

Gujarat University
Syllabus for Biochemistry at B. Sc. Semester V
 (To be effective from 2019)

BIC 301	Metabolism
BIC 302	Molecular Biology
BIC 303	Enzymology
BIC 304	Introduction to Microbiology & Nutrition
BIC 305	Subject Elective(Techniques in Biotechnology)
BIC 306	Practicals

Course Structure with respect to credit, hours and marks

Type of Course	Paper No.	Credits	Total Marks	Internal Marks	External Marks	No. of hours per week	Exam hours
Foundation Course (FC-V)	FC - 301	2	100	30	70	3	3
Core Course	BIC 301	4	100	30	70	4	3
	BIC 302	4	100	30	70	4	3
	BIC 303	4	100	30	70	4	3
	BIC 304	4	100	30	70	4	3
Subject Elective Course (SEC)	BIC 305	2	100	30	70	3	3
Practicals Core Course	BIC 306	5	100	30	70	12	12
Total Credits		25					

N.B.: The practical batch should be minimum of 10 students with respect to the credits.

Third Year	Semester V		Semester VI	
	301: Metabolism		307: Nutrition and Diseases	
4 Credits	Unit 1:	Introduction & Metabolism of Carbohydrates	Unit 1:	Obesity and Diabetes Mellitus
	Unit 2:	Metabolism of Proteins	Unit 2:	Nutritional Anaemias, Rickets, Osteomalacia
	Unit 3:	Metabolism of Lipids	Unit 3:	PEM & Role of lipids in Coronary Heart Diseases (CHD)
	Unit 4:	Energy metabolism	Unit 4:	Scurvy, Xerophthalmia and Food Toxicity
	302: Molecular Biology		308: Advanced Microbiology	
4 Credits	Unit 1:	Introduction, History, DNA Replication	Unit 1:	Bacteriological Media and Sterilisation.
	Unit 2:	DNA Repair, Genetic code, Transcription, Mutations.	Unit 2:	Growth and culturing of Bacteria
	Unit 3:	Translation, Control of gene expression. Lac, Trp operons	Unit 3:	Chemotherapy and Microbial Diseases
	Unit 4:	Techniques in Molecular Biology & Genetic Engineering	Unit 4:	Fermentation technology & Industrial microbiology.
	303: Enzymology		309: Immunology	
4 Credits	Unit 1:	Introduction to Enzymes	Unit 1:	Introduction, Organs and cells of Immune system
	Unit 2:	Metalloenzymes, Isoenzymes, Multienzyme complex & Membrane bound enzymes	Unit 2:	Host defence mechanism, Structure and types of Immunoglobulin and immune response
	Unit 3:	Enzyme Classification, Factors affecting enzyme catalysis, Role of Vitamin B complex as	Unit 3:	Immunochemical techniques, and their application

		coenzyme		
	Unit 4:	Regulatory enzymes and Two Substrate Enzyme Reaction Mechanism	Unit 4:	Applied Immunology
4 Credits	304: Introduction to Microbiology & Nutrition		310: Advanced Enzymology	
	Unit 1:	Major groups of microorganisms, Morphology of Bacteria	Unit 1:	Enzyme kinetics
	Unit 2:	Microbial Staining & the role of micro organism in human welfare	Unit 2:	Quantitative methods for following enzyme reactions
	Unit 3:	Essential Macro Nutrients in Human diet	Unit 3:	Enzyme isolation & purification , Enzyme units
	Unit 4:	Energy Balance and Nutritional value of Food Groups	Unit 4:	Applications of Enzymes and Immobilized enzymes
5 credits	306: Practicals		312: Practicals	
2 credits	305: Biochemistry Elective		311: Biochemistry Elective	

Unit 1: Introduction & Metabolism of Carbohydrates

Introduction to Metabolism, Terminology: Catabolism, Anabolism, Amphibolic pathways, Intermediary metabolism, Types of Metabolic regulations, Overall View of Carbohydrate, Lipid and Protein Metabolism.

Glycolysis, energetics, regulation of Glycolysis, Fates of pyruvate: Lactate Fermentation & Alcohol Fermentation, Feeder pathways, (Introduction & only reactions with names of the enzymes) Glycogen degradation & Regulation, Glycogen synthesis & Regulation, Reciprocal Regulation of Glycogen metabolism, Gluconeogenesis, Reciprocal regulation of Glycolysis & Gluconeogenesis, Cori cycle, Pentose Phosphate Pathway. Inborn errors of carbohydrate metabolism: Lactose intolerance, Galactosemia, all Glycogen Storage diseases (only the name of the defective enzyme & disease caused due to it)

Unit 2: Metabolism of Proteins

Over view of the fate of carbon skeletons of amino acids, Gamma-Glutamyl cycle, Transamination, Oxidative Deamination, Non-oxidative, Glucose Alanine shuttle, Decarboxylation, Urea cycle, Regulation, Energetic, Significance, Uric acid formation, Creatine metabolism. Inborn errors of Protein: PKU (in detail), Homocysteinuria, Albinism, Maple syrup urine diseases (only the name of the defective enzyme & disease caused due to it)

Unit 3: Metabolism of Lipids

Introduction, mobilization of fat, β -Oxidation of saturated, Unsaturated and odd chain fatty acids, Energetic and regulation, alpha and omega oxidation, Ketone bodies synthesis & Utilization, FA synthesis, Steps, Stoichiometry, Regulation, Desaturation and Elongation of FA, Comparison of synthesis and oxidation, TG & PL synthesis. Role of liver and adipose tissue in lipid metabolism, Integration of Metabolism (Role of Hormones (Glucagon, Epinephrine, Insulin) in Fuel Metabolism, Inborn errors of lipid metabolism (only the name of the defective enzyme & disease caused due to it)

Unit 4: Energy Metabolism

PDH Complex, TCA Cycle, Energetic, Regulation, Anaplerotic & Amphibolic Nature, Glyoxylate Cycle, Glycerol Phosphate And Malate- Aspartate Shuttle,

ETC, Inhibitors Of ETC, Chemiosmotic Hypothesis for ATP Production, Oxidative Phosphorylation, Binding Change Hypothesis, P/O Ratio, Uncouplers, Ionophores & Inhibitors of Oxidative Phosphorylation, Energy Rich Compounds.

References:

1. Berg JM, and Tymoczko TJ Stryer L,: Biochemistry (6th ed), (2008).WH Freeman Publishers
2. Bhagvan NV: Medical Biochemistry (4th ed) Bartlett Publishers.
3. Donald Voet and Voet J: Biochemistry (4th ed) 2011, Wiley Publications.
4. Grisham and Garrett: Biochemistry (3rd ed)
5. Jeoffrey Zubay: Principles of Biochemistry, McGraw Hill Publications, (1996).
6. Murray RK, Rodwell VW: Harpers review of Biochemistry (25th ed), (2000).
7. Nelson DL and Cox MM: Lehninger's Principles of Biochemistry (5th ed) 2008.

Semester V

302: Molecular Biology

(4 credits)

Unit 1: Introduction, History, DNA Replication

Griffith's experiment, Avery & Mcleod's experiment, Hershey and Chase's experiment, Chargaff's experiments and postulates, Watson and Crick's model of DNA. Structure of nucleic acids, various forms (A,B and Z), Secondary structure of RNA, Properties of DNA: Denaturation,(Both Thermal and Chemical) Renaturation, Hypochromacity, Hyperchromacity, Melting temperature and Factors affecting T_m, Super coiling types of super coiling and its biological significance.

Replication (Dispersive conservative, semi conservative,), Messelson and Stahl's experiments, Mechanism of replication, Initiation, Elongation and Termination, Role of various enzymes, Methods of replication (Rolling circle model)

Unit 2: Transcription, and Genetic code, Translation, Control of gene expression, Lac Operon a& Trp operon

Transcription: promoters, properties and functions of RNA polymerase and its subunits, Steps in initiation (transcription bubble), elongation and, termination (rho dependent and independent), Post transcriptional processing

Genetic code & its characteristics

Ribosomes as translational factory, Role of t-RNA as an adaptor Steps in translation: Activation, Initiation, Elongation, Translocation, and Termination), Post translational modifications. Effect of antibiotics such as Tetracycline, Chloramphenicol, Cyclohexamide, Streptomycin, and Puromycin on translation

Regulation of Protein biosynthesis: Lactose operon and Tryptophan operon

Unit 3: Mutations, DNA repair,

Transposable elements: Introduction, types and their effect

Mutation, types of mutations, Mutagenic agents both Physical & Chemical agents. Physical agents: X-rays, UV radiation, Ionizing radiation; Chemical mutagenic agents: Nitrous acid, Base analogue, Acridine dye and other chemical agents

Repair of DNA by Photo reactivation mechanism and Excision repair mechanism

Unit 4: Techniques in Molecular Biology and Genetic engineering

An introduction to Genetic engineering

Tools of genetic engineering: Restriction Endonucleases, Vectors (plasmid and λ bacteriophage), Basic steps in gene cloning,

Isolation, Purification and Estimation of Chromosomal & Plasmid DNA: Agarose gel electrophoresis, Spectrophotometer measurement

Properties of host organisms, Transformation, Methods to identify Recombinants (using PBR322 & pUC8)

How to obtain clone of a specific Gene: Gene libraries, Shotgun cloning, Southern blotting technique, PCR.

Applications and Potential biohazards of genetic engineering

References:

1. Berg JM, and Tymoczko TJ, Stryer L.; Biochemistry (6th ed)
2. Brown TA: gene cloning
3. De Robertis and de robertis: Cell and Molecular Biology
4. Donald Voet and Voet J: Biochemistry (4th ed) 2011
5. Grisham and Garrett: Biochemistry (3rd ed)
6. Lewin: Genes
7. Nelson DL and Cox MM: Lehninger's Principles of Biochemistry (5th ed) 2008

Unit 1: Introduction to Enzymes

Introduction & Important Definition of Terminologies

Historical Development in Enzymology

Characteristics of Enzymes, Enzyme Vs Chemical Catalysts

Active site, Enzyme mechanism & strategies of Enzyme catalysis

Fischer and Koshland Models to explain enzyme action

Activation Energy, Mechanisms to lower activation energy

Enzyme Specificity & different types of specificity

Zymogens, Properties with examples and Activation of Chymotrypsinogen

Abzymes, Synzyme, Ribozyme, Extremozyme. (Short Note)

Unit 2: Metalloenzymes, Isoenzymes, Multienzyme Complex & Membrane Bound Enzymes

Metalloenzymes: Role of Metals in Enzyme Function, Enzyme Activation by Earth Metal ions, Alkali earth metal ions, Transition metal ions.

Isoenzymes, Definition & properties, Example of Isoenzymes: LDH, Separation of Isoenzymes, Metabolic Importance, Clinical importance of isoenzymes,

Membrane Bound Enzyme, Physiological Importance, and Advantages of Membrane Bound Enzyme with examples. Maltase, Adenylate Cyclase, Glycerol 3 Phosphate Dehydrogenase

Multienzyme Complex: Properties, Examples with Reactions (PDH Complex, Fatty Acyl Synthase Complex), Physiological Importance, and Advantages of MEC.

Unit 3: Enzyme Classification and Factors Affecting Enzyme Catalysis

Need For Classification, Four Digit Classification, Examples from Each Class Including Trivial Name, Systematic Name and EC Number

Factors affecting enzyme reactions: Enzyme Concentration, Substrate Concentration, pH, Time, Temperature, Radiation, Oxidizing Agents, Inhibitors and Activators

Role of B complex Vitamins in Enzyme catalyzed reactions

Unit 4: Regulatory enzymes & two substrate enzyme reaction mechanism

Allosteric enzymes with their properties, Regulatory role of allosteric enzymes in metabolism, some examples of allosteric enzymes: Threonine Dehydratase, PFK-1, Fructose 1, 6 Bisphosphatase, Acetyl CoA Carboxylase, ATCase (Aspartate Transcarbamylase), Evidence for allosteric site on enzymes

Covalently modulated enzymes with examples: Glycogen Phosphorylase & Glycogen Synthase

Ordered, Random and Ping Pong Reactions with Examples

References:

1. Dixon, M, Webb EC: Enzymes (1979)
2. Price NL and Stevens: Fundamentals of Enzymology (1989)
3. Foster RL: The nature of Enzymes (1980)
4. Palmer T: Understanding enzymes (1981)
5. Conn and Stumpf: Outlines of Biochemistry
6. Nelson DL and Cox MM: Lehninger's Principles of Biochemistry (5th ed) 2008
7. Palmer T: Enzymes: Biochemistry, Biotechnology and clinical applications (1981)
8. Berg JM, and Tymoczko TJ Stryer L,: Biochemistry (6th ed), (2008).WH Freeman Publishers

Semester V

304: Introduction to Microbiology & Nutrition

(4 credits)

Unit 1: Major groups of Micro organisms & Morphology of Bacteria

Brief introduction to Mycoplasmas, Archaeobacteria, Viruses

Size, shape, Structure and arrangement of bacterial cell, Bacterial Flagella and motility, Arrangement of flagella, Chemotaxis, Capsules, Structure & functions, economic importance of capsule, Cell wall of both Gram positive and Gram negative bacteria, Protoplasts, Spheroplasts, L-forms, Mesosomes, Pili, and Metachromatic granules, Endospore, Sporulation and Spore germination.

Unit 2: Microbial Staining & the role of Micro organisms in human welfare

Dyes and stains, Importance, Definitions of terms: Stain, Chromogen, Acidic stain, Basic stain, Neutral and Amphoteric stain, Smear, Fixation, Mordant, Intensifier, Compound stain, Leuco compounds, Dyes used as pH indicators. Physical and Chemical theory of staining

Monochrome staining, Negative staining, differential staining: Gram staining, Acid fast staining, Structural staining techniques: Capsule, Metachromatic, spore staining. (One staining method only for each)

Role of microorganisms in human welfare in brief: Sewage treatment, SCP, Insect pest control.

Unit 3: Essential Macro Nutrients in Human diet

Carbohydrates: Dietary Fibers and their Therapeutic Roles, Dental caries, Carbohydrate Loading, Lactose intolerance, Role of carbohydrates, RDA

Proteins: Role, RDA, Complete and Incomplete Proteins, Supplementary value, Reference Proteins, Nitrogen balance and factors affecting it. Methods used to evaluate Protein Quality (Just mention the methods)

Lipids: Role, MUFA, PUFA, Trans fats, Ketosis, Fat transport, Mobilisation and Storage

Unit 4: Energy Balance and Food groups

Energy balance: Unit of Energy, Energy value of foods, RQ, BMR and factors affecting it, SDA, Physical Activity. Principle of Direct and Indirect Calorimetry. Just mention the name of methods used for finding out Energy intake and Expenditure of a person (Bomb Calorimeter, Atwater & Rosa respirometer, Benedict-Roth and Max Planck respirometer, Food composition tables and FAO method).

Balanced Diets and RDA (Definitions only)

Nutritional Value of foods of Plant Origin: Cereals, Legumes, Fruits and Vegetables.

Nutritional Value of Foods of Animal origin: Milk, Eggs, Fish and Meat.

Vegetarian vs. Non-vegetarian foods

References:

1. Atlas R: Microbiology: Fundamentals and Applications (2nd ed) 1997.
2. Frobisher, Hinsdill, Crabtree, Goodheart: Fundamentals of Microbiology(8th ed)
3. Pelczar Reid: Microbiology (5th ed)
4. Prescott, Harley Kleins : General Microbiology.(7thed)
5. Stainer: General Microbiology
6. Microbiology an introduction (6thed) 1998.
7. Microbiology: Brock 11thed)2006
8. Introduction to Microbiology: Ingraham & Ingraham.
9. B. Srilakshmi: Dietetics, 4TH Edition, 2008, New Age International Publishers.
- 10.B. Srilakshmi: Nutrition Science, 4TH Edition, 2008, New Age International Publishers.
- 11.V. Hegarty: Decisions in Nutrition, 1988, Times Mirror/Mosby college publishers.
- 12.Christopher Haslett: Davidson's principles and Practice of medicine (18th edition) 1999. Churchill Livingston.
- 13.B. Srilakshmi: Food Science, 4TH Edition, 2008, New Age International Publishers.
- 14.Shubhangi Joshi: Nutrition and dietetics, 1992, Tata McGraw Hill Publishers.
- 15.Rajlakshmi: Applied Nutrition, 3rd edition, 1990, Oxford & IBH publishing company.
- 16.Davidson and Passmore: Human Nutrition and Dietetics, 8th Edition, 1986, ELBS.
- 17.Swaminathan: Essentials of Food & Nutrition Volume I &II, 1991, BAPPCO Publishers.
18. Gordon Wardlaw: Contemporary Nutrition, 4th Edition, 2000, McGraw Hill publishers.
- 19.Guthrie: Introductory Nutrition,4th Edition,1979,C.V. Mosby Company
20. Garrow: Human Nutrition & dietetics,10th Edition,2000,Churchill Livingstone Publishers.

305: Practicals

(5 credits)

Duration: 3hr

Marks: 100

(A) Clinical Biochemistry

1. Estimation of Urea from Serum
2. Estimation of Phosphorus in Serum
3. Estimation of Serum Creatinine
4. Estimation of Uric acid

(B) Microbial Staining

5. Preparation of stains

6. Monochrome staining
7. Negative staining
8. Gram staining
9. Spore staining by Schaffer & Fulton's method
10. Capsule staining
11. Metachromatic granule staining
12. Permanent Slides (Fungal)

(C) Liver Function Tests

13. Estimation of SGPT from Serum (Demonstration)
14. Estimation of SGOT from Serum (Demonstration)
15. Estimation of Serum Bilirubin.
16. Estimation of Alkaline phosphatase (Enzyme involved in hydrolysis of ester) (Demonstration)

(D) Enzyme Kinetics

17. Extraction of beta glycerol phosphatase enzyme from potato and its activity measurement.
18. Effect of enzyme concentration on phosphatase enzyme from potato.
19. Effect of pH on phosphatase enzyme from potato.
20. Effect of substrate concentration of phosphatase enzyme from potato.

(E) Study tour

21. Tour to study advanced biochemical techniques

References:

1. Oser: Hawk's Physiological Chemistry (14th ed)
2. Plummer: An introduction to practical Biochemistry
3. Sheela Sharma: Experiments and Techniques, 2007.
4. Thomas and Schalkhammer: Analytical Biochemistry, 2002
5. Varlery H: Practical Clinical Biochemistry
6. Whatton and McCarty: Experimental methods in Biochemistry
7. Willard and Merrit: Instrumental methods of analysis
8. S. Shanmugam, TSathish Kumar, K Panneer Selvam: Laboratory Handbook on Biochemistry, 2010, PHI Learning Pvt. Ltd.
9. Practical Microbiology : R.C. Dubey & D.K. Maheshwari S.Chand. 2009.
10. Experimental Microbiology Vol-1&2, Rakesh J. Patel, Aditya Publications, 5th edition.

**BIOCHEMISTRY ELECTIVE PAPER
SEMESTER –V**

TECHNIQUES IN BIOTECHNOLOGY

(Applicable from 2019)

UNIT 1: Recombinant DNA and Genetic Analysis

Isolation, Purification and Estimation of Nucleic acids (Agarose gel electrophoresis)
Manipulation of Nucleic acids-Basic tools and techniques (Vectors and Enzymes)
Basic steps of Gene cloning

UNIT 2: Molecular Analysis of DNA

Blotting techniques-Southern blotting
Restriction mapping
DNA sequencing- Sanger sequencing, Maxam & Gilbert sequencing

UNIT 3: Polymerase chain reaction and its applications

Basic concepts and stages of the PCR
Variations of PCR
Applications of PCR
PCR vs. Gene cloning

UNIT 4: Bacterial genetics: Introduction to Transposable element Transformation,
Conjugation: F and Hfr factors Matting types, gene mapping
Transduction: Generalized and specialized

References:

1. Brown TA: gene cloning
1. 2. Atlas R: Microbiology: Fundamentals and Applications (2nd ed) 1997
2. 3. Prescott, Harley Kleins : General Microbiology.(7thed)
3. 4. Stainer: General Microbiology
4. 5.Genetic Engineering By S.Rastogi and M.Rastogi
5. 6. Text book of Biotechnology By H.K.Das
- 6.

SEM 5 BIOCHEMISTRY ELECTIVE REVISED

PLANT BIOCHEMISTRY

(2 CREDITS)

Unit I: Plant Cell and System

Plant cell structure and its organelles;
Plant Cell Wall Formation and its functions;
Tissue Systems; Cell types and their functions;
Plant Organ Systems

Unit II: Biochemical Processes and Metabolic pathways specific to plants - Photosynthesis

Light reactions: i) Cyclic photophosphorylation
ii) Non –cyclic photophosphorylation
Dark reactions: i) Calvin's Cycle (C3 metabolism)
ii) C4 metabolism
iii) CAM metabolism
Photorespiration

Unit III: Biochemical Processes and Metabolic pathways specific to plants

Nitrogen fixation and assimilation
Sucrose synthesis and breakdown
Phosphate uptake systems and role in cells
Sulphate assimilation

Unit IV: Phytohormones

Auxins: Biosynthesis, transport, signal transduction and downstream effect
Cytokinins: Biosynthesis, transport, signal transduction and downstream effect
Gibberelins: Biosynthesis, transport, signal transduction and downstream effect
Abscisic acid: Biosynthesis, transport, signal transduction and downstream effect
Ethylene: Biosynthesis, transport, signal transduction and downstream effect
Introduction to salicylic acid and jasmonic acid

Ref:

1. Berg JM, and Tymoczko TJ, Stryer L.; Biochemistry (6th ed)
2. Davies Peter: Plant hormones (3rd ed) 2004.
3. Donald Voet and Voet J: Biochemistry (4th ed) 2011
4. Goodwin TW and Mercer, E.I, introduction to Plant Biochemistry, Pergamon Press.
5. Grisham and Garrett: Biochemistry (3rd ed)
6. Hall, DO, Rao, KK.,Photosynthesis (1996), Cambridge University Press.
7. Heldt, Hans-Walter, Plant Biochemistry and Molecular Biology (1997), OUP.

8. Nelson DL and Cox MM: Lehninger's Principles of Biochemistry (5th ed) 2008
9. Salisbury and Ross: Plant Physiology, CBS Publications, Delhi.