**Allotted Credits**
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y2BCH201	Elective Course-I	Enzymology/ Biological Macromolecules/ Cell biology & endocrinology	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH202	Core Course-IV	Metabolism of Fuel Molecules	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH203	Core Course-V	Medical Biochemistry	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH204P	Core Course-VI Practical	Practical's on Core	100	50	17	20	07	30	10	-	-	10	5
Grand Total		**400**											**20**

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End
Theory Exam Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

SEMESTER-II
Elective Course (SE)(EC-1)
Course Code: 1Y2BCH201
ENZYMOLOGY

(5 Credits: 70Hrs)

Introduction to Enzymes: Nature of enzymes, localization, isolation, purification and Characterization of enzymes. Criteria of purity of enzymes, fold purity. Nomenclature and IUB classification of enzymes. Enzyme specificity, specific activity, assay methods; coupled enzyme assays, continuous, end point and kinetic assay. Units of enzyme activity, IU and Katal. Industrial and Biomedical applications of enzymes. 4Hr

Enzyme kinetics: Michaelis-Menten equation, initial velocity approach, steady state approach. Vmax, Kmand their significance. Linear transformation of Michaelis-Menten equation; Lineweaver-Burk plot, Eadie-Hofstee, Wolf and Cornish-Bowden. Scatchard plot. Rate of a reaction, order and molecularity. Ist order reaction kinetics. Rectangular hyperbola, Michaelis- Menten equation as rectangular hyperbola, asymptote, linear transformation, calculation of slope, intercept. Effect of pH, temperature and substrate concentration. 8Hr

Enzyme Inhibition: Types of reversible inhibitors - competitive, non-competitive, un-competitive and mixed inhibitors. Partial inhibition, substrate inhibition and allosteric inhibition. Irreversible Inhibition. 4Hr

Kinetics of bi-substrate reactions: Sequential mechanism, compulsory order and random order mechanism, non-sequential mechanism, ping pong mechanism, distinction between differentkinetic pathways using primary and secondary plots. Inhibition studies in the characterisation of bi-substrate reactions. 8 Hr

Mechanisms of enzyme catalysis: Active site structure; methods of determining active site structure, isolation of ES complex, affinity labelling, chemical modification studies and active sitestructureinvestigation.7Hr

Nature of enzyme catalysis: Transition state theory, proximity and orientation, orbital steering, acid base catalysis, covalent catalysis, metal ion catalysis, nucleophilic and electrophoilic catalysis, intra molecular catalyses, entropy effects. Effect of temperature and pH on enzyme catalysed reaction. 6 Hr

Mechanisms of action of specific enzyme: Chymotrypsin; zymogen activation, acid-base catalysis, charge relay network. Lysozyme, alcohol dehydrogenase, ribonuclease, carboxypeptidaseA, RNAas an enzyme. 8Hr

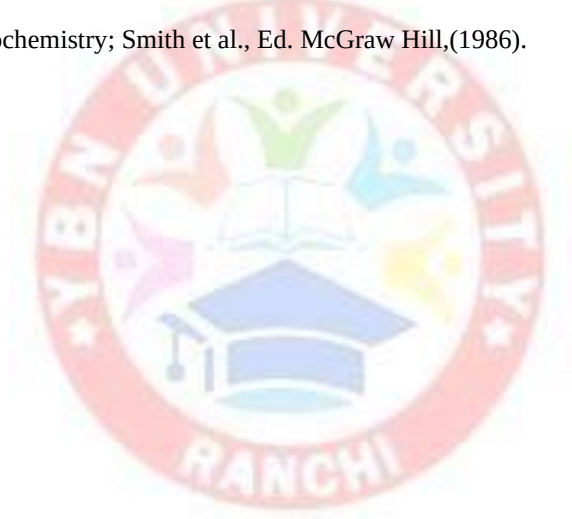
Coenzymes: The mechanistic role of the following coenzymes in enzyme catalyzed reactions- nicotinamide nucleotides, flavin nucleotides, pyridoxal phosphate, coenzyme A, thiamine pyrophosphate and biotin, Folate coenzymes. 6 Hr

Monomeric and oligomeric enzymes: Monomeric enzymes-the serine proteases, zymogen activation. Sulphahydryl enzymes-papain. Oligomeric enzymes-isoenzymes (LDH) and multi-enzyme complexes- (Pyruvate dehydrogenase complex). 4 Hr

Allosteric enzymes: Binding of ligands to proteins - Co-operativity, the Hill equation, equilibrium dialysis technique. **Sigmoidal kinetics:** The MWC and KNF models. Significance of sigmoidal behaviour. Allosteric enzymes and metabolic regulation. Study of ATCase- as typical allosteric enzyme. 8 Hr

REFERENCES

1) Fundamentals of Enzymology, Price. NC. and Stevens. L., Oxford University Press.
2) Enzymes-Biochemistry, Biotechnology, Clinical chemistry-Palmer, T., Affiliated East-West press.
3) Fundamentals of Enzyme Kinetics, Segel I H; Wiley Inter science-Wiley.
4) Biochemicalcalculations,2nd Edition By Irwin H. Segel. John Wiley &Sons,
5) Lehninger Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W.H. Freeman.
6) Fundamentals ofEzymology;3rd Edn. Nicholas C. Price and Lewis Stevens, Oxford University Press (2012).
7) Enzyme Kinetics and Mechanism; Paul F. Cook, W.W. Cleland, Garland Science (2007).
8) Enzymes: Biochemistry, Biotechnology and Clinical Chemistry; Trevor Palmer (Edn) Horwood Chemical Science Series.
9) Introduction to Enzyme and Co-enzyme Chemistry. Ed. T. Bugg, (2000), Blackwell Science.
10) An Introduction to Enzyme and Coenzyme Chemistry; Timothy B.Bugg,(1997)Jones and Bartlett publishers.
11) Lehninger Principles of Biochemistry; D.L. Nelson and M. M. Cox, 6th Publication (2012)
12) Principles of Biochemistry; Smith et al., Ed. McGraw Hill,(1986).



OR

SEMESTER-II

Elective Course (SE) (EC-1)

Course Code: 1Y2BCH201

CELL BIOLOGY AND ENDOCRINOLOGY

(5 Credits: 70h)

Cell Biology: Types of cells, Extracellular matrix, Cytoskeletal elements and cell-cell interactions- Adhesion. Cell division and Cell cycle-Mitosis and meiosis, Cell cycle phases and Programmed cell death. Biomembranes-Composition of plasma and organelle membranes, Singer and Nicholson'smodel and its salient features. Membrane domains- Caveolae and Rafts. Technique used to study the membranes structure-FRAP and single particle tracking. Preparation and usage of liposomes and erythrocytes ghosts. Membrane asymmetry. Protein-protein and protein-lipid interactions in membranes. Protein and lipid trafficking in membranes. Membrane Transport: Passive, facilitated and exchange diffusion, Fick's law of diffusion and active transport. Structure and function of $Na^{-}K^{+}$ ATPase and Ca2 ATPase. Ion channels, ionophores and aquaporins. Receptor mediated endocytosis and exocytosis. Disorders associated with membrane transport systems-Cystic fibrosis. Bacterial transport system.

16 Hr

Nervous system: Division of nervous system-neutron structure and types. Role of NGF, N-CUM and other specialized proteins. Resting membrane potential of excitable cells. Mechanism of initiation and propagation of action potential. Voltage gated ion channels (sodium, potassium and calcium). Design and use of patch clamp in measuring membrane potential. Depolarization and hyperpolarization in post-synaptic cells. Synaptic transmission, neurotransmitters, biogenic amines, amino acids and neuropeptides. Storage and exocytosis of neurotransmitters. Termination of neurotransmitters action. Acetylcholine receptors, nicotinic and muscarinic adrenergic receptors, other neurotransmitters receptors. Mechanism of synaptic transmission, receptor integrated ion channels and G-protein mediated ion channels. Use of agonists and antagonists of neurotransmitters in Biochemistry and

medicine. 15 Hr

Endocrine System: Endocrine organs in man. Location and inter relationship of endocrine glands in man; chemistry of hormones produced by hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenals, gonads and intestine. Functions and abnormalities- hypo and hyper production of hormones secreted by; pituitary, thyroid, pancreas, adrenals and gonads. Structure and control of hypothalamus:

Hormones produced; GRH, somatostatin, TRH, CRH, GnRH. 10 Hr

Pituitary-anatomy and structure- Hormones of anterior, posterior and median lobes. Proopiome lanocortin. Testes and ovaries- hormones produced by testes and ovaries, menstrual cycle. Regulation of hormone production and release: hypothalamus-pituitary-target organ axis and regulation by feedback mechanism. Conversion of cholesterol tosteroid hormone. 8 Hr

Mechanism of action of Hormone: Peptide hormones-General mechanisms of cell signalling by hydrophilic factors, transmembrane receptors, G protein coupled receptors, receptor tyrosine kinase, eicosanoid receptors. **Second messengers:** 1P3, DAG, cAMP, protein kinases. Nitric oxide signalling;

generation and action. **Growth factors:** Structure, mechanism of action and receptors of EGF, PDGF, NGF and IGF. Isolation and characterization of insulin receptor. **Steroid hormones-** Steroid receptors, isolation and characterization of steroid receptors. Receptor down regulation, desensitization and up regulation.Pineal glang, Melatonin and circadian rhythm.

10 Hr

Insect hormones: Structure and function of moulting hormone, ecdysone, juvenile hormones, Biochemistry of Plant hormones.

3Hr

Pheromones: Mechanism of perception and action.Use of pheromones in control of agricultural pests. 2Hr

REFERENCES

1. The Cell: A Molecular Approach, Fifth Edition, by Geoffrey M. Cooper and Robert E. Hausman, published by ASM Press.
2. Lehninger- Principles of Biochemistry, David L. Nelson, Michael M. Cox Publisher: W. H. Freeman.
3. Molecular Cell Biology; Lodish et al.,7th Edn. W. H. Freeman and Co. (2012).
4. Biochemistry5thEdn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer.
5. Harper's Illustrated Biochemistry; Rodwell, The McGraw-Hill(2006). 27th Edn. Robert K. Murray, Daryl K. Granner, VictorW.
6. Lipid Biochemistry; 5thEdn. Michael I. Gurr, John L. Harwood and KeithN. Frayn, Blackwell Science (2002**).**
7. Principles of HumanPhysiology;4thEdn. Cindy L. Stanfield Pearson ,(2010). Edn. Mac Millan
8. Molecular Biology of of the Cell, 3rd edition. Bruce Alberts, Dennis Bray, Julian Lewis Martin Raff, Keith Roberts, and James D Watson. Publisher New York: Garland Science.

OR

SEMESTER-II
Elective Course (SE) (EC-1)
Course Code:1Y2BCH201
BIOLOGICAL MACROMOLECULES

(5 Credits: 70 Hrs)

Properties of water: Importance of water in biological systems. Ion product of water and its measurement. Biological relevance of pH and pKa, Hendersson-Hesselbach equation. Buffers and their importance in biological systems.Preparation of buffers. 8Hr

Carbohydrates: Monosaccharides- Classification, Sugar derivatives. Disaccharides- structure of sucrose, lactose, maltose and cellobiose. Structure, Properties and importance of homo and hetero polysaccharides– starch, glycogen, cellulose, dextran, agarose andalginate. Glycosaminoglycans, glycoproteins, antifreeze glycoproteins, bacterial cell wall polysaccharides and blood group antigens.

13 Hrs

Amino acids and proteins: Classification and structure of amino acids. Acid-base properties of amino acids. Essential amino acids and Non-protein amino acids. Peptide bond-structure and conformation. Naturally occurring peptides-glutathione enkaphalins and endorphins. Ionic properties of peptides and proteins. Separation of amino acids mixtures and analysis of amino acids. 10 Hrs

Proteins: Introduction, classification and biological functions. Composition of proteins. The size and conformation of proteins. Supra molecular assemblies of proteins. The functional diversity of proteins. 7Hr

Lipids: Brief account of the chemistry and classification of lipids (without structural elucidation). Biological role of the following: Fatty acids, Aryl glycerols, Cholesterol, Terpenes, Waxes andBile salts, Phospholipids, Sphingolipids, Glycolipids, Steriods, Prostaglandins, Thromboxanes and Leukotrienes. Properties of lipids aggregates- micelles, Bilayer and Liposomes.

12 Hr

Nucleic Acids: Structure and properties of nucleosides and nucleotides. Properties of nucleic acids in solution. Hydrolysis of nucleic acids by acid and base. Enzymatic hydrolysis, Nuclease specificity and restriction endonucleases. Chemistry of DNA- Structures and functions of DNA, staining of DNA, PCR and its applications. Chemistry of RNAs: Structures and functions of mRNA, tRNA and rRNA.

12 Hr

REFERENCES

1) Lehninger-Principles of Biochemistry; DL Nelson and MM Cox [Eds), 6th dn. Macmillan Publications(2012).
2) Biochemistry VI Edition; Jeremy M Berg, John L Toymoczko and Lubert Stryer, WH Freeman and Co.(2006).
3) Physical Biology of the Cell, 2nd Edn. Rob Phillips, Jane Kondev, Julie Theriot, Herman Gracia, Garland Publishers (2012).
4) Biochermisatry; Voet, D. and J.G.[Eds.] 3rd Ed. Jhon Wiley and sons, (1999).

5. Biochemistry; David Rawn, J, Neil Patterson Publishers.
6. Nucleic acid Biochemistry and Molecular Biology, Mainwaring et al., Blackwell Scientific (1982).
7. Biochemistry Ed. Donald Voet & Judith G. John Wiley & Sons, Inc. (2010).

SEMESTER-II
Core Course -4 (CC-4)
Course Code: 1Y2BCH202
METABOLISM OF FUEL MOLECULES

(5 Credits:70Hrs)

Introduction: Basic concepts in metabolism: catabolism, anabolism, catabolic, anabolic and amphibolicpathways. 2Hr

Carbohydrate metabolism*:* Introduction, glycolytic pathway, energetics and regulation of glycolysis, fate of pyruvate, oxidation of pyruvate. Citric acid cycle and its regulation, energetics, anaplerosis. Gluconeogenesis and its regulation, Cori cycle, glyoxylate cycle. glucose paradox. Futile cycles and their applications. Entry of other carbohydrates into glycolysis-fructose and galactose. 10 Hr

Glycogen and starch metabolism: Biosynthesis and degradation of starch and glycogen and its regulation. Glycogen storage disorders. Lactose intolerance, fructosuria, galactosemia. HMP pathway and its regulation. 4 Hr

Hormonal regulation of glucose metabolism: Effect of insulin and glucogon, catecholamines, growth hormones and carticosteroids on carbohydrate and lipid metabolism in different tissues. Action of thyroid hormones andtheirmechanisms. 4 Hr

Lipid Metabolism: Degradation of triacylglycerols, phospholipids and sphingolipids and regulations; lipase, hormone sensitive lipase, phospholipases and sphingomyelinase. Fatty acid degradation; α and β and ω- oxidation. Knoop's experiment, saturated and unsaturated fatty acids. Formation of ketone bodies and their oxidation. Energetics and biosynthesis of fatty acids; fatty acid synthetase complex, chain elongation and desaturation. Pathways in plants and animals, conversion of linoleate to arachiodnant (scheme only) 12 Hr

Cholesterol synthesis and degradation and regulations: Metabolism of circulating lipids; chylomicrons, HDL, LDL and VLDL. Reverse cholesterol transport by HDL. Oxidized lipids and their metabolism, Foam cell formation. Regulation of blood cholesterol, triglycerides, LDL and HDL. Obesity, and mechanisms, exercise and regulation of energy metabolism. 7 Hrs

Phospholipid biosynthesis and regulations: Denovo pathway and inter conversion, biosynthesis of phospholipids, sphingolipids, ether lipids and glycolipids. Degradation and biosynthesis of gangliosides and cerebrosides. Biosynthesis of prostaglandins, thromboxanesandleukotrienes. 9 Hr

Integration of metabolic pathways: Integration of carbohydrate and lipid metabolism, and their regulation and manipulation. 2 Hr

Thermodynamics: I, II and III laws of thermodynamics. Enthalpy, entropy, free energy and chemical equilibrium.Highenergycompounds-Energycurrency,ATP, ADP, creatine phosphate, phosphoenol pyruvate as energy rich compound. 5 Hr

Mitochondrial electron transport: Entry of reducing equivalents for oxidation; malate-aspartate shuttle, glycerol phosphate shuttle. Organization of respiratory chain complexes, structure and function of the

components; Fe-S proteins, cytochromes, Q cycle, proton transfer, P/O ratio, respiratory control, oxidative phosphorylation, uncouplers and inhibitors, sequence of electron carriers based on redox potentials. ATP synthesis, ATP synthase complex, binding change mechanism, proton motive force, Mitchell's hypothesis. 9 Hr

REFERENCES

1) Biochemistry; Voet, D. and Voet, J.G.[Eds.](1999) 3rdEd. Jhon Wiley andsons.
2) Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
3) Principles of Biochemistry; Smith et al., [Ed.](1986) Mc Garw Hill.
4) Bioenergetics; A Practical Approach, G. C. Brown and C. E. Cooper (1995) IRL-Oxford University Press.
5) Photosynthesis, D.O. Hall and K. K. Rao, (1999), 6thEdn. Cambridge University Press.
6) Hawk's Physiological Chemistry, Oser (1976)14th Edn Tata-Mc Graw Hill
7) Text Book of Biochemistry with Clinical correlation; 6th (2012). Edn. Thomas M. Devlin, Wiley-Liss.
8) Lehninger-Principles of Biochemistry; D. L. Nelson and M. M. Cox 6 Edn. Macmillan Publications (2012).
9) Biochemistry; David Rawn, Panima Publishers (2012).

SEMESTER-II
Core Course -5 (CC-5)
Course Code: 1Y2BCH203
MEDICALBIOCHEMISTRY

(5 Credits: 70Hrs)

Basic concepts: Health and disease. Normal and pathological changes affecting cells in the body. Cell death and the physiological causes; physical, chemical, biological agents and nutritional deficiency. 6 Hr

Hematology and Hematology disorders: Blood composition: Blood cells, serum and plasma content. Different types of anemias-nutritional and sickle cell anemia. Complete blood count (CBC). Total and differential and platelet counts and their clinical significance. Blood groups, blood group substances, Rhessus factor, nature of blood group antigens and rare blood groups. Hospital-laboratory method of blood grouping and Rh typing. Erythrocyte sedimentation rate (ESR) determination and its importance in the diagnosis of certain diseases. 15 Hr

Enzymes of clinical and diagnostic importance: Enzymes as markers in the diagnosis of diseases. Clinical significance of cholinesterass, alkaline and acid phosphatases, LDH, CPK, SGOT and SGPT. 8 Hr

Biochemical investigations in kidney diseases: Kidney profile in health and disease. Urine analysis for normal and abnormal constituents, urine microscopy culture and antibiotic sensitivity test. Clearance test and its importance in the assessment of kidney function. Kidney diseases like urinary tract infection (UTI) and nephritis. Kidney transplantation and dialysis. 10 Hr

Biochemical investigations in Liver diseases: Liver profile in health and disease. Hepatocellular functions,with special emphasis on its participation in the various detoxification mechanism.Liverfunction tests(LFT),and their clinical significance in the diagnosis of liver diseases like cirrohosis and jaundice. Gall-bladder-stone analysis and its clinical significance. Hepatitis infections. 10 Hr

Cardio-vascular diseases: Brief mention of heart diseases. Atherosclerosis and its complications. 3 Hr

Cancer biology: Clinical and classical signs of cancer. Different stages and types of cancer, diagnostics. Chemotherapy (Natural and synthetic drugs) and radiation therapy. Molecular basis of cancer and mechanism of apoptosis. 6 Hr

Diabetes mellitus: Regulation of blood sugar, classification, stages and diagnosis (urine analysis, GTC/GTT, Glycosylated Hb. Role of anti-diabetic oral drugs and different types of insulins. 4 Hr

Gastric profile in health and diseases: Gastric function tests (gastric analysis). Hypo and hyper acidity and Gastric ulcers. Malabsorption syndrome. 2Hr

REFERENCES

1) Human Physiology –Chatterjee. C.C, Medical Allied Agency.
2) Manipal Manual of Clinical Biochemistry: For Medical Laboratory and MSc Students By S.Nayak, Shivnanda Nayak B, JAPEE Brother Medical Publications, New Delhi.
3) Human Biochemistry, Orten and Neuhans, 10th Edn. Mosbey International,(1983).
4) Review of Medical Physiology, Gannong, W.F.15th Edn., Maruzen Asial, (1991).
5) Textbook of Medical Physiology-Pal, G.K, Ahuja Publishing House, Delhi, 2007.
6) Textbook of Medical Physiology- Hall. J.E. Guyton andHall.12thed. Saunders, ElsevierInc.,2011.
7) Review of Medical Physiology-Barrett KE, Brooks H L,Boitano Sand Barman S M Ganong, 23rd Ed., McGraw-Hill Medical, 2009.

Semester –II
Core Course (P) -6 [CC (P)-6]
Course Code: 1YBCH204P

Full Marks: 100
Pass Marks: 34
Time: 06 Hrs

Enzymology **(2 Credits:32Hrs)**

1. Kinetic study of the following enzymes; amylase (from saliva/potato/wheat). Transaminases (from liver/plant embryos), lipase (from caster seeds), urease (from horse gram), esterases (from peas and insects). Acid and alkaline posphatases (from potato, green gram and serum). Protease and amylase inhibitors from plant sources.
2. Study of enzyme kinetics with respect to substrate, enzyme concentration, time, pH, temperature, activators, inhibitors with at least any three of the above mentioned enzymes.
3. Biochemical changes during germination of seeds and the development of embryo/seeds- specifically, the amylase, phosphatase and proteinases and their inhibitors.

Metabolism of Fuel Molecules **(2 Credits:32h)**

1) Preparation of mitochondria from rat liver.
2) Isolation of glycogen from the rat liver.
3) Esterase activity of rat liver homogenate.
4) LDH activity of rat liver homogenate.
5) Electrophoretic pattern of rat liver homogenate.
6) Lipase activity of rat liver homogenate.
7) Isolation of chloroplast from spinach leaves.
8) Determination of ATPase activity of mitochondria.
9) Determination of oxygen uptake of mitochondria.
10) Detection of cytochromes

Cell Biology and Endocrinology(2 Credits:32h)

1) Isolation of sub-cellular organelles.
2) Determination of drug induced haemolysis.
3) Determination of pro/anti-coagulant activity of plant proteins.
4) Preparation of RBC ghosts.
5) Blood cell count.
6) DeterminationofmarkerenzymessuchasSerumGlutamate-OxaloacetateTransaminase,Serum Glutamate-Pyruvate Transaminase, Lactate dehydrogenase and Creatine kinase
7) Determination of acetyl choline esterase activity.

Medical Biochemistry(2 Credits:32h)

1) Blood group analysis.
2) Differential count of blood (RBC, WBC and Platelets).
3) Estimation of Hemoglobin and methemoglobin.
4) Isolation and Separation of Hemoglobin.
5) Estimation of serum and plasma glucose.
6) Separation of hemoglobin using electrophoresis(Demonstration).
7) Estimation of urea and uric acid in biologicalsamples.
8) Estimation of SGOT andSGPT.
9) Estimation of LDH andCPK.

Biological Macromolecules (2 Credits: 32h)

1) Preparation of buffer solutions.
2) Qualitative and tests for identification of carbohydrates, amino acids, lipids and oils.
3) Quantitative estimation of sugars, amino acids and proteins.
4) Titration curve of amino acids.
5) Determination of saponification number, iodine number and acid value of fatty acids.
6) Estimation of cholesterol.
7) Isolation and estimation of nucleic acids.

Practical-1: 45 Marks, Note Book: 40 Marks, Viva: 15 Marks

COURSE STRUCTURE OF M.Sc.BIOCHEMISTRYTHIRD SEMESTER													
Course Details				External Assessment		Internal Assessment				Credit Distribution			Allotted Credits
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y2BCH301	Core Course-VII	Biostat, Bioinformatics and Drug Discovery	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH302	Core Course-VIII	Immunology	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH303	Elective Course –II	Plant Biochemistry	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH304	Elective Course-III Practical	Practical's on Core	100	50	17	20	07	30	10	-	-	10	5
Grand Total		400											20

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

SEMESTER-III

Ability Enhancement Course - 1 (AEC-1)

Course Code – 1Y2BCH301

BIOSTATISTICS, BIOINFORMATICS AND DRUG DISCOVERY

(5 Credits: 70Hrs)

Introduction to Biostatistics: Population, sample, sampling techniques, random sample, mean, median, mode, range, variance, coefficient of variation, frequency, standard deviation, standard error. Representation of statistical data line graph, histogram, bar diagram, pie chart, scatter diagram.

9 Hr

Collection of data: Relevance of sample size. Sources, methods-questionairs, records, archives, scaling-LikertandGutman.Validationandstandardizationofthemethods,modification and experimental design.

7Hr

Probability: Rules of probability, binomial distribution, normal distribution, area under the curve, Z value, choosing sample size, hypothesis testing, Student's t test. One way ANOVA, correlation and regression.

8 Hr

Bioinformatics: Introduction, scope and basic principles of bioinformatics. Bioinformatics programmes and languages, Scripts and scripting languages. Running programmes over internet, software downloading and installation, database management.

6 Hr

Biological databases: Contents, structure, annotation, file formats, annotated databases, genomes and organism specific databases

4Hr

Retrieval and analysis of biological data: Entrez and DBGET/Link DB, SRS. Searching sequence databases by similarities criteria (sequence search, amino acid substitution matrices), FASTA and BLAST searches. Sequence alignment, multiple sequence alignments, gene and protein families, and pattern data bases, protein domain families. 9 Hr

Microarray analysis: Methods, tools and resources: SAGE, proteomic data analysis, data from PAGE and protein mass spectra. 4 Hr

Drug Discovery: Use of literature and literature sources. Design of experiments, factorial experiments, randomization, interaction among factors. Types of studies: Cohort studies, double blind, placebo control, cross over and double dummy. Overview of some studies (UKPDS, CUPS, and Framingham). Clinical studies, toxicity studies, good laboratory practices, safe disposal of used and rejected samples and materials. 8 Hr

Discovering a drug: Proof of concept, target identification and validation, identifying the lead compound, optimization of lead compound, mechanism of action, drug target, validation of target, safety pharmacology, pharmaco-kinetics and pharmaco-dynamics, acute and chronic toxicity, CNS toxicity, hERG assay, in vitro and in vivo mechanism of action, DNA microarray and mechanism of action. 9 Hr

REFERENCES

1) Choosing and Using Statistics; A Biologist Guide, Clavin Dythan, Blackwell Scientific (1999).
2) Basic Mathematics for Biochemists; Cornish Bowden, Oxford University Press (1998).
3) Statistics, Basic Concepts and Methodology for the Health Sciences Daniel W W, Pub Wiley India.
4) Biostatistics–Arora & Malhan, Himalaya Publishing House.
5) Introduction to Bioinformatics-Att wood T Kandparry–smith, D.J. Pearson Education.

6) Bioinformatics (Sequence and Genome Analysis) Mount David W, Press CSH.
7) Discovering Genomics, Proteomics and Bioinformatics–Campell & Heyer, Benjamin/ Cummings pub.

Semester – III
Core Course –7 (CC-7)
Course Code: 1Y2BCH302
IMMUNOLOGY

(5 Credits: 70Hrs)

History and scope of immunology: Types of immunity-innate and adaptive. Immune reactive cells. Humoral and cell mediated immunity. Anatomy of lymphoid organs- primary lymphoid organs, secondary lymphoid organs and lymphtic system. Antigens-chemical nature, types, antigenicity, haptens, epitopes, antigenic determinants, adjuvants and superantigens.Valency of antigen, epitope analysis. 7 Hr

Immunoglobulins: Basic structure, functions, theories of antibody formation, Classes and immunoglobulin super family. Antigenic determinants on immunoglobulins. Methods of raising polyclonal antibodies. Monoclonal antibodies – production and application. Antibody diversity- mechanism contributing to diversity, somatic recombination, rearrangement and generation of antibody diversity. Class switching.

. 10 Hr

Cellular Basis of Immunity: Primary and secondary immune response. Reticulo endothelial system, T, B and accessory cells. Development of T and B cells. Sub sets of T and B cells. T-helper cells, T- killer cells, T- suppressor cells. T and B cell receptors, antigen processing and presentation. T and B interaction. Cytokines and co-stimulatory molecules; lymphokines, interleukins, structure and function of IL-lβ, IL-2, TNF-α. Suppression of immune response, immunoglobulin genes, generation of immunoglobulin diversity, gene rearrangement and other mechanisms, clonal selection theory of Burnet.

13 Hr

MHC: MHC gene and its polymorphism, role of MHC in immune response and transplantation. T and B cell lymphocytes: origin, differentiation, characterization and functions. T cell and B cell receptor complexes. Antigen processing and presentation. Cytokines and co-stimulatory molecules. Role in immune response. T and Bcellinteractions. 8Hr

Complement system- components, receptors, activation of complement pathways and its biological consequences. Major histocompatibility complex (MHC) genes and products. Role of MHC antigensin immune response, MHC antigens in transplantation. 5 Hr

Non-specific defences in man: Barriers to infection; skin, mucous membrane, inflammation, hyper sensitivity reactions (Type I, II, IIIandIV). 3Hr

Transplantation: Autograft, isograft, allograft and xenograft. Graft rejection, graft vs. host reaction.

4Hr

Tumour immunology: Tumour associated antigens, factors favouringtumour growth, immune surveillance. Tumour necrosis factor-α and β. 2Hr

Disorders of immunity: Immunological tolerance, auto immune disorders, AIDS, SCID.

Vaccines: Adjuvants, vaccines and their preparations. Polyclonal and monoclonal antibodies; hybridomatechnique. 5Hr

In vitro antigen-antibody reaction: Precipitation, agglutination, complement fixation, immuno diffusion, immunoelectrophoresis, immunofluorescence,RIA,ELISA. 4 Hr

Defence system in plants: Host parasite interaction and defence systeminplants. 3Hr

REFERENCES

1) Kuby Immunology; Oven, Punt, Stranford,7th Edn. Edn. W.H. Freeman. (2013).
2) Antibodies–A Laboratory Manual; E. D. Harlow, David Lane, 2th Edn. CSHL Press (2014).
3) Basic and Clinical Immunology; Stites et al., [Ed] (1982)Lange.
4) Roitt's Essential Immunology; Ivan, M. Rohit & Petrer J Delves (2001) Blackwell Science.
5) Immunology: Roitt et al.,Mosby(2001).
6) Immune System; M.C. Connel et al., Eds.(1981) Blackwell Science.
7) Immunology at a Glance: J.H.L. Playfare [ed.] Blackwell Science,(1987).
8) Immunology; Jan Klein [Ed.], Blackwell Science (1990).
9) Introduction to Immunology; Kim Bell [Ed.,] 3 Edn. McMillan (1990).
10) Veterinary Immunology: Ian R. Tizard, I.R. Thomson press.
11) The Immune System. By Peter Parham Publisher Garland publishing.

Semester – III
Core Course –8 (CC-8)
Course Code: 1Y2BCH303
PLANT BIOCHEMISTRY

(5 Credits: 70Hrs)

Thermodynamics: I, II and III laws of thermodynamics. Enthalpy, entropy, free energy and chemical equilibrium. 3Hr

High energy compounds: Energy currency, ATP, ADP, creatine phosphate, phosphoenol pyruvate as energy richcompound. 3 Hr

Photosynthesis: Photosynthetic apparatus in plants, photosystems I and II, light harvesting antenna complex. Electron flow and phosphorylation; cyclic and noncyclic, oxygen evolution, Calvin cycle. C3, C4 and CAM cycle. Photorespiration, bacterial photosynthesis. Regulation of photosynthesis. RUBISCO.

8 Hr

Respiration: Plant mitochondrial electron transport and ATP synthesis. 2 Hr

Nitrogen metabolism: Importance of nitrogen in biological systems, nitrogen cycle. Nitrogen fixation; symbiotic and non-symbiotic, nitrogenase complex, energetics and regulation. Formation of root nodules in legumes. Assimilation of nitrate and ammonium ion. 5 Hr

Plant hormones: Biosynthesis, storage, breakdown and transport. Physiological effects and mechanisms of action of auxines, gibberlines, cytokinins, ethylene, abscisic acid. 5 Hr

Sensory photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins, stomatal movement, photoperiodism and biological clocks. Seed dormancy, inception of germination. Germination and growth regulators, juvenility, vernalization

7 Hr

Solute transport and photo assimilate translocation: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem. Transpiration, mechanisms of loading and unloading of photo assimilates.
Methods in phytochemicals: Extraction, fractionation and characterization. 7 Hr

Secondary metabolites-Terpenes, phenols, flavonoids and nitrogenous compounds and their roles in plant physiology and as alternative medicine. 5 Hr

Stress physiology: Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress.

7 Hr

Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses, and alteration of host cell behaviour by pathogens, virus-induced cell transformation, pathogen induced diseases in plants, cell-cell fusion in both normal and abnormal cells. 8 Hr

Plant proteinases inhibitors -General properties of plant proteinase inhibitors, proteinase inhibitors of serine proteinase, acid proteinase, metalloproteinase. Role of proteinase inhibitors in plants. 4 Hr

REFERENCES

1) Lehninger- Principles of Biochemistry; David L. Nelson and Michael M. Cox, 6th Edition,W. H. Freeman (2013).
2) Biochemistry; Donald Voet, Judith G. Voet,4th Edition , John Wiley and sons (2010).
3) Biochemistry, Lubert Stryer et al., W. H. Freeman & Company, New York, (2003).
4) Principles of Biochemistry, Horton, Moran, Ochs, Rawn, Scrimgeour Prentice Hall, (2002).
5) Plant Biochemistry, P. M. Dey & J. B. Harborne (2000) Hart Court Asia Pvt Ltd.
5) Introduction to plant Biochemistry. Goodwin and Mercer, CBS Publisher (2000).
6) Biochemistry and Molecular Biology of Plants. Buchanan, Greussem and Jones, AAPS (2000).
7) Plant Biochemistry; P. M. Dey and J. B. Harborne, Academic Press (1997).
8) Plant Biochemistry and Molecular Biology; Peter J. Lea, Richard C. Leegood, 2nd Edition, Wiley (1998).
9) Plant Biochemistry; Hans-Walter Heldt and Birgit Piechulla, Academic Press (2004).

Semester –III
Core Course (P) -9 [CC (P)-9]
Course Code: 1YBCH304P

Full Marks: 100
Pass Marks: 34
Time: 06 Hrs

(2 Credits:32h)

Biostatistics, Bioinformatics and Drug Discovery

1) Biostatistics and Bioinformatics related problems will be worked out and demonstrations will be organized in the laboratory.
2) DNA ladder assay
3) Drug induced hemolysis.
4) Cytotoxicity assay
5) Neurotoxicity assay (Acetyl cholineesterase)
6) Liver toxicity assay (SGOT and SGPT)
7) Kidney toxicity assay (Creatinine)

Immunology **(2 Credits:32h)**

1) Production of immune sera: Affinity purification of antibodies.
2) Immuno-diffusion: Ouchterlony double diffusion, Radialimmuno diffusion.
3) Immuno-electrophoresis, Rocket Electrophoresis,
4) ELISA: Direct, Indirect, Sandwich and micro ELISA.
5) Conjugation of antibodies to alkaline phosphatase /HRP.
6) Western blotting of proteins and Immuno detection.
7) Determination of human blood groups.
8) Agglutination tests.

Plant Biochemistry **(2 Credits:32h)**

1) Extraction, isolation and estimation of polyphenols.
2) Extraction, isolation and estimation of lignin.
3) Extraction and estimation of flavones, tennis and quinolones.
4) Estimation of indole-3-acetic acid and gibberellins from plants.
5) Demonstration of systemic acquired resistance in plants.
6) Identification of pathogen related proteins in plants infected by pathogens.

Practical-1: 45 Marks, Note Book: 40 Marks, Viva: 15 Marks

COURSE STRUCTURE OF M.Sc.BIOCHEMISTRY FOURTH SEMESTER													
Course Details				**External Assessment**		**Internal Assessment**				**Credit Distribution**			**Allotted Credits**
Course Code	Course Type	Course Title	Total Marks	Major		Minor		Sessional		L	T	P	Subject wise Distribution
				Max Marks	Min Marks	Max. Marks	Min. Marks	Max. Marks	Min. Marks				
1Y2BCH401	Core Course-IX	Molecular Biology, Clinical Bioche. and Dietics	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH402	Elective Course – IV	Biochemical Genetics and Gene regulation, Genetic engineering and Biotech	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH403P	Elective Course – V Practical	Molecular Biology &Clinical Bioche, Genetic engineering &and Biotechnology	100	50	17	20	07	30	10	5	1	-	5
1Y2BCH404PR	Project	Project	100	50	17	20	07	30	10	-	-	10	5
Grand Total		**400**											**20**

Minimum Passing Marks are equivalent to Grade D
Lectures T- Tutorials P- Practical, Major- Term End Theory Exam
Minor- Pre University Test
Sessional weightage – Attendance 50%, Three Class Tests/Assignments 50%

SEMESTER – IV
Elective Course(GE) (EC-2)
Course Code: 1Y2BCH401
MOLECULAR BIOLOGY

(5 Credits:70Hrs)

DNA Replication: Central dogma of Molecular biology, Structure of DNA and forces stabilizing DNA structure. Genome organization in prokaryotes and eukaryotes. Experimental evidences-DNA as the genetic material and semiconservative mode of DNA replication. Models of DNA replication. Characterization, composition and mechanism of action and role of *E. coli* DNA Polymerase I, and III,
E. coli and Phage DNA Ligase, topoisomerases, primosome complex, helicase, primase, ssDNA stabilizing proteins. Brief study of E. coli DNA polymerase II. Mechanism of E. coli DNA replication (trombone model). Origin of replication and events occurring on replication fork- topological problems, initiation, elongation, and termination of E. coli DNA replication. Leading strand, lagging strand, Okazaki fragments. Proof of discontinuous synthesis of DNA. Fidelity of replication- proofreading and nick translation, nearest neighbour base frequency analysis. Eukaryotic DNA polymerases, Mechanism of replication of Eukaryotic DNA, mitochondrial and chloroplast DNA. Regulation of eukaryotic DNA replication and inhibitors of DNA replication. DNA replication in adenovirus, polyoma and SV 40. Rolling circle mode of DNA replication. Replication of ss +RNA viruses, ss–RNA viruses, dsRNA- reovirus, and retroviruses.
DNA repair; Existence of repair systems, direct repair systems, excision repair- base excision and nucleotide excision repair, photo reactivation. Post replication repair; mismatch repair, SOS repair (by passing damaged DNA during replication) and recombination repair. 20 Hr

Transcription: Structure of gene. Characterization and mechanism of action of prokaryotic RNA polymerase. Significance of sigma factor. Mechanism of transcription in E. coli. Initiation of prokaryotic transcription; bacterial promoters, Closed and open initiation complexes, promoter clearances. Sigma factors, concept of mRNA, elongation of RNA synthesis, termination; rho- dependent and independent termination. Processing of RNA in prokaryotes. Inhibitors of RNA synthesis. 10 Hr

Eukaryotic RNA polymerases: Classification and transcription units. Initiation at RNA pol I, II, and III promoters. Elongation and termination of eukaryotic transcription process. Post transcriptional modification of eukaryotic tRNA, and rRNAs, role of RNPs, RNase-P, polynuceotide kinase in modification. Post transcriptional modification of eukaryotic mRNAs; capping, and tailing. Intron splicing; Properties and role of snRNPs in splicing, mechanism of splicing by class-I (GU-AG), and class-II (GU-AC) introns, spliceosome, alternative splicing. 10 Hr

Genetic code: Genetic code and its significance. Deciphering of the genetic code; Nierenberg an Khorana's work. General features of genetic code. Mitochondrial genetic code. Co-linearity of gene and proteins. Coding properties of tRNA; wobble hypothesis.

Ribosomes: Prokaryotic ribosomes; molecular components, *in vivo* assembly, dissociation of subunits, and polysomes. Eukaryotic components and their assembly. Organelle ribosomes.

Translation: Initiation factors, elongation factors and termination factors of translation in prokaryotes and eukaryotes. Mechanism and process of protein synthesis in prokaryotes and eukaryotes; steps involved in protein synthesis, amino acid activation, exchange of ribosomal subunits, binding of mRNA to ribosomes, direction of protein synthesis and reading of mRNA. Protein chain initiation, elongation and termination. Comparative account of eukaryotic and prokaryotic translation. Inhibitors of prokaryotic and eukaryotic translation. Post-translational modifications of proteins. Synthesis of secretory and membrane proteins; signal sequence hypothesis. Mechanism of translational control.

14 Hr

REFERENCES

1) Molecular Biology of Gene; Watson, J.D. et al., 5th Edn. Pearson Education ;(2004).
2) Molecular Biology of the Cell, Alberts et al., Garland Publications, (2012).
3) Molecular Biology, David Freifelder, Narosa Publishers,(1997).
4) Molecular Biology Robert F. Weaver, McGraw Hill (2012).
5) Microbial Genetics; Maloy et al., Jones and Bartlett Publishers,(1994).
6) Modern Microbial Genetics; Uldies N. Streips and Ronals E.Yasbin, Wiley Leis Inc. New York,(2002).
7) Molecular Cell Biology; Harvey Lodish5thEdn. (2010)
8) Biochemistry 5 Edn. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer (2011).
9) LEWINS Gene XI;J.E. Krebs, E. S. Goldstein, and S. T. Kilpatrick, Jones and Barlett Publishers(2012).
10) Molecular Biology; Robert F. Weaver, McGraw-Hill(2012).
11) Molecular Biology; David Freifelder, J.(1997)Narosa publishers.
12) Nuclear Organization;Chromatin Structure and Gene Expression, Roen Van Driel and Arie P. Otte (1997) Oxford University Press.

OR

SEMESTER – IV
Elective (GE) (EC-2) Course
Code: 1Y2BCH401
CLINICAL BIOCHEMISTRY AND DIETETICS

(5 Credits: 70Hrs)

Blood: Blood Haemostasis, Composition, blood count, total, differential and platelet count. Blood group studies, Rhesus factor, ESR- its determination and importance in disease.
Blood coagulation factors, mechanism and its regulation. Plasma proteins, profile in health and diseases. Abnormal haemoglobins, Disorders of haemoglobins- thalassemmia, sickle cell anaemia. Anaemias Microcytic, macrocytic and normocytic, CSF analysis. 10 Hr

Diagnostic Enzymology: Clinical significance of enzymes like SGOT, SGPT, LDH,CPK, Alkaline and acidphosphatase,amylase. 4 Hr

Kidney profile: Assessment of renal function-clearance tests and their importance in assessment of kidney functions. Laboratory investigations of kidney disorders- UTI, kidney stones, Nephritis, Urolithiasis, Dialysis, Uremia, Hyporuricemia. 7 Hr

Liver profile: Biochemical indices of hepatobiliary diseases, Bile pigments- Formation of bilirubin, urobilinogen, bile acids, Jaundice- pre-hepatic, hepatic, post hepatic. Diagnosis Liver function tests, Diseases of liver-Hepatitis, Cholestasis Cirrhosis, Gallstone. 6 Hr

Disorders of carbohydrate metabolism: Diabetes- aetiology, classification, management, laboratory investigations. GTT, GlycatedHb, Diabetic complications, inborn errors of carbohydrate metabolism- Glycogen storage diseases, Galactosemia, Lactose intolerance, Pentosuria. Disorders of Lipid metabolism- Plasma lipoproteins and their functions, Hyperlipoproteinaemia- classification, Primary and secondary, Hypercholesterolemia, Ketosis and its significance. Disorders of amino acid and protein metabolism- Inborn errors of amino acid metabolism- PKU, Alkaptonuria. Disorders of purine and pyrimidine metabolism-Gout, Lesch-Nyhan syndrome, Xanthuria, Oroticaciduria. Cardiovascular disorders- Major cardiovascular system-Atherosclerosis- risk factors, pathogenesis, diagnosis and prognosis. Gastrointestinal disorders: Fractional gastric analysis, Hypo and hyperacidity, Gastric ulcers, Malabsorption syndrome. 16 Hr

Dietetics: Introduction to nutrition. Food pyramid. Diet planning and introduction to diet therapy. Nutritional requirements for different age groups, anaemic child, expectant women, and lactating women. Diet planning for prevention and cure of nutritional anaemia. 4Hr

Diet therapy: Functional foods, dietary considerations during fever, and typhoid, malaria, influenza and tuberculosis patients. Prevention, and correction of obesity, underweight, and metabolic diseases by diet therapy. Dietary interventions to correct and or manage gastrointestinal diseases (indigestion, peptic ulcer, stomach carcinoma, constipation, diarrhoea, steatorrhoea, irritable bowel syndrome. 10 Hr

Diets in liver diseases - Hepatitis, cirrhosis, cholecysthetis and cholelithiasis. Functional foods based diet therapy for diabetes, cardiovascular disease, nephritis, and genetic disorders (PKU,galactosemia, lactose-intolerance, fructosurea)andcancers. 7 Hr

REFERENCES

1) TextbookofBiochemistryandHumanBiology– Talwar,G.P.andSrivastava.L.M.,Printice Hall ofIndia.
2) Human Physiology -Chatterjee.C.C, Medical AlliedAgency.
3) Clinical Biochemistry, 2nd Edn. W J Marshall, F I Biol and S K Bangert. Elsevier Health- Mosby Saunders. United States of America. ISBN:9780443101861.
4) Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.] (1997), Wiley- Liss.

SEMESTER – IV
Elective Course (GE) (EC-3)
Course Code: 1Y2BCH402
BIOCHEMICAL GENETICS AND GENE REGULATION

(5 Credits: 70Hrs)

Genetics: Introduction, Nature of genetic material; Prion chromosomes and genes. Mutation, types of mutation, mutagens, mechanism of mutation, induction and isolation of mutants and their role in genetic studies. 4Hr

Classical genetics: Review of classical genetics; work on *Pisumsativum*, *Drosophila melanogaster*, *Neurosporacrassa*etc. Inheritance (sex – linked and others), population genetics, extra nuclear inheritance. Sex determination, Morgan's discovery of sex linked inheritance, pattern of inheritance of sex linked genes, X-linked traits in humans. Identification of sex chromosomes, XX, XY, mechanism of sex determination. 10 Hr

Bacterial genetics: Bacterial chromosome, plasmids; fertility, resistance, colicinogenic and others. Recombination in bacteria. Mechanism of recombination, transposable genetic elements, transformation and conjugation in bacteria. Linkage map ofbacterialchromosomes. 9 Hr

Human Genetics: Biochemical events occurring during mitosis and meiosis. Structure of chromatin; nucleosomes and higher orders of organization. Chromosome banding, Chromosome mapping based on recombination frequency data. Gene structure in eukaryotic organisms, introns, exons, pseudogenes, gene clusters, spacers, repetitive sequences and transposons. Overview of human genome project, mapping of human genes; techniques used, assignment of important genes.Transposition in human chromosomes.Chromosomalabnormalities. 9 Hr

Regulation of gene expression in prokaryotes: Principles of regulation of gene expression. Outline of transcriptional regulation, Induction, repression, constitutive/basal level expression. Genes involved in regulation; regulator, promoter, operator and structural genes- activators and repressors.
Identification of control regions by DNase-foot printing, gel mobility assay methods. 7 Hr

The operon model; Regulation of gene expression at transcriptional level. Concept of positive regulation and negative regulation. Operon concept- study of structure and regulation of Lac operon, Jacob and Monod hypothesis- Catabolite repression; role of cAMP and cAMP-receptor protein (CRP/ CAP) in the expression of glucose-sensitive operons, structure and functions of CAP. Structure function and regulation of tryptophan operon in *E.coli*, Concept and process of negative regulation, repression and attenuation in tryptophan operon. Structure and regulation of arabinose operon, and histidine operon. Structure and functions of λ repressor, Cro, and λcII. Anti-termination as a mechanism of regulation. 12 Hr

Eukaryotic gene expression: Levels of control of gene expression in eukaryotes. Regulation of gene expression in yeast. Control of galactose genes in yeast. Regulation of gene expression- β-globin gene, DHFR gene. Histone modification. Brief study of regulation of developmental genes inDrosophila. 7 Hr

DNA bindingproteinmotifs: Zinc finger, leucine zipper, helix-turn-helix and other motifs.

Regulation at the level of post translational modification: proteins stability, N-end rule, PEST and other sequences, ubiquitinmediated degradation. 6 Hr

REFERENCES

1) Principles of Genetics by Eldon John Gardner, Michael J. Simmons, D. Peter Snustad; John Wiley.
2) Concepts of Genetics by Klug, Cummings, Spencer and Palladino.10thEdn. Pearson (2012).
3) Modern Genetic Analysis Anthony J F Griffiths, William M Gilbert, Jeffrey H Miller, and Rich ard C Lewontin. Pub. W. H .Freeman.
4) Genetics, Strick Berger, M.W.(1990) 3rdEdn.McMillan.
5) Human Molecular Genetics; Peter Sudbery, (2002) Printice Hall.
6) Introduction to Genetics: A Molecular Approach; T A Brown, Garland Science (2011).
7) Molecular Cell Biology; Lodish et al.,7th Edn. W.H. Freeman and Co. (2012)
8) Molecular Biology of the Cell;7th Edn. Bruce Alberts et al., Garland Publications (2008).

OR

SEMESTER – IV
Elective Course(GE) (EC-3)
Course Code: 1Y2BCH402
GENETIC ENGINEERING AND BIOTECHNOLOGY

(5Credits: 70 Hrs)

Genetic Engineering: Extraction and purification of nucleic acids (DNA and RNA) from biological sources. Definition, aims and objectives of recombinant DNA technology, restriction-modification systems, restriction enzymes; type I, II and III, specificity, sticky ends and blunt ends, isoschizomers. 4 Hr

Gene Cloning: Basic principles and tools and techniques of gene cloning: Characteristics and applications of restriction endonucleases and modifying enzymes. Methods of Isolation of gene/ DNA fragment for cloning. Methods for gene cloning: *in vivo*- cloning in *E. coli*. *In vitro*- polymerase chain reaction. Characteristics and applications of Plasmid, Cosmid, Phagemid, M13phage vector, λvector, BAC, PAC, and YAC. Selection of suitable vectors for cloning, expression and sequencing of DNA fragments. 10 hr

Ligation: Blunt end and sticky end ligation, use of linkers and adopters, homo polymer tailing, colony hybridization, plaque hybridization. 2Hr

Transformation: Micro injection, electroporation, lipofection, calcium phosphate method, protoplast fusion/somatic cell hybridization and biolistic methods. Transgenic plants and animals, gene knock out. 4Hr

Identifying the right clones: Direct screening; insertional inactivation of marker gene, visual screening, and plaque phenotype. Indirect screening; immunological techniques, hybrid arrest translation, hybrid select translation. Screening using probes; construction of gene probes, hybridization and labelling. 6Hr

Techniques: DNA sequencing, shot gun and orderly sequencing, chromosome walking, PCR; analysis of products, nested PCR, applications of PCR in cloning, agriculture and medicine. RT-PCR technique and applications. Real time PCR for quantification. 6 Hr

Blotting techniques: Dot blot, Southern, Northern, Western blot, DNA finger print assay, gel retardation assay. 3Hr

Applications: Gene therapy, applications in agriculture medicine, industry. GM foods, terminator gene, negative impact of genetic engineering. 3 Hr

Biotechnology: Industrial microorganisms and their characteristics, Primary and secondary metabolites. Fermenter: Design of batch fermenter, CSTR, semicontinuous and continuous feed-batch fermenters. Fermentation types. Bioprocess development.

Organism and strain improvement: origin of industrial strain, Isolation, and strain improvement.

Medium and growth conditions: Raw materials and fermentation media, optimization of growth and culture conditions, growth Kinetics and product formation kinetics, Rheological parameters to be considered for scale-up of bioprocess from lab to industrial scale. Methods of cell Immobilization, Fed- batch and continuous fermentations by immobilized systems.

Downstream process, Recovery and purification of products. 10 Hr

Production of amino acids- glutamic acid, and lysine, organic acids- acetic acid, citric acid, Itaconic acid. Health care products- vitamins, antibiotics. Alcohols- bioethanol, butanol. Acrylonitrile, biogas and Biopolymers. **Production of enzymes** (amylase, proteases, cellulases, xylanases,) from bacterial and fungal strains by solid-substrate and submerged fermentation.

8 Hr

Environmental and agriculture Biotechnology: Natural control of insect pests, Production of biopesticides. Development of specialized microorganisms for bioremediation of toxic environmental pollutants (PAHs, pesticides, industrial effluents). Bioremediation of toxic industrial pollutants and pesticide contaminated sites 8 Hr

REFERENCES

1) Genes VIII, Lewin, B, Publish Oxford University Press.
2) Principles of Gene Manipulation: An introduction to GE- Old, R. and Primrose, S. B. Blackwell Sci. Pub.
3) Molecular Biotechnology Glick, B R and Paternak, J J. Publish ASM Press.
4) Molecular Biology of the Gene by Whatson J D, Losick R. Pub Pearson Education.
5) Molecular Cloning; A laboratory manual; Michael R.Green,CSHL Press (2012).
6) Molecular Cell Biology; Lodish et al.,7th Edn. W.H. Freeman and Co (2012).
7) Molecular Biology of the Cell; 7 Edn. Bruce Alberts et al., (2008), Garland Publications
8) Molecular Biology; Robert F. Weaver, McGraw Hill (2012).
9) Gene Cloning and DNA analysis- An Introduction; T. A. Brown, 5th Edition, Wiley- Blackwell Publishing (2006).
10) Molecular biology and Biotechnology; 4th Edn., J. M. Walker and R.Rapley, RSC (2000).
11) Principles and Techniques of Biochemistry and Molecular Biology; 7thEdn. Keith Wilson and John Walker(2010).
12) Industrial Microbiology: An introduction. By Michael J. Waites, NeilL. Morgan, John S. Rockey, Gary Higton. 2013, John Wiley & Sons.
13) Brock Biology of Microorganisms. Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl. 2014, Pearson's MyLab & Mastering products

Semester –IV
Elective Course (P) -4 [CC (P)-4]
Course Code: 1YBCH403P

MolecularBiology **(2 Credits:32h)**

1) Isolation of nuclei.
2) Isolation of chromosomal DNA and characterization.
3) Isolation and purification of plasmid DNA.
4) Agarose gel electrophoresis of plasmid DNA.
5) Isolation of mutants.
6) Effect of uv dose on survival rate of bacteria.
7) Assay of phosphatase, DNase and RNase.
8) Gene induction and repression beta-galactosidase activity in *E.coli.*
9) Isolation of auxotrophic mutants.
10) Ames Test.
11) Detection plasmid for antibiotic resistance.
12) Effect of UV dose on survival rate of bacteria.
13) Blue or white colony test for lac+/lac-

Clinical Biochemistry and Dietetics **(2 Credits: 32h)**

1. Urine analysis: 1) Qualitative analysis of urine for abnormal constituents- glucose, albumin and ketone bodies 2) Quantitative analysis of urine- Titratable acidity, creatine, creatinine, urea, uric acid, glucose.
2. Bloodanalysis:EstimationofBloodglucose,urea,uricacid,creatinine,A/Gratio,and Cholesterol
3. Assay of serum enzymes: SGOT, SGPT, LDH, creatine kinase, acid and alkaline phosphatase.
4. Electrophoresis of lipoproteins and Hb(Demonstration).
5. Food analysis– 1)Moisture;2)Crudeprotein;3)Ash;4)Crudefat;5)Energy;6) Crude and dietary fibre; 7) Iron; 8) Ascorbic acid and 9)Phosphorus.
6. Determination of BMR/BMI.

Gene regulation and Genetics **(2 Credits:32h)**

1) Gene induction and repression beta-galactosidase activity in E.coli.
2) Isolation of auxotrophic mutants.
3) Ames Test.
4) Detection plasmid for antibiotic resistance.
5) Effect of UV dose on survival rate of bacteria.
6) Blue or white colony test for lac+/lac-
7) Mounting of different stages of mitosis and meiosis.
8) Isolation of DNA from plant source.
9) Isolation of polythene chromosome from chironomus larva.
10) Staining of chromosomes.
11) Chromosomal abnormality identification.

Genetic Engineering and Biotechnology **(2 Credits:32h)**

2) Preparation of bacterial culture for plasmid DNA isolation
3) Isolation of plasmid DNA from bacterial cells
4) Characterization of plasmid DNA by UV spectroscopy
5) Agarose gel electrophoresis of plasmid DNA
6) Transformation of DNA by $CaCl_2$ method.
7) Restriction digestion of isolated plasmid DNA.
8) Preparation of competent cells.

9) DNA ligation demonstration.
10) Animal cell culture demonstration.

REFERENCES FOR BIOCHEMISTRY PRACTICALS

1) Basic Biochemical methods. R.R. Alexander, J.M.Griffith.2nd Edn. Wiley-Liss publications.
2) Standard methods of Biochemical analysis. S.R. Thimmaiah. Kalyani publishers.
3) Practical Biochemistry. David Plummer. Tata McGraw-Hill publishing.
4) IntroductiontopracticalBiochemistry.S.K.SawhneyandRandirSingh.NarosaPublishinghouse.
5) Biochemical Methods S.Sadashivam and A. Manikam, 2nd Edn. New Age International (P) Ltd Press.
6) Modern Experimental Biochemistry - R. Boyer (Pearson Education).
7) Experimental Biochemistry-R.W. Switzer & L. F. Garrity (W. H. Freeman & Co.)
8) Practical Biochemistry-K. Wilson & J. Walker (Cambridge Univ. Press)
9) Laboratory Manual in Biochemistry-J. Jayaraman (Narosa Publishing House)
10) Practical Biochemistry-D. T. Plummer (TATA McGraw-Hill)
11) Practical Biochemistry - R. C. Gupta & S. Bhargava
12) Experimental Physiology and Biochemistry - P.V. Chadha
13) Experiments in Microbiology -Gilstrap- Kleyn-Nester
14) Experimental Biochemistry-A Student Companion -B. S. Rao & V. Deshpande, I.K.
15) Cell Biology: A laboratory hand Book. Vol-I. Julio E. Celis. Elsevier Publishing.
16) Biochemical Calculations, Irwin H. Segel (1976)2nd Ed. John Wiley and Sons.
17) Methods in Enzymology; Colowick, S.P.et al., [Eds.] (1987) Vol.152, Academic Press.
18) Enzymes; Biochemistry, Biotechnology and Clinical Chemistry Chemical Science Series.

SEMESTER- IV
Course Code: 1Y2 BCH404PR
PROJECT

Full Marks: 100
Time: 06

The Paper will consist of

A) Field work/Lab work related to the project
B) Preparation of dissertation based on the work undertaken
C) Presentation of project work in the seminar on the assigned topic in the University
D)