REVA UNIVERSITY
Bengaluru, India

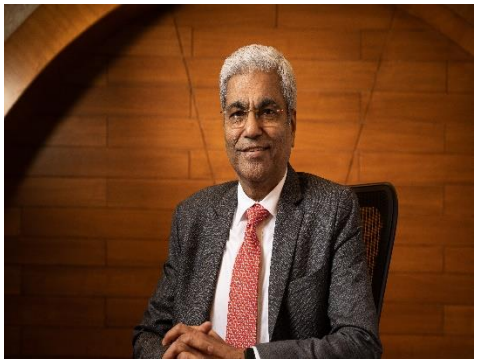
SCHOOL OF APPLIED SCIENCES

M.Sc. – BITOTECHNOLOGY

HANDBOOK: 2021-23

Rukmini Educational
Charitable Trust

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 for information 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 welcome you to REVA University to join hands in laying the foundation of your future with values, 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 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 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 the effectiveness 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. M. Dhanamjaya,

Vice-Chancellor, REVA University

Director Message

Biotechnology as interdisciplinary subject assimilates in itself a number of disciplines and as such has grown rapidly. M Sc in Biotechnology offered by REVA University aims to provide the required skills and knowledge necessary to pursue a successful career in Biotechnology. 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 Biotechnology 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 & Agricultural biotechnology, Molecular genetics, Bioinformatics, Biochemical techniques & Enzymology, Medical biotechnology, Genetic Engineering and Molecular biology aligning to current demand in the field of research & industry. Maximum number of courses are integrated with cross cutting issues, relevance to professional ethics, gender, human values, environment and sustainability. The curriculum caters to and has relevance to local, national, regional and global developmental needs.

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

This handbook provides you outline of regulations for master's degree, scheme of instruction, and detailed syllabus. I am sure the students choosing MSc Biotechnology 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. Shilpa BR
Deputy Director, SoAS

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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 of Educational 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 the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right 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 globe in 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 so as to give them the needed input and build in them confidence and courage to move forward and 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 experienced Professor& 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, Oklahoma 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 Ratna Prof. 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 Defence Dr.Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation 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 to unfold 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 medals and prizes for sports achievers every year. The physical education department conducts regular yoga 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 Biotechnology, Biochemistry, 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, Bioinformatics, Microbial Technology and B Sc with various combinations viz, Biotechnology, Biochemistry and Genetics, Medical Laboratory Technology, Physics, Chemistry and Mathematics, Mathematics , Mathematics, Statistics, Computer Science, Bioinformatics, Statistics & Computer Science, Microbiology, Chemistry and Genetics and also Post Graduate Diploma in Clinical Embryology and Artificial Reproductive Technology. The School also facilitates research leading to PhD in Biotechnology, Biochemistry, 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, professionalism and research culture 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 with leadership qualities.

Mission

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

To create intellectual curiosity, academic excellence, and integrity through multidimensional exposure

To establish state of the art laboratories to support research and innovation and promote mastery of science.

To inculcate an ethical attitude and make students competitive to serve the society and nation.

BOS MEMBERS

Name and Position	
Prof.Dr. Padma Thiagarajan Professor (Higher Academic Grade) School of BioSciences and Technology (SBST) Vellore Institute of Technology Vellore, Tamil Nadu	
Dr. Nellaiah Hariharan Head, R & D and Training, Bangalore Biotech Labs. Pvt. Ltd. (BiOZEEN) Bengaluru, Karnataka	
Mr. Kumar Shankaran Founder, Leucine Rich Bio Private Limited Bengaluru, Karnataka	
Dr. Shailesh Kumar, Ph.D. Staff Scientist, National Institute of Plant Genome Research (NIPGR), New Delhi	
Prof. Gokul S Bajaj HOD, Biotechnology Department, Brijlal Biyani Science College, Amravati Maharashtra	

M.Sc. (Biotechnology) Program Overview

Biotechnology harnesses cellular and bio-molecular processes to develop technologies and products that help improve our lives and the health of our planet. The growing list of biotechnology products includes medicines, medical devices and diagnostics, more-resilient crops, bio-fuels, biomaterials, and pollution control. At present, there are more than 250 biotechnology health care products and vaccines available to patients, many for previously untreatable diseases. Millions of farmers around the world use agricultural biotechnology to increase yields, prevent damage from insects and pests and reduce farming impact on the environment. Hundreds of bio refineries are being built across world to test and refine technologies to produce bio-fuels and chemicals from renewable biomass, which can help reduce greenhouse gas emissions.

Government of India, cognizant of the fact that Biotechnology is an ever growing technological field benefitting the whole society, established Department of Biotechnology (DBT) in the year 1986 with a mandate to promote large scale use of Biotechnology. Recent times have seen a surge in research related to innovation, invention and product orientation. In fact, top experts have made it clear that innovation in biosciences can make it a bigger industry than information technology.

The Indian biotech industry holds about 2 per cent share of the global biotech industry. The biotechnology industry in India, comprising about 800 companies, is expected to be valued at US$ 11.6 billion in 2017. The government has to invest US$ 5 billion to develop human capital, infrastructure and research initiatives if it is to realize the dream of growing the sector into a US$ 100 billion industry by 2025, as per Union Minister for Science and Technology. In the Union Budget 2017-18, the Department of Biotechnology (DBT) received Rs 2,222.11 crore (US$ 333.31 million), an increase of 22 per cent, to continue implementing the department's national biotech strategy and target increasing the turnover from the sector to $100 billion by 2025 from $7 billion in 2016.

Biopharma is the largest sector contributing about 62 per cent of the total revenue followed by bio-services (18 per cent), bio-agri (15 per cent), bio-industry (4 per cent), and bio-informatics contributing (1 per cent).The high demand for different biotech products has also opened up scope for the foreign companies to set up base in India. India has emerged as a leading destination for clinical trials, contract research and manufacturing activities owing to the growth in the bio-services sector.

In this context, University Programmes at undergraduate and postgraduate level in Biotechnology across the Country have become relevant.

M. Sc. (Biotechnology) at REVA UNIVERSITY has been designed to meet the human resources needs of existing and futuristic biotech industries, biotech research organizations and academic institutions. 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 organization and academic institutions. The programme also provides sufficient skills and training on entrepreneurship development in Biotechnology. The programme deals with courses on cell biology, micro biology, genetic engineering, biochemistry; medical, animal and environmental biotechnology, biochemical techniques and processes, entrepreneurship and many other related courses.

Program Educational Objectives (PEOs)

PEO-1	Become a professional biotechnologist with strong ethics & communication skills.
PEO-2	Pursue research in reputed institutes at national & international level.
PEO-3	Establish consultancy services and to work as entrepreneur with an ability to develop new products/processes with an attitude of lifelong learning.

Program Outcomes (POs)

1. Science knowledge: Demonstrate of the knowledge in various domains of life sciences including healthcare considering public health and safety, and the cultural, societal, and environmental concerns.

2. **Problem analysis**: Identify, formulate and analyze problems related to the various domains of Biotechnology such as Environmental Biotechnology, Agricultural Biotechnology, Genetic Engineering and Nano Biotechnology.

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.

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

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

6. **Ethics:** Apply ethical principles and commit to professional ethics, responsibilities and norms in Life Sciences.

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

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.**

9. Project management and finance: Demonstrate knowledge and understanding of Biotechnology and management principles and apply these to one's own work, as a member and leader in a team. Manage projects in multidisciplinary environments.

10. **Life-long learning**: Recognize the need for, and have the preparation and 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

1. Describe, Design, Analyse and Test biotechnology products
2. Apply appropriate processes and control parameters in the production of biotechnology products
3. Use higher order critical, analytical skills to solve a new problem

REVA University Regulations for Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) for Postgraduate Degree programs- 2021-22

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

1. Tie 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:

Biotechnology
Biochemistry
Chemistry
Physics
Mathematics
Microbial Technology
Bioinformatics

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 / self-study/ 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 various courses. 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, (iii) Open Elective

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 / related subject, with an intention to seek exposure to the related subjects other than the main discipline the student is studying is called an O**pen Elective Course.**

e. 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:

Bachelors Degree of three years with Biotechnology or any Life Science subject as one of the cognate / major / optional subjects with 60% (40% in case of candidates belonging to SC/ST) of marks in aggregate from any recognized University / Institution or any other qualification recognized as equivalent thereto.

6. Scheme, Duration and Medium of Instructions:

6.1. M.Sc., degree program is of 4 semesters - 2 years duration. A candidate can avail a maximum of 6 semesters (3 years) including blank semesters, if any to successfully complete M.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 program in Sciences

Course Type	Credits for Two Year (4 Semesters) Post Graduate Degree Programs
Hard Core Course	A minimum of 60 but not exceeding 70
Soft Core Course	A minimum of 10 but not exceeding 30
Open Elective	A minimum of 2
Project/Dissertation	A minimum of 10
MOOC / Swayam/ Coursera/Soft Skill Training	A minimum of 4
Total	**90**

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) Open Elective (OE) or Mandatory Course (MC)**

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) **or Mandatory Course (MC)** by the BoS concerned.

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 30 credits and a minimum of 20 credits per Semester. However he / she may not successfully earn a maximum of 30 credits per semester. This maximum of 30 credits 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 are eligible 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 90 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 18 extra credits either in the same discipline /subject or in different discipline / subject in excess to 90 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 such courses

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**	**8th week from the starting date of semester**	**15**
	Test-2: IA2	**16th week from the starting date of**	**15**

		semester	
C2	**1 Assignment**	**7th week**	**10**
	2 Assignment	**14th week**	**10**
C3	**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 platforms like SWAYAM/NPTEL/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 and scheme 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) Knowledge of relevant processes;

b) Skills and operations involved;

c) 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 50 marks for continuous assessment shall further be allocated as under (IA or CIA):

i	Conduction of regular practical throughout the semester	20 marks
ii	Maintenance of lab records /industry reports/SDP reports	15 marks
iii	Laboratory test and viva	15 marks
	Total	50 marks

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

i	Conduction of semester end practical examination	30 marks
ii	Write up about the experiment / practical conducted	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	7^{th} week from the start date of project semester	Weightage: 25%
3	Dissertation progress presentation-2	14^{th} Week from the start date of project semester	Weightage -25%
4	Final project Viva and Dissertation Submission	17^{th} -20^{th} 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 Controller of Examination - 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 for Supplementary Examination
In case a candidate fails to secure a minimum of 25% (13 marks) in Semester End Examination (SEE) and a minimum of 40% marks together with IA and SEE to declare pass in the course, such candidate shall seek supplementary examination of only such course(s) wherein his / her performance is declared unsuccessful. The supplementary examinations are conducted after the announcement of even semester examination results. The candidate who is unsuccessful in a given course(s) shall appear for supplementary examination of odd and even semester course(s) to seek for improvement of the performance.

13.3. 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.

13.4. **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 & Controller of Examination.

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 Controller of Examination 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 Controller of Examination.

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 - 89	9	v*9	A+
70 - 79	8	v*8	A
60 - 69	7	v*7	B+
55 - 59	6	v*6	B
50 - 54	5.5	V*5.5	C +
40 - 49	5	v*5	P
0 - 39	0	v*0	F
ABSENT			AB

O - Outstanding; A+-Excellent; A-Very Good; B+-Good; B-Above Average; C+-Average; C-Satisfactory; F – Unsatisfactory.

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) = ∑(Ci x Gi) / ∑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	26	7.71	26 x 7.71 = 200.46
3	26	8.68	26 x 8.68 = 225.68

4	14	9.20	14 x 9.20 = 128.8
Cumulative	90		718.86

Thus, CGPA = $\frac{24x6.83+26x7.71+26x8.68+14x9.20}{90} = \frac{718.86}{90} = 7.99$

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

For all PG courses since it is a double valuation (Internal and External Examiners), candidate shall not have an option to apply for challenge valuation.

Mapping of PEOS with Respect to POs and PSOs

	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO10	PSO1	PSO2	PSO3
PEO1	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√	√	√	√	√	√

Mapping of Course Outcomes with programme Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0101	CO 1	2	3	2					3		3	3	3	
	CO 2	2	3	2	2				3		3	3	3	3
	CO 3	3	3						2		3	3	3	
	CO 4	2	3	2					2		3	3	3	
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0102	CO1	2	2	3	2		1	1		1	1	2	1	1
	CO2	1	3	3	1		1		1	3	1	3	1	1
	CO3		2	3	1			1	1	1	2	2	1	1
	CO4	1	1	3				1	1	2	1	2	1	
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL010 3	CO 1	3									2	3	2	
	CO 2	3	2									3	3	`1
	CO 3			3	3		3	2	2	2	1	3	3	
	CO 4			2	3		2				1	3	3	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0104	CO1	3	3	2	1				1	2	2	2	2	1
	CO2	2	3	3	2	1	1	1	1	2	2	1	1	1
	CO3	2	3	3	2	1	1	1	1	2	2	1	1	1
	CO4	2	2	3	3	1	1	1	1	2	2	2	1	1
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0105	CO 1	3	3	2	2				1	1	2	3	2	2
	CO 2	2	2	3	3					1	2	2	2	2
	CO 3	2	3	2	2	2	1		2	2	3	3	3	3
	CO 4	3	3	3	2	2	1	2	2	2	3	3	2	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0106	CO 1	2	3	3	2						2	3	3	3
	CO 2	2	3	2	3			2	3		3	3	3	3
	CO3	3	2	2		2	3	3	2		3	3	3	
	CO4	3	3	2			2				3	3	2	

	CO5	3	3	3	3		2	3			3	3	1	2
	CO6	3	2	2			3	3	3		3	3	2	2
M21SL0107	CO1	3	3	1	3							3	3	
	CO2	1	3	2	3		2	1	2	1	1	3	3	1
	CO3	2	3	3	2	1			1	1	1	3	3	
	CO4	3	3	2	2			1	1	1		2	3	2
	CO5	3	3	2	2	2		2	2	3	1	3	2	
	CO6	3	2	3	2	1	2		3	2	1	2	3	
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL020 1	CO1	2	2	3					3		3	3	3	
	CO2	2	2	2			2	2	3		3	3	3	2
	CO3	2		3					3		3	3	3	
	CO4	2		2	3			2	3		3	3	3	3
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL020 2	CO1	2	3	2	3		3				3	3	3	
	CO2	2	3	3	3			3			3	3	3	3
	CO3	2	2	3			3				3	3	3	3
	CO4	2	3	2	3		3	3			3	3	3	3
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL020 3	CO1	2		3	3							1	2	2
	CO2		3	3	3	2		3				3	2	2
	CO3			3	3			3				3	2	2
	CO4				3					3	3	3	2	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0204	CO1	2	2	2	1	1			1	2		2	1	3
	CO2	2	2	3	1	1	2	1	1	2	1	2	1	2
	CO3	2	1			1				1	1	2	2	
	CO4	1		2	1	1		1	1	2	1	2	1	1
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SLS211	CO 1	2	3	3			3		3		3	3	3	
	CO 2	2	2	3	3				3		3	3	3	
	CO 3	2	3	3	3		3		3		3	3	3	3
	CO 4	2	2	3	3	2	3	3	3		3	3	3	3
Course Code	**POS /**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SLS212	CO1	3	2	2	3	1				3	2	3	2	
	CO2	1	2	3	3		1		3	2	1	3	3	1
	CO3	2	3	2	1				1	3	3	3	3	

	CO4	3	3	3	2	1	1		2	3	1	3	3	
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0205	CO1	2	3	3					2		3	2		2
	CO2	2	3	3	3				2		3	3	2	2
	CO3	2	3	3		2			2		3	3	2	2
	CO4	2	3	3					2		3	3	2	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0206	CO1	2	3	3					2		3	3	1	2
	CO2	2	3	3	3				2		3	2	2	2
	CO3	2	3	3		2			2		3	3	2	2
	CO4	2	3	3					2		3	3	2	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0301	CO1	2	3	2	3	3	3	3				1	2	2
	CO2	2	3	3	3				2	2	1		3	2
	CO3	3			3	3		2		2			2	3
	CO4	3	3	3	3							3	3	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0302	CO1	3					2				1	3	3	
	CO2	2	3	3	2			1	2		1	3	3	2
	CO3	3	2	3	3	1	3	2	1	2	1	3	2	
	CO4	3	3	3	1	2	2		3	2	1	3	3	1
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0303	CO 1	2	2	2	2	2	1	2	3	3	3	3	1	
	CO 2	1	1	3	2	2	1	3	3	3	3	3	1	1
	CO 3	2	2	1	2	2		1	2	3	3	1	1	
	CO 4	1	2	1	1	2	1	3	2	3	3	3		
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SLS311	CO 1	2	2		3						3	3	2	2
	CO 2		3	3							3	3	2	2
	CO 3			3	3		2			3		3	2	2
	CO 4			3	3			3		3	3	3	2	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03

M21SLS312	CO1	1	2	1	1	1			3		3	2	1	2
	CO2	2	3	2	3	2			3		3	3	2	2
	CO3	2	3	3	3	2			3		3	3	2	2
	CO4	2	3	3	3	2			3		3	3	2	2
M21SLS321	CO1	1			3							2		
	CO2	1	3		3	2		3	3	3	3	3	2	2
	CO3		3	3	3	2						3	2	2
	CO4				3	2		3	3	3	3	3	2	2
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SLS322	CO 1	1			3							2		
	CO 2		3		3	2		3	3	3	3	3	2	2
	CO 3			1	1			2	2	3	1		1	2
	CO 4	1						2	3	3	2			3
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SLO301	CO 1	2	2	2	1	2	1	3	2	3	3	3		1
	CO 2	2	2	3	1	2		2	2	3	3	2	1	2
	CO 3	2	2	3	3	2		1	2	3	2	1	1	
	CO 4		1	2	3	2	1	2	3	3	1	2		1
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0305	CO 1	2	3	2	3	3			2	2			3	2
	CO 2	2	3	3	3	3	3				1		2	3
	CO 3	3	3	3	3	3							2	3
	CO 4	3	3	3	3			2	2	1			3	3
Course Code	**POS / COS**	PO1	PO2	PO3	PO 4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS0 2	PS03
M21SL0306	CO 1	2	2	2	1	2	1	2	2	3	3	2		1
	CO 2	1	2	2	2	2		2	3	3	3	3	1	2
	CO 3	1	2	1		1		1	1		1	1		
	CO 4	1				2		1	1	1	1	1		1
	PO/ CO	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PS0 1	PS02	PS0 3
M21SL0401	CO 1	2	3	3	3							3	2	2
	CO 2	2	2	3	3	3	3					2	3	2
	CO	2	2	3	3	3	3		3	3	3	3	3	3

	3													
	CO 4	3	3	3	3	3	3	3	3	3	3	3	3	3
	PO/ CO	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PS0 1	PS02	PS0 3
M21SL0402	CO 1	2	2	3			3					1	3	3
	CO 2	3	2	3								1	3	3
	CO 3	3	3	3							3	1	2	3
	CO 4	3	3	3							3	1	2	3
	PO/ CO	PO 1	PO 2	PO 3	PO4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PS0 1	PS02	PS0 3
M21SL0403	CO 1	2	2	3			3					1	2	3
	CO 2	3	2	3								1	2	3
	CO 3	3	3	3							3	1	2	3
	CO 4	3	3	3							3	1		3

Mapping of PEO'S with Respect to PO's

	PO1	P2	PO3	PO4	PO5	PO6	P7	PO8	PO9	PO 10
PEO1	√	√	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√	√	√

M. Sc. (Biotechnology) Program

Scheme of Instruction (effective from Academic Year 2021-22)

FIRST SEMESTER			HC/ SC/ OE	L	T	P	Credits	Hours / week
1	M21SL0101	Cell Biology and Molecular Genetics	HC	4	0	0	4	4
2	M21SL0102	Biostatistics and Research Methodology	HC	4	0	0	4	4
3	M21SL0103	Microbiology	HC	4	0	0	4	4
4	M21SL0104	Biochemistry	HC	4	0	0	4	4
5	M21SL0105	Bioinformatics	HC	4	0	0	4	4
	Practical Courses							
6	M21SL0106	Cell biology and molecular genetics Laboratory	HC	0	0	2	2	4
7	M21SL0107	Microbiology and Biochemistry Laboratory	HC	0	0	2	2	4
Total Credits				**22**	**0**	**4**	**24**	**32**

SECOND SEMESTER			HC/ SC/ OE	L	T	P	Credits	Hours / week
1	M21SL0201	Molecular biology	HC	4	0	0	4	4
2	M21SL0202	Immunology and Medical Biotechnology	HC	4	0	0	4	4
3	M21SL0203	Bioprocess Engineering	HC	4	0	0	4	4
4	M21SL0204	Biochemical techniques and Enzymology	HC	4	0	0	4	4
5	M21SLS211	Animal Biotechnology	SC	4	0	0	4	4
	M21SLS212	Toxicology						
Practical Course								
6	M21SL0205	Molecular Biology, Immunology and Medical Biotechnology Laboratory	HC	0	0	2	2	4
7	M21SL0206	Biochemical techniques and Bioprocess Engineering Laboratory	HC	0	0	2	2	4
		Total credits		**20**		**4**	**24**	**30**

THIRD SEMESTER			HC/ SC/ OE	L	T	P	Credits	Hours / week
1	M21SL0301	Plant and Agricultural Biotechnology	HC	4	0	0	4	4
2	M21SL0302	Genetic Engineering	HC	4	0	0	4	4
3	M21SL0303	Environmental Biotechnology	HC	4	0	0	4	4
4	M21SLS311	Clinical Data Science	SC	4	0	0	4	4
	M21SLS312	Nano Biotechnology						
5	M21SLS321	Food science & Technology	SC	2	0	0	2	2
	M21SLS322	Entrepreneurship and Business Plan Presentation						
6	M21SLO301	Organic Farming	OE	4	0	0	4	4
7	M21SL0304	Skill Enhancement Course	HC	2	0	0	2	2
8	M21PTM301	Soft Skill Training (Common)	Mandatory	0	0	0	0	3
	Practical Courses							

9	M21SL0305	Plant, Agricultural Biotechnology and Genetic Engineering Laboratory	HC	0	0	2	2	4
10	M21SL0306	Environmental Biotechnology Laboratory	HC	0	0	2	2	4
Total Credits				**27**	**0**	**4**	**28**	**30**

FOURTH SEMESTER								
1	M21SL0401	Major Project	HC	0	0	0	10	20
2	M21SLON01	MOOC/Swayam-1	-	-	-	-	2	-
3	M21SLON02	MOOC /Swayam-2	-	-	-	-	2	-
Total Credits					**0**	**8**	**14**	**20**

Semester-wise Summary of Credit Distribution

Semesters	L	T	P	No. of Credits
First Semester	22	0	4	24
Second Semester	22	0	4	24
Third Semester	22	0	4	28
Fourth Semester	-	-	-	14
Total Credits				**90**

HC=Hard Core; SC=Soft Core; OE=Open Elective; MC=Mandatory Course

M.Sc. (Biotechnology) Program

Detailed Syllabus

(Effective from Academic Year 2021-23)

SEMESTER – I

CELL BIOLOGY AND MOLECULAR GENETICS

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0101	**CELL BIOLOGY AND MOLECULAR GENETICS**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

1. Microscopy is the prerequisite and basic knowledge of cell biology is essential.

2. Basic knowledge of genes and inheritance of traits.

Course Objectives:

The overall objectives of the course are:

1. To understand the concept of prokaryotic and eukaryotic cells, internal organelles and cytoskeletal protein organization and its functions.

2. To equip students with the understanding of the structure and organization of chromosomes and the impact of the genetic variation among the individuals.
3. To understand the cell signalling and cell cycle events in the normal cells and events that can lead to conversion of a normal cell to cancer state.
4. To eexplain the concept of population genetics and its application in studying the evolution of the species and to discuss the involvement of genes in growth and development of the organisms.

Course Outcomes:

After completing the course, the student should be able to

1. To illustrate the structure and function of the eukaryotic cell, various organelles, and concept of existence of cytoskeletal protein with their wide applications.

2. To outline the inheritance pattern at the molecular level and correlate the significance of variation at the genetic level.

3. To explore the molecules involved in cell signaling and cell cycle, and the molecules which malfunction in cancer cells.

4. Employ the concept of population genetics and understand the evolution of species and Illustrate the developmental genetics of the organisms.

Mapping of Course Outcomes with Program Outcomes

Course Code	POS/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0101	CO1	2	3	2					3		3	3	3	
	CO2	2	3	2	2				3		3	3	3	3
	CO3	3	3						2		3	3	3	
	CO4	2	3	2					2		3	3	3	

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

Unit-I **13 hrs**

Cell, Cell organelles and Cytoskeletal proteins:

Plasma membrane- structure and functions, Membrane model- Fluid Mosaic Model; Intracellular organelles; Mechanism of transport across membrane; Endocytosis and exocytosis, intracellular vesicle trafficking, Quorum sensing. Introduction to cytoskeleton and cytoskeletal proteins; Microfilaments, actin binding proteins, Intermediate filaments, Microtubules, Comparison of cytoskeletal structure based on characteristics, structure, shapes, position, number and functions. Structure and functions of cilia or flagella and interpretation for the presence of cytoskeletal proteins in cell mobility.

Unit 2 **13 hrs**

Chromosomes and Genetic Variation – concepts and theories of Mendelian genetics, Chromosome theory of inheritance. Structure and organization of eukaryotic chromosomes: Heterochromatin, euchromatin, centromere and telomeres. Organization of DNA in the nucleosome. Human chromosomal aberrations, karyotype analysis- normal and abnormal karyotype. Eukaryotic Recombination– Linkage and crossing over, Linkage maps, Mechanism of recombination and types. Holliday, model. Transposons – Transposable elements in prokaryotes and eukaryotes – IS elements, Composite transposons, Tn3 elements, Ac and Ds elements, P elements, Retrotransposons and their significance. Transposons- genetic and evolutionary significance

Unit 3 **13 hrs**

Cell signalling and Cell cycle:

Cell signalling and types of receptors- General principles of cell signalling via G-protein coupled receptors and receptor tyrosine kinase receptors.

Cell cycle- mitosis, cytokinesis, molecular events of cell cycle; role of cyclins and cyclin dependent kinases in cell cycle progression, cell cycle checkpoints, inhibitors of cell cycle. Cancer- introduction, types of cancers, metastasis, molecular basis of cancer- cell cycle deregulation in cancer, conversion of proto-oncogene to oncogene, tumour suppressor genes, apoptotic and anti-apoptotic genes. .

Unit 4 **13 hrs**

Population Genetics and Evolution - Overview of history and evolutionary theories with more emphasis on synthetic theory of evolution, Mendelian and Biometrician controversy, Population Genetics and Birth of NeoDarwinism, Forces affecting the Hardy-Weinberg Genetic equilibrium. Isolating mechanisms: Speciation. Molecular population genetics: Patterns of change in nucleotide

and amino acid sequences, Molecular clock, Neutral theory of molecular evolution, Conversion of genetic distance into divergence time, Emergence of Non- Darwinism. Molecular phylogenetics: Kinds of molecular data used in phylogenetic analysis and construction of phylogenetic tree.

Reference Books:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (2014). 6th Edition. Molecular Biology of the Cell, Garland Science publisher.
2. **Geoffrey M. Cooper** and, **Robert E. Hausman (2**016).The Cell: A molecular approach.7th edition. Publisher: Sinauer Associates, USA.
3. Gerald Karp (2013). Cell and Molecular Biology: Concepts and Experiments.7th edition. John Wiley and Sons Inc. NY.
4. Gardner/Simmons/Snustad. (2015). Principles of Genetics. 7th edition, John Wiley and sons.
5. Klug, W.S., Cummings. (2003). Concepts of genetics, 7th edition, Pearson Education.
6. Brown, T.A., Chapman and Hall (2011) Genetics a Molecular Approach, 2nd edition, Garland science..
7. Benjamin Pierce., Genetics a Conceptual Approach (2019), 7th edition, WH Freeman.

8. Brown, T.A., Chapman and Hall (2011) Genetics a Molecular Approach, 2nd edition, Garland science. Gilbert. (2013) Developmental biology. 10th edition.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0102	**BIOSTATISTICS AND RESEARCH METHODOLOGY**	SC	3	0	1	4	4

Prerequisites/Pre reading for the course:

Students should have basic knowledge of statistical techniques relevant to life science research.

Basic understanding of research approaches in various domains of life science is essential.

Course Objectives:

The overall objectives of the course are:

1. Develop knowledge on various kinds of research questions and research design.
2. Acquire basic knowledge on qualitative, quantitative and mixed method research as well as relevant ethical considerations.
3. Enable students to formulate research questions and develop a sufficient coherent research design and choose the right bio-statistical techniques to be used with the research methods.
4. Make informed choices with respect to methodology and research design.

Course Outcomes:

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

1) Compute bio-statistical parameters, test hypotheses and analyse parametric and non-parametric assumptions and tests.
2) Apply bio-statistical test parameters in different areas of life sciences including product evaluation, weighing treatment options, etc.
3) Understand concepts of research methodology and frame research problems by applying research designs along with carrying out ethical and responsible animal research.
4) Analyse and report data ethically in high impact journals

Mapping of Course Outcomes with program Outcomes

Course Code	POs/ Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO3
M21SL0102	CO1	2	2	3	2		1	1		1	1	2	1	1
	CO2	1	3	3	1		1		1	3	1	3	1	1
	CO3		2	3	1			1	1	1	2	2	1	1
	CO4	1	1	3				1	1	2	1	2	1	

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

Unit I **13 hrs**

Biostatistics I- Importance of statistical analysis in research, Data: types, classification and presentation as tables and graphs, measures of central tendency for grouped and ungrouped data, combined mean, Measures of dispersion, variance, standard deviation (SD), and combined SD, SEM, CoV, Rules of probability, features of normal distribution and related problems.

Unit II **13 hrs**

Biostatistics II-Pearson's correlation and Co-variance, Spearman and Kendall rank correlations and interpretation, multiple correlation, Regression equations and analysis, coefficient of determination and standard error of mean. Parametric and non-parametric data analyses, Concept of hypothesis and hypothesis testing, tests of significance, z test, student's t-test and F test. Chi-square tests for independence and Goodness of fit, Analysis of Variance (ANOVA).

Unit 3 **13 hrs**

Research Methodology and Designs- Definition, criteria, characteristics, objectives and types of scientific research, theory (empirical, deductive and inductive) and hypothesis, Research problems-definition, necessity, selection, objectives, types, methods and components. Research designs: Features, exploratory and descriptive types, Principles of experimental designs, informal and formal research designs, Animal research: Guidelines, ethical committees, animal models, routes of drug administration and LD_{50}, alternatives to animal research.

Unit 4 **13 hrs**

Data Analysis, Interpretation and Reporting: Primary and secondary data, Sample size determination, Data sampling considerations and design process, type I and type II errors, merits and demerits of non-probability and probability sampling techniques, Independent and dependent variables, Observation methods. Data interpretation: Techniques, precision, accuracy and precautions, Research reports: significance, layout, components, and types. Accountability, authorship and acknowledgement criteria, Ethics in research and reporting, plagiarism and online plagiarism software, Review and research articles, Journal impact factors and citations, Academic databases for biological sciences.

Reference Books:

1. Kothari, C. R. (2004), Research Methodology: Methods and Techniques, New Age International Publishers.
2. Sinha, S.C. and Dhiman, A.K., (2002). Research Methodology, EssEss Publications. 2 volumes.
3. Trochim, W.M.K., (2005). Research Methods: the concise knowledge base, Atomic Dog Publishing. 27
4. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., (2002). An introduction to Research Methodology, RBSA Publishers.
5. Wadehra, B.L. (2000). Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.
6. Leedy, P.D. and Ormrod, J.E., (2004). Practical Research: Planning and Design, Prentice Hall.
7. Satarkar, S.V., (2000). Intellectual property rights and Copy right. EssEss Publications

	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0103	**MICROBIOLOGY**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Basis of Biology & knowledge of microscopy.

Course Objectives:

The overall objectives of the course are:

1. Understand the recent developmental aspects microbiology
2. Illustrate creative and modern technology involved in microbiology
3. Understand the beneficial and deleterious roles of microbiology in society

Course Outcomes:

After completing the course, the student should be able to

1. Understand the basics of classification about microbial cells and various sterilization techniques
2. Develop professional skills in the techniques involved in Virology
3. Acquire the knowledge about industrial aspect of application of microbial cells
4. Analyse and solve the medical microbiology related issues

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0103	CO1	3									2	3	2	
	CO2	3	2									3	3	1
	CO3			3	3		3	2	2	2	1	3	3	
	CO4			2	3		2				1	3	3	2

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

Unit I **13 hrs**

Microbiology Introduction-Principles and classification of microbes-Domain classification & Bergeys' manual. Sterilization and disinfection-Physical and chemical methods of sterilization, stains and staining methods. Microbiological media and isolation and enumeration of microorganisms, methods of obtaining pure cultures and identification of microbes. Microbial growth, factors influencing microbial growth, and nutritional types in microorganisms. Prokaryotic and Eukaryotic microbes - General characteristics, reproduction and importance.

Unit II **13 hrs**

Virology-General characteristics, structure and classification of Viruses. Bacteriophages (T4 & Lambda), Animal viruses (SV40), Human virus (Retrovirus) and plants (CaMV). Isolation, cultivation and identification of Viruses. Viroids and Prions-general properties and diseases caused by viroids and prions.

Unit III **13 hrs**

Food and Industrial Microbiology-Role of microbes in food production, Microbiology of fermented foods, dairy products and alcoholic beverages. Principles of food spoilage and Preservations. Applications of Microbes in industrial production of antibiotics (penicillin and streptomycin), amino acids (Glutamic Acid) and organic Acids (citric acid and Lactic acid).

Unit IV **13 hrs**

Medical microbiology-Pathogenesis, Laboratory diagnosis, Prevention and control of important microbial diseases and Pathogenic bacteria (*E.coli, Mycobacterium tuberculosis, Salmonellatyphi, Staphylococcus aureus, Vibrio cholera and Leptospira*), Mycoses, Viral Diseases (Hepatitis A virus, Dengue, Nipah & influenza) and pathogenic Protozoa (*Plasmodium, Trypanosoma*)

Reference Books:

1. M J Pelczar Jr, ECS Chan, NR Krieg (2007) Microbiology 5th Edition Pub: Tata Mcgraw-Hill Publishing Co Ltd.
2. General Microbiology by Stanier Pub; Ingraham and Wheeler (1998), 5th edition. McMillan Publisher
3. Atlas R.M. (2000) Microbiology: Fundamentals and applications 4thEdition, Singapore : Pearson Education Asia
4. Brock T.D. and Madigan M.T (2014) Biology of Microorganisms, 14th Edn. Prentice Hall, Englewood Cliffs N.J.
5. Prescott L.M, Harley T.P and Klein D.A. (2012), 9th edition, Microbiology, WMC. Brown publishers
6. Tortor Gj, Funke BR, Case CL (2016), 12th edition, Microbiology: An introduction, Pearson.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0104	**BIOCHEMISTRY**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Microscopy is the prerequisite and strong knowledge of molecular biology is essential.

Course Objectives:

The overall objectives of the course are:

1. Explore the different aspects in the field of biochemistry.
2. Understand the recent developmental aspects of biochemical pathways in living organisms
3. Illustrate creative and modern technology involved in cell activities
4. Identify various intermediates involved in the biochemical pathways
5. Understand the deficiencies caused due to alterations in the biomolecules for addressing the human diseases.

Course Outcomes:

After completing the course, the student should be able to

1. Understand the basics about classification, structure, functions of Biomolecules and vitamins
2. To analyse and interpret the role of biomolecules and vitamins in human health
3. Understand and develop a biochemical pathway that helps to support systems biology
4. Illustrate the concept of bioenergetics and energy functions in systems biology

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0104	CO1	3	3	2	1				1	2	2	2	2	1
	CO2	2	3	3	2	1	1	1	1	2	2	1	1	1
	CO3	2	3	3	2	1	1	1	1	2	2	1	1	1
	CO4	2	2	3	3	1	1	1	1	2	2	2	1	1

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

Unit I **13 hrs**

Carbohydrates- Structure, properties, function and classification, Glycoproteins, proteoglycans and peptidoglycans, Blood group antigens; Glycolysis; Tricarboxylic acid cycle; Glyoxylate cycle, Pentose phosphate pathway; Cori cycle; Gluconeogenesis, glycogenesis and glycogenolysis.

Unit II **13hrs**

Lipids and Vitamins- Structure, properties and classification; Steroids and bile acids; Prostaglandins - prostacyclins, leukotrienes and thromboxanes;Beta-oxidation and synthesis of fatty acids; Ketone bodies; Cholesterol metabolism. Substances derived from cholesterol; Steroid hormones.

Vitamins- Classification, functions and coenzymes.

Unit III **13hrs**

Amino acids, Proteins and Nucleic acids- Structure, properties and classification Amino acids- Decarboxylation, Transamination, oxidative deamination of amino acids, transport of ammonia and urea

cycle. Biosynthesis of non-essential amino acids, Proteins – Conformation, Denaturation, Renaturation; Ramachandran's Plot.

Nucleic acids: DNA Polymorphism.Types of RNA including tRNA; Purine and Pyrimidine metabolism.

Unit IV **13 hrs**

Bioenergetics and Electron Transport Chain- Laws of thermodynamics; concept of free energy, standard free energy change and its measurement; Enthalpy and entropy. Energy-rich bonds - ATP and interconversions of nucleotide phosphates. Phosphate potential. High-energy compounds. Components of Electron Transport Chain; Theories of oxidative phosphorylation.

Reference Books:

1. Lehninger and D L Nelson (2012) Principles of Biochemistry, 6th edition. Macmillan Publications
2. Jeremy M Berg, John L Toymoczko and LubertStryer (2015) Biochemistry 8th Edition Macmillan Publications
3. Rob Phillips, Jane Kondev, Julie Theriot, Hernan Garcia, (2012) Physical Biology of the Cell, 2nd edition, Garland Publishers.
4. Voet, D. and Voet, J.G. (2009) Biochemistry. 3rd edition. John Wiley and sons.
5. Reginald H.Garrett and Charles M. Grisham (2013) Biochemistry, 6th edition, Mary Finch publisher
6. Elliot, Biochemistry and Molecular Biology (2009)4th edition, Oxford University Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0105	**BIOINFORMATICS**	HC	4	0	0	4	4

Prerequisites for the course

1. Basic knowledge of biology and computer science is required

Course Objectives:

The overall objectives of the course are to:

1. Introduce the basic concepts of bioinformatics.
2. Demonstrate applications of bioinformatics and biological databases in problem solving Pertaining to research.
3. Familiarize with the various aspects of internet applications.
4. Apply the knowledge of biological database for problem solving in the field of research.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0105	CO1	3	3	2	2				1	1	2	3	2	2
	CO2	2	2	3	3					1	2	2	2	2
	CO3	2	3	2	2	2	1		2	2	3	3	3	3
	CO4	3	3	3	2	2	1	2	2	2	3	3	2	2

Course Outcomes:

After completing the course, the student should be able to

1. Apply the knowledge and basic principles of concepts of biological data
2. Comprehend the role of various softwares and tools in computational drug discovery
3. Acquire problem-solving skills using bioinformatics algorithms to solve biological data structures
4. Understand the various concepts & methods involved in statistical analysis.

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

Unit I **13 hrs**

Biological Data Retrieval and Analysis - Introduction and Scope of bioinformatics. Biological information resources. Genome sequence acquisition and analysis; Data acquisition, Biological Databases; Structure and annotation. Data mining and data characteristics. Sequence alignment and Database searches Pair wise and multiple sequence alignment. Methods of local and global alignment, Dynamic programming, Scoring matrix.

Unit II **13 hrs**

Introduction to NCBI, NCBI data bases, Searching PubMed, BLAST, BLASTn, BLASTp, PSI-BLAST, Searching sequence databases for sequence similarity; Multiple sequence alignment, Phylogenetic Analysis; Primer designing.

Unit III **13 hrs**

Genomic data science- Introduction to genome sequencing, platforms, file types, data structures, applications; Sequencing data analysis – Quality analysis, Genome annotation and alignment, differential expression, pathway analysis, functional analysis.

Unit IV **13 hrs**

Bioinformatics in Drug discovery - Conceptual model of protein structure, Structural types and conceptual models, Globular proteins, secondary structure, tertiary structure, integral membrane proteins and domains. Protein structure analysis, Molecular docking.

Bioinformatics in the Pharmaceutical Industry- QSAR method; ADMET Predictions. Parameters in drug discovery identification of drug target molecules, drug design and its approaches. Molecular Docking studies.

Reference Books:

1. Attwood, T. and P.S. David.(2006). Introduction to Bioinformatics. Pearson Education Ltd., New York
2. Baxevanis, AD., and Ouellette, BFF. (2006). 3rd Edition. Bioinformatics A Practical Guide to Analysis of Genes and Proteins., John Wiley and Sons, New York
3. Attwood TK. and Higgs, PG. (2005). Bioinformatics and molecular evolution. Blackwell Publishers, London.
4. Lesk, AM. (2002). Introduction to Bioinformatics. Oxford University Press

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0106	**CELL BIOLOGY & MOLECULAR GENETICS (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Fundamentals of molecular biology, biochemical techniques, plant morphology, anatomy and microbiology is a prerequisite for this course.

Course Objectives:

The overall objectives of the course are:

1. To illustrate different cell organelles, different staining techniques and its enzyme activity.
2. To provide information about various stages of mitosis & meiosis.
3. To study the usage of microscope and the calibration to analyze the size of cells.
4. Facilitate students to understand the concept of polyploidy induction.
5. Impart knowledge on the development process of chick embryo.
6. Estimate the dimensions of the cells and enable students to analyse the chromosomes and characterize different models

Course Outcomes:

After completing the course, the student should be able to

1. To develop deeper understanding of cell & its function at cellular levels.
2. To understand & comprehend the various techniques used for the isolation of cells & cell organelles.
3. Analyze the role of chemicals in induction of mutations.
4. Distinguish the stages of embryo development and role of genes.
5. Analyze and observe the cells and compare chromosomes in organisms.
6. Exploit the knowledge of karyotyping in medical cytogenetics.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0106	CO1	2	3	3	2						2	3	3	3
	CO2	2	3	2	3			2	3		3	3	3	3
	CO3	3	2	2		2	3	3	2		3	3	3	

	CO4	3	3	2			2				3	3	2	
	CO5	3	3	3	3		2	3			3	3	1	2
	CO6	3	2	2			3	3	3		3	3	2	2

Course Content:

1. Microscopic measurements: Stage micrometry of onion and yeast cells
2. Study of mitosis in onion
3. Study of meiosis in grasshopper testis/onion flower buds
4. Isolation of chloroplast by sucrose density gradient and determination of its purity
5. Isolation of nucleus and mitochondria and determination of its purity
6. Determination of the rate of active transport of glucose across the intestinal membrane
7. Study of phylogenetic tree: construction and analysis
8. Induction of polyploidy in onion root tip
9. Problems on Sex linked inheritance and population genetics
10. Induction of mutation in *Drosophila melanogaster*
11. Dissection of polytene chromosome from *Drosophila melanogaster*
12. Karyotyping in animal/plant.

Reference Books:

1. John Davey and J. Michael Lord (2003).3rd edition. Essential Cell Biology- A Practical approach. Publisher Oxford University press
2. J.E. Celis.(2006). 3rd edition. Cell Biology: A Laboratory Hand Book, USA: Elsevier Academic Press
3. Gerald Karp (2013). Cell and Molecular Biology: Concepts and Experiments.7th edition. John Wiley and Sons Inc. NY.
4. Redei, George P. (1999) 3rd edition. Genetics Manual Current: Theory, Concepts, Terms World Scientific Publishers
5. Anthony JF Griffiths, Jeffrey H Miller, David T Suzuki, Richard C Lewontin, and William M Gelbart.(2000) 7th edition. An Introduction to Genetic Analysis. Publisher: New York W.H. Freeman.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0107	**MICROBIOLOGY & BIOCHEMISTRY (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Microscopy is the prerequisite and basic knowledge pertaining to analytical technique is essential.

Course Objectives:

The overall objectives of the course are:

1. Explore the practical aspects in the culturing and their importance.

2. Develop strong & knowledgeable techniques for research in microbiology area.
3. Inculcate the analytical skills in estimating carbohydrates, proteins, fats and phosphate.
4. Develop confidence in conducting the experiments independently.

Course Outcomes:

After completing the course, the student should be able to

1. Apply the knowledge of culturing and preserving the microbes in the laboratory conditions.
2. Develop professional practical skills in microbiology.
3. Acquire the knowledge of biochemistry in the areas of research.
4. Acquire enhanced skills and confidence levels to meet the industrial requirements

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0107	CO1	3	3	1	3							3	3	
	CO2	1	3	2	3		2	1	2	1	1	3	3	1
	CO3	2	3	3	2	1			1	1	1	3	3	
	CO4	3	3	2	2			1	1	1		2	3	2
	CO5	3	3	2	2	2		2	2	3	1	3	2	
	CO6	3	2	3	2	1	2		3	2	1	2	3	

Course Content:

1. Isolation of air microflora by plate exposure method. Colony characteristics and counting of colonies (serial dilution method), pure culture techniques
2. Staining techniques: Simple, differential, endospore and capsule; bacterial motility by hanging drop technique, negative staining
3. Biochemical tests (a) Indole (b) Methyl red (c) Voges-Proskauer (d) Citrate utilization (e) Triple sugar iron agar (f) Starch hydrolysis (g) Gelatin hydrolysis (h) Catalase (i) Oxidase
4. Bacterial growth curve by turbidometry
5. Testing of quality of water (Coliform test)
6. Counting of microbes using haemocytometer
7. Estimation of reducing sugar by o-Toluidine method
8. Estimation of total carbohydrates in biological samples by Anthrone method
9. Estimation of protein in biological samples by Folin-Ciocalteau method
10. Estimation of Inorganic phosphate by Fiske Subbarow method
11. Estimation of Lactose by DNS method
12. Estimation of saponification, Iodine and Acid numbers of fats from the prepared biological sample

Reference Books:

1) Katoch, Rajan (2011). Analytical techniques in Biochemistry and molecular Biology. Springer
2) Martin Holtzhauer.(2007)Basic Methods for the Biochemical Lab, Springer,.
3) Keith Wilson and John Walker(2010). 7th edition. Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press
4) Samuel Singer (2001). Experiments in Applied Microbiology. Academic Press.

5) Collins, C.H., Tatrica M. Lyne and Grange, J.M. (2004).8th edition. Microbiological methods. Hodder Arnold publishers.
6) Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, and Gary Sayler(1998). Techniques in Microbial Ecology. Oxford University Press. NY.
7) Alexander N. Glazer, Hiroshi Nikaido (2007).2nd edition. Microbial Biotechnology, Freeman
8) K. R. Aneja (2003). 4th edition. Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International publisher
9) James G. Cappuccino and Natalie Sherman (2013). 10th edition. Microbiology: A Laboratory Manual. Publisher: Pearson India

SECOND SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0201	**MOLECULAR BIOLOGY**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Basics knowledge about genetic material and characteristics of protein is essential

Course Objectives:

The overall objectives of the course are:

1. Acquire the knowledge of chromatin structure and gene expression
2. Explore the mechanism of post transcriptional events and translation
3. Apply the basic knowledge of molecular biology in Genomics and Proteomics
4. Understand the structure and functions of DNA, RNA and Protein

Course Outcomes:

After completing the course, the student should be able to

1. Explore the genetic information flow in the eukaryotic cell; including nucleic acid structures, the definition of a gene, the organization of the genome, the replication, the formation of RNA (transcription), the processing of pre mRNA and the protein synthesis (translation)
2. Explain the principles and concept of transcription, translation and gene regulation in prokaryotic and eukaryotic cells
3. Describe the consequences of different types of mutations and DNA- repair system
4. Illustrate the mechanisms of transposable elements, the concepts of applications of omics including next generation sequencing

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0201	CO1	2	2	3					3		3	3	3	

	CO2	2	2	2			2	2	3		3	3	3	2
	CO3	2		3					3		3	3	3	
	CO4	2		2	3			2	3		3	3	3	3

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

Unit I **13 hrs**

DNA Topology- Central dogma, DNA structure, Super coiled forms of DNA, Super helical density, energetics of super coiled DNA (Topological domains of DNA and role of super coiling in gene expression and DNA replication) DNA-Protein Interactions - General features, Interaction of Helix-turn Helix motif, B-sheet, Different forms of DNA (A, B and Z DNA).

Unit II **13 hrs**

DNA Replication- DNA binding motifs and types, Characteristics and functions of Prokaryotic and Eukaryotic DNA polymerases, Mechanism of prokaryotic and Eukaryotic DNA replication and its Fidelity, Telomerase and Telomere synthesis. Replication of viral DNA, Inhibitors of DNA replication.

Unit III **13 hrs**

Transcription and Translation - RNA polymerases, features of prokaryotic and eukaryotic promoters, assembly of transcription initiation complex in prokaryotes and eukaryotes and its regulation; synthesis and post transcriptional modification of prokaryotic and eukaryotic transcripts. Genetic Code, Structure and role of t-RNA in protein synthesis, ribosome assembly and structure, Wobble hypothesis, prokaryotic and eukaryotic translation.

Unit IV **13 hrs**

Protein modifications and targeting - Posttranslational modifications of proteins (protein folding, processing by proteolytic cleavage and chemical modification), Ubiquitination, Proteosome and Protein degradation. Regulation of gene expression in prokaryotes - Operon concept, positive and negative regulation. Examples of lac-, ara and trp- Operon regulation; global regulatory responses; Regulation of gene expression in eukaryotes.

Reference Books:

1.Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter (2014)6th Edition. Molecular Biology of the Cell, Garland Science publisher.

2. Harvey Lodish, Arnold Berk, Chris A Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Matthew P Scott (2012). 7th edition. Molecular Cell Biology, Macmillan Publishers

7. **Geoffrey M. Cooper** and **Robert E. Hausman (2**016).The Cell: A molecular approach.7th edition. Publisher: Sinauer Associates, USA.

8. Lehninger and D L Nelson (2012) Principles of Biochemistry. 6th edition. Macmillan Publications

9. Lewin, Benjamin; Krebs, Jocelyn E.; Goldstein, Elliott S.; Kilpatrick, Stephen T. (2014), Genes XI, Jones and Bartlett Learning

10. Jeremy M Berg, John L Toymoczko and LubertStryer (2015) Biochemistry. 8th Edition

Macmillan Publications
11. Karp, G. (2013). Cell and Molecular Biology concepts and experiments, John Wiley and Sons Inc. NY.
12. James D Watson, Tania A Baker., Stephen P Bell, Alexander Gann.,Michael Levine, Richard Losick (2014), Molecular Biology of the Gene: 7th Edition, Pearson Education
13. T. A. Brown (2007). 3rd edition. Genomes 3. GS Garland Science, Taylor and Francis Group
14. Snyder and Champness (2007) 3rd edition. Molecular Genetics of Bacteria, ASM Press

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0202	**IMMUNOLOGY & MEDICAL BIOTECHNOLOGY**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

1. Basic knowledge about bacterial and viral infection, antigen-antibody reaction.
2. Knowledge about developmental biology and concept of stem cells and recombinant DNA technology.
3. Basic knowledge of metabolism is a prerequisite.

Course Objectives:

The overall objectives of the course are:

1. Explore the fascinating field of immunology, organization and function of the immune system.
2. Provide deeper insight into production of diverse immune globulins from a single gene complex.
3. Understand the mechanism of the reaction of antibodies against antigens and also the advance concept of recombinant therapeutic products.

Course Outcomes:

After completing the course, the student should be able to

1. Understand the basic and advanced medical related issues in the society, by exploring the world of immunology and its relevant interactions.
2. Explore the recent research advancement in the medicinal research areas, including immunodiagnostics.
3. Develop skills in understanding disease biology and specific markers leading to the knowledge of disease diagnosis and management.
4. Exploit the knowledge in the development of therapeutic strategies for the treatment of genetic and acquired diseases.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0202	CO1	2	3	2	3		3				3	3	3	
	CO2	2	3	3	3			3			3	3	3	3

	CO3	2	2	3			3				3	3	3	3
	CO4	2	3	2	3		3	3			3	3	3	3

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

Unit-I **13 hrs**

Fundamental concepts of the immune system- Innate and acquired immunity, complement cascade and inflammatory responses, primary, secondary lymphoid organs and cells of immune system. Antigens-immunogens, haptens, Major Histocompatibility Complex. Disease susceptibility; Immune responses-Immunoglobulin's, multigene organization of immunoglobulin genes, Immunoglobulin super family and cell-mediated immune responses. Cytokines-properties, receptors and therapeutic uses; Antigen processing and presentation-endogenous and exogenous antigens, non-peptide bacterial antigens and super-antigens.

Unit II **13 hrs**

Clinical Immunology-Hypersensitivity-classification and types, immunosuppressive therapy, autoimmune diseases- causes, symptoms and diagnosis. Immunological techniques-Precipitation, agglutination and complement-mediated immune reactions; RIA, ELISA, Western blotting, immune fluorescence, flow cytometry; Production of monoclonal antibodies.

Unit III **13 hrs**

Fundamentals of Medical Biotechnology: Evaluation of organ functions: liver, kidney, cardiac and gastric function tests. Significance of biochemical markers, Human Diseases – Symptoms and Treatment: Tumors, Types, pre-disposing factors, cellular changes involved in tumor formation, genes associated with cancer (oncogenes, tumor suppressive genes etc.), tumor detection methods, tumor markers. Genetically inherited diseases: Phenylketonuria, Alkaptonuria, Galactosemia, Von‟Gierke disease, Lesch-Nyhan syndrome, Gout, Sickle cell anaemia, Beta Thalesimia and Diabetes.

Unit IV **13 hrs**

Molecular Therapeutics: Gene therapy-Inherited and acquired diseases for gene therapy, Gene delivery: retrovirus- and adenovirus-mediated gene transfer; Liposome- and nanoparticle-mediated gene delivery. Nanobiotechnology: introduction, types and synthesis of nanomaterials, protein- and DNA-based nano structures, Applications of nanomaterials as therapeutics, nanobiosensors, drug and gene delivery, disease diagnostics and therapy, risk potential of nanomaterials.

Reference Books:

1. Kuby J, Judy Owen, Jenni Punt, Sharon Stranford (2013). Immunology. 7th Edition. W.H. Freeman and Company.
2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt (2011). 12th edition, Essential Immunology, ELBS, Blackwell Scientific Publishers, London
3. Ian Tizard R. (2013). Immunology, 9th edition, Elsevier publisher.
4. K.M.Pavri. (1996), Challenge of AIDS, 2nd edition, National Book Trust, India.
5. Abbas & Lichtman & Pillai (2014). Cellular and Molecular immunology,8th edition, Elsevier publisher
6. C.Vaman Rao.(2012), An Introduction to Immunology. 2nd edition , Narosa publishing house
7. William E Paul (2012). Fundamentals in Immunology. 7th edition, Raven Press. NY
8. Bernhard Palsson and Sangeeta N Bhatia (2004)., Tissue Engineering, 2nd Edition, Prentice Hall,
9. Pamela Greenwell, Michelle McCulley (2008). Molecular Therapeutics: 21st century medicine, 1st Edition, Springer,
10. Andrew Read and Dian Donnai (2007). New Clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK,.
11. James W Goding (1996). Monoclonal antibodies: Principles and Practice, 3rd Edition, Academic Press,
12. George Patrinos and Wilhelm Ansorage (2005). Molecular Diagnostics, 1st Edition, Academic Press,
13. Lela Buchingham and Maribeth L Flawsm (2007), Molecular Diagnostics: Fundamentals, Methods and Clinical Applications, 1st Edition, F A Davis Company, Philadelphia, USA.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0203	**BIOPROCESS ENGINEERING**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Students should have basic knowledge of microbiology, biochemistry and instrumentation.

Course Objectives:

The overall objectives of the course are:

1. Acquire the skills employed in upstream and downstream processes in fermentation technology.
2. Integrate the research perspectives in the field of bioprocess engineering with the industrial requirements.
3. Optimize the fermentation techniques and formulate the downstream products for maximum productivity.
4. Construct a business plan for industrial important product obtained through fermentation.

Course Outcomes:

After completing the course, the student should be able to

1. Describe the microbial growth and cultivation with respect to modes of fermentation and comprehend the role of biotechnology in improving microbial cells as factories.

2. Choose the ideal bioreactor models according to the final product, the microbial strain

And market requirement employed in the process.

3. Optimise a suitable scheme of bioproduct separation and purification based upon the molecular characteristics of the product and other process criteria.

4. Apply the knowledge of fermentation process in the production of value added commercial products.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0203	CO1	2		3	3							1	2	2
	CO2		3	3	3	2		3				3	2	2
	CO3			3	3			3				3	2	2
	CO4				3					3	3	3	2	2

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

UNIT I **13 hrs**

Introduction to Bioprocess Engineering: Basic concepts of bioprocess engineering- A brief survey of organisms, processes, products. Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Industrial strain improvement for better productivity; Fermentation media and Fermentation Process: Natural and synthetic media; Sterilization- Dry and moist heat; Types of fermentation process- submerged, surface and solid state; Modes of cultivation- batch, fed-batch and continuous fermentation; Kinetics of fermentation, bioprocess control, monitoring of variables-Dissolved oxygen (DO), temperature, agitation, pH and pressure.

UNIT II **13 hrs**

Bioreactors: Architecture of advanced bioreactors and their working mechanisms; Design features; Heat and Mass transfer; Specialised bioreactors- design and their functions; Bioreactors- Airlift Bioreactor and its applications, Tubular, Membrane bioreactor-features and applications, Tower bioreactor-features and applications, Fluidized-bed and Packed-bed bioreactor-features and applications; photo bioreactors and disposable reactors bioreactor-features and applications.

UNIT III **13 hrs**

Downstream processing : Overview of unit operations and their principles; Physical and rheological characteristics of fermentation broths; Pre-treatment-Cell disruption, heating and chemical treatment; solid-liquid separation- filtration and centrifugation; Product isolation- Adsorption, precipitation and extraction; Purification- Chromatography- Size exclusion, affinity and ion-exchange and HPLC; Finishing operations – Freeze drying and crystallization. Scale up of production.

UNIT IV **13 hrs**

Production of value-added products: Bio preservatives, Biopolymers, Industrial Enzymes, Bio fuels, Cheese, Beer and Single Cell Protein. Production of recombinant proteins having therapeutic and diagnostic applications, and vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture. By-product utilisation in various industries through bioprocess engineering tools.

Reference Books:

1. Satyanarayana, U (2005). "Biotechnology" Books and Allied (P) Ltd..
2. Kumar, H.D (1998). "A Textbook on Biotechnology" 2nd Edition. Affiliated East West Press Pvt. Ltd.
3. Balasubramanian, D. etal (2004.). "Concepts in Biotechnology" Universities Press Pvt. Ltd.,
4. Ratledge, Colin and Bjorn Kristiansen (2001). "Basic Biotechnology" 2nd Edition Cambridge University Press.
5. Dubey, R.C (2006). "A Textbook of Biotechnology" S. Chand and Co. Ltd.
6. Bailey and Ollis (1986). "Biochemical Engineering Fundamentals", McGraw Hill (2nd Ed.),
7. Shuler and Kargi (1992). "Bioprocess Engineering ", Prentice Hall.
8. Pauline Doran (1995). Bioprocess Engineering Calculation, Blackwell Scientific Publications.
9. Peter F. Stanbury, Stephen J. Hall and A. Whitaker (2016), Principles of Fermentation Technology, third edition, Science and Technology Books.
10. Brod. H.Vester A, Kauling J (2012). Opportunities and limitations of disposable technologies in biopharmaceutical processes.ChemIng Tech 84(5):633-645

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0204	**BIOCHEMICAL TECHNIQUES & ENZYMOLOGY**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Students need to be familiar with the concepts of industrial fermentation.

Students should also have basic knowledge physiology and biochemistry involved in microbial metabolism.

Course Objectives:

The overall objectives of the course are:

1. Help the students to develop knowledge in research in biochemical analysis and estimation.
2. Upgrade knowledge on important protocols and techniques in biochemistry.
3. Enable the students to apply scientific principles and methods to identify and solve problems associated with biochemical techniques and enzymology.
4. Apply critical thinking and analytical evaluation to biochemical techniques and analysis of the quantitative data.

Course Outcomes:

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

1. Acquire the fundamental skills and knowledge related to concepts and techniques of chromatography.
2. Illustrate the different spectroscopy techniques for the analysis of a particular compound.
3. Understand the classification and activity of enzymes and coenzymes involved in enzymology studies.
4. Comprehend the concepts in enzyme kinetics.

Mapping of Course Outcomes with program Outcomes

Course Code	POs/ COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
M21SL0204	CO1	2	2	2	1	1			1	2		2	1	3
	CO2	2	2	3	1	1	2	1	1	2	1	2	1	2
	CO3	2	1			1				1	1	2	2	
	CO4	1		2	1	1		1	1	2	1	2	1	1

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

Unit I **13 hrs**

Separation techniques: Chromatography, Electrophoresis and Centrifugation - Basic principles, planar and column chromatography. Theory, principles and applications of Paper, Thin Layer, Gel Filtration, Ion Exchange, Affinity, Reverse phase chromatographic techniques, GLC and HPLC.

Electrophoresis Techniques - Principles and types, Agarose- Gel Electrophoresis, Isoelectric focusing, PAGE, SDS-PAGE and 2-D gel electrophoresis.

Centrifugation Techniques – Basic principles of centrifugation- Sedimentation coefficient; Preparative, analytical and gradient centrifugation and their applications.

Unit II **13 hrs**

Spectroscopy –Electromagnetic spectrum and interaction of radiation with matter, UV and Visible spectroscopy; Beer-Lambert's law and its limitation; IR spectroscopy- Principles, NMR and ESR, CD/ORD, X-ray crystallography.

Radioactivity - Introduction to Isotopes, detection and measurement of radioactivity, Autoradiography, Radio-labelling procedures.

Unit III **13 hrs**

Introduction to Enzymes – Characteristics, Classification and properties of enzymes, enzyme substrate complex. Concept of active centre, binding sites, specificity and ES complex formation. Effect of temperature, pH and substrate concentration on reaction rates. Activation energy. Transition state theory. Structure and mechanism of action of some important co-enzymes NAD+, FAD, FMN, TPP, pyridoxal phosphate, lipoic acid, Coenzyme A and Vitamin B_{12}. Isozymes and Allosteric enzymes.

Unit IV **13 hrs**

Enzyme Kinetics-Michaelis - Menten Equation - form and derivation, steady-state enzyme kinetics. Significance of V_{max} and K_m. Bisubstrate reactions. Graphical procedures - advantages and disadvantages of alternate plotting. Enzyme activity, international units, specific activity, turnover number, end-point kinetic assay. Regulation of enzymes: Covalent and noncovalent modification; Enzyme inhibition - types of inhibitions - competitive, non-competitive and uncompetitive, mode of action of inhibitors and experimental determination.

Reference Books:

1. Nelson, D.L., Cox, M.M. Lehninger. (2013). Principles of Biochemistry, 6th edition Pub WH Freeman Co.
2. Keith Wilson and John Walker, (2010) Biochemical techniques, 7th edition ,Cambridge University.
3. Daniel, L, Purich, Melvin, I. Simon, John, N., Abelson. (2009). Contemporary enzyme kinetics and mechanism, 3rd edition, Elsevier publisher.
4. Trevor Plamer and Philip Bonner, (2007). Enzymes,2nd edition, Woodhead Publishers
5. Voet, D. and Voet, J.G. (2009), Biochemistry 3rd edition, John Wiley and sons.
6. Rodney Boyer(2000), Modern experimental Biochemistry. 3rd edition, Benjamin and Cummings publisher.
7. David Plummer(2004), An introduction to practical Biochemistry, 3rd edition, Tata McGraw-Hill Education Pvt. Ltd

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SLS211	**ANIMAL BIOTECHNOLOGY**	SC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Basic knowledge of Biotechnology and concepts of cloning is essential**.**

Course Objectives:

The overall objectives of the course are:

1. Explore the applications of concepts in animal biotechnology in various fields.
2. Provide perspective on the recent advances in the field of animal biotechnology.
3. Understand the pros and cons of applications of animal biotechnology in society.
4. Familiarize the concept and techniques of transgenic animals.

Course Outcomes:

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

1. Explain the fundamental techniques and scientific principles followed for animal cell culture.
2. Acquire knowledge of isolation, maintenance, growth of cell culture, animal cloning, and applications in industry.
3. Understand the techniques and applications of transgenic plants in the field of medicine.
4. Acquire knowledge of stem cell biology and its implications.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SLS211	CO1	2	3	3			3		3		3	3	3	
	CO2	2	2	3	3				3		3	3	3	
	CO3	2	3	3	3		3		3		3	3	3	3
	CO4	2	2	3	3	2	3	3	3		3	3	3	3

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

Unit I **13 hrs**

Introduction to Animal Cell Culture - Culture medium: natural media, synthetic media, sera.

Introduction to balanced salt solutions- HBSS, EBSS, simple growth medium- MEM, RPMI-1640. Physical, chemical and metabolic functions of different constituents of culture medium, role of carbon dioxide, serum and supplements. Behaviour of cells, properties, utility. Explant culture and suspension culture.

Unit II **13 hrs**

Characteristics and maintenance of cell lines: Definition of cell culture ; Primary cell culture, Secondary culture and cell line preparation; characteristics, maintenance and management of cell lines; cell adaptation. Measurement of viability and cytotoxicity. Cell cloning, cell synchronization and cell manipulation. Various methods of separation of cell types, advantages and limitations; flow cytometry.

Unit 3 **13 hrs**

Transgenic models and cell cloning – Cloning of Dolly; Transgenic animals –generation of Knockout mice, conditional gene knockout, knocking mice, generation of disease models in mice, transgenic ruminants generation and their applications, transgenic silkworm generation. Baculo virus expression system and its applications; Rabies vaccine generation using transgenic.

Unit IV **13 hrs**

Commercial applications of cell culture - Mass production of biologically important compounds (e.g. Vaccines). Harvesting of products, purification, and assays. Three dimensional cultures and tissue engineering for skin, bone. Pharmaceuticals from animal systems for humanized pharmaceuticals - Animal system as bioreactors.; Cryopreservation. Stem cell biology - concept, methods and applications in medicine.

Reference Books:

1. John M. Walker (2007). Animal cell Biotechnology: Methods and protocols – Nigel Jenkins (Ed), Humana press, New Jersey.
2. Watson J.D.et al (2007). Molecular Biology of Gene (6^{th} Ed.) Publisher Benjamin Cummings.

3.Berger S. L. and A.R. Kimmel (1996). Methods in enzymology guide to molecular cloning Techniques (Vol 152). Academic Press Inc. San Diego
5. Glick, B.R. and Pasternak J.J (2003). Molecular Biotechnology. A- M Press, Washington DC
6. Jenni, P, Mather and David Barnes (2001). Methods in Cell Biology (Vol 37) Academic Press.
7. Ratlege, C. and B. Kristiansen (2001), Basic Biotechnology. Cambridge Univ. Press, London
8. Watson J.D. et al (2004). Molecular Biology of the Gene (6th Ed), The Benjamin Curmnings Pub. Co.Inc.USA
9. Jan Freshnev. R (2010). Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications (6th Ed.) Wiley and amp; Sons.
10. M.M. Ranga (2010). Animal biotechnology, Agrobios (India).

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SLS212	**TOXICOLOGY**	SC	4	0	0	4	4

Prerequisites/Pre-reading for the course

Students should have knowledge on chemistry, biochemistry and basics of Biotechnology, which will help them to understand the adverse effects of chemical substances, diagnosis and treatment.

Course Objectives:

The overall objectives of the course are:

1. Help to the students to build knowledge on toxic substances that react with living organism.
2. Focus on the toxicology of mammalian body systems with emphasis on dose-response, mechanism and the sites of action of major groups of chemical toxicants and biological toxins.
3. Provide an opportunity to conduct research in an area of toxicology.

Course Outcomes:

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

1. Understand the molecular mechanism of cell regulations based on various proteins, lipids and hormones that expose to the various chemical exposure and these bio molecules involved in the disease conditions.
2. Describe the human health and diseases based on signs, symptoms, diagnostics and treatment. Students also understand toxic exposure to the disease treatment.
3. Analyse and interpret the toxic substances used for prolonged exposures based on acute, sub-Acute and chronic studies.
4.Understand the concept of safety measures in pharmacology.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SLS212	CO1	3	2	2	3	1				3	2	3	2	
	CO2	1	2	3	3		1		3	2	1	3	3	1

	CO3	2	3	2	1				1	3	3	3	3	
	CO4	3	3	3	2	1	1		2	3	1	3	3	

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

Unit I **13 hrs**

Molecular Mechanisms in Cell regulation- Biosynthesis of Chemical Mediators such as mediators of inflammation and allergy, Histamine, Bradykinin, Eicosanoids: prostaglandins, thromboxanes, leukotrienes and related compounds, EDRF and vascular substances, oxygen free radicals, Cox- l and Cox-2 and their pathophysiological roles.

Unit II **13 hrs**

Health disorders-Hypertension, Ischaemic heart disease, Cardiac arrhythmias and dyslipidaemia, CNS: Parkinson's disease and Alzheimer's disease, Musculoskeletal: Rheumatoid & Osteoarthritis, GIT: Peptic ulcer, Inflammatory bowel diseases, Endocrine: Obesity, Diabetes mellitus, Osteoporosis,

Thyroid and parathyroid disorders, Infectious: UT infections, RT infections, GI infections (Bacterial and protozoal), Malaria, Tuberculosis, AIDS, Malignant: Leukaemia, Lymphomas and solid tumours.

Unit III **13 hrs**

Toxicity studies-Acute, sub-acute and chronic studies: Protocols, objectives, methods of execution and regulatory requirement. Reproductive toxicology assessment: Male reproductive toxicity, spermatogenesis, risk assessment in male reproductive toxicity, female reproductive toxicology, oocyte toxicity, alterations in reproductive endocrinology, relationship between maternal and developmental toxicity.

Unit IV **13 hrs**

Mutagenicity: *In vitro* tests for gene mutations in bacteria, chromosome damage, gene mutations in vivo (micronucleus tests and metaphase analysis) in rodents. Carcinogenicity studies: *In vivo* and *In vitro* studies e. Toxicological requirements for biological and bio-tech products: Safety analysis, concept of safety Pharmacology, antibodies, transmission of viral infections, residual DNA.

Reference Books:

1. Goodman and Gilman (2001). The Pharmacological Basis of Therapeutics. (International Edition) McGraw Hill, New York , 10th edition.
2. Rang HP, Dale MM and Ritter JM (1999). Pharmacology , Churchill Livingstone, London, 6th 3. Edition.
3. Bertram G Katzung (2001). Basic and Clinical Pharmacology by (International Edition) Lange Medical Book/McGraw-Hill, U.S.A. 8th Edition.
4. D.R. Laurence, P.N (1997). Clinical Pharmacy by Bennett & Mi. Brown, 8th Edition Churchill Livingstone.
5. Roger and Walker (2012). Clinical pharmacy and therapeutics, Churchill Livingstone Publication Experimental and surgical techniques in the rat, 2nd edition.
6. Braunwald, Fauci, Kasper, Hauser, Longo Jameson (2001), Harrison's Principles of Internal Medicine. (McGraw Hill, New York, 9th Edition.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0205	**MOLECULAR BIOLOGY, IMMUNOLOGY & MEDICAL BIOTECHNOLOGY (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Fundamentals involved in molecular biology, biochemical techniques, plant morphology, anatomy and microbiology is a prerequisite for this course.

Course Objectives:

The overall objectives of the course are:

1. Familiarise with the concepts of molecular biology on experimental basis.
2. Inculcate analytical and research skills.
3. Expose students to the techniques employed in medical laboratories and allied research labs

Course Outcomes:

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

1. Apply basic laboratory skills required for DNA isolation and bacterial conjugation.
2. Analyze, interpret and report the results of estimation of various components in biological samples.
3. Perform experiments related to purification and separation of antibodies through various techniques.
4. Analyse and interpret the technique of ELISA.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0205	CO1	2	3	3					2		3	2		2
	CO2	2	3	3	3				2		3	3	2	2
	CO3	2	3	3		2			2		3	3	2	2
	CO4	2	3	3					2		3	3	2	2

Course Contents:

1. Purification of IgG by column chromatography
2. Enzyme linked immunosorbent assay

3. Ouchterlony double diffusion
4. Rocket Immunoelectrophoresis
5.Isolation of plasmid DNA and analysis by electrophoresis
6. Isolation of genomic DNA and analysis by electrophoresis
7.Study of bacterial transformation
8. Study of conjugation in *E.coli*
9. Analysis of acid and alkaline phosphatase from serum samples
10. Estimation of Creatine and Creatinine from urine samples
11. Estimation of Cholesterol by Zak's Method
12. Estimation of Blood Urea by diacetyl monoxime method

Reference Books:

1. Ausubel F.M., Brent R., Kingston R.E., Moore D.D. et al (2003). Short protocols in molecular biology (4th Ed), Wiley publishers. India.
2. Sambrook J et al (2001). Molecular cloning Volumes I, II and III. Cold Spring Harbor laboratory Press, New York, USA
3. Keith Wilson and John Walker (2000), Practical Biochemistry- 5th edition, Cambridge University Press, UK
4. Bertram G. Katzung (2004) Basic and Clinical Pharmacology, 9th Edition, Mc GrawHill Publications
5. Devlin TM (2002), Text book of biochemistry with Clinical Correlations 5th edition
6. Richard B Silverman (2014), Organic Chemistry of Drug design and Drug action Elsevier Science, Academic Press
7. Warren Levinson, Ernest Jawetz (2003), Medical Microbiology and Immunology: Examination and Board Review 7th edn. McGraw Hill Publications
8. Jawetz, Melnuk and Adelgerg (2015), Medical Microbiology, Appleton and Lange
9.. Kuby (2007). Immunology by Goldsby, Kindt, and Osborne
10. Nelson, D.L., Cox, M.M (2005). Lehninger Principles of Biochemistry . 4th edition Pub WH Freeman Co.
11. Elliott, W.H., Elliott, D.C(2005). Biochemistry and Molecular Biology 3rd Indian edition, Pub. Oxford.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0206	**BIOCHEMICAL TECHNIQUES &BIOPROCESS ENGINEERING (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Students should have basic knowledge of microbiology, biochemistry and working principles of analytical instruments.

Course Objectives:

The overall objectives of the course are:

1. Educate the student how to perform and use the chromatographic techniques for identification and

separation of compounds.

2.Gain knowledge about the enzyme kinetics practically.

3. Get hands on with respect to various types of fermentation techniques.

4. Acquire the practical skills in enzyme essays and antibiotic production and purification.

Course Outcomes:

After completing the course, the student should be able:

1. Operate the instrument independently and identify and characterize the compound.
2. Analyse the enzyme kinetics for each reactions which are carried out by the Enzymes.
3. Demonstrate the various techniques associated with the fermentation process such as sterilization, media preparation and bioprocess control.
4. Apply the knowledge of fermentation for the pilot scale production and purification of industrially important fermentation products such as wine and antibiotics.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0206	CO1	2	3	3					2		3	3	1	2
	CO2	2	3	3	3				2		3	2	2	2
	CO3	2	3	3		2			2		3	3	2	2
	CO4	2	3	3					2		3	3	2	2

Course Content:

1) Separation of amino acids by circular Paper chromatography and TLC
2) Separation of bio molecules by Column chromatography
3) Determination of total activity of pea esterase
4) Determination of K_m and V_{max} of pea esterase
5) Determination of optimum pH of pea esterase
6) Determination of optimum temperature of pea esterase
7) Growth of Bacteria – Estimation of Biomass, Calculation of Specific Growth Rate
8) Enzyme immobilization – Gel entrapment/ Cross linking
9) Estimation of lactic acid in dairy products
10) Production and estimation of alpha amylase by solid-state fermentation
11) Production of wine and estimation of alcohol content by specific gravity method
12) Production of penicillin and antimicrobial assay

Reference Books:

1) Martin Holtzhauer (2007). Basic Methods for the Biochemical Lab;, Springer,
2) Keith Wilson and John Walker(2010)., Principles and Techniques of Biochemistry and Molecular Biology, 7th Edn ,Cambridge University Press,
3) Trevor Palmer, Horwood (2001), Enzymes: Biochemistry, Biotechnology and Clinical Chemistry:).,

4) Robert A. Copeland, by Wiley-VCH Inc. (2000).Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis
5) Jordening H J and Josef Winter.(2005). Environmental biotechnology: concepts and applications (2nd Ed.) Wiley and Sons Publishers.UK
6) Daniel Vallero.(2010). Environmental Biotechnology: A Biosystems Approach (1st Ed.) Academic press. New York
7) Wang LK.(2010). Handbook of Environmental Engineering (1st Ed.) Springer Publishers
8) Evans G G and Judy Furlong.(2011)., Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers.
9) Wang L.K., Ivanov V., Tay J.H., HungY.T(2010). Handbook of Environmental Engineering (1st Ed.) Springer Publishers
10) Gareth G. Evans (2010)., Judy Furlong Environmental Biotechnology: Theory and Application (2nd Ed.).Wiley publishers.

THIRD SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0301	**PLANT AND AGRICULTURAL BIOTECHNOLOGY**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Prior knowledge of concepts in Botany with respect to anatomy, histology, plant biochemistry in terms of metabolism & pathways involved and basic concepts in molecular biology.

Students should also have basic knowledge in plant physiology.

Course Objectives:

The overall objectives of the course are:

1. Introduce the underlying principles involved in plant tissue culture.
2. Familiarize the students with the concepts and techniques in plant genetic engineering.
3. Understand the significance of plant cell culture for the production of secondary metabolites in industry and research.

Course Outcomes:

By the end of the course, the students will be able to:

1. Apply the concepts of plant tissue culture techniques for micro propagation with the associated Advantages and disadvantages.
2. Comprehend various plant transformation techniques for better plant productivity and express the pros and cons of genetically engineered crops.
3. Choose & implement alternative plant biotechnology tools in place of genetic modification by engineering.
4. Design the process of secondary metabolite production using plant cell cultures.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0301	CO1	2	3	2	3	3	3	3				1	2	2
	CO2	2	3	3	3				2	2	1		3	2
	CO3	3			3	3		2		2			2	3
	CO4	3	3	3	3							3	3	2

Course Content: **Total Hours 52 hrs**

Unit I **13 hrs**

Introduction to Plant tissue culture: Plant tissue culture media, explants and Growth regulators, Micropropagation, axillary bud proliferation method, Meristem culture and production of virus-free plants, somatic embryogenesis, organogenesis, protoplast culture, protoplast fusion and somatic hybridisation, Cybrids. Somaclonal variation, Anther culture. *Invitro*germplasm conservation-Cryopreservation. Plant tissue culture certification.

Unit II **13 hrs**

Plant transformation for productivity and performance : *Agrobacterium* mediated gene transfer, Ti and Ri plasmids as vectors, Binary & cointegrate vectors, plasmid vectors, plant viral vectors, Selectable markers and Reporter genes. Direct gene transfer methods-Microprojectile and Electroporation, Plant growth regulators; Biofertilizers-types and production; Mycorrhiza-VAM, *Rhizobium, Azotobacter*, Phosphate Solubilising bacteria , Biopesticides -Types and production,. Strategies for engineering stress tolerance; herbicide, viral and bacterial resistance in crops, Bt Cotton and other transgenic crops. Integrated pest management.

Unit III **13 hrs**

Plant metabolic engineering and products : Shikimic Acid pathway in secondary metabolite production, Production of bioactive secondary metabolites by plant tissue culture (Optimisation of media and culture conditions, organ culture, two phase system, Hairy root culture, Biotransformation, Elicitation). Transgenic plants for the production of recombinant therapeutic protein, recombinant antibody, industrial enzyme, biodegradable plastics and edible vaccines.

Unit IV **13 hrs**

Post-harvest technology and GM crops: RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalacturonase); delay of softening and ripening of fleshy

fruits. Post-harvest protection of cereals, millets and pulses. Current status of transgenic plants in India and other countries, Ethical issues associated with GM crops and GM food.

Reference Books:

1. Adrian Slater, Nigel W. Scott, Mark R. Fowler. (2008).Plant Biotechnology: An Introduction to Genetic Engineering by Oxford University Press.
2. Bhojwani. S.S and Razdan by M.K (2004). Plant tissue culture, Oxford and IBH Publishing Co, New Delhi.
3. Bob Buchanan, Wilhelm Gruissem, Russell Jones. (2002). Biochemistry and Molecular Biology of Plants. John Wiley and Sons.
4. Gamborg O.L. and Philips G.C. (1998) Plant cell, tissue and organ culture (2nd Ed.) Narosa Publishing House. New Delhi.
5. Gistou, P and Klu, H (2004). Hand book of Plant Biotechnology (Vol. I and II). John
6. Hammond J, P McGravey and Yusibov.V (2000). Plant Biotechnology, Springer verlag.
7. Kirakosyan A and Kaufman P.B. (2009) Recent Advances in Plant Biotechnology
8. Razdan. M.K. (2003). An introduction to Plant Tissue Culture. Oxford and IBH Publishing Co, New Delhi.
9. Slatu (2003). The genetic manipulation of plants. Oxford University Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0302	**GENETIC ENGINEERING**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Strong knowledge of Molecular biology, Microbiology and fermentation technology is essential

Course Objectives:

The overall objectives of the course are:

1. Acquaint the students to versatile tools and techniques employed in RDT
2. Familiarize the students in professional, legal & ethical aspects of GMOs.
3. Emphasize the importance of research in the field of Genetic Engineering.
4. Expose students to the applications of recombinant DNA technology

Course Outcomes:

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

1. Understand the basic knowledge in gene manipulations.
2. Understand and apply different gene transfer methods
3. Analyze DNA using different genetic engineering techniques
4. Assess the ethical and environmental issues related to Genetic Engineering

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0302	CO1	3					2				1	3	3	
	CO2	2	3	3	2			1	2		1	3	3	2
	CO3	3	2	3	3	1	3	2	1	2	1	3	2	
	CO4	3	3	3	1	2	2		3	2	1	3	3	1

Course Content: **Total hours: 52 hrs**

Unit I **13hrs**

Tools in Genetic Engineering: Restriction endonucleases and modification methylases, exonucleases, enzymes for end modification of DNA., exonucleases, ligases and mechanism of ligation.

Cloning vectors: Plasmids as vectors, pBR322, pUC –Series. Phage vectors-M13 phage vectors, Cosmids & Phagemids, Yeast Vectors, YAC and BAC vectors, Adenoviruses, Retroviruses, Ti Plasmid, Expression vectors.

Unit II **13 hrs**

Transformation and library construction – Chemical based transformation - Calcium chloride method and Calcium phosphate precipitation methods, liposome mediated and DEAE dextron methods. Physical methods - Microinjection, Biolistics, Electroporation and Gene gun methods. Genomic and c-DNA libraries -Construction of library and its applications, problems, advantages and disadvantages. Screening methods for cloned libraries.

Unit III **13 hrs**

DNA analysis: Radioactive and non-radioactive labelling of DNA and RNA probes. Fluorescence *in situ* hybridization, chromosome walking. Analysis of gene and gene products: DNA finger printing - RFLP, RAPD, DNA sequencing. Blotting techniques - Southern, Northern and Western blotting techniques. PCR and its variants.

Unit IV **13 hrs**

Applications: Transgenic animals and plants, production of recombinant pharmaceuticals, Safety of recombinant DNA technology: Restriction and regulation for the release of GMOs into environment. Ethical, legal, social and environmental Issues related to rDNA Technology.

Reference Books:

1. Boylan, M. and Brown, K.E. (2003). Genetic Engineering- Science and Ethics on the New Frontier. Pearson Education (Singapore) Pte. Ltd.
2. Brown, T.A. (2001).Gene Cloning and DNA Analysis-An Introduction 4th edn. Blackwell Science.
3. Winnacker. (2003), From Genes to Clones: Introduction to Gene Technology. WILEY-VCH Verlag GmbH, Weinheim, Germany Reprinted by Panima Publishing Corporation, New Delhi

4. Old R.W., Primrose S.B (2001). Principles of gene manipulation - An introduction to genetic engineering (5th Ed.), Blackwell Scientific Publications, UK.
5. S. B. Primrose, Richard M (2006). Twyman. Principles of gene manipulation and genomics (7th Ed.) John Wiley and Sons publishers.
6. Nicholl D.S.T (2008). Introduction to Genetic Engineering Cambridge (3rd Ed.) University press.UK.
7. Benjamin Lewin (2004), Genes VIII (3rd Ed.) Oxford University and Cell Press,NY
8. Jeremy W. Dale, Malcolm von Schantz, Nicholas (2012) Plant - From Genes to Genomes: Concepts and Applications of DNA Technology, 3rd Edition

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0303	**ENVIRONMENTAL BIOTECHNOLOGY**	HC	4	0	0	4	4

Prerequisites/Pre reading for the course:

The students should have prior knowledge of environmental science and chemistry

The students also should be familiar with concepts of pollutants and wastes

Course Objectives:

The overall objectives of the course are:

1. Introduce the essential and critical principles involved in environmental biotechnology

2. Describe the concepts and techniques in environmental biotechnology with respect to bioremediation.

3. Understand the significance of environmental biotechnology studies to protect the nature

Course Outcomes:

After completing the course, the student should be able to

1. Describe the various methods to prevent pollution
2. Comprehend the various techniques related to water management and waste water treatment in order to conserve water.
3. Understand the importance of microorganisms in degrading the pollutants in the environment.
4. Create awareness about various methods involved in solid waste management for conservation of nature.

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0303	CO1	2	2	2	2	2	1	2	3	3	3	3	1	
	CO2	1	1	3	2	2	1	3	3	3	3	3	1	1
	CO3	2	2	1	2	2		1	2	3	3	1	1	
	CO4	1	2	1	1	2	1	3	2	3	3	3		

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

Unit I **13 hrs**

Energy & Environment - Renewable and non-renewable sources of energy; Biodiversity and its conservation. Environmental pollution- water, soil and air pollution sources. Global warming, its impact and management, Bio indicators and Bio monitoring: Biosensors and biochips.

Unit II **13 hrs**

Water Management Strategies- Water as a scarce natural resource, water management techniques including rain water harvesting. Sampling Techniques - Methods of Analysis - Characterization Origin of Wastewater - Sources and classification of water pollutants. Waste Water Treatment, Primary treatment - Sedimentation- Flocculation, Flotation.

Unit III **13 hrs**

Bioremediation - Application, specific advantages and disadvantages, land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump-treat method, constructed wet lands, use of bioreactors for bioremediation. Phytoremediation, bioremediation of xenobiotics (heavy metals, pesticides, oil slicks, plastics restoration of coal mines: a case study

Unit IV **13 hrs**

Solid Waste Management & Biodegradation- Definition of solid wastes, Types of domestic solid wastes – collection – transportation – characteristics of solid waste–segregation – types of disposal methods – sanitary land fill – incineration – composting – Vermicompost – recovery of energy from solid wastes;

Microbial Degradation of Biopolymers, Cellulose, xylan, starch and other glucans, pectin, lignin and chitin, protein, nucleic acids, lipids and fats and polyhydroxyalkanoates (Bioplastics).

Reference Books:

1. Jordening H J and Josef Winter (2005) Environmental biotechnology: concepts and applications. 2nd edition, Wiley and Sons Publishers.UK.
2. Daniel Vallero., (2010) Environmental Biotechnology: A Biosystems Approach, 1st edition, Academic press. New York.
3. Wang LK (2010) Handbook of Environmental Engineering, 1st edition, Springer Publishers.
4. Evans G G and Judy Furlong., (2011) Environmental Biotechnology: Theory and Application 2nd edition,Wiley publishers.
5. Wang L.K., Ivanov V., Tay J.H., HungY.T (2010) Handbook of Environmental Engineering 1st edition, Springer Publishers
6. Gareth G. Evans, Judy Furlong (2010) Environmental Biotechnology: Theory and Application 2nd edition, Wiley publishers.
7. Fulekar M.H (2010) Environmental Biotechnology, Taylor and Francis group

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SLS311	**CLINICAL DATA SCIENCE**	SC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Students should have basic knowledge of Life Science including microbiology, biochemistry and human physiology.

Students should be familiar with ethical concepts and safety aspects of scientific research

Course Objectives:

The overall objectives of the course are:

1. Develop knowledge on various kinds of research questions and research design.
2. Acquire basic knowledge on qualitative, quantitative and mixed method research as well as relevant ethical considerations.
3. Enable students to formulate research questions and develop a sufficient coherent research design and choose the right bio-statistical techniques to be used with the research methods.
4. Make informed choices with respect to methodology and research design.

Course Outcomes:

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

1) Understand the applications of bio-statistical procedure to evaluate a product situation, services or a treatment option through biostatistics.
2) Interpret statistical literature, research articles and the claims made on the basis of statistics.
3) Comprehend the research design considerations with respect to equations, formulations, Sample selections and randomization, study design and research protocols.
4) Decide the data types and graphs of samples and different standard errors, confidence intervals and p-values..

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SLS311	CO1	2	2		3						3	3	2	2
	CO2		3	3							3	3	2	2
	CO3			3	3		2			3		3	2	2
	CO4			3	3			3		3	3	3	2	2

Course Content: **Total hours: 52 hrs**

Unit I **13 hrs**

Introduction to Clinical Research: Definition of Clinical research, Terminologies & definitions used in Clinical Research, Difference between Clinical Research and Clinical practice, Types of Clinical research and Phases of Clinical Research, Features of Clinical Trials; The stand of Clinical Research in Scientific Arena, Basics of Bioavailability & Bioequivalence Studies, Clinical Research Methodology, Career Prospect in Clinical Research

Unit II **13 hrs**

Preclinical Studies: HT screening, In vitro and In vivo studies, animal models of disease, teratogenicity, reproductive toxicity, mutagenicity, carcinogenicity, selection of initial human dose from animal data, Assessment; Extrapolation of animal data to clinical situation; Clinical significances, adverse event, serious adverse event, end point.

Unit III **13 hrs**

Basics of Clinical Pharmacology: Drug, Pharmacology Pharmacokinetics, Pharmacodynamics, Therapeutics, Toxicology, Chemotherapy, Pharmacoepidemiology, Pharmacoeconomics, Pharmacokinetics, Pharmacodynamics, First Human Dose; Drug Development Process: Drug discovery, Preformulation, Formulation & Development, Preclinical testing, Preclinical, toxicity studies, evaluation of drugs and Indian regulatory framework, Clinical Development process

Unit IV **13 hrs**

Clinical Trial Management & Regulatory Affairs: Defining Clinical Trial Process, Basics of Project Management-Definition of project, Stages of Project Development, definition of a clinical trial project management, concept of clinical Trial Management flow; Essential Document preparation (IB, ICF, PIS, TMF, ISF, Advertisements, CDA, CTA etc; Pharma Regulatory Affairs; Drug Policies; Adverse Drug Reactions; Management; Good Manufacturing Practices (GMP).

Reference Books:

1. Who Expert Committee on Specification for Pharmaceutical Preparation WHO-GENEVA, 2005 edition
2. Who Expert Committee on Biological Standardization WHO-GENEVA2003 edition
3. Guidance for Industry, CDER, 2005 edition
4. ICMR Guidelines – 2008, ICMR-New Delhi, 2006 edition
5. Vishal Bansal Parar (2010). Clinical Research Fundamental and Practice –Medical Publisher
6. Dr. S. Gunasakaran and R.Salhesh Kumar (2010). Pharmacovigilance for Beginners –Tatamani Magalir Co-Operative Press,
7. Dr.Ravindra B. Ghooi and Sachin C (2010). Essential of Clinical Research –. Itkar Nirali Prakashan
8. Jaypee Brothers (2009). Basic Principles of Clinical Research and Methodology, Medical Publishers (P) Ltd
9. T.K.Pal and Sangita Agarwal (2009)Clinical Research-, CBS Publishers and Distributors
10. Samir Malhotra, Nusrat Shafiq, Promila Pandhi (2008). A Comprehensive Clinical Research Manual-Jaypee Brothers Medical Publishers (P) Ltd
11. G.N Prabhakaran (2010) .Biostatistics - Jaypee Brothers Medical Publishers (P) Ltd
12. S.K.Gupta (2009) Drug Screening Methods- - Second Edition Jaypee Brothers Medical Publishers (P) Ltd
13. Quality Assurance of Phramaceuticals-VOL1.2WHO-GENEVA 2003 editions
14. Basic Test for Pharmaceuticals dosage forms WHO-GENEVA2008 edition
15. Rakesh Kumar Joshi (2007) .Regulations of Clinical trials - KONGPOSH PUBLISHERS

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SLS312	**NANOBIOTECHNOLOGY**	SC	4	0	0	4	4

Prerequisites/Pre reading for the course:

Students should be familiar with the basic concepts of chemistry, spectroscopy techniques, microscopy techniques and chromatography techniques

Course Objectives:

The overall objectives of the course are:

1. Explore the students to the knowledge about the nanometric objects.
2. Train students in towards formulation and application of nanofabricated products.
3. Illustrate the creative knowledge of nanobiotechnology which will be helpful in research area
4. Understand the advantageous and harmful aspects of nanotechnology which can be helpful in society

Course Outcomes:

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

1. Explain the basic concepts in nanotechnology.
2. Illustration about various analytical instrumentation techniques for characterization of nanomaterials
3. Identify natural and manmade sources for nanoparticles, the routes of exposure to the human system, the effects and mechanism of action on biological systems
4. Illustrate knowledge about the properties of engineered nanomaterial and its applications

Mapping of Course Outcomes with program Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SLS312	CO1	1	2	1	1	1			3		3	2	1	2
	CO2	2	3	2	3	2			3		3	3	2	2
	CO3	2	3	3	3	2			3		3	3	2	2
	CO4	2	3	3	3	2			3		3	3	2	2

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

Unit I **13 hrs**

Principles, synthesis and characterisation of Nanomaterial : Origin and concepts, General properties of nano materials, Top down and bottom up approaches of synthesis, Nanoparticle synthesis by physical, chemical and biological methods**.**

Unit II **13 hrs**

Characterisation Methodology of Nanomaterial's – Microscopy Techniques, SEM, TEM, AFM, STM, Spectroscopic techniques – UV Vis and FTIR, XRD, DLS methods for particle size analysis, zeta potential, and Electrophoretic mobility.

Unit III **13 hrs**

Nanoparticles & Environment Natural and manmade sources for nanoparticles, fate of nanoparticles in environment, routes of exposure to the human system, their effects and mechanism of action on biological systems at organ and cellular level, High Aspect Ratio Nanoparticles,

Unit IV **13 hrs**

Engineered Nanomaterial and its Applications: Carbon nanotubes, Fullerences, Core shell nanoparticles, Quantum dots, metal nano particles their properties and applications Biomimetic systems for commercial applications.

Nanomedicine : Dendrimers, liposomes, polymer nanocontainers, biologic robots for targeted therapy including cancer treatment and regenerative medicine.

Reference Books:

1.T. Pradeep (2007) Nano: The essentials - Understanding Nanoscience and Nanotechnology, , Tata McGraw- Hill Publishing Company Limited, New Delhi.

2.Charles P.Pooli, J.R., Frank J.Owens, (2003), Introduction to nanotechnology, Wiley Interscience Publications.

3. Ahmad (2010), Principles of Nanoscience and Nanotechnology, M.A. Shah& T., Narosa Publishing House Pvt Ltd, Kolkata.

4. Guozhong Cao, Ying Wang (2011), Nanostructures and nanomaterials: Synthesis, Properties and Applications, Vol 2, World Scientific Publishing.

5.SSR Kumar (2007), Nanomaterials for Cancer Diagnosis, Wiley –VchVerlag GmbH and Co.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SLS321	**FOOD SCIENCE AND TECHNOLOGY**	SC	2	0	0	2	2

Prerequisites/Pre reading for the course:

Basic knowledge about the chemistry of biomolecules and properties is must.

Course Objectives:

The overall objectives of the course are:

1. To provide knowledge related to nutritional aspects in food science.
2. Impart knowledge on production process from raw materials to finished product in food Processing industries, and food packaging materials.

Course Outcomes:

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

1. Understand and concise the major food constituents and their nutritional makeup & importance of water in food chemistry.
2. Know the importance of microorganisms in food, food borne diseases and analytical methods for estimating microbial toxins.
3. Acquire knowledge in various food processing techniques and their advantages in food industry, and understand the food processing approaches.
4. Understand the significance of food additives with their permissible limits and the importance of packing system in food industries.

Mapping of Course Outcomes with program Outcomes

Course Code	**POS / COS**	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SLS321	CO1	1			3							2		
	CO2	1	3		3	2		3	3	3	3	3	2	2
	CO3		3	3	3	2						3	2	2
	CO4				3	2		3	3	3	3	3	2	2

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

Unit I **6 Hrs**

Food Chemistry: Major constituents of food – carbohydrates, proteins and fats, and its importance, minor constituents of food- vitamins, minerals, antioxidants and enzymes and their importance, significance of water in food.

Unit II **7 Hrs**

Food Microbiology: Importance of microorganisms in food science. Food spoilage-features, dynamics and significance, food borne diseases - Bacterial, viral and parasitic. Analytical methods for microbial metabolite and toxins determination.

Unit III **6 Hrs**

Food processing and preservation: Processing and preservation of food by heat, low temperature, drying and non-thermal methods. UHT and HTST processing. Processed foods-types and features.

Unit IV **7 Hrs**

Food additives and food packaging: Food additives: definition, types and functions, permissible limits and safety aspects. Food packaging: Definitions, objectives and functions of packaging and packaging materials. Biodegradable plastics.

Reference Books:

1. Pelczar, M.I and Reid, R.D. (2007) Microbiology McGraw Hill Book Company, New York, 5th Edition.
2. Prescott LM Harley JP and Klein DA (2006). Microbiology (7th edition) McGraw Hill, Newyork.
3. Adams, M.R. and M.G. Moss (2009): Food Microbiology, 1st Edition, New Age International (P) Ltd.
4. Doyle, P., Bonehat, L.R. and Mantville, T.J (2010): Food Microbiology, Fundamentals and Frontiers, ASM Press, Washington DC.
5. Desrosier NW & James N. (2007). Technology of food preservation. AVI. Publishers
6. Fellows, P.J. (2005). Food processing technology: Principle and Practice. 2nd Ed. CRC Publishers
7. Jelen, P. (2005). Introduction to Food Processing. Prentice Hall
8.Ahmed, S. (Ed.). (2018). Bio-based Materials for Food Packaging: Green and Sustainable Advanced Packaging Materials. Springer.
9. Ebnesajjad, S. (Ed.). (2012). Plastic films in food packaging: materials, technology and applications. William Andrew.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SLS322	**ENTREPRENEURSHIP & BUSINESS PLAN PRESENTATION**	SC	2	0	0	2	2

Prerequisites/Pre reading for the course:

Students are expected to be familiar with the basic business disciplines, concept of setting up a business, marketing, finance, operations and accounting in terms of general as well as Biotechnology entrepreneurship

Course Objectives:

The overall objectives of the course are:

1. To explore the fascinating field of Entrepreneurship– study of the entrepreneur.
2. To explore the start-ups related to biotechnology and understand the marketing concepts.
3. To enable students to understand the concept of project management and types of ownership seen in enterprises.
4. To provide insights about the support system from public and private sectors in establishing start-ups, and get trained in preparing first draft of their own business plan.

Course Outcomes:

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

1. To comprehend the concept of entrepreneurship and traits of entrepreneurs
2. Understand the trends seen in biotech start-ups and familiar with the various marketing strategies.
3. To know the concept of project planning and the steps to be taken for successful execution of project and types of enterprises.
4. Design strategies for successful implementation of creative ideas by understanding the concepts required to set up biotech business, know the source of finance for biotech business venture.

Mapping of Course Outcomes with program Outcomes

Course Code	POs/ COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PSO1	PSO2	PSO 3
M21SLS322	CO1	1			3		1	3	1	2	2	1		1
	CO2	1			1	1		1	2		1	1		1
	CO3			1	1			2	2	3	1		1	2
	CO4	1						2	3	3	2			3

Course Content:

Total Hours: 26 hrs

Unit I 6 hrs

Introduction to Entrepreneurship: Entrepreneur, Creativity, Innovation; Entrepreneurship in Biotechnology; Entrepreneurial traits and motivation, theories of Entrepreneurship, Franchising.

Unit II

Entrepreneurship in Biotechnology-I 7 hrs

Biotech enterprises, Major start-ups in Biotechnology, Small business strategic planning, Pricing and promotion, Marketing management. Digital marketing: Internet marketing, mobile marketing, Social media marketing.

Unit III 6 hrs

Entrepreneurship in Biotechnology-II: Quality control in Biotech industries, Entrepreneurial Finance: Basics of Financial Analysis. Project management; Sole proprietorship, partnership, cooperation society, private and public limited companies.

Unit IV 7 hrs

Innovation in Creative Economy: Venture creation and simulation; Desirables in start-up, steps for starting a small industry, medium and large scale industry, Location of an enterprise, incentives and subsidies for start-ups, role of various agencies; Biotech Consortium India Limited and its activities, exploring export possibilities and Global business.

Submission of Business Plan Report and Presentation.

Reference Books:

1. Scarborough, N. M. (2016). Essentials of entrepreneurship and small business management. Pearson..
2. Marriot, S. (2010). Entrepreneurship: Owning your future.
3..Kuratko, D. F. (2016). Entrepreneurship: Theory, process, and practice. Nelson Education.
4. Hisrich, Robert D., Peters, Michael P., and Shephered, (2007):Entrepreneurship, Tata mcgraw-hill; sixth edition, 2007

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SLO301	**ORGANIC FARMING**	OE	4	0	0	4	4

Prerequisites/Pre reading for the course:

Need to have general awareness on issues related to environment, environment conservation, sustainable agriculture.

Course Objectives:

The overall objectives of the course are::

1. Understand the importance of organic farming in developing a sustainable agriculture system for ensuring adequate food production.
2. Acquire the holistic concept of organic farming as a self-sustainable unit in the ecosystem.
3. Get familiarized with the practices involved in the organic farming system.

Course Outcomes:

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

1. Analyse the advantages of organic farming compared to conventional chemical agriculture.
2. Understand the significance of plant nutrient management following organic practices.
3. Apply the knowledge gathered in implementing the practices in organic crop production and plant protection.
4. Explain the basic principles involved in organic farming production, certification and marketing.

Course Code	POS/ COs	PO 1	P0 2	PO 3	PO 4	PO 5	PO 6	P 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
M21SLO301	CO1	2	2	2	1	2	1	3	2	4	3	3	1	2
	CO2	2	2	3	1	2	0	2	2	4	3	1	1	3
	CO3	2	2	3	3	2	0	1	2	4	2	1	0	1
	CO4	0	1	2	3	2	1	2	3	4	1	2	2	3

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

Unit I **13 hrs**

Introduction to Organic Farming: Organic farming, concept and development of organic farming. Principles of organic farming & need for organic farming, Agencies and institutions related to organic agriculture. Farm components for an organic farm. Benefits of organic farming.Conventional farming v/s organic farming. Scope and present state of organic farming; its relevance to India and global agriculture and future prospects.

Unit II **13 hrs**

Organic Plant Nutrient Management: Organic farming systems: Soil tillage, Choice of Varieties, crop rotation, multiple cropping systems, intercropping. Propagation: planting materials and seed treatments. Water management, Organic manures: Green manuring, Composting: Composting methods, Vermicomposting, Organic amendments and sludges, biogas. Bio-fertilizers-: methods of application and advantages.

Unit III **14 hrs**

Organic Plant Protection: Plant protection: cultural, mechanical methods. Biological methods: botanical pesticides, biopesticide, biocontrol agents. Weed management. National and international Standards for organic inputs- plant protection; Integrated pest management. Organic crop production methods: arecanut, okra. Livestock component and management in organic farming.

Unit IV **12 hrs**

Organic Certification: Farm economy; Basic concept of economics- Demand, supply, Economic Viability of a farm. Basic production principles, Reducing expenses, ways to increase returns. Cost of production system. Marketing, Imports and exports. Policies and incentives of organic production, Farm inspection and certification: Income generation activities: Apiculture, Mushroom production, Terrace farming.

Reference Books:

1. Palaniappan, S.P and Anandurai, K. (1999). Organic Farming – Theory and Practice. Scientific Publ. Rao,
2. B.V.V. (1995). Small Farmer Focused Integrated Rural Development: Socio-economic Environment and Legal Perspective: Publ.3, Parisaraprajna Parishtana, Bangalore.
3. Reddy M.V.. (1995). Soil Organisms and Litter Decomposition in the Tropics. Oxford & IBH.
4. Sharma, A. (2002). Hand Book of Organic Farming. Agrobios.
5. Singh, S. P. (1994). Technology for Production of Natural Enemies. PDBC, Bangalore.
6. Subba Rao, N.S. (2002). Soil Microbiology. Oxford & IBH.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0304	**SKILL ENHANCEMENT COURSE**	HC	2	0	0	2	2

Note: The students will have to undergo domain specific Skill Development course conducted by either external agency or Department of Biotechnology

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21PTM301	**SOFT SKILLS (COMMON)**	Mandatory	0	0	0	0	3

Note: The students will have to undergo Skill Development course being conducted by Training and Placement cell of the University.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0305	**PLANT, AGRICULTURAL BIOTECHNOLOGY &GENETIC ENGINEERING LABORATORY (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Pre reading for the course:

Fundamentals involved in molecular biology, biochemical techniques, plant morphology, anatomy and microbiology is a prerequisite for this course.

Course Objectives:

The overall objectives of the course are:

1. Develop the capabilities of knowledge ability, comprehension and applications of plants in cell and tissue culture systems.
2. Acquire practical skills and confidence to carry out research in the domains of plant and agricultural biotechnology.
3. Get exposure of various genetic manipulation techniques having industrial implications.
4. Exploit the knowledge of gene manipulations in related areas of research

Course Outcomes

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

1. Formulate & prepare plant tissue culture media based on the type of micropropagation.
2. Standardize the protocol for the micro propagation of specific plant species and recalcitrant species.
3. Develop system for the large scale production of mushroom.
4. Perform various molecular biology techniques such as cloning, PCR and apply it in optimized way in research as well as in industry.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0305	CO1	2	3	2	3	3			2	2			3	2
	CO2	2	3	3	3	3	3				1		2	3
	CO3	3	3	3	3	3							2	3
	CO4	3	3	3	3			2	2	1			3	3

Course Content:

1. Preparation of plant tissue culture media (MS and Nitsch Media)
2. Shoot tip, anther and single node culture
3. Study of VAM and isolation of VAM spores.
4. Study of biocontrol agents (*Trichoderma harzianum, Trichoderma viridae* and *Aspergillus awamori)* using dual culture method.
5. Anther culture for the production of haploid plants.
6. Mushroom cultivation using paddy straw mushroom.
7. DNA finger printing analysis.
8. Electrophoresis digested DNA and determination of its molecular weight of DNA fragment
9.Ligation of DNA and analysis by electrophoresis
10.Determination of molecular weight of proteins by SDS PAGE and analysis by western blotting
11. GFP Cloning
12.DNA amplification by PCR

Reference Books:

1. Aneja K R. (2011). Experiments in Microbiology, Plant Pathology and Biotechnology. New Age International Publishers.
2. Christou P and Klee H. (2004). Handbook of Plant Biotechnology. John Wiley and Sons.
3. Dixon RA. (2003). Plant Cell Culture. IRL Press.
4. George EF, Hall MA and De Klerk GJ. (2008). Plant Propagation by Tissue Culture. Agritech Publ.

5. Ausubel F.M., Brent R., Kingston R.E., Moore D.D. et al (1999). Short protocols in molecular biology (4th Ed), Wiley publishers. India. 1999.

6. Sambrook J et al (2001). Molecular cloning Volumes I, II and III. Cold Spring Harbor laboratory Press, New York, USA
7. Keith Wilson and John Walker (2000), Practical Biochemistry- 5th edition, Cambridge University Press, UK

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0306	**ENVIRONMENTAL BIOTECHNOLOGY LABORATORY (PRACTICAL)**	HC	0	0	2	2	4

Prerequisites/Prereading for the course

Students should be familiar with the concepts of microbiology and analytical techniques.

Awareness about the risk involved hazards and safety requirement in the laboratory.

Course Objectives:

The overall objectives of the course are:

1. Impart knowledge on the role of pollutants and their effects on health.
2. Learn techniques of controlling the environmental pollution.
3. Facilitate the understanding of the impact of industrial effluents on environment.
4. Understand the role of microorganisms in bioremediation process.

Course Outcomes:

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

1. Analyze the detrimental effects of different pollutants in the environment.
2. Develop remedies to control pollution.
3. Categorize the chemicals depending on their hazardous effect.
4. Establish and practice Vermicomposting.

Mapping of Course Outcomes with programme Outcomes

Course Code	POS / COS	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PS01	PS02	PS03
M21SL0306	CO1	2	2	2	1	2	1	2	2	3	3	2	0	1
	CO2	1	2	2	2	2	0	2	3	3	3	3	1	2
	CO3	1	2	1	0	1	0	1	1	0	1	1	0	0
	CO4	1	0	0	0	2	0	1	1	1	1	1	0	1

Course Content:

1.Determination of Total dissolved solids
2.Determination of DO and BOD of water sample
3.Determination of COD of water sample
4. Microbial analysis of water by MPN method

5.Estimation of Chromium in Industrial effluent by colorimetric method
6. Estimation of Calcium in water sample by titration method
7. Isolation of bacteriophages from sewage
8. Vermicomposting

Reference Books:

1. A.H. Patel (2011) "Industrial Microbiology" Macmillan
2. Presscott, S.C. and Cecil G. Dunn (2005), "Industrial Microbiology", Agrobios (India),
3.Cruger,Wulf and Anneliese Crueger (2000), "Biotechnology: A Textbook of Industrial Microbiology", 2nd Edition, Panima Publishing.
4. Moo-Young, Murrey (2004), "Comprehensive Biotechnology", 4 Vols. Pergamon Press, (An Imprint of Elsevier)
5. Wang L.K., Ivanov V., Tay J.H., HungY.T (2010) Handbook of Environmental Engineering 1st edition, Springer Publishers
6. Gareth G. Evans, Judy Furlong (2010) Environmental Biotechnology: Theory and Application 2nd edition, Wiley publishers.
7. Fulekar M.H (2010) Environmental Biotechnology, Taylor and Francis group

FOURTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SL0401	**MAJOR PROJECT AND DISSERTATION**	HC	0	0	8	8	8

Course outcomes

1. Apply fundamental and disciplinary concepts and methods in ways appropriate to their principal areas of study.
2. Demonstrate the skill sets acquired and employ the knowledge of current information in the domain.
3. Apply technological tools and techniques specific to the professional field of study.
4. Acquire real time exposure to the systematic execution of research components and methodology.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	3	3	3							3	2	2
CO2	2	2	3	3	3	3					2	3	2
CO3	2	2	3	3	3	3		3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3	3	3	3

Project:

Each student or a group of maximum of 3 students will choose the topic of research preferably 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 based project or R & D project the student may opt co-supervisor from the concerned industry / research institution as the case may be. 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 5th week and 10th week of the beginning of the semester and final draft report with findings by 14th week. After the completion of the project the student shall submit project report in the form of dissertation on a specified date by the School.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SLON01	**MOOC / SWAYAM 1**	-	-	-	-	2	-

Course outcomes

1. Enhance the conceptual knowledge and ensure academic achievement in the subject domain offered through the e learning.
2. Gain additional expertise gained in the process of e-learning.
3. Acquire intellectual skills such as domain-specific and generic abilities involved in reasoning, comprehension and thinking abilities.
4. Inculcate the problem-solving, and decision-making skills related to the subject domain.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3			3					1	3	3
CO2	3	2	3								1	3	3
CO3	3	3	3							3	1	2	3
CO4	3	3	3							3	1	2	3

MOOC / SWAYAM Online Courses: Globally, MOOC (Massive Open Online Course) 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 basically an 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.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
M21SLON02	**MOOC / SWAYAM 2**	-	-	-	-	2	-

Course outcomes

1. Enhance the conceptual knowledge and ensure academic achievement in the subject domain offered through the e learning.
2. Gain additional expertise gained in the process of e-learning.
3. Acquire intellectual skills such as domain-specific and generic abilities involved in reasoning, comprehension and thinking abilities.
4. Inculcate the problem-solving, and decision-making skills related to the subject domain.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	2	2	3			3					1	2	3
CO2	3	2	3								1	2	3
CO3	3	3	3							3	1	2	3
CO4	3	3	3							3	1		3

MOOC / SWAYAM Online Courses: Globally, MOOC (Massive Open Online Course) 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 basically an 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.

Students are required to complete courses like technical skills, placement related courses, Open electives and any such value addition or specialized courses through online platforms like SWAYAM/NPTEL/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

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 Centre (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 candidates for 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 Biotechnology is not only knowledge in the subject, but also the skills 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 centre 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 / certification based 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 VikasYojana.

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.