Sant Gadge Baba Amravati University, Amravati

Part A

Faculty: Science and Technology

Programme: M. Sc. Biochemistry

Programme: M.Sc. Biochemistry of Science and Technology

Programme information

M.Sc. (Biochemistry) Programme Outcomes (POs):

Upon completion of M.Sc. (Biochemistry), students will be able to:

PO1(Domain knowledge): demonstrate knowledge of basic concepts, principles and applications of the specific science discipline.

PO2(Resource Utilization): cultivate the skills to acquire and use appropriate learning resources including library, e-learning resources, ICT tools to enhance knowledge stay abreast of recent developments.

PO3(Analytical and Technical Skills tools/techniques/equipment with an understanding of the standard operating procedures, safety aspects/limitations.

PO4(Critical thinking and Problem-solving problems in the relevant discipline using appropriate tools and techniques as well as approaches to arrive at viable conclusions/solutions.

PO5(Project Management): demonstrate identify research problems, design experiments, use interpret data and provide solutions time and resources.

PO6 (Individual and team work independently and as a member or leader in diverse teams, and in multidisciplinary settings.

PO7 (Effective Communication well as through electronic media with the scientific community as well as with society at large. Demonstrate the ability to write dissertations, reports, make effective presentations and documentation.

PO8(Environment and Sustainability advances on the environment and society and the need for sustainable development.

PO9 (Ethics): exert a commitment to professional ethics and responsibilities.

PO10 (Self-directed and Life-long Learning learning in the context of the rapid developments

M.Sc. (Biochemistry) Programme Specific Outcomes (PSOs):

At the end of the programme, the students will be able to:

PSO1: Gain disciplinary knowledge and understanding of biochemistry, structure and function of biological molecules and mechanisms, such as the processes and control of bioenergetics, cell biology and physiology.

PSO2: Demonstrate an understanding of the principles and have practical experience of a wide range of biochemical techniques (e.g., analytical methods like spectrophotometry, electrophoresis, the use of standards for quantification, enzyme

kinetics; macromolecular purification, etc.).
PSO3: Analyze biochemical data (e.g., in enzyme kinetics, molecular structure analysis and biological databases) and effectively communicate scientific reasoning and data analysis in both written and oral forms.
PSO4: Explore the knowledge and practical skills for qualitative and quantitative analysis of various constituents in biological fluids for the diagnosis of clinical and genetic disorders.
PSO5: Use various bioinformatics tools and applications of programs for database searching, protein, and DNA sequence analysis.
PSO6: Evaluate the role of different enzymes in clinical diagnosis, vaccine development, food and pharmaceutical industries, research,and agriculture.

Employability Potential of the Programme:

The discipline of Biochemistry involves the study of the structure and function of biomolecules and the vital processes that occur in living organisms. It is regarded as Mother of all Biological Sciences disciplines because it unveils the chemical basis of life in all living organisms including plants, animals, and microorganisms. Biochemistry has contributed enormously to the growth of modern medical and health science and agriculture. Biochemistry has applications in clinical diagnosis, understanding pathology of diseases, treatment of diseases, designing of drugs and understanding their metabolism and manufacture of various biological products like amino acids, proteins, antibiotics, hormones, enzymes, nutrients, etc.

Understanding the biochemical basis of vital processes of plants such as photosynthesis, respiration, hormonal regulation, nutrient assimilation has helped in developing superior varieties of crop plants with better growth attributes and yield. For the estimation of pesticide residues in soil or food grain one has to rely on biochemical tests. The functions and roles of various nutrients are described only by biochemistry. The composition of food materials including the quality-milk and possible adulterations can be checked by biochemical tests. This discipline has played valuable role in farming, fishery, poultry, sericulture, bee keeping and in environmental remediation.

Students can peruse basic research work in research institutes or universities by qualifying various exams for research fellowships.

This programme includes understanding of fundamentals, acquiring practical training and application of the subject knowledge in diversified areas of Biochemistry with a clear perspective that this knowledge will equip the students to make them suitable for various Biotech, Pharma, Medicine, Agri-Biotech, Biochemical related laboratories/industries. After completing the program, candidates can expect numerous jobs in several fields.

It has always been in demand as it promises vast career opportunities to candidates in various employment sectors as it involves the study of biomolecules and biochemical techniques which helps in research and development areas. Increased environmental consciousness and demand for clean energy will lead to opportunities for biochemists focused on discovering alternative energy sources such as biofuels. Growing population and rising food prices call biochemists to advance the development of genetically engineered crops and livestock that produce higher yields.

Students can be employed in pharma-based laboratories and quality control services. They can work in food, chemicals, perfumery, oil industries, distilleries; textile industries.They can expect job opportunities in health care and paramedical laboratories, quality control assistants in analytical laboratories dealing with biochemical/clinical/Food processing/pharma industrial settings. Besides this, our students have marketing entrepreneurial opportunities.

The field of Biochemistry provides large scope in biotech-based industries, Forensic science labs, blood banks, diagnostic labs, drug discovery, medical coding, medical transcription, medical content writing etc. Students can also work as Bio-analysts in various research labs and organizations. Small companies employ biochemists to provide toxicological studies.

The students of biochemistry can also work as food technologists developing new food products or methods of detecting contaminants. Our students are employed in energy development, environmental restoration firms, laboratory technicians at Government and private pathological laboratories.

Through the present curriculum attempt has been made to generate enough interest among students so that they can pursue higher education in Biochemistry to take up the career of teaching, research or to serve the needs of medicine, nutrition, and agriculture related industrial establishments.

Part B

Syllabus Prescribed for 2023-2024 Year PG Programme

Programme: MSc Part II Biochemistry

M.Sc. PART II (Biochemistry) EXAMINATION (Semester –III)

Examination scheme under CBCS for the subject Biochemistry

Sr. No.	Paper/ Code	Course	Theory					Practical	
			Max. Marks (Credits)	Min. Passing Marks (Mi. Grade Pt.)	Internal Assessment (Credits)	Min. Pass Marks (Min. Grade Pt.)	Theory + Internal Assessment Passing Marks (Grade Pt.)	Max. Marks (Credits)	Min. Marks (Min. Grade Point)
1	2	3	4	5	6	7	8	9	10
1.	PAPER-IX [DSC, 3BCM 1C] Immunochemistry	DSC (3BCM1C)	80 (03)	40 (03)	20 (01)	08 (01)	40 (04)	-	-
2.	PAPER-IX [AEC, 3BCM 1A] Immunochemistry	AEC (3BCM1A)	(01)					25 Internal	10
3.	PAPER-X [DSC, 3BCM 2C] Advanced molecular biology	DSC (3BCM2C)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)	-	-
4.	PAPER-XI [DSC, 3BCM 3C] Human Physiology	DSC (3BCM3C)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)	-	-
5.	PAPER-XII [DSE, 3BCM 4C] Industrial Biochemistry	DSE (3BCM4C)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)	-	-
6.	PRACTICAL-V [LAB V] Immunochemistry	LAB-V	-	-	-	-	-	100 (03)	50 (04)
7.	PRACTICAL-VI [LAB-VI] Techniques in Molecular Biology and Industrial Biochemistry	LAB-VI	-	-	-	-	-	100 (03)	50 (04)
8.		Internship/ Field work/ Work Experience							
9.	PAPER-IX [OEC, 3BCM 1 C] Immunochemistry	Open elective/ GIC/Open skill/MOOC (This will be offered by the Department to the students of other discipline)							
10.	Total	Total	320 (16)	-	80 (04)	-	-	225(06)	-

Total Marks 625, Total minimum and maximum credits 26

Total Practical Marks:100, Duration of exam:06 hours	
Internal Practical Exam	External Practical Exam
Attendance, Student's performance, Practical Record Book, Internal Viva, Spotting Total….. 20 marks	Experiment Performance: Long and short experiments: 60 marks External viva : 20 marks Total….. 80 marks

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
3BCM 1C	Immunochemistry	3 periods per week

PAPER-IX
[DSC, 3 BCM 1C]
Immunochemistry
Number of periods per week: 3
Number of Credits: 3

Course learning outcomes (COs)

After completion of this course, students will be able to:
CO1: Understand the cell types and organ involved in the process of immune response.
CO2: Differentiate between innate and adaptive immunity.
CO3: Illustrate the significance of vaccines and clinical immunology.
CO4: Explain hypersensitivity, transplantation and causes of immunodeficiency diseases.

Unit I: Fundamentals of immune system	A) Immunity –Anatomic organization of the immune system cell types and organs, Innate and acquired immunity. B) Antigen, Haptens, adjuvants, mitogens. C) Antibodies and Immunoglobulins structure and functions of IgG, IgA, IgM, IgD and IgE. D) Immune response: - Cellular and Molecular mechanism of Ab production humoral immunity and cell mediated immunity, Regulation of immune response.	11 periods
Unit II: Immunity against infection	A) Antigen processing and presentation, MHC, complement system, T & B cell activation. B) Mechanism of immunity against bacterial, viral, protozoan and parasitic infections with special reference to diphtheria, influenza, malaria and helminthes.	11 periods
Unit III: Vaccines and immunization	Active and passive immunization, genetically engineered vaccines, multivalent subunit vaccines, synthetic peptide vaccines, application of lymphokines, Antibody diversity, Immunogenetics	11 periods
Unit IV: Clinical Immunology	A) Hypersensitivity: - Type I, II, III, and IV reactions. Autoimmunity – organ specific and systemic autoimmune diseases. Treatment of autoimmune diseases. B) Transplantation and tumor immunology: - Graft rejection, tissue typing, immunosuppressive therapy and clinical Transplantation. Tumor antigens, cancer immunotherapy. C) Immunodeficiency diseases - Phagocytic, humoral, cell mediated deficiencies and SCID. AIDS- causes, syndrome, diagnostic tools, Immunological Tolerance	12 periods

Code of the Course/Subject	Title of the Course/Subject	(Total Number of Periods)
3BCM 1A	Immunochemistry	1 period per week

PAPER-IX
[AEC, 3BCM 1-A]
Immunochemistry
Number of period per week: 1
Number of Credits: 1

Course learning outcomes (COs)
After completion of this course, student will be able to:
CO1: Employ the antigen- antibody reactions to conduct different immunological test for public health.

AEC: Immunodiagnostics	A) Antigen-antibody reactions – Principles, types and applications of agglutination, precipitation, complement fixation, viral neutralization, immunodiffusion, immunoelectrophoresis, Concept and applications of ELISA with special reference to HIV detection and RIA with special reference to thyroid hormones B) Monoclonal antibodies – Hybridoma technology, Production of monoclonal antibodies and their diagnostic application in immunohistochemistry and therapeutic application in radioimmunotherapy	15 periods
Marks distribution for AEC will be as follows: **Activities:** Assignment 15 Marks Seminar 10 Marks Total 25 Marks		

Code of the Course/Subject	**Title of the Course/Subject**	**Total Number of Periods**
3BCM 2C	Advanced Molecular Biology	4 periods per week

PAPER-X
[DSC, 3 BCM 2C]
Advanced Molecular Biology
Number of periods per week: 4
Number of Credits: 4

After completion of this course students will be able to:
CO1: Understand structure, organization and analysis of genes.
CO2: Understand the function of the key proteins involved in the process of replication.
CO3: Describe how information flows from DNA to RNA to proteins.
CO4: Comprehend the regulation of gene expression in prokaryotes and eukaryotes.

Unit I: Gene structure and Organization	A) Gene Structure, Organization and analysis: Location of genes, Chromomere, Recon Mucon, Citron, types of genes Split, repeated housekeeping, Pseudo, overlapping etc. B) Gene analysis: Gene and Environmental and developmental transformation, genotype and phenotype, Developmental noise, Chromosome theory, Eukaryotic chromosome mapping.	12 periods
Unit II: DNA Replication and Transcription	A) Replication: Possible modes of replication, Meselson-Stahl experiment, the origin of replication in E. coli, major proteins and enzymes involved in the replication process; rolling circle model of replication. Role of telomerase B) Transcription: Mechanism of transcription, DNA-dependent RNA polymerase(s), recognition, binding and initiation sites, TATA/Pribnow box, transcription elongation and termination. Post-Transcriptional modifications; inhibitors of transcription.	12 periods
Unit III: Genetic Code and Translation	A) Genetic Code: Basic features of genetic code, the biological significance of degeneracy, Wobble hypothesis, gene within genes, overlapping genes, split genes and pseudogenes, universality of genetic code and its exceptions, single coding system between nucleic acids and amino acids. B) Mechanism of Translation: Ribosome structure, A and P sites; charged tRNA, f-met tRNA, initiation codon and non-sense codons, Shine-Dalgarno consensus sequence, formation of 70S initiation complex, the role of EF-Tu, EFTs, EF-G, GTP and release factors (RFI and RF2). Post-translational modifications and inhibitors of protein synthesis.	12 periods
Unit IV: Regulation of gene expression in Prokaryotes	Enzyme induction and repression constitutive enzymes, operon hypothesis, structure and regulation of lactose, galactose, arabinose, Tryptophan and histidine operons. Expression Vectors - CAT and luciferase. Transcriptional Regulation - Positive, negative control, attenuation, stringent responce. Holoenzyme modification, antitermination. Post transcriptional regulation - Spliced and unspliced introns.	12 periods

	Translational regulation - Instability of mRNA, regulation at ribosome binding site, ribosomal binding efficiency, protein respressors. Autogeous translation respression, transacting RNA, repressors translation coupling baised codon usage, elongation block termination.	
Unit V: Regulation of gene expression in Eukaryotes	Transcriptional regulation - Basic promoter elements response elements, enhancers, transcription, factors regulation to transcription initiation. Post-transciptional regulation - Poly A choice, splice site choice RNA editing. RNA transport from nucleus to cytoplasm and its regulation. Translational Regulation - Modifications in translational apparatus and mRNA. mRNA making modification of RNA secondary structure, use of different translation initiation codons, significance of control. Regulation of plant genes - Normal & stress conditions. Special Mechanisms of gene regulation - Gene loss gene amplification and gene rearrangement.	12 periods

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
3BCM 3C	Human Physiology	4 periods per week

PAPER-XI
[DSC, 3 BCM 3C]
Human Physiology
Number of periods per week: 4
Number of Credits: 4

After completion of this course students will be able to:
CO1: Understand basic and advance knowledge of human organ system.
CO2: Understand how different organ systems work in to maintain homeostasis
CO3: Identify the critical physiological processes has been evolved from anatomical structures of different organs.
CO4: Correlate the functioning of the body with the basic knowledge on human physiology.

Unit I: Respiratory and cardiovascular System	A) Respiratory System: Lungs, structure and functions, Exchange of gases, transport of O_2 and CO_2 in blood, O_2 and CO_2 dissociation curves, control and regulation of respiration B) Cardiovascular System: Structure and function of heart and blood vessels; cardiac cycle; origin, conduction and regulation of heart beat, cardiac disorders and ECG	12 periods
Unit II: Nervous system	Organization of nervous system-CNS, PNS, Somatic nervous system; autonomic nervous system-sympathetic and parasympathetic system; enteric nervous system, structure and function of neuron, Synapse, nerve impulse transmission, synaptic modification, and neuromodulation; molecular and cellular properties of ion channels in neurons and sensory cells and their relationship to brain and sensory systems, Neurological Disorders: Alzhemer's disease, Parkinson's disease and multiple sclerosis	12 periods
Unit III: Excretory system	Structure and functions of nephron, mechanism and regulation of urine formation, urine concentration, waste elimination, micturition, regulation and disorders of water balance, blood volume, electrolyte balance and acid-base balance, Mechanism of Renin-angiotensin system	12 periods
Unit IV: Digestive system	Anatomy and functions of alimentary canal and digestive glands, Composition, functions and regulation of saliva, gastric, pancreatic, intestinal and bile secretions, Digestion and absorption of carbohydrates, lipids, proteins and nucleic acids, digestive disorders like GERD, IBS and celiac disease	12 periods
Unit V: Reproductive system	Anatomy of female reproductive system and Causes of female infertility (acquired and genetic), Gametogenesis, fertilization (natural and assisted (in vitro), Pregnancy (first, second & third trimester), Placenta as source of stem cells, cord banking, reproductive aging (menopause and andropause). Anatomy of Male reproductive system and causes of male infertility (environmental and genetic).	12 periods

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
3BCM 4E	Industrial Biochemistry	4 periods per week

PAPER-XII
[DSE, 3BCM 4E]
Industrial Biochemistry
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)
After completion of this course, student will be able to:
CO1: Categorize the in depth upstream and downstream processes in fermentation.
CO2: Distinguish the Modern trends in Microbial Productions.
CO3: To evaluate the utility of various techniques as a qualitative and quantitative tool for handing biomolecules on industrial scale.
CO4: To develop the concepts for managing biomolecules at commercial scale.

Unit I: Fermentation and bioreactors	Introduction to Fermentation: A) Industrial fermentation and its range, advantages of industrial fermentations over chemical manufacturing process, types of fermentation processes: submerged and solid-state fermentation, modes of fermentation: batch, fed-batch and continuous, microbial growth curve. B) Fermenters: Basic components of a fermenter, types of fermenters with their advantages and disadvantages C) Significance and control of various fermentation parameters: Maintenance of aseptic conditions, methods of sterilization, aeration and agitation, organisms, scale up and scale down of a fermentation process. D) Isolation of fermentation products - removal of solids, primary separations, purification operations, product isolation.	12 periods
Unit II: Food technology	A) Characteristics of industrial microorganisms; strain improvement; use of auxotrophic mutants; cultivation of microorganisms. B) Industrial production of few food products; i. Production of foods made from milk: Cheese, Probiotics – yoghurt/ curd. ii. Production of alcohol-based fermentation products: wine, beer, vinegar. iii. Production of oriental fermented foods: Soy sauce, tofu	12 periods
Unit III: Industrial production of biochemically important products	A) Production of industrially important proteins. : i. Industrially important enzymes - amylase / protease / lipase. B) Production of industrially important carbohydrates. i. Manufacturing and refining of cane sugar, pectin/cellulose ii. Manufacturing of polysaccharides. Plant polysaccharide (Gum Arabic), microbial polysaccharides, modified carbohydrates – modified starches, modified celluloses	12 periods

Unit IV: Production of pharmaceuticals, nutraceuticals and biochemicals	A) Production of Antibiotics: penicillins/ streptomycins. B) Production of Vitamins: B12/ascorbic acid. C) Production of Amino acids: lysine/glutamine. D) Production of Alcohol: ethanol. E) Production of Organic acid: citric acid/ lactic acid.	12 periods
Unit V: Microbial fermentation and Immobilization of Biocatalysts	A) Microbial cells as fermentation products: a. Production of Baker's yeast. b. Single cell proteins/Spirulina. c. Bacterial insecticides. B) Immobilized Biocatalysts: Enzymes and Cells, Methods for enzyme and whole cell immobilization, supports and their selection, Properties and Industrial applications of immobilized biocatalysts,	12 periods

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands on/Activity)	Total Number of Periods
Lab V	Immunochemistry	6 periods per week

PRACTICAL-V
[LAB-V]
Immunochemistry
Number of periods per week: 6.
Number of Credits: 3.

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Understand the principles of estimation of biomolecules by using Immunological Techniques
CO2: Evaluate serological testing and perform diagnostic immunology for human diseases.
CO3: Apply antigen-antibody interactions for various serological and immunological assays.
CO4: Develop electrophoretic separation and purification techniques for Ig

Sr. No	**Part A Serology**
1	TRUST test for Syphilis
2	Widal test
3	C-Reactive Protein (CRP)
4	Anti streptomycin-o
5	R.A Factor
7	Dengue Rapid test NS1, IgG, IgM
8	Rapid latex agglutination test for detection of Hepatitis – B antigen.
9	ABO Blood Grouping and Rh typing
	Part B Immunotechnology
1	Immunoglobulin separation by Fractional precipitation
2	Isolation of polymorphonuclear neutrophil cells
3	Precipitation Techniques : Double Immunodiffusion (Ouchterlony), Single (Radial) Immunodiffusion
4	Immuno-electrophoresis, Rocket Immunoelectrophoresis

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands on/Activity)	Total Number of Periods
Lab VI	Techniques in Molecular Biology and Industrial Biochemistry	6 periods per week

PRACTICAL-VI
[LAB-VI]
Techniques in Molecular Biology and Industrial Biochemistry
Number of periods per week: 6.
Number of Credits: 3.

Course learning outcomes (COs)

After completion of this course students will be able to:
CO1: Isolate the genomic DNA.
CO2: To perform and understand agarose electrophoresis
CO3: Isolate and characterize protein
CO4: Produce wine and monitor the alcohol and sugar content.

Sr. No	Experiment
	Part 1 Molecular Biology
1.	Preparation of various buffers required in molecular biology
2.	Isolation of Eukaryotic DNA
3.	DNA agarose gel electrophoresis
4.	To extract specific bands of DNA fragment from agarose gels
5.	To perform activity staining
6.	Estimation of Tm of DNA
7.	Separation of proteins by PAGE
8.	Seperation of proteins by SDS gel electrophoresis
	Part 2 Industrial Biochemistry
1.	Isolation of microorganisms by plating, streaking and pour plate method.
2.	Production of wine and monitoring of sugar reduction during the fermentation
3.	Production of wine and monitoring of alcohol production during fermentation
4.	Production of vinegar and estimation of acetic acid

Books recommended for M.Sc. Part-II Sem III (Biochemistry)

1. Principles of Biochemistry by Lehninger
2. Biochemistry by Stryer
3. Biochemistry by Campbell
4. Text Book of Biochemistry by West & Todd.
5. Molecular Biology of the Gene by Watson
6. Genes by Benjamin Lewin
7. Molecular Cell Biology by Lodish
8. Harper's illustrated Biochemistry by Robert K Murray
9. Principles of Biochemistry by White Handler & Smith
10. Textbook on Metabolism by Ravi Dabhade and Dr Pooja Rana, Nirali Publication
11. Textbook of Biochemistry & Human Physiology by G.P.Talwar.
12. Outlines of Biochemistry by Conn & Stumpf. B
13. Fundamentals of Biochemistry by I L Jain, S Chand.
14. Advances in Biotechnology by Kumar N.C.
15. Genetics by P.S.Verma & V.K.Agrawal, S.Chand & Co
16. Cell Biology, Genetic, evolution & Ecology by P.S.Verma & V.K.Agrawal, S.Chand & Co.
17. Elementary Biochemistry by J.LJain, S.Chand & Co.
18. The chemical Foundations of Molecular Biology by Steiner, S.Chand & Company.
19. Molecular Biology of the Cells (3rd Edn. 1994) by Alberts et aI., Garland Publications Inc.NY and London.
20. Text Book of Medical Physiology (10th Ed. 2001) by A.C.Guyton & J.E.Hall, Harcourt Asia.
21. Biochemistry (4th edn. 1992) by Lubert Stryer WH Freeman & Co., NY
22. General Enzymology, Kulkarni and Deshpande, Himalaya Publishing House.
23. The chemical Foundations of Molecular Biology by Steiner, S.Chand & Company.
24. Stryer, L., Berg, J., Tymoczko, J., Gatto, G. (2019). Biochemistry (9 th ed.). New York, WH: Freeman
25. Kuby Immunology (2007) 6th ed., Kindt, T.L., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York)

26. William, E. Paul (1989) Fundamental Immunology, 2nd Edition Raven Press, New York
27. Vander's Human Physiology (2008) 11th ed., Widmaier, E.P., Raff, H. and Strang, K.T. McGraw Hill International Publications, ISBN: 978-0-07-128366-3.
28. Molecular Biology of the Cells (3rd Edn. 1994) by Alberts et aI., Garland Publications Inc.NY and London.
29. Gene structure and expression - John D. Hawkins (Cambridge University Press)
30. A textbook of Industrial Microbiology - WulfCrueger and Annekiese Cruger(Panima Publishing Corporation)
31. Immunodiagonostics S.C. Rastogi (Wiley Eastern Pub.)
32. Immunology by Roitt. (Black well)
33. Fundamentals of Dairy Microbiology by J.B. Prajapati (AktaPrakashan) 46. Bio-Fertilizer.By Vyas&Modi (AktaPrakashan)
34. Press Scott and Dunn's Industrial Microbiology.
35. Fundamentals of Enzymology (2000) by N. Price and L. Stevens.
36. Understanding Enzymes by Trevor Palmer
37. Molecular Biology of the Gene: Watson 6th Edition, Pearson Publication.
38. Gene Regulation: A Eukaryotic Perspective: David Latchman 5 illustrated, Taylor & Francis, 2005
39. Molecular Biology, David Freifelder, Narosa Publishers, (1997).
40. Lewins Gene XI; J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick, Jones and Barttlett Publishers (2012).
41. Practical Biochemistry - Plummer (TMH Pub.)
42. Practical Biochemistry - Jayraman (Wiley Estern Pub.)
43. Human Physiology; Vander Sherman & Luciano (2001), McGraw-Hill
44. Medical Physiology: Principles for Clinical Medicine 3 rd Ed. by Rodney R. Rhoades and David R. Bell. Lippincott Williams & Wilkins.
45. Text Book of Biochemistry with Clinical correlations; Thomas Devlin [Ed.](1997), Wiley –Liss.
46. Principles of Human Physiology; 4 th Edn. Cindy L. Stanfield Pearson, (2010).

M.Sc. PART II (BIOCHEMISTRY) EXAMINATION (Semester –IV)
Examination scheme under CBCS for the subject BIOCHEMISTRY

Sr. No.	Paper/ Code	Course	Theory					Practical	
			Max. Marks (Credits)	Min. Passing Marks (Mi. Grade Pt.)	Internal Assessment (Credits)	Min. Pass Marks (Min. Grade Pt.)	Theory + Internal Assessment Passing Marks (Grade Pt.)	Max. Marks (Credits)	Min. Marks (Min. Grade Point)
1	2	3	4	5	6	7	8	9	10
1.	PAPER-XIII [DSC, 4BCM1C] Cell Physiology	DSC (4BCM1C)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)	-	-
2.	PAPER-XIV [DSC, 4BCM2C] Genetics	DSC (4BCM2C)	80 (03)	40 (03)	20 (01)	08 (01)	40 (04)		
3.	PAPER-XIV-AEC [AEC, 4BCM2A] Genetics	AEC (4BCM2A)	(01)					25 Internal	10
4.	PAPER-XV [DSC, 4BCM3C] Recombinant DNA Technology	DSC (4BCM3C)	80 (04)	40 (04)	20 (01)	08 (01)	40 (04)		
5.	PAPER-XVI [DSE, 4BCM 4E] Plant Biochemistry and/ or 2GIC-X (Student of Biochemistry will take other departments)	DSC/DSE (4BCM 4E) and/or2GIC-X (Student of Biochemistry will take at other departments)	80 (04) and/ or 80 (04)	40 (04) and/ or 40 (04)	20 (01) and/ or 20 (01)	08 (01) and/ or 08 (01)	40 (04) and/ or 40 (04)	-	-
6.	PRACTICAL-VII [LAB-VII] Plant Biochemistry & rDNA techniques	LAB-VII	-	-	-	-	-	100 (03)	50 (04)
7.	Project	Project	-	-	-	-	-	100 (03)	50 (04)
8.		Internship/ Field work/ Work Experience							
9.	PAPER- [OEC, 4BCM3C] Cell Physiology	GIC/Open skill/MOOC (This will be offered by the Department to the students of other discipline)							
10.	Total	Total	320 (16)	-	80 (04)	-	-	225 (06)	-

Total Marks 625, Total minimum and maximum credits 26.

Total Practical Marks:100, Duration of exam:06 hours	
Internal Practical Exam	External Practical Exam
Attendance, Student's performance, Practical Record Book, Internal Viva, Spotting Total….. 20 marks	Experiment Performance: Long and short experiments: 60 marks External viva : 20 marks Total….. 80 marks

Sant Gadge Baba Amravati University, Amravati

Format and Template for Courses (Theory) of UG/PG Programmes

Code of the Course/Subject	**Title of the Course/Subject**	**Total Number of Periods**
4BCM 1C	Cell Physiology	4 periods per week

PAPER-XIII
[DSC, 4 BCM 1C]
Cell Physiology
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Understand the basics of cell communication and signal transduction
CO2: Describe the mechanism of activation of receptors by their respective ligands.
CO3: Explain the structure of ion channels and pumps and their role in membrane transport.
CO4: Comprehend the molecular basis of cancer

Unit I: Cellular Signal Transduction	Cellular Signal Transduction and Metabolic Control a) Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants. b) Development of Signals - Ionic triggers of development, transcellular ion currents in development.	12 periods
Unit II: Information transactions in Eukaryotic Cells	a) The cyclic AMP facet; phosphorylation of Proteins, Ca++ Messenger system, The CGMP story, intersection signals. b) Control of metabolism by endocrines paracrines.	12 periods
Unit III: Cellular Transport Mechanism -	Membrane transport, Simple and facilitate diffusion, active transport, primary and secondary transport, porters, antiporters, Uniporters and symporters, the carrier concept, translocation of electric charge, Macromolecules as carriersglucose transporter system Protein targetting.	12 periods
Unit IV: Pumps and Channels	Circulation of Sodium, Na-pump regulation of cytoplasmic pH cell-volume. The proton circulation and pump Circulation of Calcium and pump ion regulated and Receptor operated Channels, ionomotive ATPases, Concept of membrannce, depolarisation and ionophores, Macromolecules at channels, Grouptranslocation.	12 periods
Unit V: Cancer Biochemistry	Causes and types of cancer-Viral carcinogenesis, tumor suppressors, oncogenes, proto oncogenes and signal transduction, growth and spread of cancer, metastasis and angiogenesis, molecular basis of cancer therapy, molecular markers, Programmed cell death (PCD) and its regulation in normal physiology, regulation and execution of mammalian apoptosis, cytokines signaling and role of apoptosis in tumor genesis.	12 periods

Code of the Course/Subject	**Title of the Course/Subject**	**Total Number of Periods**
4BCM 2C	Genetics	3 periods per week

PAPER-XIV
[DSC, 4 BCM 2C]
Genetics
Number of periods per week: 3
Number of Credits: 3

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Understand human genetics and hereditary
CO2: Explain all possible extensions of Mendelian principles
CO3: Analyze different natural ways of transfer of genetic material in to host genome
CO4: Identify the types and possible cause of mutation.

Unit I: Concept of gene and Mendelian principles	Concept of gene, Allele, multiple alleles, pseudoallele, complementation tests Dominance, segregation, independent assortment.	11 periods
Unit II: Extensions of Mendelian principles	Co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters	11 periods
Unit III: Extra chromosomal inheritance	Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.	11 periods
Unit IV: Structural and numerical alterations of chromosomes and recombination	Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination: Homologous and non-homologous recombination including transposition.	12 periods

Code of the Course/Subject	**Title of the Course/Subject**	**Total Number of Periods**
4BCM 2A	Genetics	1 period per week

PAPER-XIII
[AEC, 4BCM 2-A]
Genetics
Number of period per week: 1
Number of Credits: 1

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Identify the genetic basis of important genetic disorders.

AEC: Genetic Disorders	Human Genetic disorders like sickle cell anemia, hemophilia, thalassemia, down syndrome, muscular dystrophy, turner's syndrome, cystic fibrosis, color blindness, Klinefelter syndrome, Tay-Sach's Disease	15 periods
Marks distribution for AEC will be as follows: **Activities:** Assignment 15 Marks Seminar 10 Marks Total 25 Marks		

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
4BCM 3C	Recombinant DNA Technology	4 periods per week

PAPER-XV
[DSC, 4BCM 3C]
Recombinant DNA Technology
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)
After completion of this course students will be able to:
CO1: Gain knowledge about the Gene cloning vectors and techniques employed in DNA manipulation.
CO2: Understand the basics of in vitro DNA amplification procedure
CO3: Apply and use of recombinant DNA technology in production of insulin, drugs, diagnostics, vaccines and transgenic plants.
CO4: Use forensic techniques for investigation of case studies.

Unit I: Enzymes of Recombinant DNA Technology	DNA manipulation, insertion of Genes, Isolation, Enzymes used in genetic engineering, e.g., Restriction endonucleases, SI nucleases, DNA ligases, Alkaline phosphatase, Reverse transcriptase, DNA polymerase, polynucleotide kinase, terminal transferase.	12 periods
Unit II: Cloning vectors	Cloning vectors: General properties and types of ideal cloning vectors. Recombinant DNA Expression, Expression vectors, Expression construct. Different types of expression systems.	12 periods
Unit III: Methods for cloning	Reproductive and Therapeutic Principles, implication, social ethical perspectives. Methods for cloning(both). Introduction of DNA into living cells - Microinjector, biolistics, transfection, in vitro packaging etc. Gene synthesis - advantages, requirements technology, gene machines. Gene libraries - cDNA library, preparation, their advantages, disadvantages and detection of clone by immunoassays or radioactive probes, characterization of cDNA, Sub-cloning and expression system	12 periods
Unit IV: Advanced techniques in Molecular Biology	A) Amplification of genomic DNA and cDNA by PCR. Cloning of PCR products. Applications of PCR B) Principles, applications, methods, future perspectives of RAPD, RFLP, AFLP, DNA fingerprinting	12 periods
Unit V: Applications of recombinant DNA technology	A) Application in Medicine - Production of insulin, interferons, recombinant vaccines, antivirus therapy, Gene therapy. B) Applications in Agriculture - Manipulating plant resistant to viruses, pesticides, Herbicides. Improving nutritional value of plants prevention of fruit softening from damage. Manipulation of livestock.	12 periods

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
4BCM 4E	Plant Biochemistry	4 periods per week

PAPER-XVI
[DSE, 4BCM 4E]
Plant Biochemistry
Number of periods per week: 4
Number of Credits: 4

Course learning outcomes (COs)
After completion of this course students will be able to:

CO1: Understand plant cell structure, organization and biosynthetic pathways of essential biochemical molecules

CO2: Use cell culture techniques to propagate the plants in vitro to raise virus free, pest resistance, new variety of plants etc.

CO3: Understand biochemistry of flowering, seed formation and fruit development and mineral nutrition

CO4: Describe the biochemistry of plant growth hormones and stress mechanisms that operate in plants in various stress conditions

Unit I: Photosynthesis	Structure and function of chloroplast system. Development of plastids and synthesis of photosynthetic pigments and their functions. C-4 pathway, Calvin and Hatch Pathway, Crassulacean acid metabolism. Electron transport and energy coupling systems; generation of ATP	12 periods
Unit II: Plant tissue culture	Plant tissue culture: History of plant cell culture, culture media-composition, preparation and development, cellular totipotency, cryopreservation. Callus and cell culture: Isolation of cells, growth of single isolated cells. Suspension culture: Regeneration and maintenance of callus, organogenesis and embryogenesis. Applications of plant tissue culture.	12 periods
Unit III: Reproduction in plants.	Physiology of flowering senescence and seed formation. Biochemistry of fruit development and ripening. Physiology and biochemistry of seed dormancy and germination. Biochemical changes during germination of seeds.	12 periods
Unit IV: Plant Hormones and Development	Plant hormones - growth regulating substances and their mode of action. Molecular effects of auxins in the regulation of cell extension and of gibberellic, abscisic acids, and cytokinins in the regulation of seed dormancy, germination, growth and development, and embryogenesis. Response of plants to biotic (pathogens and insects) and abiotic (water, temperature, and salt) stress. Transgenic plants	12 periods
Unit V: Water relations	Mineral nutrition in plants and translocation of elements from soil to plants, translocation of elements within the plant. Factors affecting salt absorption and translocation. Biochemistry of plant diseases and biochemical basis of resistance to plant diseases and defensive mechanisms.	12 periods

Code of the Course/Subject	Title of the Course/Subject (Laboratory/Practical/practicum/hands on/Activity)	Total Number of Periods
Lab VII	Plant Biochemistry	6 periods per week

PRACTICAL-VII
[LAB-VII]
Plant Biochemistry and rDNA techniques
Number of periods per week: 6.
Number of Credits: 3.

Course learning outcomes (COs)

After completion of this course students will be able to:
CO1: Understand seed germination.
CO2: Isolate chloroplast and estimate plant pigments from it.
CO3: Assay of enzyme and determine its activity
CO4: Perform biochemical analysis of plant physiological aspects that would improve the applications of plant biochemistry.

Sr. No	Experiment
	Part A- Plant Biochemistry
1	Assay of amylase and change in sugar content in germinating seeds.
2	Estimations of Ascorbic acid in germinating seeds.
3	Isolation of peroxidase enzyme from leaf tissue and determination of specific activity
4	Separation of green plant pigments by column chromatography.
5	Development of callus culture from meristems and leaves.
6	Effect of inhibitor on trypsin activity
7	Preparation of extracts of crude herbs by successive solvent extraction method and its Preliminary phytochemical screening
8	Screening of herbal extracts for free radical scavenging and antioxidant activities
	Part B- r DNA Technology
1	Isolation and characterization of genomic DNA from plant.
2	Restriction Digestion
3	Southern Blotting
4	Demonstration of amplification of nucleotide fragments by PCR

Code of the Course/Subject	Title of the Course/Subject	Total Number of Periods
Project	Project work	6 periods per week

Project Work

Examination of Project work:

1. The examination should be held at the centers of practical examination.
2. There shall be panel of examiners including Head of the department and the Supervisor of the student.
3. There should be at least 2 to 3 external examiners for a batch of up to 10 Students or 3 to 5 external examiners for a batch of more than 10 Students.
4. The Students should submit the project report within 20 days after the last/final theory paper in University examination.
5. The date of Viva-voce examination on project work should be within the 30 days after the completion of theory examination.

Distribution of marks in Project work examination:

1. Evaluation of Project: 50 marks,
2. Viva—voce: 30 marks (Jointly by internal and external examiners)
3. Internal Assessment: 20 marks

Total: 100 marks

Books recommended for M.Sc. Part-II Sem IV (Biochemistry)

1. Principles of Biochemistry by Lehninger
2. Biochemistry by Stryer
3. Biochemistry by Campbell
4. Text Book of Biochemistry by West & Todd.
5. Molecular Biology of the Gene by Watson
6. Genes by Benjamin Lewin
7. Molecular Cell Biology by Lodish
8. Harper's illustrated Biochemistry by Robert K Murray
9. Principles of Biochemistry by White Handler & Smith
10. Outlines of Biochemistry by Conn & Stumpf. B
11. Fundamentals of Biochemistry by I L Jain, S Chand.
12. Advances in Biotechnology by Kumar N.C.
13. Biotechnology: A new Industrial Revolution by Steven prentis, Atlantic Publication.
14. Genetics by P.S.Verma & V.K.Agrawal, S.Chand & Co
15. Plant Physiology & Biochemistry by Verma S.K.Chand & Co
16. Biotechnology & other alternative Technologies for Utilization of Biomass/Agricultural Waste by Chakraverti. Oxiford & IBH~Pub:
17. Genetic Engineering & Biotechnology by Chopra Nasim.
18. Biotechnology by Keshav Terham.
19. Biotechnology in Agriculture by Chopra (Oxfort & IBH Pub.)
20. Genetic Engineering & Biotechnology by Chopra/Nasim (Oxford & IBH pub.)
21. Biotechnology by OECD (Oxford & IBH)
22. Cell physiology by Swami (Oxford & IBH Publishings)
23. Biotechnology Business Possibilities and prospects by Malgavkar (Oxford & IBH publishing)
24. Principles and Techniques of Practical Biochemistry (4th ed 1999) by K.Wilson and J.Walker (eds.) Cambridge Univ. Press.
25. Molecular Biology of the Cells (3rd Edn. 1994) by Alberts et aI., Garland Publications Inc.NY and London.
26. Cell and Molecular Biology (8th Ed. 2001) by E D P de Robertis& E M F de Robertis (Jr.) LIppincott Williams & Wilkins, Philadelphia.

27. Handbook of Photosynthesis (ed) Mohammand Pe Sarakle, Marcel Dekkar, Inc. NY, Basel, Hong Kong 1997.
28. Introduction to Plant Biochemistry (1983) T W Goodwin and E I Mercer, Pergaman Press, Oxford, NY, Toronto: Sydney, Paris, Frankfurt.
29. Seed Physiology of development and germination (2nd ed. 1994) J, D Bewley and M Black Plenum Press NY.
30. Biochemistry of Energy utilization in plants D T Dennis Blackie, Glasgow, and London 1987.
31. Plant Biochemistry by P M Dey and J B Harborne. Harcourt Asia PTE Ltd., Singapore.
32. Gene Cloning and DNA analysis- An Introduction; T. A. Brown, 5th Edition, Wiley-Blackwell Publishing (2006).
33. Molecular Cloning; A laboratory manual; Michael R. Green, CSHL Press (2012)
34. Das, H.K Textbook of Biotechnology, Wiley India Pvt. Ltd.
35. Plant Physiology, Biochemistry and Molecular Biology, David T. Dennis and David H. Turpin. Publisher: Longman
36. Plant Biochemistry and Molecular Biology, Hans-Walter Heldt. Oxford University Press.
37. Genetic Biochemical Disorders - Benson and Fenson
38. Cell physiology by Swami (Oxford & IBH Publishings)
39. The Cell: A Molecular Approach (2018) 8th ed., Cooper, GM, Oxford University Press.
40. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (2018) 8 th ed., Hoffmann A and Clokie S, Cambridge University Press, ISBN: 978- 1108716987.
41. Introductory Practical Biochemistry (2001). 2 nd Edition. S.K. Sawhney and Randhir Singh. Narosa Publishing House, ISBN- 8173193029
42. Cancer Biology, 4th Ed. Raymond W. Ruddon, Oxford University Press, Inc.
43. Principles of Genetics - R.H.Tamarin (TMH Edition)
44. Practical Biochemistry - Plummer (TMH Pub.)
45. Practical Biochemistry - Jayraman (Wiley Estern Pub.)