THE ASSAM
ROYAL GLOBAL UNIVERSITY
GUWAHATI

ROYAL SCHOOL OF BIO-SCIENCES

(RSBSC)

DEPARTMENT OF BIOTECHNOLOGY

COURSE STRUCTURE AND SYLLABUS

FOR

B.SC. IN BIOTECHNOLOGY

(4 YEARS SINGLE MAJOR)

W.E.F.

AY-2023-24

(BASED ON NATIONAL EDUCATION POLICY 2020)

Preamble

The National Education Policy (NEP) 2020 conceives a new vision for India's higher education system. It recognizes that higher education plays an extremely important role in promoting equity, human as well as societal well-being and in developing India as envisioned in its Constitution. It is desired that higher education will significantly contribute towards sustainable livelihoods and economic development of the nation as India moves towards becoming a knowledge economy and society.

If we focus on the 21st century requirements, the higher education framework of the nation must aim to develop good, thoughtful, well-rounded, and creative individuals and must enable an individual to study one or more specialized areas of interest at a deep level, and also develop character, ethical and Constitutional values, intellectual curiosity, scientific temper, creativity, spirit of service, and twenty-first-century capabilities across a range of disciplines including sciences, social sciences, arts, humanities, languages, as well as professional, technical, and vocational subjects. A quality higher education should be capable enough to enable personal accomplishment and enlightenment, constructive public engagement, and productive contribution to the society. Overall, it should focus on preparing students for more meaningful and satisfying lives and work roles and enable economic independence.

Towards the attainment of holistic and multidisciplinary education, the flexible curricula of the University will include credit-based courses, projects in the areas of community engagement and service, environmental education, and value-based education. As part of holistic education, students will also be provided with opportunities for internships with local industries, businesses, artists, crafts persons, and so on, as well as research internships with faculty and researchers at the University, so that students may actively engage with the practical aspects of their learning and thereby improve their employability.

The undergraduate curriculums are diverse and have varied subjects to be covered to meet the needs of the programs. As per the recommendations from the UGC, introduction of courses related to Indian Knowledge System (IKS) is being incorporated in the curriculum structure which encompasses all of the systematized disciplines of Knowledge which were developed to a high degree of sophistication in India from ancient times and all of the traditions and practices that the

various communities of India-including the tribal communities—have evolved, refined and preserved over generations, like for example Vedic Mathematics, Vedangas, Indian Astronomy, Fine Arts, Metallurgy, *etc*.

At RGU, we are committed that at the societal level, higher education will enable each student to develop themselves to be an enlightened, socially conscious, knowledgeable, and skilled citizen who can find and implement robust solutions to its own problems. For the students at the University, Higher education is expected to form the basis for knowledge creation and innovation thereby contributing to a more vibrant, socially engaged, cooperative community leading towards a happier, cohesive, cultured, productive, innovative, progressive, and prosperous nation."

Abbreviations

1.	**Cr.**	**Credit**
2.	Major	Core Courses of a Discipline
3.	Minor	May/may not be related to Major.
4.	SEC	Skill Enhancement Course
5.	VAC	Value Addition Course
6.	AECC	Ability Enhancement Compulsory Course
7.	GEC	Generic Elective Course
8.	IKS	Indian Knowledge System
9.	AICTE	All India Institute of Technical Education
10.	CBCS	Choice Based Credit System
11.	HEIs	Higher Education Institutes
12.	MSDE	Ministry of Skill Development and Entrepreneurship
13.	NAC	National Apprenticeship Certificate
14.	NCrF	National Credit Framework
15.	NCVET	National Council for Vocational Education and Training
16.	NEP	National Education Policy
17.	NHEQF	National Higher Education Qualification Framework
18.	NSQF	National Skill Qualifications Framework
19.	NTA	National Testing Agency
20.	SDG	Sustainable Development Goals
21.	UGC	University Grants Commission
22.	VET	Vocational Education and Training
23.	ME- ME	Multiple Entry Multiple Exit
24.	OJT	On Job Training
25.	NCH	Notional Credit Hours

Section 1:
Overview

1. 1. Introduction:

The National Education Policy (NEP) 2020 clearly indicates that higher education plays an extremely important role in promoting human as well as societal well-being in India. As envisioned in the 21st-century requirements, quality higher education must aim to develop good, thoughtful, well-rounded, and creative individuals. According to the new education policy, assessments of educational approaches in undergraduate education will integrate the humanities and arts with Science, Technology, Engineering and Mathematics (STEM) that will lead to positive learning outcomes. This will lead to develop creativity and innovation, critical thinking and higher-order thinking capacities, problem-solving abilities, teamwork, communication skills, more in-depth learning, and mastery of curricula across fields, increases in social and moral awareness, etc., besides general engagement and enjoyment of learning. and more in-depth learning.

The NEP highlights that the following fundamental principles that have a direct bearing on the curricula would guide the education system at large, viz.

i. Recognizing, identifying, and fostering the unique capabilities of each student to promote her/his holistic development.
ii. Flexibility, so that learners can select their learning trajectories and programmes, and thereby choose their own paths in life according to their talents and interests.
iii. Multidisciplinary and holistic education across the sciences, social sciences, arts, humanities, and sports for a multidisciplinary world.
iv. Emphasis on conceptual understanding rather than rote learning, critical thinking to encourage logical decision-making and innovation; ethics and human & constitutional values, and life skills such as communication, teamwork, leadership, and resilience.
v. Extensive use of technology in teaching and learning, removing language barriers, increasing access for Divyang students, and educational planning and management.
vi. Respect for diversity and respect for the local context in all curricula, pedagogy, and policy.
vii. Equity and inclusion as the cornerstone of all educational decisions to ensure that all students can thrive in the education system and the institutional environment are responsive to differences to ensure that high-quality education is available for all.
viii. Rootedness and pride in India, and its rich, diverse, ancient, and modern culture, languages, knowledge systems, and traditions.

1.2. Credits in Indian Context:

1.2.1. Choice Based Credit System (CBCS) By UGC

Under the CBCS system, the requirement for awarding a degree or diploma or certificate is prescribed in terms of number of credits to be earned by the students. This framework is being implemented in several universities across States in India.

The main highlights of CBCS are as below:

- The CBCS provides flexibility in designing curriculum and assigning credits based on the course content and learning hours.
- The CBCS provides for a system wherein students can take courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, and adopt an interdisciplinary approach to learning.
- CBCS also provides opportunity for vertical mobility to students from a bachelor's degree programme to masters and research degree programmes.
- The detailed Guidelines for Choice Based Credit System is available at https://ugc.ac.in/pdfnews/8023719_Guidelines-for-CBCS.pdf

1.3. Definitions

1.3.1. Academic Credit:

An academic credit is a unit by which a course is weighted. It is fixed by the number of hours of instructions offered per week. As per the National Credit Framework [2];

1 Credit = 30 NOTIONAL CREDIT HOURS (NCH)

Yearly Learning Hours = 1200 Notional Hours (@40 Credits x 30 NCH)

30 Notional Credit Hours		
Lecture/Tutorial	**Practicum**	**Experiential Learning**
1 Credit = 15 -22 Lecture Hours	10-15 Practicum Hours	0-8 Experiential Learning Hours

Note: *The Department may consider any such combination by due approval from the Dean of Academics and The Vice -Chancellor before placing to the Board of Studies (BoS) & Academic Council.*

Some Theory based papers should have 22/23 physical classes to adhere to 30 NCH. The division of credits should depend upon the Course of Study, level of the students admitted (slow/fast learners).

1.3.2. Course of Study:

Course of study indicate pursuance of study in a particular discipline/programme. Discipline/Programmes shall offer Major Courses (Core), Minor Courses, Skill Enhancement Courses (SEC), Value Added Courses (VAC), Ability Enhancement Compulsory Courses (AECCs) and Interdisciplinary courses.

1.3.3. Disciplinary Major:

The major would provide the opportunity for a student to pursue in-depth study of a particular subject or discipline. Students may be allowed to change major within the broad discipline at the end of the second semester by giving her/him sufficient time to explore interdisciplinary courses during the first year. Advanced-level disciplinary/interdisciplinary courses, a course in research methodology, and a project/dissertation will be conducted in the seventh semester. The final semester will be devoted to seminar presentation, preparation, and submission of project report/dissertation. The project work/dissertation will be on a topic in the disciplinary programme of study or an interdisciplinary topic.

1.3.4. Disciplinary/interdisciplinary minors:

Students will have the option to choose courses from disciplinary/interdisciplinary minors and skill-based courses. Students who take a sufficient number of courses in a discipline or an interdisciplinary area of study other than the chosen major will qualify for a minor in that discipline or in the chosen interdisciplinary area of study. A student may declare the choice of the minor at the end of the second semester, after exploring various courses.

1.3.5. Courses from Other Disciplines (Interdisciplinary):

All UG students are required to undergo 3 introductory-level courses relating to any of the broad disciplines given below. These courses are intended to broaden the intellectual experience and form part of liberal arts and science education. Students are not allowed to choose or repeat courses already undergone at the higher secondary level (12^{th} class) in the proposed major and minor stream under this category.

i. Natural and Physical Sciences: Students can choose basic courses from disciplines such as Natural Science, for example, Biology, Botany, Zoology, Biotechnology, Biochemistry, Chemistry, Physics, Biophysics, Astronomy and Astrophysics, Earth and Environmental Sciences, etc.

ii. Mathematics, Statistics, and Computer Applications: Courses under this category will facilitate the students to use and apply tools and techniques in their major and minor disciplines. The course may include training in programming software like Python among others and applications software like STATA, SPSS, Tally, etc. Basic courses under this category will be helpful for science and social science in data analysis and the application of quantitative tools.

iii. Library, Information, and Media Sciences: Courses from this category will help the students to understand the recent developments in information and media science (journalism, mass media, and communication)

iv. Commerce and Management: Courses include business management, accountancy, finance, financial institutions, fintech, etc.,

v. Humanities and Social Sciences: The courses relating to Social Sciences, for example, Anthropology, Communication and Media, Economics, History, Linguistics, Political Science, Psychology, Social Work, Sociology, etc. will enable students to understand the individuals and their social behaviour, society, and nation. Students be introduced to survey methodology and available large-scale databases for India. The courses under humanities include, for example, Archaeology, History, Comparative Literature, Arts & Creative expressions, Creative Writing and Literature, language(s), Philosophy, etc., and interdisciplinary courses relating to humanities. The list of Courses can include interdisciplinary subjects such as Cognitive Science, Environmental Science, Gender Studies, Global Environment & Health, International Relations, Political

Economy and Development, Sustainable Development, Women's, and Gender Studies, *etc*. will be useful to understand society.

1.3.6. Ability Enhancement Courses (AEC): Modern Indian Language (MIL) & English language focused on language and communication skills. Students are required to achieve competency in a Modern Indian Language (MIL) and in the English language with special emphasis on language and communication skills. The courses aim at enabling the students to acquire and demonstrate the core linguistic skills, including critical reading and expository and academic writing skills, that help students articulate their arguments and present their thinking clearly and coherently and recognize the importance of language as a mediator of knowledge and identity. They would also enable students to acquaint themselves with the cultural and intellectual heritage of the chosen MIL and English language, as well as to provide a reflective understanding of the structure and complexity of the language/literature related to both the MIL and English language. The courses will also emphasize the development and enhancement of skills such as communication, and the ability to participate/conduct discussion and debate.

1.3.7. Skill Enhancement Course (SEC): These courses are aimed at imparting practical skills, hands-on training, soft skills, etc., to enhance the employability of students and should be related to Major Discipline. They will aim at providing handson training, competencies, proficiency, and skill to students. SEC course will be a basket course to provide skill-based instruction. For example, SEC of English Discipline may include Public Speaking, Translation & Editing and Content writing. A student shall have the choice to choose from a list, a defined track of courses offered from 1st to 3rd semester.

1.3.8. Value-Added Courses (VAC):

i. **Understanding India:** The course aims at enabling the students to acquire and demonstrate the knowledge and understanding of contemporary India with its historical perspective, the basic framework of the goals and policies of national development, and the constitutional obligations with special emphasis on constitutional values and fundamental rights and duties. The course would also focus on developing an understanding among student-teachers of the Indian knowledge systems, the Indian education system, and the roles and obligations of teachers to the nation in general and to the school/community/society. The course will attempt to deepen knowledge about and understanding of India's freedom struggle and of the

values and ideals that it represented to develop an appreciation of the contributions made by people of all sections and regions of the country, and help learners understand and cherish the values enshrined in the Indian Constitution and to prepare them for their roles and responsibilities as effective citizens of a democratic society.

ii. **Environmental science/education**: The course seeks to equip students with the ability to apply the acquired knowledge, skills, attitudes, and values required to take appropriate actions for mitigating the effects of environmental degradation, climate change, and pollution, effective waste management, conservation of biological diversity, management of biological resources, forest and wildlife conservation, and sustainable development and living. The course will also deepen the knowledge and understanding of India's environment in its totality, its interactive processes, and its effects on the future quality of people's lives.

iii. **Digital and technological solutions:** Courses in cutting-edge areas that are fast gaining prominences, such as Artificial Intelligence (AI), 3-D machining, big data analysis, machine learning, drone technologies, and Deep learning with important applications to health, environment, and sustainable living that will be woven into undergraduate education for enhancing the employability of the youth.

iv. **Health & Wellness, Yoga education, sports, and fitness:** Course components relating to health and wellness seek to promote an optimal state of physical, emotional, intellectual, social, spiritual, and environmental well-being of a person. Sports and fitness activities will be organized outside the regular institutional working hours. Yoga education would focus on preparing the students physically and mentally for the integration of their physical, mental, and spiritual faculties, and equipping them with basic knowledge about one's personality, maintaining self-discipline and self-control, to learn to handle oneself well in all life situations. The focus of sports and fitness components of the courses will be on the improvement of physical fitness including the improvement of various components of physical and skills-related fitness like strength, speed, coordination, endurance, and flexibility; acquisition of sports skills including motor skills as well as basic movement skills relevant to a particular sport; improvement of tactical abilities; and improvement of mental abilities.

These are a common pool of courses offered by different disciplines and aimed towards embedding ethical, cultural and constitutional values; promote critical thinking. Indian knowledge systems; scientific temperament of students.

1.3.9. Summer Internship /Apprenticeship:

The intention is induction into actual work situations. All students must undergo internships / Apprenticeships in a firm, industry, or organization or Training in labs with faculty and researchers in their own or other HEIs/research institutions during the summer term. Students should take up opportunities for internships with local industry, business organizations, health and allied areas, local governments (such as panchayats, municipalities), Parliament or elected representatives, media organizations, artists, crafts persons, and a wide variety of organizations so that students may actively engage with the practical side of their learning and, as a by-product, further improve their employability. Students who wish to exit after the first two semesters will undergo a 4-credit work-based learning/internship during the summer term to get a UG Certificate.

1.3.9.1. Community engagement and service:

The curricular component of 'community engagement and service' seeks to expose students to the socioeconomic issues in society so that the theoretical learnings can be supplemented by actual life experiences to generate solutions to real-life problems. This can be part of summer term activity or part of a major or minor course depending upon the major discipline.

1.3.9.2. Field-based learning/minor project:

The field-based learning/minor project will attempt to provide opportunities for students to understand the different socio-economic contexts. It will aim at giving students exposure to development-related issues in rural and urban settings. It will provide opportunities for students to observe situations in rural and urban contexts, and to observe and study actual field situations regarding issues related to socioeconomic development. Students will be given opportunities to gain a first hand understanding of the policies, regulations, organizational structures, processes, and programmes that guide the development process. They would have the opportunity to gain an understanding of the complex socio-economic problems in the community, and innovative practices required to generate solutions to the identified problems. This may be a summer term project or part of a major or minor course depending on the subject of study.

1.3.10. Indian Knowledge System:

In view of the importance accorded in the NEP 2020 to rooting our curricula and pedagogy in the Indian context all the students who are enrolled in the four-year UG programmes should be encouraged to take an adequate number of courses in IKS so that the total credits of the courses taken in IKS amount to at least five per cent of the total mandated credits (*i.e.* min. 8 credits for a 4 yr. UGP & 6 credits for a 3 yr. UGP).The students may be encouraged to take these courses, preferably during the first four semesters of the UG programme. At least half of these mandated credits should be in courses in disciplines which are part of IKS and are related to the major field of specialization that the student is pursuing in the UG programme. They will be included as a part of the total mandated credits that the student is expected to take in the major field of specialization. The rest of the mandated credits in IKS can be included as a part of the mandated Multidisciplinary courses that are to be taken by every student. All the students should take a Foundational Course in Indian Knowledge System, which is designed to present an overall introduction to all the streams of IKS relevant to the UG programme. The foundational IKS course should be broad-based and cover introductory material on all aspects. Wherever possible, the students may be encouraged to choose a suitable topic related to IKS for their project work in the 7/8th semesters of the UG programme.

1.3.11. Experiential Learning:

One of the most unique, practical & beneficial features of the National Credit Framework is assignment of credits/credit points/ weightage to the experiential learning including relevant experience and professional levels acquired/ proficiency/ professional levels of a learner/student. Experiential learning is of two types:

a. Experiential learning as part of the curricular structure of academic or vocational program. E.g., projects/OJT/internship/industrial attachments etc. This could be either within the Program- internship/ summer project undertaken relevant to the program being studied or as a part time employment (not relevant to the program being studied- up to certain NSQF level only). In case where experiential learning is a part of the curricular structure the credits would be calculated and assigned as per basic principles of NCrF i.e., 40 credits for 1200 hours of notional learning.
b. Experiential learning as active employment (both wage and self) post completion of an academic or vocational program. This means that the experience attained by a person after undergoing a particular educational program shall be considered for assignment of credits.

This could be either Full or Part time employment after undertaking an academic/ Vocation program.

In case where experiential learning is as a part of employment the learner would earn credits as weightage. The maximum credit points earned in this case shall be double of the credit points earned with respect to the qualification/ course completed. The credit earned and assigned by virtue of relevant experience would enable learners to progress in their career through the work hours put in during a job/employment.

Section 2

Award of Degree

The structure and duration of undergraduate programmes of study offered by the University as per NEP 2020 include:

2.1. Undergraduate programmes of either 3 or 4-year duration with Single Major, with multiple entry and exit options, with appropriate certifications:

2.1.1. UG Certificate: Students who opt to exit after completion of the first year and have secured 40 credits will be awarded a UG certificate if, in addition, they complete one vocational course of 4 credits during the summer vacation of the first year. These students are allowed to re-enter the degree programme within three years and complete the degree programme within the stipulated maximum period of seven years.

2.1.2. UG Diploma: Students who opt to exit after completion of the second year and have secured 80 credits will be awarded the UG diploma if, in addition, they complete one vocational course of 4 credits during the summer vacation of the second year. These students are allowed to re-enter within a period of three years and complete the degree programme within the maximum period of seven years.

2.1.3. 3-year UG Degree: Students who will undergo a 3-year UG programme will be awarded UG Degree in the Major discipline after successful completion of three years, securing 120 credits and satisfying the minimum credit requirement.

2.1.4. 4-year UG Degree (Honours): A four-year UG Honours degree in the major discipline will be awarded to those who complete a four-year degree programme with 160 credits and have satisfied the credit requirements.

2.1.5. 4-year UG Degree (Honours with Research): Students who secure 75% marks and above in the first six semesters and wish to undertake research at the undergraduate level can choose a research stream in the fourth year. They should do a research project or dissertation under the guidance of a Faculty Member of the University. The research project/dissertation will be in the major discipline. The students who secure 160 credits, including 12 credits from a research

project/dissertation, will be awarded UG Degree (Honours with Research) (Note: UG Degree Programmes with Single Major: A student must secure a minimum of 50% credits from the major discipline for the 3-year/4-year UG degree to be awarded a single major. For example, in a 3-year UG programme, if the total number of credits to be earned is 120, a student of Mathematics with a minimum of 60 credits will be awarded a B.Sc. in Mathematics with a single major. Similarly, in a 4-year UG programme, if the total number of credits to be earned is 160, a student of Chemistry with a minimum of 80 credits will be awarded a B.Sc. (Hons./Hon. With Research) in Chemistry in a 4-year UG programme with single major. Also the 4-year Bachelor's degree programme with Single Major is considered as the preferred option since it would allow the opportunity to experience the full range of holistic and multidisciplinary education in addition to a focus on the chosen major and minors as per the choices of the student.)

2.2. The Post Graduate Programme structure and duration of study offered by the University will include:

2.2.1. 2-year PG programme (with the option of having the second year devoted entirely to research) for those who have completed a 3-year Bachelor's programme.

2.2.2. 1-year PG programme for students who have completed a 4-year Bachelor's degree; and

2.2.3. Integrated 5-year Bachelor's/Master's programme.

2.2.3. 2-year PG programme (with the option of having the second year devoted entirely to research) for those who have completed a 4-year Bachelor's programme may also opt for a 2 years PG.

2.3. The Ph.D. programme shall require a PG degree or a 4-year Bachelor's degree.

Table: 1: Award of Degree and Credit Structure with ME-ME

Award	**Year**	**Credits to earn**	**Additional Credits**	**Re-entry allowed within (yrs)**	**Years to Complete**
UG Certificate	1	40	4	3	7
UG Diploma	2	80	4	3	7
3-year UG Degree (Major)	3	120	X	X	X
4-year UG Degree (Honours)	4	160	X	X	X
4-year UG Degree (Honors with Research):	4	160	Students who secure cumulative 75% marks and above in the first six semesters		

1. Aim of the Bachelors Degree Programme in Biotechnology:

The aim of the undergraduate degree in Biotechnology is to make the students gather knowledge and understand the various basic concepts in Biotechnology. The students are required to improve upon their skills in handling laboratory instruments and learn about the principles and mechanism of working of the instruments. The understanding, knowledge and skills in Biotechnology need to be developed through a well-developed teaching learning processes in the class. Practical skills will be obtained through laboratory work and presentation and articulation skills through various seminars and internship exposure. The students will also be mentored and guided through research projects in their final year of study.

2. Career Opportunities:

Various scopes of career opportunities awaits graduates in Bio-Technology. Some such are as follows.

- Microbiologists
- QC Manager
- Pharmaceutical Industries
- Research and Development
- Academics
- Government Jobs

Students can also pursue higher studies such as M. Sc. /Ph. D programme in Biotechnology or other areas of biological sciences.

3. Graduate Attributes & Learning Outcomes

As per the NHEQF, each student on completion of a programme of study must possess and demonstrate the expected Graduate Attributes acquired through one or more modes of learning, including direct in-person or face-to-face instruction, online learning, and hybrid/blended modes. The graduate attributes indicate the quality and features or characteristics of the graduate of a programme of study, including learning outcomes relating to the disciplinary area(s) relating to the chosen field(s) of learning and generic learning outcomes that are expected to be acquired by a graduate on completion of the programme(s) of study.

The graduate profile/attributes must include,

- capabilities that help widen the current knowledge base and skills,
- gain and apply new knowledge and skills,
- undertake future studies independently, perform well in a chosen career, and
- play a constructive role as a responsible citizen in society.

The graduate profile/attributes are acquired incrementally through development of cognitive levels and describe a set of competencies that are transferable beyond the study of a particular subject/disciplinary area and programme contexts in which they have been developed.

Graduate attributes include,

- learning outcomes that are specific to disciplinary areas relating to the
- chosen field(s) of learning within broad multidisciplinary/interdisciplinary/
- transdisciplinary contexts.
- generic learning outcomes that graduate of all programmes of study should
- acquire and demonstrate.

3.2. Graduate Attributes:

Table: 2: The Learning Outcomes Descriptors and Graduate Attributes

Sl. no.	**Graduate Attribute**	**The Learning Outcomes Descriptors (The graduates should be able to demonstrate the capability to:)**
GA 1	Disciplinary Knowledge	acquire knowledge and coherent understanding of the chosen disciplinary/interdisciplinary areas of study.
GA 2	Complex problem solving	solve different kinds of problems in familiar and non-familiar contexts and apply the learning to real-life situations
GA 3	Analytical & Critical thinking	apply analytical thought including the analysis and evaluation of policies, and practices. Able to identify relevant assumptions or implications. Identify logical flaws and holes in the arguments of others. Analyse and synthesize data from a variety of sources and draw valid

		conclusions and support them with evidence and examples.
GA 4	Creativity	create, perform, or think in different and diverse ways about the same objects or scenarios and deal with problems and situations that do not have simple solutions. Think 'out of the box' and generate solutions to complex problems in unfamiliar contexts by adopting innovative, imaginative, lateral thinking, interpersonal skills, and emotional intelligence.
GA 5	Communication Skills	listen carefully, read texts and research papers analytically, and present complex information in a clear and concise manner to different groups/audiences. Express thoughts and ideas effectively in writing and orally and communicate with others using appropriate media
GA 6	Research-related skills	develop a keen sense of observation, inquiry, and capability for asking relevant/ appropriate questions. Should acquire the ability to problematize, synthesize and articulate issues and design research proposals, define problems, formulate appropriate and relevant research questions, formulate hypotheses, test hypotheses using quantitative and qualitative data, establish hypotheses, make inferences based on the analysis and interpretation of data, and predict cause-and-effect relationships. Should develop the ability to acquire the understanding of basic research ethics and skills in practicing/doing ethics in the field/ in personal research work.
GA 7	Collaboration	work effectively and respectfully with diverse teams in the interests of a common cause and work efficiently as a member of a team.

GA 8	Leadership readiness/qualities	plan the tasks of a team or an organization and setting direction by formulating an inspiring vision and building a team that can help achieve the vision.
GA 9	Digital and technological skills	use ICT in a variety of learning and work situations. Access, evaluate, and use a variety of relevant information sources and use appropriate software for analysis of data
GA 10	Environmental awareness and action	mitigate the effects of environmental degradation, climate change, and pollution. Should develop the technique of effective waste management, conservation of biological diversity, management of biological resources and biodiversity, forest and wildlife conservation, and sustainable development and living.

3.3. Programme Learning Outcomes (PLO)

The outcomes described through learning outcome descriptors are attained by students through learning acquired on the completion of a programme of study relating to the chosen fields of learning, work/vocation, or an area of professional practice. The term 'programme' refers to the entire scheme of study followed by learners leading to a qualification. Individual programmes of study will have defined learning outcomes that must be attained for the award of a specific certificate/diploma/degree.

The Departments and Schools of the University are responsible for ensuring that individual programme learning outcomes align with the relevant graduate attributes. Programme learning outcomes (PLOs) include outcomes that are specific to disciplinary areas of learning associated with the chosen field (s) of learning. The programme learning outcomes would also focus on knowledge and skills that prepare students for further study, employment, and responsible citizenship.

The programme learning outcomes related to the BSc degree in Biotechnology includes the following competencies to be acquired by the students during the course of their studies.

- Understand the fundamental concepts in biology and technological applications related to biology and have the ability to analyse and evaluate the situation in solving practical problems.
- Develop the ability to communicate with peers and understand the delivery of the lectures given.
- Ability to think and apply the knowledge of scientific texts, reports and updates
- Ability to solve the problems with a logical mind and also provide solutions to emerging problems.
- Understand the relate the scientific texts to reason the argument and observe the strength and weakness of scientific texts/ articles *etc*.
- Ability to identify and consult relevant sources to find answers related to formulation of hypothesis and other research questions.
- Ability to participate constructively in class room discussions, work in combination and be able to meet deadlines.
- Ability to analyze texts, evaluate ideas and strategies for scientific research and formulate logical and convincing arguments
- Ability to use various digital platforms/sources and apply the same to convey and explain the core concepts of the discipline.
- Ability to interrogate one's own ethical values, and be aware of ethical and environmental issues.
- Ability to lead group discussions, to formulate questions related to scientific and socialissues.
- Ability to retain and build on critical thinking skills, and use them to update scientific knowledge and apply them in day to day business.

3.4. Course Learning Outcomes (CLOs)

The programme learning outcomes are attained by learners through the essential learnings acquired on the completion of selected courses of study within a programme of study. The term 'course' is used to mean the individual courses of study that make up the scheme of study for a programme. The Departments and Schools of the University are expected to map the relevant programme learning outcomes when setting the course learning outcomes for the undergraduate certificate/diploma, Bachelor's degree, Bachelor's degree with honours/ honours with research or master's degree programmes.

Course learning outcomes are specific to the learning for a given course of study related to a disciplinary or interdisciplinary/multi-disciplinary area of learning. Some courses of study are highly structured, with a closely laid down progression of compulsory/core courses to be taken at different phases/stages of learning. Course-level learning outcomes are expected to be aligned with relevant programme learning outcomes and should be designed based on the Cognitive Level based on Bloom's Taxonomy. At the course level, each course may well have links to some but not all graduate attributes as these are developed through the totality of student learning experiences across the period/ semesters of their study.

The course outcomes for each course are mentioned in syllabi of program. Course Learning outcome formed should meet the following guidelines:

- Follows Bloom's taxonomy.
- Reflects the whole syllabus prescribed by university for each course.
- No. of CLOs for each course should be a maximum of six.

4. ProgrammeSpecific Outcome (PSO)

The programme specific outcome for a graduate student in Biotechnology are as follows

PSO1: Enable a student to be a better and effective communicator of the subject by applying the basic principles and skills.

PSO2: Ability to understand the principles of the core subject areas in Biotechnology including identifying crucial biological problems and handle basic, sophisticated and advanced instrumentation required to execute the solutions.

PSO3: To understand the various laws and ethics in Biotechnology.

PSO4: To launch start-ups and become entrepreneurs for novel biotechnology products.

5. Teaching and Learning Process

- Lectures: Regular class lectures shall be accompanied with teaching using ICT tools for interactive learning.
- Tutorial classes: The tutorials are conducted for students who are unable to achieve average grades in their weekly assessments.

- Remedial classes: The remedial classes are conducted for students who achieve average and above average grades in their weekly assessments. The focus is laid to equip the students to perform better in the exams/assessments.
- Dissertation/ Projects: Project based training are implemented to instil skill amongst the students and enhance their ability to apply and analyze the knowledge gained.
- Quizzes: Quizzes shall be periodically organized to test the level of knowledge and learning and remembering ability of the students.
- Seminars/ Presentations: Will be organized to prepare the students for social speaking, making them more vocal and allowing them to understand their course and study accordingly.
- Practicals: Biotechnology being an applied subject, the practical component is incorporated for better skill development and training.
- ICT enabled learning: ICT enabled learning and training are incorporated in the syllabus for holistic development of the students.
- Library resources: To enhance the teaching learning process the library facility is provided with reference books and other subject related texts.
- Blended Learning: Blended learning has been developed as a part of learning through both online and offline mode.

6 Experiential learning:

Experiential learning occurs outside of the classroom, and allows students to expand their knowledge and practice problem solving. Experiential learning is an important part of a student's personal, professional, and educational growth. Experiential learning in Biological Sciences includes undergraduate research experiences, service learning, leadership in student organizations, participation in student design teams, and co-ops and internships. In order to complete the experiential learning requirement in Biotechnology, all students must complete a core required experiential learning requirement and one elective experience.

Experiential learning activities may include:

- undergraduate research
- leadership in a student organization
- participation in a student design team

- completion of an internship
- student teaching *etc.*

7. The Qualification Specifications:

Table: 3: NHEQF Qualification specifications

Qualification type	**Purpose of the qualification**
Undergraduate Certificate	The students will be able to apply technical and theoretical concepts and specialized knowledge and skills in a broad range of contexts to undertake skilled or paraprofessional work and/or to pursue further study/learning at higher levels.
Undergraduate Diploma	The students will be able to apply specialized knowledge in a range of contexts to undertake advanced skilled or paraprofessional work and/or to pursue further learning/study at higher levels.
Bachelor's degree	The students will be able to apply a broad and coherent body of knowledge and skills in a range of contexts to undertake professional work and/or for further learning.
Bachelor's degree (Honours/ Honours with Research)	The students will be able to apply the knowledge in a specific context to undertake professional work and for research and further learning.
	The students will be able to apply an advanced body of knowledge in a range of contexts to undertake professional work and apply specialized knowledge and skills for research and scholarship, and/or for further learning relating to the chosen field(s) of learning, work/vocation, or professional practice.
Master's degree (1 year/2 semesters of study)	The students will be able to apply an advanced body of knowledge in a range of contexts for professional practice, research, and scholarship and as a pathway for further learning. Graduates at this level are expected to possess and demonstrate specialized knowledge and skills for research, and/or professional practice and/or for further learning.
Master's degree (2 years /4 semesters of study)	The students will be able to apply an advanced body of knowledge in a range of contexts for professional practice, research, and scholarship

	and as a pathway for further learning. Graduates at this level are expected to possess and demonstrate specialized knowledge and skills for research, and/or professional practice and/or for further learning. Master's degree holders are expected to demonstrate the ability to apply the established principles and theories to a body of knowledge or an area of professional practice.
Doctoral degree	The Doctoral degree qualifies students who can ask relevant and new questions and develop appropriate methodologies and tools for collecting information in pursuit of generating new knowledge and new data sets; and apply a substantial body of knowledge to undertake research and investigations to generate new knowledge, in one or more fields of inquiry, scholarship or professional practice. Graduates at this level is expected to have a systematic and critical understanding of a complex field of learning and specialized research skills for the advancement of knowledge and/or professional practice and making a significant and original contribution to the creation of new knowledge relating to a field of learning or in the context of an area of professional practice.

Concluding Note:

The Curriculum Framework 2023-24 gives the multidisciplinary approach while adhering the innovative ways within the curriculum framework to allow the student maximum flexibility in pursuing his/her studies at the undergraduate level and post graduate level. The student will have the extent of liberty to eventually design his/her own path depending upon the needs and aspirations. The University expects maximum involvement of students in utilising the benefits of this curriculum framework which flexible yet rigorous. They can enrich their skills in their area of interest which will eventually benefit them in employment, developing their own ventures and live the life of a global citizen.

Semester wise and component wise distribution of Courses
(Four Year UGP-Single Major)

Year	Semester	Major (Core)		Minor		Interdisciplinary	AEC-(English/MIL/Regional Language)	SEC/Internship/Apprenticeship/Dissertation	VAC	Total credits
		Course Level	No. of Courses	Course Level	No. of Course	No. of Courses	No. of Courses	No. of Courses	No. of Courses	
I	I	100	2	100	1	1	1	1	1	20
	II	100	2	100	1	1	1	1	1	20
	Exit -1: UG Certificate in the relevant discipline/Subject *Total credit requirement : 40 credit (Additional 4 credit of work based vocational course/ internship/ apprenticeship on exit)*									
2	III	200	2	(200 & above)	1	1	1	1	0	20
	IV	200	3	(200 & above)	2	0	1	0	0	20
	Exit -2:UG Diploma in the relevant discipline/subject *Total credit requirement: 80 credit (additional 4 credit of work based vocational course/internship/apprenticeship on exit) To undergo Summer Internship during Summer Break*									
3	V	300	3	(200 & above)	1	0	0	1 (internship)	0	20
	VI	300	4	(200 & above)	1	0	0		0	20
	For students who undertake 3 year UG Programme, UG Degree will be awarded in the relevant subject/discipline *Total credit requirement: 120*									
4	VII	400	4	(300 & above)	1	0	0	0	0	20
	VIII	400	2	(300 & above)	0	0	0	1 (Res. Proj/Dissertation)	0	20
									Total	**160**

Note:

After completion of Internship during Summer Term, students will have to submit a report with a completion certificate and comments from the internship supervisor/coordinator and make a presentation on his/her work relating the work to the overall learning objectives.

Annexure I

DEPARMENT OF BIOTECHNOLOGY

VISION

To produce biologists with strong ethics, integrity, acumen, and preparedness to tackle any emerging problem of global concern by fostering curated opportunities in the course area to push themselves at the global platform.

MISSION

· To impart quality education to students through scientifically designed up-to-date course structure and make them globally competitive.

· To instill confidence in the students for developing analytical skills to find out solutions for current and emerging problems of global concern.

· To provide state of the art academic and laboratory facilities with skilled training and integration of interdisciplinary approach to foster entrepreneurial thinking.

CREDIT DISTRIBUTION

Semester	Course Credits								Total
	Major	Minor	ID	AEC	SEC	VAC	SI	RP	
I	6	3	3	2	3	3	0	0	**20**
II	6	3	3	2	3	3	0	0	**20**
III	8	4	3	2	3	0	0	0	**20**
IV	12	6	0	2	0	0	0	0	**20**
V	12	4	0	0	0	0	4	0	**20**
VI	16	4	0	0	0	0	0	0	**20**
VII	16	4	0	0	0	0	0	0	**20**
VIII	4	4	0	0	0	0	0	12	**20**
	80	**32**	**9**	**8**	**9**	**6**	**4**	**12**	**160**

Assessment and Evaluation:

Scheme of Evaluation

The following suggestive table indicates the distribution of marks for various components in a semester

	Component of Evaluation	Marks	Frequency	Code	Weightage (%)
A	**Continuous Evaluation**				
i	Analysis/Class test	Combination of any three from (i) to (v) with 5 marks each	1-3	C	25%
ii	Home Assignment		1-3	H	
iii	Project		1	P	
iv	Seminar		1-2	S	
v	Viva-Voce/Presentation		1-2	V	
vi	Mid-term examination	MSE shall be of 10 marks	1-3	Q/CT	
vii	Attendance	Attendance shall be of 5 marks	100%	A	5%
B	Semester End Examination		1	SEE	70%
	Project				**100%**

Outline of the syllabus for B.Sc. in Biotechnology (Royal School of Bio-Sciences)

1ST SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BTC152M101	Biochemistry	100	3	2-1-0
	BTC152M112	Practical on Biochemistry	100	3	0-0-6
Minor *	BTC152N101	Biotechnology and Human Welfare	100	3	3-0-0
Interdisciplinary (IDC)	IKS992K101	Indian Knowledge System – I	100	3	3-0-0
Ability Enhancement Course (AEC)	CEN982A101	Communicative English – I	100	1	1-0-0
	BHS982A102	BHS – I	100	1	1-0-0
Skill Enhancement Course (SEC)	BTC152S111	Compost Preparation and Applications	100	3	0-0-6
Value Added Course (VAC) **	VAC992V1---	To be chosen from a pool of courses	100	3	
SWAYAM				3/ 4	
			TOTAL CREDIT FOR 1ST SEMESTER	**20+3/4**	
2ND SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BTC152M201	Microbiology	100	2	2-0-0
	BTC152M211	Practical in Microbiology	100	1	0-0-2
Major (Core)	BTC152M202	Cell Biology	100	2	2-0-0
	BTC152M212	Practical in Cell Biology	100	1	0-0-2
Minor	BTC152N201	Basic Instrumentation in Biology	100	3	3-0-0
IDC	IKS992K201	Indian Knowledge System – II	100	3	3-0-0
AEC	CEN982A201	Communicative English – II	100	1	1-0-0
	BHS982A202	BHS – II	100	1	1-0-0
SEC	BTC152S211	Biochemical Analysis of Food	100	3	0-0-6
VAC	VAC992V2---	To be chosen from a pool of courses	100	3	
SWAYAM				3/ 4	
			TOTAL CREDIT FOR 2ND SEMESTER	**20+3/4**	
Exit 1 – UG Certificate in Biotechnology (with 40 credits + a vocational course of 4 credits in summer break)					
3RD SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BTC152M301	Genetics	200	3	2-1-0
	BTC152M311	Practical in Genetics	200	1	0-0-2
Major (Core)	BTC152M302	Biophysical Chemistry	200	4	3-1-0
Minor	BTC152N301	Introduction to IPR	200	4	3-1-0
IDC #	BTC152I301	Health and Hygiene	200	3	3-0-0
AEC	CEN982A301	Communicative English – III	200	1	1-0-0
	BHS982A302	BHS – III	200	1	1-0-0
SEC	BTC152S311	Clinical Biochemistry	200	3	0-0-6
SWAYAM				3/ 4	
			TOTAL CREDIT 3RD SEMESTER	**20+3/4**	
4TH SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BTC152M401	Molecular Biology	200	3	2-1-0
	BTC152M411	Practical in Molecular Biology	200	1	0-0-2
Major (Core)	BTC152M402	Immunology	200	3	2-1-0
	BTC152M412	Practical in Immunology	200	1	0-0-2

Outline of the syllabus for B.Sc. in Biotechnology (Royal School of Bio-Sciences)

Major (Core)	BTC152M403	Bioethics, Biosafety and IPR	200	4	3-1-0
Minor	BTC152N401	Biofertilizer and Its Application	200	3	3-0-0
	BTC152N402	Food Biotechnology	200	3	3-0-0
AEC	CEN982A401	Communicative English – IV	200	1	1-0-0
	BHS982A402	BHS – IV	200	1	1-0-0
SWAYAM				3/ 4	
			TOTAL CREDIT 4TH SEMESTER	**20+3/4**	
Exit 2 – UG Diploma in Biotechnology (with 80 credits + a vocational course of 4 credits in summer break of 2nd year)					
5TH SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BTC152M501	Genomics and Proteomics	300	4	4-0-0
	BTC152M502	Plant and Animal Biotechnology	300	4	4-0-0
	BTC152M513	Practical – V	300	4	0-0-8
Minor	BTC152N501	Basics of Molecular Biology	300	4	3-1-0
		INTERNSHIP	300	4	
			TOTAL CREDIT FOR 5TH SEMESTER	**20**	
6TH SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BTC152M601	Genetic Engineering	300	4	4-0-0
	BTC152M602	Bioinformatics and Biostatistics	300	4	4-0-0
	BTC152M603	Bioprocess Engineering	300	4	4-0-0
	BTC152M614	Practical – VI	300	4	0-0-8
Minor	BTC152N601	Entrepreneurship Development	300	4	3-1-0
			TOTAL CREDIT FOR 6TH SEMESTER	**20**	
Course completion Option 1 – UG Degree (B.Sc.) in Biotechnology (with 120 credits)					
7TH SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BTC152M701	Environmental Biotechnology	400	4	3-1-0
	BTC152M702	Medical Biotechnology	400	4	3-1-0
	BTC152M703	Plant and Animal Physiology	400	4	3-1-0
	BTC152M714	Practical – VII	400	4	0-0-8
Minor	BTC152N701	Pharmaceutical Biotechnology	400	4	3-1-0
			TOTAL CREDIT 7TH SEMESTER	**20**	
8TH SEMESTER					
COMPONENT	**COURSE CODE**	**COURSE TITLE**	**LEVEL**	**CREDIT**	**L-T-P**
Major (Core)	BTC152M801	Research Methodology & Scientific Writing	400	4	3-1-0
Minor	BTC152N801	Ecology & Environment Management	400	4	3-1-0
Project/Dissertation	**BTC152M821**	***Students with ≥ 75% till the 6th semester***	400	12	0-0-24
(Major courses for the rest of the students in lieu of Project/ Dissertation)					
Major (Core)	BTC152M802	Developmental Biology	400	4	3-1-0
	BTC152M803	Ecosystem Degradation and Intervention	400	4	3-1-0
	BTC152M804	Techniques in Molecular Biology	400	4	3-1-0
			TOTAL CREDIT 8TH SEMESTER	**20**	
Course completion Option 2 – B.Sc. (Honours) in Biotechnology (with 160 credits)					
§ Course completion Option 3 – B.Sc. (Honours with Research) in Biotechnology (with 160 credits)					

Outline of the syllabus for B.Sc. in Biotechnology (Royal School of Bio-Sciences)

**** Students must choose a minor course outside their major course (a separate department) and are expected to continue with the same department in subsequent semesters. As such the minor papers offered by Department of Biotechnology are for students from other departments only.***

***** Students must choose a VAC outside their major course (a separate department) and are free to choose a course offered by the same or different departments in subsequent semesters.***

 # Students must choose an IDC outside their major course (a separate department).

§ This option is available only to the students securing ≥ 75% (cumulative) till the 6th semester.

SYLLABUS (1st SEMESTER)

Course Title: Biochemistry	**Course Component: Major**
Course code: BTC152M101	**Credit: 3**
Level of course: 100	**L-T-P-C: 2-1-0-3**

Course Objectives: The main objective of the course is to provide basic foundation on biomolecules of life with reference to their properties, and biological functions.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Recall the** structure of atoms, biomolecules and chemical bonds	**BT 1**
CO 2	**Understand** the concepts of enzyme kinetics, bio-polymers etc.	**BT 2**
CO 3	**Develop** the knowledge gained in solving practical experiments.	**BT 3**
CO 4	**Analyze** the metabolic processes.	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	**Introduction to Biochemistry:** A historical prospective. **Amino acids & Proteins:** Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Protein Purification. Denaturation and renaturation of proteins. Fibrous and globular proteins. **Carbohydrates**: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoproteins and their biological functions	**16**
II.	**Lipids**: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol. **Nucleic acids**: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines &pyrimidines, biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.	**16**

III.	**Enzymes**: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metalloenzymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity: types & theories, Biocatalysts from extreme thermophilic and hyper thermophilic archaea and bacteria. Role of: NAD+, NADP+, FMN/FAD, coenzymes A, Thiamine pyrophosphate, Pyridoxal phosphate, lipoic-acid, Biotin vitamin B12, Tetrahydrofolate and metallic ions	**16**
IV	**Carbohydrates Metabolism**: Reactions, energetics and regulation. Glycolysis: Fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron Transport Chain, Oxidative phosphorylation. ß-oxidation of fatty acids, glyoxylate cycle.	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (80 class hours + 10 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Nelson, D.L., Cox, M.M., *Lehninger Principles of Biochemistry* 4th Edition, 2004, WH Freeman and Company, New York, USA

Reference Books

1. Berg, J. M., Tymoczko, J. L. and Stryer., *Biochemistry*, 6th Edition,2006, W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R., *Biochemistry and Molecular Biology of Plants*, 2nd Edition, 2015, American Society of Plant Biologists, USA.

Course Title: Practical on Biochemistry	**Course Component: Major**
Course code: BTC152M112	**Credit: 3**
Level of course: 100	**L-T-P-C: 0-0-6-3**

Course Objective: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember** about the process of preparation of buffers and calculate the same.	**BT 1**
CO 2	**Understand** about pH and its importance, enzyme kinetics.	**BT 2**
CO 3	**Apply** the knowledge of microscopy in identifying various stages of cell division.	**BT 3**
CO 4	**Categorize** the equipment's used and the underlying safety measures in a laboratory.	**BT 4**

Detailed Practical:

Module	Topics & Course Contents	Periods
I	• Safety measures in Biochemistry laboratory. • Effect of α-amylase on starch • Determination of K_m and V_{max} of α-amylase activity	20
II	• pH meter and buffers • Preparation of phosphate buffer • Preparation citrate buffer	20
III	• Principles of Colorimetry and Verification of Beer's law • Separation of Amino acids by paper chromatography. • Separation of various biomolecules by using TLC	20
IV	• Estimation of carbohydrates (glucose, maltose, lactose) present in a sample solution by DNS method • Estimation of protein by Lowry's method • Extraction and estimation of cellular protein from animal tissue by ammonium salt precipitation method.	20
	TOTAL	80

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (80 lab hours + 10 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team

- completion of an internship
- student teaching
- classroom presentation *etc*.

Reference Books:
As suggested under the theory papers.

Course Title: Biotechnology and Human Welfare	**Course Component: Minor**
Course code: BTC152N101	**Credit: 3**
Level of course: 100	**L-T-P-C: 3-0-0-3**

Course Objective: The main objective of the course is to provide a detailed description of the organization of the cell, the structure and functions of various organelles. The course also focuses on cell-cell communication and the importance of cell division.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various roles played by Biotechnology.	**BT 1**
CO 2	**Understand** the role of Biotechnology in solving environmental issues.	**BT 2**
CO 3	**Employ** the theoretical knowledge in future studies.	**BT 3**
CO 4	**Analyze** the role of the techniques learnt in development of society	**BT 4**

Detailed Syllabus

Modules	**Topics & Course Contents**	**Periods**
I.	Biotechnology in Industries: Development of protein products, development of recombinant proteins, modification and application of enzymes, antibiotic production, alcohol production. Biotechnology in Agriculture: Production of new crops, genetically modified crops, development of stress/flood/drought tolerant crops. Better production of resistant crops. Improvement of livestock.	**12**
II.	Biotechnology in Environment: Development of products which can degrade organic and inorganic pollutant, degradation of hydrocarbons and agriculture wastes, development of biodegradable polymers.	**12**

III.	Biotechnology in Food: Development of better-quality food products, development of innovative food products, development of new microbial strains, new beverages, quality preservation in foods, development of nutraceuticals and their role in health.	**12**
IV	Biotechnology in Forensics: Biotechnological interventions in solving crimes, DNA fingerprinting-Principles and applications, serology tools and role in solving crimes, biological solutions to solving crimes. Biotechnology in Pharmaceutical and Health: Development of new therapeutic agents, vaccines, gene therapy techniques, new diagnostic techniques for detection of viral disease, e.g. Covid-19, HIV, etc. Role of Human Genome Project.	**12**
	TOTAL	**48**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (48 class hours + 42 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. S. M. Reddy, S. R. Reddy, G.N. Babu, Basic industrial Biotechnology, 2012, New Age Publishers.

Reference Books

1. Ratledge, C., Kristiansen, B., Basic Biotechnology, 3rd edition,2006, Cambridge University Press;
2. Das, H. K., Text book of Biotechnology, 5th edition, 2017, Wiley Publishers.

Course Title: Compost Preparation and Applications	**Course Component: SEC**
Course code: BTC152S111	**Credit: 3**
Level of course: 100	**L-T-P-C: 0-0-6-3**

Course Objective: The main objective of the course is toprovide the graduates with the knowledge of biofertilizers and their applications in agriculture.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various techniques in production of biofertilizer	**BT 1**
CO 2	**Understand** the principles and applications biofertilizer	**BT 2**
CO 3	**Apply** the theoretical knowledge in practical applications.	**BT 3**
CO 4	**Analyze** the role of biofertilizers in agricultural production.	**BT 4**

Detailed Syllabus

Modules	**Topics & Course Contents**	**Periods**
I.	Earthworms: Introduction, classification and types of earthworms. The behavior of earthworms as indicators of soil fertility, plant growth and promoters & soil health regulators. Role of Earthworms to protect Environment. Starter culture of compost. Its preparation.	**15**
II	Vermicomposting: Vermiculture and Vermicomposting, Advantages of Vermicomposting, Chemical composition of vermicompost. Vermicomposting in everyday life earthworms and vermicomposting at commercial scale. Vermicomposting and Sustainable agriculture, restoration of degraded soil systems, vermicomposting and its effect on the greenhouse effect. Vermicomposting and its economic viability.	**15**
III	Definition, science and classification of compost, role of microbes in composting, carbon-nitrogen balance, C:N ratio, Moisture content, availability of temperature and oxygen,	**15**
IV	Methods of composting: Indore method, activated compost, NADEP method, Coimbatore method, Windrows composting. Coir pith, fly ash, Sewage and sewage sludge, sugar cane waste, compost of animal waste, phosphorous compost, weed composting	**15**
	TOTAL	**60**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 20 Lab hours + 10 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship

- student teaching
- classroom presentation *etc*.

Text Book

1. Singh, K. A Textbook of Vermicompost: Vermiwash and Biopesticides, 2014, Biotech Books.

Reference Books

1. Sreenivasan, E. Handbook of Vermicomposting Technology, 2018, The Western India Plywoods Ltd.
2. M. K. Rai., Handbook of Microbial Biofertilizers, 2006, Food Products Press

List of Practical Experiments

Modules	Topics & Course Contents	Periods
I.	1. Evaluation of various microbial species used in preparation of compost. 2. Assessment of earthworm species used in preparation of vermicompost 3. Determination of constituents in preparation of compost and vermicompost	**12**
II	1. Preparation of the soil structure used in vermicompost. 2. Analysis of composition of vermicompost bed. 3. Preparation of vermicompost shed	**12**
III	1. Assessment on the methods of preparation of compost. 2. Estimation on the organic constituents of compost 3. Evaluation on the growth patterns of earthworms on different feeds.	**12**
IV	1. Assessment of the quality of compost and vermicompost. 2. Estimation of the NPK content. 3. Study of market potential of compost	**12**
	TOTAL	**48**
Pedagogy: Lectures, Experiments, Laboratory sessions		

SYLLABUS (2nd SEMESTER)

Course Title: Microbiology	**Course Component: Major**
Course code: BTC152M201	**Credit: 2**
Level of course: 100	**L-T-P-C: 2-0-0-2**

Course Objective: The course aims to give a holistic theoretical and practical knowledge in field of general microbiology, its core concepts, scopes, applications and future prospects.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Recall** the various types of microorganism and the roles played by them.	**BT 1**
CO 2	**Relate** the microbial world, their diversity and utilization.	**BT 2**
CO 3	**Apply** the knowledge gained in understanding the causative agents of various diseases and maintenance of sterility.	**BT 3**
CO 4	**Analyze** and **relate** the co-evolutionary pattern and relationship between microbes and the environment.	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	**An introduction to microbiology**: History of microbiology, concepts of microbial diversity, scope and applications of microbiology. **Microscopy and specimen preparation**: Bright and dark field microscopy, TEM and SEM. Concepts of fixation and staining, Gram staining, acid fast staining, negative staining, capsule, flagellar and endospore staining. **Prokaryotic cellular architecture**: The cell wall and other constituents. Comparison between prokaryotic and eukaryotic organisms. Introduction to Eubacteria and Archaea, their major structural differences. General characteristics and classification of viruses, differences between bacteria and viruses. Bacteriophages; lytic and lysogenic cycles. Prions and viriods.	**12**
II.	**Eukaryotic microbial diversity**: Introduction to protists, bacteria, actinomycetes and fungi, Mycelia of fungi and Actinomycetes, cytoskeleton filament, heterocysts and akinets of Cyanobacteria. **Microbial growth and nutrition**: Principles of growth and growth curve, methods of growth determination and factors affecting growth. Mode of nutrition,	**12**

	growth mediums and pure culture techniques; isolation, preservation and maintenance of cultures, sterilization techniques.	
III.	**Microbial taxonomy**: Concept of microbial species and strains, classification of bacteria based on-morphology (shape flagella), staining reaction, mutation and extreme environment. **Microbial Reproduction and recombination**: Transformation, conjugation (cointegrate Formation and Hfr Cells, F-Plasmid) and transduction (generalized and specialized).	**12**
IV	**Microbial Metabolism**: Bacterial Photosynthesis, photophosphorylation, assimilation of inorganic nitrogen, phosphorus and sulphur, ED Pathway **Microorganisms and health:** Basics of host pathogen interaction, commensalism, colonization, infection and disease. Infections caused by Enterobacteriaceae, Mycobacteriaceae, *Candida, Aspergillus, Variola, Varicella-Zoster, HPV, EBV* **Plant microbe interactions**: Plant microbe interaction in the rhizosphere. Carbon and Nitrogen cycle, biological nitrogen fixation – symbiotic and non-symbiotic Plant Growth Promoting Rhizobacteria (PGPR) - Mycorrhizae -Blue Green Algae (BGA)	**12**
	TOTAL	**48**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

2 credits: 2 × 30 = 60 Notional Credit Hours (48 class hours + 12 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Gupta P.K., *Genetics*, ISBN-10 8171339328, ISBN-13 978-8171339328, Rastogi Publications, Meerut.
2. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R. *Molecular Biology of the Gene*, 6th edition, 2008. Cold Spring Harbour Lab. Press, Pearson Pub.

Reference Books

1. Gardner, E. J., Simmons, M. J. & Snustad, D. P. (2013). Principles of Genetics, 8th Edition, John Wiley and Sons.

2. Tamarin, R.H. (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Publishing Company Ltd.

Course Title: Practical on Microbiology	**Course Component: Major**
Course code: BTC152M211	**Credit: 1**
Level of course: 100	**L-T-P-C: 0-0-2-1**

Course Objective: The main objective of the course is toperform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember** about the process of preparation of media and calculation of molarity and estimation of pH.	**BT 1**
CO 2	**Understand** the components of the various media and their roles in microbial culture	**BT 2**
CO 3	**Apply** the knowledge of microscopy in identifying the morphology of microbes	**BT 3**
CO 4	**Analyze** the equipment's used and the underlying safety measures in a laboratory.	**BT 4**

Detailed Practical

Module	**Topics & Course Contents**	**Periods**
I	• To study the various instruments used in a microbiology laboratory • To study the safety protocols to be followed in a microbiology laboratory	15
II	• To prepare media for growth of microorganisms • To isolate microbes from soil and water	15
III	• To perform pure culture techniques for isolation of microbes • To perform Gram's staining of microbes	15
IV	• To perform Growth curve analysis of microbes • To perform sliding motility test in bacteria	15
	TOTAL	60

Credit distribution:

1 credit: 1 × 30 = 30 Notional Credit Hours (60 lab hours)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship

- student teaching
- classroom presentation *etc*.

Reference Books

As suggested under the theory papers.

Course Title: Cell Biology	**Course Component: Major**
Course code: BTC152M202	**Credit: 2**
Level of course: 100	**L-T-P-C: 2-0-0-2**

Course Objective: The main objective of the course is to provide a detailed description of the organization of the cell, the structure and functions of various organelles. The course also focuses on cell-cell communication and the importance of cell division.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various components of the cell and their function.	**BT 1**
CO 2	**Understand** the function of the cells and their roles.	**BT 2**
CO 3	**Apply** the knowledge gained in solving of problems associated with the topic.	**BT 3**
CO 4	**Analyze** the components of the cellular structure in prokaryotes, eukaryotes and archaea.	**BT 4**

Detailed Syllabus

Module	**Topics & Course Contents**	**Periods**
I	Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, cell fractionation. Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport. Extracellular matrix and its composition.	**12**
II	Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.	**12**

III	Lysosomes: Vacuoles and micro bodies: Structure and functions, Ribosomes: Structures and function including role in protein synthesis. Mitochondria: Structure and function, Genomes, biogenesis. Chloroplasts: Structure and function, genomes, biogenesis Nucleus: Structure and function, chromosomes and their structure. Signal transduction.	**12**
IV	Structure and function of prokaryotic cell and its components. Cell wall of bacteria, outer membrane of Gram-negative bacteria. Overview of the cell-cycle, Intracellular and extracellular control of cell division. Programme cell death, Cell cycle and cancer.	**12**
	TOTAL	**48**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

2 credits: 2 × 30 = 60 Notional Credit Hours (48 class hours + 12 Experiential learning)

Experiential learning activities may include

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Karp, G., *Cell and Molecular Biology: Concepts and Experiments,* 6th Edition, 2010 John Wiley & Sons Inc.

Reference Books

1. De Robertis, E.D.P. and De Robertis, E.M.F., *Cell and Molecular Biology,*8th edition, 2006, Lippincott Williams and Wilkins, Philadelphia.
2. Cooper, G.M. & Hausman, R.E. *The Cell: A Molecular Approach,* 5th edition. 2009, ASM Press& Sunderland, Washington, D.C.; Sinauer Associates, MA.

Course Title: Practical on Cell Biology	**Course Component: Major**
Course code: BTC152M212	**Credit: 1**
Level of course: 100	**L-T-P-C: 0-0-2-1**

Course Objective: The main objective of the course is toperform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember** the different components of cells.	**BT 1**
CO 2	**Understand** the mechanism of cell division and differentiation.	**BT 2**
CO 3	**Apply** the knowledge identifying various mechanisms involved in cell growth and development	**BT 3**
CO 4	**Analyze** the equipment used and the underlying safety measures in a laboratory pertaining to cell biology.	**BT 4**

Detailed Practical

Module	Topics & Course Contents	Periods
I	● Study the effect of temperature and organic solvents on semi permeable membrane. ● Demonstration of dialysis.	15
II	● Study of plasmolysis and de-plasmolysis. ● Cell fractionation and determination of enzyme activity in organelles using sprouted seed or any other suitable source.	15
III	● Study of structure of any Prokaryotic and Eukaryotic cell. ● Study of cell counting and their viability	15
IV	● Cell division in onion root tip/ insect gonads. ● Identification of blood cells in human blood smear	15
	TOTAL	60

Credit distribution:

1 credit: 1 × 30 = 30 Notional Credit Hours (60 lab hours)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Reference Books

As suggested under the theory papers.

Course Title: Basic Instrumentation in Biology	**Course Component: Minor**
Course code: BTC152N201	**Credit: 3**
Level of course: 100	**L-T-P-C: 3-0-0-3**

Course Objective: The main objective of the course is toprovide the graduates with a strong foundation in the area of instrumentation's used in Biology.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various instruments that play a major role in the study of biology.	**BT 1**
CO 2	**Understand** the principles and applications of the instruments.	**BT 2**
CO 3	**Apply** the theoretical knowledge in practical applications.	**BT 3**
CO 4	**Analyze** the results of practical carried out using the instruments	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	Microscopy and Imaging techniques: Principles and applications of Light microscopy, Phase contrast microscopy, fluorescence microscopy, electron microscopy- Scanning electron microscopy and Transmission electron microscopy	**12**
II	pH and Centrifugation: pH meter: Principles and application, Centrifugation: Principles, types of centrifuges, types of rotors, differential and density grad7ient centrifugation. Electrophoresis techniques: Gel electrophoresis, PAGE, Pulse field, 2DGE	**12**
III	Chromatography techniques: Principles and Application of Thin layer chromatography, Column chromatography, Gas Chromatography, High pressure liquid chromatography Preparation of Buffers, Molar solutions, Dilutions, Handling of chemicals, Good Laboratory Practices	**12**
IV	Spectroscopy and other techniques: UV-Vis spectroscopy, Infra-Red spectroscopy, Mass Spectroscopy, Lyophilizer, Sonication, Freeze Drying, Micropipettes	**12**
	TOTAL	**48**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (48 class hours + 42 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Bajpai, P.K., Biological Instrumentation and methodology, 2006, S. Chand & Co. Ltd.

Reference Books

1. K. Wilson and J. Walker Eds. Biochemistry and Molecular Biology, 2005, Cambridge University Press.
2. F. Partibhan and S. Felix, Biochemical Techniques and Instrumentation, 2020, Daya Publishing House.

Course Title: Biochemical Analysis of Food	**Course Component: SEC**
Course code: BTC152S211	**Credit: 3**
Level of course: 100	**L-T-P-C: 0-0-6-3**

Course Objective: The main objective of the course is toprovide the graduates with a strong foundation in the area of instrumentation's used in Biology.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Recall** the various theories taught and relate them to the analysis of food materials.	**BT 1**
CO 2	**Understand** the various theories and the practical in analysis of different food components.	**BT 2**
CO 3	**Apply** the knowledge of instruments in analysis of food products.	**BT 3**
CO 4	**Analyze** the components of food and relate them to health and wellness.	**BT 4**

Detailed List of Practical Experiments

Modules	Topics & Course Contents	Periods
I.	• Preparation of buffers and chemicals required in analysis of food. • Isolation and separation of food components by paper chromatography and TLC. • Extraction and estimation total sugar and reducing-sugar present in food.	**20**
II	• Biochemical analysis of different food components. • Analysis of protein and fats of cereals. • Analysis of lipid and lactose from milk and milk products. • Estimation of casein from milk.	**20**
III	• Assessment of microbial contamination in food products and water. • Estimation of sucrose and glucose in food products. • Estimation of starch in food samples.	**20**
IV	• Estimation cholesterol from egg yolk. • Milk adulteration analysis • Analysis of synthetic colours present in food.	**20**
	Total	**80**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (80 lab hours + 10 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc*.

Text Books

1. Pearson, D. Chemical analysis of foods, 1970 (6th Edn), London: TA Churchill.

Reference Books

1. Plummer DT. Introduction to practical Biochemistry. Bombay: 1979, Tata McGraw Hill Pub. Co. Ltd.
2. Sadasivan S, and Manickam A. Biochemical Methods, 2nd Edn., 2003, New Age International (P) Ltd., Publishers.

SYLLABUS (3rd SEMESTER)

Course Title: Genetics	**Course Component: Major**
Course code: BTC152M301	**Credit: 3**
Level of course: 200	**L-T-P-C: 2-1-0-3**

Course Objective: The main objective of the course is to understand the structure and function of genes and chromosomes as well as the harmful effects of mutations which can cause various genetic disorders

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Memorize** the various laws of genetics	**BT 1**
CO 2	**Understand** the concepts of the core areas	**BT 2**
CO 3	**Apply** the knowledge gained in solving of genetic problems.	**BT 3**
CO 4	**Analyze** the theoretical knowledge gained in solving inheritance pattern.	**BT 4**

Detailed Syllabus

Modules	**Topics & Course Contents**	**Periods**
I.	**Historical developments in the field of genetics**. Organisms suitable for genetic experimentation and their genetic significance. **Mendelian genetics:** Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, Law of segregation & Principle of independent assortment. Verification of segregates by test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, pleiotropy, multiple alleles, pseudo-allele, essential and lethal genes, penetrance, and expressivity.	**12**
II.	**Non-allelic interactions**: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes. **Linkage & crossing over** - Chromosome theory of Linkage, types of linkage, linkage groups, types of Crossing over, mechanism of Meiotic Crossing over.	**12**
III.	**Sex determination and sex linkage**: Mechanisms of sex determination in human, Environmental factors and sex determination, sex differentiation, sex limited traits, sex linked inheritance. **Human Genetics:** Concept, Human chromosomes and Mendelian pedigree pattern. Basic concept of Mutation and chromosome abnormalities.	**12**

IV	**Extra chromosomal inheritance**: Rules of extra nuclear inheritance, maternal effects, maternal inheritance, cytoplasmic inheritance, organelle heredity, genomic imprinting. **Evolution and population genetics**: Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, in breeding and out breeding, evolutionary genetics, natural selection.	**12**
	TOTAL	**48**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 30 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc*.

Text Books

1. Gupta P.K., *Genetics*, ISBN-10 8171339328, ISBN-13 978-8171339328, Rastogi Publications, Meerut.
2. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., *Molecular Biology of the Gene*, 6th edition, 2008. Cold Spring Harbour Lab. Press, Pearson Pub.

Reference Books

1. Gardner, E. J., Simmons, M. J. & Snustad, D. P. (2013). Principles of Genetics, 8th Edition, John Wiley and Sons.
2. Tamarin, R.H. (2002). Principles of Genetics, 7th Edition, Tata McGraw-Hill Publishing Company Ltd.

Course Title: Practical on Genetics	**Course Component: Major**
Course code: BTC152M311	**Credit: 1**
Level of course: 200	**L-T-P-C: 0-0-2-1**

Course Objective: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember** the different components of cells.	**BT 1**
CO 2	**Understand** the mechanism of mitotic and meiotic cell division.	**BT 2**
CO 3	**Apply** the knowledge identifying chromosomes at various stages of cell division	**BT 3**
CO 4	**Analyze** the equipment used and the underlying safety measures in a laboratory pertaining to genetics.	**BT 4**

Detailed Practical

Module	**Topics & Course Contents**	**Periods**
I	• Calibration of Microscope • To prepare the media for culturing *Drosophila melanogaster* • To clean and sterilize the Drosophila culture bottle	15
II	• Preparation of metaphase plate from mouse bone marrow. • Preparation of human karyotypes from well spread metaphase photographs	15
III	• Temporary slide preparation of buccal smear to study Barr-body. • Introduction of chromosome abnormalities in mammalian chromosomes.	15
IV	• Temporary slide preparation of Grasshopper testis to study the meiotic phases. • Temporary slide preparation of onion root tip to study the mitotic phases.	15

Credit distribution:

1 credit: 1 × 30 = 30 Notional Credit Hours (60 lab hours)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc*.

Reference Books

As suggested under the theory papers.

Course Title: Biophysical Chemistry	**Course Component: Major**
Course Code: BTC152M302	**Credit: 4**
Level of course: 200	**L-T-P-C: 3-1-0-4**

Course Objective: The course is designed to learn about the process of biophysical chemistry and understand the underlying phenomenon involved in protein structure and its composition.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basics of biophysical chemistry	**BT 1**
CO 2	**Understand** the principles of and processes of biophysical chemistry and its application in solving protein structure	**BT 2**
CO 3	**Apply** the basics in understanding the role of bioenergetics.	**BT 3**
CO 4	**Analyze** the role of equilibrium and study the properties of protein folding and refolding.	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	**Structure and Bonding:** Structure of atoms, molecules and chemical bonds (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, Co-valent bonding, etc.). Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).	**16**
II.	**Conformation and configuration of proteins:** Ramachandran plot, secondary, tertiary and quaternary structure; domains; motif and folds. Conformation of nucleic acids (A, B, Z-DNA forms), t-RNA structure, micro-RNA etc.)	**16**
III.	**Bioenergetics:** Concept of energy coupling in biological processors, Energy requirements in cell metabolism, high energy phosphate bond, energy currency of cell, biological oxidation, Electron-transport chain, Oxidative Phosphorylation including chemiosmotic hypothesis.	**16**
IV	**Multiple equilibrium:** Titration of proteins to evaluate total and net charge; Scatchard and hill plots; Protein stability, denaturation, unfolding equilibrium; Kinetics and thermodynamics of protein folding; Protein refolding and	**16**

	aggregation; Effect of solvent and temperatures on the protein stability and folding, Heat Shock Proteins	
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Text Books

1. Nelson, D.L., Cox, M.M. *Lehninger Principles of Biochemistry*, 4th Edition, 2004, W. H. Freeman and Co., New York, USA

Reference Books

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. *Biochemistry*, 6th Edition, 2006, W.H. Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. *Biochemistry and Molecular Biology of Plants*, 2nd Edition, 2015, American Society of Plant Biologists, USA.

Course Title: Introduction to IPR	**Course Component: Minor**
Course code: BTC152N301	**Credit: 4**
Level of course: 200	**L-T-P-C: 3-1-0-4**

Course Objectives

This subject aims to introduce students to Intellectual Property Rights and apprise them of ethical issues in the biological sciences and the laws pertaining to these in both the global and national context and also to aware the students with ethical practices appropriate for various scientific disciplines at all times and to adopt safe working practices relevant to the different biotech industries & fields of research.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** intellectual property laws/principles (including copyright, patents, designs and trademarks) to real problems and to analyse the social impacts of intellectual property law and policy.	**BT 1**

CO 2	**Understand,** recognize, and distinguish an ethical issue from other issues	**BT 2**
CO 3	**Apply** the knowledge gained during the course in spreading IPR related awareness.	**BT 3**
CO 4	**Analyze** experimental results for their potential to file suitable IPR.	**BT 4**

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I	**Concept of Property:** Tangible and Intangible Property, Intellectual Property-Origin Development and Objectives, Classification of Intellectual Property-Patents, Copyright, Trademark, Industrial Design, Geographical Indications, *etc*.	**12**
II	**Patent Rights and Copyrights**- Origin, Meaning of Patent, Types, Patentability Criterion-Discovery and Invention, Patentable Subject Matters; Novelty, Utility (Industrial Applicability), Non-Obviousness (Inventive Step) and Written Description, Product Patents vis-à-vis Process Patents, Inventions which are not patentable. **Copyright**- Origin, Definition &Types of Copy Right, Registration procedure, Assignment & license, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to software.	**12**
III	**Trademarks**-Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties. **Design**- Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design. Semiconductor Integrated circuits and layout design Act-2000.	**12**
IV	Protection of Plant Varieties and Traditional Knowledge, Relevance of Intellectual Property Rights for Science and Technology; Patentability of Biotechnology Inventions; Patent Laws in Indian and International Perspective; Indian Patent Act 1970 (Patent Amendment Acts-1999, 2002 and 2005); International Conventions relating to Intellectual Property; General Agreement on Trade and Tariff (GATT); Trade Related Aspects of Intellectual Property Rights (TRIPS)	**12**
	TOTAL	**48**

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (60 class hours + 60 Experiential learning)

Text books

1. Cornish, W. R., Intellectual Property (Latest Edition)
2. Intellectual Property Rights by Paul Goldstein
3. Intellectual Property Rights by K. R. G. Nair, Ashok Kumar, K. R. G. Nair

Reference Books

1. B.L. Wadera, Patents, Trademarks, Copyright, Designs and Geographical Indications
2. Matthew Rimmer, Intellectual Property and Biotechnology: Biological Inventions (2008)

Course Title: Health and Hygiene	**Course component: IDC**
Course Code: BTC152I301	**Credit: 3**
Level of course: 200	**L-T-P-C: 3-0-0-3**

Course objective: The main objective of the course is to familiarize the students with different aspects of health like nutrition, the role of microorganisms, and good practice to ensure hygiene in day-to-day life.

Course Outcome:

On successful completion of the course the students will be able to		
Sl. No.	**Course Outcome**	**Blooms Taxonomy Level**
CO1	**Remembering** the basics of health and hygiene	BT1
CO2	**Understanding** the role of microbes in health	BT2
CO3	**Applying** the knowledge to maintain a hygienic life style	BT3
CO4	**Categorize** commonly encountered health problems due to hygiene issues	BT4

Detailed Syllabus:

Module	**Topics & Course Contents**	**Periods**
I	**Nutrition**– definition, importance, nutrition and malnutrition; Balanced Diet: Basics of Meal Planning; **Carbohydrates**, **Lipids**, **Proteins**: Sources and Deficiency, **Brief account of Vitamins**- functions, food sources, effects of deficiency, **Macro and micro minerals** –functions, effects of deficiency; food sources of Calcium, Potassium and Sodium; food sources of Iron, Iodine and Zinc; **Importance of water**– functions, sources, requirement and effects of deficiency; Types, Symptoms and Diagnosis of nutritional deficiencies: Iron	**14**

	deficiencies (Anemia) and Vitamins (Night Blindness, Beriberi, Pellagra, birth defects, Osteoporosis	
II	**Microorganisms in health**: Basic concept of bacteria and viruses, Cellular morphology of bacteria, fungi and viruses, microorganisms in human health; Microbial toxins; Mechanism of host-pathogen interaction. Host immunity against infectious diseases	**10**
III	**Health hazards**: **Food poisoning**: Introduction, Organism involved, source of food contamination Causes and symptoms in food poisoning by: Clostridium, **water borne diseases**: jaundice, cholera, diarrhoea and typhoid; **Sexually transmitted infections**– AIDS, **Zoonotic diseases**: Bacterial zoonoses (anthrax, plague); Viral zoonoses (rabies, influenza), Rickettsial zoonoses (scrub typhus, Q-fever), Fungal zoonoses (histoplasmosis)	**16**
IV	**Hygiene** – Hygiene: Definition, personal hygiene- body odour, oral hygiene, grooming, feminine hygiene, sleep hygiene, hand washing, toiletry. Social hygiene – clean living movements, occupational hygiene, food and cooking hygiene, medical hygiene, excessive hygiene. **Rural Community Health**: Village health sanitation & Nutritional committee (Roles & Responsibilities); Accredited Social Health Activist (ASHA). **Public Awareness** – Introduction to antibiotic and their resistance; Importance of vaccine, Introduction to Mobile Apps of Government of India: NHP, Swasth Bharat, No More Tension, Pradhan Mantri Surakshit Mantritva Abhiyan (PM Suman Yojana), My Hospital (Mera aspataal), India fights Dengue, JSK Helpline, Ayushman Bhava, Arogya Setu, Covid-19AP	**8**
	TOTAL	**48**

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (48 class hours + 42 Experiential learning)

Text Books

1. Adams MR and Moss MO (2008) Food Microbiology (3rd Edition) RSC publications, UK.
2. Geoffrey Campbell-Platt (Editor) (2009) Food Science and Technology, Willey and Blackwell Publication, UK.

Reference Books

1. Lightfoot NF and Maier EA (Editor) (2003) Microbiological analysis of food and water, Elsevier Publication, Netherland.
2. Ray B and Bhunia A (2008) Fundamental food Microbiology (4th Edition) CRC publication, UK
3. Jatin V. Modi and Renjith S. Chawan. Essentials of Public Health and Sanitation – Part I- IV.

Course Title: Clinical Biochemistry	**Course Component: SEC**
Course Code: BTC152S311	**Credit: 3**
Level of Course: 200	**L-T-P-C: 0-0-6-3**

Course Objective: This subject aims to introduce students to Intellectual Property Rights and apprise them of ethical issues and practices.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the principles of the experiments and apply them during their practical	BT 1
CO 2	**Understand**, the basic reaction mechanism of the chemical processes.	BT 2
CO 3	**Apply** the knowledge gained in carrying out experiments associated with the course of study.	BT 3
CO 4	**Analyse** the data and relate them with the experiments being conducted.	BT 4

Detailed List of Practical Experiments:

Modules	**Topics & Course Contents**	**Periods**
I.	1. Preparation of solutions of acid, base and buffers based on molarity and normality 2. Preparation of serial and simple dilutions of salt solutions 3. Measurement of pH of various solutions.	**20**
II.	1. Measurement of absorbance and transmittance 2. Determination of Beer-Lambert's equation 3. Estimation and separation of plasma proteins.	**20**
III.	1. Estimation of salivary amylase. 2. Estimation of glucose from blood sample. 3. Separation of amino acid using paper/ thin layer chromatography	**20**
IV	1. Estimation of cholesterol in blood. 2. Analysis of urine and its components 3. Determination of serum urea/ creatinine/ SGPT/SGOT/ALP/ALT	**20**
	TOTAL	**80**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (80 practical hours + 10 Experiential learning)

Text Books

1. Temple, V.J., Practical Manual in Biochemistry and Clinical Biochemistry, University of Papua New Guinea Press, 4th edition, 2013.

Reference Books

1. Mohanty, S. and Verma, A., Practical Clinical Biochemistry, Jaypee Publications, 5th edition, 2016.

SYLLABUS (4th SEMESTER)

Course Title: Molecular Biology	**Course Component: Major**
Course code: BTC152M401	**Credit: 3**
Level of course: 200	**L-T-P-C: 2-1-0-3**

Course Objective: The main objective of the course is to allow the students to perceive the structure of the DNA molecule, understand the various mechanisms of molecular events and relate the role played in maintaining the biological system.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts in molecular biology.	**BT 1**
CO 2	**Demonstrate** the concepts in understanding the formation of various	**BT 2**
CO 3	**Apply** the theoretical knowledge in carrying out the practical assigned.	**BT 3**
CO 4	**Analyze** and **categorize** the various molecular reactions involved in mutations and DNA repair	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	Introduction to Molecular Biology, Types of genetic materials- Experiments of Griffith, Avery, MacLeod and McCarty, Hershey and chase, Lederberg and Tatum, Central dogma of life. Replication of DNA, Models of DNA replication, Mechanism of DNA replication in prokaryotes and eukaryotes (initiation, elongation, replication fork, replication machinery, termination), Enzymes and proteins involved in DNA replication (nucleases, DNA polymerases, DNA helicases, gyrases, SSCP, topoisomerase, primase).	**12**

II.	Mechanism of transcription in prokaryotes and eukaryotes. Enzymes and proteins involved in transcription, post transcriptional modification. Inhibitors of transcription. Translation initiation and elongation.	**12**
III.	Genetic code - characteristics and properties, Wobble hypothesis. Post translational modification, protein degradation, Inhibitors of protein synthesis. Regulation of gene expression (lac and trp operons).	**12**
IV	Mutation and its types- spontaneous, induced, reverse, suppressor mutations; chemical mutagens- alkylating agent, nitrous acid, hydroxylamine; physical mutagen- radiation (X-Ray, Gamma Ray and UV). Concept of DNA repair.	**12**
	TOTAL	**48**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 30 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text books

1. Watson, J.D., Molecular Biology of the Gene, Pearsons, 8th edition

Reference books

1. Lodish. H, Berk. A, Lawrence, A, Matsudaira. A, Baltimore. D and Dernell. J. Molecular Cell Biology (Fourth Edition). Media Connected – W. H. Freeman and Company. 2009
2. Cell and Molecular Biology by De Robertis E.D.P and De Robertis E.M.F, 1987. Lea and Febiger International Edition, USA. 8th Ed. 2010.

Course Title: Practical on Molecular Biology	**Course Component: Major**
Course code: BTC152M411	**Credit: 1**
Level of course: 200	**L-T-P-C: 0-0-2-1**

Course Objective: The main objective of the course is toperform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember** about the process of preparation of chemicals and calculate the same.	**BT 1**
CO 2	**Understand** about the various molecular mechanisms.	**BT 2**
CO 3	**Apply** the knowledge about the structure of DNA, its isolation and use of electrophoresis in isolation.	**BT 3**
CO 4	**Analyse** the role of bioinformatics and biostatistics in solving biological problems.	**BT 4**

Detailed Practical:

Module	Topics & Course Contents	Periods
I	1.Isolation of genomic DNA from plants/ microorganisms/ animal cells 2.Isolation of plasmid DNA by alkaline lysis method 3. Isolation of plasmid DNA by phenol method	15
II	1. To perform restriction digestion of DNA 2. Gel electrophoresis of DNA	15
III	1.To perform ligation of foreign DNA into cloning/ expression vector 2.Quantification and purity determination of isolated genomic DNA by UV-Spectrophotometry.	15
IV	1.To carry out polymerase chain reaction of genomic DNA 2. Gel electrophoresis of the PCR amplified product	15

Credit distribution:

1 credit: 1 × 30 = 30 Notional Credit Hours (60 lab hours)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Reference Books: As suggested under the theory papers.

Course Title: Immunology	**Course Component: Major**
Course code: BTC152M402	**Credit: 3**
Level of course: 200	**L-T-P-C: 2-1-0-3**

Course Objective: The course aims to provide knowledge in the field of immunology and demonstrate the various forms in relation to their purpose of defending the living system.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic forms of immune system present in the body.	**BT 1**
CO 2	**Understand** the mechanism of the immune system.	**BT 2**
CO 3	**Apply** the knowledge learnt in relating the same to the defence of the body during diseases.	**BT 3**
CO 4	**Analyse** the importance of the various molecules that play an important role in immune function.	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	Immunology - History & Milestones, Microbial infections and host resistance. Immune response: Innate & Adaptive responses, Humoral and cell mediated Immune Responses. Structures, composition and functions of cells and organs of immune system.	**12**
II.	Antigens & Immunogenicity. Antigens - Types, properties, Haptens, Adjuvants, Toxoids, Immunoglobulins- structure, types and properties, Theories of antibody formation, Structural and genetic basis of antibody formation. Antigen and antibody reactions, Immunodiagnostic methods - Agglutination, precipitations, complement fixation, RIA, ELISA and its types, Immunofluorescence, Production of Monoclonal Antibodies and Hybridoma technique.	**12**
III.	Cytokines &Chemokines - Classification, types and its functions, Complement system: structure, properties, functions of complement components and its pathways. Hypersensitivity reactions: Type I, II, III and IV, MHC - Structure and function of class I and class II MHC molecules	**12**
IV	Immunity and tumors: Types of tumors, tumor antigens, immune response to tumors. Immunodeficiency and auto immune diseases, Vaccines, Transplantation immunology - types and mechanisms involved.	**12**
	TOTAL	**48**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 30 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc*.

Text books:

1. Kuby, J., Immunology by (7th edition) W.H. Freeman and Company, New York, 2013

Reference books:

1. Khan. F.H. The Elements of Immunology, Pearson Education India, 2009

Course Title: Practical on Immunology	**Course Component: Major**
Course code: BTC152M412	**Credit: 1**
Level of course: 200	**L-T-P-C: 0-0-2-1**

Course Objective: The main objective of the course is toperform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Learn** and **remember** about the process of preparation of chemicals and calculate the same.	**BT 1**
CO 2	**Understand** about the various immunological cells and tissues.	**BT 2**
CO 3	**Apply** the knowledge about the role of immune molecules in organism defence.	**BT 3**
CO 4	**Analyse** the role of the instruments and techniques used in immunology	**BT 4**

Detailed Practical:

Module	**Topics & Course Contents**	**Periods**
I	1. Isolation of lymphocytes from blood / spleen 2. Assays based on agglutination reactions - Blood typing (active) and passive Agglutination	15

II	1. Blood film preparation and identification of cells 2. Demonstration of ELISA	15
III	1. Estimation of RBCs in blood 2. Estimation of WBCs in blood 3. Widal test for determination of typhoid	15
IV	1.Blood Grouping assay 2. Determination of coagulation time of blood	15

Credit distribution:

1 credit: 1 × 30 = 30 Notional Credit Hours (60 lab hours)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Reference Books: As suggested under the theory papers.

Course Title: Bioethics, Biosafety and IPR	**Course Component: Major**
Course code: BTC152M403	**Credit: 4**
Level of course: 200	**L-T-P-C: 3-1-0-4**

Course Objective: The course aims to provide knowledge in field of immunology and demonstrate the various forms in relation to their purpose of defending the living system.

Course Outcomes:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basics of Bioethics, biosafety and IPR	**BT 1**
CO 2	**Understand** the principles of bioethics and biosafety and the importance of IPR	**BT 2**
CO 3	**Applying** the knowledge of IPR in applying for patent, copyright etc.	**BT 3**
CO 4	**Analyzing** the rules and regulations involving biosafety, bioethics and	**BT 4**

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	**Concept of Property:** Intellectual Property Rights-Origin Development and Objectives, Classification of Intellectual Property-Patents, Copyright, Trademark, Industrial Design, Geographical Indications, Protection of Plant Varieties and Traditional Knowledge, Patentability Criterion, Product Patents vis-à-vis Process Patents	**16**
II.	Patentability of Biotechnology Inventions; Patent Laws in Indian and International Perspective; Indian Patent Act 1970 (Patent Amendment Acts-1999, 2002 and 2005); International Conventions relating to Intellectual Property; General Agreement on Trade and Tariff (GATT); Trade Related Aspects of Intellectual Property Rights (TRIPS)	**16**
III.	**Biosafety:** Definition and requirement; Important symbols and their meaning, Biosafety in relation to human health, environment, transgenic research and applications; International Legal Instruments on Biosafety Cartagena Protocol on Biosafety, Nagoya Protocol Laws relating to Biosafety in India: The Biological Diversity Act, 2002, Biosafety procedures, rules and guidelines under Environment (Protection) Act 1986 and Rules 1989;	**16**
IV	Nature, Concept and Relevance of Bioethics; Basic Principles of Bioethics; Legal, Social and Economic Impacts of the Products and Techniques in Biotechnology; Bioethics in Plants, Animals and Microbial Genetic Engineering; Ethical issues in Healthcare; Biopiracy and Bioethics, Institutional Bioethical Committees and Composition on Human and Animals.	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text books

1. Cornish, W. R., Intellectual Property (Latest Edition)
2. Intellectual Property Rights by Paul Goldstein
3. Intellectual Property Rights by K. R. G. Nair, Ashok Kumar, K. R. G. Nair
4. Kilner, John, et.al, eds., Cutting-Edge Bioethics. Eerdmans 2002.

Reference Books

1. B.L. Wadera, Patents, Trademarks, Copyright, Designs and Geographical Indications
2. S. Ignacimuthu, Bioethics, Alpha Science International, Limited (2009)
3. Matthew Rimmer, Intellectual Property and Biotechnology: Biological Inventions (2008)
4. Arthur L. Caplan, Robert Arp, Contemporary Issues in Bioethics (2014)

Course Title: Biofertilizer and Its Application	**Course Component: Minor**
Course code: BTC152N401	**Credit: 3**
Level of course: 200	**L-T-P-C: 3-0-0-3**

Course Objective: The main objective of the course is toprovide the graduates with the knowledge of biofertilizers and their applications in agriculture.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various techniques in production of biofertilizer	**BT 1**
CO 2	**Understand** the principles and applications biofertilizer	**BT 2**
CO 3	**Apply** the theoretical knowledge in practical applications.	**BT 3**
CO 4	**Analyze** the role of biofertilizers in agricultural production.	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	Soil Environment- microorganisms, soil structure, soil profile, physicochemical conditions, microbial composition, sampling techniques, role of microorganisms in organic matter decomposition (cellulose, Hemicellulose, Lignins). Bio-geochemical cycles: Carbon cycle, Nitrogen cycle	**12**
II	Biofertilizers-Introduction, biofertilizers using nitrogen fixing microbes, phosphate solubilization- Rhizobium, Azatobacter, Azospirillum, Azolla- Anabaena Symbiosis, bluegreen algae and Ecto- and Endomychorizae. Cultivation, mass production and inoculation of Rhizobium, Azotobacter, Azospirillum, Azolla and cyanobacteria, Carrier-based inoculants, methods of application, quality control, agronomic importance. Application methods for different biofertilizers.	**12**

III	Role of endophytic fungi in the production of biofertilizer: symbiotic and opportunistic associations, coevolution and loss of reproductive structures, Secondary metabolite production, toxins-importance, toxicity to herbivores and insects. Role of algae and lichens as biofertilizers.	**12**
IV	Solid wastes in the production of biofertilizers: Types and Concept of solid waste; solid waste management.	**12**
	TOTAL	**48**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 30 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc*.

Text Book

1. S. Kannaiyan, BiotechnologyofBiofertilizers,2002, Alpha Science International.

Reference Books

1. The Complete Technology Book on Bio-Fertilizer and Organic Farming.2004, Niir Board.
2. M. K. Rai. Handbook of Microbial Biofertilizers, 2006, Food Products Press

Course Title: Food Biotechnology	**Course Component: Minor**
Course code: BTC152N402	**Credit: 3**
Level of course: 200	**L-T-P-C: 3-0-0-3**

Course Objective: The main objective of the course is toprovide the graduates with the knowledge of biofertilizers and their applications in agriculture.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various sources for production of food	**BT 1**

CO 2	**Understand** the principles and applications of enzymes and molecules	**BT 2**
CO 3	**Apply** the knowledge in practical applications for preparation of food	**BT 3**
CO 4	**Analyze** the role of biotechnology in food production.	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	Micro-organisms important in biotechnology processes, Strain improvement; mutation, recombination, protoplast fusion. Microbial growth kinetics; principles of batch, fed-batch and continuous fermentation, processes; sterilization of culture media; stirring, mixing and aeration of fermentation cultures.	**12**
II	Bacteria-based products; dairy, meat, fish and vegetable products, vinegar and additives. Yeast-based products; food yeasts, alcoholic beverages and bread. Other microbial based products; enzymes, microbial biomass protein (MBP), additives and "smart foods."	**12**
III	Testing and analysis of genetically modified foods; protein-based methods to detect the transgene product and DNA-based methods to detect the transgene or associated marker or regulatory sequences. Safety evaluation of novel food products. Benefits and risks of GM foods.	**12**
IV	Plant cell and tissue culture, Genetic modification of agronomic traits in crops such as herbicide tolerance, pest and disease resistance, Laboratory generated meat, Animal nutrition and health. Generation of transgenic animals. Biotechnology in the animal feed industry, Regulations in production of GMO.	**12**
	TOTAL	**48**
Pedagogy: Lectures, Experiments, Laboratory sessions		

Credit distribution:

3 credits: 3 × 30 = 90 Notional Credit Hours (60 class hours + 30 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Book

1. Ratledge, C. and Kristiansen, B. (Eds.) (2006) Basic Biotechnology. 3rd Edition. Cambridge University
2. Johnson-Green, P. (2002). Introduction to Food Biotechnology

Reference Books

1. Adams, M.R., and Moss, M.O. (2000). Food Microbiology. Second Edition. The Royal Society of Chemistry, UK.
2. Wood, B.J.B. (Editor) (1998). Microbiology of Fermented Foods, 2-Volumes, Second Edition. Blackie Academic & Professional, London.

SYLLABUS (5th SEMESTER)

Course Title: Genomics and Proteomics	**Course Component: Major**
Course code: BTC152M501	**Credit: 4**
Level of course: 300	**L-T-P-C: 4-0-0-4**

Course Objective: The course is designed to apprise the students to the vital concepts of technologies pertinent to Genomics and Proteomics, their applications and demonstrate skills to apply the knowledge in scientific queries.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various techniques involved in the study of genomics and proteomics.	BT 1
CO 2	**Understand** the basic principle of all the techniques associated with genomics and proteomics study.	BT 2
CO 3	**Apply** the knowledge in the study of genomics and proteomics of a cell under specific conditions.	BT 3
CO 4	**Analyze** the effect of various intrinsic and extrinsic factors on the genome and proteome of a cell under certain conditions	BT 4

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	Importance of genome projects, human genome project, Sequence component of eukaryotic genome, satellite, microsatellite and minisatellite DNA; physical	**16**

	mapping by building clone contigs, genomic libraries, YAC, BAC libraries. General organization of human genome. Introduction to functional genomics	
II.	Genomics and Transcriptomics: Microarray, RNA sequencing, methods to study differential gene expression: differential display PCR Tools for genome analysis- PCR and automated DNA sequencing, RFLP, DNA foot printing, DNA finger printing, RAPD, AFLP, SNP detection techniques, Applications of DNA markers	**16**
III.	Introduction to Proteome Concept and nature of proteome, overview of the tools to study proteome, and categories of current proteomic studies, Application of Proteomic studies in (Gene Expression, Protein, Biomarker discovery in disease diagnosis and drug designing); Proteomic interactions (Y2H approaches, Co-IP); Sequencing of proteins, Concepts of protein engineering, protein microarray.	**16**
IV	Proteomic tools: SDS-PAGE, Native PAGE, western blotting and immune-detection, 2D-gel electrophoresis., in gel digestion, Purification of proteins using various chromatographic techniques. Mass spectrometry: Principle and practices.	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc*.

Text Books

1. Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Campbell AM &Heyer LJ, Benjamin Cummings 2007; CSH Press, NY. ISBN-10: 8131715590
2. Principles of Proteomics. R.M Twyman (2004) (BIOS Scientific publishers). ISBN-10: 1859962734
3. Genome III – T.A. Brown Garland Science Publ. June 08, 2006. ISBN-10: 0815341385

Reference Books

1. Principles of Gene Manipulation and Genomics- Primrose S &Twyman R, 7th Edition, Blackwell, 2006. ISBN-10: 1405135441
2. Principles of Genome Analysis and Genomics. Primrose SB &Twyman RM. 2007. Blackwell. ISBN-10: 1405101202

Course Title: Plant and Animal Biotechnology	**Course Component: Major**
Course Code: BTC152M502	**Credit: 4**
Level of Course: 300	**L-T-P-C: 4-0-0-4**

Course Objective: The course is designed to understand the various processes involved in plants tissue culture and how the techniques learnt can help in the creation of tissue cultured plants.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** about the process of tissue culture, callus culture, suspension cell culture of plant tissues and the basic theories of animal cell culture.	**BT 1**
CO 2	**Understand** the processes and techniques of creation of tissue cultured plants and animal cells and new hybrids	**BT 2**
CO 3	**Apply** the knowledge of in conservation of plants and animals and production of high yield animals.	**BT 3**
CO 4	**Analyse** the theoretical knowledge in the generation of new plants and animal cell lines for experimental purpose	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	**Plant tissue cultures**: callus, meristem culture etc., secondary metabolites in plant tissue cultures; protoplast culture and somatic hybridization; haploid plants and soma-clonal variation. Methods for Plant Conservation: Germplasm conservation- in situ, ex situ conservations and in vitro conservation; cryopreservation, Transgenic crop plants - Review of transgenic plants (Bt-cotton and other Bt- plants, Golden rice etc.), development of pathogen resistant cultivars using resistant lines.	**16**
II.	**Genetic engineering of crop plants**: Agrobacterium-mediated gene transfer, direct gene transfer; Biolistic gene transfer, alternative approaches of gene transfer – micro injection and electroporation. Bioreactors- Stirred tank, Bubble column, Air lift, Rotating drum and immobilized plant cell reactor.	**16**
III.	**Animal Cell Culture**: History of animal cell culture; Basic requirement for animal cell culture; Cell culture media and reagents; Animal cell; Tissue and organ cultures; Primary culture and established cell lines; Basic technique of mammalian	**16**

	cell culture, cell synchronization, Scaling of animal cell culture, Transfection and transformation of cells, Application of animal cell culture for in vitro testing of drugs; Testing of toxicity for environmental pollutants in cell culture; Stem cells and their application, in-vitro fertilization; culture of embryos; cryopreservation of embryos; embryo transfer; embryo splitting	
IV	**Animal health Biotechnology:** History of development of vaccines; Introduction to the concept of vaccines; Conventional methods and Recombinant approaches to vaccine production; Hybridoma technology; Application of cell culture technology in vaccine production and pharmaceutical proteins. Introduction of DNA fingerprinting. Scope and application of DNA forensics: animal species identification; detection of adulteration of meat by DNA based techniques.	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30= 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc*.

Text books

1. Satyanarayana, U. Biotechnology (Books and Allied (P) Ltd.2005).
2. Slater, A., Scott, N. W., Fowler, M. R Plant Biotechnology: The Genetic Manipulation of Plants (Oxford University Press, USA; 2NDedition, 2008).
3. Animal cell biotechnology Portner, 2nd edition, Humana Press,2007.
4. Pinkert, Transgenic animal technology, Academic Press,2006.

Reference Books

1. Adrian, S. Plant Biotechnology: The Genetic Manipulation Of Plants (Oxford University Press,2008)
2. Bohnert, H. J. et al Bioengineering and Molecular Biology of Plant Pathways, Volume 1 (Elsevier, USA,2008)
3. Davey, M.R. Plant Cell Culture: Essential Methods (Wiley-Blackwell Publishing, 2010)
4. Gordon, Reproductive technologies in farm animals, CAB Intl,2005.
5. Ed. John R.W. Masters, Animal cell culture- Practical approach, 3rd edition, Oxford University Press, 2000.

Course Title: Practical – V	**Course Component: Major**
Course Code: BTC152M513	**Credit: 4**
Level of Course: 300	**L-T-P-C: 0-0-8-4**

Course Objective: The course is designed to learn about the various experiments used in plant and animal tissue culture and their role in the generation of new plants, animals and their products.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** about the procedures of tissue culture and maintenance of plant culture laboratory. The students will also be aware of the process of fermentation and preparation of various fermented food products.	**BT 1**
CO 2	**Understand** the role of various instruments and setups in the tissue culture laboratory and in bioprocess industry.	**BT 2**
CO 3	**Apply** the knowledge of plant tissue culture in conservation and fermentation in food preservation and processing.	**BT 3**
CO 4	**Analyze** the theoretical knowledge in the generation of new plants and innovative food products	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	1. Overview of setup in a plant tissue culture laboratory 2. Preparation of media for plant tissue culture. 3. Micropropagation using apical/nodal explants. 4. Isolation of protoplasts.	**24**
II.	1. Study of equipment's and materials for animal cell culture. 2. Demonstration of the process and techniques of animal cell culture. 3. Isolation of human lymphocytes from the blood. 4. Culture of human blood lymphocytes	**24**
III.	1. G-banding of human chromosomes and physical mapping of human genome. 2. Design of PCR primers from Genomic DNA. 3. DNA isolation and single nucleotide genotyping.	**24**
IV	1. Extraction and quantification of proteins 2. Digests proteins into peptides, which are then separated and analysed by mass spectrometry 3. Native and SDS-PAGE. 4. Compare protein expression in biological samples.	**24**
	TOTAL	**96**

Credit distribution:

4 credits: 4 × 30= 120 Notional Credit Hours (96 lab hours + 24 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text books

1. Ed. John R.W. Masters, Animal cell culture- Practical approach, 3rd edition, Oxford University Press, 2000.

Reference books: As suggested under the theory courses.

Course Title: Basics of Molecular Biology	**Course Component:** Minor
Course Code: BTC152N501	**Credit: 4**
Level of Course: 300	**L-T-P-C: 3-1-0-4**

Course Objective: The main objective of the course is to provide basic foundation on biomolecules and molecular events of life with reference to their properties, and biological functions.

Course outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts of cellular organelles biomolecules and molecular biology.	**BT 1**
CO 2	**Demonstrate** the concepts in understanding the formation of various molecular events in life forms.	**BT 2**
CO 3	**Develop** the knowledge gained in solving practical experiments.	**BT 3**
CO 4	**Analyze** and **categorize** the various molecular reactions involved in various molecular events	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	**Basics of cell structure:** Introduction and classification of organisms by cell structure, Structure and function of prokaryotic cell and its components. Cell wall of bacteria, outer membrane of Gram-negative bacteria,	**14**

	Compartmentalization of eukaryotic cells, cytosol, Cell Membrane, Chemical components of biological membranes, organization and Fluid Mosaic Model, **Cell organelles**: Structure and functions of various cell organelles like Endoplasmic reticulum: Golgi complex, Mitochondria, Chloroplasts, Overview of the cell-cycle and cell division.	
II.	**Biological macromolecules:** **Amino acids and Proteins:** structure, classification of amino acids, concept of zwitterionic structure, physical and chemical properties. classification of proteins on the basis of composition, conformation and function, different level of structural organization of proteins (primary, secondary, tertiary &quaternary) **Nucleic acids:** Ribonucleic and deoxyribonucleic acids, purines and pyrimidines, nucleosides and nucleotides. **Carbohydrate:** Structure, function and properties of Carbohydrates. **Lipids:** Definition and classification of lipids, structure and function of fatty acids, storage lipids, structural lipids.	**12**
III.	**DNA Replication:** Models of DNA replication, Mechanism of DNA replication in prokaryotes and eukaryotes (initiation, elongation, replication fork, replication machinery, termination), Enzymes and proteins involved in DNA replication (nucleases, DNA polymerases, DNA helicases, gyrases, SSCP, topoisomerase, primase).	**12**
IV	**Protein synthesis**: Central dogma of life, transcription in prokaryotes and eukaryotes, Enzymes and proteins involved in transcription, post transcriptional modification, Genetic code - characteristics and properties, Wobble hypothesis, Translation initiation and elongation.	**10**
	TOTAL	**48**

Credit distribution:

3 credits: 4 × 30 = 120 Notional Credit Hours (60 class hours + 60 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*.

Text Books

1. Nelson, D.L., Cox, M.M., *Lehninger Principles of Biochemistry* 4th Edition, 2004, WH Freeman and Company, New York, USA
2. Watson, J.D., Molecular Biology of the Gene, Pearsons, 8th edition

Reference Books:

1. Berg, J. M., Tymoczko, J. L. and Stryer., *Biochemistry*, 6th Edition, 2006, W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R., *Biochemistry and Molecular Biology of Plants*, 2nd Edition, 2015, American Society of Plant Biologists, USA.
3. Lodish. H, Berk. A, Lawrence, A, Matsudaira. A, Baltimore. D and Dernell. J. Molecular Cell Biology (Fourth Edition). Media Connected – W. H. Freeman and Company. 2009
4. Cell and Molecular Biology by De Robertis E.D.P and De Robertis E.M.F, 1987. Laea Febiger International Edition, USA. 8th ed 2010.

Course Title: Internship	**Course Component:** Major
Course Code: BTC152M513	**Credit:** 4
Level of Course: 300	

Course Objective: In this course the students shall carry out a period of training in the form of an internship at a well-established laboratory/ industry/ factory or University. The student will train himself/ herself in the core areas of biotechnology and shall present a report.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the basic concepts taught to be incorporated in the training	**BT 1**
CO 2	**Understand** the role of various instruments required in biology and their use in training process.	**BT 2**
CO 3	**Apply** the knowledge of working with the instruments/ equipment during the internship period.	**BT 3**
CO 4	**Analyze** the results obtained based upon the concept and training received	**BT 4**

SYLLABUS (6th SEMESTER)

Course Title: Genetic Engineering	**Course Component:** Major
Course code: BTC152M601	**Credit:** 4
Level of course: 300	**L-T-P-C:** 4-0-0-4

Course Objectives: The main objective of the course is to provide basic foundation on Genetic Engineering with reference to their practical applications in biological systems.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course outcome**	**Blooms Taxonomy Level**
CO1	**Recall** the structure of various vectors used in Genetic Engineering	**BT1**
CO2	**Understand** the concepts of gene manipulation and the techniques involved.	**BT2**
CO3	**Develop** the knowledge gained in solving practical experiments.	**BT3**
CO4	**Analyze** the practical outcome of the gene manipulation techniques.	**BT4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Period**
I	Basics Concepts: DNA modifying enzymes, classification and nomenclature; Cohesive and blunt end ligation; Linkers; Adaptors; Radioactive and non-radioactive probes; Selectable and Scorable marker genes. Cloning Vectors: Plasmids; Phagemids, M13 vectors; pUC19, Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Plant based vectors: Ti and Ri as vectors; Expression vectors.	**12**
II	Cloning Methodologies: Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Hybridization techniques: Southwestern, Northern and Western hybridization; DNA-Protein Interactions Electromobility shift assay; DNase I foot printing.	**17**
III	PCR and Its Applications: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis;	**17**
IV	Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; Transfection techniques; Introduction to	**18**

	siRNA technology and MicroRNA; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knockout mice; DNA microarray techniques.	
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*.

Text Books:

1. Brown, T. A., Gene Cloning and DNA Analysis: An Introduction, 8th Edition, John Wiley & Sons Ltd., 2021
2. Nicholl D. S. T., An Introduction to Genetic Engineering, 4th Edition, Cambridge University Press, 2023

Reference Books:

1. Sambrook, J., and Russel, D.W., Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
2. Primrose, S. B., Twyman, R.M., and Old, R.W. Principles of Gene Manipulation. 6th Edition, S. B. University Press, 2001.
3. Selected papers from scientific journals.

Course Title: Bioinformatics and Biostatistics	**Course Component: Major**
Course code: BTC152M602	**Credit: 4**
Level of course: 300	**L-T-P-C: 4-0-0-4**

Course Objective: The course aims to give a holistic theoretical and practical knowledge in field of bioinformatics and biostatistics to relate the role of computational biology and statistics in biotechnology.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the various software and biological databases and their application in the analysis of various biological experiments.	**BT 1**
CO 2	**Understand** the various software and their use in the analysis of various biological results.	**BT 2**
CO 3	**Apply** the knowledge to analyse the results of biological experiments statistically using various computational tools.	**BT 3**
CO 4	**Analyse** the various biological events and their probable outcome using computational tools.	**BT 4**

Detailed Syllabus:

Modules	Topics & Course Contents	Periods
I.	**Basics of bioinformatics**: Definition, Scope and Goal, Application in Computational Biology, Limitations; **Biological Database**: Types of databases, biological database: GenBank, EMBL, DDBJ, Uniprot-KB: SWISS-PROT, PDB, AceDBs, literature databases, PubMed; Webtools: ExPASy server **Sequence Analysis and Sequence Alignment:** Basic concepts of sequence similarity, identity and homology, definitions of homologues, orthologues and paralogues, Basic concepts of sequence alignment, Uses of Sequence Alignment, Pairwise, multiple, Database Similarity search, **Scoring matrices:** Basic concept of a scoring matrix, Matrices for nucleic acid and proteins sequences, PAM and BLOSUM series, matrix derivation methods and principles **Sequence similarity search:** BLAST and FASTA **Structural bioinformatics**: proteins and its structure, Determination of protein 3-Dimensional structure, Protein structure visualization, comparison, Secondary and tertiary structure prediction	**16**
II.	Molecular Phylogenetics: Basic concepts, Methods in evaluation of phylogeny and steps in constructing alignments and phylogenetic Trees, Types of phylogenetic tree. Protein Structure Prediction and Molecular Interaction studies: Methods of protein structure prediction, validation by Ramachandran Plot, Docking and Molecular Dynamic Simulation (MDS). Chemoinformatic and Computer Aided Drug Designing (CADD): Introduction to cheminformatics, Use of cheminformatics, Prospectus of cheminformatics,	**16**

III.	**Statistical tools:** Measures of central tendencies and dispersion, concept of probability and theoretical distributions (Binomial, Poisson and normal distribution), Correlation and Regression; Random numbers, sampling methods, random plot design. Basics of testing of hypothesis. Analysis of variance (one way and two way), Students t test, Chi-square test, F-test and Z-test.	**16**
IV	**Statistical Science and biological assays:** Importance, nature and planning of bioassays; Direct and indirect bioassays; Design of experiments by Analysis of variance and Dose-response analysis. **Analysis of biochemical data:** Application of multiple regressions in epidemiologic and clinical data; Study of association between disease and risk factors. Application of odds ratio, Logistic regression with dichotomous response variable.	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*.

Text Books:

1. Lesk, A. (2019). Introduction to bioinformatics. Oxford university press.
2. Xiong, J. (2006). Essential bioinformatics. Cambridge University Press.

Reference Books:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis, Published CSHL Press.
2. Des Higgins, Willie R. Taylor. Bioinformatics: Sequence, Structure and Databanks: A Practical, Approach, Oxford University Press.

Course Title: Bioprocess Engineering	**Course Component:** Major
Course code: BTC152M603	**Credit:** 4
Level of course: 300	**L-T-P-C:** 4-0-0-4

Course Objectives: The main objective of the course is to provide comprehensive understanding on the principles underlying various techniques used in bioprocess engineering and technology for the development of fermented product.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course outcome**	**Blooms Taxonomy Level**
CO1	Recall the structure of various types of fermenters and bioreactors	**BT1**
CO2	Understand the concepts of fermented product development	**BT2**
CO3	Develop the knowledge to implement modern biotechnology in the food and pharmaceutical industries	**BT3**
CO4	Analyze the practical outcome of bioprocess engineering	**BT4**

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Basic principle of Biochemical engineering: Isolation screening and maintenance of industrially important microbes, microbial growth and death kinetics (particularly with reference to industrially useful microorganisms), strain improvement for increased yield and other desirable characteristics.	**16**
II	Detailed study of the design and operation of different types of fermenters, Mode of fermentation processes: Bioreactor designs, types of fermentations and fermenters: Upstream processing: scale up and scale down process. thermal death of micro-organisms, enzyme inhibition, Downstream processing: Bioseparation: drying, crystallization, storage and packaging, treatment of effluent and its disposal.	**16**
III	Applications of enzymes in industry and food processing: enzymatic bioconversions e.g. starch and sugar conversion processes, High-Fructose Corn Syrup, and their downstream processing, backing by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing, cheese making by proteases; application of enzymes in detergents. Fermentated foods: microbes and their use in pickling, producting colours and flavours, and process of wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products; Bacteriocins: production and applications.	**16**
IV	Biodegradation of xenobiotic compounds and toxic wastes, removal of spilled oil & grease deposits, Biosurfactants, Bioremediation of soil &	**16**

	water, solid waste & waste water treatment, use of microorganism for the production of energy: Biogas (production of methane and hydrogen), fuel alcohol production & hydrocarbon production.	
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*.

Text Books:

1. Fermentation and Biochemical Engineering Handbook, Principles, Process Design, and Equipment; Edited by Henry C. Vogel; Noyes Publications, New Jersey, U.S.A. ISBN: 0-8 155- 1407-7. 2.
2. Biotechnology- Volume 3- Bioprocessing; VCH Verlagsgesellschaft mbH. Weinheim, ISBN 3-527- 28313-7 (Weinheim); ISBN 1-56081-153-6 (New York).

Reference Books:

1. Principles of Fermentation Technology, P. E. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heinemann, ISBN: 07506 45016.
2. Practical Fermentation Technology, B. Mcneil and L. M. Harvey, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, ISBN 978-0470-0143492.
3. Buchanan, B., Gruissem, W. and Jones, R., Biochemistry and Molecular Biology of Plants, 2nd Edition, 2015, American Society of Plant Biologists, USA.

Course Title: Practical – VI	**Course Component:** Major
Course code: BTC152M614	**Credit:** 4
Level of course: 300	**L-T-P-C:** 0-0-8-4

Course Objectives: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course outcome**	**Blooms Taxonomy Level**
CO1	**Learn** and **remember** about the process of preparation of consumables for various experiments	**BT1**
CO2	**Understand** about the principles involved in Genetic Engineering, Bioprocess Technology and Bioinformatics	**BT2**
CO3	**Apply** the knowledge of bioprocess technology in developing various products	**BT3**
CO4	**Categorize** the equipment's used and the underlying safety measures in a laboratory	**BT4**

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	• Isolation of genomic DNA from bacteria, plants and blood. • Isolation of plasmid DNA from bacteria • Quantification of DNA through Spectrophotometric analysis	**20**
II	• Agarose gel electrophoresis • PCR (Polymerase Chain Reaction), Setting up a PCR reaction, Optimization of PCR conditions, gel documentation	**24**
III	• Designing of stirred tank bioreactor • Production of wine from fruit juice • Isolation of protoplast from plant • Fusion of protoplast • Preparation of synthetic seeds	**24**
IV	• Introduction to bioinformatics software • Database search and sequence download • Sequence retrieval and analysis • BLAST, FASTA: Search and analysis of data • Sequence alignment: algorithms for global and local alignments, pairwise alignment and multiple sequence alignment • Phylogenetic analysis and tree building • Protein structure download and structural analysis • ADMET – drug properties analysis and toxicology study	**28**
	TOTAL	**96**

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (96 lab hours + 24 Experiential learning)

Experiential learning activities may include:

- undergraduate research

- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation etc.

Text Books:

As suggested under the theory papers.

Course Title: Entrepreneurship Development	**Course Component:** Minor
Course code: BTC152N601	**Credit: 4**
Level of course: 300	**L-T-P-C: 3-1-0-4**

Course Objective: The main objective of the course is to provide the basic understanding in entrepreneurship and its importance in daily life.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the role of entrepreneurship in daily life.	**BT 1**
CO 2	**Understand** the role of development of entrepreneurship and its activities in sustaining a life.	**BT 2**
CO 3	**Interpret** the knowledge in generating entrepreneurship avenues.	**BT 3**
CO 4	**Outline** the role of entrepreneurship in solving unemployment problem.	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	Entrepreneurship: Meaning and its needs and importance. Promotion of entrepreneurship, factors influencing entrepreneurship, Features of successful entrepreneurship	**12**
II.	Establishment of enterprise: Forms of business organization, project identification, formulation and feasibility, selection of product. Entrepreneurship and International Business: Meaning of International business, selection of product and market, financing in business and export, institutional support for exports.	**12**

III.	Enterprise financing: Importance of finance/loans and repayments, characteristics of business finance, sources of fixed capital, working capital and its sources, application for loans. Inventories, raw materials and its management.	**12**
IV	Marketing Management: Meaning and importance, marketing mix, product management, marketing research, survey and its importance, physical distribution and stock management.	**12**
	TOTAL	**48**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (60 class hours + 60 Experiential learning)

Experiential learning activities may include:

- undergraduate research
- participation in a student design team
- completion of an internship
- student teaching
- classroom presentation *etc.*

Text Books

1. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, 2017, Sultan Chandand Sons.

Reference Books

1. D.H. Holt, Entrepreneurship: New Venture Creation. 2016, Pearson Education India.

SYLLABUS (7th SEMESTER)

Course Title: Environmental Biotechnology	**Course Component:** Major
Course code: BTC152M701	**Credit:** 4
Level of course: 400	**L-T-P-C:** 3-1-0-4

Course Objectives: The main objective of the course is to provide comprehensive understanding on the use of biotechnology to protect and improve the environment. The course covers topics such as the role of microorganisms in environmental processes, and how they can be used to remediate polluted soil and water.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course outcome**	**Blooms Taxonomy Level**
CO1	Recall the environmental problems and their sources	**BT1**
CO2	Understand the concepts of various global and regional environmental concerns due to natural causes and/or human activities, and the impact of these on various forms of life including native biodiversity	**BT2**
CO3	Develop the knowledge on the applications of environmental biotechnology in various fields	**BT3**
CO4	Analyze the examples of different types of environmental pollution and their impacts	**BT4**

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Limiting factors, energy transfer and biogeochemical cycling in ecological systems; Response of microbes, plant and animals to environmental stresses; Concept of ecosystems and ecosystem management, Environmental problems- ozone depletion, green house effect, water, air and soil pollution, land degradation.	**16**
II	GEMs in environment; Role of environmental biotechnology in management of environmental problems, Bioremediation, advantages and disadvantages; In situ and ex-situ bioremediation; slurry bioremediation; Bioremediation of contaminated ground water and phytoremediation of soil metals; microbiology of degradation of xenobiotics	**16**
III	Sewage and waste water treatment and solid waste management, chemical measure of water pollution, conventional biological treatment, role of microphyte and macrophytes in water treatment; Recent approaches to biological waste water treatment, composting process and techniques, use of composted materials	**16**
IV	Biofuels, plant derived fuels, biofuel from algae, biogas, landfill gas, bioethanol, biohydrogen; use of biological techniques in controlling air pollution; Removal of chlorinated hydrocarbons from air.	**16**
	Total	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*.

Text Books:

1. Wang, L. et al. (2010). Environmental Biotechnology, Humana Press. (available at UTS Library, either in hard copy or electronic version)
2. Wang, L. et al. (2010). Environmental Engineering, Humana Press. (available at UTS Library, either in hard copy or electronic version)

Reference Books:

1. Vallero, D. A. (2010). Environmental Biotechnology: A Biosystems Approach, Elsevier. (available at UTS Library)
2. Evans, G. M. and Furlong, J. C. (2011). Environmental Biotechnology: Theory and Application, Wiley-Blackwell. (available at UTS Library)
3. Jördening, H. J. and Winter, J. (2005). Environmental Biotechnology: Concepts and Applications, Wiley-VCH. (available at UTS Library E-book)

Course Title: Medical Biotechnology	**Course Component:** Major
Course code: BTC152M702	**Credit:** 4
Level of course: 400	**L-T-P-C:** 3-1-0-4

Course Objectives: The objective of a Medical Biotechnology course is to teach students how to apply biotechnology to medicine and healthcare. Students learn about molecular biology, genetic engineering, and other areas to address medical challenges.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course outcome**	**Blooms Taxonomy Level**
CO1	Recall the cellular and molecular the cause and development of diseases or abnormal conditions	**BT1**
CO2	Understand the concepts of human oncogenesis	**BT2**

CO3	Develop the knowledge on the applications of biotechnology in various medical fields	**BT3**
CO4	Analyze the examples of different types of recombinant and immunotherapeutic techniques	**BT4**

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Introduction: History and scope of medical biotechnology, current status and future prospects. Classification of genetic diseases: Chromosomal disorders – Numerical disorders e.g. trisomies & monosomies, Structural disorders e.g. deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders.	**16**
II	Molecular basis of human diseases: - Pathogenic mutations Gain of function mutations: Oncogenes, Huntington's Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor. Genomic. Dynamic Mutations - Fragile- X syndrome, Myotonic dystrophy. Mitochondrial diseases	**16**
III	Gene therapy: Ex-vivo, In vivo, In situ gene therapy, Strategies of gene therapy: gene augmentation Vectors used in gene therapy Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer. Gene therapy trials – Familial Hypercholesterolemia, ADA, AIDS, Cystic Fibrosis, Solid tumors. epigenetic inheritance, problems & ethics. Gene therapy Models – Liver diseases, Lung diseases, Hematopoietic diseases, & Auto-immune diseases. SARS-CoV-2 (severe acute respiratory syndrome coronavirus 2), and HPV	**16**
IV	Recombinant & Immunotherapy; Clinical applications of recombinant technology; Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors, Monoclonal antibodies and their role in cancer; Role of recombinant interferons; Immunostimulants; Immunosupressors in organ transplants; Role of cytokine therapy in cancers	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*.

Text Books

1. Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine by Andrew J.T. George (Editor), Catherine E. Urch (Editor) Publisher: Humana Press; edition (2000)

Reference Books

1. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine) by Jochen Decker, U. Reischl
2. Human Molecular Genetics by T. Strachan, Andrew Read Amazon Sales Rank

Course Title: Plant and Animal Physiology	**Course Component:** Major
Course code: BTC152M703	**Credit:** 4
Level of course: 400	**L-T-P-C:** 3-1-0-4

Course Objectives: The objective is to teach the students the structure and function of plants and animals so that they learn about the structure of organs, organ systems, and cells, and how they function.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course outcome**	**Blooms Taxonomy Level**
CO1	**Remember** about the various organs, organ structures and cell types in plants and animals.	**BT1**
CO2	**Understand** the functions of the organs and organ systems in growth and development.	**BT2**
CO3	Utilize fundamental understanding to analyze the diverse life processes, including the operations of the nervous system, respiratory system, cardiovascular system, excretory system, and digestive system.	**BT3**
CO4	Compare and contrast between different biological system.	**BT4**

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing, factors affecting stomatal movement. Role of micro and macro nutrients in plants and their mechanism of transport.	**16**
II	Photosynthesis and its importance: Photosynthetic pigments and photosystems, C3, C4 and CAM photosynthesis. Plant growth regulators and its role, Movement in plants, Physiology of flowering, seed dormancy and germination, photoperiodism and vernalization.	**16**
III	Digestive system: Comparative account of physiology of digestive system in herbivores and carnivores. Digestion and absorption of various nutrients; Hormonal control of secretion of enzymes in Gastrointestinal tract in humans. Disorders of the digestive system. Excretory system: Comparative account of physiology of excretory system; Structure of kidney and its functional unit; Micturition; Urine formation; Disorders of the excretory system. Cardiovascular System: Comparative account of circulation; Lymphatic system; Components of blood and their functions; Haemopoiesis; Structure of mammalian heart; Origin and conduction of cardiac impulses; ECG – its principle and significance. Disorders of the cardiovascular system.	**16**
IV	Nervous System: Comparative account of nervous system; Structure of neuron; Types of neurons, Resting membrane potential, Origin of action potential and its propagation; Synaptic transmission; Reflex action and its types. Disorders of nervous system. Respiratory system: Structural components of respiratory system; Mechanism of respiration, Gaseous exchange: CO_2 and O_2 transport, Disassociation curve, respiratory volumes; Comparative account of respiratory systems in animals; Disorders of nervous system. High altitude respiratory adaptations.	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*

Text Books

1. Guyton, A.C. & Hall, J.E. (2015). Textbook of Medical Physiology. XIII Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company. 51 | Page
2. Tortora, G.J. & Grabowski, S. (2017). Principles of Anatomy & Physiology. XI Edition John Wiley & Sons
3. Marieb E.N & Hoehn K.N (2022). Human Anatomy & Physiology. 12th Ed, Pearson Education.
4. Salisbury, F.B. and Ross, C.W. Plant Physiology, Wadsworth Publishing Co. Ltd. 1991, Latest edition.
5. Taiz, L. and Zeiger, E. Plant Physiology, 4 th edition, Sinauer Associates Inc .MA, USA, 2006, Latest edition.

Reference Books

1. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, Mcgraw Hills
2. Dr Ian Kay (1998). Introduction to Animal Physiology. 1st Ed, Garland Science.
3. Fahn, A. 1974 Plant Anatomy. Pergmon Press, USA and UK.
4. Hopkins, W.G. and Huner, P.A. 2008 Introduction to Plant Physiology. John Wiley and Sons.

Course Title: Practical – VII	**Course Component:** Major
Course code: BTC152M714	**Credit:** 4
Level of course: 400	**L-T-P-C:** 0-0-8-4

Course Objectives: The main objective of the course is to perform the experiments associated with the subjects taught and understand the underlying principles.

Course Outcome:

On successful completion of the course the students will be able to:

SI No	Course outcome	Blooms Taxonomy Level
CO1	**Learn** and **remember** about the process of preparation of consumables for various experiments	**BT1**
CO2	**Understand** the principles involved in Environmental, Medical Biotechnology and Plant and Animal Physiology	**BT2**
CO3	**Apply** the knowledge in developing solutions to environmental issues	**BT3**
CO4	**Categorize** the equipment's used and the underlying safety measures in a laboratory	**BT4**

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	• Isolation and screening of fecal coliforms from contaminated water. • Determination of BOD of contaminated water. • Determination of COD of contaminated water	**20**
II	• To learn the principle and procedure of ELISA • Determination of human blood grouping • VDRL test • WIDAL test • SGPT and SGOT test for liver functioning	**28**
III	• Histological staining of tissues	**20**
IV	• Preparation of stained mounts of anatomy of monocot and dicot's root, stem & leaf. • Demonstration of plasmolysis by *Tradescantia* leaf peel. • Demonstration of opening & closing of stomata • Separation of photosynthetic pigments by paper chromatography. • Demonstration of aerobic respiration. • Preparation of root nodules from a leguminous plant.	**28**
	TOTAL	**96**

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (96 lab hours + 24 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*

Text Books:

As suggested under the theory papers.

Course Title: Pharmaceutical Biotechnology	**Course Component:** Minor
Course code: BTC152N701	**Credit:** 4
Level of course: 400	**L-T-P-C:** 3-1-0-4

Course Objectives: The objective of this course is to make Students understand the basic concepts involved in pharmaceutical industry.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course outcome**	**Blooms Taxonomy Level**
CO1	Recall the scientific principles involved in drug development	**BT1**
CO2	Understand the strategies and various steps of new drug discovery process	**BT2**
CO3	Develop the knowledge of pharmaceutical manufacturing in the production of biopharmaceuticals like antibiotics, vaccines, proteins and hormones	**BT3**
CO4	Analyze available drug formulations for suitability of usage	**BT4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Period**
I	Definition and scope of Pharmaceutical Biotechnology, sources of drugs, classification of pharmacological agents (based on chemistry, mode of action, dosage forms), route of administration, absorption and bioavailability of drugs, distribution and liver detoxification metabolism and drug excretion.	**16**
II	General classes and properties of phytopharmaceuticals, Extraction of phytochemicals, Phytochemical screening of medicinal plants. Bioassay guided fractionation methods TLC, HPTLC, GC, and HPLC, Role of NMR and Mass spectrometry in drug discovery.	**16**
III	Antimicrobial agents, Antibiotics -source, classification, mode of action, Antimicrobial resistance, and Antimicrobial activity studies (antibacterial, antiviral, antifungal and antiparasitic activity). Pharmacological Assays - In-vitro assays - chemical (anti-oxidant),	**16**

	Biological (anticancerous and assay system based on enzymes and cells), and immunological (RIA and ELISA) - In vivo assays (Anti-inflammatory and Anti-analgesic). Basic concept of computer aided drug designing, ADMET of drugs	
IV	Vaccines: concept, production and types - Inactivated, Attenuated, toxoid, Recombinant vaccines, Peptide and DNA vaccines, Edible vaccines, nanodrugs. Recombinant proteins, approved rDNA drugs in market, Probiotics, Nutraceuticals, Economic and legal considerations in Pharmaceutical Biotechnology	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books:

1. Satoskar R.S, Nirmala N. Rege, and Bhandarkar S. D, Pharmacology and Pharmacotherapeutics (Revised 23rd Edition), Popular Prakashan, Mumbai.
2. Tripathy K. D, Essentials of Medical Pharmacology (6th edition), Jaypee publishers
3. Shoba rani R Hiremath, Text book of industrial pharmacy, Orient Longman Pvt ltd 2008.
4. Crommelin Daan J. A., Sindelar D. Robert (3rd edition) Pharmaceutical Biotechnology: Fundamentals and Applications, CRC Press, 2007.

Reference Books:

1. Trease, G. E. and Evans, W.C., 2011, Pharmacognosy (12th edition), Bailliere Tindall Eastbourne, U.K
2. Mukherje P. K., Quality Control Herbal Drugs–An approach to evaluation of botanicals. Business Horizons Pharmaceutical Publishers, 2005
3. Sambamurthy K., Pharmaceutical Biotechnology (1st edition) New Age International

SYLLABUS (8th SEMESTER)

Course Title: Research Methodology & Scientific Writing	**Course Component:** Major

Course code: BTC152M801	**Credit:** 4
Level of course: 400	**L-T-P-C:** 3-1-0-4

Course Objectives: The course aims to build scientific perspective, attitude and skills for systematic enquiry by developing understanding of philosophical foundations of research, various elements of research design and methods and tools for data collection and analysis. The course will enable comprehension of principles and elements of research methodology, to formulate research problem, objectives and questions. It will introduce students to various methods, tools and techniques related to research. The course has a strong practical component. The students will write research proposal and submit a full-length review article based on secondary data.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course outcome**	**Blooms Taxonomy Level**
CO1	Recall the scientific principles involved in research methodology	**BT1**
CO2	Understand the strategies and various steps involved in defining research problems	**BT2**
CO3	Develop the knowledge of various tools and techniques involved in for data collection and fieldwork	**BT3**
CO4	Analyze the effectiveness of literature survey in drafting quality manuscripts	**BT4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Period**
I	Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	**16**
II	Types of Researches Survey, historical, philosophical, experimental, case study, genetic Design of Experiments. Need and purpose, importance, characteristics of good experimental design, basic principles, types of basic experimental design. Questionnaire, schedule, rating scale, tests Collection of Data Need, meaning, nature; constants, variables, variate; characteristics of quantitative data, types of data, data collection, organization of data.	**16**
III	Tools of Research Questionnaire, schedule, rating scale, tests Collection of Data Need, meaning, nature; constants, variables, variate;	**16**

	characteristics of quantitative data, types of data, data collection, organization of data.	
IV	Research Report & Proposal Writing Need of research report, format of research report (preliminary section, main section & reference section), Journal matrices: citation index, h-index, impact factor of journals, mechanics of writing Reports, Research Abstract, and Research Paper, Need of research proposal for dissertation and for obtaining funds from various sources. Effective literature study approaches, analysis Plagiarism, Research ethics.	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books:

1. Kothari R.C. (2005): Research Methodology, 2nd Edition, New Age International Publisher Ltd., New Delhi.

Course Title: Ecology & Environment Management	**Course Component:** Minor
Course code: BTC152N802	**Credit:** 4
Level of course: 400	**L-T-P-C:** 3-1-0-4

Course Objectives: The main objective is to learn and understand the various components of ecology and environment. It focuses on understanding the causes of environmental problems and learns about the various policies for environment conservation, and the modern strategies for environment management.

Course Outcome:

On successful completion of the course the students will be able to:

SI No	Course outcome	Blooms Taxonomy Level
CO1	**Remember** the various components of ecology and environment.	**BT1**
CO2	**Understand** the interaction of various components of ecosystem	**BT2**
CO3	**Apply** ecological knowledge to solve real-world environmental problems.	**BT3**
CO4	**Analyze** critical thinking and problem-solving skills in the context of environmental sustainability.	**BT4**

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	**Basic concepts:** Components of Environment; Key concepts: ecosystems, biomes, and biodiversity; Levels of ecological organization (individuals, populations, communities, ecosystems); Ecological succession and stability; Energy flow and nutrient cycling; Biogeochemical cycles (carbon, nitrogen, water, etc.)	**16**
II	**Human Impact on Ecosystems:** Importance of biodiversity; Threats to biodiversity (habitat loss, invasive species, climate change); Pollution: air, water, and soil; Consequences of pollution; Climate change and its ecological consequences; Overexploitation of natural resources; Anthropogenic substances and endocrine disrupting compounds.	**16**
III	**Environmental Policy and Governance:** Definition and scope of environmental policy; Historical development of environmental policy; The Role of governments, NGOs, and international organizations in environment conservation; The importance of Environmental impact assessment (EIA), its objectives and implementation; National and international environmental policies.	**16**
IV	**Tools and Techniques in Environmental Management** : Principles of sustainable development; Circular economy and waste management; AI tools and applications for monitoring environmental quality; Geographic Information Systems (GIS) and remote sensing; Environmental modelling and simulation; Life cycle assessment (LCA); understanding the role of social media in environment conservation; Biotechnological intervention for environment management; Carbon foot printing and mitigation *etc*.	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc.*

Text Books

1. Ecology: Concepts and Applications by Manuel C. Molles
2. *Ecology and Environment* by P. D. Sharma, Rastogi Publications
3. Environmental Management: Principles and Practice by Christopher J. Barrow
4. Principles of Environmental Science by William P. Cunningham and Mary Ann Cunningham.

Reference Books

1. Fundamentals of Ecology, M. C. Dash, Tata McGraw-Hill Education
2. Environmental Management, S. K. Agarwal, APH Publishing Corporation

Course Title: Project/ Dissertation* **	**Course Component:** Major
Course code: BTC152M821	**Credit: 12**
Level of course: 400	**L-T-P-C: 0-0-24-12**

***** Only for students with an overall percentage ≥ 75% till the 6th semester***

***Major courses for the rest of the students in lieu of Project/ Dissertation**

Course Title: Developmental Biology	**Course Component:** Major
Course code: BTC152M802	**Credit:** 4
Level of course: 400	**L-T-P-C:** 3-1-0-4

Course Objectives: The main objective is to teach the processes of development, the genetic and molecular basis of development, and the evolutionary history of life forms.

Course Outcome:

On successful completion of the course the students will be able to:

SI No	Course outcome	Blooms Taxonomy Level
CO1	**Remember** the various principles of developmental biology.	BT1
CO2	**Understand** the functions of cellular organelles and how a cell carries out and regulates cellular functions	BT2
CO3	**Apply** the acquired knowledge to solve real-world medical issues.	BT3
CO4	**Analyze** critically to solve theoretical questions in the topic.	BT4

Detailed Syllabus:

Modules	Topics & Course Contents	Period
I	Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division	**16**
II	Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastulae; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizer	**16**
III	Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)	**16**
IV	Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories; Teratogenesis: Teratogenic agents and their effects on embryonic development; Amniocentesis	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*.

Text Books:

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press

Reference Books

1. Carlson, R. F. Patten's Foundations of Embryology
2. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
3. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press.

Course Title: Ecosystem Degradation and Intervention	**Course Component:** Major
Course code: BTC152M803	**Credit:** 4
Level of course: 400	**L-T-P-C:** 3-1-0-4

Course Objectives: The main objective of the course is to provide the knowledge of functioning of ecosystem, their degradation and the interventions required.

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course outcome**	**Blooms Taxonomy Level**
CO1	**Remember** the concepts of ecosystem and ecology.	**BT1**
CO2	**Understand** the role of ecosystem and ecology in degradation of environment.	**BT2**
CO3	**Apply** the theoretical knowledge of ecosystem in understanding environmental issues.	**BT3**
CO4	**Analyze** the impact of ecosystem degradation upon environment.	**BT4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Period**
I	Environment: Definitions, Components and Inter-relationships, Parts of the environment, Ecology and Ecosystems, examples of interconnections in nature. Ecology and ecosystem: Structure and boundaries of ecosystem, evolution of an ecosystem, value of ecosystem and ecosystem services. Biogeochemical cycles: Cycling elements,	**16**

	water cycle, carbon cycle, nitrogen cycle, phosphorus cycle, sulphur cycle. Impact of human activity on the cycling elements.	
II	Environmental degradation: Impact of anthropogenic activities on biotic and abiotic components of ecosystem. Causes of biodiversity loss. Ecological balance and footprint; United Nations Millennium ecosystem assessment. Environmental toxicology: Toxic chemicals in the environment (air and water) – their effects and biochemical interactions; Pesticides, Heavy metals, etc.	**16**
III	Global environmental issues: Ozone layer depletion (Montreal protocol), El Nino, Acid rain - causes and effects, Green House Gases(GHG) and greenhouse effect, global climate change, global warming – effect on oceans, coastline and marine ecosystem, impact of global warming on India. Response to global warming – Kyoto protocol and its outcome. Environmental laws: The Environment Protection Act, 1986; The Water (Prevention and Control of Pollution) Act, 1974; The Air (Prevention and Control of Pollution) Act, 1981; The Forest Conservation Act, 1980, Cartagena protocol, COP27,	**16**
IV	Biotechnological interventions for pollution control: Biofilters, Bioremediation, Biotransformation, Biodegradation, and Phytoremediation: In situ and Ex situ bioremediation; Evaluating Bioremediation; Bioremediation of VOCs. Factors affecting process of biodegradation; Contaminant availability for biodegradation; Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation; Phytoremediation: Waste water treatment using aquatic plants, sustainable agriculture, waste to energy and waste management.	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*

Text Books:

1. Kumar H. D., Modern Concepts Of Ecology, 2018, 8th edition, Vikas Publishing House
2. Tyler Miller, G. Living in the Environment: Principles, Connections, and Solution, 16th edition, 2009, Cengage Publications

Reference Books

1. Nebel, B.J. & Wright, R. Environmental Science: Toward a Sustainable Future. Pearsons, Latest edition.
2. Cunningham, W.P., Cunningham, M.A. & Saigo, B. Environmental Science, a Global Concern. (16th edition). 2021, McGraw-Hill (Boston)

Course Title: Techniques in Molecular Biology	**Course Component: Major**
Course code: BTC152M804	**Credit: 4**
Level of course: 400	**L-T-P-C: 4-0-0-4**

Course Objective: The course is designed to learn about the various molecular biology techniques and their use in the various molecular biology experiments/tests in different biotech/biomedical laboratories/industries

Course Outcome:

On successful completion of the course the students will be able to:		
SI No	**Course Outcome**	**Blooms Taxonomy Level**
CO 1	**Remember** the procedures of various molecular techniques to perform molecular biology experiments/tests in different biotech/biomedical	**BT 1**
CO 2	**Understand** the role of various instruments and setups in the Molecular Biology laboratory and in biotech/biomedical industry.	**BT 2**
CO 3	**Apply** the knowledge of molecular biology in biotech/biomedical industry	**BT 3**
CO 4	**Analyze** the theoretical knowledge in the implementation of proper molecular techniques in biotech/biomedical industry	**BT 4**

Detailed Syllabus:

Modules	**Topics & Course Contents**	**Periods**
I.	Extraction methods of nucleic acids, basic extraction steps, and nucleic acid analysis, Polymerase chain reaction (PCR), Agarose gel electrophoresis, Restriction enzymes, Restriction Digestion, RFLP, AFLP, RAPD, DNA fingerprinting, qPCR, DNA microarray	**16**

II.	Extraction methods of proteins, SDS-PAGE, 2D-gel Gel electrophoresis, Radioimmunoassay, Enzyme Linked Immunosorbent Assay (ELISA) and its types, ELISPOT, CLIA, Immunoprecipitation and Co-immunoprecipitation, Immunoelectrophoresis	**16**
III.	Preparation of antigens and antibodies, purification of antibodies, analysis of antibodies and antigens, Types of immunodiffusion methods, immunohistochemistry, Immunoflowcytometry, Immunofluorescence.	**16**
IV.	Principles of cloning, vectors and cloning strategies, Selection, screening and analysis of recombinants by genetic, immunological and nucleic acid hybridization methods, Expression in bacterial, yeast, insect and mammalian cells.	**16**
	TOTAL	**64**
Pedagogy: Lectures, Assignments, Seminars		

Credit distribution:

4 credits: 4 × 30 = 120 Notional Credit Hours (80 class hours + 40 Experiential learning)

Experiential learning activities may include:

- Undergraduate research
- Participation in a student design team
- Completion of an internship
- Student teaching
- Classroom presentation *etc*.

Text books

1. Wilson and Walker, Principles and Techniques of Biochemistry and Molecular Biology, 6th Edition, 2008, Cambridge University Press, New York, USA.
2. Owen JA, Punt J and Stranford SA (2013) Kuby Immunology, 7th Edition, WH Freeman and Company, NY.

Reference books

1. Principles of Gene Manipulation and Genomics- Primrose S &Twyman R, 7th Edition, Blackwell, 2006. ISBN-10: 1405135441
2. Male D., Brostoff J., Roitt I and Roth D (2012) Immunology, WB Saunders Co. USA.