Master of Science in Bio-Chemistry

Master of Science in biochemistry is post graduate degree programme in Biochemistry science. The study of Biochemistry involves the study of chemical processes within living organisms, including but not limited to living matter. All living organisms and living processes are governed by biochemical processes, which control information flow through biochemical signaling and chemical energy flow through metabolism. Generally Biochemistry, focuses on molecules such as proteins, carbohydrates, lipids, nucleic acids and other bio molecules, though increasingly processes instead of specific molecules are of primary concern.The program aims to provide a legitimate knowledge of each aspect of the structure and function of dwelling matters on the molecular stage and to utilize the information for the benefit of mankind. The course length is two years period both on everyday and distance foundation and the syllabus is divided into four semesters.

M.Sc. Biochemistry Eligibility for admission

Candidate who has passed the B.Sc. degree in any Life Sciences [Biochemistry/ Bsc MLT/Botany/ Plant Sciences and Plant Biotechnology/ Zoology/ Bioinformatics/ Biology/Chemistry with Botany/ Zoology as Allied Subjects] of this university or an examination of any other university accepted by the syndicate as equivalent thereto shall be eligible for admission to M.Sc. Degree Course in Biochemistry.

Duration of the programme

The duration of the course is for two academic years consisting of four semesters

M.Sc. Biochemistry Course Quality

The best candidates for it are those with the capacity to comprehend intricate biological processes and who possess a thorough comprehension of pertinent texts. The ability to construct arguments and participate in debates, to think critically and analytically, to think independently, and to solve problems are further essentials. This course is appropriate for students who can put together arguments, participate in debates, have critical and analytical thinking, and problem-solve independently. Practical abilities, numeracy abilities, communication, presentation, and IT skills, interpersonal and teamwork abilities, self-management abilities, and professional growth abilities are also necessary. Candidates who possess these qualities are a good fit.

How is M.Sc. Biochemistry Course Beneficial

As all of these programmes have biochemistry as one of the papers, they can enter the teaching profession for courses like B.Sc., M.Sc., B.Sc., B.Pharm., BPT, NURSING, MBBS, and BE biotech. Exciting prospects are waiting for them in foreign biotechnology and biochemical enterprises, and those with entrepreneurial skills can start their own biotech companies, diagnostic companies, or pharmaceutical companies. They can also work in a variety of research, technical, and related positions in both corporate and public institutions. By taking the UGC CSIR JRF/NET test after receiving their M.Sc. they might choose to pursue a junior research fellowship. After that, students can pursue a career as a lecturer and one in research and development, consulting, or a related field.

M.Sc. Biochemistry Employment Areas

Research Laboratories

Pharmaceutical Industries

Diagnostic Centres

Biotechnology firms

Health care centres and Clinical Laboratories

Join in as scientific writers in life science companies

Medical transcriptionists

Clinical trial and drug designing

Scientists in national and international research labs

Entering into Ph.D. progra

M.Sc. Biochemistry Job Types

Consultant - Clinical Biochemistry

Guest Lecturer - Biochemistry

Assistant Professor - Biochemistry

Technician - Biochemistry

Reader - Physiology & Biochemistry

Medical Laboratory Technician

Business Specialist – Bioscience

Learning Outcomes: Biochemistry

At the conclusion of the degree program students will be able to:

1. Develop and demonstrate an in-depth knowledge of a specific area of biochemical research, which may include (but is not limited to) protein, nucleic acid and/or membrane biochemistry, cancer and molecular immunology, computational and quantitative biology, etc.
2. Demonstrate independent and critical skills necessary to formulate specific experiments aimed at understanding molecular processes.
3. Gain the necessary experience and skills to train others in the performance of experiments.
4. Develop communication skills suitable to discuss scientific outcomes at a level for the layperson to understand but critical enough for peers. Typically, such training is developed through writing and editing scientific manuscripts, with input from a faculty advisor.
5. Deliver effective oral and written presentations of the results and conclusions of experimental work.
6. Be able to ask and answer questions within the research areas of Biochemistry.
7. Develop skills and abilities for effective teaching of Biochemistry in a course room setting.
8. Develop the skills and intellectual background to succeed at postdoctoral work in academics or in the commercial sector.
9. Demonstrate ethical conduct within the research process and the responsibilities of the scientist.

OUTCOME BASED EDUCATION

Department of Applied Microbiology and Biochemistry

Program: M.Sc. Biochemistry

1. Mission

- To provide a learning environment that fosters problem-solving skills in the students through the use of cutting-edge biochemistry teaching.
- To help students develop their problem-solving abilities, career success, and to by providing a strong theoretical and practical foundation in a variety of teaching them about their rofessional and academic biochemistry discipline ethics-related obligations.
- To expose students to the most recent resources and technologies in the field biological chemistry.
- To offer projects based on research in the developing field of biochemical technology.
- To develop the human resource with sound theory and application in the an understanding of biology and the capacity to use information for the society as a whole

2. Vission

- Generating top-notch students who are trained in the newest techniques and innovations and working to establish the institution as a global leader in the study of biochemistry.
- To attain academic excellence in biochemistry by providing the students with in-depth knowledge, supporting research efforts, and meeting changing societal and industrial demands.
- Being a Centre of excellence in the field of biochemistry is one of the organization's goals, which is supported by its mission and vision statements.

Programme Specific Qualification Attributes

Programme specific qualification attributes achieved through courses in the programme in terms of

- **Knowledge and understanding level (K1 and K2)**
- **Application level (K3)**
- **Analytical level (K4)**
- **Evaluation capability level (K5)**
- **Scientific or synthesis level (K6)**

Program Educational Objectives:

The program educational objectives (PEO) are the statement that describes the career and professional achievement after the program of studies (graduation/post-graduation) is known as the programme educational objectives (PEO). The PEOs are motivated by the mission statement's question (ii): "What is the purpose of the organisation?" PEOs can range in number from three to five

PEO1: should be well-versed in the field of biochemistry

PEO2: To offer the expert services to industry, research organization, Institutes.

PEO3: To offer qualified consulting and research assistance to the pertinent organization in the area of super specialty

PEO4: choosing higher education, engaging in discipline and multidisciplinary research, and continuing to study throughout one's life. **PEO5:** To give moral leadership in both the professional and social spheres

Program Outcomes:

The statement of talents and abilities is contained in the programme outcomes (PO). POs are a declaration of the skills and knowledge a graduate or postgraduate will possess at the conclusion of their degree of study.

PO1: In depth understanding of the experimental procedures and foundational theoretical principles of biochemistry.

PO2: Biochemistry is used to Apply or apply the interface between issues relating to contemporary technology, health, and environmental concerns, on the one hand, and the history of biochemistry and natural science, on the other.

PO2: Capabilities for organizing and carrying out sophisticated chemical experiments and using structural-chemical characterization methods.

PO3: The ability to analyses certain occurrences theoretically, experimentally, or both

PO4: The creation of novel scientific theories or the development of novel biochemistry research applications.

PO5: Recognize the need for organization, time management, planning abilities, and the capacity for independent work

PO6: Gains the capacity to analyse and resolve issues using facts from science.

PO7: Acquires comprehensive knowledge in the fields of immunology, immunotechnology, pharmaceutical biochemistry, medical biochemistry and endocrinology, genetics and metabolic diorders, molecular biology cancer biology and applied biotechnology, bio nanotechnology and infectious diseases, and computational biology.

PO8: Incorporate the growing significance of digital-based activity into your analysis, evaluation, and presentation of Biochemistry information.

PO9: Consider including the expanding importance of digital activities in your examination, analysis, and presentation of biochemistry data.

PO10: Acknowledge the need for designing, structure and time governance skills and the cognition to employment severally.

PO11: Demonstrate specific skills in analyzing, evaluating and biochemistry information, in particular incorporating the increasing importance of digital-based activity.

PO12: Gains an awareness of and appreciation for, the social and cultural context of the implications of biochemistry to gain knowledge and investigation.

CBCS- Structure of the programme

The programme structure comprises of two parts

Course Component	No. of courses	Hours of Learning/week	Marks	Credits
Part A (Credit Courses)				
Core courses	08	80	100	46
Skill development course	04	40	50	24

Skill Enhancement Course	02	20	100	08
Internal Elective (IE) Course	02	20	100	6 (For each internal elective)
External Elective Course (EE)	02	36	50	8
Research	-	-	200	8
Part B (Self-Learning Credit Courses)				
Elective Foundation courses	3	36	50	6
Total	25	256	650	106

Curriculum structure for each semester as per your courses alignment

SEMESTER-I	Subject Code	Subject Type	Paper Title	Instruction Hours / Week		Total IH	Credits		Total Credits	Examination Maximum Marks					Total Marks
										Theory			Practicals		
				Th	Pra		Th	Pra		IA	EA	Tot	EA	Tot	
	BCH 101	**CC**	Biochemistry of Biomolecules	4	5	10	4	2	6	20	80	100	50	50	150
	BCH 102	**CC**	Immunology	4	5	10	4	2	6	20	80	100	50	50	150
	BCH 103	**CC**	Introduction to Microbiology	4	5	10	4	2	6	20	80	100	50	50	150
	BCH 104	**SC**	Analytical Techniques	4	5	10	4	2	6	20	80	100	50	50	150
	Total			**16**	**20**	**40**	**16**	**8**	**24**	**80**	**320**	**400**	**200**	**200**	**600**
		FC	Communicative English	2		2	2		2			50			

Subject Type: CC – Core Course: Essential Course for the degree of M.Sc. Biochemistry
FC Foundation Course
SC- Skill Development course
EA –External assessment

SEMESTER-II	Subject Code	Subject Type	Paper Title	Instruction Hours / Week	Total IH	Credits	Total Credits	Examination Maximum Marks		Total Marks
								Theory	Practicals	

				Th	Pra		Th	Pra		IA	EA	Tot	EA	Tot	
	BCH 201	**SC**	Enzymes and its Applications	4	5	10	4	2	6	20	80	100	50	50	150
	BCH 202	**CC**	Molecular Biology	4	5	10	4	2	6	20	80	100	50	50	150
	BCH 203	**CC**	Cell Physiology and Endocrinology	4	5	10	4	2	6	20	80	100	50	50	150
	BCH 204	**IE**	Food Safety & Quality Management/ Immuno Technology & Molecular Signaling / Bioinformatics	4	5	10	4	2	6	20	80	100	50	50	150
			Total	**16**	**20**	**40**	**16**	**8**	**24**	**80**	**320**	**400**	**200**	**200**	**600**
		FC	Foundation Course in Computer Applications	2		2	2		2			50			

Subject Type: CC – Core Course: Essential Course for the degree of M.Sc. Biochemistry
FC Foundation Course
SC- Skill Development course
IE –Internal Elective

SEMSTER-III	Subject Code	Subject Type	Paper Title	Instruction Hours / Week		Total IH	Credits		Total Credits	Examination Maximum Marks					Total Marks
										Theory			Practicals		
				Th	Pra		Th	Pra		IE	EA	Tot	EA	Tot	
	BCH 301	**IE**	Genetic Engineering / Animal Pharmaceutical Biotechnology / Molecular and Immuno Diagnostics/MOOCS	4	5	10	4	2	6	20	80	100	50	50	150
	BCH 302	**CC**	Intermediary Metabolism	4	5	10	4	2	6	20	80	100	50	50	150
	BCH 303	**CC**	Nutritional Biochemistry	4	5	10	4	2	6	20	80	100	50	50	150
	BCH 304	**SC**	Research Methodology	2	-	2	2	-	2	-	50	50	-	-	50
		EE	External Elective	4	-	4		-	4	20	80	100	-	-	100
			Total	**18**	**15**	**36**	**14**	**6**	**24**	**80**	**370**	**450**	**150**	**150**	**600**
		FC	Gender Studies and Self Defense	2	-	2	2	-	2	-	-	50	-	-	-

EXTERNAL ELECTIVE

SEMESTER-III	Subject Code	Subject Type	Paper Title	Instruction Hours / Week		Total IH	Credits		Total Credits	Examination Maximum Marks						Total Marks
										Theory			Practicals			
				Th	Pra		Th	Pra		IE	EA	Tot	IE	EA	Tot	
		EE	Quality Control and Laboratory Maintenance	4	-	4	-	-	4	20	80	100	-	-	-	100

Subject Type: CC – Core Course: Essential Course for the degree of M.Sc. Applied Microbiology.
EE – External Elective: Basic Course Offered to students of others courses. Minimum

Strength to offer the course is 10 students
FC –Foundation Course & & EA – External Assessment
IE – Internal Elective: Choice to the students to opt for one paper

SEMESTER-IV	Subject Code	Subject Type	Paper Title	Instruction Hours / Week		Total IH	Credits		Total Credits	Examination Maximum Marks						Total Marks
										Theory			Practicals			
				Th	Pra		Th	Pra		IE	EA	Tot	IA	EA	Tot	
	BCH 401	SE	Genomics & Proteomics	4	5	10	4	2	6	20	80	100	-	50	50	150
	BCH 402	CC	Clinical Biochemistry	4	5	10	4	2	6	20	80	100	-	50	50	150
	BCH 403	SE	Techno Entrepreneurship & Bioethics	4	-	4	4	-	4	20	80	100	-	-	-	100
	BCH 404	RC	Project	-	16	16	-	8	8	-	-	-	50	150	200	200
			Total	**12**	**32**	**40**	**12**	**12**	**24**	**60**	**240**	**300**	**50**	**250**	**400**	**600**
	Total															**2400**
	Total Credits: 24+24+24+24 = 96 Credits															

Subject Type: CC – Core Course & SE – Skill Enhancement Course
EA- External assessment & RC- Research based course

CBCS- Scheme of Examinations semester wise structure

Examinations

There shall be four semester examinations: first semester examinations at the middle of the first academic year and the second semester examination at the end of the first academic year. Similarly, the third and fourth semester examinations shall be held at the middle and end of the second academic year, respectively.

Scheme for Evaluation and Execution Rules

Attainment Rules for Theory Courses

External : 80 Marks
Internal : 20 Marks
Total : 100 Marks
Time : 3 hours

The following procedure will be followed for Internal Marks:
Theory Papers Internal
Average of two tests out of 2 : 10 marks
Seminar : 5 mar
Assignment : 5 marks
Total : 25 marks

Question Paper Pattern (Theory)

Section	Approach	Mark pattern
A	100 to 400 words (Answer any four out of six questions)	4X5= 20 (analytical type questions)
B	1000 to 1500 words	5X12 =60 (Essay type questions)

Attainment Rules for Lab courses

Four practical for each semester

Each Practical : 50 Marks
Practical Test : 40 marks
Record : 5 marks
Viva-voce : 5 marks

Attainment Rules for Research Project

Internal evaluation : 50 marks
Viva - voce : 20 marks
Project Report : 80 marks

Grading System Evaluation of performance of students is based on ten-point scale grading system as given below

	Ten Point Scale		
Grade of Marks	**Grade Point**	**Letter Grade**	**Description**
75 - 100	7.5-10	O	Outstanding
65 – 74.9	6.5-7.49	A+	Very Good
60 – 64.9	6.0-6.49	A	Good
55 – 59.9	5.5-5.99	C	Average
50 – 54.9	5.0-5.49	D	Below Average
45 – 49.9	4.5-4.99	Pass	Poor
0 - 44	0-4.4	Fail	Fail
ABSENT	AAA	Absent	ABSENT

SUBJECT NAME	COURSE OUTCOME	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
SEMESTER-I													
BCH 101: BIOCHEMISTRY OF BIOMOLECULES	Overview on classification, structure and function of carbohydrates, lipids, proteins,amino acids , nucleic acids and their biological significance in the body	✓	✓										
	Through this course the students are exposed to importance of biological macromolecules	✓	✓										
	They acquire knowledge in the quantitative and	✓	✓	✓									

	qualitative estimation of biomolecules They study the influence and role of structure in reactivity of biomolecules												
	At the end of the course, the students have a thorough understandin g on the role of biomolecules and their functions	✓	✓	✓									
	Specify the significance and role of Vitamins and Porphyrin during metabolic activity in the body	✓	✓	✓	✓								
BCH 102: IMMUNOL OGY	Describe the fundamental mechanisms of humoral and cellular immunity, including innate and acquired immunity.	✓	✓	✓									
	Describe the cellular and molecular mechanism of lymphocyte production and	✓	✓	✓									

	activation												
	Understand the significance the Major Histocompatibility Complex in terms of immune response and transplantation, describe lymphocyte development and the expression of their receptors, an overview of hypersensitive reactions.	✓	✓					✓	✓				
BCH 103: INTRODUCTION TO MICROBIOLOGY	Know about the basic aspects of microbiology, different methods of isolation of microorganism, preservation and controlling Of microorganIsm	✓	✓	✓									
	Know the basis of microbial physiology with its biochemical pathway and the	✓	✓					✓	✓				

	ecology of the icrobes with eference to Extreme Ecosystems.												
	Know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi. Master aseptic techniques and be able to perform routine culture handling tasks safely and effectively.	✓	✓	✓	✓								
	Know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement	✓	✓	✓	✓								

BIOCHEMISTRY OF BIOMOLECULES (CC)

Course Code: BCH 101 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

Course Objectives

The course contents are designed to gain knowledge about the Bio molecules such as Carbohydrates, proteins, amino acids, Vitamins, minerals and nucleic acids along with the basic principles of chemistry of Bio molecules . The learner will understand about the Biochemistry of Molecules and their applications in metabolism of macro molecules

Course Outcome

At the end of the course, the learner will be able to

CO1. Overview on classification, structure and function of carbohydrates, lipids, proteins,

CO2. amino acids , nucleic acids and their biological significance in the body

CO3. Classification of proteins and structure of proteins - primary, secondary, super secondary, tertiary and quaternary structures

CO4 Through this course the students are exposed to importance of biological macromolecules

CO5. They acquire knowledge in the quantitative and qualitative estimation of biomolecules

CO6. They study the influence and role of structure in reactivity of biomolecules

CO7. At the end of the course, the students have a thorough understanding on the role of biomolecules and their functions

CO8. Specify the significance and role of Vitamins and Porphyrin during metabolic activity in the body

Syllabus

Unit	Unit Title	Intended learning Chapters		Hours of Instruction
		(K1, K2)	(K3,K4,K5)	
I	**Proteins**	classification, structure and physiochemical properties, chemical synthesis of peptides – solid and liquid phase peptide synthesis	Structural organization, sequence determination and characterization of proteins. Conformation of proteins – Ramachandran plots. Denaturation of proteins.	12

II	**Carbohydrates**	Classification, chemical properties of carbohydrates, Chemistry and biological roles of homo and heteropolysaccharides, Structural elucidation of polysaccharides	peptidoglycan, glycosaminoglycans, glycoproteins, Oligosaccharides – lectin interaction in biochemical processes. Biological applications of disaccharides and polysaccharides	12
III	**Lipids**	Classification of Lipids, Fatty acids and their physiochemical properties. Structure and properties of Prostaglandins. Fats and waxes, physicochemical properties and characterization of fats and oil	Structure, properties and biological roles of phospholipids and Sphingolipids. Chemistry and properties of Sterols and Steroids. Salient features of bacterial and plant lipids.	12
IV	**Nucleic acids**	Bases, nucleosides, nucleotides, physicochemical properties of nucleic acids Types of RNA. Structure of tRNA	cleavage of nucleic acids by enzymatic methods, non – enzymatic transformation of nucleotides and nucleic acids, methylation,. Three dimensional structure of DNA. Different forms of DNA – circular DNA and Supercoiling.	12
V	**Vitamins and Porphyrins**	Fat-soluble and water-soluble vitamins and their source, daily requirements, structure	biochemical functions and deficiency symptoms Structure and properties of porphyrins – hemoglobin , Chlorophyll and Cytochromes. Minerals	12

REFERENCES

Text Book

1. Harper's Biochemistry 26th ed. 2013. McGraw Hill.
2. Lehninger Nelson Cox, 2013. Principles of Biochemistry 4th ed. Freeman Publishers.
3. Stryer, Biochemistry, 4th Freeman, 2012
4. Zubay, Biochemistry, 4t ed. 2005. William c. Brown Publication
5. Biochemistry – Vote.D Voet.J.G, 3rd edition, 2013, John Wiley & Sons, Inc.
6. The chemical reactions of living cells – Metzler D.E. 2nd edition, 2011, Academic Press.
7. Principles of Biochemistry – Nelson D.L, Cox M.M. 2nd Edition, 2013, CBS publishers and Distributors Delhi.
8. Biochemistry – Sathyanarayana U, 2014, Arunabha Sen Books & Allied (P) Ltd., Kolkata.
9. Text book of biochemistry West,E.S.,Todd,Masonand Vanbruggen,Macmillian &Co.
10. J.L. Jain, Fundamentals of Biochemistry,2009.
11. Eria E. Conn Paul. Stampf 2002. Outlines of Biochemistry. Wiley publications.
12. Practical Biochemistry – Sawhney (2000)
13. Experimental Biochemistry by –Vijay Deshpande&Beedu Sashidhar Rao
14. Medical Biochemistry by- M.D.Rafi

IMMUNOLOGY (CORE COURSE)

Course Code: BCH 102 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

Course Objective

The course contents are designed to provide students with knowledge on how the immune system works and to state the role of immune system, be able to compare and contrast humoral and cell mediated immune responses, to distinguish and characterize various immune cells, to understand the mechanism of antibody diversity, to understand the role of cytokines in immunity, to understand the significance of the major histocompatibility and to provide an overview of the interaction between the immune system and pathogens.

Course outcomes

CO1 The students learns about molecular basis of antigen recognition, hypersensitivity reaction, antigen- antibody reactions

CO2 It is able to articulate the roles of innate recognition receptors (i.e. Toll-Like Receptors) in immune responses compare and contrast humoral versus cell-mediated immune responses.

CO3 Be able to distinguish various cell types involved in immune responses and **CO3**associated functions, role of CD4+ T helper cell lineages Th1, Th2, Th17, and regulatory T cell.

CO4 Be able to distinguish and characterize antibody isotypes, development, and functions, understand the role of cytokines in immunity and immune cell activation.

CO5 Understand the significance the Major Histocompatibility Complex in terms of immune response and transplantation, describe lymphocyte development and the expression of their receptors, an overview of hypersensitive reactions.

CO6 This study develops in the student an appreciation for principles of immunology and its applications in treating human diseases

CO7 Understand the cellular process involved in inflammation and immunity, hypersensitivity reactions

Unit	**Unit Title**	**Intended learning Chapters**		**Hours of Instruction**
		(K1, K2)	**(K3, K4 & K5)**	12
I	**History and Scope of Immunology**	Haemopoeisis, lymphoid, mononuclear, granulocytic, mast and dendritic cells. Origin and organization of primary and secondary lymphoid organs. Types of immunity, Cells and molecules involved in innate and adaptive	Non- specific immune factors, inflammation and phagocytosis, Nature and types of antigens, Haptens, antigen specificity, cross reactivity. Iso antigens, T-dependent and independent antigens, Super antigens and Adjuvants	

		immunity.		
II	**Types, structure and properties of antibodies, Affinity and avidity of antibodies**	Cell types involved in cell mediated immunity. Cell-mediated effector functions Origin, biology and maturation of 'B' and T Lymphocytes (B-dependent and T independent)	Genetic events in the synthesis of immune globulin chains, organization and rearrangement of light chain and heavy chain genes, Regulation of immunoglobulin synthesis –idiotypic network, class or isotype switching of antibody diversity and immunoglobulin gene super family	12
III	**Immune response genes and Structure and function of MHC antigens**	Role of MHC in controlling the T-cell response, MHC restriction.	Triggering of immune response and tolerance Antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, Humoral and cell-mediated immune responses, primary and secondary immune modulation, clonal selection theory. Cytokines and their role in immune regulation.	12
IV	**The complement system**	Complement components, iological activity of complement components, classical and alternate pathways. Toll-like receptors, immune	Antigen and antibody interactions: Agglutination, precipitation, complement fixation, neutralization. Immuno-electrophoresis, immunofluorescence	12

		esponse during bacterial (tuberculosis), parasitic malaria) and viral (HIV) infections, monoclonal antibodies, antibody engineering	FACS, ELISA, RIA and immunoblotting, Hybridoma technology	
V	**Hypersensitivity reactions**	Antibody mediated type II, anaphylactic reactions, Antibody mediated, type II cytotoxic reactions	Immune complex reactions Type – III, T-cell mediated delayed type hypersensitivity Type-IV**.** Immunological tolerance and tolerance induction	12

Text Book

References

1. Advanced Concepts in Human Immunology: Prospects for Disease Control: Prospects for Disease Control 1st ed. 2020 Edition by Pooja Jain (Editor), Lishomwa C. Ndhlovu (Editor), Publisher : Springer; 1st ed. 2020 edition (August 13, 2020).
2. Immunology: With STUDENT CONSULT Online Access 9th Editionby David Male MA PhD (Editor), R. Stokes Peebles Jr. MD (Editor), Victoria Male MA PhD (Editor), Publisher : Elsevier; 9th edition (July 15, 2020)
3. Oxford Handbook of Clinical Immunology and Allergy (Oxford Medical Handbooks) 4th Editionby Gavin Spickett (Author), Publisher : Oxford University Press; 4th edition (December 30, 2019)
4. Medical Immunology, 7th Edition 7th Editionby Gabriel Virella (Editor), Publisher : CRC Press; 7th edition (October 16, 2019)
5. IMMUNOLOGY Paperback – April 26, 2019by KANNAN I (Author), Publisher: MJP Publishers (April 26, 2019)
6. Basic Immunology: Functions and Disorders of the Immune System 6th Editionby Abul K. Abbas MBBS (Author), Andrew H. Lichtman MD PhD (Author), Publisher : Elsevier; 6th edition (April 24, 2019)
7. Immunology: An Introductory Textbook 1st Editionby Anil K. Sharma (Editor), Publisher : Jenny Stanford Publishing; 1st edition (March 5, 2019)
8. Cooper E.L. (1982) General Immunology, Pergamon press, N.Y.
9. Eli Benzamini Geoffry sunshine, Sidneyleskowitz (1966) Immunology - a short course, 3rd edition, A John Wiley & Sons inc. publication
10. Nandinishetty (1999) Immunology introductory text book New Age international (p) Ltd. Publishers.
11. B.S.Malik (1996) A laboratory manual of Veterinary, Medicine CBS publishers.
12. Paul W.E. (ed). Fundamental Immunology.3rd edition Newyork: Raven Press
13. Ivan M Roitt.1997 Essential Immunology 9th ed. Blackwell Scientific publ. Oxford.
14. Golub, E.S. (ed.) 1981. The cellular basis of the immune response, Sinauer Associates, Inc. Sunderland
15. Hobert, J. and Ian Mc Connell. The Immune system. Black well, 1986.
16. Stitles Fudenberg. Basic clinical Immunology. 8th ed. Lange Medical Publ. USA.

INTRODUCTION TO MICROBIOLOGY (CORE COURSE)

BCH 103
Max marks: 100

Course Objectives

The course contents are designed to gain knowledge about the different forms of bacteria, fungi, algae, protozoan's along with the basic principles of microbial taxonomy. The learner will understand about the microbial metabolism and microbes thriving in extreme environments.

CO1 Demonstrate theory and practical skills in microscopy and their handling techniques and staining.
CO2 Understand the basic microbial structure and function and study the comparative characteristics of prokaryotes and eukaryotes and also understand the structural similarities and differences among various physiological groups of bacteria/archaea.
CO2 Know various Culture media and their applications and also understand various physical and chemical means of sterilization.
CO2 Know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi. Master aseptic techniques and be able to perform routine culture handling tasks safely and effectively.
CO3 Know the various Physical and Chemical growth requirements of bacteria and get equipped with various methods of bacterial growth measurement.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4& K5)	
I	**Principles of Microbiology**	History of Microbiology, Basis for the classification of Bacteria- morphological, biochemical, metabolic and molecular criteria. Major Taxonomical groups of bacteria. MB Diversity	General properties of fungi, Mycoplasma (PPLO), Rickettsiae, Chlamydia, Actinomycetes, Archebacteria (extremophiles) and micro algae.	**12**
II	**Microbiological Techniques**	Structure of prokaryotic and eukaryotic cell. Comparison of the structure and function of each component of Eubacterial cell and	Biosynthesis of bacterial cell wall and Phases of cell division. Sporulation: Structure of bacterial endospores, physiology and	**12**

		Archaebacteria	genetics of sporulation.	
III	**Cytology**	Structure of prokaryotic and eukaryotic cell. Comparison of the structure and function of each component of Eubacterial cell and Archaebacteria	Biosynthesis of bacterial cell wall and Phases of cell division. Sporulation: Structure of bacterial endospores, physiology and genetics of sporulation.	**12**
IV	**Nutrition and Growth**	Bacterial growth curve and factors influencing growth. Methods for estimation of bacterial growth. Batch , synchronous cultures and continuous culture methods.	Nutritional groups of bacteria (autotrophy and heterotrophy), Nutritional mutants - auxotrophs and their applications in metabolic studies, Carbon assimilation in bacteria, factors influencing growth (physical and chemical),	**12**
V	**Auxotrophs Host parasite interactions**	Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens	virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.	**12**

TEXT BOOKS
REFERENCE

1. Microbiology: An Introduction 13th Edition, 2018 by Gerard Tortora (Author), Berdell Funke (Author), Christine Case (Author), Derek Weber (Author), Warner Bair III (Author).
2. Microbiology: Laboratory Theory & Application, Brief 3rd Edition 3rd edition (January 1, 2016) by Michael J. Leboffe (Author), Burton E. Pierce (Author) Morton Publishing Company.
3. Prescott's Microbiology 10th Editionby Joanne Willey (Author), Linda Sherwood (Author), Christopher J. Woolverton (Author), Publisher : McGraw-Hill Education; 10th edition (January 4, 2016).
4. Brock Biology of Microorganisms (14th Edition) 14th Editionby Michael T. Madigan (Author), John M. Martinko (Author), Kelly S. Bender (Author), Daniel H. Buckley (Author), David A. Stahl (Author), Thomas Brock (Author), Publisher : Pearson; 14th edition (January 12, 2014).
5. Microbiology (Lippincott's Illustrated Reviews) 3rd Editionby Cynthia Nau Cornelissen (Author), Bruce D. Fisher (Author), Richard A. Harvey (Author), Publisher- Lippincott Williams & Wilkins; 3rd edition (October 12, 2012).
6. Foundations in Microbiology 10th Editionby Kathleen Park Talaro (Author), Barry Chess (Author), Publisher : McGraw-Hill Education; 10th edition (February 20, 2017).

ANALYTICAL TECHNIQUES (SKILL DEVELOPMENT COURSE)

BCH 103
Max marks: 100

Course Objective

This skill based course will teach the students the various instrumentations that are used in the analytical laboratories. This course covers both fundamental and applications of the instruments that are routinely used for the characterization of biomolecules.

Course Outcomes

CO1. Design an analytical work flow to acquire the required data in fulfilling the research objectives, provides the student with detailed scientific information about the instruments, their merits and limitations.

CO2. The students learn specific topics including tools for describing central tendency and variability in data; statistical hypothesis testing and its application to group comparisons; issues of power and sample size in study designs; and random sample and other study types. Biostatistics tools make the students to interpret their experimental data in a systematic manner.

CO3. At the end of the course, the student has the basic knowledge on the theory, operation and function of analytical instruments.

SYLLABUS

Unit	**Unit Title**	**Intended Learning Chapters**		**Hours of Instruction**
		(K1, K2)	**K3, K4 & K5)**	
I	**Electrochemical and Microscopic Techniques**	Principles of biophysical chemistry pH, buffer, reaction kinetics, thermodynamics, colligative properties.	Visualization of cells and sub cellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods	12

			for EM, Cryo -electron microscopy and Confocal microscopy.	
II	**Centrifugation**	Basic principle of centrifugation technique- Different types of centrifuges and their applications.- Preparative and analytical ultracentrifugation- Differential and Density gradient methods	Role of centrifugation in separation of cellular fractions, viruses and macromolecules Isolation of biomolecules such as DNA, RNA and proteins from mammalian and bacterial cells	12
III	**Chromatography and Radio Labeling**	Principles of chromatography- Thin layer, paper, ion exchange, gel permeation	High Performance Liquid Chromatography, Gas Chromatography & and affinity chromatography with examples. Applications of Radioactive and Non-radioactive labeling.	12
IV	**Electrophoresis and pectroscopy**	Eletrophoresis – Basic principle and types- Paper/cellulose acetate, gel electrophoresis-starch gel, SDS PAGE, Agarose and isoelectrofocussing, Types of blotting techniques	Spectroscopy: UV/Visible, fluorescence, IR. Fundamentals of X-ray diffraction, NMR , Mass spectrometry and Flow Cytometry. ELISA and RIA	12
V	**General Methods**	Freeze drying, speed vaccume concentrator, rotavapor, gel drying methods	Distillation of aqueous and non-aqueous solvents, filteration and dialysis, sonication (probe	

			sonicators, general sonicators etc),	

PRACTICAL - I

PRACTICAL EXAM: 6 HRS / DAY: 1

PRACTICAL -1 BIOCHEMISTRY OF BIOMOLECULES and BIOABALYTICAL TECHQUES

Course Code: BCH(P:101 &104) **Hours: L + T + P = C**

Marks: 100 **0 0 5 4**

Course Objectives

The learners will be able to gain adequate knowledge and acquire adequate skill to perform qualitative and quantitative analysis. . To impart thorough knowledge and understanding of practical skills in handling of different equipments like Centri fuge, HPTLC, Spectrophotometry, Coloumn chromatograpy through isolation of plant pigments, separation of amino acids and protein sequence analysis.

Course Outcome

At the end of the course, learners will be able to:

CO1. Perform the various qualitative and quantitative techniques of analysis and study the isolation techniques

CO2. Competently isoltedthe different types of pigments presented in plant through analytical techquis.

CO3. Demonstrate knowledge and understanding of Biochemistry of Biomolecules and the means of applying in the diagnostic and therapeutic techniques and research.

CO4. Understand the safe working practice in an Biochemistry laboratory.

SYLLABUS

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	**Qualitative analysis for Carbohydrate Amino acids, Lipids and Proteins**	Identification of Unknown sugars, Amino acids, lipids	Glucose, Arabinose, xylose, fructose, galactose, sucrose, maltose and lactose, Tyrosine, Tryptophan, Cysteine, Arginine,	12

			Histidine, Methionine,	
II	**Quantitative analysis for Carbohydrate Amino acids, Lipids and Proteins**	Assay of unknown bio molecules from biological samples	Assay of fructose and prepare a clinical significance of fructose in the ketone body formation. Calculation of Nutritive significance of proteins and lipid	12
III	**Isolation and purification methods**		Starch from Potato Cholesterol from egg yolk Casein from Milk	12
IV	**Preparation of buffers**		Measurement of pH in biological fluids	12
V	**Separation of amino acids, carbohydrates and lipids by chromatography**	Principle involved in chromatography, HPLC	paper chromatography thin layer chromatography HPLC technique Ion exchange and gel filtration chromatography paper electrophoresis	12
VI	**Microscopy**	Phase contrast, Dark Field, Fluorescent Microscopy Principle and Functions.		

References

1. Practical mannual of Vijay Deshponde
2. A practical laboratorymannual of Sadasivam amd Manikyam

PRACTICAL - II

PRACTICAL EXAM: 6 HRS / DAY: 1

PRACTICAL -II INTRODUCTION TO MICROBIOLOGY and IMMUNOLOGY

Course Code: BCH(P:102 &104) **Hours: L + T + P = C**

Marks: 100 **0 0 5 4**

Course Objectives

The learners will be able to gain adequate knowledge and acquire adequate skill to perform different staining techniques, growth rate of

bacteria and biochemical test. To impart thorough knowledge and understanding of practical skills in immunology and means of applying these principles in diagnostic and therapeutic techniques and research

Course Outcome

At the end of the course, learners will be able to:

CO1. Carry out the different staining techniques of bacteria and study the growth rate of bacteria.

CO2. Competently cultivate bacteria in different types of media.

CO3. Demonstrate knowledge and understanding of immunology and the means of applying in the diagnostic and therapeutic techniques and research.

CO4. Understand the safe working practice in an immunology laboratory.

CO5. Develop skills to design and usage of diagnostic kits.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	**Sterilization techniques and Preparation of Media**		Autoclaving, heat sterilization, filtration, UV irradiation and chemical, Nutriant broth, Potato dextrose, Mcconky Agar etc.	12
II	**Staining techniques and Isolation and cultivation of pure cultures**	Isolation and cultivation of Bacteria Growth CurveGrowth rate and Generation Time	Gram Staining Spore Staining Lactophenol Cotton Blue Staining	12
III	**Testing and the efficiency of disinfectant action**		Dettol, phenol (Reidel – Walker test)	12
IV	**Separation of serum and plasma Blood typing – A, B, O and Rh system. Enumeration of R.B.CEnumeration of WBC Differential Leukocyte count**		Calculation of total RBS, WBC and different structural findings of Leukocytes, Monocytes, basophills and Nutrophills	12

V	**Precipitation test**		Immunodiffusion, Radial immuno diffusion	12
VI	**Enumeration of `T` and `B` cells**		Enumeration of `T` and `B` cells by rosette formation	
V	**Westren blotting and dot blot techniques.**		Antigen and Antibody identification	

References

1. Oxford Handbook of Clinical Immunology and Allergy (Oxford Medical Handbooks) 4th Editionby Gavin Spickett (Author), Publisher : Oxford University Press; 4th edition (December 30, 2019).
2. Medical Immunology, 7th Edition 7th Editionby Gabriel Virella (Editor), Publisher : CRC Press; 7th edition (October 16, 2019)
3. Laboratory exercises in Microbiology, John P.Harley, McGraw-Hill education - 2013.
4. Microbiology: Principles and Explorations, Jacquelyn G. Black, John Wiley &sons, 2015.
5. Foundations in Microbiology, Kathleen Park Talaro, Chess, McGraw-Hill education -2014.

SEMESTER-II

SUBJECT NAME	COURSE OUTCOME	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
SEMESTER-I													
BCH 201: ENZYMES AND ITS APPLICATIONS	Define enzyme structure and explain the differences between enzymes and normal catalytic substances. Explain the recognition of chemical structures of biological cofactor and coenzymes express the Important coenzymes and the groups they transfer explain heat, pH , concentration and the other factors on the effect of activity define enzyme kinetics recognize Km	✓	✓	✓			✓						
	The study will provide an overview of the key enzymes currently used in large scale industrial processes.	✓		✓	✓				✓			✓	
	It helps the students to learn the significant features of the biochemical	✓		✓	✓				✓			✓	

	catalysts. It helps the students to learn the methodology involved in assessing the enzyme activity and mechanism of enzyme action. It illustrates the enzyme catalysis, kinetics and regulatory aspects												
BCH 202: MOLECULAR BIOLOGY (CORE COURSE)	To study the major Biomolecules regulating the cell at molecular level based on the knowledge gained basic core papers	✓		✓	✓				✓			✓	
	Gain knowledge of basic mechanism of transcription and translation and distinguish the process in prokaryote and eukaryote organism	✓			✓				✓				
	Understand DNA interacting protein and important domains which confer	✓			✓		✓		✓				

	the activity. Significance of Plasmids and Transposons in microbial genetics. Gain ractical Skills independentl yin purification, handling of DNA. RNA and protein												
BCH 203: CELL PHYSIOLOGY AND ENDOCRINOLOGY (CORE COURSE)	Cell biology: This course introduces the students to the basics of cell and its components. This gives them a strong foundation on the basic unit of life.	✓	✓	✓									
	At the end of the course, the student has a strong foundation on the functions of the cell.			✓	✓	✓		✓					
	Physiology: understand the functions of important physiological systems including the cardio-respiratory, renal, reproductive and metabolic systems;				✓	✓	✓						
	Explain the role of the pancreatic				✓	✓	✓						

	endocrine cells in the regulation of blood glucose Identify the hormones released by the heart, kidneys, and other organs with secondary endocrine functions												
BCH 204: FOOD SAFETY AND QUALITY MANAGEMENT SIGNALING (INTERNAL ELECTIVE)	Acquire an understanding of relevance of food components Acquire an understanding of application and detection techniques in food.	✓	✓	✓								✓	
BCH: 204 IMMUNO TECHNOLOGY & MOLECULAR SIGNALING (INTERNAL ELECTIVE)	Understand the structure and function at the molecular and cellular level of the immune defence, provide the knowledge about the transfusion and transplantation immunological reactions able to provide an overview for polyclonal, monoclonal and humanized	✓	✓	✓			✓					✓	

	antibodies and production of hybridoma												
	To gain a deep knowledge about the auto immune diseases and Immune deficiency disorders, describe immunizatio n/vaccination mmunologica l disease and immunothera py.	✓						✓	✓			✓	
	Stages of mitosis and meiosis, highlighting similarities and differences, understand the cancer and cell cycle.	✓	✓		✓	✓						✓	
BCH 204: BIOINFOR MATICS (INTERNAL ELECTIVE)	Aimed to provide an overview of various bioinformatic s tools, databases available and sequence analysis. Retrieve information from available databases and	✓	✓		✓	✓						✓	

	use them for microbial identifications.												

SEMESTER - II
BCH 201: ENZYMES AND ITS APPLICATIONS
(SKILL DEVELOPMENT COURSE)

Course Code: BCH 201 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

Course Objectives

Students will have to write a small experimental project aiming to isolate and characterize an enzyme including its kinetic parameters. To this end students will have to search the best methods in scientific papers and discuss the scientific content of the papers used to achieve their goal.

Course Outcomes

CO1. At the end of this unit students must establish molecular structure/activity relationships and predict its implications in enzymes mechanisms.

CO2. This is fundamental to the acquisition of competences to solve problems with impact in daily life e.g., health and environment. Students should also acquire skills to initiate a research or industrial career (food, pharmaceutics or biotechnology) in the country or abroad

CO3. Define enzyme structure · define differences between enzymes and normal catalytic substances

Unit	Unit title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 &K5)	
I	**Enzyme**	Definition, Nomenclature, classification. Active site determination, transition state, Enzyme catalysis, enzyme specificity, Transformation of different forms of energy, Enzyme unit, specific activity and turnover number	Activation energy. Methods of enzyme assay and Purification. Ribozymes, Abzymes and DNA enzymes	12
II	**Enzyme**	Chemical kinetics (Pre	Rate expression for	

	kinetics	steady state and steady state). Kinetics of single substrate enzyme catalyzed reactions, Michaelis – Menten equation, Lineweaver - Burk, Eadie – Hofstee and Hanes plots. Significance of Vmax, Km, Kcat, specificity constant (Kcat/Km). Bi-substrate reactions and Kinetics of multi-substrate reaction – Classification with examples	non-sequential (ping-pong) and sequential (ordered and random) mechanisms. Kinetics of allosteric enzymes, MWC and KNF models. Hill's equation and co-efficient	
III	**Enzyme Catalysis and inhibition**	Irreversible and reversible, Competitive, non competitive, uncompetitive, mixed inhibition, suicidal inhibition and allosteric inhibition. Clinical uses of competitive inhibition.	Mechanism of enzyme action - general acid-base catalysis, covalent catalysis, role of metal ion in enzyme catalysis. Mechanism of reaction catalyzed by serine proteases – trypsin and chymotrypsin, carboxy peptidase, lysozyme, triose phosphate isomerase, ribonuclease ,Rotational catalysis – ATPase	12
IV	**Co factors and Isoenzymes**	Metal ions and Co enzymes (TPP, FADH2, NADH, PLP, Biotin, CoA and Co enzyme Q_{10}**)** functions. PDH, Metal dependent and metallo enzymes. Zymogen-Covalent modification of enzymes	Isoenzymes. Enzyme immobilization: Methods of immobilization and application of immobilized enzymes	12
V	**Industrial and clinical uses of enzymes**	Industrial uses of enzymes - sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerase, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and	Clinical enzymology - anti-inflammatory agents, digestive aids. Therapeutic use of asparginase, streptokinase.	12

		leather industry, detergents and cheese production.		

REFERENCES

TEXT BOOKS

1. Dixon and Webb. Enzymes 2009. Longmans.
2. Marangoni AG. Enzyme Kinetics. 2010, A Modern Approach John Wiley and Sons.
3. Palmer, T.Understanding Enzymes 2012, Prentice Hall.
4. Stryer, Biochemistry 2014. Freeman.
5. Zubay, Principles of Biochemistry, 2013. William C. Brown Publ.
6. Uhlig H. 2009,Industrial Enzymes and their Applications. John Wiley.
7. Whitehurst, R.J. 2010, Enzymes in Food Technology. CRC Press.
8. Fundamentals of Biochemistry – Donald Voet, Judith Voet and Pratt, 2014,
9. Harper's Biochemistry – Murray et al, 2013, Appleton and Lange Publishers.
10. Principles of Biochemistry with human focus – Garrett and grisham, 2010, Harcourt College Publishers, Orlando, Florida USA.
11. Principles of Biochemistry – Lehninger, Nelson and Cox, 2013, WH Freeman and Company, New York, USA
12. Biochemistry by Stryer. W. H. Freeman; 6 editions (2006).
13. Industrial enzymes and their applications,Uhling H.,John Wiley
14. Practical Biochemistry by T Plummer
15. Practical Biochemistry J Jayaraman
16. Practical Biochemistry by Thimmaiah
17.

SEMESTER-II

BCH 202: MOLECULAR BIOLOGY (CORE COURSE)

Course Code: BCH 202 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

Course Objectives

Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, protein synthesis ….. etc.

At the end of this course students should be able to demonstrate a clear understanding of the facts and basic concepts of molecular biology which are covered in lectures, including:

1. To provide with the core principles of molecular biology.
2. To gain higher level thinking skills that is necessary for scientists.
3. This course should excite about basic science and its applications.

Course outcomes

CO1. Molecular Biology gives you in-depth knowledge of biological and/or medicinal processes through the investigation of the underlying molecular mechanisms.

CO2. Understanding of chemical and molecular processes that occur in and between cells. Your understanding will become such that you will be able to describe and explain processes and their meaning for the characteristics of living organisms.

CO3. Gain insight into the most significant molecular and cell-based methods used today to expand our understanding of biology.

Unit	Unit title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 &K5)	
I	**Genetic Material & Mutations**	Nature of Genetic material: Evidence to prove DNA & RNA as genetic material. Organization of genome in Prokaryotes and Eukaryotes.	Mutations: Types of mutations, molecular basis of mutations, mutagenic agents, Evaluation of mutagens by Ames test. Site directed mutagenesis and its applications. DNA repair**:** Photo reactivation, Excision repair, post replication, recombination and SOS repair mechanisms.	12
II	**Genetic transfer & Recombination**	Mechanism of genetic transfer in bacteria Transformation, Transduction, conjugation, mapping of bacterial chromosome by transformation, conjugation and Transduction Recombination: Homologous recombination, role of Rec proteins in recombination	Plasmids and Transposons: Types of plasmids, Natural and artificial methods of plasmid transfer, their significance and applications, Transposable elements in prokaryotes and eukaryotes, types of bacterial transposons – Insertional sequences, complex transposons, Mechanisms of transposition (Replicative and non replicative).	12
III	**DNA Replication**	Replication of DNA, Mechanism and	Models of replication of DNA, Replication	12

		enzymology of replication. fidelity of replication, extrachromosomal replicons	of E.coli chromosome, colE1 plasmid, ϕ x174 and yeast chromosomal DNA significance of telomerases, synthesis of telomers	
IV	**RNA synthesis, Processing and Regulation**	RNA synthesis - (transcription factors and machinery, RNA polymerases, Mechanism of transcription and inhibitors of transcription.Post transcriptional modifications - Nuclear splicing capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, RNA transport.	Control of gene expression at transcription and translation level. Regulation of Gene Expression in prokaryotes. Levels of regulation, clustered genes, operon and regulon concept, Negative and positive regulation of gene expression. Regulation of lac, arabinose, tryptophan operons. Global regulatory responses, stringent response of regulation in small molecules such as ppGpp .	12
V	**Translation**	Genetic code deciphering, role of RNA in protein synthesis, structure of ribosomes, aminoacyl tRNA synthetase, mechanism of protein synthesis, inhibitors of protein synthesis, post translational modifications.	Protein targeting: Structure and function of signal peptide, signal hypothesis and protein trafficking.	12

REFERENCES

Text Book

1. William Hayes, Genetics of Bacteria and their viruses CBS Publisher, 2011
2. B. Lewin Gene X Oxford press, 2011
3. J.W. Dale, Molecular Genetics of Bacteria, 2006
4. Jeremy W. Dale Simon F Park, Molecular Genetics of Bacteria 4th Ed. John Wiley & Sons Ltd., 2004
5. Twayman, R.M. Advanced Molecular Biology, Viva books Private Limited, 2019
6. Stanly R. Maloy, John E. Cronan, Jr. David Freifelder, Microbial Genetics, 2 ed. Narosa Publishing House,. 2000
7. Jogdand, S.N. Gene Biotechnology, Himalaya Publishing house,. 2010
8. Essential Cell Biology Fifth Editionby Bruce Alberts (Author), Karen Hopkin (Author), Alexander D. Johnson (Author), David Morgan (Author), Martin Raff (Author), Keith Roberts (Author), Peter Walter (Author), Publisher : W. W. Norton & Company; Fifth edition (July 1, 2019).
9. Molecular Cell Biology Eighth Editionby Harvey Lodish (Author), Arnold Berk (Author), Chris A. Kaiser , Publisher : W. H. Freeman; Eighth edition (April 1, 2016)
10. Benjamin Lewin Genes X. Oxford University Press, New York, 2011.
11. David Freifelder George M. Malacinik, Essentials of Molecular Biology, Panima, 2012
12. G. Karp, Cell and Molecular Biology Concepts and Experiment, John Wiley, 1996.
13. W.H. Elliott and D C.Elliott, Biochemistry & Molecular Biology, Oxford University Press, 2012
14. L. Stryer, Biochemistry, Freeman & Company, 2013
15. Shivarama Sastry, Text Book of Molecular Biology, Macmillan India 2004
16. M.Morange, Molecular Biology, Oxford University Press, 1999
17. R.F. Weaver, Molecular biology, MC Graw Hill, 2000
18. R.M. Twyman, Advanced Molecular Biology: A Concise, Viva Books Pvt.Ltd., 2011
19. P.C. Turner, instant Notes in Molecular biology, Viva Books Pvt.Ltd.2008
20. Watson, 5th Edition, Molecular biology of the Gene, Addison Wesley, Longman, 1998
21. D.F.M. Ausubel, R. Brent D. Moor etal Short Protocols in Molecular Biology., John Wiley,

II SEMESTER

BCH 203: CELL PHYSIOLOGY AND ENDOCRINOLOGY (CORE COURSE)

Course Code: BCH 203 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

Course objective

Students will understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles. Students will understand how these cellular components are used to generate and utilize energy in cells. Students will understand the cellular components underlying mitotic cell division.

Course Outcomes

CO1. Demonstrate/illustrate how the homeostatic model applies to every endocrine system in normal physiology and disease.
CO2. Demonstrate/illustrate how every aspect of our physiology and behavior is directly controlled or modified by hormones using reproduction, growth, development, stress, and metabolism as examples.
CO3. Explain how biological structure is related to biological function for cells, organelles, and macromolecules
CO4. Describe the physiological relevance of basic biological processes discussed in this course, including how they are regulated by physiological signals, what their physiological consequences are, and how their dysregulation might result in disease states

Syllabus

Unit	Unit title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 &K5)	
I	**Cellular organization, division and cytoskeletons Cell types**	organization of prokaryotic and eukaryotic cells, cell division - mitosis and meiosis, cell cycle - phases of cell cycle	Regulation of cell growth and cell cycle, cell motility - molecular motors, microtubules, tructure and composition, microtubular, associated proteins - role in intracellular motility	12

II	**Composition and structure of cell membranes**	Molecular constituents of membranes, asymmetric organization of lipids and overview of membrane protein - peripheral and integral, fluidity of membranes, different membrane models.	Membrane channels and pups, ligand gated ion channels, Ionic channels. Molecular models of transport mechanism, Membrane biogenesis, cell- cell interactions, ionophores, gap junctions, artificial membranes and liposomes.	12
III	**Structure and organization of muscle cell, types of muscles**	Molecular organization of contractile systems and molecular mechanisms of contraction and relaxation of muscle. Biochemical changes associated with muscle contraction and relaxation.	Structure of nerve cell, origin of membrane potential, mechanism of propagation of nerve impulse in unmyelinated and myelinated nerve fibers. Synapse – types of synapses, transmission at adrenergic and cholinergic nerve endings. Blood brain barrier, Neurotransmitters. Physiology of vision. Blood corpuscles and formed elements & cardiac cycle.	12
IV	**Hormones**	Definition. classification, Hormone receptors- types, external features and structure, regulation of receptor levels	Mechanisms of hormone action. Signal transduction	12
V	**Thyroid & Parathyroid hormones**	synthesis, secretion, transport and metabolic fate. And Biological action of hormones	Thyroid diseases, Hashimoto's thyroiditis, Pathopysiology of Parathyroid hormone, Calcitriol, Gastrointestinal hormones, Location of peptide producing cells	12

REFERENCES

1. Lodish, et al. 2012 Molecular Cell Biology 5th ed., WH Freeman.
2. Murray, et al. 2013. Harper's Biochemistry 26th ed. McGraw Hill.
3. Smith, et al. Principles of Biochemistry, Mamalian Biochemistry, 7th ed., McGraw Hill.
4. Alberts, et al. 2010. Molecular Biology of the Cell, 4th ed. Garland Sci.
5. De Robrtis and De Robertis, Cell and Molecular Biology, Lea and Febiger 8th Ed.
6. Cell Biology: A short course – Bolsover S, 2004, 2nd edition John Willey & Sons.
7. Molecular biology of cell – Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Water, 2002, 4th edition, Garland Science.
8. Molecular Biology – Weaver, 2011, 5th edition, Mc Graw Hill.
9. Molecular Cell Biology – Levin Benjamin, 2000, 4th edition, WH Freeman & Company, NY
10. Introduction to Molecular Biology – Paolella P, 1998, Mc Graw Hill
11. Cell and Molecular Biology – Krap G, 2002, 3rd edition, John Wiley and Sonc. New York.
12. Cell Biology – Singh S.P, Tomar B.S, 1993, Rastogi Meerut, Delhi.
13. Cell Biology, Genetics Molecular Biology and Evolution – Verma O.P.S. and Agarwal O.V.K, 1986, s. Chand & Co. Madras
14. Text book of physiology and nutrition – M. Swaminathan
15. Textbook of Medical Physiology -Guyton and Hall,2012, 11th Edition
16. Murray, et al.Harper's Biochemistry, 2014. McGraw Hill.
17. Autin and Short,2010.Mechanisms of Hormone Action.
18. Smith, et al. Principles of Biochemistry – Mammalian Biochemistry, 2012 McGra Hill.
19. Wilson and Foster, Williams Textbook of Endocrinology, 2010.
20. Textbook of Endocrinology by Hadley, 2009.
21. Textbook of Physiology by Guyton 2009.

II SEMESTER

BCH 204: FOOD SAFETY AND QUALITY MANAGEMENT SIGNALING (INTERNAL ELECTIVE)

Course Code: BCH 204 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

COURSE OBJECTIVES

To prepare graduates for careers in the national and international food chain, e.g. food businesses, consultancy, research and development. To equip graduates with the knowledge and skills that will enhance their employability. To enrich graduates understanding of the dynamics of food safety and quality management systems and the context under which they operate at national and international levels.

COURSE OUTCOMES

CO1: Explain the application of food quality and food safety system
CO2: Identify the hazard of the food chain to ensure food safety
CO3: Examine the chemical and microbiological quality of food samples

CO4: Detect the adulteration in food samples
CO5: Review of legislative approaches for the management of food safety

SYLLABUS

Unit	Unit title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 &K5)	
I	**Microbiology of foods**	Microbiology of foods and food safety. Factors affecting the growth of microorganisms in food	Role of microorganisms in fermented foods and food industry. Economically important fermentation products	12
II	**Food safety**	Food safety and importance of safe food. Factors affecting food safety – Physical, Chemical and Biological. Recent concerns of food safety	Food safety and food service establishments – food safety measures – hygiene and sanitation in food service establishments, licensing and sale.	12
III	**Food adulteration**	Food adulteration – common adulterants, classification of adulterants	Harmful effects of adulterants – methods for detection of adulterants.	12
IV	**Food packaging**	Food packaging – significance and function – classification of packaging material – packing methods – interaction between packaging and food – toxicity hazards. Packaging laws and regulations.	Biodegradable materials and environmental issues – labeling requirements, nutritional labeling and coding of foods.	12
V	**Risk analysis**	Risk analysis – HACCP – A food safety assurance system, Food regulations	Food regulations, standards and quality control. Prevention of food adulteration. Consumer protection Act, 1986 – regulations related to genetically modified foods.	12

REFERENCES

TEXT BOOKS

1. Food Microbiology (5th ed.) 2017. by W.C. Frazier & D.C. Tata Mc Graw Hill publishing house, New Delhi..
2. Adams, M.R. Food Microbiology fundamentals & Frontiers 2018 American .Society for Microbiology.5th ed. Washington. D.C.
3. James M.Jay.5th ed.2006. Modern food Microbiology. Food Science text series. Springer publication, US.

II SEMESTER
BCH: 204 IMMUNO TECHNOLOGY & MOLECULAR SIGNALING (INTERNAL ELECTIVE)

Course Code: BCH 204 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

COURSE OBJECTIVES

To enable candidates by imparting updated analytical and hands-on skills to use and implement technological developments related to advanced and potential areas involving molecular diagnostics, automated systems of diagnosis, immunoblotting technology, upstream or downstream processing and nanotechnology with scope for upskilling upto future technologies so as to contribute effectively for Research & Development leading to patenting and publishing.

COURSE OUTCOMES

CO1. understand the basic principles of signal transduction mechanisms, in particular the concepts of response specificity, signal amplitude and duration, signal integration and intracellular location
CO2. Describe immunization/vaccination, immunological disease and immunotherapy
CO2. plan, carry out and present achieved results of immunological serum analyses by means of enzyme coupled immune adsorbent analysis (ELISA)
CO3 Discuss immunological techniques and their applications in biotechnical industry.
CO4. Describe immunization/vaccination, immunological disease and immunotherapy

SYLLABUS

Unit	Unit title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 &K5)	
I	**Cell cycle and Cancer biology**	Mitosis and meiosis, their regulation, steps in cell cycle, and control of cell cycle.Check points in cell cycle, regulation and control of cell cycle, inhibitors	Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis,Angiogenesis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.	12
II	**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 signaling systems.	Quorum sensing in bacteria	12
III	**Immunodeficiency disorders**	Auto immunity – Pathogenesis of auto immune disease	Disease with positive HLA associations, systemic lupus erythematus, multiple sclerosis, rheumatold arthritis, auto – immune haemolytic anemia, Myasthenia gravis, Graves' disease, Type 1 Diabetes Mellitus, Hashimotos thyroiditis, treatment	12

			of auto immune disease.	
IV	**Transfusion immunology**	ABO system, Rh antigens, Rh disease, MN blood group, Kell and duffy blood groups	Selection of donors by cross matching. Transfusion reactions – Haemolytic, febrile and allergic reactions. Transfusion transmitted infections.	12
V	**Immunoprophylaxis**	Types of vaccines – Conventional (BCG, Salk, Influenza, DPT) DNA vaccines, Glycoconjugate vanccines, Deletion vaccines, DC based vaccines	basis of attenuation. Recent developments in vaccine technology, Vaccine delivery system and approaches to enhance immunogenicity, immunomodulators and immunomodulation, adjuvant, cytokines / interleukins based immune therapy.	12

References

Text Books

1. Basic Immunology: Functions and Disorders of the Immune System 6th Edition by Abul K. Abbas MBBS (Author), Andrew H. Lichtman MD PhD (Author), Shiv Pillai MBBS PhD (Author), Publisher : Elsevier; 6th edition (April 24, 2019)
2. Roitt's Essential Immunology (Essentials) 13th Edition by Peter J. Delves (Author), Seamus J. Martin (Author), Dennis R. Burton (Author), Ivan M. Roitt (Author), Publisher : Wiley-Blackwell; 13th edition (January 17, 2017)
3. Introductory Immunology, 2nd: Basic Concepts for Interdisciplinary Applications 2nd Edition, Publisher : Academic Press; 2nd edition (February 27, 2019)
4. Clinical Immunology: Principles and Practice 5th Edition by Robert R. Rich MD (Author), Thomas A Fleisher MD FAAAAI FACAAI (Author), William T. Shearer MD PhD (Author), Harry Schroeder (Author), Anthony J. Frew MD FRCP (Author), Cornelia M. Weyand MD PhD, Publisher : Elsevier; 5th edition (March 27, 2018)
5. Hancock, J. T. Cell signalling. 2a ed. Oxford University Press, 2005.

II SEMESTER
BCH 204: BIOINFORMATICS (IE)

Course Code: BCH 204 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

Course objectives

Bioinformatics is the science of storing, extracting, organizing, analyzing, interpreting and using information. The approaches to the discipline of bioinformatics incorporate expertise from the biological sciences, computer science and mathematics. The major in bioinformatics is designed for students interested in molecular biology and genetics, information technologies and computer science. Bioinformaticists are involved in the analysis of the human genome, identification of targets for drug discovery, development of new algorithms and analysis methods, the study of structural and functional relationships, and molecular evolution.

Course out comes

CO1. Knowledge and awareness of the basic principles and concepts of biology, computer science and mathematics

CO2. existing software effectively to extract information from large databases and to use this information in computer modeling

CO3. problem-solving skills, including the ability to develop new algorithms and analysis methods

CO4. an understanding of the intersection of life and information sciences, the core of shared concepts, language and skills the ability to speak the language of structure-function relationships, information theory, gene expression, and database queries.

Unit	Unit title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 &K5)	
I	**Introduction to Biological Databases:**	Types of databases, Nucleic Acid Sequence databases, Protein sequence databases. Structure databases: Protein data bank (PDB), visualizing structural information (RasMol) Prediction analysis of DNA sequences (GRAIL; FGENES, Genescan) Sequence alignment (FASTA, BLAST and CLUSTALW)	Phylogenetic analysis: Phylogenetic trees, Methods of analysis (Distance method, Neighbor joining method), Phylogenetic tree evaluation - PHYLIP, MEGA	12

II	**Protein Structure and prediction**	Protein structure analysis, Secondary analysis, Motifs, profiles, patterns and fingerprints.	Sequence based protein prediction: Homology or comparative modeling: Remote homology (Threading), Protein function prediction.	12
III	**Molecular Modeling**	Molecular structures & Internal energy.	Areas of application-single molecule calculation, assemblies of molecules. Introduction to molecular graphics & its application.	12
IV	**Quantum mechanics**	Empirical force field modelselectronic structure calculations, abinitio, semi-empirical and density fraction theory calculations	Molecular mechanics, energy calculation, Bond stretch, angle bending, torsion angles, vanderwaal's interaction, etc), Molecular dynamics	12
V	**Molecular docking & its statistics**	Introduction to molecular docking, Docking programs: Flexible & rigid body docking.	Geometry bases, Energy bases, fragment based, descriptor method, grid Method.Evaluation of docked prediction. Automated docking. Protein-ligand docking, Regression analysis, Fourier correlation transfer algorithm, RMS Deviation.	12

REFERENCES

1. Understanding Bioinformatics by Market Zvelebil , Garland Science; 1 edition (April 30, 2007)
2. K. Attwood & D.J. Parry-Smith 1999. Introduction to Bioinformatics Pearson Education Asia
3. Stephen Misener& S.A. Krawez 2000. Bioinformatics: Methods and Protocol
4. R. Durbin, S. Eddy.A. Krogh & G. Mitchson 1998. Biological sequence analysis Cambridge University Press
5. C.P. Freidman & J.C. Wyatt. 1997 Computers and machine Evaluation methods in Medical information. Springer Veriag, New York
6. M.J.Bishop& C.J. Wyatt, 1997 DNA and Protein structure analysis: A practical approach, Oxford University Press
7. R.M. Kolodner, 1997 Computer in Health care: Computerising large integrated health networks. Springer – Veriag, New York.

SEMESTER-II
PRACTICAL - I
PRACTICAL EXAM: 6 HRS / DAY: 1

PRACTICAL -1 ENZYME AND ITS APPLICATIONS and FOOD SAFETY AND QUALITY MANAGEMENT

Course Code: BCH(P:201 &204) **Hours: L + T + P = C**
Marks: 100 **0 0 5 4**

Course objectives

Determination of the rate of the reaction (MM equation) and various techniques to study it. Students will also learn factors affecting rate of reactions (Inhibitors, pH, temp). Students will also learn the assay of enzyme activity.Learn principle behind enzyme isolation and Various purification techniques.

To Emphasis the various properties of the raw material used in food processing, different processing technologies required in transforming them into quality food products and material handling equipment involved in food processing operations

Course outcomes

CO1. Acquiring training to estimate activity of enzymes.

CO2. To determine pH optimum, Km and Vmax of enzymes and to analyse enzyme kinetics.

CO3. To determine optimum temperature for the activity of an enzyme.

CO4. To understand about the important parameters of food safety systems.

CO5. To get know International food laws

CO6. To know about history of food law and standards 4. Can become advisor to the

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	**Assay of enzyme activities from Biological samples**		Amylase from saliva Urease from Horse gram Acid phosphatase from potato Alkaline phosphatse from serum Trypsis SOD, Invibitor Some activators and inhibitors	122
II	**Study of enzyme kinetics**	Effect of factors on enzyme activity	A. Effect of substrate concentration on enzyme activity B. Effect of enzyme concentration on enyme activity C. Effect of pH on enzyme activity D. Effect of temperature on enzyme activity.	12

			E. Effect of activators and inhibitors on enzyme activity	
	Enzyme purification by 3 or 4 steps		Acetone precipitation Ammonium sulphate fractionation Electrophoresi	12
IV	**Determination of quality of food**		fungal and yeast count in a given food sample. quality of milk sample of methylene blue reductase test Detection of number of bacteria in milk by breed count	12
V	**Determination of food adultarants**		presence of sugar in honey Detection of NaHCO3 (chalk) in Flour. Check the presence of Vanaspati and Rancidity in the ghee Metanil yellow in a given food sample.	
VI	Food processing		Analysis of air of processing facility for microbial load	

REFERENCES

1. Food Microbiology (5th ed.) 2017. by W.C. Frazier & D.C. Tata Mc Graw Hill publishing house, New Delhi..
2. Adams, M.R. Food Microbiology fundamentals & Frontiers 2018 American .Society for Microbiology.5th ed. Washington. D.C.
3. James M.Jay.5th ed.2006. Modern food Microbiology. Food Science text series. Springer publication, US.
4. Text book of biochemistry by thimmaiam

SEMESTER-II
PRACTICAL - II
PRACTICAL EXAM: 6 HRS / DAY: 1

PRACTICAL -1 MOLECULAR BIOLOGY and CELL PHYSIOLOGY AND ENDOCRINOLOGY

Course Code: BCH(P:202 &203) **Hours: L + T + P = C**
Marks: 100 **0 0 5 4**

Course objectives

Demonstrate an understanding of the principles, and have practical experience of, a wide range of biochemical techniques (e.g. basic molecular biology, cell biology and microbiology methods, spectrophotometry,

Course outcomes

CO1. Students will learn the to isolate RNA, DNA, total nucleic acids and total RNA from bacteria, yeast and plant tissues.

Unit	Unit Title	Intended Learning Chapters		Hours of Instruction
		(K1, K2)	(K3, K4 & K5)	
I	**Cell cycle and cell division**		Mitosis and meiosis	122
II	**Extraction of genetic material**		DNA from plant leaves. DNA from animal tissue. Vitamin D2 and D3	12
III	**Isolation and**			
IV	Purification and estimation		serum globulin	12
V	**Induction of mutation in bacteria using UV light, photoreactivation, chemical mutagens and Ame`s test**			
VI	**Transformation, Transduction and Conjugation**		Strepptomycin mutant resistant by gradient plate technique Lethality curve construction	

SEMESTER-III

SUBJECT NAME	COURSE OUTCOME	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
SEMESTER-III													
BCH 301 GENETIC ENGINEERING (IE)	To provide students with Conceptual knowledge on emergence of recombinant DNA technology from knowledge gained in biochemistry, genetics, cell biology and molecular biology	✓	✓		✓								✓
	Overview of the important techniques used in sequencing, amplification and cloning of DNA	✓						✓	✓			✓	
	Gain knowledge on the significance of important enzymes and cloning. Able to Importance of different type of vectors available and basis for their construction and selection.			✓					✓		✓		✓

	Understand the major issues in heterlogous expression of gene and strategies employed to overcome Conceptual knowledge on ways to maximize the expression in prokaryotic and eukaryotic systems.	✓		✓			✓					✓	
BCH 301 ANIMAL PHARMACEUTICAL BIOTECHNOLOGY	Providing students with a theoretical and practical understanding of animal biotechnology	✓		✓			✓					✓	
	Describe how genes are expressed and what regulatory mechanisms contribute to control of gene expression.	✓		✓			✓			✓		✓	
	Describe basic principles and techniques in genetic manipulation and genetic engineering, describe gene transfer technologies	✓					✓				✓	✓	

	for animals and animal cell lines.												
BCH 301 MOLECULAR AND IMMUNO DIAGNOSTICS	To explain the available molecular, genomic, proteomic and metabolomics diagnostic procedures available for various diseases		✓		✓		✓				✓		
	To interpret certain molecular reasons behind the certain hereditary diseases		✓	✓			✓		✓	✓			
	To learn the technologies available and lacuna for the non-cultured and slow growing pathogens		✓		✓	✓				✓			✓
	To explain the available molecular, genomic, proteomic and metabolomics diagnostic procedures available for various diseases	✓					✓	✓	✓		✓	✓	
BCH 302: INTERMEDIARY METABOLISM (CC)	Understand the differences between anabolic and	✓					✓	✓	✓		✓	✓	

	catabolic processes in metabolism Known photosynthesis reaction In this course, students learn about the energy producing pathways of glycolysis, Krebs cycle, oxidative phosphorylatio n, and fatty-acid oxidation. Be able to describe how anabolic and catabolic processes are coupled to energetics from ATP hydrolysis												
	Define the major pathways of intermediary metabolism of biomolecules, and discuss their bioenergetics, physiological adaptation, metabolic and main hormonal regulation, localization and cellular compartmental ization.	✓				✓		✓			✓	✓	
	Discuss how disruptions in intermediary	✓			✓		✓		✓		✓	✓	

	metabolism may lead to disease, and illustrate with selected examples												
BCH 303: NUTRITIONAL BIOCHEMISTRY (CORE COURSE)	The paper provides the structural and functional role of cell organelles and cell membrane at the biological level.	✓	✓	✓	✓							✓	
	Students will be exposed classification, biochemical and required quantities of nutrients in diet.	✓	✓	✓	✓								
	It helps students to understand the nutritive roles of macro and micro nutrients.	✓	✓	✓	✓								
(Skill Development Course) RESEARCH METHODOLOGY	Demonstrate the ability to choose methods appropriate to research aims and objectives	✓	✓	✓							✓		✓
	Understand the limitations of particular research methods			✓	✓		✓			✓		✓	
	Develop skills in qualitative and quantitative data analysis		✓				✓		✓		✓	✓	

	and presentation												
	Develop advanced critical thinking skills Demonstrate enhanced writing skills		✓		✓		✓			✓		✓	
BCH 304: QUALITY CONTROL/ LABORATORY MAINTENANCE(EXTERNAL ELECTIVE)	Explain differences between quality control and statistical quality control,Determine several quality concept,Define Quality Assurance	✓	✓	✓				✓				✓	✓
	System and Total Quality Management,Express the main attributes of Quality Assurance System, Define the Total Quality Management, Use the Problem Solving Techniques	✓	✓	✓				✓				✓	✓
	calculate, analyse and interpret quality costs, Analyse Measurement System	✓	✓	✓	✓			✓				✓	✓

III SEMESTER
GENETIC ENGINEERING (IE)

Course Code: BCH 301 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

Course Objective

The objective of this course is to provide an insight into the fundamentals of genetics and cloning technology. Further this course also deals with the understanding between prokaryotes and eukaryotes genetic system.

Course outcomes

CO1. To provide students with Conceptual knowledge on emergence of recombinant DNA technology from knowledge gained in biochemistry, genetics, cell biology and molecular biology.

CO2. Overview of the important techniques used in sequencing, amplification and cloning of DNA

CO3. Gain knowledge on the significance of important enzymes and cloning. Able to Importance of different type of vectors available and basis for their construction and selection.

CO4. Understand the major issues in heterlogous expression of gene and strategies employed to overcome Conceptual knowledge on ways to maximize the expression in prokaryotic and eukaryotic systems.

CO5. Study the application of r DNA in various fields benefitting mankind. Gain practical experience in amplification and isolation of gene fragments and cloning. Use of *insilico* tools to design primers. Generation of restriction maps and identification of genes

Syllabus

Unit	Unit Title	Intended learning chapter		Hours of instruction
		(K1, K2)	K3, K4 &K5)	
I	**Tools in r-DNA Technology**	Nucleic acid sequencing – Maxam Gilbert, Dideoxy methods, Automated DNA sequencing , Chemical Synthesis of DNA by phosphoramidite method. Labeling of DNA	Nick translation, Random priming, Radioactive and non-radioactive nucleic acid probes, Amplification of DNA by PCR and its variants. DNA fingerprinting techniques – Southern blotting, RFLP, RAPD, AFLP and next generation sequencing	**12**

			methods, Aptamers and molecular beacons	
II	**Cloning vehicles and Enzymes**	Cloning vehicles: Plasmid, bacteriophages, cosmid, phagemids, yeast shuttle and viral vectors. T1 plasmids, binary vectors, bacterial and yeast artificial chromosomes. methods of plasmid transfer.	Enzymes used in molecular cloning – Restriction and modification enzymes, DNA polymerases, S1 nuclease, BAL 31 nuclease, polynucleotide kinase, ligases, topoisomerases, phosphatases, methylase, reverse transcriptase.	**12**
III	**Cloning in bacteria**	Core techniques of gene manipulation, Construction of c-DNA and genomic libraries. Generation of DNA fragments.	Isolation and purification of RNA, DNA (genomic and plasmid), Introduction of cloned genes into host, Screening and detection of recombinant clones – genetic and immunochemical methods.	**12**
IV	**Expression in prokaryotes**	Expression of cloned genes in prokaryotes, Gene expression ,factors influencing gene expression of cloned genes. Problems associated with heterologous gene expression.	Design of vectors for the over expression of recombinant proteins: selection of suitable promoter sequences, fusion protein tags, protease cleavage sites and enzymes, Inducible expression systems; Expression vectors (pET-based vectors pBAD vector), Protein purification, His-	**12**

			tag , GST-tag , Inclusion bodies , Methods to reduce formation of inclusion bodies.	
V	**Expression in Eukaryotes**	Principles in maximizing gene expression, Baculovirus and pichia vectors system, Gateway cloning system.Methods for analysis of gene expression at RNA and protein level using reporter genes such as (Chloramphenicol Acetyl Transferase) (*CAT*), ,Luciferase, β- galactosidese GUS,GPF etc.).	Antisense technology -Gene silencing techniques. Application of recombinant DNA technology in Biology, Agriculture and Medicine. CRISPR technology.	

Reference
Text book

1. R.W. Old S.B. Primrose, Principles of Gene manipulation: An introduction to
2. Genetic Engineering, 6th Edition, Blackwell Scientific, 2000
3. S.B. Primrose Principles Of Gene Manipulation And Genomics 7th Edition 2014.
4. James D. Watson , A. Baker Tania, et al Molecular Biology of the Gene 2017
5. P. Karanfilska, Dijana & P, Zoran & Stankovic, Bratislav. Recombinant DNA Technology and Genetic Engineering. 2015.
6. E.L. Winnacker, from Genes to Clones Introduction of gene technology VCH Publishers, 1998
7. A.N.Glazer, H.Nikaldo, Microbial Biotechnology. W.H. freeman, 2008
8. J.M. Walker, E.B.Gingold, Molecular Biology and Biotechnology, Panima Publishers, 2000
9. B.R.Glick and J.J. Pasternak, Molecular Biotechnology, Principles and applications of recombinant DNA, Panima Publishers 2015
10. S.B. Primrose, Molecular Biotechnology, 2019.
11. T.A. Brown, Gene Cloning and DNA Analysis: An Introduction 2020
12. F.M. Ausuble, R.Brent R.E. Kengston, Short Protocols in Molecular biology 4th edition John Wiley 2002
13. Sarnbrook J.et al Molecular cloning – A Laboratory Manual vol.1 II & III Cold Spring Harbor Laboratory Press, 2001.
14. Joseph F. Sambrook and David Russell Condensed Protocols from Molecular Cloning: A Laboratory Manual 2006

III SEMESTER
ANIMAL PHARMACEUTICAL BIOTECHNOLOGY(IE)

Course Code: BCH 301 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

Course Objective

Animal biotechnology is a branch of biotechnology in which molecular biology techniques are used to genetically engineer animals in order to improve their suitability for agriculture, industrial and pharmaceutical applications. Advances in animal biotechnology have been facilitated by recent progress in sequencing animal genomes, gene expression and metabolic profiling of animal cells. Genome editing technologies (Zinc Finger Nucleases, TALENS, and CRISPR-Cas systems) have opened up new opportunities to easily create genetic variations in animals that can improve their health and well-being, agricultural production, and protection against diseases.

Course outcomes

CO1. Providing students with a theoretical and practical understanding of animal biotechnology.

CO2. Describe the structure of animal genes and genomes.

CO3. Describe how genes are expressed and what regulatory mechanisms contribute to control of gene expression.

CO4. Describe basic principles and techniques in genetic manipulation and genetic engineering, describe gene transfer technologies for animals and animal cell lines.

CO5. Describe techniques and problems both technical and ethical in animal cloning.

Syllabus

Unit	Unit Title	Intended learning chapter		Hours of instruction
		(K1, K2)	K3, K4 &K5)	
I	**Animal cell culture media and sterilization**	Media for culturing cells and tissues; natural and defined media Preparation of various tissue culture media, sterilization and storage	Sterilization of various equipments and apparatus Short-term lymphocyte culture (suspension cultures) Development and maintenance of cell lines	**12**

II	**Techniques in animal cell culturing and breeding**	Techniques in Animal Tissue Culture Development and maintenance of cell lines	*Invitro* culture of oocytes/embryos Cell/embryo cryopreservation Conventional methods of animal improvement, predominantly selective breeding and cross breeding, IVF	**12**
III	**Biotechnology for animal improvement**	Embryo biotechniques for augmentation of reproductive efficiency and faster multiplication of superior germ plasm .	Transgenesis for animal improvement and production of animals as bioreactors for proteins of pharmaceuticals value Gene mapping in farm animals Marker-assisted selection and genetic improvement of livestock. Gene therapy	**12**
IV	**Drug discovery and delivery systems**	Drug Discovery and the drug development process. Applications of genomics, proteomics and related technologies upon drug discovery.	Delivery of Biopharmaceuticals-Oral delivery systems – Pulmonary delivery – Nasal, transmucosal and transdermal delivery systems.	**12**
V	**Biopharmaceuticals**	The cytokines – The interferon family, cytokines as Biopharmaceuticals. TNF – therapeutic aspects.	Haemopoietic growth factors, Growth factors, Hormones of therapeutic interest, Blood products, therapeutic enzymes and Nucleic acid therapeutics.	**12**

REFERENCES:

Text Books;

1. B.D. Singh 2017, Animal biotechnology 5th ed. ABM Publishers, New Delhi
2. A.Ramadass 2019Animal biotechnology , Oxford Publishers, New Delhi
3. R.C.Dubey 2014,Advanced Biotechnology 5th revised.ed.S. Chand Publications, New Delhi
4. A.Ranga 2019. Animal biotechnology 3rd ed. Agrobios,India
5. Ian Fresney, 2016. Invitro cultivation of animal cells . 7TH ed. Wiley Publications, New Delhi.
6. Gary Walsh, 2018.Biopharmaceuticals Bench mark. John Wiley and Sons, New York
7. S.P. Vyas and K.C. Dixit.2019. Pharmaceutical Biotechnology . CBS publishers, New Delhi
8. Ritter Rod Flower Graeme Henderson Humphrey Rang.2015.Rang and Dale Pharmacology 8th edition, Elsevier, Academic Press. New York.
9. S.N.Jogdand, 2011 Medical Biotechnology 4th ed. New Age Publishers, New Delhi
10. S.N. Mukhopadhay. 2019. Process Biotechnology Fundamentals 4rth revised ed.MV Learning Pvt. Ltd., New Delhi

III SEMESTER
MOLECULAR AND IMMUNO DIAGNOSTICS (IE)

Course Code: BCH 301 **Hours: L + T + P = C**

Marks: 100 **4 1 0 5**

Syllabus

Unit	Unit Title	Intended learning chapter		Hours of instruction
		(K1, K2)	K3, K4 &K5)	
I	**Introduction and Concept of Molecular Diagnostics**	Molecular probes, Amplification of DNA, Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing.	DNA finger printing techniques and their application, Detection of sequences at the gross level, single nucleotide polymorphisms (SNPs), importance of SNPs, forensic applications of VNTRs RFLP, RAPD, AFLP, *in vitro* mutagenesis and deletion techniques, signature-tagged mutagenesis.	**12**
II	**Micro Array-base**	G-banding, in situ	PCR and its	**12**

	diagnostics	hybridization (FISH and on-FISH), comparative genomic hybridization (CGH) , Phage display concept and applications of Phage display , Immunoarrays, FACs	variants, factors influencing PCR and their applications, Quantitative PCR, LCR.	
III	**PCR based diagnostics**	Southern blot, Western blot diagnostics, RNA interference and siRNA technology.; Micro RNA	gene silencing and applications. Suicide gene therapy, Gene replacement, Gene targeting; Gene Therapy and its applications. Principle and application of gene silencing.	**12**
IV	**Immunodiagnostics**	Concept and basis of development of diagnostics and tools used. Immuno electrophoresis: rocket immunoelectrophoresis	CIE, Graber and William Technique, RIA, Flow cytometryimmuno fluorescence FACS, ELISA, RIA and immunoblotting. ELISA – Methodology and a Immuno fluorescer indirect and Sandwich Immuno diagnosis of infectio respiratory diseases	**12**
V	**Polyclonal and Monoclonal antibodies**	Polyclonal and Monoclonal antibodies Production and applications in diagnosis , Immunoblot analysis &immunocytochemical staining.	Development of rapid diagnostic tests and their applications . Biochemical diagnostics, development. Biochemical markers of disease diagnosis and their applications.	**12**

References:

TEXT BOOKS

1. Molecular Diagnostics:Current Technology and Applications by Juluri R. Rao, Colin Craig Fleming, John Edmund Moore – 2006
2. Molecular Diagnostics: A Training and Study Guide by Gregory J. Tsongalis, William B. Coleman - 2002
3. Molecular Diagnostics: For the Clinical Laboratorian by William B. Coleman, Gregory J. Tsongalis - 2006
4. Molecular Diagnostic PCR Handbook by Gerrit J. Viljoen, L. H. Nel, J. R. Crowther – 2005
5. The Neuropathology of Dementia by Margaret M. Esiri, Virginia M.-Y. Lee, John Q. Trojanowski
6. Diagnostic Bacteriology Protocols, by Louise O'Connor - 2006
7. Immunodiagnosis of Cancer by Ronald B. Herberman, Donald W. Mercer – 1990
8. Immunodiagnostics: A Practical Approach by Ray Edwards – 1999

III SEMESTER

INTERMEDIARY METABOLISM (CORE COURSE)

Course Code: BCH 302	**Hours: L + T + P = C**
Marks: 100	**4 1 0 5**

Course objectives

Understand reactions and importance of cellular metabolism and connection to physiology. Understand some of the clinical pathology like starvation, Diabetes, etc. Explain the major catabolic and anabolic pathways by which human cell types metabolize carbohydrates, lipids, amino acids and nucleotides. To explain the molecular mechanisms underlying the major inherited diseases of metabolism.To recognize the role of vitamins and minerals in intermediary metabolism.

Course outcomes

CO1. Understand the differences between anabolic and catabolic processes in metabolism

CO2. In this course, students learn about the energy producing pathways of glycolysis, Krebs cycle, oxidative phosphorylation, and fatty-acid oxidation.

CO3. Be able to describe how anabolic and catabolic processes are coupled to energetics from ATP hydrolysis

CO4. Understand redox and electron transfer reactions in biological systems

CO5. Understand that reaction coordinate diagrams are useful for thermodynamics of coupling anabolic and catabolic processes in metabolism

CO6. Define the major pathways of intermediary metabolism of biomolecules, and discuss their bioenergetics, physiological adaptation, metabolic and main hormonal regulation, localization and cellular compartmentalization.

CO7. Correlate the metabolic activity of tissues and organs with their function.

CO8. Discuss how disruptions in intermediary metabolism may lead to disease, and illustrate with selected examples

SYLLABUS

Unit	Unit Title	Intended learning chapter		Hours of instruction
		(K1, K2)	K3, K4 &K5)	
I	**Energy metabolism**	Thermodynamic principles – Chemical equilibria; free energy, enthalpy (H), entropy (S), High energy compounds. Oxidation-reduction reactions. Oxidative phosphorylation – the chemiosmotic theory.	Light harvesting complexes; mechanisms of electron transport; photo protective mechanisms; CO2 fixation-C3, C4 and CAM pathways.Mechanism of ATP synthesis. Inhibitors & Uncouplers of oxidative phosphorylation. Mitochondrial transport system, ATP/ADP exchange, malate / glycerol phosphate shuttle.	**12**
II	**Carbohydrate metabolism**	Glycolysis, Citric acid cycle, HMP shunt and its significance, Uronic acid pathway, Cori cycle, Glyoxylate pathway, Gluconeogenesis	Glycogen metabolism and its regulation. Integration of Metabolic pathways. Amphibolic role of TCA cycle. Anaplerotic reactions Energetics and regulation of carbohydrate metabolism.	**12**

			Pasteur effect, warburgh effect and crab tree effect. Digestion and absorption of carbohydrates.	
III	**Protein metabolism**	Degradation of proteins by proteases,Transamination, oxidative and non-oxidative deamination, decarbodxylation - urea cycle and its regulation. Nitrate and ammonium assimilation	Biosynthesis and degradation of Amino acids. Clinical significance of Biological amines (Serotonin, gamma aminobutyric acid, dopamine, epinephrine, nor-epinephrine, melanin, creatinine).	**12**
IV	**Nucleotides**	Biosynthesis and degradation of purine and pyrimidine nucleotides and its regulation. Purine salvage pathway. Role of ribonucleotide reductase.	Biosynthesis of deoxyribonucleotides and polynucleotides including inhibitors of nucleic acid biosynthesis. Porphyrins – Biosynthesis and degradation of porphyrins. Production of bile pigments. Biochemistry of biological nitrogen fixation.	**12**
V	**Lipid Metabolism**	Biosynthesis and degradation (α, β and ω oxidation) of saturated and unsaturated fatty acids. Regulation of fatty acids metabolism. Metabolism of triaclyglycerol, Phospholipids and sphingolipids	Cholesterol biosynthesis, degradation and regulation. Cholesterol transport and excretion. Lipoprotein metabolism. Arachidonic acid metabolism.	**12**

REFFERENCES

TEXT BOOKS

1. Donald Voet. J.G. Voet and John nwILEY, Biochemistry.
2. Murray et al. Harper's Biochemistry, 26th ed. Mc Graw Hill.
3. Nelson & cox, Lehninger's Principles of Biochemistry, 4th ed. McMillian Worth.
4. Stryer, Biochemistry, 5th ed. Freeman.
5. Biochemistry – Geoffrey L, Zubay, 4th edition.
6. Fundamentals of Biochemistry – Donald voet, Judith Voet and Pratt, 2nd edition.
7. Harper's Biochemistry – Murray et al, 25th edition, Appleton and Lange Publishers.
8. Principles of Biochemistry – Lehninger, Nelson and Cox, 4th edition, WH Freeman and Campbell New York, USA

III SEMESTER

NUTRITIONAL BIOCHEMISTRY (CORE COURSE)

Course Code: BCH 303	**Hours: L + T + P = C**
Marks: 100	**4 1 0 5**

Course objective

The course is an introcuction to nutritional biochemistry. The students will learn how nutrients effect biochemical processes and signal transduction pathways, and how this can lead to development of nutritionally related diseases. The laboratory course will give insight in biochemical methods and analyses used in nutritional research.

Course Outcomes

CO1. The paper provides the structural and functional role of cell organelles and cell membrane at the biological level.

CO2. Students will be exposed classification, biochemical and required quantities of nutrients in diet.

CO3. It helps students to understand the nutritive roles of macro and micro nutrients.

Syllabus

Unit	Unit Title	Intended learning chapter		Hours of instruction
		(K1, K2)	K3, K4 &K5)	
I	**Body weight and the body composition**	Determination of body fat and body water. Body composition during growth and energy requirements. Measurement of energy expenditure, direct and indirect calorimetry, Respiratory quotient and BMR.		**12**
II	**Protein nutrition**	Essential and non-essential amino acids. Nitrogen balance, methods of calculation of biological value of proteins.	Protein calorie deficiency Kwashiorkor and Marasmus. Fats as component of diet, Energy value of fats. Essential fatty acids and Phospholipids in nutrition	
III	**Nutraceuticals and Functional Foods**	Sources of Nutraceuticals. Properties, structure and functions of various Phytonutraceuticals (Glucosamine, Lycopene, Carnitine, grape products, flaxseed oil as nutraceuticals).	Anti-nutrients and Dietary fibers in nutrition. Nutraceutical remedies for common disorders like Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis.	**12**
IV	**Macro and micro elements**	Macro and micro elements in nutrition as regards to dietary sources. Deficiency symptoms,diseases and recommended dietary allowances.		
V	**Starvation**	Techniques for the study of starvation and malnutrition.	Nutritional requirements for infants, children,	

		Protein metabolism in prolonged fasting. Obesity – Definition, Genetic and environmental factors leading to obesity.	pregnant a lactating woman and in old age. Importance of Nutrition under stress conditions.	

REFERENCES
TEXT BOOK

1. Techniques of Food Analysis – Andrew L Winton and Kate Barber Winton, 2001, Published by Agrobios (India Ltd).
2. Human nutrition and Dietics – Garrow and James, 1996, 9th edition, published by chruchill Livingstone eiNC.
3. Antioxidant status, diet, nutrition and health – Andreas M Papers, 1996, published by CRC Press Washington, DC.
4. Nutritional Biochemistry – Tom Brody, 1994, Academic Press, USA.
5. Food Fundamentals – Margaret Mc Williams, 2nd Swaminathan.
6. Text book of Physiology and nutrition-M. Swaminathan.
7. Harper's Biochemistry
8. Trace Elements by Underwood.
9. Nutrition by M.S.Swaminathan.
10. The book of Human Nutrition (1996) MS. Bamji, N. Prahlad Rao and V. Reddy.

III SEMESTER

RESEARCH METHODOLOGY
(CORE COURSE)

Course Code: BCH 303 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

Unit	Unit Title	Intended learning chapter		Hours of instruction
		(K1, K2)	K3, K4 &K5)	
I	**Research Significance & Planning**	Types: Fundamental, Applied- Qualities of Research- Steps involved in Scientific Research.	Selection of a problem- Formulation of Research Problem- Need for literature review- sources of literature- Hypothesis	**12**

			formation – Types of Hypothesis.	
II	**Research Design & Report writing**	Basic principles- Features of a good design-experimental design. Sampling methods: characteristics of a good sample design, probability and non-probability sampling methods.	Components-types of reports – layout of research report-principles of writing – references – appendices-format of publication in research journal-paper presentations: planning, preparation, visual aids-preparation of research proposal.	**12**

References

1. Anthony, M. Graaziono,A.M. and Raulin, M.L.,2009. Research Methods. A Process of Inuiry. Allyn Bacon.
2. Burno, R.B, 2000. Introduction to research methods. New Delhi: Sage publications
3. Colin, S.M and Sheinberg, C.A 1990. Proposal Writing: New Delhi: Sage publications
4. Aay, R.A. 1992. How to Write and publish a scientific paper, Cambridge University Press.
5. Fink, A. 2009. Conducting research literature reviews: From the internet to paper, New Delhi: Sage publications
6. Kothri, C.R. 2004. Research methodology. Methods and techniques. New Delhi. New age International Publishers.
7. Leedy, P.D and Ormrd, J.E.2004: practical research: planning and design New York: prentice hall.
8. Satarkar, S.V.2000. Intellectual property rights and copy rights. ESS publications
9. William, C.G. 1981. Concepts of statistical influence 2nd edition. New York: Mc. Grave hill international

III SEMESTER
BCH 304: QUALITY CONTROL/ LABORATORY MAINTAINANCE
(EXTERNAL ELECTIVE)

Course Code: BCH 304 **Hours: L + T + P = C**
Marks: 100 **4 1 0 5**

Course Objectives
Explain quality and quality control, Define quality,Explain differences between quality control and statistical quality control,Determine several quality concept,Define Quality Assurance System and Total Quality Management, Express the main attributes of Quality Assurance SystemDefine the Total Quality Managemen.

Course Outcomes

CO1. Use the Problem Solving Techniques;
CO2. Distunguish between techniques,
CO3. Apply Problem Solving Techniques;
CO4. Calculate, analyse and interpret quality costs,
CO5. Analyse Measurement System;
CO6. Express the importance of Measurement System and analysis,
CO7. Raise data collection assurance,
CO8. Define Statistical Quality Control,
CO9. Question and interpret production or service quality by using different quality control charts

Unit	Unit Title	Intended learning chapter		Hours of instruction
		(K1, K2)	K3, K4 &K5)	
I	**Essentials of quality control**	Preparations - buffer, solvents, solutions and microbial media for running bio-analytical quality tests, assays to carry out quality control procedures on biopharmaceutical products	Bio analytical and microbiological methods, working of instruments/apparatus/equipment, biological assays, application of various analytical techniques such as HPLC, capillary electrophoresis including FTIR, UV and Fluorescence spectroscopy, ELISAs, enzyme assays and other applicable methods for the	**12**

			testing of biopharmaceutical	
II	**Quality Assurance**	Quality checks - quality assurance samples, master sample, internal controls, statistical analysis of test data, techniques and concepts of statistical quality control and statistical process control, non-conformities.	Operational aspects – calibration, accuracy checks of quality control equipments like stability chambers and BOD incubators, HPLC, gas chromatography, etc., application softwares used in quality analysis Handling Instruments of HPLC, Gas chromatography	**12**
III	**Safety and Security at workplace**	Different types of occupational health hazards, knowledge of chemical substances, characteristics & safety measures, use of safety gears, masks, gloves & accessories, evacuation procedures for workers & visitors	Health, safety & security issues – types (illness, fire accidents), company policies and procedures, When and how to report, summon medical assistance & emergency services	**12**
IV	**Clean work station**	Cleaning the work area and equipments, materials and equipments required for cleaning, adequate ventilation for the work area, personal protective equipments, dealing with accidental damage, procuring and storing housekeeping equipment and supplies, disposal of		

		wastes, maintain schedules and records for housekeeping		
V	**Reporting and documentation in quality**	Reporting – company procedures, escalation matrix for reporting identified issues - defects, problem, incidents, quality issues and test results, feedback to production manager and R&D staff.	Documentation – procedures and good documentation practices, offline and online mode, accuracy, details, controlled document files and test records, regulatory and compliance requirements, inspection - procedures, protocols and checklists, inspection reports.	**12**

References

Text books

1. Quality Assurance Guide by organization of Pharmaceutical Procedures of India, 3rd revised edition, Volume I & II, Mumbai, 1996.
2. Good Laboratory Practice Regulations, 2nd Edition, Sandy Weinberg Vol. 69, Marcel Dekker Series, 1995.
3. Quality Assurance of Pharmaceuticals- A compedium of Guide lines and Related materials Vol I & II, 2nd edition, WHO Publications, 1999.
4. How to Practice GMP's – P P Sharma, Vandana Publications, Agra, 1991.
5. The International Pharmacopoeia – vol I, II, III, IV & V – General Methods of Analysis and Quality specification for Pharmaceutical Substances, Excepients and Dosage forms, 3rd edition, WHO, Geneva, 2005.
6. Good laboratory Practice Regulations – Allen F. Hirsch, Volume 38, Marcel Dekker Series, 1989.

SEMESTER-III
PRACTICAL - I
PRACTICAL EXAM: 6 HRS / DAY: 1

PRACTICAL -1 GENETIC ENGINEERING and INTERMEDIARY METABOLISM

Course Code: BCH(P:301& 302) **Hours: L + T + P = C**
Marks: 100 **0 0 5 4**

COURSE OBJECTIVE

The contents for above practicals are designed to impart hand on experimental knowledge on the various techniques in genetic engineering and biotechnological experiments. This would enable them to design experiment for the production of recombinant products using above molecular techniques.

COURSE OUTCOMES

CO1. To provide students with Conceptual knowledge on emergence of recombinant DNA technology from knowledge gained in biochemistry, genetics, cell biology and molecular biology.
CO2. Overview of the important techniques used in sequencing, amplification and cloning of DNA
CO3. Gain knowledge on the significance of important enzymes and cloning. Able to Importance of different type of vectors available and basis for their construction and selection.

List of Experiments- GENETIC ENGINEERING

1. Isolation of Plasmid DNA mini and maxi, preps
2. Restriction digestion of plasmid, single and double digestion
3. Cloning of genes and their selection
4. Construction of restriction map of a plasmid *insilico* using addgene and restriction mapper
5. Identification of coding region or ORF using ORF finder
6. Design of PCR primers
7. Amplification of DNA by PCR.
8. Purification of DNA fragment from gel by electro elution
9. Purification of DNA fragment from gel by affinity chromatography

List of experiments- INTERMEDIARY METABOLISM

1. Estimation of blood glucose.
2. Estimation of blood urea.
3. Estimation of creatine in serum.
4. Estimation of calcium and phosphorus in the serum

5. Estimation of uric acid in serum.
6. Estimation of serum total proteins.
7. Estimation of serum albumin.
8. Estimation of serum total cholesterol.
9. Estimation of bilirubin
10. Estimaiton of vitamin-C
11. Electrophoretic behavior of serum proteins
12. Field visit – Visiting a neighboring hospital and finding out how the blood is collected and processed in hospital .

References

1. Isolation of Plasmid DNA mini and maxi, preps
2. Restriction digestion of plasmid, single and double digestion
3. Cloning of genes and their selection
4. Construction of restriction map of a plasmid insilico using addgene and restriction mapper
5. Identification of coding region or ORF using ORF finder
6. Design of PCR primers
7. Donald Voet. J.G. Voet and John nwILEY, Biochemistry.
8. Murray et al. Harper's Biochemistry, 26th ed. Mc Graw Hill.
9. Nelson & cox, Lehninger's Principles of Biochemistry, 4th ed. McMillian Worth.
10. Stryer, Biochemistry, 5th ed. Freeman.
11. Biochemistry – Geoffrey L, Zubay, 4th edition.

SEMESTER-III
PRACTICAL - II
PRACTICAL EXAM: 6 HRS / DAY: 1

PRACTICAL -II NUTRITIONAL BIOCHEMISTRY

Course Code: BCH(P:303) **Hours: L + T + P = C**
Marks: 100 **0 0 5 4**

Course objective

The course is an introduction to nutritional biochemistry. The students will learn how nutrients effect biochemical processes and signal transduction pathways, and how this can lead to development of nutritionally related diseases. The laboratory course will give insight in biochemical methods and analyses used in nutritional research.

Course Outcomes

CO1. The paper provides the structural and functional role of cell organelles and cell membrane at the biological level.

CO2. Students will be exposed classification, biochemical and required quantities of nutrients in diet.

CO3. It helps students to understand the nutritive roles of macro and micro nutrients.

List of Experiments

1. Determination of reduced Ascorbic acid by DCPIP method.
2. Determination of total Ascorbic acid by DNPH method.
3. Determination of Thiamine by colorimetry.
4. Determination of copper in food.
5. Determination of calcium in food.
6. Determination of iron in food.
7. Isolation of casein from milk and determination of its protein by any conventional.
8. Determination of cholesterol of edible oil.
9. Determination of ash content.
10. Determination of moisture content of foods/food grains/powders.
11. Determination of lactose from skimmed milk and the estimation of lactose.
12. Determination of pyridoxine of fruits/leaves.

REFERENCES

1. Techniques of Food Analysis – Andrew L Winton and Kate Barber Winton, 2001, Published by Agrobios (India Ltd).
2. Human nutrition and Dietics – Garrow and James, 1996, 9th edition, published by chruchill Livingstone eiNC.
3. Antioxidant status, diet, nutrition and health – Andreas M Papers, 1996, published by CRC Press Washington, DC.
4. Nutritional Biochemistry – Tom Brody, 1994, Academic Press, USA.
5. Food Fundamentals – Margaret Mc Williams, 2nd Swaminathan.
6. Text book of Physiology and nutrition-M. Swaminathan.
7. Harper's Biochemistry
8. Trace Elements by Underwood.
9. Nutrition by M.S.Swaminathan.
10. The book of Human Nutrition (1996) MS. Bamji, N. Prahlad Rao and V. Reddy.

SEMESTER-IV

SUBJECT NAME	COURSE OUTCOME	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
SEMESTER-III													
BCH 401: GENOMICS & PROTEOMICS	Understanding the basic concepts of genomics, metagenomics, proteomics, learning of genomics tool box with special focus on PCR and Non PCR based approaches	✓	✓		✓								✓
	Understanding of DNA microarrays ,Protein arrays, Community genome arrays Phylogenetic oligonucleotide arrays, depth of knowledge on application of Omic technologies in Bioprospecting and Agriculture.	✓						✓	✓			✓	
	Explain the principles and protocols of 2DE, Mass spectrometry analysis MS 2-DE/MS, ICAT			✓					✓		✓		✓
	Training on bioinformatics tools like nBLAST, pBLAST, Multiple	✓	✓	✓		✓			✓		✓	✓	✓

	Sequence Analysis and Gene Annotation of genome sequences Amplification of 16S DNA, Separation and characterizatio n of proteins.												
BCH 402: CLINICAL BIOCHEMIS TRY (CORE COURSE)	Clinical Biochemistry aims to initiate the student in understanding the in vitro study of the biological properties that contribute to the prevention, diagnosis, prognosis and monitoring of diseases and disease states in humans	✓	✓	✓			✓				✓		✓
	Familiarize students with the specific characteristics of a laboratory of clinical biochemistry. It trains the students to gain concepts of assessing the human physiology using biological fluid.	✓	✓	✓				✓		✓		✓	✓
	clinical laboratory techniques to determine biochemical	✓	✓	✓			✓				✓	✓	✓

	and genetic markers of different pathologies and critically assess the results, speculating on the nature of any possible underlying pathologie												
BCH 403: TECHNO ENTRENEUR BIOETHICS	Understand their personal characteristics and interests to that of the "successful" entrepreneur, Identification and assess sources of support for small businesses and entrepreneurs	✓	✓	✓		✓			✓		✓	✓	✓
	Eevaluate methods of entering an entrepreneursh ip venture – including but not limited to starting a new venture, buying an existing business, or becoming a franchisee Acquire idea and information on funding for start-ups	✓	✓	✓		✓			✓		✓	✓	✓
	Different forms of	✓	✓	✓		✓			✓		✓	✓	✓

	patents, terms and conditions of patents												

IV SEMESTER

GENOMICS & PROTEOMICS(SKILL ENHANCEMENT COURSE)

Course Code: BCH(401) **Hours: L + T + P = C**
Marks: 100 **0 0 5 4**

Unit	Unit Title	Intended learning chapter		Hours of instruction
		(K1, K2)	K3, K4 &K5)	
I	**Introduction to omics**	Genomics, Transcriptomics, proteomics, metabolomics and omic data bases. Sequencing by conventional, automated and next generation sequencing approaches- advantages and limitations.	PCR dependent approaches of DNA amplification RFLP, AFLP, T-RFLP, ARDRA,, RISA, DGGE/TGGE, Real-time PCR (q-PCR). PCR-independent amplification approaches- Multiple Displacement Amplification (MDA).	**12**
II	**Microbiome-Metagnomic tools (sequence based and Functional metagenomics**)	Whole genome analysis. Functional genomics and Metagenomic shift.	Pipeline of the metagenomic project. Advantages and limitation of Metagenomics approach. Accessing microbial diversity using culture independent methods. **Culturomics**.	**12**
III	**Proteomic Tools**	Proteome, Functional proteomics,	. Proteome tools – 2-DE Mass spectrometry	**12**

		metaproteome.	analysis MS (ESI-MS/MS) 2-DE/MS, ICAT, Yeast two hybrid analysis; Peptide finger printing. Identification of post-translational modifications: Phosphorylation, Glycosylation, Acetylation	
IV	**Proteome analysis**	Methods for sequencing proteins: Edman degradation.	Sequence based protein prediction: Homology or comparative modeling, Remote homology (Threading), Protein function prediction.	
V	**Microarrays**	DNA and Protein arrays, Analysis of gene expression patterns using labeled probes. Functional gene arrays (FGA), Community genome arrays (CGA) Phylogenetic oligonucleotide arrays-Application and limitations.	Application of omic technologies in Bioprospecting. Integration of omic platforms, interactomics, Systems biology	

References:

TEXT BOOKS

1. Principles of Proteomics by Richard Twyman, Bios Scientific Publishers Tylor and Francis group 2004.
2. Proteomics. S.R. Pennigton and M.J. Dunn Viva books. New Delhi, 2002.
3. Genomes 3 by T.A. Brown, Garland science Tylor and Francis group 2006.
4. Introduction to Genomics by Lesk 2015.
5. Introduction to protein Science: Architecture, Function and Genomics by Lesk 2010 Oxford.
6. Genomics - Fundamentals and Applications by SupratimChoudhuri& David B Carlson 2008.
7. Molecular Cell Biology, Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell 4th edition W.H. Freeman and Company 2000.

8. Genomics and Proteomics Principles, Technologies and Applications by DevarajanThangadurai and JeyabalanSangeetha1 ed. CRC and Apple Academic Press 2015Microarrays for an integrative genomics. A.J. Kohane, IS., Kho, A and Butte Barnes and Nobles, MIT press.
9. Molecular biology Philip C Turner Garland Science2005.

IV SEMESTER

CLINICAL BIOCHEMISTRY (CORE COURSE)

Course Code: BCH(402) **Hours: L + T + P = C**
Marks: 100 **0 0 5 4**

Unit	Unit Title	Intended learning chapter		Hours of instruction
		(K1, K2)	K3, K4 &K5)	
I	**Specimen collection and Blood disorders**	Introduction and maintenance of Clinical Biochemistry laboratory. Collection, preparation and preservation of biological specimens such as blood, urine, CSF, bile, Saliva and faeces.	Disorders of blood – blood diseases (agranulocytosis, thrombocytopenia, hemolytic anemia, hematuria, hemoglobinopathies and thrombosis). Blood clotting mechanism and disorders. Anticoagulants. Tests used to evaluate acid-base status of blood and their significance	**12**
II	**Disorders of Carbohydrate and Lipid Metabolism**	Disorders of carbohydrate metabolism –Hyper and hypoglycemia, regulation of blood glucose, renal threshold, diabetes mellitus- classification, metabolic abnormalities, diagnosis and management. Acute and long term	Atherosclerosis – risk factors, biochemical findings and management Lipid metabolism:- Plasma lipids and lipoproteins and their functions. Hyper lipoproteinemias classification – primary and secondary,	**12**

		complications of diabetes. Glucose tolerance test, glycosylated hemoglobin, glycogen storage diseases, galactosemia, fructosuria, pentosuria, ketone bodies.	Cardiovascular disorders.	
III	**Inborn errors of amino acid metabolism and clinical enzymology**	non-protein nitrogenous constituents in blood - urea, uric acid and creatinine. Plasma protein abnormalities - deficiency, agammaglobulinemia, Phenylketonuria, alkaptonuria, albinism, Hartnup's disease and maple syrup urine disease, multiple myeloma, homocystinuria, histidinuria, disorders of urea cycle.	Clinical Enzymology – Diagnostic applications of Enzymes, clinical significance of Asparatate transaminase, Creatine kinase, Lactate dehydrogenase, amylase, r-glutamyl transferase. Disorders of thyroid secretions and thyroid functional tests.	**12**
IV	Disorders of Gastrointestinal Tract	Composition of gastric juice, Gastric function. Stimulation of gastric secretin, Composition of gastric secretin. Test for gastric function – fractional test meal. Pentagastrin test, hyperchlorohydria, achlorohydria, achylia gastric	Liver function tests related to protein, carbohydrate, lipid, pigment metabolism, detoxification and excretion. Jaundice – classification and differential diagnosis. Kernicterus Renal function: Glomerular and tubular functions. Tests for evaluation: Concentration, dilution, excretion,	**12**

			creatinine clearance tests, nephritic syndrome.	
V	Cancer:	Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, mechanisms of protooncogene activation. cancer and the cell cycle, virus-induced cancer, interaction of cancer cells with normal cells, therapeutic interventions of uncontrolled cell growth, Cancer stem cells, embryonic signature in cancer stem cells, stem cell markers and factors. Apoptosis and Necrosis.	Tumor markers- AFP (alpha fetoprotein), CEA (carcino embryonic antigen), hcG (human chorionic gonadatropin), Carcinogenic agents. Agents causing cancer: Oncogenes and tumor suppressor genes – Institutional Ethics Committee and clinical trials, etc	

REFERENCES:

TEXT BOOKS

1. Mayne, Clinical Chemistry in Diagnosis and Treatment, ELBS.
2. Mosby, Clinical Chemistry Marshall 5th Ed.
3. Harrison's Principles of Internal Medicine. Vol 1 and 2, 14thed. Mc Graw Hill.
4. Williams and Wilkins, 2006, Biochemistry and Disease, Cohn and Roth.
5. Harper's 2013. Biochemistry, 26th ed. Mc Graw Hill.
6. Mosby, Biochemistry – A Case Oriented Approach Montgomery et al.
7. Varley's Practical Clinical Biochemistry – Alan H Gowenlock, published by CBS Publishers and distributors, 2008, 6th edition India.
8. Textbook of Biochemistry with clinical correlations – T.M.Devlin, 2002, 5th edition.

Biochemistry: A case oriented approach – Montogomery, Comway, Spector, Cappell, 1996

IV SEMESTER

TECHNO ENTRENEURSHIP & BIOETHICS

Course Code: BCH(402) **Hours: L + T + P = C**
Marks: 100 **0 0 5 4**

Unit	Unit Title	Intended learning chapter		Hours of instruction
		(K1, K2)	K3, K4 &K5)	
I	**Biosafety and Bioethics**	Biosafety, Definition, Requirement Biosafety and biodiversity, Biosafety for human health and environment, Social and ethical issues, Biosafety in relation to transgenic research and applications.	Regulations for clinical trials, Documentation and Compliance, in India and selected countries - Rules for import and export of biological materials	**12**
II	**Regulatory Procedures**	Good laboratory practice, Good manufacturing practice and FDA regulations	Regulations for Animal ethical committee, Human ethical committee recombinant DNA research and manufacturing process. Disposal of biomedical, chemical waste and animal waste.	**12**
III	**Entrepreneurship Development**	Significance of Entrepreneurship in Economic Development; Characteristics, qualities and pre – requisites of entrepreneur. Business opportunities identification-- Generation of Ideas; screening of Ideas	Steps involved in preparations for a New Venture Concept of SME's, Govt. support to new enterprise; Source of Finance; Entrepreneurship Development Programmes (EDP); Emerging trends in	**12**

		and Selection; Identifying new Projects; Preparing Project Profiles, Feasibility Study of project.	Entrepreneurship: Technopreneurship, netpreneurs, agripreneurs, Women entrepreneurship, Portfolio entrepreneurship, Franchising.	
IV	**Intellectual property**	Fundamentals regarding intellectual property (IP), intellectual property protection (IPP) and intellectual property rights (IPR). TRIPs (Trade Related Intellectual Property Rights) and GATS (General Agreement on Trade in Services).	OECD guidelines for chemical testing pertaining to use as drug, related substances, excipients, toxicity, etc. WHO guidelines for standardization of raw material and finished products including herbal products.	**12**
V	**Patent and Copy Rights**	Indian Patent Act 1970 and the Product Patent Regime, 2005; Patent application-forms and guidelines, fee structure, time frames, jurisdiction aspects; Filing of a patent application; specialized services-search requests, costs;	Types of patent applications-provisional, non provisional, PCT and convention patent applications; Patent infringement. Copy rights - Publication-article / thesis	**12**

References:

Text Books

1. Sree Krishna V 2007.Bioethics and Bio safety in Biotechnology., New Age International (P) Ltd., Publ., Mumbai. 2007
2. Deborah E. Bouchoux., 2005.Intellectual Property Rights. Delmar Cenage Learning.
3. The Indian Environmental Protection Act (EPA), 1986
4. Rules for manufacture, use/import/export and storage of hazardous microorganisms or cells Act, 1989
5. Food Safety and Standards act (Government of India), 2006
6. Singh, KC, 2016.Intellectual Property Rights on Biotechnology Central Law Agency..BCIL, New Delhi.

7.Eric Ries,.2020.The Lean Startup: How Constant Innovation Creates Radically Successful Businesses Kindle Edition
8. Dhruv Nath and Sushantho Mitra. 2020. Funding for your Start ups:and other nightmares. Kindle edition.

SEMESTER-IV
PRACTICAL - I
PRACTICAL EXAM: 6 HRS / DAY: 1

PRACTICAL -I GENOMICS & PROTEOMICS

Course Code: BCH(P:401) **Hours: L + T + P = C**
Marks: 100 **0 0 5 4**

Course objective

The course is an introduction to nutritional biochemistry. The students will learn how nutrients effect biochemical processes and signal transduction pathways, and how this can lead to development of nutritionally related diseases. The laboratory course will give insight in biochemical methods and analyses used in nutritional research.

Course Outcomes

CO1. The paper provides the structural and functional role of cell organelles and cell membrane at the biological level.

CO2. Students will be exposed classification, biochemical and required quantities of nutrients in diet.

CO3. It helps students to understand the nutritive roles of macro and micro nutrients.

List of Experiments

1. Polyacrylamide gel electrophoresis of serum proteins
2. Glucose tolerance test
3. Estimation of Calcium
4. Estimation of serum cholesterol, lipoproteins.
5. Determination of SGOT.
6. Determination of SGPT.
7. Estimation of serum phosphate.
8. Estimation of serum bilirubin
9. Estimation of creatine in serum
10. Determination of urine Protein
11. Tests for abnormal constituents in urine
12. Field visit – Visiting a neighboring hospital and finding out how the blood is collected and processed in hospital.

Project **200M**

Biochemistry is **a branch of science. The subject explores the chemistry of living organisms and that of their biological processes**. Biochemistry deals with the chemical combinations and reactions that takes place because of the biological processes such as growth, reproduction, metabolism, heredity, etc.Biochemistry is considered as one of the most important areas of research that yield far-reaching discoveries. Combining the core concepts of various disciplines (primarily Chemistry and Biology), **Biochemistry plays an essential role in the development of groundbreaking scientific methods and approaches**.