REVA UNIVERSITY
Bengaluru, India

(School of Applied Sciences)
M.Sc. Biochemistry
HANDBOOK
2020

Rukmini Knowledge Park
Kattigenahalli, Yelahanka, Bengaluru – 560064
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www.reva.edu.in

REVA UNIVERSITY
Bengaluru, India

SCHOOL OF APPLIED SCIENCES

M. Sc (Biochemistry) Program

Hand Book

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Rukmini Educational
Charitable Trust

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Chancellor's Message

"Education is the most powerful weapon which you can use to change the world."
- Nelson Mandela.

There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it. Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look forinformation and those who look for knowledge.

It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is Power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts in to develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centred and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me and I believe, it takes team-work to build successful institutions. I w elcome you to REVA University to join hands in laying the foundation of your future withvalues, wisdom and knowledge.

Dr.P.Shyama Raju
The Founder and Hon'ble Chancellor
REVA University

Vice-Chancellor's Message

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of REVA University.

At REVA University, research, consultancy and innovation are regarded as our pillars of

success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students. REVA University has entered intocollaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% placement of eligible students speaks theeffectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centres" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise.

With firm faith in the saying, "Intelligence plus character –that is the goal of education" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavour to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr. S. Y. Kulkarni
Vice-Chancellor, REVA University

MESSAGE FROM THE DIRECTOR

Biochemistry as interdisciplinary subject assimilates in itself a number of disciplines and as such has grown rapidly. M Sc in Biochemistry offered by REVA University aims to provide the required skills and knowledge necessary to pursue a successful career in Biochemistry. This program imparts need based, practical education in contemporary world to develop global competence among students. It strives to prepare students to become leaders in the field of Life Sciences in general and Biochemistry in particular by encouraging them to inculcate scientific thinking coupled with creative and innovative ideas.

The program provides hands- on training and practical skills in the field of Plant &Industrial Biochemistry, Microbiology, Bioinformatics, Molecular Biology, Protein chemistry& Enzymology, Clinical Biochemistry, Genetic Engineering and Molecular biology aligning to current demand in the field of research & industry.

As far as employment is concerned Biochemistry has become one of the fast-growing sectors. Employment record shows that Biochemistry has a great scope in future. Biochemists can find careers with pharmaceutical companies, chemical, health and allied companies. They can be employed in the areas of planning, production and management of bio-processing industries. Thereis a large-scale employment in research laboratories run by the government as well as the corporate sectors. Further, there is great demand for Biochemistry experts in numerous industries and sectors after the completion of MSc Biochemistry course, some of which are: Agriculture, Animal Husbandry, Environment Conservation, Genetic Engineering, Health Care, Medicine, Industrial Research and Development.

The curriculum caters to and has relevance to local, regional, national, global developmental needs. Maximum number of courses are integrated with cross cutting issues with relevant to professional ethics, gender, human values, environment and sustainability.

This handbook provides you outline of regulations for master's degree, scheme of instruction, and detailed syllabus. I am sure the students choosing MSc Biochemistry at REVA University will enjoy the curriculum, teaching and learning environment, the vast infrastructure and the experienced teacher's involvement and guidance. We will strive to provide all needed comfort and congenial environment for their studies. I wish all students a pleasant stay at REVA and grand success in their career.

Dr. Beena G
Director
School of Applied Sciences

PREFACE

M.Sc. Biochemistry conceived by REVA University is an intensive intellectually challenging programme intended to provide students the deeper knowledge in Biochemistry in general and Applied Biochemistry in particular. It also facilitates students to acquire many transposable skills, gain research and industrial experience in contemporary Biochemistry. The curriculum apart from important Hard Core courses covers good number of specialized courses as electives in the areas of Bioinformatics, Food Technology, Pharmacovigilance and SAS, Clinical Biochemistry and Diagnostics, and Plant & Industry Biochemistry. The short term training in industries / R & D institutions, Internships, Student Projects in Biochemistry, Clinical Research, SAS, Clinical Diagnostics provide opportunity for the students to choose and acquire in-depth knowledge and skills in their area of interest.

The students may also choose fast track learning and acquire additional Proficiency Certificate or Diploma in addition to the curriculum. Interactions with Industries, Diagnostic Laboratories, and Research Institutes are achieved through industrial visits, internships, training in industries and research labs in R & D institutions. To ensure this the University has established collaborations and entered into MOUs with various industries and research institutions. To mention a few:

- FRLHT-The Trans disciplinary University
- CIMAP- CSIR Laboratory
- CIFT & other Central Institutes
- Himalaya Drug Company
- Clinical Research Institutes

These initiatives would not only broaden the exposure of the students but also help them to acquire deeper knowledge and better skills. The students thus will have greater opportunities of employment in reputed Chemical, Biological, Healthcare, Pharmaceutical, Agriculture, Petrochemicals, Cosmetics, Food Industries, Clinical data management industries and Diagnostic Laboratories. They will also have better opportunities to join as research scholars in different R & D institutions within the country and abroad.

I am sure the students choosing MSc Biochemistry at REVA University will enjoy the curriculum, teaching and learning environment, the vast infrastructure and the experienced teachers involvement and guidance. We will strive to provide all needed comfort and congenial environment for their studies. I wish all students a pleasant stay at REVA and grand success in their career.

Prof. Jayashree. S
Head, M Sc Biochemistry Program

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RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of Rukmini Educational Charitable Trust (RECT), in the year 2002. Rukmini Educational Charitable Trust (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group ofEducational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfil its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of theTrust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his ownright and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond road park, building and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has well qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 15,000+ students study various courses

across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and conducive environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of Government of Karnataka and notified in Karnataka State Gazette No. 80 dated 27thFebruary, 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom and patriotism to face the global challenges and become the top leaders of the country and the globein different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer centre, the well planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

REVA consistently ranked as one of the top universities in various categories because of the diverse community of international students and its teaching excellence in both theoretical and technical education in the fields of Engineering, Management, Law, Science, Commerce, Arts, Performing Arts, and Research Studies. REVA offers 28 Undergraduate Programmes, 22 Full-time and 2 Part-time Postgraduate Programmes, 18 Ph. D Programmes, and other Certificate/ Diploma/Postgraduate Diploma Programmes in various disciplines.

The curriculum of each programme is designed with a keen eye for detail by giving emphasis on hands-on training, industry relevance, social significance, and practical applications. The University offers world-class facilities and education that meets global standards.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed

universities / institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the capabilities to surpass others. These programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners soas to give them the needed input and build in them confidence and courage to move forwardand accomplish success in their career. The University has also entered into MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and also assisting students' placements.

REVA University recognizing the fact that research, development and innovation are the important functions of any university has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology and other areas of study. The interdisciplinary-multidisciplinary research is given the top most priority. The division continuously liaisons between various funding agencies, R&D Institutions, Industries and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fuel Mechanics, Operation Research, Graph theory,

Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to develop the much required skills through variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experiencedProfessor& Dean, and supported by well experienced Trainers, Counsellors and Placement Officers.

The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal VikasYojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Okalahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC^2, VMware, SAP, Apollo etc, to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitates students to study some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing and developing different quality tools, implementing them and

monitoring the implementation of these quality tools. It concentrates on training entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists and such others from time to time. As a part of this exercise great personalities such as Bharat RatnaProf. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr.Balaram, Former Director IISc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of DefenceDr.Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted ourinvitation and blessed our students and faculty members by their inspiring addresses and interaction.

REVA organises various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events the students are given opportunities tounfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVAMP conducted every year. The event not only gives opportunities to students of REVA but also students of other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions and variety of cultural events. Another important event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in a right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognised by distributing awards and prizes. The founders have also instituted medalsand prizes for sports achievers every year. The physical education department conducts regularyoga class's every day to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

Vision

REVA University aspires to become an innovative university by developing excellent human resources with leadership qualities, ethical and moral values, research culture and innovative skills through higher education of global standards

Mission

- To create excellent infrastructure facilities and state-of-the-art laboratories and incubation centres
- To provide student-centric learning environment through innovative pedagogy and education reforms
- To encourage research and entrepreneurship through collaborations and extension activities
- To promote industry-institute partnerships and share knowledge for innovation and development
- To organize society development programs for knowledge enhancement in thrust areas
- To enhance leadership qualities among the youth and enrich personality traits, promote patriotism and moral values.

Objectives

- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines
- Smooth transition from teacher - centric focus to learner - centric processes and activities
- Performing all the functions of interest to its major constituents like faculty, staff, students and the society to reach leadership position
- Developing a sense of ethics in the University and Community, making it conscious of its obligations to the society and the nation
- Accepting the challenges of globalization to offer high quality education and other services in a competitive manner

ABOUT THE SCHOOL OF APPLIED SCIENCES

The School of Applied Sciences offers graduate and post graduate programs in Biochemistry, Biotechnology, Chemistry, Physics and Mathematics which are incredibly fascinating. It aims to attract talented youth and train them to acquire knowledge and skills useful to industrial sectors, research laboratories, and educational institutions. The School presently offers M.Sc. degree programs in Bio-Chemistry, Bio-Technology, Chemistry, Physics, Mathematics and B Sc with various combinations viz, Physics Chemistry and Mathematics, Mathematics, Physics and Statistics, Mathematics Statistics and Computer Science, Biochemistry, and Biology Mathematics & Computer Science and also Post Graduate Diploma in Clinical Research Management. The School also facilitates research leading toPhD in Biochemistry, Biotechnology, Physics, Chemistry, Mathematics and related areas of study.

The School of Applied Sciences is shouldered by well qualified, experienced and highly committed faculty. The state-of-the-art infrastructure digital classrooms, well equipped laboratories, conference rooms and the serene academic atmosphere at REVA University will enhance the transfer as well as creation of knowledge. The school provides an interactive, collaborative peer tutoring environment that encourages students to break down complex problems and develop strategies for finding solutions across a variety of situations and disciplines. The school aims to develop a learning community of critical thinkers who serves as models of innovative problems solving in the university environment to enrich their academic and professional careers.

Vision

To nurture intellect, creativity, character and professionalism among students and impart contemporary knowledge in various branches of Chemical, Biological, Physical and Mathematical Sciences that are socially relevant and transform them to become global citizens.

Mission

To achieve excellence in studies and research through pedagogy and support interface between industry and academia

ABOUT THE DEPARTMENT OF BIOCHEMISTRY

Department of Biochemistry comes under school of Applied sciences, has been established to meet the requirements in current research and development to understand biomolecule and cell biochemistry. Department has well established laboratories equipped with HPLC, Spectrophotometer, LAF, -80 ^{0}C freezer, Centrifuge, BOD, Microscope, diagnostic analysers, etc. Department faculties are well qualified and expertise in their respective biochemistry domain. Biochemistry Department has various research funded projects such as Alcohol Induced Oxidative and Nitrosative Stress and Epigenetic Changes in the pathogenesis of Alcohol Liver Disorders with the role of transcriptional factors - HIF-1 & 2α, green synthesis of nano-particle as antimicrobial, inflammatory response in tissue, plant secondary metabolites as immune booster, biochemistry of diabetes and so on. The programme is designed as per demand in biotech industries, pharmaceuticals, food processing, agriculture, biomedical devices and health sector. All biochemistry practical and research projects are guided under specialized faculties with well-trained lab technicians. Students have choice for project and internship in reputed research institutes or companies such as Central Food Technology Research Institute (CFTRI), FRLHT-The Trans disciplinary University, CIMAP-a CSIR Laboratory, CIFT and other Central Institutes, CIPLA Pharmaceuticals, Himalaya Drug Company, Elbit & ChanRe Diagnostics Laboratory, Clini India - Clinical Research Institute, Biocon, Medreich Pharma, Jampa groover and Fortes Research System India Pvt. Ltd

BOS MEMBERS

Name and Position	
Dr. Jayashree S Prof. and HOD School of Biochemistry, REVA University jayashree.s@reva.edu.in	**Chairperson**
Dr. U.V Babu, Head, Research and Development, Himalaya Drug Company, Yeshwanthpur, Bangalore. dr.babu@himalayawellness.com	**External member**
Dr. Dhamodhar P Associate Professor, Department of Biotechnology, M. S. Ramaiah Institute of Technology dhamu.bio@gmail.com	**External member**
Dr. Senthil Duraisamy Founder- Managing Director Pharma Genica Healthcare Pvt Ltd senthildu@gmail.com	**External member**
Dr. V. Veeraraghavan Professor, School of Biochemistry, REVA University veera.raghavan@reva.edu.in	**Internal member**
Dr. Ramesh Kumar Kushwaha Assistant Professor, School of Biochemistry, REVA University rameshkumar.k@reva.edu.in	**Internal**
Dr. Sikandar Mulla Assistant Professor, School of Biochemistry, REVA University sikandar.mulla@reva.edu.in	**Internal**

M. Sc (Biochemistry) Program Overview

Programme Overview

Biochemistry explores the chemical processes within and related to living organisms. The subject focuses on processes happening at a molecular level. It focuses on what's happening inside our cells by studying components like proteins, lipids and organelles. It also looks at how cells communicate with each other, for example during growth or fighting illness. Biochemists need to understand how the structure of a molecule relates to its function, allowing them to predict how molecules will interact.

By using chemical knowledge and techniques, biochemists can understand and solve biological problems. Biochemistry covers a range of scientific disciplines, including genetics, microbiology, forensics, plant science and medicine. Because of its breadth, biochemistry is veryimportant and advances in this field of science over the past 100 years have been staggering. It's a very exciting time to be part of this fascinating area of study.

Biochemists find opportunities in Hospitals, Universities, Agriculture, Food institutes/organisations, Cosmetics, Forensic crime research, Drug discovery and development, and many other sectors.

In India, the hospital, pharmaceutical, food processing and agricultural sectors are all growing at a significant rate and development of biotech industries is being given prime importance by the Government of India to make it $100 billion industry by 2025, creating greater opportunities for Biochemists.

In this context, University Programme in Biochemistry at postgraduate level in India remains relevant for the creation of trained human resources.

M. Sc. (Biochemistry) at REVA UNIVERSITY has been designed to meet the human resources needs of existing and futuristic biotech industries and biotech research organizations involved in pharmaceuticals, food processing, agriculture, biomedical devices development; academic institutions and hospitals. The programme is designed to produce graduates with higher order critical, analytical, problem solving and research skills; ability to think rigorously and independently to meet higher level expectations of biotech industries, research organizations, hospitals and academic institutions. The programme in addition to core courses covers a number of specialized electives in the areas of Bioinformatics, Food Technology, Pharmacovigilance and SAS, Clinical Biochemistry and Diagnostics, and Plant & Industrial Biochemistry. The short-term training in industries / R & D institutions, Internships, Student Projects in Biochemistry, Clinical Research, SAS and Clinical Diagnostics provide opportunity for the students to choose and acquire in-depth knowledge and skills in their area of interest.

Program Educational Objectives (PEOs)

PEO-1	Become a professional biochemist with strong ethics and communication skill
PEO-2	Pursue carrier in reputed industry and diagnostic laboratories
PEO-3	Explore idea in research and consultancy services to develop new process and product

Program Outcomes (POs)

PO-1: Science knowledge: Apply the knowledge of different fundamentals of life sciences including healthcare considering public health and safety, and the cultural, societal, and environmental concerns.

PO-2: Problem analysis: Identify, design and analyse problems related to the various domains of Biochemistry such as Clinical Biochemistry, Agricultural Biochemistry, Genetic Engineering, Molecular Biology, Food biochemistry and enzymatic diagnosis.

PO-3: Conduct investigations of complex problems: Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO-4: Modern tool usage: Identify, select the methodology, and apply appropriate techniques, resources, and modern technology for product/process development which in turn benefit the society.

PO-5 Environment and sustainability: Understand and implement environmental-friendly approaches in Biochemistry to support sustainable development.

PO-6: **Ethics:** Apply ethical principles and commit to professional ethics, responsibilities and norms in life sciences.

PO-7: **Individual and team work**: Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO-8: Communication: Communicate effectively with the science community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO-9: Project management and finance: Prove knowledge and understanding of Biochemistry and management principles and apply these to research work, as a member and leader in a team. Manage projects in interdisciplinary field.

PO-10: Life-long learning: Recognize the need for, and have the preparation as well as ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

After successful completion of the programme, the graduates shall be able to

PSO-1: Work as scientist or biochemist experts in industries and research organizations in a team with further training.

PSO-2: Develop strong ethics and communication as consultant with lifelong learning attitude.

PSO-3: Use higher order critical, analytical skill to solve a new problem.

REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Postgraduate Degree programs- 2020

(Framed as per the provisions under Section 35 (ii), Section 7 (x) and Section 8 (xvi) & (xxi) of the REVA University Act, 2012)

1. Title and Commencement:

1.1. These Regulations shall be called the **"REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Post Graduate Degree Programs- 2020".**

1.2. These Regulations shall come into force from the date of assent of the Chancellor.

2. The Programs:

The following programs and all Graduate Degree programs to be instituted and introduced in REVA University in coming years shall follow these regulations.

M. Sc in:

Biochemistry
Biotechnology
Chemistry
Physics
Mathematics

3. Definitions:

Course: Every course offered will have three components associated with the teaching-learning process of the course, namely:

(i) L= Lecture (ii) T= Tutorial (iii) P=Practice; where:

L stands for **Lecture** session consisting of classroom instruction.

T stands for **Tutorial** session consisting participatory discussion / selfstudy/ desk work/ brief seminar presentations by students and such other novel methods that make a student to absorb and assimilate more effectively the contents delivered in the Lecture classes.

P stands for **Practice** session and it consists of Hands on Experience / Laboratory Experiments / Field Studies / Case Studies that equip students to acquire the much-required skill component.

4. Courses of study and Credits

4.1. The study of various subjects in M. Sc., degree program is grouped under variouscourses. Each of these course carries credits which are based on the number of hours of teaching and learning.

4.1.1. In terms of credits, every **one-hour session of L amounts to 1 credit per Semester.**
In terms of credits, every **one-hour session of L amounts to 1 credit per Semester** and a minimum of **two-hour session of T or P amounts to 1 credit per Semester** over a period of one Semester of 16 weeks for teaching-learning process.

4.1.2. The total duration of a semester is 20 weeks inclusive of semester-end examination.

4.1.3. A course shall have either or all the four components. That means a course may have only lecture component, or only practical component or combination of any two or all the three components.

4.1.4. The concerned BOS will assign Credit Pattern for every course based on the requirement. However, generally, courses can be assigned with 1-4 Credits depending on the size of the course.

4.1.5. Different **Courses of Study** are labelled and defined as follows:

Core Course:
A course which should compulsorily be studied by a candidate as a core-requirement is termed as a Core course. The CORE courses of Study are of THREE types, viz – (i) Hard Core Course, and (ii) Soft Core Course.

a. Hard Core Course (HC):

The **Hard-Core Course** is a Core Course in the main branch of study and related branch(es) of study, if any that the candidates have to complete compulsorily.

b. Soft Core Course (SC):

A Core course may be a **Soft Core** if there is a choice or an option for the candidate to choose a course from a pool of courses from the main branch of study or from a sister/related branch of study which supports the main branch of study.

c. Open Elective Course:

An elective course chosen generally from other discipline / subject, with an intention to seek exposure to the basics of subjects other than the main discipline the student is studying is called an O**pen Elective Course.**

d. Project Work / Dissertation:

Project work / Dissertation work is a special course involving application of knowledge in solving / analysing /exploring a real-life situation / difficult problem. A project work carrying **FOUR or SIX** credits is called **Minor Project** work / **Dissertation.** A project work of **EIGHT, TEN, TWELVE or SIXTEEN** credits is called **Major Project** work / **Dissertation**. **A Project work may be a hard core or a Soft Core as decided by the BoS / concerned.**

5. Eligibility for Admission:

Bachelor's degree of 3 years with Biochemistry, Chemistry, Microbiology, Agriculture Sciences, Animal Sciences, Medical Laboratory Technology (B. Sc. MLT), Life Sciences as Biochemistry as principal or subsidiary subject with 45% (40% in case of SC/ST) of marks in aggregate form any recognized University/ Institution or eligible for admission to the program.

6. Scheme, Duration and Medium of Instructions:

6.1. M.Sc., degree program is of 4 semesters - 2 years duration. A candidate can avail amaximum of 6 semesters (3 years) including blank semesters, if any to successfully completeM. Sc. degree. Whenever a candidate opts for blank semester, he/she has to study the prevailing courses offered by the School when he/she resumes his/her studies.

6.2. The medium of instruction shall be English.

7. Credits and Credit Distribution

7.1. A candidate has to earn 96 credits for successful completion of Two-Year Postgraduate degree with a distribution of credits for different courses as given in Table - 1 given below:

Table-1

Credits and Credit Distribution for Two Year Post Graduate degree programs

Course Type	**Credits for Two Year (4 Semesters) Post Graduate Degree Programs**
Hard Core Course	80
Soft Core Course	6
Open Elective	4
RULO	6
Total	**96**

7.2. The concerned BOS based on the credits distribution pattern given above shall prescribe the credits to various types of courses and shall assign title to every course including project work, practical work, field work, self-study elective, as **Hard Core (HC) or Soft Core (SC) or Open Elective (OE)**.

7.3. Every course including project work, practical work, field work, self-study elective should be entitled as Hard Core (HC) or Soft Core (SC) or Open Elective (OE) by the BoS concerned.

However, following shall be the

RULO (REVA Unique Learning Offering) courses with credits mentioned against them, common to all branches of study. However, the BOS of respective program/discipline shall decide about the total credits for RULO courses.

Sl. No.	**Course Title**	**Number of Credits**
1	Sports/Yoga/Music/Dance/Theatre	2
2	SWAYAM/MOOC/Coursera/Soft Skill/Short term training	4
	Total	6

7.4. The concerned BOS shall specify the desired Program Objectives, Program Educational Objectives, Program Specific Outcomes and Course Outcomes while preparing the curriculum of a particular program.

7.5. A candidate can enrol for a maximum of 28 credits and a minimum of 16 credits per Semester. However, he / she may not successfully earn a maximum of 28 credits per semester. This maximum credit does not include the credits of courses carried forward by a candidate.

7.6. Only such full time candidates who register for a minimum prescribed number of credits in each semester from I semester to IV semester and complete successfully 96 credits in 4 successive semesters shall be considered for declaration of Ranks, Medals, Prizes and areeligible to apply for Student Fellowship, Scholarship, Free ships, and such other rewards / advantages which could be applicable for all full time students and for hostel facilities.

8. Add-on Proficiency Certification / Diploma:

8.1 Add- on Proficiency Certification:

To acquire Add on Proficiency Certification a candidate can opt to complete a minimum of 4 extra credits either in the same discipline /subject or in different discipline / subject in excess to 96 credits for the Two Year Post Graduate degree programs.

8.2 Add on Proficiency Diploma:

To acquire Add on Proficiency Diploma, a candidate can opt to complete a minimum of 8 extra credits either in the same discipline /subject or in different discipline / subject in excess to 96 credits for the Two Year Post Graduate degree programs.

The Add on Proficiency Certification / Diploma so issued to the candidate contains the courses studied and grades earned.

9. Assessment and Evaluation

a) Each course is assessed for a total weight of 100%. Out of the total 100% weight; 50% weight is for Continuous Internal Assessment (CIA or IA) and the remaining 50% for the Semester End Examination (SEE). This applicable for theory, laboratory, workshop, studio and any suchcourses

b) Out of 50% weight earmarked for Internal Assessment (IA)- 15% for test-1, 15% for test-2 and 20% for Assignments and this is applicable for theory-based courses

c) The tests and assignments are conducted as per the semester academic calendar provided by the University

The details as given in the table

Component	Description	Conduction	Weight Percentage
C1	**Test-1: IA1**	**6th week from the starting date of semester**	**15**
	Test-2: IA2	**12th week from the starting date of semester**	**15**
C2	**Assignment (1&2)**	**7th week**	**10**
C3	**Seminar (1&2)**	**13th week**	**10**
C4	**SEE including practical**	**between 17th Week-20th Week**	**50**
Results to be Announced			**By the end of 21st Week**

Note: IA or CIA includes C1 and C2

Each test must be conducted for a duration of 60 minutes, setting the test question paper for a maximum of 30 marks. The final examination must be conducted for a duration of 3 hours and the question paper must be set for a maximum of 100 marks.

d) Students are required to complete courses like technical skills, placement related courses, Open electives and any such value addition or specialized courses through online platformslike SWAYAM/NPTEL/Coursera Any other reputed online education aggregator. Students are required to choose the courses on the advice of their course coordinator/Director and required to submit the course completion certificate along with percentage of marks/grade scored in the assessment conducted by the online education aggregator. If the online education aggregator has issued a certificate along with the grade or marks scored to students, such courses will be considered for SGPA calculations, in case the aggregator has issued only a certificate and not marks scored, then such courses will be graded through an examination by concerned School, in case, if grading is not possible, students will be given a pass grade and award the credit and the credits will not be considered for SGPA calculations. The Online/MOOCs courses will not have continuous internal assessment component

Such of those students who would like to discontinue with the open elective course that they have already registered for earning required credits can do so, however, they need to complete the required credits by choosing an alternative open elective course.

Setting question paper and evaluation of answer scripts.

i. For SEE, three sets of question papers shall be set for each theory course out of which two sets will be by the internal examiners and one set will be by an external examiner. In subsequent years by carrying forward the unused question papers, an overall three sets of question papers should be managed and depending on the consumption of question papers either internal or external examiner be called for setting the question paper to maintain an overall tally of 3 papers with the conditioned mentioned earlier. The internal examiner who sets the question paper should have been course tutor

ii. The Chairman of BoE shall get the question papers set by internal and external examiners.

iii. The Board of Examiners shall scrutinize and approve the question papers andscheme of valuation. It is the responsibility of the BoE to see that all questions

contained in the question paper are within the prescribed syllabus of the concerned course.

iv. There shall be single valuation for all theory papers by internal examiners. However, there shall be moderation by the external examiner who has the subject background. In case no external examiner with subject background is available, a senior faculty member within the discipline shall be appointed as moderator.

v. The SEE examination for Practical work / Field work / Project work/Internship will be conducted jointly by internal and external examiners as detailed below: However, the BoE on its discretion can also permit two internal examiners.

vi. If a course is fully of (L=0): T:(P=0) type or a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for SEE component will be as decided by the BoS concerned.

10. Evaluation of Practical's and Minor Project / Major Project / Dissertation

10.3.1 A practical examination shall be assessed on the basis of:

a) Regular assessment while during practical classes

b) Knowledge of relevant processes;

c) Skills and operations involved;

d) Results /products including calculation and reporting.

10.3.2. In case a course is fully of P type (L=0: T=0:P=4), the performance of a candidate shall be assessed for a maximum of 100 marks as explained below:

a) Continuous Internal assessment (CIA) = 50 marks

b) Semester end practical examination (SEE) = 50 marks

The 25 marks for continuous assessment shall further be allocated as under (IA or CIA):

I	Conduction, assessment of regular practical and discipline maintained by the students throughout the semester	20 marks
Ii	Maintenance of lab records	10 marks
Iii	Laboratory test and viva	20 marks
	Total	50 marks

The 50 marks meant for Semester End Examination, shall be allocated as under:

I	Conduction of semester end practical examination and assessment of the performance	30 marks
Ii	Write up about the experiment / practical conducted/spotter	10 marks
Iii	Viva Voce	10 marks
	Total	50 marks

10.3.3. The SEE for Practical work will be conducted jointly by internal and external examiners. However, if external examiner does not turn up, then both the examiners will be internal examiners.

10.3.4. In case a course is partly P type i.e, (L=3): (T=0) (P=1), then the examination for SEE component will be as decided by the BoS concerned.

10.3.5. The duration for semester-end practical examination shall be decided by the concerned School Board.

10.4. Evaluation of Minor Project / Major Project / Dissertation:

Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the supervisor. At the end of the semester, the candidate has to submit

final report of the project / dissertation, as the case may be, for final evaluation. The components of evaluation are as follows:

1	First Dissertation presentation describing the problem definition	Should be done a semester before the project semester	Weightage: 0%
2	Dissertation Progress presentation-1	7th week from the start date of project semester	Weightage: 25%
3	Dissertation progress presentation-2	14th Week from the start date of project semester	Weightage -25%
4	Final project Viva and Dissertation Submission	17th -20th Week of project Semester	Weightage: 30% for Dissertation Weightage: 20% for Final Viva Voce

11. Provision for Appeal

If a candidate is not satisfied with the evaluation of C1,C2 components, he/she can approach the grievance cell with the written submission together with all facts, the assignments, test papers etc, which were evaluated. He/she can do so before the commencement of semester-end examination. The grievance cell is empowered to revise the marks if the case is genuine and is also empowered to levy penalty as prescribed by the university on the candidate if his/her submission is found to be baseless and unduly motivated. This cell may recommend taking disciplinary/corrective action on an evaluator if he/she is found guilty. The decision taken by the grievance cell is final.

For every program there will be one grievance cell. The composition of the grievance cell is as follows: -

- The Registrar (Evaluation) - Ex-officio Chairman / Convener

- One Senior Faculty Member (other than those concerned with the evaluation of the course concerned) drawn from the school / department/discipline and/or from the sister schools / departments/sister disciplines – Member.

- One Senior Faculty Members / Subject Experts drawn from outside the University school / department – Member.

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12. Eligibility to Appear Semester End Examination (SEE)

12.1 Only those students who fulfil a minimum of 75% attendance in aggregate of all the courses including practical courses / field visits etc, as part of the course(s), as provided in the succeeding sections, shall be eligible to appear for SEE examination.

12.2. Requirements to Pass a Course

Students are required to score a total minimum of 40% (Continuous Internal assessment and SEE) in each course offered by the University/ Department for a pass (other than online courses) with a minimum of 20 (40% of 50) marks in final examination

13. Requirements to Pass the Semester

To pass the semester, a candidate has to secure minimum of 40% marks in each subject / course of the study prescribed in that semester.

13.1 Provision to Carry Forward the Failed Subjects / Courses:

A student who has failed in a given number of courses in odd and even semesters of first year shall move to third semester of second and final year of the study. However, he / she shall have

to clear all courses of all semesters within the double duration, i. e., within four years of admission of the first semester failing which the student has to re-register to the entire program.

13.2 Provision to Withdraw Course:

A candidate can withdraw any course within ten days from the date of notification of final results. Whenever a candidate withdraws a course, he/she has to register for the same course in case it is hard core course, the same course or an alternate course if it is Soft Core Course or Open Elective Course.

A DROPPED course is automatically considered as a course withdrawn.

13.3. Re-Registration and Re-Admission:

a) In case a candidate's class attendance in aggregate of all courses in a semester is less than 75% or as stipulated by the University, such a candidate is considered as dropped the semester and is not allowed to appear for end semester examination (C3) and he / she shall have to seek re-admission to that semester during subsequent semester / year within a stipulated period.

b) In such case where in a candidate drops all the courses in a semester due to personal reasons, it is considered that the candidate has dropped the semester and he / she shall seek re-admission to such dropped semester.

14. Attendance Requirement:

14.1 All students must attend every lecture, tutorial and practical classes.

14.2 In case a student is on approved leave of absence (e g: - representing the university in sports, games or athletics, placement activities, NCC, NSS activities and such others) and / or any other such contingencies like medical emergencies, the attendance requirement shall be minimum of 75% of the classes taught.

a) Any student with less than 75% of attendance in aggregate of all the courses including practical courses / field visits etc, during a semester shall not be permitted to appear to the end semester (C4) examination and such student shall seek re-admission as provided in 7.8.4.

b) Teachers offering the courses will place the above details in the School Board meeting during the last week of the semester, before the commencement of C3, and subsequently a notification pertaining to the above will be brought out by the Director of the School before the commencement of C3 examination. A copy of this notification shall also be sent to the office of the Registrar & Registrar (Evaluation).

15. Absence during Mid Semester Examination:

In case a student has been absent from a mid-semester (C1, C2) examination due to the illness or other contingencies he / she may give a request along with necessary supporting documents and certification from the concerned class teacher / authorized personnel to the concerned Head of the School, for make-up examination. The Head of the School may consider such request depending on the merit of the case and after consultation with course instructor and class teacher, and arrange to conduct a special test for such candidate(s) well in advance before the C3 examination of that respective semester. Under no circumstances C1, C2 test shall be held after C3 examination.

16. Grade Card and Grade Point

16.1. **Provisional Grade Card**: The tentative / provisional grade card will be issued by the Registrar (Evaluation) at the end of every semester indicating the courses completed successfully. The provisional grade card provides **Semester Grade Point Average** (SGPA).

16.2. **Final Grade Card:** Upon successful completion of M.Sc., Degree a Final Grade card consisting of grades of all courses successfully completed by the candidate will be issued by the Registrar (Evaluation).

16.3. The Grade and the Grade Point: The Grade and the Grade Point earned by the candidate in the subject will be as given below.

Marks P	Grade G	Grade Point (GP=V x G)	Letter Grade
90 >100	10	v*10	O
80 > 90	9	v*9	A+
70 > 80	8	v*8	A
60 > 70	7	v*7	B+
55 > 60	6	v*6	B
50 > 55	5.5	V*5.5	C +
40 > 50	5	v*5	P
0-40	0	v*0	F
ABSENT			AB

O - Outstanding; A-Excellent; B-Very Good; C-Good; D-Fair; E-Satisfactory; F - Fail

Here, P is the percentage of marks (P=[C1+C2+C3]) secured by a candidate in a course which is **rounded to nearest integer**. V is the credit value of course. G is the grade and GP is the grade point.

16.3.1. Computation of SGPA and CGPA

The Following procedure to compute the Semester Grade Point Average (SGPA)

The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in a given semester, i.e:

SGPA (Si) = $\sum$ (Ci x Gi) / $\sum$Ci where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

Illustration for Computation of SGPA and CGPA

Illustration No. 1

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade)
Course 1	4	A+	9	4X9=36
Course 2	4	A	8	4X8=32
Course 3	3	B+	7	3X7=21
Course 4	3	O	10	3X10=30
Course 5	3	P	5	3X5=15
Course 6	3	B	6	3X6=18
Course 7	2	O	10	2X10=20
Course 8	2	A	8	2X8=16
	24			188

Thus, **SGPA = 188 ÷ 24 = 7.83**

Illustration No. 2

Course	Credit	Grade letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	4	A	8	4X8=32
Course 2	4	B+	7	4X7=28
Course 3	3	A+	9	3X9=27
Course 4	3	B+	7	3X7=21
Course 5	3	B	6	3X6=18
Course 6	3	P	5	3X5=15
Course 7	2	B+	7	2X7=21
Course 8	2	O	10	2X10=20
	24			175

Thus, **SGPA = 175 ÷ 24 = 7.29**

Illustration No.3

Course	Credit	Grade Letter	Grade Point	Credit Point (Credit x Grade point)
Course 1	4	O	10	4 x 10 = 40
Course 2	4	A+	9	4 x 9 = 36
Course 3	3	B+	7	3 x 7 = 21

Course 4	3	B	6	3 x 6 = 18
Course 5	3	A+	9	3 x 9 = 27
Course 6	3	B+	7	3 x 7 = 21
Course 7	2	A+	9	2 x 9 = 18
Course 8	2	A+	9	2 x 9 = 18
	24			199

Thus**, SGPA = 199 ÷ 24 = 8.29**

Cumulative Grade Point Average (CGPA):

Overall Cumulative Grade Point Average (CGPA) of a candidate after successful completion of the required number of credits (96) for Two year Post Graduate degree program is calculated taking into account all the courses undergone by a student over all the semesters of a program i. e.,
CGPA = $\sum(Ci \times Si) / \sum Ci$

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

Illustration: No.1

CGPA after Final Semester

Semester (ith)	No. of Credits (Ci)	SGPA (Si)	Credits x SGPA (Ci X Si)
1	24	6.83	24 x 6.83 = 163.92
2	24	7.71	24 x 7.71 = 185.04
3	24	8.68	24 x 8.68 = 208.32
4	24	9.20	24 x 9.20 = 220.80
Cumulative	96		778.08

Thus, CGPA = 24x6.83+24x7.13+24x8.68+24x9.20 = 8.11

16.3.2. CONVERSION OF GRADES INTO PERCENTAGE:

Conversion formula for the conversion of CGPA into Percentage is:

Percentage of marks scored = CGPA Earned x 10

Illustration: CGPA Earned 8.10 x 10=81.0

16.3.3. Classification of Results

The final grade point (FGP) to be awarded to the student is based on CGPA secured by the candidate and is given as follows.

CGPA	Grade (Numerical Index) G	Letter Grade	Performance	FGP Qualitative Index
9 >= CGPA 10	10	O	Outstanding	Distinction
8 >= CGPA < 9	9	A+	Excellent	
7 >= CGPA < 8	8	A	Very Good	First Class
6 >= CGPA < 7	7	B+	Good	
5.5> = CGPA < 6	6	B	Above average	Second Class
>5 CGPA< 5.5	5.5	C	Average	
>4 CGPA<5	5	P	Pass	Satisfactory

Overall percentage=10*CGPA

17. Challenge Valuation

a. A student who desires to apply for challenge valuation shall obtain a photo copy of the answer script by paying the prescribed fee within 10 days after the announcement of the results. He / She can challenge the grade awarded to him/her by surrendering the grade card and by submitting an application along with the prescribed fee to the Registrar (Evaluation) within 10 days after the announcement of the results. This challenge valuation is only for SEE.

The answer scripts for which challenge valuation is sought for shall be evaluated by the external examiner who has not involved in the first evaluation. The higher of two marks from first valuation and challenge valuation shall be the final.

b. With regard to any specific case of ambiguity and unsolved problem, the decision of the Vice-Chancellor shall be final.

M.Sc. (Biochemistry) Program

Scheme of Instruction (effective from Academic Year 2020-22)

Sl. No.	Course Code	Course Title	Course Type	Credit Pattern and Value L T P Credits				Weekly Contact Hours	Teaching School/Dept.
				L	T	P	C		
First Semester									
1	M20BC1010	Applied Microbiology and Biochemical ecology	HC	2	1	0	3	4	Biochemistry
2	M20BC1020	General Physiology	HC	4	0	0	4	4	Biochemistry
3	M20BC1030	Metabolism -I	HC	4	0	0	4	4	Biochemistry
4	M20BC1040	Analytical Techniques	HC	4	0	0	4	4	Biochemistry
5	M20BC1050	Research Methodology & Statistics	HC	2	1	0	3	4	Biochemistry Biochemistry
	Practical Courses								
6	M20BC1060	Biophysical chemistry (Laboratory– I)	HC	0	0	2	2	4	Biochemistry
7	M20BC1070	Clinical Biochemistry (Laboratory cum Training– II)	HC	0	0	2	2	4	Biochemistry
8	M20BC1080	Enzymology (Laboratory– III)	HC	0	0	2	2	4	Biochemistry
9	M20BC1090	Microbiology (Laboratory – IV)	HC	0	0	2	2	4	Biochemistry
Total Credits for the First Semester							**26**	**36**	
Note: Industrial visits will be organized to Public/Private Sectors in Bengaluru.									
Second Semester									
1	M20BC2010	Enzymology	HC	4	0	0	4	4	Biochemistry
2	M20BC2020	Biotechnology	HC	4	0	0	4	4	Biochemistry
3	M20BC2030	Immunology	HC	4	0	0	4	4	Biochemistry
4	M20BC2040	Metabolism -II	HC	3	1	0	4	4	Biochemistry
5	M20BC2051	Bioinformatics	SC	1	1	0	2	3	Biochemistry
6	M20BC2052	Food Technology							
7	M20BC2060	Sports/Yoga/Music/Dance/ Theatre	RULO	0	0	2	2	3	Sports Dept. / Performing Arts

	Practical Courses								
8	M20BC2070	Protein Chemistry (Laboratory – V)	HC	0	0	2	2	4	Biochemistry
9	M20BC2080	Immunology (Laboratory – VI)	HC	0	0	2	2	3	Biochemistry
10	M20BC2090	Molecular Biology (Laboratory – VII)	HC	0	0	2	2	4	Biochemistry
11	M20BC20X0	Bioinformatics (Laboratory – VIII)	HC	0	0		2	3	Biochemistry
Total Credits for the Second Semester				**16**	**2**	**10**	**28**	**37**	
Note: *RULO: REVA **U**nique **L**earning **O**pportunity**									

Sl. No.	Course Code	Course Title	Course Type	Credit Pattern and Value				Weekly Contact Hours	Teaching School/Dept.
				L	T	P	C		
Third Semester									
1	M20BC3010	Molecular Biology	HC	4	0	0	4	4	Biochemistry
2	M20BC3020	Nutritional Biochemistry	HC	3	0	0	3	3	Biochemistry
3	M20BC3030	Biochemical Genetics	HC	2	1	0	3	4	Biochemistry
4	M20BC3041	Pharmacovigilance and SAS	SC	4	0	0	4	4	Biochemistry
5	M20BT3042	Clinical Biochemistry and Diagnostics							
6	M20BC3043	Plant and Industrial Biochemistry							
7	M20BC3050	Biochemistry in daily life	OE*	3	1	0	4	4	Biochemistry
8	M20BC3060	Soft Skill	RULO	0	0	2	2	2	Training & Placement
	Practical Courses								
8	M20BC3070	Advanced Molecular Techniques (Laboratory – IX)	HC	0	0	4	4	4	Biochemistry
9	M20BC3080	Genetic Engineering (Laboratory– X)	HC	0	0	2	2	4	Biochemistry
Total Credits for the Third Semester							**26**	**33**	

Note: Open Elective Course "Biochemistry in daily life" offered is for students other than Biochemistry discipline. The students of M Sc Biochemistry shall have to choose the Open Elective course offered in other disciplines.

Sl.	Course Code	Course Title	Course Type	Credit Pattern and Value				Weekly Contact Hours	Teaching School/Dept.
				L	T	P	C		
Fourth Semester									
1	M20BC4010	Molecular Physiology	HC	4	0	0	4	4	Biochemistry
1	M20BC4020	Internship	HC	0	0	2	2	6	Biochemistry
2	M20BC4030	Submission of Project work and Evaluation	HC	0	0	8	8	18	Biochemistry/ Others
3	M20BC4040	SWAYAM/MOOC/Short term project/coursera	RULO	2	0	0	2	-	Biochemistry
Total Credits for the Fourth Semester				**6**		**10**	**16**	**28**	

Note:

1. Project dissertation will begin in 4thSemester. Students will either choose internal guide from the school and continue with in-house projects or choose to do project work either in industry or research organization.

2. Internship – Students must undergo hand-on training program (Skill development program) either at REVA University/Industry/Research Organization.

Semester-wise Summary of Credit Distribution

Semesters	No. of Credits
First Semester	26
Second Semester	28
Third Semester	26
Fourth Semester	16
Total Credits	**96**

Distribution of Credits Based on Type of Courses

Semester	HC	SC	OE	RULO	TOTAL
I	26	0	0	0	26
II	24	2	0	2	28
III	16	4	4	2	26
IV	14	0	0	2	16
Total	**80**	**6**	**4**	**6**	**96**

HC=Hard Core; SC=Soft Core; OE=Open Elective;
RULO=REVA Unique Learning Offerings;

M.Sc. (Biochemistry) Program

Detailed Syllabus

(Effective from Academic Year 2020-21)

SEMESTER – I

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC1010	Applied Microbiology and Biochemical ecology	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Graduate level knowledge of microbes and its classification with ecological niches. Knowledge of natural environment and its evolution along with living organisms.

Course Objectives:

The overall objectives of the course are:

Gain knowledge on microbes, ecology and chemicals and its interactions with the natural environment for abuse.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Gain knowledge on various classes of microorganisms; their structural components, cultural characteristics and their growth conditions.

CO2 - Acquire knowledge on sterilization techniques, resistant forms of bacteria, microbial culture media and pure culture techniques for aerobic and anaerobic cultivation methods for microbes.

CO3 - Understand various ecological interactions that unfold in various types of ecosystems and human impacts

CO4 - Understand of climate change, environment, pollution and toxicology with its effect on humans.

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit 1 **13hrs**

Introduction and Classification of microbiology: Historical development and scope of microbiology, discovery on microorganisms. Nomenclature, study of different types of microorganisms, characteristics of the main groups of microorganisms-Bacteria, fungi, algae and viruses.

Methods of sterilization, Culture Media and Preservation of microbial cultures: General methods of sterilization, pasteurization and disinfection. Culture media types and classification, selective and differential. Preservation and maintenance of pure cultures

Methods for isolation of pure culture and Cultivation of bacteria: Different methods of isolation of pure cultures, enrichment culture techniques. Nutritional requirements, growth and reproduction of microorganisms, Growth curve, chemostat, synchronous and diauxic growth. Measurement of growth, cell number-methods of enumeration. Study of bacterial cell structures- genetic elements, ribosomes, membranes, cell envelopes, capsule, flagella, pili and endospores.

Unit 2 **13hrs**

Identification of bacteria and Bacterial toxins: staining methods-Gram staining and acid-fast staining, structure and differences between Gran-negative and Gram-positive bacteria. Exotoxins and endotoxins for associated diseases.

Normal flora, Air and Soil microbiology: Flora of the normal human body. Role of microbes and soil fertility. Extremophiles and types. Microbes for sewage water treatment – primary, secondary and tertiary treatments.

Viruses and Replication of DNA and RNA viruses: Classification and properties of viruses. Isolation, culturing and assay of viruses. Animal and plant viruses. Negative strand (vsv),positive strand (polio), retroviruses (infection cycle).

Clinical Microbiology-Bacterial diseases: Typhoid, Diphtheria, Cholera, Tuberculosis, Leprosy, Plague, Syphilis, Gonorrhea. Viral diseases: Herpes, Polio, Hepatitis, AIDS, Rabies, Ebola, SARS and H1N1; Protozoan diseases: Malaria: common types of fungal infections.

Unit- 3 **13hrs**

Ecology of population and species interactions: Characteristics of a population, growth curves. Strategies of life history (*r* and *K* selection); metapopulation concept– demes and dispersal, interdemic extinctions, age structured populations. Interactions types, interspecific competition, herbivory, carnivory, and symbiosis. Habitat and niche; fundamental and realized niche

Community ecology and succession: Nature of communities, community structure and attributes, levels of species diversity and its measurement, edges and ecotones. Types, mechanisms, changes involved in succession, concept of climax.

Ecosystem: Structure and function, energy flow, primary production and decomposition. terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Biogeochemical cycles

Applied ecology and conservation biology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change;

biodiversity management approaches. Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Unit-4 **13hrs**

Toxicology and Mechanism: Eco-toxicology and its environmental significance. Toxic effects: Basic for general classification & nature. Dose - Response relationship: Synergism and Antagonism, Determination of ED_{50}& LD_{50}. *In vitro* and *In vivo* models for testing toxicity, Acute and Chronic exposures. Factors influencing Toxicity. Pharmacodynamics &chemodynamics. OECD guidelines. Whole body and organ specific toxicity.

Principles & procedures of testing for acute toxic effects: Regulatory guidelines, Mammalian systems affected & the clinical signs of Systemic Toxicity. Factors affecting acute Toxicity studies.

Xenobiotic metabolism: Absorption & distribution. Phase I reactions. Oxidation, Reduction, Hydrolysis and Hydration. Phase II reactions/Conjugation: Methylation, Glutathione and amino acid conjugations.

Pesticide toxicity: Insecticides: Organochlorines, Anticholinesterases. Organophosphates and Carbamates. Fungicides Herbicides. Environmental consequences of pesticide toxicity. Biopesticides.

Metal toxicity: Toxicology of Arsenic, mercury, lead and cadmium, sources and permissible limits of metals in organs, antidotes.

Reference Books:

1. Ecology and Environment by P D Sharma
2. Ecology by Michael Begon, Colin R Townsend and John L. Harper
3. General and Applied Toxicology 1995 by Marrs and Turner. Macmillan Press Ltd.
4. Basic Environmental Toxicology (1994) by Lorris G. Corkerhem and Barbara S S Shane CRP Press Inc.

5. Introduction to Food Technology by Talayurki Shibamato & Leonard F Bzeldanes.
6. Molecular Biotechnology 2nd ed 1994 by Barnard R Glick & J J Pasternak.
7. Ecology: Principles and Applications. Chapman, J.L. & M.J. Reiss. 1998 Cambridge Univ. press. 2nd edition.
8. Ecology: The experimental Analysis of Distribution and Abundance (6th Edition) by Krebs, C.J. 2008. Benjamin Cummings Publ. 688pgs. 3.
9. Ecology, Environment and Resource conservation by Miller. G.T. 2004. Environmental Science. Thomson, California. 538 pgs. 4. Singh, J.S., Singh, S.P & Gupta, S.R. 2006. Anamaya Publ., New Delhi, 688 pp.
10. Microbiology Prescott, Harley, Klein McGraw Hill Seventh Edition 1996
11. Microbiology Michael J Pelczar Jr Chan ECS, Noel R Krieg Tata McGraw-Hill Education Pvt Fifth Edition 2013
12. Soil Microbiology N S Subba Rao Oxford and IBH 1999
13. Text Book of Microbiology Ananthanarayan and Jayaram, Panicker Universities Press Seventh Edition 2006

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC1020	General Physiology	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Knowledge of fundamental human *physiological* systems from the molecular and cellular levels to the human body as a whole.

Course Objectives:

The overall objectives of the course are:

To study the basic concepts of cellular physiology and the fundamental properties of eukaryotic cell.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Investigate the various causes for specific diseases and diagnose the clinical symptoms of various diseases

CO2 - Acquire the complete knowledge and analyze the proper functions of various organs.

CO3 - Apply the knowledge on various disorders and detect the real symptoms for curing certain diseases.

CO4 - Correlate the body physiological and function in abnormal condition

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit-1 **13hrs**

Blood and Body fluids: Fluid compartment, composition and functions of blood and blood cells. Plasma proteins. Morphology, Count, Functions of Erythrocyte, Leucocytes and Thrombocytes, Erythrocyte Sedimentation rate, Osmotic fragility. Hemoglobin, Erythropoiesis, Anemia, Polycythemia, Fate of RBC, Jaundice.

Hemostasis, Blood cells, Blood Clotting/Coagulation – mechanism and regulation. Blood Volume & Regulation of Blood pH - buffers. Blood groups, transfusion. Fibrinolysis, anticoagulants, transfers of blood gases – oxygen and carbon dioxide. Hydrogen ion homeostasis. Composition and functions of lymph and CSF. Acid-base balance, metabolic and respiratory acidosis and alkalosis

Cardiovascular system: Organization of CVS, Properties of Cardiac Muscle, Physiology of cardiac muscle, Rhythmical excitation of heart, Regulation of heart pumping, Capillary fluid exchange. Origin and spread of cardiac impulse, Cardiac Cycle, Heart sounds – Electrical and mechanical events, ECG. Cardiac output, Measurement, regulation Blood pressure (measurement & variation, determinants, regulation, shock), Regional circulation- coronary, Pulmonary, Cerebral, Cutaneous and Microcirculation.

Cardiac abnormalities: Normal electrocardiogram, Cardiac Arrhythmias, Heart sounds, Dynamics of valvular and congenital heart defects, Cardiac failure and circulatory shock.

Unit-2 **13hrs**

Digestive system: General principles of G-I function, Mastication, swallowing, deglutition, Esophageal motility, Salivary secretion & its regulation, Gastric secretion and its regulation and Gastric mucosal barrier, Pancreatic &billiary secretion & its regulation, Gastrointestinal motility, Digestion & absorption, Intestinal juice Functions of Colon, Pathophysiology of peptic ulcer and diarrheal disease, Detoxification mechanism. Liver functions. Movement of stomach and intestine, Vomiting and Defecation.GI Disorders: constipation, irritable bowel syndrome, hemorrhoids, anal fissures, perianal abscesses, anal fistulas, perianal infections, diverticulardiseases and colitis,

Respiratory-System:

Mechanics of ventilation, Pressure changes, volume changes, Surfactant, Compliance, Airway re sistance. Mechanism and regulation of respiration (Voluntary, Neural, Chemical.), principle of exchange, transport and diffusion of gases O_2 and CO_2, mechanism of acid and base balance with briefly the disorders of respiratory system. Acids, Bases and Buffers: pH scale, acids-bases, Henderson-Hasselbalch equation, buffers; Pulmonary ventilation, Alveolar ventilation, Pulmonary circulation, Pleural fluid, Lung edema, Principles of gas exchange, Artificial Respiration, Effect of Exercise on Respiration,

Abnormalities of respiration: Hypoxia, Cyanosis, Dyspnea, Asphyxia, High altitude and Dysbarism.

Unit-3 **13hrs**

Endocrine system: Hormones activity and its chemistry, feedback regulation, biosynthesis, storage, secretion, Circulation in blood. Degradation and peripheral transformation. Receptors and the mechanism of hormone action. Measurement of hormones, and receptors. Disorders of endocrine system.

Renal physiology: Structure and functional unit of kidney, kidney hormones, regulation of acid-base balance, electrolyte and water balance. Mechanism of urine formation and composition of urine. Urine analysis for abnormal constituents, tubular function tests. Nephritis and nephrosis. Kidney hormones. Regulation of acid-base electrolyte and water balance. Respiratory and metabolic acidosis and alkalosis.

Renal circulation - peculiarities, renal blood flow and its determination; GFR - definition, factors influencing, measurement, normal value &variations. Tubular functions - Reabsorption, secretion and concentration mechanisms. Acidification of urine, Diuretics. tubular function test, Micturition- Nerve supply to urinary bladder: Micturition reflex, its higher control Non-excretory function of kidney. Principles of Dialysis and Renal failure, Diuretics, nephrosisand nephrites,

Unit-4 **13hrs**

Nervous system: Types and structure of neuron. Neurotransmitters and receptors, mechanism of synaptic transmission. Myelin sheath; composition and function. Resting membrane and action potential. Mechanisms of conduction in nerve fibers, factors affecting conduction. Nernst and Goldman equations. Mechanism of initiation and propagation of action potential – voltage gated ion channels, ionophores and toxins in study membrane transport. Design and use of Patch- Clamp in measuring membrane potential. Neurotransmitters and receptors; synaptic transmission, post-synaptic potentials. Outline and functions of autonomic and central nervous systems.

Muscular System:

Classification of muscles & Morphology & properties of each type. Mechanism of neuro-muscular transmission. Ultra-structure of smooth, skeletal and cardiac muscle fibers.

Contractile and other proteins of muscle. Molecular mechanism of muscle contraction Excitation contraction coupling. Electrical, chemical, mechanical & thermal changes during muscle contraction. Types of contraction. Length tension relationships. Organization of sarcolemma, transverse-tubular system and sarcoplasmic reticulum, mechanism of muscle contraction. Regulation of contraction in striated and smooth muscle. Calmodulin and its regulatory role, muscular dystrophies.

Reference Books:

1. Molecular Biology of the Cells (3rdedn 1994) by Alberts et al., Garland Publications INC NY and London.
2. Cell Biology (1993) by E S Sedava, Jones and Barlett Publishers Boston, London.
3. Cell and Molecular Biology (8th ed. 2001) by E D P de Robertis& E M F de Robertis
4. Textbook of Physiology by Dr. A K Jain,7th Edition, Avichal publishing company
5. Text book of Medical Physiology (10th ed. 2001) by A C Guyton & J E Hall. Harcourt Asia
6. Essentials of Medical physiology by K. Sembulingam and PremaSembulinga, 5th Edition, JAPEE Publication

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC1030	Metabolism -I	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Graduate level familiarity of life sustaining biochemical reaction of living organisms

Course Objectives:

The overall objectives of the course are:

Understand the fundamental energetic of biochemical processes, and the relation between biochemical defects and metabolic disorders.

Recognize and understand basic mechanisms of pathway regulation.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Acquire the knowledge of carbohydrates and Lipids which makes students easier to study about advanced course in Biochemistry and Molecular Biology.

CO2 - Understand fundamental of energetic biochemical processes, knowledge of carbohydrates and Lipids to central Biochemical processes.

CO3 - Acquire the knowledge about the fundamentals of energetic biochemical processes.

CO4 - Demonstrate an understanding of the diversity of metabolic regulation, defects and metabolic disorders and how this is specifically achieved in different cells.

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit-1 **13hrs**

Biochemical Thermodynamics**:** Applications of laws of thermodynamics in understanding energy in living cells, chemical potential, equilibrium constant. Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic properties and Gibbs-Helmholtz equation**.**

Bioenergetics: Energy transformation, Laws of thermodynamics, Biological oxidations, oxygenases, hydroxylases, dehydrogenases and energy transducing membranes. Gibbs energy, free energy changes and redox potentials, phosphate potential, chemo-osmotic theory. Proton circuit and electrochemical gradient, ionophores. Uniport, antiport and symport mechanisms, shuttle systems.

The mitochondrial respiratory chain, order and organization of carriers, proton gradient, iron sulphur proteins, cytochromes and their characterization. The Q cycle; P/O ratio. Reversedelectron transfer, respiratory controls and oxidative phosporylation, uncouplers and inhibitors of energy transfer. Fractionation and reconstitution of respiratory chain complexes. ATP – synthetase complex, partial reduction of oxygen, superoxides.

Free radicals in biological system: Endogenous source of free radicals' generation. Oxygen as free radical in the auto oxidation of fats**.** Carbanions, carbocations, carbenes nucleophiles and electrophiles (Formation and Stability). Non enzymatic antioxidants (GSH, vitamin A, vitamin E and vitamin C).

Unit-2 **13hrs**

Chemistry of Carbohydrates:

Biological importance of carbohydrate, Classification of carbohydrate, Monosaccharides: Elucidation of structure of glucose (open chain and ring structure); glucopyranose, fructopyranose and fructofuranos. Brief review on configurational and conformational aspects of carbohydrates; Confirmation and configuration, boat and chair forms. Types of isomers-stereoisomerism of monosaccharide, Epimers, anomers- and mutarotation. Derived monosaccharides: structures and biological importance of: Amino sugars: glucosamine and galactosamine and their N-acetylated forms, Sugar phosphates: D-ribose-5-P, β-D-ribose-5-P, glucose-6-P and fructose -1,6- diphosphate. Sugar acids: glycosidic bonds involved in carbohydrates, disaccharides: Structure of isomaltose, cellobiose and trehalose, brief discussion on reducing chemical property of disaccharides; Polysaccharides: types classification with examples; structure, properties and importance of homo and hetero polysaccharides. Blood group, bacterial

polysaccharides; glycosaminoglycans, cardioglycosides, Glycoproteins structure and functions, Lectins-characteristics and biological importance.

Unit-3 **13hrs**

Intermediary metabolism: Approaches for studying metabolism. Introduction to metabolism.

Carbohydrates Metabolism: Glycogenesis and glycogenolysis, Glycolysis, citric acid cycles, its function in energy generation and biosynthesis of energy rich bonds, pentose phosphate pathway and its regulation. Alternate pathways (glyoxalic and uronic acid pathways) of carbohydrate metabolism. Gluconeogenesis. Interconversions of sugars. Biosynthesis of starch and oligosaccharides. Regulation of blood glucose homeostasis. Hormonal regulation of carbohydrate metabolism**.** Disorders**:** Pentosuria, Hexose interconversion, fructose and lactose intolerance, fructosuria, galactosemia and glycogen storage diseases

Unit-4: Lipids **13 hrs**

Chemistry of Lipids: Structure, Classification, Characteristics and biological importance oflipids. Behaviour of amphipathic lipids in water, formation of micelles and lioposomes. Prostaglandins. Bio membranes, membrane composition and fluid mosaic model.

Lipid Metabolism: Acetyl CoA carboxylase, Fatty acid synthase, desaturase and elongase.Fatty acid oxidation: α, β, ω oxidation and lipoxidation. Lipid Biosynthesis: Biosynthesis of triacyglycerols, phosphoglycerides and sphingolipids, Biosynthetic pathways for terpenes, steroids and prostaglandins. Ketone bodies: Formation and utilization. Metabolism of circulating lipids: chylomicrons, LDL, HDL and VLDL. Free fatty acids. Lipid levels in pathological conditions. Disorders: Sphingolipid dystrophies, Lipoproteinemias, fatty liver, hypercholesterolemia.

Reference Books:

1. Biochemistry; Voet , D. and Voet, J.G. [Eds.] (1999) 3 Ed. Jhon Wiley and sons.
2. Biochemistry; David Rawn, J. (1989) Neil Patterson Publishers.
3. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarwHill.

4. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL-Oxford University Press.
5. Photosynthesis, D.O. Hall and K. K. Rao, (1999), 6th Edn. Cambridge University Press.
6. Hawk's Physiological Chemistry, Oser (1976) 14th EdnTata-McGraHill.
7. Advances in Carbohydrate Chemistry and Biochemistry; Horton, Elseveir(1994).
8. Biochemistry of Foods, Eskin Elseveir(2012).
9. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M.A.Devlin, Wiley – Liss(2012).
10. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn Macmillan publications (2012).
11. Biochemistry and Molecular Biology; 5th Edn. D. Papachristodoulou, A. Snape, W.H. Elliott, and D. C. Elliott, Oxford University press (2014).
12. Biochemistry; David Rawn, Panima Publishers (2012).
13. Stereo chemistry of organic compounds (1994) by E L Eliel & SHW Awley. Inter Science Pub.30. Wiley and sons.Inc.
14. Organic Chemistry, 11th edition 2014, by T W Graham Solomons, Craig B Fryhle and Scott ASynder.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC1040	Analytical Techniques	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Graduate level understanding of principles of biophysics, fundamental mathematics and biological Sciences.

Course Objectives:

The overall objectives of the course are:

To develop the skills among students to understand the theory and practice of bio analytical techniques
To provide among students the scientific understanding of analytical techniques and detail interpretation of results

Course Outcomes:

After completing the course, the student should be able to

CO1 - Explain the theory for image formation, contrast, resolution of various microscopes, and use of chromatography in real time industrial environments.
CO2 - Correlate the relevance of microscopic approaches to life sciences inquiries.
CO3 - Acquire knowledge about the interaction of electromagnetic radiations with matter and apply analytical techniques to accurately determine the elements present in the given sample
CO4 - Acquire knowledge about the various techniques of centrifugation, extractions, chromatography, electrophoresis, Microscopy and spectroscopy

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit-1 **13hrs**

Extraction methods for preparation of samples: Preparation of extracts for biochemical investigations, physicochemical properties of metabolites and drugs extracts from biological materials. Different types of extraction methods. Physico-chemical properties of solvents, solubility and miscibility, ionic bonds, and salting out. Choice of solvent for solvent extraction, mixed solvents, solid phase extraction.

Centrifugation: Basic principles of centrifugation. Factors affecting sedimentation, Sedimentation Coefficient, Types of Rotors. Instrumentation and applications of Desktop, High speed and Ultra centrifuges; Preparative and Analytical centrifugation; isolation of sub-cellular

organelles, proteins, and nucleic acids using density gradient and differential centrifugation and Isopycnic Centrifugation,

Unit-2 **13 hrs**

Chromatography: Introduction, partition coefficient, phase systems- liquid and solid phases. Principle and separation of biomolecules like sugars, amino acids and lipids using paper, thin layer chromatography and high-performance thin-layer chromatography (HPTLC). Principle and applications of column chromatography, Ion exchange chromatography, Affinity chromatography gel permeation Chromatography and HPLC. Fast protein liquid chromatography(FPLC).

Gas Chromatography: Principle, design of instrument and application of Gas chromatography (GC). Factors affecting GC. Types of detectors (flame ionization, thermionic, electron capture, mass spectrometer) used in GC. Principle and application of Gas-Liquid Chromatography (GLC).

Unit-3 **13hrs**

Electrophoresis: Basic principles of electrophoresis and factors affecting electrophoretic mobility, Separation of nucleic acids using Agarose gel electrophoresis and Pulse field electrophoresis. Separation of nucleic acids and proteins by Capillary electrophoresis.Determination of Proteins using Native PAGE and SDS PAGE. Principle and applications of RT-PCR, and 2D-electropheresis.

Electro blotting: Western, southern, northern equipment's and application.

Microscopic techniques: Types of microscopy (light, bright field, dark field, Phase Contrast and florescence). Electron Microscopy- Working principle and applications of TEM and SEM. Confocal microscopy, FISH

Unit-4 **13 hrs**

Spectroscopic techniques: Electromagnetic spectrum, transition in spectroscopy. Principle, design and analysis of biochemicals including Proteins, sugars, lipids using UV-Visible, fluorescence and circular dichroism spectroscopy.

FT-IR, Raman spectroscopy, Atomic Absorption Spectroscopy, Flame photometer.

Principle, instrumentation and Protein structure determination using X-RAY crystallography and NMR, ESR.

Mass Spectroscopy: Principle, overview of MS experiment, ionization modes: MALDI, equipment's in MS analysis (Identification of biochemicals including proteins). Interfacing MS with other methods; MS/MS, Q-TOF, LC/MS, GC/MS.

Reference Books:

1. Instrumental methods of analysis H. H. Wilard, L. L. Merritt, J A Dean.
2. Biochemistry Laboratory: Modern Theory and Techniques, 2nd Edition, Rodney Boyer
3. Instrumental Methods of Chemical analysis.
4. Analytical Chemistry G.D. Chritiain. Wiley
5. Introduction of instrumental analysis. R. P. Braun
6. Biophysical chemistry by Upadhyay and Upadhyay.
7. Principles and Techniques of Practical Biochemistry by Keith Wilson, John Walker, 5th Edition, 2000. Cambridge Univ. Press
8. Organic Spectroscopy by Willium Kemp, 3rd edition 2008.
9. Essentials of Nuclear Chemistry- H.J. Arnikar
10. A text book of quantitative Inorganic analysis A I Vogel.
11. Pharmacopoeia of India, British Pharmacopoeia
12. Standard methods of Chemical analysis A Series of Volumes Edited F.J. Welcher R.G. Krieger Publishing Company.
13. Principles of Instrumental Analysis Fifth edition Skoog, Holler, Niemay
14. Principles and techniques of practical Biochemistry. K. Wilson and J. Walker. 4thEdn. Cambridge University Press (2012).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC1050	Research Methodology & Statistics	HC	2	1	0	3	4

Prerequisites/Pre reading for the course:

Basic knowledge of mathematics and analytical skills in understanding data for research problems

Course Objectives:

The overall objectives of the course are:

To introduce the students to the fundamental aspects of research methods and statistics.
To familiarise them with various research techniques such as experimentation, observation etc, and recording data and also interpreting the data and writing report.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Understand the importance of research and various research methods and techniques

CO2 - Identification of new method and applying them to molecular biology, Immunology and other related fields.

CO3 - Identify novel methods of preparation of hormones, steroids, other biological macromolecules, and explore and classify the reaction mechanisms and their pathways

CO4 - Correlate the analytical data, patients' profile etc. using statistics

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit-1 **13 hrs**

Introduction, Meaning, Objectives, Types of Research, Significance of Research, Research methods versus methodology, Methodology of scientific research. The nature of scientific methods. Problems encountered by researchers in India. Experimental errors, nature of experimental errors- random and systemic errors. Model-Based Identification of SystematicErrors in Measurements, SOPs.

Quantitative biochemical measurements: Analytical considerations. Performance of analytical methods, precision, accuracy, detection limit, analytical range, specificity and sensitivity.

Unit-2 **13 hrs**

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

Designing research methodologies. General strategies for preparation of research proposals. Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Data representation in technical reports, posters, presentation in scientific conferences

and workshops. Preparation of manuscripts for publication in national and international journals. Yardsticks employed in evaluation of manuscripts for publications.

Unit-3 **13 hrs**

Correlation and regression analyses. Least mean square method of fitting straight line to data with example. Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Population statistics- confidence limits and confidence intervals, Null hypothesis, Distribution of student t-test, chi-square (X2), F-test to validate analytical methods unpaired, paired, one-sample, two-sample tests with examples.

Unit 4 **13 hrs**

Basic statistics: samples and populations, measures of average, measures of dispersion, standard error, quantification of precision by standard deviation, coefficient of variation and variance. Standard error of mean, examples for calculation. Probability distribution: normal, binomial and Poisson distribution; ANOVA, one way and two-way ANOVA. Principles and practice of statistical methods in biological research, test of statistical significance, latest software, introduction of software, exercise on biochemical problems.

Reference Books:

1. Biostatistics: A foundation for analysis in the health. (7th ed. 1999) by W W Daniel John Wiley and Sons Inc., New York.
2. Choosing and Using Statistics; A Biologist Guide, Clavin Dythan, Blackwell Scientific(1999).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC1060	Biophysical chemistry (Laboratory– I)	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Comprehension of separation of bio molecule and through TLC and column for biochemical assay

Course Objectives:

The overall objectives of the course are:

To be able to prepare pH of different range, separate molecule through TLC or column chromatography technique

Course Outcomes:

After completing the course, the student shall be able to:

CO1 - Prepare the all range of buffer as per require pH

CO2 - Understand the principle of buffer preparation of various kind

CO3 - Use the chromatography technology in further education or company

CO4 - Separate the molecule through chromatography technique

Course Content: **Total Hours: 30 hrs**

Weightage Distribution for Assessment

COs	IA	Regular Performance	SEE	Total	Hours
CO1	5	8	13	25	8
CO2	5	7	12	25	7
CO3	5	8	13	25	8
CO4	5	7	12	25	7

Total	20	30	50	100	30

Course Contents:

- Preparation of buffers; Acetate, phosphate and tris buffer.
- Chromatographic techniques: Paper
- Chromatographic Techniques: TLC
- Chromatographic Techniques: Column

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC1070	Clinical Biochemistry (Laboratory cum Training– II)	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Knowledge of various disease pathogenesis and understanding and interpretations of test and results for diagnosis.

Course Objectives:

The overall objectives of the course are:

- To Compare and contrast human body chemistry levels under normal and abnormal conditions.
- To perform, evaluate and explain clinical chemistry procedures and correlate test results with patient conditions.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Analyse the urine or stool sample for biochemical resting

CO2 - To range of cholesterol present and analysis from blood sample

CO3 - Analyse the haemoglobin present in blood

CO4 - Estimate the glucose, serum bilirubin level in blood

Course Content: **Total Hours: 30 hrs**

Weightage Distribution for Assessment

COs	IA	Regular Performance	SEE	Total	Hours
CO1	5	8	13	25	8
CO2	5	7	12	25	7
CO3	5	8	13	25	8
CO4	5	7	12	25	7
Total	20	30	50	100	30

Course Contents:

1. Qualitative Tests for bio constituents in biological sample.
2. Estimation of cholesterol, urea and glucose in biological sample.
3. Estimation of Serum bilirubin by Diazo method.
4. Estimation of Haemoglobin.
5. Microscopic examination and chemical analyses of blood, urine and stools.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC1080	Enzymology (Laboratory–III)	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Basic conception of physio chemical properties of proteins/ RNA and its interaction with multimolecular components

Course Objectives:

The overall objectives of the course are:

To explore the different enzymes used in industries for various applications and to evaluate the activity of the enzymes

Course Outcomes:

After completing the course, the student shall be able to:

CO1 - Acquire knowledge with respect to salivary amylases enzyme

CO2 - Explore regarding the functions of different enzymes SGOT, SGPT and LDH

CO3 - Outline the activity relationship and kinetics of alkaline phosphatises enzyme

CO4 - Can be able to do assay for the others enzymes as well

Course Content: **Total Hours: 30 hrs**

Weightage Distribution for Assessment

COs	IA	Regular Performance	SEE	Total	Hours

CO1	5	8	13	25	8
CO2	5	7	12	25	7
CO3	5	8	13	25	8
CO4	5	7	12	25	7
Total	20	30	50	100	30

Course Contents:

1. Assay of salivary amylases,
2. Assay of Alkaline phosphatises
3. Assay of SGOT, SGPT and LDH

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC1090	Microbiology (Laboratory – IV)	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Knowledge in use of light microscope and fundaments of microbial culture with skill to avoid microbial contaminations

Course Objectives:

The overall objectives of the course are:

To attain experience in handling microbes and to illustrate the physical and chemical characteristics of the microorganisms.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Attain the experience to handle the microbes to facilitate working in various laboratories

CO2 - Improve their skill and competency in various experimentations

CO3 - Understand the bacterial growth curve in culture

CO4 - Make pure culture of bacteria and their testing in contaminate water

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Course Contents:

- Isolation of air microflora Colony characteristics and Counting, pure culture techniques.
- Biochemical tests for microbial culture, testing water quality by microbial method.
- Bacterial growth curve.

SEMESTER-II

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.

M20BC2010	Enzymology	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Basic conception of physio chemical properties of proteins/ RNA and its interaction with multimolecular components

Course Objectives:

The overall objectives of the course are:

- To enable students to gain fundamental knowledge on classification, structure, mechanism, Enzyme kinetics, inhibitors and related diseases of enzymes
- To integrate the practical aspects of Enzymology with the kinetic theories to provide a mechanistic overview of enzyme activity and regulation in cells

Course Outcomes:

After completing the course, the student shall be able to

CO1 - Acquire knowledge about structure, functions and the mechanisms of action of enzymes.

CO2 - Attain concepts of kinetics of enzyme catalysed reactions and enzyme inhibitory and regulatory process.

CO3 - Compare and contrast the historical uses of enzyme technology with current applications in a diverse range of industries.

CO4 - Demonstrate foundation knowledge in Biochemistry in the areas of Theory & Practical Biochemistry

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours

CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

UNIT 1 **13 hrs**

Introduction of Enzymes:

General concepts; Nomenclature and classification of enzymes, properties of enzymes. Models of mono substrate reaction- Fischer and Koshland model, monomeric, oligomeric and multimeric form of enzymes (Pyruvate dehydrogenase complex and fatty acid synthetase). Isolation and purification of enzymes from natural recourses. Active site, Allosteric site, substrate analogue, Isoenzyme

UNIT 2 **13 hrs**

Factors influencing enzyme activity:

Substrate concentration, Temperature, pH, radiation and oxidation; Mechanisms of action of lysozyme, ribonuclease, serine proteases and triose phosphate isomerases, restriction endo nucleases and carbonic anhydrase. Co-enzymes: function and types of Coenzymes, Vitamins – derived Coenzymes; Non vitamin derived coenzymes; metalloenzymes, Cofactors

UNIT 3 **13 hrs**

Enzyme Catalysis and Kinetics:

Chemical nature of enzyme catalysis, General acid-base catalysis, electrostatic catalysis, covalent catalysis, intra molecular catalysis. Order of a reaction-zero order, first order, second order and third order reaction. Activation energy, enzyme kinetics, Micaelis – Menton equations, Hill equations, Lineweaver- Burk plot, Eadie-Hostee transformation. Kinetics of multi substrate enzyme catalysed reaction- reorder, order and Ping-Pong mechanism

UNIT 4 **13 hrs**

Enzyme Inhibition and Regulation of Enzyme activity

Enzyme inhibitors, types of enzyme inhibition; Competitive, non-competitive, uncompetitive). Enzyme regulation; feedback inhibition, enzyme inducer, repressor, covelent modification, phosphorylation and protease action. Proenzyme, Allosteric enzymes. Application of Enzymes; diagnostic agents, analytical agents. Industrial aspect - Protease, Lipase and carbohydrases. Immobilisation of enzymes and their applications; introduction to biosensors and Biochips and its biochemical importance.

Reference Books

1. The chemical kinetics of enzyme action by K J Laidler and P S Bunting, Oxford University Press. London.
2. Enzymes by M Dixon, E C Webb, CJR Thorne and K F Tipton, Longmans, London.
3. Enzyme structure and mechanism (1977) by Alan Fersht, Reading, USA.
4. Enzymatic reaction mechanism (1979) by Cheristopher Walsh, freeman Pub., San Francisco.
5. Immobilized enzymes (1978) by Ichiro Chibata, Haisted Press Book
6. Enzymology by T.Devasena
7. Text book of Biochemistry by DM Vasudevan, 8 thedition,The Health sciences publisher
8. Enzymes by Trevor palmer and Philip Bonner, Second edition.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC2020	Biotechnology	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Graduate level understanding of chemistry, biology and basic applied mathematics with physics.

Course Objectives:

The overall objectives of the course are:

- To recognize the importance of recombinant DNA technology in the advancement of animals and plants;
- To distinguish the difference in plant cell culture and animal cell culture giving an outline of different fermenters used for each of them.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Analyze various tools and techniques used in recombinant DNA technology

CO2 - Explain the advancement in sequencing technology.

CO3 - Incorporate the recombinant genes and their products in agriculture, industry and environment related fields.

CO4 - Illustrate the manufacture of fermenters and to execute efficient fermentation process, importance of plant tissue culture and animal cell culture in modern life science.

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

Cos	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13

CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit-1 **13hrs**

Gene transfer to plants: Callus culture, Acclimatization of micro propagated plants. Agrobacterium mediated transformation, Ti plasmid, mechanism of T-DNA transfer, Function ofT-DNA genes, Ti-plasmid derivatives as plant vectors (disarmed T-DNA), co-integrate andbinary vectors, selectable markers for plants, Direct DNA transfer to plants: particle bombardment, chloroplast transformation, electroporation.

Animal tissue culture: Cell culture media, monolayer and suspension culture, In vitro fertilization and embryo transfer. Transgenic animals as bioreactors for production of recombinant proteins, Bone marrow transplantation, organ culture: techniques. Stem cells and therapeutics, novelsources of MSC, ethical issues regarding genetically modified organisms.

Unit-2 **13hrs**

Recombinant DNA Technology

Introduction to recombinant DNA technology, importance of recombinant DNA technology, construction and screening of genomic and cDNA libraries, cloning vectors (Lambda-phage, plasmid, cosmids, BAC, and Yeast Based vectors), gene silencing, agrobacterium mediated gene transfer, DNA ligation, properties of restriction endonucleases and their mode of action.

Unit-3 **13hrs**

Molecular marker and gene sequencing

Sequencing of DNA by Sanger's method, Maxam Gillbert method, shot gun sequencing, Automated Fluorescent sequencing, Principle and technique of pyrosequencing, Protein sequencing by Edman degradation method, site directed mutagenesis, AFLP, RFLP, RAPD,SNP, SSR PCR and Types, DNA finger printing, Phage display, Yeast-two-hybrid (Y2H), Threehybrid assay.

Unit-4 **13hrs**

Fermentation technology

Fermentation technology- surface, submerged and continuous culture techniques. Principle, design and operation of fermenters, agitation and aeration. Selection and growth of microorganisms in controlled environments, medium development. Strategies for improvement and maintenance of the industrial strains, Bioreactors.

Primary and secondary metabolites in fermentation, Secondary metabolite production from plants. Scale up of fermenters for suspension culture and monolayer culture fermentation processes- brewing, production of single cell proteins, production of antibiotics- penicillin, streptomycin, and organic compounds- citric acid, lactic acid, etc

Reference Books

1. Molecular Cloning; A laboratory manual; Michael R. Green, CSHL Press (2012).
2. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co (2012).
3. Molecular Biology of the Cell; 7th Edn. Bruce Alberts et al., (2008), Garland Publications
4. Molecular Biology; Robert F. Weaver, McGraw Hill (2012).
5. Principles and Techniques of Biochemistry and Molecular Biology; 7th Edn. Keith Wilson and John Walker (2010).
6. Principles of Gene Manipulations; 6th Edn. S.B. Primrose, R.M. Twyman, and R.W. Old,Blackwell Science (2012).
7. Gene Cloning and DNA analysis- An Introduction; T. A. Brown, 5th Edition, Wiley-Blackwell publishing (2006).
8. Molecular biology and Biotechnology; 4th Edn. J.M. Walker and R. Rapley, RSC (2000).
9. Plant Biotechnology and Agriculture; Arie Altman and Paul Hasegawa Academic Press(2011).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC2030	Immunology	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Firm foundational knowledge of molecular genetics, cell biology, pathogens and infections

Course Objectives:

The overall objectives of the course are:

Provide students with knowledge on how the immune system works building on their previous knowledge from biochemistry, genetics, cell biology and microbiology.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Ascertain the roles of Immune system in protection against Disease and Autoimmune disorders.

CO2 - Describe the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity

CO3 - Define the cellular/molecular pathways of humoral/cell-mediated adaptive responses, mechanisms that regulate immune responses and maintain tolerance

CO4 - Explain the cellular and molecular aspects of lymphocyte activation, homeostasis, differentiation, and memory.

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	**IA1**	**IA2**	**Assignment**	**SEE**	**Total**	**Hours**
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit-1 **13 hrs**

Introduction to Immune System

Memory, specificity, diversity, innate and acquired immunity, self vs non-self-discrimination. Structure and functions of primary and secondary lymphoid organs.

Cells Involved in Immune Responses

Structure and functions of Lymphocytes, Granulocytes, Macrophages, Dendritic cells and mast cells

Nature of Antigen and Antibody

Antigen vs Immunogen, Haptens, Structure and functions of immunoglobulins (IgG, IgA, IgM, IgE, IgD), Isotypic, allotypic and idiotypic variations. Clonal selection theory – concept of antigen specific receptor.

Unit-2 **13hrs**

Humoral and Cell Mediated Immune Responses

Complement activation and its biological consequences, T cell receptors, Activation of T cells, APC-T cell interaction, Th1/Th2 cells and cytokines. T cell differentiation in thymus, thymic selection and tolerance to self, MHC restriction, super antigens Antigen processing and presentation

Cytokines and costimulatory molecules: Role in immune responses.T and B cell interactions.

Major Histocompatibility Complex (MHC) Genes and Products

Structure and Polymorphism of MHC genes, Class I and class II MHC molecules, structure and Role of MHC antigens in immune responses, MHC antigens in transplantation.

Unit-3 **13hrs**

Hypersensitivity

Hypersensitivity and types (Type I, II, III and IV), role of eosinophils, and mast cells. Asthma. IgE receptor, prostaglandins and leukotrienes,

Immunological Techniques.

Hybridoma, Production of polyclonal and monoclonal antibodies, Principles, procedure and applications of Agglutination and precipitation techniques, Radio immunoassay (RIA), ELISA, Immunofluorescence assays, Fluorescence activated cell sorter (FACS) technique.

Unit-4 **13 hrs**

Immune Responses in Diseases

Immune responses to infectious diseases: viral, bacterial and protozoal. Immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections. Cancer and immune system. Cancer: Genetic rearrangements in progenitor cells, oncogenes, tumour suppressor genes, cancer and the cell cycle, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth, Immunodeficiency disorders, congenital and acquired immune deficiencies, Autoimmune disorder

Vaccines

Definition, types of vaccines, Active immunization, Passive immunization, Role of vaccines in the prevention of diseases.

Reference Books:

1. Antibodies– A Laboratory Manual; E. D. Harlow, David Lane, 2nd Edn. CSHL Press (2014).
2. Basic and Clinical Immunology; Stites et al., [Ed] (1982) Lange.
3. Roitt's Essential Immunology; Ivan, M. Rohitt & Petrer J Delves (2001) Blackwell Science.
4. Immunology: Roitt et al., Mosby (2001),
5. Kuby Immunology; Oven, Punt, Stranford, 7th Edn. W. H. Freeman (2013).
6. Immune System; M. C. Connel et al., Eds. (1981) Blackwell Science.
7. Immunology at a Glance: J.H.L. Playfare [ed.] Blackwell Science, (1987).
8. Immunology; Jan Klein [Ed.], Blackwell Science (1990).
9. Introduction to Immunology; Kim Bell [Ed.,] 3rd Edn. McMillan (1990).
10. NMS for Immunology; Hyde and Patnide [Eds.] John Wiley (1990).
11. Microbiology; Prescott, Harley and Klein, McGraw-Hill (2003).

12. Understanding Immunology (Cell and Molecular Biology in Action); Peterwood, Pearson Education Ltd. (2006).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC2040	Metabolism -II	HC	3	1	0	4	4

Prerequisites/Pre reading for the course:

Graduate level familiarity of life sustaining biochemical reaction of living organisms for energy

Course Objectives:

The overall objectives of the course are:

- Understand the fundamental energetic of biochemical processes, and the relation between biochemical defects and metabolic disorders.

  Recognize and understand basic mechanisms of pathway regulation

Course Outcomes:

After completing the course, the student shall be able to:

CO1 - Understand molecule and their interaction carry out research and Projects
CO2 - Compare and contrast the structural organization and functions of Protein and Nucleic acids.
CO3 - Under the biosynthesis and metabolism of amino acid and nucleic acid
CO4 - Apply the knowledge about the fundamental of energetic biochemical processes. Develop an integrative approach for biological problems.

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Course Content:

Unit- 1 **13 hrs**

Molecules and their interactions:

Structure of atoms and molecules; atomic, molecular orbitals; shapes of and hybridization of molecules. Atomic bonding their interaction; hydrogen bond, ionic, covalent, coordinate bond, and hydrophobic interactions, Vander walls forces,

Chemistry of Amino Acids: Amino acids as constituents: Ways of representation, Stereochemistry, Chemical and structural features, Acid/Base properties and their applications, structure, Classification and properties of amino acids.

Unit- 2 **13hrs**

Protein:

Structural organization of proteins, Covalent & non-covalent interaction, Importance of weak interactions in protein structures. Primary structure; Flexibility and conformational restrictions,

Characteristics of peptide bond, Ramachandran plot. Secondary structure; alpha-helices, Beta-stand and sheet, turns and loops, Importance of loops. Super secondary structure; domains and motifs. Tertiary structure: General properties and characteristics. Quaternary structure: Concept of subunits and promoters and their association, Importance of quaternary structure; myoglobin, haemoglobin and their cooperativity and allostery. Keratin, silk fibroin, collagen, Integral membrane proteins, concanavalin-A and Rossmann fold, ribonuclease, glyceraldehyde-3-phosphate dehydrogenase, lysozyme, chymotrypsin, Triose phosphate isomerase. Protein folding; Folding pathways, protein-protein interaction

Unit- 3 **13 hrs**

Amino Acid Metabolism

Overall nitrogen metabolism, digestion of dietary proteins, transamination reaction (ALT, AST), mechanism of action of aminotransferases. Urea cycle and its regulation. Metabolism of ammonia and related its disorders. Biosynthesis and degradation of essential and non-essential amino acids and their regulation. Synthesis and degradation of catecholamines. In-born errors of amino acid metabolism: Phenylketonuria, alkaptonuria, homocystinuria, maple syrup urine disease.

Heme Metabolism: Biosynthesis and degradation of porphyrin and their regulation, porphyrias, jaundice and Hemoglobinopathies

Unit- 4 **13 hrs**

Nucleic acid Metabolism:

Structure and properties of Nucleosides and Nucleotides.

Biosynthesis of purines and pyrimidines. Degradation of purines and pyrimidines. Regulation of purine and pyrimidines biosynthesis. Structure and regulation of ribonucleotide reductase. Biosynthesis of ribonucleotides, deoxy ribonucleotides and polynucleotides. Inhibitors of nucleic acid biosynthesis, Salvage pathways, Disorders of nucleic acid metabolism**:** Gout**,** hyperuricemia, oroticaciduria , Lesch-Nyhan Syndrome

Reference Books:

1. Biochemistry- R. Garret, Charles M Grisham, Belmont (2013)

2. Biochemistry; Geoffrey Zubey (1998), WCB Publishers.

3. Biochemistry; David Rawn, Panima Publishers, (1989).

4. Text Book of Biochemistry with Clinical correlations; 6th Edn. Thomas M. Devlin (2012), Wiley-Liss.

5. Lehninger- Principles of Biochemistry; D. L. Nelson and M.M. Cox 6th Edn. Macmillan Publications (2012).

6. Principles of Biochemistry; Smith et al., [Ed.] (1986) McGarw Hill.

7. Bioenergetics; A Practical Approach, G.C. Brown and C.E. Cooper (1995) IRL- Oxford University Press.

8. Biochemistry Ed. Donald Voet& Judith G. Voet, John Wiley & Sons, Inc. (2010).

9. Bioenergetics; David Nicholls and Stuart Ferguson, Elsevier (2013).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC2051	Bioinformatics	SC	1	1	0	2	3

Prerequisites/Pre reading for the course:

Basic knowledge of molecular biology, genetics, chemistry, statistics, linear algebra and computer programming.

Course Objectives:

The overall objectives of the course are:

To make the students familiar with the use of a wide variety of internet applications, biological database so that they will be able to apply these methods to research problems.

Course Outcomes:

After completing the course, the student shall be able to:

CO1 - Basic computer, apply Biological data in drug design using different software, develop new methodology.

CO2 - Apply knowledge in the areas of Biotechnology, Pharmaceuticals and software fields

Course Content: **Total Hours: 26hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2		7.5	5	12.5	25	13
Total	7.5	7.5	10	25	50	26

Unit-1 **13 hrs**

Computer basics; Characteristics of Computers, Input, Output, Storage units, Central Processing Unit, Memory, RAM, ROM, Booting, Memory- Storage Devices, Floppy and Hard Disks,Optical Disks CD-ROM, DVD, E-Mail

Operating Systems:

MS windows basics, LINUX, File transfer (ftp, WSftp), System and application software, evolution of operating systems, layered structure of operating system, CUI and GUIs, DOS internet & external commands, Batch files.

Office Applications: MS-office including MS-Word, MS-Excel, and MS-Powerpoint.

Data bases: Databases structure organization and management of data bases, Data mining. Retrieval tools of biological data, Entrez, DBGET and SRS. Biological information resources, Nucleic acid and protein data bases.

Unit 2 **13 hrs**

Sequence Alignment and prediction of structure of protein

Database similarity searches: BLAST and FASTA, Sequence alignment; pairwise and multiple sequence alignment, local and global alignment. Dynamic programming, scoring matrix, PAM, BLOSUM. Phylogenetic tree construction software, Methods of phylogenetic analysis: UPGMA, maximum likelihood, neighbour joining method. Protein structure prediction; methods of prediction of structure of protein and structure prediction softwares, Drug designing: Chemo-informatics in Biology.

Reference Books:

1. Discovering Genomics, Proteomics and Bioinformatics, Campbell A M &Heyer L J, 2nd Edn. Benjamin Cummings, (2007).
2. Protein Bioinformatics; M. Michael Gromiha, Academic Press (1983).
3. Principle and Practice of Bioanalysis; Richard F. Venn (Ed.) Taylor and Francis (2000).
4. Introduction to Bioinformatics by Attwood, T. and P.S. David. 2006. Pearson Education Ltd.,New York.
5. Bioinformatics A Practical Guide to Analysis of Genes and Proteins by Baxevanis, A.D., and Ouellette, B.F.F. (eds) 2006, 3rd Edition, John Wiley and Sons, New York.
6. Bioinformatics and molecular evolution by Attwood T.K. and Higgs, P.G. 2005 Blackwell Publishers, London.
7. Introduction to Bioinformatics by Lesk, A.M. 2002. Oxford University Press

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.

M20BC2052	Food Technology	SC	1	1	0	2	3

Prerequisites/Pre reading for the course:

Understanding of raw materials from crops for nutrition from dairy, livestock, poultry and agricultural foods

Course Objectives:

The overall objectives of the course are:

- To develop the knowledge among students about healthy food and safety technologies
- To evaluate the quality food products which are new to the market
- To develop the methods to improve the quality of food products

Course Outcomes:

After completing the course, the student should be able to

CO1 - Attain fundamental understanding of food science, principles of food preparation, assess and solve food science problems.

CO2 - Apply critical thinking, design and problem-solving skills to address current challenges in the food industry.

Course Content: **Total Hours: 26hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2		7.5	5	12.5	25	13

Total	7.5	7.5	10	25	50	26

Unit 1 **13hrs**

Introduction and Constituents of foods

Introduction of Food chemistry. Sources and functions of food – food groups – basic five food groups, usage of the food guide – food in relation to health – objectives of cooking.

Water: Purification processes – Ion exchangers, reverse osmosis, activated charcoal treatment. Use of chlorination, ozone, and UV light disinfection. Specification of drinking water. Water borne diseases – microbiological examination. Sources and detection.

Milk: Composition and effectiveness as a diet. Fat content in milk, whole and skimmed. Effect of cooking and heat processing of milk – pasteurization. Preservation of milk. Deep freeze preservation, dairy products – cheese, butter, ghee and kova. Spray drying technique – milk powder, infant food preparation. Lactose intolerance. Milk substitutes – vegetable milk. Toned milk.

Effect of cooking on the nutritive value of carbohydrate, protein, fat, vitamins and minerals food products. Emulsions and emulsifiers, rancidity of fats – chemistry of fat and oil processing, Fortification with vitamins and minerals. Effect of cooking on different methods of cooking of vegetables, fruits – dehydrated fruits, canned fruit, canned fruit juices. Estimation of thiamine, riboflavin (fluorimetry) and metals in tea dust.

Unit 2: **13hrs**

Food additives, adulteration and hygiene

Enzymes in food processing. Enzymic browning – mode of action and prevention of enzymic and non-enzymic browning.

Food hygiene and Additives: Food contamination types and its prevention, Food additives: Artificial sweeteners – saccharin, cyclomate, asparatame – food flavours – esters, aldehydes and heterocyclic compounds. Antioxidants. Food colours – changes in cooking. Restricted use. Spurious colours. Emulsifying agents, preservatives – leavening agents. Baking powder –Yeast. Taste enhancers – MSG-vinegar. Modern food: Mushroom cultivation and types. Production of

bread, bun and biscuits. Raw materials, methods and machinery required. Functions and uses of food additives.

Beverages: Composition of soft drinks. Preservation of tetrapack. Nitrogen preservation and packing of fruit juices.

Food Adulterants: Common adulterants in different foods – milk and milk products, vegetable oils, fats, spices, cereals and pulses. Prevention of food adulteration.

Food preservation and processing: Food deterioration, methods of preservation and processing. Quality control: Specifications and standards: PFA, FPO, FDA, Hazard Analysis and Critical Control Point (HACCP), drug license, WHO standards, ISI, AGMARK.

Reference Books:

1. Advanced Text Book on Food and Nutrition by Swaminathan M, volume I and II Printing and Publishing CO., Ltd., Bangalore. 1993.
2. Text Book on Food chemistry by Swaminathan M. Printing and Publishing CO., Ltd., Bangalore. 1993.
3. , Food science by Norman N. Potter CBS publishers and distributors, New Delhi. 1994.
4. Food Chemistry by Lillian Hoagoland Meyer CBS publishers and distributors, New Delhi. 1994.
5. Food Chemistry by Owen R Fennema,, Marcel Decker Inc., New York. 1996.
6. Food Science by Srilakshmi B New age International Pvt. Ltd. Publishers, III ed. 2003.
7. Modern Food Microbiology by Jay JM, Loessner MJ & Golden DA. 2005 7th Ed. Springer
8. Food Processing and Preservation by Siva Sankar B., Prentice – Hall of India Pvt. Ltd., New Delhi. 2002.
9. Principles. Text book of medical biochemistry by Ramakrishnan S., Prasannam K.G and Rajan R Orient Longman Ltd. III ed. 2001.
10. FOODS: Facts and Principles. Shakuntala Manay N. and Shadakshara swamy M New age International Pvt. Ltd. Publishers

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC2060	Sports/Yoga/Music/Dance/ Theatre	RULO	0	0	2	2	3

Note: Music, Dance, and Theatre courses are offered by the School of Performing Arts, whereas the Sports and Yoga courses are offered by the Department of Physical Education. The students have to choose any ONE of these courses.

Prerequisites/Pre reading for the course:

Graduate level knowledge of sport activity and basic knowledge of sport rule and regulation.

Course Objectives:

The overall objectives of the course are:

- To prepare the students for the integration of their physical, mental and spiritual faculties;
- To enable the students to maintain good health;
- To practice mental hygiene and to attain higher level of consciousness;
- To possess emotional stability, selfcontrol and concentration; and
  To inculcate among studentsself discipline, moral and ethical values

Course Outcomes:

After completing the course, the student should be able to

CO1 - Practice yoga for strength, flexibility, and relaxation.
CO2 - Learn techniques for increasing concentration and decreasing anxiety
CO3 - Become self-disciplined and self-controlled, improve physical fitness and perform better in studies
CO4 - Gain self-confidence to face the challenges in the society with commitment to serve the society

Unit-I:

Yoga: Introduction, Tips from Sage Patanjali's Yoga Sutras

Surya Namaskara:- 10 counts,12 counts,16 counts

Unit-II:

Asanas: Sitting-Vajrasana, Dandasana, Padmasana, Matsyasana, Ardha Matsyendrasana, Suptavajrasana, Paschimottasana, Bakasana, Simhasana, Shirasasana

Asanas: Standinng Tadasana, Trikonasana, Parshwakonasana, Veerabadrasana, Parivruttatrikonasana.

Unit-III:

Asanas: Prone Position- Bhujangasana, Dhanurasana, Shalabhasana.

Asanas: Supine Position- Sarvangasana, Sethubandhasarvangasana, Halasana, Karnapeedasana.

Mudras- Dhyana mudra, Chinmaya mudra, Namaste mudra, Nasika mudra

Unit-IV:

Pranayams:- Ujjayi, NadiShodhana, Anuloma – Viloma, Basthrika, Bhramari, Sheethali

Dhyana & its types

Competition format, Rules and their interpretations

SPORTS (VOLLEYBALL)

Prerequisites:

Course Objectives:

- To learn the rules, fundamental skills, and strategies of volleyball.
- To develop skills in passing, setting, serving, spiking, and blocking.
- To learn basic offensive and defensive patterns of play.
- To develop a positive attitude towards volleyball as a lifetime sport and to improve physical
- fitness through participation in volleyball.

Course Outcomes:

On completion of the course learners will be able to:

CO1 - Learn basic skills and knowledge associated with volleyball.

CO2 - Apply these skills while playing volleyball and exhibit improved performance

CO3 - Improve physical fitness and practice positive personal and lifestyle.

CO4 - Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Unit-I

Introduction about Volleyball

Players Stance, Receiving and passing

The Volley (Overhead pass), The Dig (Underhand pass), Service Reception

Unit-II

Service- under Arm Service, Tennis Service, Side Arm Spin Service, Round Arm Service, High spin service, Asian serve / American serve (floating)

Setting the ball- Set for attack, back set, Jump set

Unit-III

Smash/Spike- Straight smash, Body turn smash, Wrist outward smash and Wrist inward smash

Block- Single block, Double block, Three-man block

Rolls- Overhead pass & back rolling, one hand underhand pass with side rolling, Forward dive

Unit-IV

Attack Combination, Defense Systems and Libero play

Court marking, Rules and their interpretations and Duties of officials

SPORTS (BASKETBALL)

Prerequisites:

Course Objectives:

- To learn the rules, fundamental skills, and strategies of Basketball

- To develop technical skills in passing, in ball handling, individual offense, individual defense, rebounding, screen, team offense, team defense and fast break.
- To learn basic offensive and defensive strategies of play.
- To develop a positive attitude towards Basketball as a lifetime sport and to improve physical fitness through participation in Basketball.
- To develop positive understanding and appreciation of the basketball game.

Course Outcomes:

On completion of the course learners will be able to

- Learn basic skills and knowledge associated with basketball.
- Apply these skills while playing basketball and exhibit improved performance
- Improve physical fitness and practice positive personal and lifestyle.
- Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Unit-I

Basketball: Introduction

Grip; Player stance- Triple threat stance and Ball handling exercises

Passing (Two hand/one hand)- Chest pass, Bounce Pass, Over head pass, Underhand pass, Hook Pass, Behind the back pass, Baseball pass, Side arm pass and passing in running.

Receiving-Two Hand receiving, One hand receiving, Receiving in stationary position, Receiving while jumping, Receiving while running.

Unit-II

Dribbling- How to start dribble, How to stop dribble, High / Low dribble with variations

Shooting- Layup shot and its variations, One hand set shot, One hand jump shot, Free throw, Hook shot, Tip-in shot.

Stopping- Stride/Scoot, Pivoting and Faking /Feinting footwork.

Unit-III

Rebounding- Defensive rebound, Offensive rebound, Box out, Rebound Organization.

Individual Defensive- Guarding the man with the ball and without the ball.

Offensive drills, Fast break drills, Team Defense/Offense, Team Tactics

Unit-IV

Court marking, Rules and their interpretations

SPORTS (FOOTBALL)

Prerequisites:

Course Objectives:

- To learn the rules, fundamental skills, and strategies of football.
- To develop skills in passing, receiving, controlling the ball, dribbling, shielding, shooting, tackling, beating a defender and heading in football.
- To learn basic offensive and defensive patterns of play
- To use different parts of the body in utilizing the above skills while playing football
- To develop a positive attitude towards football as a lifetime sport and to improve physical fitness through participation in football.

Course Outcomes:

On completion of the course learners will be able to:

CO1 - Learn basic skills and knowledge associated with football, apply these skills while playing football and exhibit improved performance

CO2 - Use the knowledge and understanding to perform, refine and adapt the above skills and related skills with precision, accuracy, fluency and clarity in any situation.

CO3 - Improve physical fitness and practice positive personal and lifestyle.

CO4 - Gain an understanding of the value of sports in attaining wellness, maintaining good health and developing spirit of teamwork.

Unit-I

Football: Introduction

Kicks- Inside kick, Instep kick, Outer instep kick, lofted kick, Chipping, Volley, Half Volley

Trapping- Trapping rolling the ball, trapping bouncing ball with sole

Unit-II

Dribbling- With instep and outer instep of the foot.

Heading- From standing, running and jumping.

Feinting- With the lower limb and upper part of the body.

Unit-III

Tackling- Simple tackling, Slide tackling.

Throw-in- Standing and Sliding

Goal Keeping- Collection of balls, Ball clearance, throwing and deflecting.

Unit-IV

Ground marking, Rules and their interpretations

SPORTS (TRACK AND FIELD)

Prerequisites:

Course Objectives:

- To teach students the skilled techniques in sprints, relay running, hurdles, long jump, high jump, and shot put and practice them.
- To develop competence among students in demonstrating all the techniques covered in the course.
- To make students understand some of the scientific and empirical principles and their rationale underlying the development of skilled performance.
- To inculcate among students the habit of team work and cooperative learning and develop competence in detecting / correcting technique errors.
- To develop a positive attitude towards sports in general and athletics in particular and to improve physical fitness through participation in various athletic games / sports activities.

Course Outcomes:

On completion of the course learners will be able to:

CO1 - Display competencies in executing basic techniques and skills associated with select track and field events.

CO2 - Develop basic skills and techniques to improve one's running posture and take-off position for different jumps.

CO3 - Learn regular practice of select track and field events and improve physical fitness

C04 - Appreciate track and field events by applying sports science knowledge to explain the execution of the events.

Unit-I

Athletics: Introduction

Track Events - Steeple Chase, Race Walking, Middle and Long distance races

Race walking - Technique, Faults and Officiating.

Middle and Long distance races – Technique and Training

Unit-II

Jumping Events - High Jump and Triple Jump: Basic Skills and techniques

High Jump - Straddle Roll & Flop Technique, Approach, Take-off, Technique in the air, Clearance over the bar & Landing

Triple Jump – Hop, Step and Jump Technique, Approach, Take-off & Landing

Unit-III

Throwing Events - Discus Throw and Hammer Throw: Basic Skills and techniques

Discus Throw - Standing and Rotatory techniques, Grip, Stance, Rotation Technique, Power stance, Release and Reverse (Follow through)

Hammer Throw - Grip, Swings, Rotation foot work, Release and Follow through

Unit-IV

Rules, Officiating and Marking - Ground / Sector Marking, Interpretation of Rules.

Reference Books:

1. (Athletics Part-I and Athletics Part-II)
2. Athletic Training and Sports Medicine by Arthur E. Ellison (ed) (1994).
3. Hurdles Basic Coaching Manual by Ballisteros, J.M. (1998). IAAF.
4. Teaching Athletics Skills and Technique by Bosen K.O. (1993).
5. Study Material on Hurdles for the Regular Course Students by Bosen K.O. (1990).
6. Track and Field Omni booby k by Doherty K. (1995).
7. Training Distance Runner Martin, David E. Peter N. Coe (1991).
8. Science of Track and Field Athletics by Howard S. (1981).
9. Track and field coaching Manual, Australian Track and Field Coaches Association. Rothmans Foundation National Sports Division by Briggs Graeme (1987).
10. Fundamentals of Track and Field by Carr, Gerry (1999). Track Athletics 1 Title G.V. 1060 5.e. 368.
11. Text Book on Jumping Event. .A.A.F. Level-II (2001
12. The Jump Track and Field Coaching Manual Australia by Jarver, Jesse (1987).

DRAMATICS

Prerequisites:

Students with background in Theatre Arts/ Keen interest in Dramatics.

Course Objectives:

- To imbibe the acting skills.
- To understand the broader applications of theatre studies in allied arts forms.
- To be able to use body language for better communication.
- Students shall also be able to understand voice modulation and Navarasas.

Course Outcomes:

On successful completion of this course, students should be able to:

CO1 - Freely express improvisation in non-verbal communication.

Shall hone good acting skills and be able to emote better.

CO2 - Be able to put up a theatre act and play a key role.

CO3 - Be able to differentiate good acting and understand the importance of good lyrics, stage crafting, music, dance, costume and lighting.

UNIT – 1

Working on Body:

Body and its analysis. Understanding physical abilities (Anga, Pratyanga and Upanga). Challenges of the body. Using body as metaphor and language. The class's bodies as a collective, an ensemble, a collaborative team.

UNIT – 2

Sound and Movement:

Awareness of creating sound patterns, voice modulations, rhythm in speech and diaologues. Understanding the rhythm and patterns of movements like walking, framing, shaping, primitive and animal movements.

UNIT – 3

Characterization and Improvisation:

Observation of people around. Getting into the role and living it. Developing a character from establishment (pace and rhythm). Improvisation techniques of body and mind.

UNIT – 4

Group work and Production:

Develop a theme, concept or a play and include all the theatre skills, stage craft, costuming and put up an act. Choosing theme and characters.

Reference Books:

1. All about Theatre – Off stage – Chris Hogget.
2. RangadalliAnataranga – K V Subbanna
3. The Indian Theatre – Hemendranath Das Gupta.
4. A Practical handbook for an Actor – MilisaBruder, eeMilchel Cohn, Madeleine Oliek et al, Zigler Publisher.

INDIAN CLASSICAL DANCE FORMS (Bharathanatyam, Kuchipudi ,Mohiniyattam)

Prerequisites:

Background of classical dance training or any other dance forms.

Note: Non-classical dancers can also join.

Course Objectives:

- To develop an understanding about the Indian classical dance forms and its universal application.
- To be able to understand the fine nuances of Classical dance.

- To understand the importance of health through Indian classical dance, strengthen the body capacity.
- To understand mythology and its characters in Indian classical dance form through lessons of Abhinaya.

Course Outcomes:

CO1 - To be able to identify and appreciate the classical dance forms.

CO2- To be able to execute basics of Adavus with finesse.

CO3 - To be able to express through abhinaya.

CO4 - To be able to perform to perform the fundamentals in the chosen dance form.

Unit 1

An introduction to Indian classical dance forms: Bharatanatyam, Kuchipudi, Mohiniyattam.

Unit 2

Learning of Fundamentals: Exercises and Adavus- 1 (Bharathanatyam, KuchipudI, Mohiniyattam).

Unit 3

Adavus –II (Bharathanatyam ,Kuchipudi, Mohiniyattam)

Unit 4

Learn a basic composition in the chosen dance form.

Reference Books:

1. Indian classical dance forms –U S Krishna Rao,U K Chandrabhaga Devi
2. Classical Dances –SonalMansingh, AvinashParischa
3. Kuchipudi – Sunil Kothari
4. Bharatanatyam An in depth study- Saroja vydyanathan
5. Mohiniyattam – Bharathi Shivaji

PERCUSSION INSTRUMENT (TABLA AND MRIDANGAM)

Prerequisites:

Students with background in Percussion instruments and knowledge of Rhythm/ Keen interest in studying Mridagam / Tabala.

Course Objectives:

- To understand the Rhythmology.
- To understand the importance of Laya, Taala.
- To be able to understand the fine finger techniques of playing the instrument.

Course Outcomes:

On successful completion of this course, students should be able to:

CO1 - To be able to set instrument to Sruthi.

CO2 - To be able to play the fundamentals on instrument.

CO3 - To be able to learn and perform a particular taala.

CO4 - Able correlate with instrument of instrument and taala

UNIT 1

1. Introduction to Musical Instruments
2. Percussion Instruments
3. Mridangam and its History

UNIT 2

1. Introduction to Tala System
2. Definitions of 5 jaathis and their recitation
3. Adi Talam and its various forms
4. Definitions and recitation of different gathis

UNIT 3

1. TisraJaathi
2. Khanda Jaathi
3. Misrajaathi
4. SankeernaJaathi

UNIT 4

1. Learning of Jathi Formation
2. Basic jathis
3. Jathis for Dance forms
4. Some Basic Definitions of Korvai, Teermanam etc.,

Reference Books:

1. Mridangam- An Indian Classical Percussion Drum – Shreejayanthi Gopal
2. Theory and practice of Tabala – SadanandNaimpally.
3. Theory and practice of Mridangam – Dharmala Rama Murthy
4. The Art of the Indian Tabala – SrdjanBeronja.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC2070	Protein Chemistry (Laboratory – V)	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Graduate level understanding of protein sciences and separation techniques for biomolecules

Course Objectives:

The overall objectives of the course are:

- To provide general knowledge on protein structure and function, as well as the experimental techniques in protein chemistry
- To develop the ability of identifying the experimental techniques required to solve specific problems related to proteins and enzyme functions and
- To train students in the evaluation of the consequences of biochemical and biological tools in their professional activities.

Course Outcomes:

After completing the course, the student shall be able to:

CO1 - Apply the knowledge about standard laboratory equipment, modern instrumentation & classical techniques to carry out experiments

CO2 - To explain the importance of protein–protein interactions in biological systems.

CO3 - Estimate the amino acid (Tyrosine) and protein in extract

CO4 - Understand the molecular weight determination and cell free protein synthesizing system

Course Content: **Total Hours: 30 hrs**

Weightage Distribution for Assessment

COs	IA	Regular Performance	SEE	Total	Hours
CO1	5	8	13	25	8

CO2	5	7	12	25	7
CO3	5	8	13	25	8
CO4	5	7	12	25	7
Total	20	30	50	100	30

Course Contents:

- Isolation, separation and identification of protein/enzyme using thin layer chromatography.
- Purification of an enzyme using column chromatography (ion-exchange columns/gel filtration/ affinity chromatography).
- Estimation of protein by Lowry's method.
- Estimation of tyrosine by Millon's method.
- Molecular weight determination and kinetic studies on purified enzymes.
- Protein synthesis in a cell free protein synthesizing system from animal and plant source (industrial visit)

Course Code	**Course Title**	**Course Type**	**L**	**T**	**P**	**C**	**Hrs./ Wk.**
M20BC2080	Immunology (Laboratory – VI)	HC	0	0	2	2	3

Prerequisites/Pre reading for the course:

Fundamental knowledge of microbiology, immunology, radioisotopes and special handling of samples.

Course Objectives:

The overall objectives of the course are:

To familiarize students with the various immunological techniques that include antigen-antibody interactions, quantitation of antigens or antibody, ELISA, agglutination reactions etc.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Design experiments to confirm interactions between known proteins using immune precipitation reactions.

CO2 - Apply the knowledge of blood group antigens to determine the blood groups.

- Analyse antigen and antibody analysis by rocket electrophoresis
- Understand principle of WIDAL test

Course Content: **Total Hours: 30 hrs**

Weightage Distribution for Assessment

COs	IA	Regular Performance	SEE	Total	Hours
CO1	5	8	13	25	8
CO2	5	7	12	25	7
CO3	5	8	13	25	8
CO4	5	7	12	25	7
Total	20	30	50	100	30

Course Contents:

- Demonstration of Ag-Ab interaction: Radial immuno-diffusion and ODD.
- Demonstration of direct agglutination reaction using human blood group antigens.
- Bacterial agglutination (WIDAL)

- Antibody titration – ELISA; Direct, Indirect ELISA.
- Rocket electrophoresis.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC2090	Molecular Biology (Laboratory – VII)	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Basic knowledge of genetics, genomics, proteomics, gene and protein expression at molecular level

Course Objectives:

The overall objectives of the course are:

To have the knowledge about the importance of solvents and their uses in the isolation of genomic DNA and plasmid DNA from various sources like plants, bacteria and animal source.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Isolate the DNA from any bacteria culture.

CO2 - Isolate the DNA from any tissue of the animal or plant source

CO3 - Extract the protein form sample and SDS-PAGE analysis.

CO4 - Understand principle of HPLC and quantitative estimation

Course Content: **Total Hours: 30 hrs**

Weightage Distribution for Assessment

COs	IA	Regular Performance	SEE	Total	Hours
CO1	5	8	13	25	8
CO2	5	7	12	25	7
CO3	5	8	13	25	8
CO4	5	7	12	25	7
Total	20	30	50	100	30

Course Contents:

- Isolation of DNA from cauliflower, sheep liver and bacterial source.
- Isolation, separation, identification and Determination of molecular weight of Proteins by SDS-PAGE.
- Subcellular fractionation of organelles from liver cells and identification by the use of marker enzymes.(industrial visit)
- Separation of Protein in HPLC

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC20X0	Bioinformatics (Laboratory – VIII)	HC	0	0		2	3

Prerequisites/Pre reading for the course:

Basic knowledge of molecular biology, genetics, chemistry, statistics, linear algebra and computer programming.

Course Objectives:

The overall objectives of the course are:

To make the students familiar with the use of a wide variety of internet applications, biological database so that they will be able to apply these methods to research problems.

Course Outcomes:

After completing the course, the student should be able to

CO1 - To describe the contents and properties of the most important bioinformatics databases, perform text- and sequence-based searches,

CO2 - Analyze and discuss the results in light of molecular biological knowledge

CO3 - Search the sequence from data base and use the retrieval tools

CO4 - Understand Rasmol, docking principle and analysis of docking

Course Content: **Total Hours: 30 hrs**

Weightage Distribution for Assessment

COs	IA	Regular Performance	SEE	Total	Hours
CO1	5	8	13	25	8
CO2	5	7	12	25	7
CO3	5	8	13	25	8
CO4	5	7	12	25	7
Total	20	30	50	100	30

Course Contents:

- Writing a BASIC computer program to plot graphs of enzyme kinetic data by a variety of linear transforms and the Michaelis- Menten hyperbolic plot.
- Prediction of structure of a biomolecule by using various softwares (Rasmol, PDB, Identification of ligands/substrate through docking, chemsketch etc,
- Subcellular fractionation of organelles from liver cells and identification by the use of marker enzymes (industrial visit)

SEMESTER – III

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC3010	Molecular Biology	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Basic knowledge of genetics, genomics, proteomics, gene and protein expression at molecular level.

Course Objectives:

The overall objectives of the course are:

- To understand the scientific process, in the context of learning the fundamental biological and chemical ‘facts' of molecular biology.
- To propose hypotheses and explain biological phenomena by adopting scientific methods

Course Outcomes:

After completing the course, the student should be able to

CO1 - Analyze the molecular mechanisms by which DNA controls development, growth or morphological characteristics of organisms

CO2 - Explain concepts such as gene structure and function, gene regulation, microbial genetics, mutation and DNA

CO3 - Describe the importance of recent discoveries and the applications and potential of molecular biology and the ethical issues associated with these new technologies

CO4 - Develop effective, creative and innovative solutions, both independently and cooperatively, to current and future research problems in Molecular Biology

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit -1 **13hrs**

Chemistry of Nucleic Acids

Structure of nucleic acids– primary, secondary and tertiary structure of DNA. Central dogma, DNA as genetic material. Watson and Crick model of DNA, deep and narrow grooves, single stranded DNA, A, B and Z DNA etc. Physico- chemical properties of nucleic acids - effect of alkali, acid and heat (denaturation and renaturation), Isolation, fractionation and characterization

of nucleic acids. Chirality of the helix, syn/antiparallel complementary stands. Physical properties of RNA: Classes of RNA, rRNA, tRNA, mRNA, HnRNA etc.

Secondary structure of tRNA and role of secondary structure in mRNA stability. Chemical synthesis of oligonucleotides (phosphate and phosphite method). Nucleoproteins – histone and nonhistone**,** Nucleosomes, role of H1

Unit -2 **13hrs**

DNA Replication and Genetic code:

Replication origin and replication fork, mapping origin of replication by autoradiography and electrophoresis, semi-conservative and semi-discontinuous replication; DNA Polymerases; properties and functions of DNA polymerase-I, II, III, Korenberg enzyme, Subunit composition of DNA polymerase. Telomerase, topoisomerase and gyrase. Fidelity of replication, Regulation of replication. Eukaryotic DNA polymerases, type sand mechanism of replication. Replication ofviral DNA

Properties of genetic code, coding properties of mRNA, Coding properties of tRNA, triplet binding assay, Khorana and Neirenberg experiments, base pairing between codon and ani-codon,Wobble base pairing, deviation from universal genetic code.

Unit-3 **13hrs**

Transcription and translation:

RNA synthesis and processing; transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport.

Protein synthesis and processing; Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylationof tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins.

Unit -4 **13hrs**

DNA Repair: Damaging agents, different types of DNA damages, and recognition of DNA damage. DNA repair systems; direct repair, mismatch repair, Base excision repair(BER), Nucleotide excision repair (NER) systems, recombination repair, transcription coupled repair, error-prone repair, SOS and Rec-A.

Satellite DNA: C-value paradox, possible functions of satellite DNA, Mechanical strength, gene library, suppressor mutation, centromeric DNA, split genes.

Reference Books:

1. Molecular cloninig:a laboratory manual (Vol.1,2&3) 1989) by T.Maniatis, E.F.Fritsch, J. Sambrook. Cold SpringHarbor Laboratory Publications.
2. RNA Isolation and Analysis by P.Jones, J.Qiu, D.Rickwood (1st ed.1994) Bios Scientific Publishers.
3. Gene and Probes: A practical Approach Series (1995) by B D Hames and S J Higgins. Oxford universityPress.
4. Gel Electrophoresis of nuclei Acids: A practical Approach (1990) by D.Rickwood and B.D.Hames. OxfordUniversity Press.
5. Biochemistry and Molecular Biology of Plant; Buchanan, Gruissum and Jones, (2000), ASPP, USA.
6. Biochemistry; David Rawn, Panima Publishers (2012).
7. The Bacteriophages; Richard Calendar, 2nd Edition, Oxford University Press (2005).
8. Basic Virology; Wagner and Hewlett; Blackwell Science, (2004)
9. LEWINS Gene XI; J.E. Krebs, E.S. Goldstein, and S.T. Kilpatrick, Jones and Barttlett Publishers (2012).
10. Molecular Biology of the Cell, Alberts et al., Garland Publications, (2012).
11. Molecular Biology, David Freifelder, Narosa Publishers, (1997).
12. Molecular Biology Robert F. Weaver, McGraw Hill (2012).
13. Microbial Genetics; Maloy et al., Jones and Bartlett Publishers, (1994).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC3020	Nutritional Biochemistry	HC	3	0	0	3	4

Prerequisites/Pre reading for the course:

Graduate level understanding of nutrients, food constituents and their functions in humans at normal and diseased state.

Course Objectives:

The overall objectives of the course are:

To make the students familiar with various classes of nutritional food groups, contents and their biochemical importance in various health conditions.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Acquire the knowledge and analyse the nutritional importance of food groups.

CO2 - Acquire the knowledge about the allergic substances present in various foods.

CO3 - Attain the knowledge about fortification and food supplementation.

CO4 - Understand the purpose of food analysis to avoid various food related diseases.

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13

CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit-1 **13hrs**

Introduction of Nutrition: Energy concept of foods- Definition and characteristic feature of balanced diet, proximate analysis of foods for carbohydrates, proteins, fats, fibre material. Determination of calorific value of foods, like carbohydrates, fats and proteins. Biochemical importance of R.Q. BMR, measurement of BMR, direct and indirect method, factors affecting BMR.

Biological Oxygen Demand: Definition and importance. Energy requirement for different physical activities. Standard Dynamic Action (SDA) of food. Recommended Daily Allowance (RDA) – Definition & for various food and physical activities.

Unit-2 **13hrs**

Carbohydrates: carbohydrate reserves of the human body, nutritional importance of carbohydrates.

Proteins: Protein reserves of human body. Nitrogen balance studies and factors influencing nitrogen balance. Essential amino acids for man and concept of protein quality. Protein energy malnutrition: Marasmus, Kwashiorkor, causative factors, symptoms, treatment & prevention

Lipids: Major classes of dietary lipids. Properties and composition of plasma lipo-proteins. Dietary needs of lipids. Essential fatty acids and their physiological functions.

Unit-3 **13hrs**

Nutritional importance of vitamins: Classification, sources, daily requirement and functions. Hypervitaminosis of fat-soluble vitamins

Nutritional importance of Minerals: Definition, classification, sources, daily requirement and deficiency, symptoms. The process of digestion, absorption, functions, toxicity interaction with other nutrients.

Unit-4 **13 hrs**

Biochemical aspects of oxidative stress and antioxidants. Free radicals- formation and biological importance in human system. Natural antioxidants, role of free radicals and antioxidants in health & diseases.

Starvation: Protein metabolism in prolonged fasting. Protein sparing treatments during fasting. Basic concept of high protein, low caloric weight reduction diets.

Obesity: Definition and classification. Genetic and environmental factors leading to obesity. Obesity related diseases and management of obesity.

Reference Books:

1. Nutrition: An integrated approach (3rd edn. 1984) R L Pike and M L Brown, Wiley & Sons Inc., NY.
2. Text Book of Biochemistry and Human Biology G P Talwar, Prentice Hall.
3. Mechanism and Theory is food chemistry (1996) DWS Wong, CBS, New Delhi.
4. Text Book of Human Nutrition (1996) M S Bamji N Pralhad Rao and V Reddy, Oxford & IBH Publishers.
5. Nutritional Biochemistry and Metabolism Linten.
6. Principles of Food Science-l (Food chemistry) Fennemona D R.
7. Human Nutrition and Dietetics (8th Ed. 1982) by Davidson and Passmore ELBS.
8. Modern Nutrition in Health and Diseases (7th ed. 1988) by Maurice E Skills and V R Young K M Varghese Co. Bombay.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC3030	Biochemical Genetics	HC	2	1	0	3	4

Prerequisites/Pre reading for the course:

Fundamental understanding of genome structure and mapping, gene expression and regulation, genetic variation, evolution, phylogenetics genetic disorders and genetic epidemiology

Course Objectives:

The overall objectives of the course are:

To develop and demonstrate an understanding of the structure and function of genes and the organization of the human genome; the patterns of inheritance and clinical manifestations of genetic diseases; chromosomes, chromosomal abnormalities, and the clinical features of common chromosomal disorders; population genetics; inborn errors of metabolism;

Course Outcomes:

After completing the course, the student should be able to

CO1 - Demonstrate an understanding of how the principles of genetics underlie much of the basis of modern molecular biology.

CO2 - Understand the relationship between the phenotype and genotype in human quantitative traits, describe the gene expression regulated at different levels.

CO3 - Attain knowledge of basic concepts of hereditary, population genetics and master the calculations of fundamental genetics

CO4 - Describe examples of human genetic disorders caused by gene mutations and chromosomal rearrangements

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13

CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit- 1 **13 hrs**

Introduction: Chromosomes and genes. Mutation: types of mutation, mutagens, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis. Quantitative Genetics: Human quantitative traits, discontinuous traits and continuous traits, Breeding analysis, estimation of Heritability Index. Polygenic inheritance, heritability and its measurements, QTL mapping

Unit- 2 **13 hrs**

Classical Genetics: Mendel's laws - Dominance, segregation, independent assortment. Allele, multiple alleles, pseudo allele, complementation tests. Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Sex determination and dosage compensation: sex determination- in humans, Drosophila and other animals; Morgan's discovery of sex linked inheritance of sex linked genes, X;linked traits in humans. Identification of sex chromosomes, XX, XY, mechanism of sex determination,dosage compensation of X-linked genes– hyperactivation of X-linked gene in male Drosophila, inactivation of X-linked genes in female mammals; human genetics- karyotype and nomenclature of metaphase chromosome bands; Extranuclear inheritance, maternal inheritance, mitochondrial and chloroplast genes inheritance. Population genetics- Populations, Gene pool, Gene frequency; Hardy-Weinberg Law;

Unit- 3 **13hrs**

Human Genetics: Biochemical events occurring during mitosis and meiosis. Structure of chromatin; nucleosomes and higher orders of organization. Metaphase chromosomes: centromere and kinetochore, telomere and its maintenance; Holocentric chromosomes; Heterochromatin and euchromatin, polytene and lamp brush chromosomes. Chromosome banding, Chromosome mapping based on recombination frequency data. Transposable element; LINES, SINES, Alu family and their application in genome mapping. Recombination; Homologous and non-homologous human genome project, mapping of human genes; identification of genes. Chromosomal abnormalities.

Unit- 4 **13 hrs**

Bacterial Genetics: Bacterial chromosomes, Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating. Plasmids; R-plasmid, F-Plasmid, colicinogenic factor and other types. Recombination in bacteria.

Viral Genetics: Bacteriophage: Life cycles of bacteriophages, lytic and Lysogeny cycle and its regulation; replication of T-phages. Transduction; specialized, generalized and abortive. Fine structure analysis of T- phages; Benzers work, concept of cistrons.

Reference Books:

1. Discovering Genomics, Proteomics and Bioinformatics, Campbell A M &Heyer L J, 2nd Edn. Benjamin Cummings, (2007).
2. Introduction to Genetics: A Molecular Approach; T A Brown, Garland Science (2011).
3. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co. (2012).
4. Molecular Biology of the Cell; 7th Edn. Bruce Alberts et al., Garland Publications (2008)
5. Principles of Developmental Genetics; S.A. Moody, Academic Press (2007).
6. The Cell; Geoffrey Cooper, and Robert E.; 5th edn. Hausman Sinauer Associates (2009).

7. Human Genetics; Lewis, 7th Edn. WCB & McGraw Hill (2007).
8. Essential Genetics: A Genomics Perspective; Daniel L. Hartl, 6th Edition, Jones and Barlett Learning (2012).
9. Bacterial and Bacteriophage Genetics; Edward A. Birge, 5th Edition, Springer (2006).
10. Nucleosome Histone, and Chromatin; Part-A; Carl Wu and C. Allis, Academic Press (2012).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC3041	Pharmacovigilance and SAS	SC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Basic understanding of drugs, its mechanism of actions and symptomatic reactions on treatment

Course Objectives:

The overall objectives of the course are:

- Develop special expertise in the corresponding clinical domain and/or research methods.
- Enable students to gain in-depth knowledge on the best way to collect and report adverse events and safety data
- Manage the risks associated with certain products.
- Provide students with the key skills and knowledge needed to operate a fast, effective drug safety or Pharmacovigilance program

Course Outcomes:

After completing the course, the student should be able to

CO1 - Compile, analyse and evaluate reports from scientific literature and databases about adverse drug reactions.

CO2 - Explain the importance of pharmacogenomics for individual variation in adverse drug reactions.

CO3 - Analyse methods for Pharmacovigilance.

CO4 - Analyse and assess warnings, risk management and risk communication about adverse drug reactions, effects and safety of drugs.

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit-1 **13hrs**

Drug Development Process and Pharmacoepidemiology

Drug discovery, Permulation and formulation, ICH-GCP Guidelines, ICMR Guidelines, USFDA guidelines, Indian Regulatory Authority Frame Work-CDSCO Regulations, DCGI, Data to be submitted along with the application to conduct clinical trials/import/manufacture of new drugs for marketing in the country, Data required to be submitted by an applicant for grant of

permission to import and manufacture a new drug already approved in the country. Structure, Contents and Format for clinical study reports.

Definitions: epidemiology, Disease distribution, disease determination, disease frequency, Aims of epidemiology, Difference between epidemiology and clinical medicines, Epidemiological approach, Measurements in epidemiology, (rates, ratios, and proportions) Measurement of mortality: international death certificate, limitations and use of mortality data, mortality rates and ratios, crude death rates, specific death rates, case fatality ratio, proportional mortality ratio, survival rate, standardize rates, direct standardization, indirect standardization, Measurement of morbidity: Incidence, Prevalence, uses of prevalence, relationship between incidence and prevalence.

Unit-2 **13hrs**

Clinical Trial Management and Clinical Data Management:

Definition: Clinical Research, Different phases, study designs in research, glossary, Different parties involved in Clinical research, Regulatory Authorities, IRB/IEC, Sponsor, CRO, SMO, Investigator, Patients, Clinical Research History, Food, Drug & Cosmetic Act, Nuremberg Code, Declaration of Helsinki, ICH, Thalidomide Disaster

Different Regulatory Bodies- an overview, FDA, DCGI, MHRA, MHLW, TGA, IRB/IEC, Schedule Y, IND & NDA Application, Regulatory requirements & Forms, Clinical Trials process & monitoring, Roles of different parties, Clinical Trial process and design, Informed Consent Process, TMF (Trial Master File), Investigator Boucher, Essential Documents

CDM Overview, CRF Design – Theory & Practical Design of the pCRF (Paper CRF) &eCRF (electronic CRF), Data Entry & DE Guidelines, Discrepancy Management, Data Validation, CDISC (SDTM), Query Management, QA, QC in CDM, Audits & Inspections (Indian DCGI & USFDA), SAE Reconciliation, Data Management Systems and Tools, Medical Coding and Medical Dictionaries – MedRA& WHODD, Documentation and Document Management System, Data Archival, Software's in CDM, CDM,SAS

Unit-3 **13hrs**

Pharmacovigilance, Introduction and use of SAS

Introduction, Scope, definition and Aims of Pharmacovigilance.Adverse drug reactions – Classification, mechanism, predisposing factors and casualty assessment. Role of clinical pharmacist in Reporting, evaluation, monitoring, prevention and management of ADR Adverse drug reaction. Signal detection, PSUR (Periodic safety update report), Safety specification, and Risk management. Exporting and monitoring Drug induced diseases.

Environment of SAS, Library structure in SAS, Data steps and Procstep, manipulating the data- Converting the numeric data to character and vice versa. Using logical operators and where conditions, Merging of the datasets, Writing the data into multiple datasets. Debugging errors in the program. Writing the procedure- Tabulate, Univariate, Means, Median, Mode, Report, Sort, Mixed, Transpose etc. Creating the html reports. Importing the data to SAS and exporting the data from SAS. Overview of SAS macros.

Unit-4 **13hrs**

Regulatory Affairs, Medical & Scientific writing

Basic Fundamentals of Regulatory Affairs, Introduction to Regulatory Bodies, Introduction to Quality Standards for Regulatory Compliance, Common Technical Documents - CTD (API & Formulation), Introduction to eCTD, ASEAN Common Technical Dossier (ACTD), Marketing Authorization Procedures in USA, Marketing Authorization Procedures/ Channels in Europe, Marketing Authorization Procedures in India, Marketing Authorization Procedures in ROW markets, Maintenance and Annual updates for Marketing authorizations, Reference on Further reading & Dissertation.

What is Medical Writing, Scope of Medical Writing, Medical Writing in Clinical trials, Medical Writing and Scientific Writing, Fundamentals of Medical Writing, Regulatory Medical Writing, The Writing Process, Good Writing Skills: Introduction to basic rules, Elements of style Good Clinical Practice guidelines, The Clinical Study Report

Introduction to publication writing, Regulations and Industry Standards, Writing Effective Documents, writing standard operating procedures policies, procedures, instructions and methods, Writing quality manuals and plans

Reference Books:

1. Basic and Clinical Pharmacology, Prentice hall, International, Katzung, B.G.
2. Clinical Pharmacology, Scientific book agency, Laurence, DR and Bennet PN.
3. Clinical pharmacokinetics, Pub. Springer Verlab, Dr. D.R Krishna, V. Klotz
4. Remington Pharmaceutical Sciences, Lippincott, Williams and Wilkins
5. Drug interaction, Kven Stockley. Hamsten
6. Drug interaction, Basic BussinessPubl, Bombay, J.K. Mehra
7. Clinical pharmacology and drug therapy Grahame smith and Aronson,
8. Text Book of Therapeutics Drug and Disease Management Hardbound. Richard A Helms,
9. Clinical Pharmacy and therapeutics Herfindal E T and Hirschman JL, Williams and Wilkins

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BT3042	Clinical Biochemistry and Diagnostics	SC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Graduate level knowledge of biochemistry, physiology along with fundamentals of pharmacology, pharmacy and medicine

Course Objectives:

The overall objectives of the course are:

- To describe the principle involved in the measurement of analyses in the clinical biochemistry laboratory,
- Outline how biochemical analysis can be employed to differentiate between normal and diseased conditions
- Discuss the function, structure, laboratory investigation and diseases of the different body systems.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Illustrate the various metabolic disorders and analyse the diagnostic procedures to find remedy.

CO2 - Attain the knowledge of causes, symptoms of various diseases.

CO3 - Construct the new diagnostic tools to demonstrate the blue print of various diseases

CO4 - Understand the genetically inheritance disease in human being

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit-1 **13hrs**

Human Physiology

Rhythmical excitation of heart, basic theory of circulatory function, blood flow and resistance, function of arterial and venous systems

Microcirculation and lymphatic system, control of blood flow, regulation of arterial pressure, cardiac output.

Spinal cord and motor functions, role of brain stems in controlling motor functions, functions of cerebellum, functions of cortical areas, the limbic system and cerebrospinal fluid system.

Medico –informatics

Introduction to Medical Network Design & Development Emergence of Medical Informatics as a Discipline; Library facilities & Logistics; Online Resources; Grading and Class Policies, Medical data acquisition and database systems: PC based multichannel data acquisition system; storage, analysis and retrieval techniques.

Basics of sequence analysis-

Dot matrix method, Needleman–Wunsch Algorithm and Smith-Waterman algorithm, Alignments using BLAST and FASTA, Multiple Sequence Alignment (CLUSTAL-X and CLUSTAL-W), Application of multiple sequence alignment.

Unit-2 **13hrs**

Analysis tools: Analysis by TreeView, Genedoc and Lasergene. Protein Structure Prediction in Bioinformatics- Ab initio based methods, Homology based methods, prediction with neural networks, secondary structure prediction (helical membrane proteins, beta-barrel membrane proteins). Protein structure comparison of intermolecular and intramolecular methods Phylogenetics- construction by distance-based methods, character based methods.

Visual programming concepts

Visual Basic environment, tools and controls; Dynamic data exchange; VB based Medical information System. Basic concepts of Multimedia; Design of Multimedia information systems; Components of virtual reality; Virtual reality applications in medicine. Medical Informatics and

its levels; Design and development of educational packages on medical sciences; Integrated design concepts; Interactive multimedia, Virtual and digital libraries, Internet and itsapplications.
Hospital Information System its design and functional characteristics; Pattern Recognition, Neural Network and Fuzzy Logic in Medicine. Autonomous, Decision-Support & "Expert" System: History of Artificial Intelligence in Medicine; Expert Systems in Medicine; Clinical Software Overview Risks of Decision-Support Systems, Computational Statistics in medical biology.

CLINICAL BIOCHEMISTRY

UNIT – 3 **13hrs**

Concepts of accuracy, reproducibility, reliability and other factors in quality control: Specimen collection and processing, collection of blood- venepuncture, arterial puncture and anticoagulants. Collection and analysis of normal and abnormal urine samples, preservation, clinical significance of sugars, ketone bodies, proteins & bilirubin. Theories of CSF collection, composition and analysis.

Disorders of carbohydrate metabolism: Blood sugar levels, hyper and hypoglycemia, regulation of blood glucose level. Diabetes mellitus- types, causes and symptoms. GTT, HbAIC, GSD, HMP Shunt, fructosuria & fructose intolerance.

Disorders of lipid metabolism: Lipid levels in various conditions, lipoproteins, clinical inter-relationship of lipids.

Diagnostic tests for apolipoproteins, HDL-C, LDL-C, and triglycerides levels in healthy &diseases conditions. Hypercholestremia, fatty liver and myocardial infarction.

Disorders of protein metabolism: Non-protein nitrogenous constituents in blood- urea, uric acid & creatinine. Plasma protein abnormalities, multiple myeloma, proteinuria,haemoglobinopathies, PKU, AKU, homocystinuria, albinism & Bence Jones proteins.

UNIT – 4 **13hrs**

Disorders of nucleic acid metabolism: Disorders of purine metabolism- Gout- causes & symptoms, xanthinuria, orotic acidic uria& L-N syndrome.

Disorders of mineral metabolism: Hypercalcemia, hypocalcemia, hypophosphatemia & hyperphosphatemia.

Disorders of vitamins & trace elements: Hypervitaminosm- causes & symptoms, trace elements deficiency disorders.

Evaluation of organ function test: Assessment and clinical manifestation of renal, pancreatic, gastric and intestinal functions.

Disorders of heme metabolism: Jaundice- types, causes & symptoms. Clinical importance of diagnostic enzymes- SGOT, SGPT, creatine kinase, aldolase, LDH, CPK, troponin 'C'

Renal and gastric functional test: Acute and chronic renal failure, urinary tract, observation and analysis of urinary calculi, LFT, pancreatic and gastric function test.

Reference Books:

1. Computer in Medicine by R. D. Lele, Tata McGraw-Hill, New Delhi, 1997.
2. Multimedia making it work by Tay Vaughan, Tata McGraw-Hill, New Delhi, 1997.
3. "Teach Yourself Visual Basic 6 in 21 days", Davis Chapman, New Delhi, 1997.
4. Fundamentals of Clinical Chemistry – Harold Sackman, Tietz (5th edn.) C A Burtis, E R Ashwood (eds.) Saunders WB Co.
5. Notes on Clinical Chemistry – Whitby L G, A F Smith, G J Beckett, S M Walker, Blackewll science Inc.
6. Practical Clinical Biochemistry methods and later ,3rd edition,2003,2006 by Ranjna Chawla.
7. Practical Clinical Biochemistry,4th edition,2005,by Harold Valley.
8. Practical Biochemistry-Principles and Techniques,5th edition by Keith Wilson and John Walker(2000).
9. Introductiory Practical Biochemistry-3rd edition,2005 by S.K.Sawtrey,Randhir Singh.
10. Biochemical Methods- 3rd edition,2008,byS.Sadasivan and A.Manickam.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC3043	Plant and Industrial Biochemistry	SC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Graduate level understanding of plant metabolites in various industrial manufacturing processes.

Course Objectives:

The overall objectives of the course are:

- To acquire a good working knowledge of the chemistry of important biological processes in plants,
- To understand and explain secondary metabolites and their potential therapeutic and nutritional uses
- To enable students to readily assess current developments in plant and industrial biochemistry.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Acquire knowledge about how light energy is captured and transformed to power the functions of cells and whole plants.

CO2 - Analyse the response of plants for various factors, screening of industrially important Strains

CO3 - Attain knowledge about the structure, function and biosynthetic pathways of essential biochemical molecules and their key chemical and physical properties

CO4 - Develop an understanding of various aspects of Bioprocess Technology.

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Plant Biochemistry

Unit-1 **13hrs**

Structure and functions of plant cell (including cell wall, plasmodesmata, vacuoles, meristematic cells, secretary systems and root quiescent zone), Isolation of cell organelles, absorption, adsorption and transport of water and ions in plants. Transpiration, mechanisms of loading and unloading of photo assimilates, translocation of inorganic and organic substances.

Biological nitrogen fixation and ammonia assimilation. Nitrate and sulphate reduction and their incorporation into amino acids.

Photosynthesis – structure of organelles involved in photosynthesis in plants and bacteria. Light receptors – chlorophyll, light harvesting complexes. Cyclic and non-cyclic photophosphorylation-photosystem I and photosystem II, Calvin cycle and its regulation, Hill's equation, light and dark reaction, Light activation of enzymes, regulation of photosynthesis. C4 and CAM pathway of CO2 fixation, photorespiration. Mechanism of quantum capture and energy transfer between photosystems – ferridoxin, plastocyanin, plastoquinone, carotenoids. Metabolism of sucrose and starch. Proton gradients and electron transfer in chloroplasts of plants and in purple bacteria – differences from mitochondria, bacteriorhodopsin, rhodopsin as ion pump

Unit-2 **13hrs**

Important pathways of secondary metabolite biosynthesis- methylerythritol 4-phosphate (MEP) pathway, mevalonate pathway (MVA), phenyl propanoid pathway, formation of phenolic acids, tannins, lignins, pigments, terpenes, terpenoids, alkaloids, flavonoids, nitrogenous compounds and surface waxes – their biosynthesis and function.

Plant hormones –Structure and functions of ethylene, cytokininins, auxins (indole acetic acid), absicic acid, and gibberellins. Molecular effects of auxin in regulation of cell extension and of gibberllic, abscisic acids and cytokinins in the regulation of seed dormancy, germination, growth and development and embryogenesis.Biochemistry of seed development and fruit ripening.

Defence system in plants, responses of plants to biotic (pathogen and insects) and abiotic (water, temperature, heavy metal and salt) stresses; Osmotic adjustment and significance of osmotic agents such as proline, sugar alcohols and quaternary ammonium compounds. Oxidative stress, oxidative damage and antioxidant enzymes. Mechanisms of resistance to biotic stress and tolerance to abiotic stress. Hypersensitive response, systemic acquired resistance, induced systemic resistance.

Industrial Biochemistry

Unit-3 **13hrs**

Nanobiotechnology: Types of nanoparticles, DNA based nanostructures, nanosized carriers for drug delivery. Role of nanoparticles in drug delivery. Nanobiotechnology in gene therapy, tissue engineering and transplantation.

Development of new drug/molecules and elucidation of their mechanisms of actions;formulations; pharmacokinetics and pharmacodynamics; factors affecting drug efficacy drug resistance; traditional medicines; biotransformation; large scale production of humanized monoclonal antibodies; vaccine development.

Introduction to different categories of food; constituents of food products and their functional properties. Introduction to food processing; food poisoning, molasses, food spoilage, intrinsic and extrinsic factors affecting the quality and life of food material; food storage and preservation techniques.

Unit -4 **13hrs**

Pharmaceutical Product: Pharmaceutical product from microorganism, Industrial futures of plant products, Enzymes production –amylase, proteases, lipases, Amino acid-glutamic acid, lysine, Vitamins-B12, alcoholic beverages and vitamin-C. Vaccine production by rDNA technology; downstream processing.

Microbial transformation techniques and commercial applications. Bioleaching and biosorption, Biodegradation and Bioremediation, Biomass and Bioenergy, Biopolymers and Biosurfactants. Bio-control agents- Insecticidal toxins of Bacillus thuringenesis.

Bioethics and Biosafety, biosafety guideline and regulations, animals in research, Legal and socio-economic impacts of Biotechnology, Ethical, legal and social implications (ELSI) ofHGP.Ethics in clinical trials. Intellectual property rights and protections for biological inventions. Patent and process involved in patenting.

Reference Books:

1. Handbook of photosynthesis (ed) mohammadpesarakle, marcel Dekkar, Inc. NY. Basel. Hong Kong 1997.
2. Introduction to plant biochemistry (1983) T W Goodwin and E I mercer. Pergaman press, Oxford, NY<Toronto,Sydney, Paris, Frankfurt.
3. Seed: physiology of development and germination (2nd ed. 1994) J D Bewley and M Black Plenum Press.
4. Biochemistry of energy utilization in plants D T Dennis Blackie, Glasgow and London 1987.
5. Industrial Microbiology by Prescott, 4th ed. CBS Publishers.
6. Biotechnology by Crueger, PANI Publishers.
7. Principles of Fermentation Technology by Stanbury .
8. Plant Physiology and Development, Sixth Edition by Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy, published by Sinauer Associates.
9. Biochemistry and Molecular Biology of Plants, 2nd Edition. Bob B. Buchanan (Editor), Wilhelm Gruissem (Editor), Russell L. Jones (Editor)
10. Industrial Biochemistry.B K Dass Gupta, Published by Swastik,

11. Industrial Biochemistry.Abdul Ghaffar (Author), Bushra Munir (Author)

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC3050	Biochemistry in daily life	OE*	3	1	0	4	4

Prerequisites/Pre reading for the course:

Fundamental understanding of DNA, RNA, Proteins, Carbohydrates and conception of food and medicines.

Course Objectives:

The overall objectives of the course are:

- To provide the students with theoretical information on micronutrients, water and electrolytes in nutritional biochemistry and their functions in metabolism.
- To develop knowledge about malnutrition and obesity
- To impart knowledge about various diseased conditions and their prevention

Course Outcomes:

After completing the course, the student should be able to

CO1 - Attain knowledge about importance of water, macro and micro nutrients, malnutrition and obesity.

CO2 - Analyse the causes, symptoms of various diseased conditions and their prevention.

CO3 - Understand the report of blood biochemical test

CO4 - Analyse the symptom of different diseases in human being

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Unit 1 **13hrs**

Nutrition

Water; General consideration, role of water in life Balanced diet. Nutritional importance of Energy giving, Body building and Protective foods (Vitamins and Minerals) Dietary fiber.Malnutrition diseases, Overweight and obesity.

Unit 2 **13hrs**

Diseases 1

Incidence, symptoms, Prevention and dietary management. of various Diseases:

Diabetes, diseases of Liver, & Pancreas-Hepatitis: alcoholic liver diseases. Renal disease: Acute and Chronic renal failure. Dialysis, medical and nutrition therapy.

Unit 3 **13hrs**

Diseases 2

Incidence, symptoms, Prevention and dietary management. of various Diseases:

Gastrointestinal diseases, Gastritis, Peptic, stomach and duodenal ulcer, Diarrhoea, constipation. Cancer and HIV/AIDS: Types, stages of cancer, and colon cancer. HIV infection and social issues.

Unit 4 **13hrs**

Interpretation of Diagnostic Reports

Commonly used bio chemical tests for diagnosis of various diseases and their interpretation. Total blood count, Blood glucose and urea; serum lipid–cholesterol, LDL and HDL triglyceride, and serum proteins. Urine creatinine, Glucose and protein (albumin). Enzymes: SGPT, SGOT

Reference Books:

1. Physical Biochemistry. Kansal Edward Van Halde. Prentice Hall.
2. Practical Clinical Biochemistry, ed. Harold Varley, 4th edn. CBS Publishers (1988).
3. Practical Clinical Biochemistry: Methods and Interpretation, ed. Ranjna Chawla, Jaypee Brothers Medical Publishers (1996).
4. Practical and Clinical Biochemistry for Medical Students, ed. T.N. Pattabhiraman, Gajanna Publishers (1994).
5. Hawk's Physiological Chemistry, ed. Oser, 14th Edn.(1976), Tata-McGrawHill.
6. Kuby Immunology; Oven, Punt, Stranford, 7th Edn. W. H. Freeman (2013).
7. Hepatology- A clinical text book by k Mauss, Berg, Rockstroh, Sarrazin, Wedemeyer H (2017)
8. Hepatology: a Textbook of Liver Disease, 4th edition by Zakim, Boyer 2003.
9. Text book of Diabetes 5th edition by Richard I. G. Holt, Clive Cockram, Allan Flyvbjerg, Barry J. Goldstein John Wiley & Sons 2011.
10. Molecular Biology of the Cell; 6 thEdn. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter; Garland Science (2014).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.

M20BC3060	Soft Skill	RULO	0	0	2	2	2

Prerequisites/Pre reading for the course:

Application of different instrument, software and computer knowledge in life science to analyse the problems.

Course Objectives:

The overall objectives of the course are:

Training of instrument, computer and software in biological science or clinical sector to analyse the data and other uses.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Compete national wide in soft skill
CO2 - Understand working principle of different instrument in lab
CO3 - Handle different software related to biological science
CO4 - Use the software in clinical sector

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

Cos	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Soft skill training aid the students to know the recent developments in their field and become job-ready. It includes instrument training, Computational Biology and Clinical Research.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC3070	Advanced Molecular Techniques (Laboratory – IX)	HC	0	0	4	4	4

Prerequisites/Pre reading for the course:

Analytical knowledge of DNA, RNA, protein and lipids traditional characterization methods

Course Objectives:

The overall objectives of the course are:

Acquire an advanced level of knowledge on the activity of genes and genomes and the mechanisms of genome regulation at the transcriptional and post- transcriptional level, in the contexts of development, differentiation, cellular homeostasis and cancer.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Understand key principles of how cells work, including gene regulation, protein synthesis and signal transduction.
C02 - Develop an understanding of the observational and experimental character of science, including
CO3 - Learn appreciation of the need for good experimental design and scientific research practices
CO4 - Apply the knowledge of RT-PCR, DNA/RNA sequencing and molecular marker

Course Content: **Total Hours: 30 hrs**

Weightage Distribution for Assessment

COs	IA	Regular Performance	SEE	Total	Hours
CO1	5	8	13	25	8
CO2	5	7	12	25	7
CO3	5	8	13	25	8
CO4	5	7	12	25	7
Total	20	30	50	100	30

Course Contents:

1. DNA and RNA techniques using nitrocellulose - Southern and Northern Blotting.
2. Electroblotting of DNA restriction fragments.
3. Sequencing of DNA and RNA on polyacrylamide gels(Industrial Visit)
4. Rapid amplification of polymorphic DNA (RAPD).
5. Amplification of desirable gene by PCR
6. Real Time– Polymerase Chain Reaction RT-PCR. (Industrial Visit)
7 . Sequencing of DNA and RNA on polyacrylamide gels.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC3080	Genetic Engineering (Laboratory– X)	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Graduate level knowledge of biochemistry, biophysics, molecular biology and molecular genetics.

Course Objectives:

The overall objectives of the course are:

- To achieve basic understanding of molecular genetics, structure, function and regulation of genes in both prokaryotes and eukaryotes, as conceptualized
- To provide a firmer conceptual basis for all of genetics

Course Outcomes:

After completing the course, the student should be able to

CO1 - Describe techniques involved in genetic engineering and apply this technology to combine genetic material from two different species
CO2 - Diagnose the alternation of an organism's genetics, or hereditary material to eliminate undesirable characters or to produce desirable characters.
CO3 - Isolate the RNA, and DNA from any bacterial culture
CO4 - Make gene clone by use of restriction digestion and ligation technique

Course Content: **Total Hours: 30 hrs**

Weightage Distribution for Assessment

COs	IA	Regular Performance	SEE	Total	Hours
CO1	5	8	13	25	8
CO2	5	7	12	25	7
CO3	5	8	13	25	8
CO4	5	7	12	25	7
Total	20	30	50	100	30

Course Contents:

1. Preparation of plasmid DNA from bacterial source.
2. Digestion by endonucleases and separation of DNA restriction fragment on agarose gel electrophoresis.
3. Ligation of DNA.
4. Preparation of competent cells
5. Isolation, quantification and characterization of total RNA from plant and microbial source.
6. Digestion of endonucleases and separation of DNA restriction fragment on agarose gel electrophoresis.

SEMESTER – IV

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC4010	Molecular Physiology	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Insight in to physiological processes its mechanisms and regulations through systems biology

Course Objectives:

The overall objectives of the course are:

- To understand the neurotransmitter and signaling mechanism of nervous system in human body
- To know about the messenger molecule and different signaling pathways within cell
- To learn cell division stage, mechanism and regulation of cell cycle
- To understand process of natural cell, cancer cell physiology, signaling mechanism in plant and bacteria.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Achieved knowledge about different type of neurotransmitter and signalling process in nervous system.
CO2 - Ready to understand different messenger molecule and their signalling cascade pathways within cell
CO3 - Able to understand the cell division mechanism, check point at different phase and regulation of cell cycle.
CO4 - Achieved knowledge of natural cell death mechanism, mechanism of cancer cell physiology, and signalling mechanism in plant and bacteria.

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

UNIT-1 **13hrs**

Nerve signaling:

Action potential generation and propagation, types of pumps in nerve cells, Ion and ligand-gated channel. Acetylcholine receptor (AchR) channel and types of acetylcholine receptors, origin and mechanism of actions of neurotransmitters (Acetylcholine, catecholamine, serotonin; amino acids (glutamate, aspartate, GABA, and glycine) and neuropeptides (somatostatin/enkephalins). Trafficking proteins of synaptic vesicles, vesicle cycle – exo – and endocytosis of synaptic vesicles. Structure, subtypes and functions of receptors of ACh, GABA, Glycine, Serotonin and glutamate and peptide neurotransmitters, activation by ligands & interaction with effectors. Role of agonists & antagonists of neurotransmitters. Biochemical basis of neurological diseases.

Natural, genetic and environmental factors affecting the development of CNS, Co – ordination between nervous and endocrine systems.

UNIT-2 **13hrs**

Endocrine signaling:

Signal transduction, extra – cellular signaling; hormones as signal molecules – peptide, amino acid derivatives, steroid, eicosanoids.

Signal transduction pathways; G-protein coupled receptors (epinephrine, serotonin, glucagons), Ion–channel, 3) Tyrosine kinase {(RTK), [EGF, IGF, insulin]}, and 4) Intrinsic enzyme / cytokine, receptors.

Biochemistry of vision: Structure of an eye, lens and retina, perception of light, rods and cones, rhodopsin, primary events in visual excitation, cGMP and transduction in generation of nerve impulse, colour vision

Intracellular signaling proteins: {adaptors, activators, bifurcators, integrators, effectors, etc.}. Second messengers; and their regularization: cAMP, CREB, cGMP, phosphoinositides, arachidonic acid, Ca2+, and NO. Signal amplification cascades; Cascades downstream of RTK; Erk – fos – jun – cyclin – D, MAPK – Ras – Raf – Sos, specificity of protein kinases. Mode of action of cholera toxin and pertusis toxin and their signalling pathway.

UNIT-3 **13hrs**

Effectors on intercellular signaling: Adenylate cyclase, Phospholipase- C, Nitric oxide synthase, guanylate cyclase and their activation, negative modulation.

Nuclear signaling: Steroid, thyroid, Vitamin-D and retinoic acid receptors and transcriptional activation. Transcriptional activation by phosphorylation cascade; CREB.

Cell Cycle: Interphase and M-phase, and check points of cell cycle (DNA replication and spindle-attachment checkpoint) and their regulation. Growth factors, MPF, and cytokines, Cyclins and cyclin- depended kinases, role of M – Cdk, role of ubiquitin. Promotion of G1/S by growth factors, cell cycle arrest at G1, role of Rb proteins in cell cycle arrest. Mechanisms of the

Budding and Fission Yeasts. Regulation of M- phase (role of mitogen, survival factor and TGF-β).

UNIT-4 **13hrs**

Stem Cells: Embryonic and adult stem cells; unique properties, and potential applications.

Apoptosis: Discovery, morphological changes, mitochondrial regulation. Direct signal transduction (TNF pathway, Fas pathway, caspases, execution and removal of dead cells). Distinguishing apoptotic cells from necrotic cells. Role of HeLa cells, Hyperactive apoptosis and treatments.

Cancer: Introduction, Signs and symptoms, causes pathophysiology, diagnosis, prevention and management. Genetic basis of Cancer, Physical and chemical carcinogenic agents; Viral and cellular oncogenes, tumor suppressor genes, Telomerases and their role in cancer. Signaling cascades in cancer (MAP kinases, Ras pathways, JAK-STAT and TGF-β pathways). Etiology of breast, colon and prostrate cancer

Signaling in Plants and bacteria: Outline of plant hormones and pheromones signaling. bacterial and plant two-component systems, light signalling in plants, bacterial chemotaxis and quorum sensing.

References

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2. Greenspan's Basic and Clinical Endocrinology; 9th Edn. David Gardner and Dolores Shoback Lange Clinical Medicine (2012).
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5. Basic Neurochemistry; George Siegel et al., (1999) Wippincott, Williams and Wilkins.
6. Neuroscience; 2nd edn. Purves, Dale; et al., Sinauer Associates, Inc. (2001).
7. G-Proteins coupled Receptors; P. Michael Conn Academic Press (2013).
8. Molecular Biology of the Cell; 6 thEdn. Bruce Alberts, Alexander Johnson, Julian Lewis,

David Morgan, Martin Raff, Keith Roberts, Peter Walter; Garland Science (2014).
9. Molecular Cell Biology; Lodish et al., 7th Edn. W.H. Freeman and Co. (2012).
10. Cell Signaling; Wendell Lim, Bruce Mayer, Tony Pawson; Garland Science (2014).
11. Cell Biology; A short course; Stephen R. Bolsover et al., John Wiley & Sons, Inc. (2004)
12. Electrochemical methods for neuroscience; Michael AC, Borland LM, editors. Boca Raton (FL): CRC Press (2007).
13. Signal Transduction; Lewis Cantley, CSHL Press (2014).
14. When Cells Die; A Comprehensive Evaluation of Apoptosis And Programmed Cell Death; Richard, A. Lockshin, and Zahra Zakeri, Wiley Liss (2004).
15. Neuroscience; 2nd edn. Purves, Dale; et al., Sinauer Associates, Inc.; (2001).
16. Biochemistry of Signal Transduction and Regulation; 3rd Edn. Gerhard Krauss, Wiley-VCH, (2003).
17. The Biology of Cancer; Robert A. Weinberg; Garland Science (2013).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC4020	Internship	HC	0	0	2	2	6

Prerequisites/Pre reading for the course:

At post graduate level, have to knowledge about the R&D in industry or company product development.

Course Objectives:

The overall objectives of the course are:

To gain the knowledge in company, research institute or university to understand the research development and product development.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Understand research culture at company/institute

CO2 - Upgrade their knowledge about the industry/ research institute

CO3 - Explore the idea or designed project in research and development

CO4 - Work in R&D environment of any company or institute

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Internship: Minimum of four weeks duration internship should be carried out by the student either in industry or in an R&D organization, including educational institutes with excellent research culture. In case, if a student is unable to secure internship either in industry or in an R&D organization, a project may be carried out within the university. The student is expected to submit a formal report at the end of the internship programme. The student shall be awarded the marks for internship based on the (a) presentation and (b) comprehensive viva by the panel of examiners constituted by the school.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M20BC4030	Submission of Project work and Evaluation	HC	0	0	8	8	18

Prerequisites/Pre reading for the course:

Knowledge to explore biochemical concepts through extensive research in close collaboration between other students and departments/ Institutions

Course Objectives:

The overall objectives of the course are:

To carry out the research under the guidance of supervisor and in the process learn the techniques of research.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Familiarize with literature search

CO2 - Conduct the experiments related to research and formulate computational techniques

CO3 - Interpret the scientific data.

CO4 - Write report and defend the research findings.

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13

CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Project:

Each student will choose the topic of research particularly from any area of soft cores studied and work under the guidance of allocated faculty member. The project shall preferably be application oriented or industry need based that could be useful to the society. In case of industry need base project the student may opt co-supervisor from the concerned industry. The student will have to make a preliminary survey of research done in broad area of his/her area of interest and decide on the topic in consultation with his/her supervisor(s). The project work floated should be completed within 16 weeks and project report has to be submitted within the stipulated date by the University/ within 18 weeks whichever is earlier. The student has to meet the concerned supervisor(s) frequently to seek guidance and also to produce the progress of the work being carried out. The student should also submit progress report during 5^{th} week and 10^{th} week of the beginning of the semester and final draft report with findings by 15^{th} week. After the completion of the project the student shall submit project report in the form of dissertation ona specified date by the School.

Course Code	**Course Title**	**Course Type**	**L**	**T**	**P**	**C**	**Hrs./ Wk.**
M20BC4040	SWAYAM/MOOC/Short term project	RULO	2	0	0	2	-

Prerequisites/Pre reading for the course:

Online courses that allow participants free access and unrestricted participation to any course of their choice, this is for Study Webs of Active Learning for Young Aspiring Minds

Course Objectives:

The overall objectives of the course are:

Student can explore their interest in same field or different field of science from different source of knowledge.

Course Outcomes:

After completing the course, the student should be able to

CO1 - Under very with their respective interest filed
CO2 - Under interdisciplinary subject
CO3 - Think new concept to interlinked
CO4 - Get open knowledge from different expert

Course Content: **Total Hours: 52 hrs**

Weightage Distribution for Assessment

COs	IA1	IA2	Assignment	SEE	Total	Hours
CO1	7.5		5	12.5	25	13
CO2	7.5		5	12.5	25	13
CO3		7.5	5	12.5	25	13
CO4		7.5	5	12.5	25	13
Total	15	15	20	50	100	52

Massive Open Online Courses (MOOCs) are online courses that allow participants free access and unrestricted participation to any course of their choice. Besides the conventional modes of teaching such as lectures, videos and reading material; MOOCs also provide a platform for interactive forums.

Globally, MOOC platforms are gaining much popularity. Considering the popularity and relevance of MOOCs, Government of India has also launched an indigenous platform, SWAYAM. SWAYAM (Study Webs of Active Learning for Young Aspiring Minds) is basicallyan integrated MOOCs platform for distance education that is aimed at offering all the courses from school level (Class IX) to post-graduation level. The platform has been developed collaboratively by MHRD (Ministry of Human Resource Development) and AICTE (All India Council for Technical Education) with the help of Microsoft and is capable of hosting 2,000 courses.

A student shall register and successfully complete any of the courses available on SWAYAM / MOOC. Student shall inform the MOOC / SWAYAM coordinator of the school about the course to which he/she has enrolled. The duration and credits of the course shall vary depending upon the agency offering MOOC / SWAYAM courses. The student should submit the certificate issued by the agency offering SWAYAM / MOOC courses to the Coordinator of the school, the grades obtained in the course shall be forwarded to concerned authority of the University.

Career Opportunities

Having a degree will open doors to the world of opportunities for you. But Employers are looking for much more than just a degree. They want graduates who stand out from the crowd and exhibit real life skills that can be applied to their organizations. Examples of such popular skills employers look for include:

1. Willingness to learn
2. Self - motivation
3. Team work
4. Communication skills and application of these skills to real scenarios
5. Requirement of gathering, design and analysis, development and testing skills
6. Analytical and Technical skills
7. Computer skills
8. Internet searching skills
9. Information consolidation and presentation skills
10. Role play
11. Group discussion, and so on

REVA University therefore, has given utmost importance to develop these skills through variety of training programs and such other activities that induce the said skills among all students. A full-fledged Career Counselling and Placement division, namely Career Development Center (CDC) headed by well experienced senior Professor and Dean and supported by dynamic trainers, counsellors and placement officers and other efficient supportive team does handle all aspects of Internships and placements for the students of REVA University. The prime objective of the CDC is to liaison between REVA graduating students and industries by providing a common platform where the prospective employer companies can identify suitable candidatesfor placement in their respective organization. The CDC organizes pre-placement training by professionals and also arranges expert talks to our students. It facilitates students to career guidance and improve their employability. In addition, CDC forms teams to perform mock interviews. It makes you to enjoy working with such teams and learn many things apart from working together in a team. It also makes you to participate in various student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of Biochemistry is knowledge in the subject, but also the skill to do the job proficiently, team spirit and a flavour of innovation. This kept in focus, the CDC has designed the training process, which will commence from second semester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, and communication skills to every student of REVA University is given with utmost care. The process involves continuous training and monitoring the students to develop their soft skills including interpersonal skills that will fetch them a job of repute in the area of his / her interest and march forward to make better career. The School of Chemical and Biological sciences also has emphasised subject based skill training through lab practice, internship, project work, industry interaction and many such skilling techniques. The students during their day to day studies are made to practice these skill techniques as these are inbuilt in the course curriculum. Concerned teachers also continuously guide and monitor the progress of students.

The University has also established University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director to facilitate skill related training to REVA students and other unemployed students around REVA campus. The center conducts variety of skill development programs to students to suite to their career opportunities. Through this skill development centre the students shall compulsorily complete at least two skill / certificationbased programs before the completion of their degree. The University has collaborations with Industries, Corporate training organizations, research institutions and Government agencies like NSDC (National Skill Development Corporation) to conduct certification programs. REVA University has been recognised as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana.

The University has also signed MOU's with Multi-National Companies, research institutions, and universities abroad to facilitate greater opportunities of employability, students' exchange programs for higher learning and for conducting certification programs.

FACULTY PROFILE

Name	Designation
Dr. Jayashree. S	Professor and Head School of Biochemistry, REVA University
Dr. V. Veeraraghavan	Professor, School of Biochemistry, REVA University
Dr. V. Damodara Reddy	Associate Professor, School of Biochemistry, REVA University
Dr. Ramesh Kumar Kushwaha	Assistant Professor, School of Biochemistry, REVA University
Dr. Sikandar Mulla	Assistant Professor, School of Biochemistry, REVA University
Dr. Satish Kumar M	Assistant Professor, School of Biochemistry, REVA University
Mrs. Deepa. H N	Assistant Professor, School of Biochemistry, REVA University
Ms. Pooja Karkera	Assistant Professor, School of Biochemistry, REVA University