



## **GUJARAT UNIVERSITY**

**DEPARTMENT OF BIOCHEMISTRY,  
University School of Sciences  
Ahmedabad – 380009, Gujarat, India.**

### **M. Sc. Biochemistry**

The recent advances in Biochemistry have proved that the present era is for Life sciences especially for Molecular Biology. Hence the course which was started in 1995 with same aim, revised regularly according to latest developments and discoveries. An experimental research based Dissertation was made compulsory along with a viva-voce examination which was introduced in M.Sc. Semester IV. The dissertation is incorporated with the aim to inculcate research acumen in students. As Biochemistry is an interdisciplinary subject, the papers like Instrumentation and methodology, biostatistics, Plant Biochemistry, Microbial biochemistry etc. have been added.

In accordance with the UGC norms and the introduction of the Choice based Semester system, the syllabus was revised once again in June, 2017.

These students will be able to pursue careers in pharmaceutical industries, research laboratories, clinical research organizations, school, colleges and Universities.

### **BIOCHEMISTRY SYLLABUS**

#### **M. Sc.**

**Effective from June 2017**

1. There shall be Four papers each of four hours (3+1) duration and two practical each of Nine hours per week.
2. Each Course (Theory & Practical) shall carry 100 (Hundred) marks (Internal 30 marks and External 70 marks). External exam for each theory is of 3 hours and practical exam is of more than 6 hours per semester.
3. The major emphasis of this Course is to motivate students for improvement through regular internal assessment. They should be encouraged for self-study and seminar according to allotted times of the course per week.
4. Each theory paper is divided into four UNIT – s. Each UNIT – will have equal weightage of teaching and while setting question paper.
5. Question or its sub question including the options will be set from the same UNIT – .
6. Practical batch will be consisting of maximum 10 students.
7. The elective papers will be offered as per availability of the expert faculty and feasibility of the department and schedule of teaching.
8. There shall be at least one study tour during the span of two years of P.G. study, pertaining to different Biochemistry/ Biotechnological/ Pharmaceutical industries/ research institutes/ various ecosystems, even outside Gujarat State. The study tour is highly essential for study various concepts, processes and technology pertaining to Molecular.

Gujarat University

Design and Structure of Biochemistry; PG Courses for Credit Based Semester system to be implemented from June 2010 (New 2017)

Department	Semester	Course		No. of Hours per week				Course credits
		No	Name	Lectures	Others	Practicals	Total	
Bio Chemistry	1	BCH 401	Bioenergetics and Intermediary Metabolism	3	1		4	4
		BCH 402	Microbial Biochemistry	3	1		4	4
		BCH 403	Molecular Cell Biology	3	1		4	4
		BCH 404	Stem Cell Biology and Toxicology	3	1		4	4
		BCH 405PR	Practical – I +Viva voce			6	6	4
		BCH 406PR	Practical – II +Viva voce			6	6	4
			Total	12	4	12	28	24
	2	BCH 407	Plant and Environmental Biochemistry	3	1		4	4
		BCH 408	Human Physiology	3	1		4	4
		BCH 409	Advance Enzymology	3	1		4	4
		BCH 410	Nutritional and Clinical Biochemistry	3	1		4	4
		BCH 411PR	Practical – III +Viva voce			6	6	4
		BCH 412PR	Practical – IV +Viva voce			6	6	4
			Total	12	4	12	28	24
	3	BCH 501	Immunology and Immunotechnology	3	1		4	4
		BCH 502	Instrumentation and Techniques	3	1		4	4
		BCH 503	Biostatistics, Bioinformatics Bioinstrumentation and Bioassays	3	1		4	4
		BCH 504EA	1. Advance Molecular Biology and Biotechnology	3	1		4	4
		BCH 504EB	2. Molecular Oncology					
		BCH 505PR	Practical – V +Viva Voce			6	6	4
		BCH 506PR	Practical – VI +Viva Voce			6	6	4
			Total	12	4	12	28	24
	4	BCH 507PT	Dissertation / Project Work				20	16
		BCH 508S	Seminar / Field /Industrial visit				4	4
BCH 509M		Assignment / Group Discussion				4	4	
		Total					28	24

### M.Sc. Semester I

Course No.	Course Name	Hours Per Week	Credits	Marks		
				Internal	External	Total
BCH 401	Bioenergetics and Intermediary Metabolism	04	04	30	70	100
BCH 402	Microbial Biochemistry	04	04	30	70	100
BCH 403	Molecular Cell Biology	04	04	30	70	100
BCH 404	Stem Cell Biology and Toxicology	04	04	30	70	100
BCH 405PR	Practical – I +Viva voce	09	04	30	70	100
BCH 406PR	Practical – II +Viva voce	09	04	30	70	100
	Library	02	-	-	-	-
<b>Total</b>		<b>36</b>	<b>24</b>	<b>180</b>	<b>420</b>	<b>600</b>

### M.Sc. Semester II

Course No.	Course Name	Hours Per Week	Credits	Marks		
				Internal	External	Total
BCH 407	Plant and Environmental Biochemistry	04	4	30	70	100
BCH 408	Human Physiology	04	4	30	70	100
BCH 409	Advanced Enzymology	04	4	30	70	100
BCH 410	Nutritional and Clinical Biochemistry	04	4	30	70	100
BCH 411PR	Practical – III +Viva voce	09	4	30	70	100
BCH 412PR	Practical – IV +Viva voce	09	4	30	70	100
	Library	02	-	-	-	-
<b>Total</b>		<b>36</b>	<b>24</b>	<b>180</b>	<b>420</b>	<b>600</b>

### M.Sc. Semester III

Course No.	Course Name	Hour Per Week	Credits	Marks		
				Internal	External	Total
BCH 501	Immunology and Immunotechnology	04	04	30	70	100
BCH 502	Instrumentation and Techniques	04	04	30	70	100
BCH 503	Biostatistics, Bioinformatics and Bioinstrumentation	04	04	30	70	100
BCH 504 504EA 504EB	<b>Elective</b> 1. Advanced Molecular Biology & Biotechnology 2. Molecular Oncology	04	04	30	70	100
BCH 505PR	Practical – V +Viva Voce	09	04	30	70	100
BCH 506PR	Practical – VI +Viva Voce	09	04	30	70	100
	Library	02	-	-	-	-
<b>Total</b>		<b>36</b>	<b>24</b>	<b>180</b>	<b>420</b>	<b>600</b>

## M.Sc. Semester IV

Course No.	Course Name	Hours Per Week	Credit	Marks		
				Internal	External	Total
BCH 507PT	Dissertation / Project Work	24	16	100	300 (200+100)	400
BCH 508S	Seminar / Field /Industrial visit	06	4	50	50	100
BCH 509M	Assignment / Group Discussion	06	4	50	50	100
<b>Total</b>		<b>36</b>	<b>24</b>	<b>200</b>	<b>400</b>	<b>600</b>

## M. Sc.

Semester	Course Name	Hours Per Week	Credit	Marks		
				Internal	External	Total
I	Principles of Life Sciences I	36	24	180	420	600
II	Principles of Life Sciences II	36	24	180	420	600
III	Research Methodology and Elective	36	24	180	420	600
IV	Dissertation & Seminar+ Assignment	36	24	200	400	600
<b>Total</b>		<b>144</b>	<b>96</b>	<b>740</b>	<b>1660</b>	<b>2400</b>

### Examinations for the 4<sup>th</sup> semester

#### Dissertation

##### Internal Examination

70 marks are based on day-to-day work of the concern student in terms of experimental designing, Practical performance in the laboratory, interpretation of the results obtained, regularity etc.

Internal 30 marks viva: Presentation of the work in front of the faculty of the department at least 3 times during this project work as follows.

- (1) Deciding of the project and state of the art presentation ..... 10 marks
- (2) Discussion of the materials and methods and protocols..... 10 marks
- (3) Presentation of the obtained results ..... 10 marks

##### External Examination

- (1) 200 marks examination of the dissertation by two examiners 100 marks each
- (2) 100 marks viva-voce conducted by examiners

#### Evaluation of seminars and assignments/ training reports/ study tour report etc.

Internal: 50 marks for the presentation of seminar which includes content, presentation slides, explanation, understanding of the topic and response to the raised questions (10 marks each)

External: 50 marks evaluation of the prepared hard copy of the seminar and viva (marks distribution: 30 marks for viva and 20 marks for the report)

## SEMESTER I

### **BCH 401: BIOENERGETICS AND INTERMEDIARY METABOLISM**

#### **UNIT – 1 *Bioenergetics – I:***

- Energy transformation, Laws of thermodynamics, Energy transducing membranes.
- Gibbs energy, Free energy change and redox potentials, phosphate potential, ion-electrochemical potentials
- Chemiosmotic theory, ion transport across energy transducing membranes
- Influx and mechanisms, Proton circuit and electrochemical gradient.

#### **UNIT – 2 *Bioenergetics – II:***

- Mitochondrial Respiratory Chain, Q cycle and the stoichiometry of proton extrusion and uptake
- Reversed electron transfer, respiratory controls and oxidative phosphorylation, uncouplers and inhibitors of energy transfer
- ATP Synthetase Complex
- Microsomal electron transports, Biological oxidations, Oxygenases, hydroxylases, partial reduction of oxygen, Superoxide,

#### **UNIT – 3 *Intermediary Metabolism – I:***

- Glycolysis, TCA cycle — Regulation and function in energy generation
- pentose phosphate pathway and its regulation, (HMP Shunt)
- Gluconeogenesis, Biosynthesis of glycogen, starch
- Regulation of blood glucose homeostasis.

#### **UNIT – 4 *Intermediary Metabolism – II:***

- Fatty acid biosynthesis: Acetyl CoA carboxylase, Fatty acid synthesis, desaturase and elongase
- Fatty acid oxidation:  $\alpha$ ,  $\beta$  &  $\omega$  oxidation and lipoxidation
- Lipid biosynthesis: Biosynthesis of triacylglycerols, phosphoglycerides and sphingolipids,
- biosynthetic pathway of steroids and prostaglandins
- Chylomicrons, LDL, HDL, and VLDL.

### **BCH 402: MICROBIAL BIOCHEMISTRY**

#### ***Unit – 1 : Introduction and Scope of Microbiology:***

- Introduction to Microbiology and its various branches.
- The scopes and avenues of Microbiology.
- Historical developments in Microbiology :
- General characteristics of major group of Atypical Bacteria:  
a) Rickettsia, b) Chlamydia, c) Mycoplasma, d) Actinomycetes, e) Archaeobacteria

#### ***Unit – 2 : Microbial Phylogeny:***

- Importance and systems of Classification
- Status of Microorganisms into kingdoms
- Basic principles of nomenclature and classification
- Criteria used for classification and identification of microorganisms
- Genetic approaches used for microbial taxonomy.
- Numerical Taxonomy; Bergey's Manual
- Present State of Bacterial, fungal and Viral taxonomy

#### ***Unit – 3 : Characteristics of Microorganisms:***

- *Staphylococcus* (Gram positive) and *Escherichia* (Gram negative) as model examples
- Moulds – *Rhizopus*, *Penicillium*, *Puccinia* as model examples
- Yeasts – *Saccharomyces* as model example

- Bacterial Viruses – Coliphage T<sub>4</sub> and Lamda phage as model examples; Animal Viruses – Adenovirus and Influenza virus as model examples; Plant Viruses – TMV as model example
- Gene Transfer Methods in Bacteria; Plasmids, Transposons,

**Unit – 4 : Microbial physiology:**

- Principles of microbial nutrition:
  - a) Nutritional Classification and requirements of microorganisms
  - b) Nutritional classification of microorganisms
- An overview of Bacterial metabolism
- Microbial growth :
  - a) Growth in prokaryotes and modes of cell division
  - b) Normal growth curve of microbial population and Diauxic growth.
  - c) Continuous cultivation of microorganisms.
  - d) Methods for measurement of microbial growth.
  - e) Effect of environment on microorganisms
- Primary and Secondary metabolites produced by Microorganisms

**BCH 403: MOLECULAR CELL BIOLOGY**

**UNIT – 1 Evolution of cell:**

- Cell variability (size, shape, complexity, functions)
- Structural organization of prokaryotic and eukaryotic cells
- Molecular Basis of the Cell and Macromolecular recognition process
  - a) Cell - Cell interactions; Cell adhesions and cell junctions
  - b) Cell Cycle and Cell Division

**UNIT – 2 Biomembrane and Cytoskeleton:**

- Molecular organization of Biomembrane: Ultrastructure and molecular composition of membrane
- Physical and Dynamic properties of membrane
- Movement of molecules/ions across Biomembrane and Human perspective-defects in ion channels
- Cytoskeleton topography: Membrane Cytoskeleton interactions
- Microtubule and its dynamics, motor proteins
- Microfilament and its functions, Intermediate filaments and their functions

**UNIT – 3 Cell organelles I:**

- Molecular Organization and functions of: Endoplasmic reticulum,
- Golgi complex, Lysosomes and Lysosomal disorders
- Microbodies: Peroxisomes, Ribosomes.

**UNIT – 4 Cell organelles II:**

- Molecular Organization and Functions of Nucleus, Chromatin chemistry, Nucleolus
- Basic concept of cancer and Biology
- Characteristics of a cancer cell, Carcinogens and carcinogenesis
- Cancer Biomarker and metabolic Pathway.

**BCH 404: STEM CELL BIOLOGY AND TOXICOLOGY**

**UNIT – 1 Developmental Biology:**

- Gametogenesis, Fertilization, Embryo development
- Gastrulation; - Embryonic germ layer, tracking of Migrating cells
- Epithelial Mesenchymal interactions, Cell differentiation
- Cell ageing and Apoptosis

**UNIT – 2 Basic Stem Cell Biology:**

- Stem cell types, embryonic and adult stem cells
- Stem cell Isolation
- Stem cell characterization techniques
- Stem cell differentiation, induced pluripotency

**UNIT – 3 Applied Stem Cell Biology:**

- Autologous and allogenic stem cell transplantation: Therapeutic applications mesenchymal & hematopoietic stem cells
- Cryopreservation and stem cell banking
- Regulatory guidelines on stem cell therapy and research
- Stem Cell Therapy in Cardiac and Osteogenic regeneration, Stem Cell Therapy in Leukemia,

**UNIT – 4 Animal Toxicology:**

- General Principles and terminology
- Types of toxicity, Factors affecting toxicity,
- Acute, subacute and chronic toxicity,
- Classification of toxicants, Estimation of toxicity; LD<sub>50</sub>; LC<sub>50</sub>;

**BCH 405 PR: Practical and viva voce based on BCH 401 & BCH 402**

**BCH 406 PR: Practical and viva voce based on BCH 404 & BCH 404**

**SEMESTER II**

**BCH 407: PLANT AND ENVIRONMENTAL BIOCHEMISTRY**

**UNIT – 1 Cell wall and Membrane Systems:**

- Cell Wall Structure, Compositions and Functions
- Plasmodesmata: Structure and Functions
- Plant Vacuole: Tonoplast Membrane; functions
- Plastids: Chloroplasts, Energetic, Molecular Organizations & Functions; Genome.

**UNIT – 2 Plant Physiology: Growth and Development:**

- Growth, development, concept, qualitative — quantitative changes
- Growth regulators, biosynthesis, bioassay, mechanism of action, physiological effects, applications (auxin, Cytokinin, gibberellins, ABA, ethylene)
- Physiological effects and role of Jasmonic acid, polyamines, Brassinosteroids, salicylic acid

**UNIT – 3 Plant Breeding and Ethics:**

- Plant breeding — objectives, origin, domestication, hybrid vigour
- Principles and methods of Plant Breeding, Self pollinated crops, Cross pollinated crops, Clonal crops
- Plant Introductions — NBPGR
- Plant Tissue Culture – Basics; Requirements, Techniques and application;

**UNIT – 4 Environmental Chemistry:**

- Ecological Factors: Soil, light, water etc, Principles of limiting factors; biotic factors
- Productivity: Ecosystem Organization: Structure and Function, Types, Energy Flow in Ecosystem, Food Chain & Web
- Biogeochemical cycles (C, N, P and S)
- Global Warming Causes and Impacts; Acid Rain and Green House Gases
- Sustainable Living Environments, Waste Management.

## **BCH 408: HUMAN PHYSIOLOGY**

### **UNIT – 1 *Circulatory System:***

- Heart Beat, initiation, conduction and regulation
- Blood: Composition and function of plasma, erythrocytes including Hb, leukocytes and thrombocytes, plasma proteins in health and disease
- Blood coagulation — mechanism and regulation. Fibrinolysis.

### **UNIT – 2 *Respiratory System:***

- Physiology of nerve impulse conduction, excitability of membranes
- Transfer of blood gases- oxygen and carbon dioxide. Role of 2,3 DPG, Bohr effect and chloride shift
- Hydrogen ion homeostasis- Factors regulating blood pH — buffers, respiration and renal regulation. Acid-base balance- metabolic and respiratory acidosis and alkalosis.

### **UNIT – 3 *Digestive System:***

- Composition, functions and regulation of saliva, Gastric, Pancreatic, intestinal and bile secretions- digestion and absorption of carbohydrates, lipids, proteins, filtration, tubular re-absorption of vitamins.

### **UNIT – 4 *Excretory System:***

- Structure of nephron, formation of urine, glomerular filtration, tubular re-absorption of glucose, water and electrolytes — tubular secretion
- Regulation of water and electrolyte balance
- role of kidneys and hormones in their maintenance
- Role of Hormones, Signal transduction

## **BCH 409: ADVANCED ENZYMOLOGY**

### **UNIT – 1 *Enzyme Kinetics – I:***

- Review of unisubstrate enzyme kinetics and factors affecting the rates of enzyme catalysed reactions
- Classification of multisubstrate reaction with examples of each class
- Kinetics of multisubstrate reactions.

### **UNIT – 2 *Enzyme Kinetics – II:***

- Method of examining enzyme-substrate complexes
- Methodology for measuring kinetic and rate constants of enzymic reaction and their magnitudes
- Enzyme turnover and methods employed to measure turnover of enzymes
- Significance of enzymes turnover.

### **UNIT – 3 *Immobilized Enzymes:***

- Protein-Ligand binding, including measurement, analysis of binding isotherms
- Co-operativity phenomenon. Hill and Scatchard plots
- Allosteric enzymes, Sigmoidal kinetics and their physiological significance
- Immobilized enzymes and their industrial applications

### **UNIT – 4 *Enzyme Regulation:***

- Multienzyme system: Occurrence, isolation and their properties, Polygenic nature of Multienzyme systems.
- Co-enzymes and cofactors: Water soluble vitamins and their coenzymes. Metalloenzymes
- Enzyme regulation: general mechanisms of enzyme regulation: Feed Back Inhibition and Feed forward stimulation; Enzyme repression, induction and degradation, control of enzymic activity by product and substrates; Reversible covalent modification of enzymes; Mono-cyclic and cascade systems with specific examples.



## **BCH 410 : NUTRITIONAL AND CLINICAL BIOCHEMISTRY**

### **UNIT – 1 *Chemistry of Nutrients:***

- Minerals: nutritional significance of dietary calcium, phosphorus, magnesium, iron, iodine, zinc and copper
- Vitamins: dietary sources, biochemical functions and specific deficiency disease associated with fat and water-soluble vitamins. Hypervitaminosis symptoms of fat soluble vitamins. Nutritional requirements during pregnancy, lactation and infants and children
- Basic Concepts: Composition of human body- Energy content of foods. Measurement of energy expenditure: Direct & indirect calorimetry - Definition of BMR and SDA and factors affecting these. Thermogenic effects of foods. Energy requirements of men and woman and factors affecting.

### **UNIT – 2 *Nutritional Biochemistry – I:***

- Protein Energy malnutrition (PEM): Aetiology, clinical features, metabolic disorders and management of Marasmus and Kwashiorkar disease
- Starvation: Techniques for the study of starvation. Protein metabolism in prolonged fasting. Protein sparing treatment during fasting. Basic concept of high protein, low caloric weight production diets. Obesity
- Enzymes and metabolites as Liver function indices; clinical tests for renal function
- Disorders of amino acid metabolism Phenylalaninemia, homocystineuria, tyrosinemia and related disorders, aminoacidurias
- Disorders of Purine and Pyrimidine metabolism, Anaemia

### **UNIT – 3 *Nutritional Biochemistry – II:***

- Clinical significance of lipids/lipoproteins, lipidosis
- Clinical inter-relation of lipids (sphingolipidosis,multiple sclerosis), lipoproteins and apolipoproteins
- Diagnosis tests for apolipoproteins, HOL-cholesterol, LDL-cholesterol and triglycerides disorders
- Enzymes and other tests of cardiac function
- Diabetes mellitus and related tests

### **UNIT – 4 *Clinical Nutrition:***

- Role of diet and nutrition in the prevention and treatment of disease
- dental caries, fluorosis, renal failure, hyperlipidemia
- Atherosclerosis and Rheumatic disorders
- inherited metabolic disorders: Phenyl ketonuria, maple syrup disease
- Homocystinuria, galactosemia, gout
- Diabetes insipidus and diabetes mellitus.

***BCH 411 PR: Practical and viva voce based on BCH 407 & BCH 408***

***BCH 412 PR: Practical and viva voce based on BCH 409 & BCH 410***

## SEMESTER III

### **BCH 501: IMMUNOLOGY & IMMUNOTECHNOLOGY**

#### **UNIT – 1 Basic Immunology – I:**

- History and Significance of immunology
- Immunity and its types,
- Immune System, Cell and Organs involved
- Complement System
- Cytokines and their significance
- Cancer and Immune response (Tumour Immunology)

#### **UNIT – 2 Basic Immunology – II:**

- Antigens: General properties, criteria for antigens, types of Antigens
- Antigenicity MHC, HLA complex
- Immunoglobulins: Basic structure and types
- Immunogenetics: Genetic basis of clonal selection and generation of antibody diversity
- In-vivo antigen-antibody interactions.

#### **UNIT – 3 Immunotechnology:**

- In vitro antigen-antibody reactions and diagnostic significance
- Agglutination tests
- Precipitation and Immunodiffusion Tests Radioimmunoassay
- IRMA, ELISA / ELISPOT, RAST
- Hybridoma technology applications of monoclonal antibodies
- Vaccines and Immunotherapy

#### **UNIT – 4 Dysfunction Immunity:**

- Hypersensitivity Reactions
- Tolerance and Autoimmunity; Autoimmune diseases
- Immunodeficiency and their consequences
- Transplantation immunology
- Hazards of vaccine

### **BCH 502: INSTRUMENTATION AND TECHNIQUES**

#### **UNIT – 1 Analytical Biochemistry:**

- Basic Quantitative Biochemistry: Concept of pH, Dissociation and Ionization of acid and Base, pKa, Buffer and Buffering System, Henderson Hassel Balch equation, Dissociation of amino acids, Normality, Molarity and Molality.
- Automation In Clinical Biochemistry: Instrument concepts, Chemical reaction phase, Measurement approaches, Selection of instrument, Control of analytical variables, External and internal quality control measurements

#### **UNIT – 2 Separation Techniques:**

- General principles and applications of Adsorption chromatography
- Partition; ion-exchange chromatography; Thin-layer chromatography & HPTLC
- Molecular-sieve chromatography; Gas- liquid chromatography
- FPLC & UPLC, Affinity chromatography
- Preparative and Analytical Ultracentrifugation, Basic principles and types of Gel

#### **UNIT – 3 Analytical Techniques:**

- Beer-Lambert law, Types of emission spectra, light absorption and its transmittance and application of extinction coefficient
- application of visible and UV spectroscopic techniques (structure elucidation and numerical excluded)

- Electrophoresis, PAGE and SDS-PAGE, Two- dimensional electrophoresis and its importance
- Iso-electro-focussing; Immuno-electrophoresis,

#### **UNIT – 4 *Radio-Isotopic and Non-Radioisotope Techniques:***

- Type of radio isotopes used in Biochemistry, Isotopes commonly used in biochemical studies: 32-P, 35-S, 4-C, and 125-I)
- Techniques used to measure radioactivity (gas ionization and liquid scintillation counting), Autoradiography
- Biological hazards of radiation and safety measures in handling radioisotopes, Biological applications
- Radioimmunoassay.
- Principle and application of Chemiluminescence in biomarker assessment

### **BCH 503: *BIostatISTICS, BIOinformatics, BIOinstrumentation AND BIOassays***

#### **UNIT – 1: *Biostatistics:***

- Introduction, Sample and Sample techniques, Types and Presentation of Data, Concepts of population, Measures of central tendency: Mean, Mode and Median,
- Standard deviation and standard error, Basic of Probability theory and theory of distribution, Simple linear correlation and regression
- Tests of significance, 't' test, ANOVA-one way and two way analysis
- Entrepreneurship and marketing - starting and managing an enterprise
- Entrepreneurship, advertising, marketing.

#### **UNIT – 2: *Research Methodology & Bioinformatics:***

- Research methodology: Meaning, objectives and types of research, significance of research. Definition and identification of a research problem, justification, theory and hypothesis.
- Research design: Features of a good design, concepts of variables, experimental and control groups. Hypothesis testing, Interpretation: Meaning of interpretation and techniques. Interpretation of tables and figures. Reporting: Significance of report writing, steps in report writing and types of reports
- Introduction to Bioinformatics, Basic concepts of biological databases; Protein and Genome Information Resources, Computer in Life Sciences
- Structure prediction and quality assessment
- Virtual screening of drug molecules
- Molecular dynamic simulation

#### **UNIT – 3: *Microscopy:***

- Principles, working and application of Bright field and Dark field
- Phase contrast and Interference, Differential Interference Contrast Microscope
- Fluorescence Microscopy; Immunofluorescence, Confocal Microscopy
- Specimen fixation, processing and staining in Light Microscopy
- Electron Microscopy; TEM, SEM, and STEM, Cryoelectron microscopy
- Processing of Biological sample for EM, Special Techniques in EM: Negative staining
- Shadow casting and Freeze fracture deep etch replication techniques;

#### **UNIT – 4: *Bioinstrumentation & Bioassays in Drug discovery:***

- PCR & qRTPCR
- Sanger sequencing (principle and clinical applications)
- Next generation sequencing (principle and clinical applications)
- Microarray (principle and clinical applications)
- Principle of MS and MALDI-TOF;
- Flow cytometry (principle and clinical applications)
- Viability and cytotoxicity assays (MTT, SRB etc); Functional assays
- In-vitro model for drug screening; In-vivo animal models

## **BCH 504EA: Elective – ADVANCED MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

### **UNIT – 1 *Molecular Biology:***

- Physical and chemical properties of nucleic acids (DNA & RNA)
- Isolation and separation techniques; DNA Sequencing
- Blotting techniques (southern & northern)

### **UNIT – 2 *Genomics:***

- Eukaryote genome and chromosome organization
- Eukaryotic gene structure
- Replication, Transcription, post transcriptional modifications, translation, post-translational modifications and regulation of gene expression
- DNA Damage & Repair

### **UNIT – 3 *Recombinant DNA Technology:***

- Methodology of creating a recombinant DNA molecule, splicing, properties of restriction endonucleases and their mode of action, selection/screening,
- construction of DNA library; Chemical synthesis of gene
- cloning vectors ( $\lambda$ -phage, plasmid, M-13 phage, cosmid), shuffle vectors, yeast and viral vectors, expression vectors, uses of cloned gene, sub cloning,
- protein production in bacteria; antisense-RNA technology

### **UNIT – 4 *Proteomics:***

- Basics of Proteomics, Isolation, Purification and characterization of Proteins
- Protein Folding and basics of protein engineering
- Therapeutic proteins including Monoclonal antibodies
- Purification and application and of monoclonal antibodies.

## **BCH 504EB: Elective – MOLECULAR ONCOLOGY**

### **UNIT – 1: *Dynamics of Cell Growth:***

- Cell cycle, Cell division -molecular aspects, mechanics, regulation
- Cell growth; Growth factors, Cell aggregation
- Cell ageing (senescence), Cell death, apoptosis
- Autophagy

### **UNIT – 2: *Cancer Biology – I:***

- Normal and cancerous cells; Cancer Hallmarks
- Carcinogens and Carcinogenesis
- Cancer Biomarkers; Chromosomes and Cancer
- Oncogenes and tumour suppressor genes;
- Signal transduction pathways

### **UNIT – 3: *Cancer Biology – II:***

- Principle of cancer therapies, radiation, chemotherapy, immunotherapy and targeted therapy; Biological therapy
- Cancer stem cells,
- Drug resistance

### **UNIT – 4: *Cancer drug discovery:***

- Cancer drug targets identification and validation
- In-vitro screening
- In-vivo models in cancer
- Cancer clinical trials

***BCH 505 PR : Practical and viva voce based on BCH 501 & BCH 502***

***BCH 506 PR : Practical and viva voce based on BCH 503 & BCH 504***

## SEMESTER IV

### **BCH 507PT: DISSERTATION/ PROJECT WORK**

Students are supposed to carry out field / laboratory training cum experimental work and prepare a comprehensive report along with a research proposal. The area should include basics to latest developments and discoveries, which will impart a broad training in various disciplines of Biochemistry and Biotechnology. These students will be able to pursue careers in pharmaceutical industries, research laboratories, clinical research organizations, school, colleges and Universities as researchers or academicians.

### **BCH 508S: SEMINARS / FIELD / INDUSTRIAL VISIT**

Students should deliver seminars and attend the same at regular basis topics from syllabus, or recent advances in the subject and from prepared review of research articles from research Journals. Students are also required to visit laboratories, research institutes and industries for real exposure in subject and qualitative interactions to understand applications of the subject. If possible a study tour during the span of two years may be organized pertaining to different Biochemistry/Microbiological/ Biotechnological/ Pharmaceutical industries/ research institutes/ within or outside Gujarat State. The study tour is highly essential for study various concepts, processes and technology pertaining to Biochemistry and its advances.

### **BCH 509M: ASSIGNMENT AND GROUP DISCUSSION**

Department will allocate the assignment from the subject and related areas to each student and arrange group discussion between students and also between faculties and students.

### **Reference Books**

1. Instrumental Analysis in the Biological Sciences. M.H. Gordon and R. Macrae Latest Edition. Blackies, Scientific Publishers.
2. Lehninger's Principles of Biochemistry, Nelson and Cox, 5th Edition. 2009.
3. Biochemistry. Grisham and Garret 4th Edition 2009.
4. An Introduction to Practical Biochemistry. David T Plummer. Third Edition
5. Fundamentals of Analytical Chemistry. D.A. Skoog, D.M. West, F.J. Holler and S.R. Crouch, Thomson Pub. 2004.
6. Principles of Instrumental Analysis. D.A. Skoog, F.J. Holler and T.A. Nieman Harcourt Asia Pvt. Ltd. 2001.
7. Cell and Molecular Biology. Gerald Karp, John Wiley & Sons, 1996.
8. Molecular Cell Biology. H. Lodish, D.Baltimore, A. Berk and J. Darnell. W.H. Freeman, New York. Fourth Edition, 1995
9. Molecular Biology of the Cell. Bruce Alberts, D. Bray J. Lewis M.Raff K. Roberts and J.D. Watson. 5th Edition Garland Publishing Inc., NY. 2002/
10. Laboratory procedures in Biotechnology, Cell and Tissue Culture. Doyle. Wiley International. 1999.
11. Molecular Biology of the Gene. J.D. Watson. Pearson Publications Inc. 2004.
12. The Enzymes. Bayer, Lardy and Myrback Academic Press 2000
13. Enzymes. Trevor, S.P. Harwood Inc. 2001.
14. Enzymology for Recombinant DNA technology. Academic press. 1996
15. Textbook of Medical Physiology. Guyton, Elsevier 2000
16. Human Physiology : The basis of Medicine. G. Pocock and C. Richards 1999
17. Blood: Physiology and Pathophysiology C. Pallister Butterworths, 2000
18. Clinical Biochemistry: Metabolic and Clinical Aspects. W.J. Marshall and S.K.Bangert. Churchill Livingstone 1995.
19. Clinical Biochemistry —Lecture notes . A.F. Smith G.J. Beckett S.W. Walker, P.W.H. Rae. 1998.
20. Immunology - Roitt, Brostoff and Male – 3rd edition 1998. Mosby Intl.
21. Kuby's Immunology 4th Edition R.A. Goldsby T.J. Kindt and B.A. Osborne. Freeman Press
22. Molecular Biology and Gene Cloning Volumes I and II T.A. Brown , Academic Press 2000.
23. Genomes T.A. Brown Academic press. Latest Edition.

24. Culture of Animal Cells. Ian Freshney. 2003
25. Molecular Biotechnology. S.B. Primrose. Blackwell Scientific Publishers Oxford University Press. 2004
26. Genes VII. Benjamin Lewin Oxford University Press.
27. Microbiology 5th Edition M.J. Pelczar, E.C.S.Chan and N.R. Krieg. Tat McGraw Hill 1996.
28. Microbial Genetics S.S. Rajan Anmol Publications New Delhi
29. Harper's Illustrated Biochemistry. Robert Murray, Daryl Granner, Peter Mayes and Victor Rodwell. McGraw Hill International Publications 26th Edition, 2006.
30. Immunobiology 4th Edition C.A. Janeway P.Travers Churchill Livingstone Pub. 1999.
31. Fundamentals of Enzymology Nicholas C. Price & Lewis Steven Oxford Univ. Press 2003