Enclosure II

Shri Manibhai Virani and Smt.Navalben Virani Science College, Rajkot
(Autonomous)
Affiliated to Saurashtra University, Rajkot

B.Sc. BIOCHEMISTRY

Semester V Syllabus

For Students Admitted From A.Y.2021-2022 and Onwards

Applied Course For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Biochemistry**	Offered to: **B.Sc. Biochemistry**	
Semester – III		
Course Code	Course Title (App.)	Course Credit and Hours
21UBCCC501	**Advanced Molecular Biology**	**4 Credits - 4 hrs/wk**

Course Description: The present core course has been organized magnificently to cover all the essential aspects related to Molecular Biology field.The course will also impart detailed explanation of Prokaryotic and Eukaryotic Transcriptional Regulation . This course provides theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and/or recombinant transformants. Students will also be introduced to prominent nucleic acid labeling techniques. Introduction to various types of vectors viz. cloning, transformation, expression; and also vectors for genomic and cDNA library and whole genome sequencing will be provided.

Course Purpose: The objective of the course is to familiarize the students with the basic concepts in genetic engineering; to acquaint the students to versatile tools and techniques employed in genetic engineering and recombinant DNA technology; and to appraise them about applications genetic engineering.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO1	Describe and differentiate how gene expression is regulated at the transcriptional and posttranscriptional level in prokaryotes and eukaryotes	K1, K2, K3, K4

CO 2	Differentiate the various steps involved in the gene cloning and different enzymes involved in gene modification and their role in recombinant DNA technology.	K1, K2, K3, K4,K5 and K6
CO 3	Achieve broad thinking on different types of vectors and share insights of its applications in the field of biotechnology.	K1, K2, K3, K4,K5 and K6
CO 4	Gain insights on principle and applications of various techniques such as, nucleic acid hybridization, DNA sequencing, PCR , Microarray and blotting in the field life science.	K1, K2, K3, K4,K5 and K6
CO 5	Summarize various applications of genetic engineering in different fields.	K1, K2, K3, K4,K5 and K6

Course Content	**Hours**
Unit-I : Regulation of gene expression in prokaryotes and eukaryotes	**12Hrs**
• Principles of gene regulation, negative and positive regulation. • Concept of operons, regulatory proteins, inducers, repressors, regulation of lac operon and trp operon. • Overview of gene regulation by Heterochromatin, euchromatin, chromatin remodeling. • Regulation of galactose metabolism in yeast. • Regulation of eukaryotic gene expression at transcriptional and translational levels. • Hormonal control of gene expression.	
Unit-II: DNA modifying enzymes and Gene Cloning	**12 Hrs**
• Restriction modification systems: Types I, II and III. Mode of action, nomenclature. • Applications of Type II restriction enzymes in genetic engineering. • DNA modifying enzymes and their applications: Terminal deoxynucleotidyl transferase, kinases and phosphatases, DNA ligases and DNA polymerases, reverse transcriptases, bacteriophage RNA polymerases, exonuclease III, S1 nuclease. • Simple cloning of DNA fragments, process of cloning and their applications.	
Unit-III: Vectors in Recombinant DNA Technology	**12 Hrs**
• Vectors: Definition and properties. • Plasmid vectors-pBR and pUC series, Bacteriophage lambda and M13 based vectors, Cosmids, Phagemids. • Overview of Shuttle vectors-BACs and YACs. • Baculovirus based vectors.	

• Ti based vectors (Binary and Cointegrated vectors)	
Unit-IV: Gene Delivery and Analytical Methods	**12 Hrs**
• Brief introduction to Gene transfer: Bacterial Conjugation, Transformation, Transduction, Episomes, Microinjection, Electroporation, Microprojectile, Ultrasonication, Shot Gun method, Liposome fusion, *Agrobacterium*-mediated delivery. • Polymerase chain reaction – tools and mechanism, RT-PCR and Reverse transcription PCR. • Introduction to Southern , Northern and Western blotting. • Brief introduction to: DNA fingerprinting by RFLP , RAPD and DNA foot printing, DNA microarray. • Overview of Genomic and cDNA libraries.	
Unit- V: Applications of genetic engineering	**12 Hrs**
• Applications in medicine- production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII, Recombinant vaccines and Gene therapy. • Applications in agriculture- GM crops for disease resistance, yield and quality improvement. • Applications in microbiology- environment, dairy, strain improvement. • Genetic Engineering: Society, Risk and Ethics.	

Text books :

1**.** Satyanarayan U. (2010). *Biotechnology.* Books and allied (P) ltd.

2. . Primrose, S. B., & Twyman, R. (2013). *Principles of Gene Manipulation and Genomics*. John Wiley & Sons.

Reference books:

1. Brown, T. A. (2016). *Gene Cloning and DNA analysis: An Introduction*. John Wiley & Sons.
2. Weaver R F (2016), *Molecular Biology.* (ed 6th), WCB/McGraw-Hill
3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology*: *Principles and Applications of Recombinant DNA*. ASM Press

Pedagogic tools:

- Chalk and Board
- Power point presentation
- Seminar

- Videos

Methods of Assessment & Tools:

Components of CIE: 30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	Units 3,4,5	3 hours	15 (Set for 70)	
B	Assignment			05	10
C	Class activity			05	
				Grand Total	**30**
Assignment	● Abstract and executive summary ● Case study writing ● Concept mapping ● Student generated handbook ● Essay writing etc.				
Class activity	● Reaction paper ● Quiz ● One-minute paper ● Situation based question ● Application card etc.				

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Applied Course For the students admitted from A.Y. 2023-2024 & onwards		
Offering Department: **Biochemistry**	Offered to: **B.Sc. Biochemistry**	
Semester – V		
Course Code	Course Title (App.)	Course Credit and Hours
21UBCCC502	**Genetics**	**4 Credits - 4 hrs/wk**

Course Description:

The courses will provide students with a broad genetics background, it covers the topics ranging from inheritance pattern of single gene to population genetics. It also displays the role of meiosis in development of inheritance pattern inhumans.

Course Purpose:

To study general principles of heredity and variation in organisms. It enables the students to relate the effect of genes from family to the population.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K_1 to K_6)
CO_1	Recall Mendelian laws and solve problems related to it. Infer gene interactions, and environmental effect on genes.	K1, K2, K3, K4
CO_2	Identify, associate and analyze pedigree. Display effect of crossing over on next generation.	K1, K2, K3, K4, K5
CO_3	Develop an understanding of influence of gene flow on population trends and correlate it with evolutionary changes.	K1, K2, K3, K4
CO_4	Identify chromosomal abnormalities, understand basics of Prenatal diagnosis tests and match it up with the genetic disorders.	K1, K2, K3, K4
CO_5	Relate mendelian genetics, linkage and population genetics to understand human genetics and heredity.	K1, K2, K3, K4, K5

Course Content	Hours
	12 hrs

Unit 1: Basics of Mendelian genetics	
• Genetical terminology • Chromosomal basis of Mendelism • Genetic interaction: epistatic and non epistatic • Pleiotropy, multiple alleles, lethal alleles, null alleles and pseudo alleles. • Interaction of gene with environment.	
Unit 2: Linkage, crossing over and pedigree analysis.	**12 hrs**
• Sex linked inheritance: Definition and types • Linkage: Experiments of T. H. Morgan on *drosophila.* • Crossing over: Experiments of T. H. Morgan on *drosophila.* • Characteristics of dominant and recessive inheritance; mitochondrial inheritance. • Pedigree analysis	
Unit 3: Overview on population genetics	**12 hrs**
• Introduction to Population Genetics, Mendelain population, gene frequency, gene pool. • Hardy-Weinberg law • Predicting allele and genotype frequencies • Exceptions to Hardy-Weinberg principle.	
Unit 4: Chromosomal Aberrations	**12 hrs**
• Organization, structure and types of human chromosome • Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy- Autopolyploidy and Allopolyploidy.) Aneuploidy (Monosomy, Nullisomy, Trisomy and Tetrasomy.) • Structural- Deletions, Duplication, Translocation and Inversions. • Prenatal diagnosis tests; amniocentesis and chorionic villus sampling.	
Unit 5: Basic Human Genetics	**12 hrs**
• Normal Human Karyotype • Autosomal inheritance- Dominant (Ex. Achondroplasia and Neurofibromatosis) • Autosomal inheritance- Recessive (Ex. Albinism, Sickle cell anemia, Phenylketonuria) • X-linked – Recessive: (Ex. Duchenne muscular dystrophy-DMD) • X-linked- Dominant: (Ex. Xg blood group) • Y-linked inheritance: Holandric gene (Ex. Testes determining factor - TDF)	

Text books :
• Gupta, P. K., (2006). G*enetics*. Rastogi Publications, Meerut, India. • Meyyan R. P., (2012). *Genetics*. Saras Publications.

Reference books:

- Gardner, E. J., Simmons, M. J., &Snustad, D. P. (2016). *Principles of genetics* (No. Ed. 8). John Wiley and Sons, Inc..
- Pierce, B. A. (2012). *Genetics: A conceptual approach*. W.H. Freeman & Co.
- Carroll, S. B., Doebley, J. F., Griffiths, A. J., &Wessler, S. R. (2015).Introduction to genetic analysis., W.H. Freeman & Company (New York)
- Kowles, R. (2001). *Solving problems in genetics*. Springer Science & Business Media.
- Klug, W. S., Cummings, M. R., Spencer, C. A., Palladino, M. A., & Ward, S. M. (2009). *Concepts of genetics* (Vol. 9). Pearson.
- Rothwell, N. V. (1988). *Understanding genetics*. Oxford University Press.
- Green, N. P., Stout, G. W., Taylor, D. J., & Soper, R. (1998). Biological Science 1 & 2. Cambridge University Press.

Pedagogic tools:

- Chalk and Board
- Powerpoint presentation
- Seminar
- Videos
- Case studies

Suggested MOOCs

- Genes and the human condition (from behavior to Biotechnology)
  Offered by: University of Maryland
  Platform: Coursera

- Introduction to Genetics and evolution
  Offered by: Duke university
  Platform: Coursera

Methods of Assessment & Tools:

Components of CIE: 30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	Units 3,4,5	3 hours	15 (Set for 70)	
B	Assignment			05	10
C	Class activity			05	
				Grand Total	**30**

Assignment	• Abstract and executive summary • Case study writing • Concept mapping • Student generated handbook • Essay writing etc.
Class activity	• Quiz • Situation based question

Note: Any other assessment tools or methods can be adopted as per the requirement of the course.

Self study Course For the students admitted from A.Y. 2021-2022 & onwards	
Offering Department: Biochemistry	**Offered to: B.Sc Biochemistry students**

Semester – V		
Course Code	**Course Title (Advanced Course)**	**Credits**
21UBCCC503	**Core 13: Nutritional Biochemistry-Self Study**	**4 Credits- 1 hrs/wk**

Course Description: This course in Nutritional biochemistry (self study) is aimed to give students awareness of various types of nutrients in human health and disease. It provides deeper insight into dietary sources, properties and functions, deficiency of different of various macro nutrients, micro nutrients and trace elements in human body and prevention and treatment of various nutritional deficiency disorders through a healthy diet.

Course Purpose:

To enable the students to

- Understand basic concepts of food science and nutrition and biochemical role of food and nutrients in growth, development and healthy living.
- Recognize various methods to assess nutrient status and the strengths and weaknesses of these methods.
- Justify manifestations of deficiency and toxicity states and relate biochemical and physiological roles of nutrients to these manifestations.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_2 to K_6)**

CO_1	Summarize, critically evaluate and correlate the fundamental and applied aspects of nutrition.	K_2 , K_3 , K_4
CO_2	Relate balance of energy intake through diet and expenditure via various physical activities in management of weight gain or weight loss and maintaining healthy body.	K_2 , K_3, K_4, K_5,
CO_3	Illustrate functions of various nutrients and their deficiency diseases and prevention and treatment of various nutritional deficiency disorders.	K_2 , K_3, K_4, K_5, K_6
CO_4	Identify the rich dietary sources for various macronutrients, vitamins, minerals as well as trace elements and design the balanced diet.	K_2 , K_3, K_4, K_5, K_6
CO_5	Apply the knowledge of nutritional biochemistry to make best food choices for promoting healthy lifestyle at individual, family and ultimately at society level.	K_2 , K_3, K_4, K_5, K_6

Course Content	**Hours**
Unit 1: Introduction to Nutrition and Energy Metabolism	**12 hrs**
• Defining Food, Nutrition and role of macro nutrients, micro nutrients and trace elements in human body. Concept of RDA, Food tables and their use. • Units of energy, Biological oxidation of foodstuff. Measurement of energy content of foods, physical v/s Physiological energy value of foods. • Basal Metabolic Rate (BMR) and factors affecting BMR. Measurement of energy expenditure during rest and various physical activities. Direct and Indirect Calorimetry, Specific dynamic action of foods (SDA) thermogenesis. • Overview of calories burned during different types of physical activities; mild, moderate, heavy and very heavy activities. • Factors affecting energy input - hunger, appetite, Energy balance. Energy requirements for different age groups.	
Unit 2: Nutritionally Important Carbohydrates and Lipids	**12 hrs**
• Overview of functions of carbohydrates. Sources, Digestion, absorption, utilization and storage of carbohydrates, Glycemic Index (GI) and health benefits of low GI foods with examples. • Dietary fibers and their importance in human health. • Overview of classification, sources, functions, digestion, absorption, utilization and storage of Lipids. • Types of Fatty acids- Saturated fatty acids, Mono and Poly unsaturated fatty acids. Essential Fatty Acids (EFA); Functions of EFA and their deficiency. Omega 3 and Omega 6 fatty acids and their importance in diet. Dietary sources and adverse effects of trans fats on human health. • Different lipoproteins and their importance in health and diseases.	

Unit 3: Nutritional importance of Proteins and amino acids.	**12 hrs**
• Review of functions of amino acids, peptides and proteins in the body. RDA of Proteins for different age groups. • Different food sources of proteins – rich, moderate and poor sources, process of digestion and absorption of proteins. • Essential and Non-essential amino acids and their examples. Nutritional classification of proteins; complete proteins, partially complete proteins and incomplete proteins. • Concept of Protein quality, brief introduction to various chemical and biological methods to assess protein quality. Limiting amino acids and different ways and means of improving protein quality in human diet- fortification, complementation. • Protein calorie malnutrition in children -Marasmus and Kwashiorkor; etiology, clinical symptoms, treatment and prevention. Causes and prevention of protein deficiency in adults.	
Unit 4: Fat soluble and Water Soluble Vitamins	**12 hrs**
• Introduction to vitamins and comparative account of water soluble v/s fat soluble vitamins. Fat soluble vitamins - Vitamin A, D, E and, K: Dietary sources, RDA, Absorption, Distribution, Metabolism and their biochemical functions. • Nutritional deficiency diseases of Vitamin A (night blindness, xeropthalmia etc) and Vitamin D (rickets and osteomalasia). Hypervitaminosis and toxicity of vitamin A and D. • Vitamins of B complex and Vitamin C: Brief history, dietary sources, RDA, Absorption, Distribution, Metabolism and their biochemical functions. • Clinical symptoms, diagnosis, prevention and treatment of some vitamin deficiency diseases such as Beriberi, Pellagra, Scurvy and Vitamin deficiency anemias.	
Unit 5: Nutritionally Important Minerals and trace elements	**12 hrs**
• Calcium, Phosphorus and Iron - Distribution in the body, absorption, transport, storage, utilization, excretion, and biochemical functions. • Rich, moderate and poor dietary Sources, RDA values, balance, deficiency symptoms and toxicity of Calcium, Phosphorus and Iron. • Role of iron in prevention of iron deficiency anemia. • Some important trace elements: Iodine, Fluoride, Mg, Cu, Zn, Se, Cr- Dietary sources, RDA, absorption, distribution, major biochemical functions, deficiency and toxicity.	

Text books (2 textbooks):

1. Passmore, R., & Eastwood, M. A. (1996). Davidson and Passmore: Human Nutrition and Dietetics: 8th edition. Churchill Livingstone
2. Swaminathan, M, Handbook of Food and Nutrition, The Bangalore Press, 5th Edition (2018).
3. Mudambi S R and Rajagopal M V, Fundamentals of Foods, nutrition & Diet therapy, New Age International Publishers, 6th Edition (2020).

Reference books:

1.Williams, M. H., Rawson, E. S., & Branch, J. D. (2017). Nutrition for Health, Fitness, and Sport.McGraw Hill international edition.
2. Mahan, L. K., & Raymond, J. L. (2016). Krause's Food & the Nutrition Care Process-E-Book. Elsevier Health Sciences.
3.Devlin, T. M. (2011). Textbook of Biochemistry with Clinical Correlations, .John Wiley &Sons, Inc. (New York)

Pedagogic tools:

- Power point preparation and presentation
- Chalk and Board
- Charts/ Notes/posters preparation
- Seminar and presentations.
- Videos

Methods of Assessment & Tools: Components of CIE:30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	Units 3,4,5	3 hours	15 (Set for 70)	
B	Assignment-1	Power point presentation on assigned topic	-	05	10
C	Assignment-2	Study material preparation on assigned topic and sharing	-	05	
				Grand Total	**30**
Assignments		● Preparing notes on assigned topic ● Presentation of the assigned topic using power point ● Poster preparation and presentations ● Chart preparation etc…			

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Applied Course For the students admitted from A.Y. 2023-2024& onwards		
Offering Department: **Biochemistry**	Offered to: **B.Sc Biochemistry**	
Semester – V		
Course Code	Course Title (Ap)	Course Credit and Hours
21UBCCC504	**Core Practical-5 Molecular Biology and Genetics Practicals**	**3 Credits –6-8 hrs/wk**

Course Description:

This course will cover isolation and purification of nucleic acids, mechanisms of gene cloning, practical aspects of recombinant DNA technology. It also concernsbasic genetic analysis techniques like gene interactions, gene mapping, pedigree etc.

Course Purpose:

The course is developed to strengthen the fundamentalunderstanding of the principles of molecular biology. The objective of this course is to teach students with various approaches to conduct genetic engineering and their applications in biological research as well as in biotechnology industries. It also elucidates the concepts genetics to solve problems related to heredity.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (S_1 to S_6)**
CO_1	Isolate and purify nucleic acids/plasmids for routine laboratory procedures.	**S1, S2, S3**
CO_2	Explain the underlying mechanisms of gene cloning.	**S2, S3, S4, S5**
CO_3	Discuss the practical aspects of applying recombinant DNA technology.	**S1, S2, S3, S4, S5**
CO_4	Analyze inheritance pattern to create a pedigree chart.	**S1, S2, S3, S4, S5**
CO_5	Elucidate the concepts of linkage and crossing over to solve basic gene mapping problems.	**S1, S2, S3, S4**

Suggested laboratory experiments:

1. Isolation of plasmid DNA from *E. coli* cells by CTAB method
2. Isolation of plasmid DNA from *E. coli* cells by alkaline lysis method
3. Digestion of plasmid DNA with restriction enzymes.
4. Gel electrophoresis of digested product.
5. Ligation of foreign DNA in plasmid (demonstration).
6. Bacterial conjugation.
7. Preparation of bacterial competent cells.
8. Gene transfer in bacterial competent cells by $CaCl_2$ method.
9. Antibiotic screening / blue-white selection of transformants.
10. Amplification of a DNA fragment by PCR. (demonstration)
11. Pedigree Analysis.
12. Calculation of gene frequencies.
13. Problem analysis for gene interactions.
14. Practice problems for gene mapping.
15. Explore the pattern of Sex-linked inheritance.
16. Solving the worksheet on multiple alleles.

Pedagogic tools:

- Chalk and Board
- Laboratory Hands-on training
- PowerPoint Presentation and Videos.
- Virtual Lab

Reference Books:

- Sambrook J., Russell D.W., Maniatis T. (2001) *Molecular cloning: a laboratory manual*. (ed 3rd.).Cold Spring Harbor, N.Y.,Cold Spring Harbor Laboratory Press, 2001.
- Ausubel F [et al.]. (2001). *Current protocols in molecular biology*.(Vol. 5) New York: John Wiley & Sons.

Laboratory Manual/ Book

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Methods of assessing the Course Outcomes

The COs of the course will be assessed through

- CIA (Test, Performance, Record book, Viva Voce)
- SEE

CIA Components	**Marks**
Test (After completion of 70-80% of accessible Practicals)	30
Performance and Record book	10
Grand Total	**40**

Sr. No.	SEE Component	Content	Duration (if any)	Marks	Sub Total
A	Test	After completion of the course	6 hours (3+3)	60	60
				Grand Total	**60**

Applied Course For the students admitted from A.Y. 2021-2022 & onwards	
Offering Department: Biochemistry	**Offered to: B.Sc Biochemistry students**

Semester – V		
Course Code	**Course Title (Applied course)**	**Credits**
21UBCCE501	Core Elective: Clinical Biochemistry	**4 Credits- 4 hrs/wk**

Course Description: This course is intended to comprehend students with common disorders of cardiovascular, hepatic and renal systems as well as genetically inherited diseases and make them apply these facts in prevention and better management of various clinical diseases.

Course Purpose:

- Get better insights about setup and flawless working of clinical laboratories.
- Relate common and advanced tests in diagnosis, prognosis and management of various diseases.
- Integrate concepts such as impact of healthy diet, lifestyle changes on prevention and better management of various clinical diseases.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K_2 to K_6)
CO_1	Recognize importance and uses and of various lab instruments and describe requirements for setting up a clinical laboratory. Get organized with preparation and storage of reagents as well as samples. Point out importance of lab automation and quality control in laboratory procedures. Execute the precautionary and first-aid measures in clinical laboratories.	K_2 , K_3, K_4, K_5, K_6

CO_2	Identify and critically evaluate clinical problems associated with liver and kidney function.	K_2 , K_3 , K_4, K_5
CO_3	Recognize biochemical basis and risk factors for cardiovascular diseases and apply various strategies for effectively in prevention and management of cardiovascular diseases for self, family and the society.	K_2 , K_3, K_4, K_5, K_6
CO_4	Distinguish inborn errors of metabolism and chromosomal diseases from other treatable diseases. Relate gene defects and its biochemical associations with symptoms and complications of genetically inherited diseases. Associate importance of prenatal diagnostic approaches in prevention of common and highly prevalent chromosomal diseases like Down's syndrome.	K_2 , K_3, K_4, K_5, K_6
CO_5	Explore modern diagnostic approaches in diagnosis, better management, and prevention of serious life threatening complications of Diabetes mellitus - the most common metabolic disease in India and especially in Gujarat.	K_2 , K_3, K_4, K_5, K_6

Course Content	**Hours**
Unit 1: Laboratory Setup and Safety	**12 hrs**
• Requirements of setting up of clinical laboratories. Importance and different types of clinical laboratories. Code of conduct and ethics for laboratory technologists. • Introduction to lab instrumentation and importance and advantages of automation (Pre-analytical, Analytical and Post-analytical stages) in clinical biochemistry laboratories. • SI units in clinical laboratory. Preparation of various reagents, dilutions, serial dilutions and basic laboratory maths. • Various types of samples of biological fluids and cells/tissues. Collection, preparation, preservation, and handling and storage of clinical samples • Quality control, MSDS and Safety measures in clinical laboratory practice. • Formulation of clinical and diagnostic kits. Overview about various lab certifications: ISO, NABL and CLSI.	
Unit 2: Liver and Kidney Disorders and Diagnosis:	**12 hrs**
• Bilirubin metabolism, types of jaundice and clinical assessment. • Acute and chronic liver diseases, alcoholic and non-alcoholic fatty liver diseases, cirrhosis, viral, metabolic and drug induced/toxic liver diseases. • Liver cancer, liver function tests, non-invasive investigations of liver function. • Glomrular filtration rate (GFR) , Renal threshold and clearance values • Disorders of kidney; acute and chronic kidney diseases, renal tubular disorders and renal stones. Various approaches for prevention and management of kidney diseases. Renal function tests, brief overview about artificial kidneys.	
Unit 3: Cardiovascular diseases and their Diagnosis	**12 hrs**

• Ischemic heart diseases, Cardiovascular stroke, Angina pectoris, Acute myocardial infarction, cardiac failure. • Causes and risk factors for cardiovascular diseases. • Role of enzymes and other proteins as markers in assessment of ischemic heart diseases. Brief overview about prevention and various approaches for treatment of ischemic heart diseases. • Hypertension – definition, measurement, types and causes of hypertension. Adverse health effects of hypertension on human body. Non pharmacological approaches towards control of hypertension • Basis of drug therapy for hypertension. Different classes of antihypertensive drugs and their mode of action; adrenergic alpha and beta blockers, diuretics, calcium channel blockers, ACE inhibitors, angiotensin receptor blockers and vasodilators,	
Unit 4: : Inborn Errors of Metabolism and genetic diseases:	**12 hrs**
• Disorders associated with carbohydrate metabolism-glycogen storage diseases, Galactosemia, hereditary fructose intolerance, G6PD deficiency etc. • Protein metabolism – phenylketonuria, albinism, alkaptonuria, maple syrup urine disease, homocystineuria and overview of urea cycle disorders. • Lipid and nucleotide metabolism – Acyl CoA dehydrogenase deficiencies, Niemann – Pick disease, Krabbe's disease, Tay-Sach's disease, Gaucher's disesease, Fabry's disease, Lesch Nyhan disease, Adenosine deaminase deficiency and SCID. • Disorders due to chromosomal aberrations. Their molecular basis, symptoms, diagnosis and prevention and management: Down's syndrome, Turner's syndrome, Klinefelter's syndrome.	
Unit 5: Diabetes- types, diagnosis and management	**12 hrs**
• Diabetes insipidus and Diabetes mellitus. Types of Diabetes mellitus, incidence and the risk factors. • Hormonal, drug and stress induced hyperglycemia. • Clinical symptoms and complications of diabetes mellitus. • Blood and urine tests for diagnosis and management of diabetes mellitus; fasting, post prandial and random blood glucose, glucose tolerance test (GTT), Glycosylated hemoglobin (HbA1C), and ketone bodies tests. • Different approaches for control of diabetes mellitus; role of diet and exercise. Treatment by insulin injections and oral hypoglycemic drugs.	

Text books (2 textbooks):
1. Kaplan L.A. and Pesce A. J. C. V. Mosby, (1989). Clinical Chemistry. 2.Mukherjee, K.L., (2010), Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Volumes .I, II and III Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi)

Reference books:

1. W. J. Marshall and S. K. Bangert, Churchill LivinstonN.Y.(1995). Clinical Biochemistry.
2. Tietz Text book of Clinical Chemistry 2nd edition, (1994).
3. Baynes, J.W. and Dominiczak, M.H., (2005) Medical Biochemistry 2nd ed., Elsevier Mosby Ltd. (Philadelphia)

Pedagogic tools:

- Chalk and Board
- Power point presentation
- Charts
- Seminar
- Videos

Methods of Assessment & Tools:

Components of CIE:30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	Units 3,4,5	3 hours	15 (Set for 70)	
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C	Class activity			05	
				Grand Total	**30**
Assignments	● Abstract and executive summary ● Case study writing ● Concept mapping ● Student generated handbook ● Chart preparation etc…				
Class activity	● Reaction paper ● Quiz ● One-minute paper ● Situation based questions ● Application card etc..				

Note : Any other assessment tools or methods can be adopted as per requirement of the course.

Applied Course For the students admitted from A.Y. 2021-2022 & onwards	
Offering Department: Biochemistry	**Offered to: B.Sc Biochemistry students**

Semester – V		
Course Code	**Course Title (Applied course)**	**Credits**
21UBCCE502	Core Elective: Bioinformatics	**4 Credits- 4 hrs/wk**

Course Description: The course is designed to provide basic knowledge about Bioinformatics and biological information on the web. Major topics include sequence alignment, gene finding, genome assembly, drug design, drug discovery, protein structure alignment, protein structure prediction, and prediction of gene expression.

Course Purpose:

- This course will outline the brief historical context of sequencing, provide an introduction to what bioinformatics is and why it is important; along with an overview of the application areas of bioinformatics,

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (K_2 to K_6)
CO1	**Describe, Examine the basic concepts of Bioinformatics and its significance in Biological data analysis.**	K_2 , K_3, K_4, K_5, K_6
CO2	**Classify and Test different types of Databases**	K_2 , K_3 , K_4, K_5
CO3	**Explain , Analyse and assess about the methods to characterise and manage the different types of Biological data**	K_2 , K_3, K_4, K_5, K_6
CO4	**Introduction to the basics of sequence alignment and analysis.**	K_2 , K_3, K_4, K_5, K_6
CO5	**Overview about biological macromolecular structures and structure prediction methods.**	K_2 , K_3, K_4, K_5, K_6

Course Content	Hours

Unit I: Introduction to Bioinformatics and Databases	12 hrs
• History & Future prospects of Human Genome Project • Overview of Bioinformatics & Applications • Introduction, Need & Types of databases. • Biological Databases: Nature of Biological data, Importance of Biological Databases in Biological Discovery • Microarray-Principle & Applications	
Unit II: Biological Databases - Tools and Their Uses	**12 hrs**
• Introduction to bibliographic databases: PubMed • Major Bioinformatics Resources: NCBI, EBI & ExPASY • Nucleic acid sequence databases: GenBank, EMBL, DDBJ • Protein sequence databases: SWISS-PROT, TrEMBL	
Unit III: Structure Identification, Data Bases And Evolutionary Analysis	**12 hrs**
• Experimental methods for protein structure determination (John Karanicolas) : X-ray crystallography ,Nuclear magnetic resonance (NMR), Infrared Spectroscopy(IR) etc.. • Protein Structure data base: PDB • Structure databases (CATH, SCOP, and PDBsum) • Overview of Comparative & Functional Genomics • Phylogenetic Analysis	
Unit IV: Sequence Alignments and Visualization	**12 hrs**
• Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example) • Pairwise alignment (BLAST and FASTA Algorithm) • Multiple sequence alignment (Clustal W algorithm). • Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol).	
Unit V: Protein: Structure-Based Function Annotation and Drug Discovery Process	**12 hrs**
• Gene ontology • Enzyme classification • Overview of Ligand-protein interaction • Structure-based function prediction • Overview of Discovering a drug - target identification and validation	

Text books (2 textbooks):
1. Westhead, D. R., Parish, J. H., & Twyman, R. M. (2002). *Instant Notes: Bioinformatics, The INSTANT NOTES Series.* 2. David, W. M. (2001). *Bioinformatics: Sequence And Genome Analysis*. Cold Spring Harbor Laboratory Press.

1. Attwood, T. K., & Parry-Smith, D. J. (2003). *Introduction to Bioinformatics*. Prentice Hall.
2. Rastogi .S. C., Rastogi P and Mendiratta N.(2008). *Bioinformatics methods and applications: Genomics proteomics and drug discovery.* PHI Learning Pvt. Ltd
3. Baxevanis, A. D., & Ouellette, B. F. (2004*). Bioinformatics: a practical guide to the analysis of genes and proteins* (Vol. 43). John Wiley & Sons.

Pedagogic tools:

- Chalk and Board
- Power point presentation
- Charts
- Seminar
- Videos

Methods of Assessment & Tools:

Components of CIE:30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	Units 3,4,5	3 hours	15 (Set for 70)	
B	Assignment			05	10
C	Class activity			05	
				Grand Total	**30**

Assignments	● Abstract and executive summary ● Case study writing ● Concept mapping ● Student generated handbook ● Chart preparation etc…
Class activity	● Reaction paper ● Quiz ● One-minute paper ● Situation based questions ● Application card etc..

Note : Any other assessment tools or methods can be adopted as per requirement of the course.

Applied Course For the students admitted from A.Y. 2021-2022 & onwards	
Offering Department: Biochemistry	**Offered to: B.Sc Biochemistry students**

Semester – V		
Course Code	**Course Title (Applied course)**	**Credits**
21UBCCE503	Core Elective: Pharmaceutical Biochemistry	**4 Credits- 4 hrs/wk**

Course Description: The course emphasizes on teaching the students to identify some general drugs used in medicine, their mode of action, clinical application, side effects and toxicity.

Course Purpose:

- The course forms the basis for further understanding of the chemistry of pharmaceuticals and other pharmacologically active compounds, their mode of action, and their turnover in the human body, and how this contributes to health benefits.
- These graduates will have the requisite skills in biochemistry, drug design and pharmacology to set them on a career path in the pharmaceutical industry.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (K_2 to K_6)**
CO_1	Define drug and illustrate on types of drugs including their use. Classify the various routes of administration with advantages and disadvantages.	K_2 , K_3, K_4, K_5, K_6
CO_2	Discuss , Interpret and Assess drug absorption and elimination from body	K_2 , K_3 , K_4, K_5
CO_3	Discuss , Interpret and Assess drug action and metabolism	K_2 , K_3, K_4, K_5, K_6
CO_4	Explain, Analyse and assess adverse drug reactions and drug toxicity so that it can get minimize.	K_2 , K_3, K_4, K_5, K_6
CO_5	Identify, Devise and design process of new drug discovery and development of drug.	K_2 , K_3, K_4, K_5, K_6

Course Content	**Hours**
Unit I: General Pharmacology	**12 hrs**
• **Introduction:** Sources of drugs, routes of drug administration, dosage forms, drug dosage. • **Bioavailability: -** Bioavailability of drugs, determination and its importance, Bioequivalence. Combined effect of drugs: - Synergism, antagonism.	
Unit II: Pharmacokinetics	**12 hrs**

• Absorption, distribution of drugs, factors influencing drug absorption and distribution. • Drug elimination: - Renal excretion, feacal excretion, biliary excretion, pulmonary excretion and other routesof excretion.	
Unit III: Pharmacodynamics	**12 hrs**
• Mechanism of phase I and Phase II metabolic reactions, factors affecting drug metabolism, significance of drug metabolism. • Mechanism of drug action: Basis of drug action, drug - receptor interactions, Receptor mediated and non-receptor mediated drug action, Placebo effects, Factors modifying drug action.	
Unit IV: Adverse drug reactions	**12 hrs**
• Classification: - Pharmacologic ADRs, Non-pharmacological ADRs, disease-related ADRs, multiple drug reactions, miscellaneous ADRs. • Acute poisoning: - General principles and management. Drug dependence, drug tolerance and intolerance.	
Unit V: Drug discovery and Development	**12 hrs**
• Random screening, serendipity, molecular modification of a known drug, rationalapproaches in drug designing • **Drug development:** Preclinical research, clinical research, FDA review and FDA post- market safety monitoring.	

Text books (2 textbooks):
1. Pharmaceutical Pharmacology by S C Metha and Ashutosh Kar, 2011, New age Internationalpublishers. 2. Text book of Medical Pharmacology by Padmaja Udayakumar, 2nd Edition, CBS Publishers &Distributors, New Delhi, Bangalore.
Reference books: 1. Oxford Text book of Clinical Pharmacology and Drug Therapy, D.G Grahme Smith and K.Aronson 2. Lippincotts Illustrated review Pharmacology, Mary.J.Mycek, Richards, Pamela.

Pedagogic tools:

- Chalk and Board
- Power point presentation
- Charts
- Seminar
- Videos

Methods of Assessment & Tools:

Components of CIE:30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	Units 3,4,5	3 hours	15 (Set for 70)	
B	Assignment			05	10
C	Class activity			05	
				Grand Total	**30**
Assignments	● Abstract and executive summary ● Case study writing ● Concept mapping ● Student generated handbook ● Chart preparation etc…				
Class activity	● Reaction paper ● Quiz ● One-minute paper ● Situation based questions ● Application card etc..				

Note : Any other assessment tools or methods can be adopted as per requirement of the course.

Applied Course For the students admitted from A.Y. 2021-2024 & onwards		
Offering Department: **Biochemistry**	Offered to: **B.Sc Biochemistry**	
Semester –V		
Course Code	**Course Title (App)**	**Course Credit and Hours**
21UBCCE504	**Core elective: Clinical Biochemistry Practicals**	**1 credit--3 hours/ Wk**

Course Description:
This laboratory course compliments the theory courses by providing students with hands on experiences on analysis of samples, evaluation of data and interpretation of results and derive conclusions correlate various clinical conditions.

Course Purpose:

- Comprehend the role of different metabolites and their levels present in various body fluids of the human body.
- Plan and perform various clinical biochemistry analyses from biological samples as non invasive techniques of diagnosis.
- Correlate normal values and clinical significance of changes in levels of different metabolites in diagnosis, prognosis and management of diabetes mellitus, liver and kidney diseases, cardiovascular diseases and thyroid gland related diseases etc.
- Evaluate the risk factors based on clinical tests and help reduce the risk for various diseases.

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (S_1 to S_5)
CO_1	Design and perform experiments to analyze various biochemical substances, metabolites from body fluids-plasma and serum using advanced kit based methods.	S_1, S_2 S_3, S_4, S_5
CO_2	Compile and interpret the results of various biochemistry laboratory tests.	S_1,S_2 ,S_3, S_4, S_5 ,S_6
CO_3	Master the skills of clinical biochemistry analysis and interpretations in evaluation of risk factors, diagnosis, prognosis and management of various diseases.	S_2 ,S_3, S_4, S_5, S_6
CO_4	Have better insights on biochemistry and pathophysiology associated with renal, hepatic, cardiovascular and metabolic diseases with tests performed in a clinical biochemistry laboratory.	S_1, S_2 S_3, S_4, S_5
CO_5	Critically evaluate various case studies and derive meaningful conclusions.	S_2 ,S_3, S_4, S_5

Suggested laboratory experiments:

1. To perform and learn to draw glucose tolerance curve and interpret glucose tolerance test (GTT).
2. Evaluate and compare normal, pre-diabetic and severe diabetic conditions based on GTT.
3. Significance of HbA1c (Glycosylated Hb) levels in the blood as an important tool to get clear idea about blood glucose control over a long period of time in diabetics.
4. Estimation of Blood urea and Serum creatinine to evaluate kidney function. Correlate urea levels, BUN, urea/creatinine ratios and e-GFR in diagnosis of renal diseases. Calculate the severity of loss of kidney function by e-GFR in chronic kidney diseases.
5. Evaluation of Serum Uric Acid levels in diagnosis and management of gout.
6. Perform case studies and assessment of various clinical conditions like infections, liver and kidney diseases using various proteins profile parameters; Total Protein, Serum Albumin and Globulin levels and A/G ratio.
7. Assessment of serum levels of Aminotransferases (Transaminases) SGOT and SGPT and their diagnostic significance in evaluation of liver function and cardiac function.
8. Compare serum bilirubin levels (direct and total) and its role in diagnosis in different types of jaundices- hemolytic jaundice, hepatic jaundice and obstructive jaundice.
9. Evaluation of Lipid profile: serum triglycerides, Cholesterol (Total), LDL and HDL cholesterol and correlation of lipid profile components with risk for ischemic heart disease.
10. Cardiac specific markers for assessment of risk for ischemic heart disease- apo-protein levels (APO-A, APO-B) and high sensitivity C-reactive protein (HS- CRP).
11. Significance of analysis of Lipoprotein A (Lp (a)) levels and its dependence on genetic factors and risk assessment of cardiovascular diseases in individuals with family history and genetic factors.
12. Thyroid function tests: T3, T4 and TSH estimation methods and their interpretations. Case studies based on variations in T3, T4 and TSH levels in diagnosis and management of euthyroid condition, hypothyroidism and hyperethyroidism.

Pedagogic tools:

- Chalk and Board
- Laboratory Hands on training and various case studies.
- PowerPoint Presentation and Videos.
- Virtual Lab

Text books – Not applicable

Reference Books:

1. Godkar B.P. (1994). *Clinical Biochemistry Principle And Practice*. Mumbai Bhalani Publishing House
2. Mukherjee, K.L., (2010), *Medical Laboratory Technology - A Procedure Manual For Routine Diagnostic Tests* (Vol.I). NewDelhi, Tata Mc Graw–Hill Publishing Company Limited .

Laboratory Manual/ Book

- Manual of Biochemistry Department, Shri M. & N. Virani Science College

(Autonomous), Rajkot

Suggested reading / E-resources
• Not Applicable

Suggested MOOCs
• Not Applicable

Methods of assessing the Course Outcomes The COs of the course will be assessed through
• CIA (Test, Performance, Record book, Viva Voce) • SEE

CIA Components	**Marks**
Test (After completion of 70-80% of accessible Practicals)	15
Performance and Record book	05
Grand Total	**20**

Sr. No.	**SEE Component**	**Content**	**Duration (if any)**	**Marks**	**Sub Total**
A	Test	After completion of course	3 hours	30	30
				Grand Total	**30**

Core Practicals For the students admitted from A.Y. 2021-2024 & onwards		
Offering Department: **Biochemistry**	Offered to: **B.Sc Biochemistry**	
Semester –V		
Course Code	**Course Title (App)**	**Course Credit and Hours**
21UBCCE505	**Core elective: Bioinformatics Practicals**	**1 credits- 3 hours/ Wk**

Course Description: On taking this course the student is able to have practical exposure on Bioinformatics tools and databases upon the analysis of genes and Proteins.
Course Purpose: • The objective of this practical course is to provide training in the application ofprograms used for database searching, protein and DNA sequence analysis, and prediction of protein structures

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	CO Statement	Blooms taxonomy Level (S_1 to S_5)
CO_1	Predict functions of gene and genomes using online tools	**S_1, S_2 S_3, S_4, S_5**
CO_2	Predict and evaluate the sequence and structure of proteins and peptides	**S_1,S_2 ,S_3, S_4, S_5 ,S_6**
CO_3	Align protein and nucleotide sequence using various tools	**S_2 ,S_3, S_4, S_5, S_6**
CO_4	Use tools and programmes used in Bioinformatics.	**S_1, S_2 S_3, S_4, S_5**
CO_5	perform insilico experiments and will predict structures of proteins.	**S_2 ,S_3, S_4, S_5**

Suggested laboratory experiments:
1. Introduction to PUBMED database using the ENTREZ search engine. 2. Retrieval of desired biological sequences by exploring and querying the nucleic acid databases. GenBank, EMBL & DDBJ 3. Database similarity search through BLAST. 4. Getting the amino acid sequences by exploring and querying the protein sequence database.: Swiss Prot, Uniprot. 5. 3-D Protein structure visualization using RasMol. 6. Multiple alignment of the given sequences by using ClustalW

Pedagogic tools:

- Chalk and Board
- Laboratory Hands on training and various case studies.
- PowerPoint Presentation and Videos.
- Virtual Lab

Text books – Not applicable

Reference Books:

1. Attwood, T. K., & Parry-Smith, D. J. (2003). *Introduction to bioinformatics*. Prentice Hall

2. Rastogi .S. C., Rastogi P and Mendiratta N.(2008). *Bioinformatics methods and applications: Genomics proteomics and drug discovery.* PHI Learning Pvt. Ltd

Laboratory Manual/ Book

- Manual of Biochemistry Department, Shri M. & N. Virani Science College (Autonomous), Rajkot

Suggested reading / E-resources
• Not Applicable

Suggested MOOCs
• Not Applicable

Methods of assessing the Course Outcomes The COs of the course will be assessed through
• CIA (Test, Performance, Record book, Viva Voce) • SEE

CIA Components	**Marks**
Test (After completion of 70-80% of accessible Practicals)	15
Performance and Record book	05
Grand Total	**20**

Sr. No.	**SEE Component**	**Content**	**Duration (if any)**	**Marks**	**Sub Total**
A	Test	After completion of course	3 hours	30	30
				Grand Total	**30**

Core Practicals For the students admitted from A.Y. 2021-2024 & onwards		
Offering Department: **Biochemistry**	Offered to: **B.Sc Biochemistry**	
Semester –V		
Course Code	**Course Title (App)**	**Course Credit and Hours**
21UBCCE506	**Core elective: Pharmaceutical Biochemistry Practicals**	**1 credits- 3 hours/ Wk**

Course Description: The course is designed to provide the student with basic laboratory skills regarding pharmacognosy and phytochemistry. Experiments will cover the microscopic examination of the different plant parts, extraction and identification.
Course Purpose: • Prepare students for Industries like pharmaceutical R & D and Clinical Trials.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (S_1 to S_5)**
CO_1	Enhance knowledge on drug labels.	**S_1, S_2 S_3, S_4, S_5**
CO_2	Analyse various components of pharmaceuticals	**S_1,S_2 ,S_3, S_4, S_5 ,S_6**
CO_3	Evaluate effect of drugs and drug metabolites	**S_2 ,S_3, S_4, S_5, S_6**
CO_4	Analyse drug elimination and metabolism through kidney function test	**S_1, S_2 S_3, S_4, S_5**
CO_5	Critically evaluate various case studies and derive meaningful conclusions.	**S_2 ,S_3, S_4, S_5**

Suggested laboratory experiments:
1. Qualitative Analysis of Phytochemicals. 2. Estimation of Total Phenols by Folin – Ciocalteau method. 3. Estimation of Flavonoids and assessment of its medicinal role 4. Estimation of Bilirubin by Vanden Bergh reaction 5. Kidney Function Test & calculation of clearance. 6. Preparation of ORS. 7. Understating drug label and drug composition. 8. Case study.

Pedagogic tools:

- Chalk and Board
- Laboratory Hands on training and various case studies.
- PowerPoint Presentation and Videos.
- Virtual Lab

Text books – Not applicable
Reference Books: 3.
Laboratory Manual/ Book
• Manual of Biochemistry Department, Shri M. & N. Virani Science College (Autonomous), Rajkot

Suggested reading / E-resources
• Not Applicable

Suggested MOOCs
• Not Applicable

Methods of assessing the Course Outcomes The COs of the course will be assessed through
• CIA (Test, Performance, Record book, Viva Voce) • SEE

CIA Components	**Marks**
Test (After completion of 70-80% of accessible Practicals)	15
Performance and Record book	05
Grand Total	**20**

Sr. No.	**SEE Component**	**Content**	**Duration (if any)**	**Marks**	**Sub Total**
A	Test	After completion of course	3 hours	30	30
				Grand Total	**30**

Semester VI Syllabus

Advanced Course For the students admitted from A.Y. 2021-2022 & onwards	
Offering Department: Biochemistry	**Offered to: B.Sc Biochemistry students**

Semester – V		
Course Code	**Course Title (Adv course)**	**Credits**
21UBCCC601	Advanced Cell Biology	**4 Credits- 4 hrs/wk**

Course Description:

This course will focus on biological processes occurring between cells and their environment. Emphasis will be placed on animal cells; Topics will include cellular architecture, function and evolution, bio membranes and transport processes, the control of the cell cycle as well as communication between cells and cellular communities. Students will learn modern techniques in cell culture, tissue engineering and microscopy.

Course Purpose:

- Cells are the basic functional units of eukaryotic organisms, and a deeper knowledge of their structure and organisation is an essential aspect of our wider understanding of health and disease. Drawing on information gained in earlier course, this course integrates concepts in molecular biology, biochemistry and genetics to provide an understanding of processes and functions carried out in eukaryotic cells.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K_2 to K_6)**
CO_1	• Discuss, compare and distinguish different types of nuclear transport	K_2 , K_3, K_4, K_5, K_6
CO_2	• Describe and assess different cell – cell interactions and its role in cell migration and adhesion.	K_2 , K_3 , K_4, K_5
CO_3	• Describe the mechanism and control of the cell cycle at the molecular level • Understand the molecular mechanisms that control apoptosis and how apoptosis is used in development	K_2 , K_3, K_4, K_5, K_6
CO_4	• Explain , recognize and evaluate cancer development and progression.	K_2 , K_3, K_4, K_5, K_6
CO_5	Compare and choose different techniques for study of cell structure and function.	K_2 , K_3, K_4, K_5, K_6

Course Content	**Hours**
Unit I: : Nuclear membrane and Transport	**12 hrs**
• Properties and Composition of Nucleus, Nucleolus and Nuclear Membrane • Structure of Nuclear Pore Complex • Transport of ribosome, RNA , Proteins across Nuclear Envelope and Nuclear Pore complex. • Regulation of Nuclear Protein Import and Export. • Abnormalities associated with Nuclear transport.	
Unit II: Cell-Cell Interaction	**12 hrs**

• Cell-Cell Interactions and Cell-Matrix Interactions • Components of Extracellular Matrix • Collagen and Non-Collagen Components • Tight Junctions; Gap Junctions; Desmosomes; Hemidesmosomes; Focal Adhesions And Plasmodesmata • Cell Wall; Role of Cell Interaction in Development.	
Unit III: Control of Cell Cycle and Programmed Cell Death	**12 hrs**
• Control and regulation of cell cycle. • Regulation Of Cell Division And Cell Growth • Necrosis and Molecular mechanism of Apoptosis . • Stem Cells And Maintenance of Adult Tissues, Hematopoiesis, Embryonic Stem Cells and Therapeutic Cloning	
Unit IV: Cancer Biology	**12 hrs**
• Development and Types Of Cancer • Benign and Malignant Tumors and Steps involved in Metastasis. • Physical, Chemical and Biological Carcinogens. • Genetic Basis of Cancer • Diagnosis and different approaches for cancer treatment .	
Unit V: Advanced Methods in Cell Biology	**12 hrs**
• Ultracentrifugation • Confocal Microscopy • Plant and Animal Cell Culture • Immunohistochemistry.	

Text books (2 textbooks):
1. Cooper, G.M. and Hausman, R.E. (2009). *The cell: A molecular approach*. (ed.5th). Washington, D.C. Sinauer Associates, MA. ASM Press & Sunderland. 2. Karp, G. (2009). *Cell and Molecular Biology: concepts and experiments*. John Wiley & Sons.
Reference books: 1. Alberts, B., Johnson,A., Lewis, J., and Enlarge, M. (2008) *Molecular Biology of the Cell.* (ed.5th). Garland Science (Princeton). 2. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell. J., (2012). *Molecular Cell Biology*. (ed. 7th), W.H. Freeman & Company (New York) 3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009) *The World of the Cell*. (ed. 7th). San Francisco. Pearson Benjamin Cummings Publishing.
Pedagogic tools: ● Chalk and Board ● Power point presentation ● Charts ● Seminar ● Videos

Methods of Assessment & Tools:

Components of CIE:30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	Units 3,4,5	3 hours	15 (Set for 70)	
B	Assignment			05	10
C	Class activity			05	
				Grand Total	**30**
Assignments	● Abstract and executive summary ● Case study writing ● Concept mapping ● Student generated handbook ● Chart preparation etc…				
Class activity	● Reaction paper ● Quiz ● One-minute paper ● Situation based questions ● Application card etc..				

Note : Any other assessment tools or methods can be adopted as per requirement of the course.

Applied Course For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: **Biochemistry**	Offered to: **B.Sc. Biochemistry**	
Semester – VI		
Course Code	Course Title (App.)	Course Credit and Hours
21UBCCC602	**IMMUNOLOGY**	**5 Credits - 5 hrs/wk**

Course Description:

This course of immunology is designed to introduce the students about different aspects of immune functions and dysfunctions at the cellular and molecular level. The course comprises of detailed study of various types of immune responses and their classification. The course gives detailed insights in the molecular structures of immunoglobulins, their types and mechanism of processing and presentation of antigen with applied aspects in vaccines and principles behind

various immuno-techniques.
Course Purpose: The course aims to provide an advanced understanding of the principles and mechanisms of the cells and organs of immune system in immune response. Course provides basic understanding of immunological tolerance, role of MHCs in antigen processing and presentation. The course also intended to provide critical understanding that how concepts of immunology are employed to develop vaccines, clinical diagnosis and understanding pathogenesis of autoimmune responses and hypersensitive reactions.

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K_1 to K_6)**
CO_1	Define and describe the cells and organs of immune system and summarize the role of antigen presenting cells, Analyze the different roles of lymphocytes, and identify the integration of Innate and adaptive immune response.	K1, K2, K3, K4
CO_2	Classify and justify the role of MHC molecules based on the nature of Ag, Analyze and evaluate various immuno-diffusion techniques and compare different types and functions of immunoglobulins.	K1, K2, K3, K4, K5
CO_3	Analyze and evaluate the results of immuno techniques, understand the integrated role of complement system and describe molecular basis of antibody diversity	K1, K2, K3
CO_4	Compare, classify the cellular and molecular basis for Autoimmune disorders, analyze differences between various hypersensitive reactions and determine the differences between normal and cancer cells	K1, K2, K3, K4
CO_5	Define, understand and apply the principles, applications and methods used in vaccine development, Compare and differentiate pathways of antigen processing and presentation.	K1, K2, K3, K4, K5

Course Content	**Hours**
Unit-I : Immune System and Immune Response	**12hrs**
• Historical Perspective - Early theories of immunity, discovery of humoral and cellular immunity • Innate Immunity-Anatomic barrier, Physiologic barrier, Endocytic and Phagocytic barrier, Inflammatory barrier • Acquired Immunity - Characteristics of Specific Immune response, Functions	

of humoral and cell mediated immunity, Generation of cell mediated and Humoral response, Primary and Secondary immune Response, Clonal selection of lymphocytes. • Cell and Organs Involved in the Immune System- Cells of immune system; Lymphoid cells, Mononuclear cells, Granulocytic cells, mast cells, Dendritic cells • Primary and Secondary Lymphoid organs - Bone Marrow Thymus Spleen, Lymph nodes and MALT	
Unit-II: MHC, Antigen and Antibody	**12 hrs**
• Major Histocompatibility Complex (MHC) - Location and Functions of MHC molecules, Structure of Class I and II molecules, Organization of class I and Class II genes. Polymorphism of Class I and Class II molecules, Peptide interactions with MHC molecules • Antigen - Immunogenicity, Antigenicity, Factors Influencing Immunogenicity of the compound, Adjuvants, Epitop, Haptens, Exotoxins, Endotoxins, Mitogens. • Immunoglobulin – Experimental evidence for the Determination of antibody structure, Introduction to the fine structure of Immunoglobulin, Isotypic, Allotypic and Idiotypic Determinants, Immunoglobulin Classes. • Introduction to monoclonal antibodies and Immunoglobulin super family.	
Unit-III: Complement System, Immuno Techniques and Generation of Antibody Diversity	**12 hrs**
• Antigen-Antibody Reactions - Concept of Antibody affinity and Avidity, Cross Reactivity, Precipitation reactions in fluids and gels (RID, Ouchterlony, Immunoelectrophoresis, Ab Titer), Agglutination Reactions (Hemagglutination, Bacterial Agglutination, Passive agglutination and Agglutination inhibition) • Components of Complement System- Nomenclature, Classical and Alternative pathway of Complement Activation, Cell Lysis, Anaphylaxis, Opsonization. • Molecular Basis of Antibody Diversity - Multigene Organization of Ig Genes, Gene Rearrangements of variable Region. • Introduction to generation of antibody diversity and Class Switching	
Unit-IV: Hypersensitive Reactions, Autoimmunity and Tumor Immunology	**13 Hrs**
• Hypersensitive Reactions - Classification, Molecular Basis of different classes of Hypersensitivity, Clinical Manifestations, Diagnosis and Treatment/Control • Autoimmune Diseases-Organ Specific Autoimmune Diseases; Hashimoto's Thyroiditis, Autoimmune Anaemias, Goodpasture's Syndrome, Insulin Dependent Diabetes Mellitus, Graves Disease, Myasthenia Gravis • Systemic Autoimmune Disease; SLE, Multiple Sclerosis, Rheumatoid Arthritis • Tumor immunology (Introduction) -Tumor specific antigens and tumor	

associated Antigens, Immune Response to neoplastic cells	
Unit- V: Antigen Processing and Presentation, Vaccines and Immunodeficiency	**12 hrs**
• Antigen Processing and Presentation-The Cytosolic Pathway (proteasome mediated peptide generation, peptide transport from to cytosol to RER, Overview of the pathway) The Endocytic Pathway (Peptide generation of endocytic vesicles, Transport of Class II MHC molecule to Endocytic Vesicles, Overview of the pathway) • Vaccines- Active and passive Immunization, Concept of Inactive and Attenuated vaccine, Whole Organism vaccine, Introduction to Recombinant Vector vaccine, DNA Vaccine, Multivalent Subunit Vaccine. • HIV and Immunodeficiency - Structure of HIV, Target cell of HIV and consequences of infection, Transmission and Diagnosis of HIV infection • SCID associated with HIV and Concept of HAART.	

Text books :

1) Dr. P. M. Latha, (2012). A Text Book of Immunology. S. Chand & Company
2) Ladyard P.M., Whelan A. &Fanger M.W. (2002). Instant notes in immunology. Viva
1. Books Private limited

Reference books:

1) Kuby J. (2007). Immunology (ed. 6th) New York. W.H Freeman and Company.
2) Male, D., Brostoff, J., Roth, D. B., &Roitt, I. (2006). Immunology. (ed. 7th). Philadelphia,
PA: Elsevier.
3) A. K. Abbas, A.H. Lichtman, Shiv Pillai, Cellular and Molecular Immunology (ed. 7th), Elsevier.

Pedagogic tools:

- Chalk and Board
- Power point presentation
- Seminar
- Videos

Methods of Assessment & Tools:

Components of CIE: 30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	Units 3,4,5	3 hours	15 (Set for 70)	
B	Assignment			05	10
C	Class activity			05	
				Grand Total	**30**
Assignment	● Abstract and executive summary ● Case study writing ● Concept mapping ● Student generated handbook ● Essay writing etc.				
Class activity	● Reaction paper ● Quiz ● One-minute paper ● Situation based question ● Application card etc.				

Note: Any other assessment tools or methods can be adopted as per requirement of the course.

Applied Course For the students admitted from A.Y. 2021-2022 & onwards		
Offering Department: Biochemistry	**Offered to: B.Sc Biochemistry students**	
Semester – V		
Course Code	**Course Title (App)**	**Credits**
21UBCCC603	Plant Biochemistry	**5 Credits- 5 hrs/wk**

Course Description: This course includes topics in photosynthesis, carbohydrate, nitrogen, and lipid metabolism, specialized metabolism, and plant metabolic engineering.
Course Purpose: This course covers biochemical processes specific to plants and is aimed to allow students to gain an understanding and appreciation of how biochemical components are synthesized and utilized by plants during growth and development and in their interactions with their environment, as well as how these processes can be manipulated

Course Outcomes: Upon completion of this course, the learner will be able to		
CO No.	**CO Statement**	**Blooms taxonomy Level (K_2 to K_6)**
CO 1	Familiarize with the structure and function of Plant cell and its organelles. Learn the relationship between plant cell and electron transport components.	K_2 , K_3, K_4, K_5, K_6
CO 2	Analyze the Nitrogen cycle and Nitrogen fixation. Investigate the role and mode of action of plant regulators.	K_2 , K_3 , K_4, K_5
CO 3	Review the components and reactions of photosynthesis (Light reactions, Dark reactions and CAM pathway) and photorespiration.	K_2 , K_3, K_4, K_5, K_6
CO 4	Perceive the role of secondary metabolites.	K_2 , K_3, K_4, K_5, K_6
CO 5	Demonstrate the physiological events. Illustrate the role of biochemical events with photo periodism and phytochrome.	K_2 , K_3, K_4, K_5, K_6

Course Content	**Hours**
Unit I: Electron transport system in plants	**12 hrs**

• Oxidative phosphorylation, mitochondrial respiratory complexes, order and organization of electron carriers, electrochemical gradient. • Chemiosmotic theory, ATP synthase and mechanism of ATP synthesis. • Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; • Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photophosphorylations, complexes associated with thylakoid membranes; light harvesting complexes, • path of carbon in photosynthesis – C3 and C4 pathway of carbon reduction and its regulation, Photorespiration.	
Unit II: Nitrogen metabolism	**12 hrs**
• Assimilation of nitrate, structural features of nitrate reductase and nitrite reductase, incorporation of ammonia into organic compounds, regulation of nitrate assimilation. • Biological nitrogen fixation by free living and in symbiotic association; structure and function of the enzyme nitrogenase.	
Unit III: Photosynthesis	**12 hrs**
• Photosynthetic apparatus, pigments of photosynthesis, role of carotenoids, photosystems I and II, their location; • Hill reaction, photosynthetic electron transport and generation of NADPH & ATP, cyclic and non-cyclic photophosphorylations, complexes associated with thylakoid membranes; • Light harvesting complexes, path of carbon in photosynthesis – C3 and C4 pathway of carbon reduction and its regulation • Photorespiration.	
Unit IV: Special features of secondary plant metabolism and toxins of plant origin	**12 hrs**
• Terpenes (classification,biosynthesis), lignin, tannins, pigments, phytochrome, waxes,alkaloids, biosynthesis of nicotine, functions of alkaloids, cell wall components. • Toxins of plant origin – mycotoxins, phytohemagglutinins, lathyrogens, nitriles, protease inhibitors, protein toxins.	
Unit V: Stress metabolism in plants and Antioxidativedefense system in plants	**12 hrs**
• Environmental stresses, salinity, water stress, heat,chilling, anaerobiosis, pathogenesis, heavy metals, radiations and their impact onplant growth and metabolism, criteria of stress tolerance. • Reactive oxygen species and theirgeneration, enzymic and non-enzymic components of antioxidative defense mechanism.	

Text books (2 textbooks):
1.Buchann (2015), Biochemistry and Molecular Biology of Plants, 2nded. Publisher: I KInternational. ISBN-10: 8188237116, ISBN- 978047 0714218 2.Taiz and Zeiger, Plant Physiology, 5thedition, Sinauer Associates Inc.ISBN-13: 978- 0878938667, ISBN-10:0878938664

Reference books:

1.Caroline Bowsher, Martin steer, Alyson Tobin (2008), Plant Biochemistry, Garland science ISBN978-0-8153-4121-5.
2.P.M Dey and J.B. Harborne (Editors) (1997), Plant Biochemistry, Publisher: Academic Press ISBN-10:0122146743,ISBN-13:978-0122146749

Pedagogic tools:

- Chalk and Board
- Power point presentation
- Charts
- Seminar
- Videos

Methods of Assessment & Tools:

Components of CIE:30 marks (Example as below)

Sr. No.	Component	Content	Duration (if any)	Marks	Sub Total
A	Test 1	1st 2 units	$1^{1/2}$ hours	5 (Set for 30)	20
	Test 2	Units 3,4,5	3 hours	15 (Set for 70)	
B	Assignment			05	10
C	Class activity			05	
				Grand Total	**30**
Assignments	● Abstract and executive summary ● Case study writing ● Concept mapping ● Student generated handbook ● Chart preparation etc…				
Class activity	● Reaction paper ● Quiz ● One-minute paper ● Situation based questions ● Application card etc..				

Note : Any other assessment tools or methods can be adopted as per requirement of the course.

Applied Course
For the students admitted from A.Y. 2021-2022 & onwards

Offering Department: **Biochemistry**	Offered to: **B.Sc. Biochemistry**	
Semester – VI		
Course Code	**Course Title (App)**	**Course Credit and Hours**
21UBCCC604	**Applied Biochemistry Practical**	**4 credits- 8 hours/ Wk**

Course Description:
This laboratory course compliments the theory core courses by providing students with hands on experiences on various techniques in Immunology and Plant Biochemistry. Course correlate the principles of immunodiffusion, immunoprecipitation methods implemented for comparison of antigen types and quantification. Practical course also includes evaluation and comparison of plant pigments and metabolites.

Course Purpose:
This course is designed to equip students with the fundamental concepts and methods in immunology and plant biochemistry. The goal is to provide students with fundamental understanding of immunology, ability to plan , evaluate, diagnose various molecular as well as serological tests and methods to analyze and evaluate primary and secondary metabolites from different plant sources

Course Outcomes: Upon completion of this course, the learner will be able to

CO No.	**CO Statement**	**Blooms taxonomy Level (S_1 to S_5)**
CO_1	Develop skills to perform, analyze and evaluate the results obtained from immunoelectrophoresis	**S_1, S_2, S_3, S_4, S_5**
CO_2	Compare and evaluate immunodiffusion with immunoelectrophoresis and perform experiments to analyze the differences in the antigen structure.	**S_2 ,S_3, S_4, S_5**
CO_3	Perform calculations and interpret the results of various immuno and serological test and derive conclusions and clinical correlations.	**S_1,S_2 ,S_3, S_4, S_5**
CO_4	Perform DOT ELISA method, analyze and evaluate the importance of positive and negative control in the experiment.	**S_1, S_2 S_3, S_4**
CO_5	Plan and Perform calculations to estimate plant pigments, metabolites required to compare and evaluate the results obtained from different plant sources	**S_2 ,S_3, S_4, S_5, S_6**

Suggested laboratory experiments:

1. Radial Immuno-diffusion (RID)
2. Ouchterlony Double Diffusion Technique
3. Rocket Immunoelectrophoresis
4. Ouchterlony Double Diffusion for Antibody Titration
5. Sandwich Dot ELISA Technique
6. Identification and study of the cancerous cells using photomicrographs
7. Determination of Blood group by Hemagglutination method
8. Evaluation of chlorophyll content in different plant sources
9. Separation of plant pigments by Thin layer Chromatography (TLC)
10. Comparison of antioxidant potential in different fruit samples
11. Estimation of Tannin from the tea sample
12. Estimation of Curcumin from turmeric powder

Pedagogic tools:

- Chalk and Board
- Laboratory Hands on training
- PowerPoint Presentation and Videos.
- Virtual Lab

Text books – Not applicable

Reference Books:

1. Wilson, K., & Walker, J. M. (2000) Principles and techniques of practical biochemistry. Cambridge: Cambridge University Press.
2. J. Jayaraman (2011) Laboratory Manual in Biochemistry New Age International Publishers, New Delhi.

3. Thimmaiah S.R. (2004) Standard Methods of Biochemical Analysis. Kalyani Publishers, New Delhi.

4. G P Talwar and S K Gupta (2012), A Handbook of Practical And Clinical Immunology, Volume 1, CBS Publication

Laboratory Manual/ Book

- Manual of Biochemistry Department, Shri M. & N. Virani Science College (Autonomous), Rajkot

Suggested reading / E-resources

- Not Applicable

Suggested MOOCs

- Not Applicable

Methods of assessing the Course Outcomes

The COs of the course will be assessed through

- CIA (Test, Performance, Record book, Viva Voce)
- SEE

CIA Components	**Marks**
Test (After completion of 70-80% of accessible Practicals)	30
Performance and Record book	10
Grand Total	**40**

Sr. No.	**SEE Component**	**Content**	**Duration (if any)**	**Marks**	**Sub Total**
A	Test	After completion of course	6 hours	60	60
				Grand Total	**60**