Learning Outcomes based Curriculum Framework (LOCF)

as per NEP 2020

For M.Sc. Biotechnology

Department of Biotechnology

School of Interdisciplinary and Applied Sciences

Central University of Haryana

Jant-Pali, Mahendergarh-123031, Haryana

Session 2021-2023

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Background

Considering the curricular reforms as instrumental for desired learning outcomes, all the academic departments of Central University of Haryana made a rigorous attempt to revise the curriculum of undergraduate and postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021. The process of revising the curriculum could be prompted with the adoption of "Comprehensive Roadmap for Implementation of NEP-2020" in 32nd meeting of the Academic Council of the University held on April 23, 2021. The Roadmap identified the key features of the Policy and elucidated the Action Plan with well-defined responsibilities and indicative timeline for major academic reforms.

The process of revamping the curriculum started with the series of webinars and discussions conducted by the University to orient the teachers about the key features of the Policy, enabling them to revise the curriculum in sync with the Policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to appreciate and incorporate the vital aspects of the Policy in the revised curriculum focused on 'creating holistic, thoughtful, creative and well-rounded individuals equipped with the key 21st century skills' for the 'development of an enlightened, socially conscious, knowledgeable, and skilled nation'.

With NEP-2020 in background, the revised curricula articulate the spirit of the policy by emphasising upon— integrated approach to learning; innovative pedagogies and assessment strategies; multidisciplinary and cross-disciplinary education; creative and critical thinking; ethical and Constitutional values through value-based courses; 21st century capabilities across the range of disciplines through life skills, entrepreneurial and professional skills; community and constructive public engagement; social, moral and environmental awareness; Organic Living and Global Citizenship Education (GCED); holistic, inquiry-based, discovery-based, discussion-based, and analysis-based learning; exposure to Indian knowledge system, cultural traditions and classical literature through relevant courses offering 'Knowledge of India'; fine blend of modern pedagogies with indigenous and traditional ways of learning; flexibility in course choices; student-centric participatory learning; imaginative and flexible curricular structures to enable creative combination of disciplines for study; offering multiple entry and exit points initially in undergraduate programmes; alignment of Vocational courses with the International Standard

Classification of Occupations maintained by the International Labour Organization; breaking the silos of disciplines; integration of extra-curricular and curricular aspects; exploring internships with local industry, businesses, artists and crafts persons; closer collaborations between industry and higher education institutions for technical , vocational and science programmes; and formative assessment tools to be aligned with the learning outcomes, capabilities, and dispositions as specified for each course. In case of UG programmes in Engineering and Vocational Studies, it was decided that the departments shall incorporate pertinent NEP recommendations while complying with AICTE, NBA, NSQF, International Standard Classification of Occupations, Sector Skill Council and other relevant agencies/sources. The University has also developed consensus on adoption of Blended Learning with 40% component of online teaching and 60% face to face classes for each programme.

The revised curricula of various programmes could be devised with concerted efforts of the faculty, Heads of the Departments and Deans of Schools of Study. The draft prepared by each department was discussed in series of discussion sessions conducted at Department, School and the University level. The leadership of the University has been a driving force behind the entire exercise of developing the uniform template and structure for the revised curriculum. The Vice Chancellor of the University conducted series of meetings with Heads and Deans to deliberate upon the vital parameters of the revised curriculum to formulate a uniform template featuring Background, Programme Outcomes, Programme Specific Outcomes, Postgraduate Attributes, Structure of Masters Course, Learning Outcome Index, Semester-wise Courses and Credit Distribution, Course-level Learning Outcomes, Teaching-Learning Process, Blended Learning, Assessment and Evaluation, Keywords, References and Appendices. The experts of various Boards of Studies and School Boards contributed to a large extent in giving the final shape to the revised curriculum of each programme.

To ensure the implementation of curricular reforms envisioned in NEP-2020, the University has decided to implement various provisions in a phased manner. Accordingly, the curriculum may be reviewed annually.

Introduction of the Department

The Department of Biotechnology at CUH was established in 2015 under the umbrella of School of Interdisciplinary and Applied Life Sciences (SIAL) with an aim for providing quality education and performing cutting edge technological research. Currently the Department of Biotechnology is kept under the School of Interdisciplinary and Applied Sciences. With faculties form different backgrounds and skillset in modern technologies, the department is aimed at training students in the field of biotechnology and related subjects by encouraging interdisciplinary and multidisciplinary approaches. The focus of the department is also to develop technologies that seek solutions to real life problems related to society. Therefore, the department provides an opportunity for students seeking training in an advanced course in Biotechnology in the form of MSc Biotechnology. The programme is of two years duration (four semesters) and the curriculum is designed to cater the needs of modern research and development all over the world.

Learning Outcome based Curriculum Framework

The M.Sc. Biotechnology course at the Department of Biotechnology, CUH has been designed on the basis of learning outcome based curriculum framework (LOCF) motto. The course covers the fundamental and advanced areas of Biotechnology with a range of core subjects in each semester. Along with providing the traditional biotechnology knowledge, the course also has enough scope for inter- and multi-disciplinary subjects in the form of departmental electives. This course also caters the skill enhancement needs of the students as well as provides opportunity for collaboration and learning from other disciplines in the form of general elective courses, and thus enabling the students to broaden their horizon in complementary subjects. Every semester has a practical course for strengthening their skills in designing and conducting experiments in the field of Biotechnology. The six-month dissertation in the last semester orients and prepares the students for research and development in academia and industry.

Nature and extent of the Programme

The M.Sc. Biotechnology programme is of two years duration. Each year is divided into two semesters. Each semester will be of sixteen weeks duration. The teaching and learning in the M.Sc. Biotechnology programme will involve theory classes (lectures), tutorials, practical and

dissertation. The curriculum will be taught through formal lectures with the aid of ICT tools like power-point presentations, audio and video tools and other teaching aids can be used as and when required. The specialized subjects could be augmented by special lectures from the eminent experts in the relevant fields, which can be incorporated along with regular teaching. The latest developments in the field involving emerging technologies could be incorporated in the form of seminars, workshops, training, conferences etc.

Postgraduate Attributes

On completion of the course, the students are expected to be proficient in the fundamental, applied and modern areas of =Biotechnology. They are expected to have acquired the skills of theoretical and practical aspects of different branches of biotechnology; to be able to develop rationale thinking skills, logical interpretation and analytical skills. Effective communication of scientific developments to the society at large is very critical attribute expected from the students of this course. The attributes expected from the post-graduates of M.Sc. Biotechnology programme are:

PA1- Fundamental and advanced knowledge of biotechnology and its different branches

PA2- Orientation and specialization in at least one specific branch of biotechnology and related fields

PA3- Proficiency in theoretical and practical aspects of traditional as well as modern tools and techniques in the fields of biotechnology

PA4- Awareness and sensitization about various societal problems related to biotechnology

PA-5- Effective communication of scientific knowledge and recent developments with the society

PA-6-Acquiring skills of writing, editing and publication of research findings in reputed journals and magazines.

PA-7- Acquire skills and training in scientific communications and presentation

PA-8- Ability to design and undertake research projects to solve societal problems

PA-9-Proficiency in ICT technologies for personal, academic and professional purposes

Aims of Masters Degree Programme in Biotechnology

The objective of this course is to provide fundamental and advanced knowledge of biotechnology and its related subjects.

- To generate competent human resources skilled to contribute towards the sustainable development of industry, teaching, and research in different areas of Biotechnology.
- To develop a set of interdisciplinary professional skills that will enable the students in research and development in Biotechnology.
- To bring social, ethical, and professional awareness among the students about various issues of contemporary practices in biotechnology and related fields.

Qualification Descriptors

Upon successful completion of the course, the students receive a M.Sc. degree in Biotechnology. Biotechnology postgraduates of this department are expected to branch out into different paths of seeking advanced research based knowledge, professional employment, or entrepreneurship that they find fulfilling. They will be able to demonstrate knowledge as well as skills in diverse fields of Biotechnology. This will provide a foundation, which shall help them to embark on research careers by attaining doctoral positions in coveted institutions, as well as securing employment in research projects in industry or institutes. Besides research, they can get suitable teaching positions in Colleges and Universities as an Assistant Professor after qualifying National Eligibility Test (NET). It is expected that besides the skills specific to the discipline, the wider life skills of analysis, logical reasoning, scientific aptitude, communication skills, research and life ethics, and moral values will be inculcated in the students. The list below provides a synoptic overview of possible career paths provided by a postgraduate training in Biotechnology:

1. Research

2. Industry

3. Teaching

4. Biotechnology entrepreneurship

5. Administration and Policy Making

6. Scientific Communication

7. Patents and Law

8. Scientific Writing and Editing

9. Document preparation and publication

Programme learning outcomes M.Sc. Biotechnology

After completion of the programme, the students will be able

PLO 1 – To apply the knowledge of basic biotechnology to solve complex problems in the society

PLO 2 – To identify, formulate, review research literature, analyse, and design experiments and identify solutions for complex problems using modern tools

PLO 3 – To apply reasoning informed by contextual knowledge to assess societal, health, safety and the consequent responsibilities relevant to the professional biotechnology practices.

PLO 4 – To apply ethical principles and commit to professional ethics and responsibilities and norms of the biotechnology practices.

PLO 5 – To function effectively as an individual and as a member or leader in diverse teams and in inter- and multi-disciplinary settings.

PLO – 6 To communicate effectively on complex biotechnology activities with the biology community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PLO – 7 To recognize the need for, and have the preparation and ability to engage inindependent and lifelong learning in the broadest context of technological change.

Programme Outcomes

- **Basic and applied knowledge:** Interdisciplinary knowledge to find solution for the complex biological problems
- **Problem analysis:** Ability to analyse society related/ applied research problem, design and execute experiments to find relevant solutions
- **Advanced Usage of Technology**: Apply advanced instrumentation tools, online resources with an understanding of the troubleshooting and limitations

- **Ethics:** Commitment towards professional ethics and responsibilities as a social endeavour to bring harmony with nature
- **Lifelong learning:** Scientific skills for industrial applications and entrepreneurship

Programme Specific Outcomes

After completion of M.Sc. Biotechnology, the students will be able:

PSO – 1 To understand the basic principles and applications of biotechnology.

PSO – 2 To understand the principles of microbiology, cell biology, biochemistry, molecular biology, genetics, and molecular biology involved in biotechnology to identify crucial biological problems.

PSO – 3 To realize the importance of laws and ethics in biotechnological practices and be able topractice good laboratory practices.

PSO – 4 To handle basic, sophisticated advanced instruments needed in a research laboratory with ability to design and execute experiments with precision in a logical manner.

PSO – 5 To understand theoretical as well as practical aspects of gene cloning, expression of recombinant proteins, tissue culture, and transgenic development.

PSO – 6 To understand the basics of statistics and computational methods used in biological processes.

PSO – 7 To understand the principles and applications of genomics, transcriptomics, and proteomics, and integrate the knowledge of omics and genetic engineering to address problemsof healthcare, crop improvement, energy and environment.

PSO – 8 To understand the principles and applications of bioprocess designing, pharmaceutical biotechnology, and nanotechnology for solving problems of biology and other related sciences.

PSO-9- To launch start-ups and become entrepreneurs for novel biotechnology products and processes in various industries.

PSO-10-To understand Biosafety measures, Ethical issues and regulatory compliances in the field of Biotechnologyand effective scientific communication.

Course Structure semester wise

Semester-I (Total credits - 26)

Course code	Course title	L	T	P	Type of course	Credit
SIAS BT 1 1 01 C 2002	Introduction to Biotechnology	2	0	0	Core	2
SIAS BT 1 1 02 C 4004	Principles of Biochemistry	4	0	0	Core	4
SIAS BT 1 1 03 C 4004	Introduction to Microbiology	4	0	0	Core	4
SIAS BT 1 1 04 C 4004	Genetics	4	0	0	Core	4
SIAS BT 1 1 05 C 4004	Analytical Techniques	4	0	0	Core	4
SIAS BT 1 1 06 C 0084	Practical-I	0	0	8	Core	4
	Generic Elective Course (to be opted from other Departments of CUH or from SWAYAM/NPTEL MOOC courses)	4	0	0	GEC	4

Semester-II (Total credits - 27)

Course code	Course title	L	T	P	Type of course	Credit
SIAS BT 1 2 01 C 4004	Cell and Molecular Biology	4	0	0	Core	4
SIAS BT 1 2 02 C 4004	Immunology	4	0	0	Core	4
SIAS BT 1 2 03 C 3003	Biosafety, Bioethics and IPR	3	0	0	Core	3
SIAS BT 1 2 04 C 3003	Genetic Engineering	3	0	0	Core	3
SIAS BT 1 2 05 C 2002	Seminar	1	1	0	Core	2
SIAS BT 1 2 06 C 4004	Omics in Biotechnology	4	0	0	Core	4
SIAS BT 1 2 07 C 0084	Practical-II	0	0	8	Core	4
SIAS BT 1 2 01 DCEC 3003	Pharmaceutical Biotechnology[#]	3	0	0	DCEC	3
SIAS BT 1 2 02 DCEC 3003	Microbial Biotechnology[#]	3	0	0	DCEC	3
SIAS BT 1 2 03 DCEC 3003	Environmental Biotechnology[#]	3	0	0	DCEC	3

[#] One of the courses will be opted by the student.

Semester-III (Total credits – 27)

Course code	Course title	L	T	P	Type of course	Credit
SIAS BT 1 3 01 C 4004	Biostatistics and Bioinformatics	4	0	0	Core	4
SIAS BT 1 3 02 C 4004	Biophysics and Nano sciences	4	0	0	Core	4
SIAS BT 1 3 03 C 4004	Medical Biotechnology and Diagnostics	4	0	0	Core	4
SIAS BT 1 3 04 C 4004	Fermentation and Bioprocess Technology	4	0	0	Core	4
SIAS BT 1 3 05 C 00084	Practical-III	0	0	8	Core	4
SIAS BT 1 3 01 DCEC 3003	Animal Biotechnology[#]	3	0	0	DCEC	3
SIAS BT 1 3 02 DCEC 3003	Agricultural Biotechnology[#]	3	0	0	DCEC	3
	Generic Elective Course (to be opted from other Departments of CUH or from SWAYAM/NPTEL MOOC courses)	4	0	0	GEC	4

[#] One of the courses will be opted by the student.

Semester-IV (Total credits - 20)

Course code	Course title	Type of course	Credit
SIAS BT 1 4 01 SEC 2002	Review Writing, Editing and Presentation Skills	Core	2
SIAS BT 1 4 02 SEC 0018	Dissertation	Core	18
	Total credits of the Program		**100**

L- Lecture , T- Tutorial P-Practical; C- Core; DCEC - Discipline Centric Elective Course - to be opted by the student; SEC- Skill Enhancement Course; GEC- Generic Elective Course.

Learning Outcome Index (Core courses*)

PSO	CC -1	CC -2	CC -3	CC -4	CC -5	CC -6	CC -7	CC -8	CC -9	CC -10	CC -11	CC -12	CC -13	CC -14	CC -15	CC -16	CC -17	CC -18
PSO-1	√					√			√	√	√	√	√		√	√	√	√
PSO-2	√	√	√	√	√	√	√	√		√	√	√	√			√		√
PSO-3	√				√	√			√	√			√				√	√
PSO-4					√	√				√			√	√			√	√
PSO-5	√	√	√	√	√	√	√			√	√		√			√	√	√
PSO-6						√							√	√			√	√
PSO-7								√		√	√	√				√		
PSO-8	√		√					√			√				√	√	√	
PSO-9	√								√	√			√			√		
PSO-10			√			√		√	√	√			√					√

*Core courses details

	Course code	Course title
CC1	SIAS BT 1 1 01 C 2002	Introduction to Biotechnology
CC2	SIAS BT 1 1 02 C 4004	Principles of Biochemistry
CC3	SIAS BT 1 1 03 C 4004	Introduction to Microbiology
CC4	SIAS BT 1 1 04 C 4004	Genetics
CC5	SIAS BT 1 1 05 C 4004	Analytical Techniques
CC6	SIAS BT 1 1 06 C 00105	Practical-I
CC7	SIAS BT 1 2 01 C 4004	Cell and Molecular Biology
CC8	SIAS BT 1 2 01 C 4004	Immunology
CC9	SIAS BT 1 2 02 C 3003	Biosafety, Bioethics and IPR
CC10	SIAS BT 1 2 03 C 4004	Genetic Engineering
CC11	SIAS BT 1 2 04 C 2002	Seminar
CC12	SIAS BT 1 2 05 C 4004	Omics in Biotechnology
CC13	SIAS BT 1 2 06 C 00105	Practical-II
CC14	SIAS BT 1 3 01 C 4004	Biostatistics and Bioinformatics
CC15	SIAS BT 1 3 02 C 4004	Biophysics and Nano sciences

CC16	SIAS BT 1 3 03 C 4004	Medical Biotechnology and Diagnostics
CC17	SIAS BT 1 3 05 C 0202	Fermentation and Bioprocess Technology
CC18	SIAS BT 1 3 04 C 00105	Practical-III

Learning outcome index (elective and skill enhancement courses)*

PSO	EC-1	EC-2	EC-3	EC-4	EC-5	SEC-1	SEC-2
PSO-1	√	√	√	√	√	√	√
PSO-2	√	√	√	√	√	√	√
PSO-3	√	√	√	√	√	√	
PSO-4				√	√	√	
PSO-5	√	√	√	√	√	√	
PSO-6						√	
PSO-7	√	√	√	√	√	√	
PSO-8	√	√	√				
PSO-9	√	√	√	√	√		
PSO-10						√	√

*Details of elective and skill enhancement courses

EC1	SIAS BT 1 2 01 DCEC 4004	Pharmaceutical Biotechnology
EC2	SIAS BT 1 2 02 DCEC 4004	Microbial Biotechnology
EC3	SIAS BT 1 2 03 DCEC 4004	Environmental Biotechnology
EC4	SIAS BT 1 3 01 DCEC 4004	Animal Biotechnology
EC5	SIAS BT 1 3 02 DCEC 4004	Agricultural Biotechnology
SEC1	SIAS BT 1 4 01 SEC 2002	Review Writing, Editing and Presentation Skills
SEC2	SIAS BT 1 4 02 SEC 0018	Dissertation

Teaching Learning Processes

- Lectures
- Discussions
- Simulations
- Role Playing
- Participative Learning
- Interactive Sessions
- Seminars
- Practical based learning
- Research-based Learning/Dissertation or Project Work
- Technology-embedded Learning
- Reverse classroom based learning

Blended Learning

Blended Learning is a pedagogical approach that combines face to-face classroom methods with computer-mediated activities in the process of teaching and learning. It implies nice blend of face-to-face and online activities to make the learning processes more interesting and engaging. It focuses on integration of traditional classroom activities and innovative ICT-enabled strategies. It emphasizes student-centric learning environment where the teacher is the facilitator for productive and measurable learning outcomes. It optimizes and compliments the face to face learning, giving ample freedom and flexibility to the students and teachers to access and explore the wide range of open-access sources such as video lectures, podcasts, recordings and articles through digital platforms. It gives freedom and autonomy to the teachers in selection of appropriate digital platforms, resources and time-slots to complement and supplement face to face learning. The Blended Learning doesn't undermine the role of the teacher, rather it gives

him/her an opportunity to explore the unexplored in accordance with the requirements of the curriculum. Each course will be taught as 60 % offline and 40 % online mode.

Assessment and Evaluation

- Continuous Comprehensive Evaluation at regular after achievement of each Course-level learning outcome
- Formative Assessment on the basis of activities of a learner throughout the programme instead of one-time assessment
- Oral Examinations to test presentation and communication skills
- Online examination and evaluation
- Open Book Examination for better understanding and application of the knowledge acquired
- Group Examinations on Problem solving exercises
- Seminar Presentations
- Review of Literature
- Collaborative Assignments
- Practical examination

Continuous assessment of all papers will be broadly carried out in two forms:

1) **Continuous Internal Evaluation (CIE):** The theoretical courses will be assessed based on any or all of the following-written tests, assignments, presentations and regularity in the class. Assessment of the practical courses will be based on any or all of the following- regularity, practical records, experiments performance, viva etc. The dissertation will be assessed based on the regular interaction with the supervisor, regular presentation of work, completion of assigned tasks, thesis submission, viva etc. The internal evaluation will be carried out throughout the term and will comprise 30% of the final grade. Participation of students in quiz, seminar, workshop, games, yoga and other extra-curricular activities will be promoted and facilitated by the department.

2) Term End Assessment/Evaluation (TEE): The theoretical courses will be assessed based on written exam, which may be subjective, objective for both. This will cover the entire syllabus. Assessment of the practical courses will be based on performing and/or description of experiments, maintaining of the practical records, viva etc. The dissertation will be assessed based on the thesis reported, viva etc. The end of semester examination comprises 70% of the final grade.

Both internal and Term end evaluations will be in blended mode.

Keywords

- LOCF
- NEP-2020
- Blended Learning
- Face to face (F to F) Learning
- Online Learning
- Programme Outcomes
- Programme Specific Outcomes
- Course-level Learning Outcomes
- Postgraduate Attributes
- Learning Outcome Index
- Formative Assessment and Evaluation
- Comprehensive and Continuous Evaluation

References

- National Education Policy-2020. https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
- The draft subject specific LOCF templates available on UGC website. https://www.ugc.ac.in/ugc_notices.aspx?id=MjY5OQ==
- Draft Blended Mode of Teaching and Learning: Concept Note available on UGC website. https://www.ugc.ac.in/pdfnews/6100340_Concept-Note-Blended-Mode-of-Teaching-and-Learning.pdf

Department of Biotechnology
Master of Science in Biotechnology (Semester - wise Scheme 2021-2023)

Semester-I (Total credits - 26)

Course code	Course title	L	T	P	Type of course	Credit
SIAS BT 1 1 01 C 2002	Introduction to Biotechnology	2	0	0	Core	2
SIAS BT 1 1 02 C 4004	Principles of Biochemistry	4	0	0	Core	4
SIAS BT 1 1 03 C 4004	Introduction to Microbiology	4	0	0	Core	4
SIAS BT 1 1 04 C 4004	Genetics	4	0	0	Core	4
SIAS BT 1 1 05 C 4004	Analytical Techniques	4	0	0	Core	4
SIAS BT 1 1 06 C 0084	Practical-I	0	0	8	Core	4
	Generic Elective Course (to be opted from other Departments of CUH or from SWAYAM/NPTEL MOOC courses)	4	0	0	GEC	4

Semester-II (Total credits - 27)

Course code	Course title	L	T	P	Type of course	Credit
SIAS BT 1 2 01 C 4004	Cell and Molecular Biology	4	0	0	Core	4
SIAS BT 1 2 02 C 4004	Immunology	4	0	0	Core	4
SIAS BT 1 2 03 C 3003	Biosafety, Bioethics and IPR	3	0	0	Core	3
SIAS BT 1 2 04 C 3003	Genetic Engineering	3	0	0	Core	3
SIAS BT 1 2 05 C 2002	Seminar	1	1	0	Core	2
SIAS BT 1 2 06 C 4004	Omics in Biotechnology	4	0	0	Core	4
SIAS BT 1 2 07 C 0084	Practical-II	0	0	8	Core	4
SIAS BT 1 2 01 DCEC 3003	Pharmaceutical Biotechnology[#]	3	0	0	DCEC	3
SIAS BT 1 2 02 DCEC 3003	Microbial Biotechnology[#]	3	0	0	DCEC	3
SIAS BT 1 2 03 DCEC 3003	Environmental Biotechnology[#]	3	0	0	DCEC	3

[#] One of the courses will be opted by the student.

Semester-III (Total credits – 27)

Course code	Course title	L	T	P	Type of course	Credit
SIAS BT 1 3 01 C 4004	Biostatistics and Bioinformatics	4	0	0	Core	4
SIAS BT 1 3 02 C 4004	Biophysics and Nano sciences	4	0	0	Core	4
SIAS BT 1 3 03 C 4004	Medical Biotechnology and Diagnostics	4	0	0	Core	4
SIAS BT 1 3 04 C 4004	Fermentation and Bioprocess Technology	4	0	0	Core	4
SIAS BT 1 3 05 C 00084	Practical-III	0	0	8	Core	4
SIAS BT 1 3 01 DCEC 3003	Animal Biotechnology[#]	3	0	0	DCEC	3
SIAS BT 1 3 02 DCEC 3003	Agricultural Biotechnology[#]	3	0	0	DCEC	3
	Generic Elective Course (to be opted from other Departments of CUH or from SWAYAM/NPTEL MOOC courses)	4	0	0	GEC	4

[#] One of the courses will be opted by the student.

Semester-IV (Total credits - 20)

Course code	Course title	Type of course	Credit
SIAS BT 1 4 01 SEC 2002	Review Writing, Editing and Presentation Skills	Core	2
SIAS BT 1 4 02 SEC 0018	Dissertation	Core	18
	Total credits of the Program		**100**

L- Lecture , T- Tutorial P-Practical; C- Core; DCEC - Discipline Centric Elective Course - to be opted by the student; SEC- Skill Enhancement Course; GEC- Generic Elective Course.

Credit Summary of Courses Offered by Department of Biotechnology

(Academic Session 2019-21)

Total Credits: 100

Semester	Credits				Total credits
	Core courses	Skill enhancement course	Elective courses		
			DCEC (For Department of Biotechnology students)	GEC (For other Department students)	
I	18	4	-	4	**26**
II	20	4	3	-	**27**
III	16	4	3	4	**27**
IV	-	20	-	-	**20**
Total	**44**	**32**	**6**	**8**	**100**

Generic Elective Course: Offered by Department of Biotechnology to students from other Departments of University.

Semester	Type of course	Course code	Course title	Credit
I	GEC	SIAS BT 1 1 01 GE 4004	Principles of Biotechnology	4
III	GEC	SIAS BT 1 3 01 GE 4004	Basics of Bioinformatics	4

Course Name: Introduction to Biotechnology					Course Code: SIAS BT 1 1 01 C 2002		
Batch:	**Programme:**	**Semester : I**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 02**
2021-2023	M.Sc. Biotechnology		2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 50 **CIE:** **15** Marks **TEE:** **35** Marks		**Examination Duration:** 2 Hrs.					
Course Objectives	To provide basic understanding of biotechnology; it's scope, different branches and applications in the agriculture, medicine, industrial, environment and advancement of biology.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Knowledge in the field of basic biotechnology and career opportunities. **CO2:** Understanding of major concepts and disciplines related to biotechnology **CO3:** Understanding about the scope and applications of biotechnology in different fields.						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have four sub-parts and students need to answer any two. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries three and half marks.

Unit No.	Contents	Contact Hrs.
I	An overview-: Definition, scope and importance of old and new biotechnology, Historical development and major breakthrough research in Biotechnology; societal implications and ethical issues in biotechnology. Concepts of recombinant DNA technology and Gene Cloning.	8
II	An overview of different fields of biotechnology and their applications- plant biotechnology, animal biotechnology, microbial biotechnology, medical biotechnology, environmental biotechnology, food biotechnology, pharmaceutical biotechnology, industrial biotechnology and bioinformatics;	7
III	Career options for biotechnology students in India and abroad; formulation and implementation of strategy for a desired career path; list of leading biotechnology research institutes/universities/industries in India and abroad;	8
IV	An overview of Nanobiotechnology Indian biotechnology industry: status, opportunities and challenges; bio-entrepreneurship and start-ups; funding agencies for research and developments. Role of biotechnology in pollution control	7

Suggested Readings:

1. Elements of Biotechnology (4th reprint), P. K. Gupta, Rastogi Publications, 2019-20.
2. Biotechnology-Expanding Horizons, B. D. Singh, Kalyani Publishers, 2015.
3. Biotechnology: Prospects and Applications (2013). Salar, R.K., Gahlawat, S.K., Siwach, P. and Duhan, J. S., Springer, Germany. ISBN 978-81-322-1682-7.
4. Textbook of Biotechnology, H.K. Das, John Wiley & Sons 2004.
5. Introduction to Biotechnology (4^{th} edition), W. J. Thieman & M. A. Palladino, Pearson Publications, 2018.
6. History of Modern Biotechnology, A. Fiechter (Ed.), Springer Publishing House, 2000.

Course Name: Principles of Biochemistry					Course Code: SIAS BT 1 1 02 C 4004		
Batch:	**Programme:**	**Semester : I**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology		4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	• To understand structures and functions of bio-molecules • To provide in depth knowledge of metabolic pathways in the living systems						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Comprehensive knowledge of biochemical pathways operating in living systems **CO2:** Advanced knowledge of synthesis and catabolism of major biomolecules						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Monosaccharides-structure of aldoses and ketoses, ring structure of sugars, conformations of sugars, mutarotation, anomers, epimers and enantiomers. Disaccharides: maltose, lactose and sucrose. Polysaccharides: homo and hetero-polysaccharides, structural and storage polysaccharides. Glycolysis - a universal pathway, reactions of glycolysis, production of acetyl CoA, reactions of citric acid cycle. Gluconeogenesis, glycogenesis and glycogenolysis.	15
II	Building blocks of lipids - fatty acids, glycerol, ceramide. Storage lipids - triacyl glycerol and waxes. Structural lipids in membranes-phospholipids, glycerophospholipids, galactolipids, sulpholipids, sphingolipids and sterols. β-oxidation of fatty acids. Fatty acid synthase complex. Synthesis of fatty acids.	15
III	Amino acids and peptides- classification (essential and non-essential amino acids), chemical reactions and physical properties. Introduction to protein structure and function. Enzymes: classification, kinetics (significance of k_m, k_{cat} and V_{max}), inhibition; amino acid metabolism-amino acid deamination and transamination, urea cycle. Synthesis and utilization of ketone bodies. Biosynthesis and breakdown of nutritionally non-essential amino acids. Synthesis of other amino acid derivatives such as neurotransmitters.	15

IV	Nucleotides - structure and properties. Nucleic acid structure-Watson - Crick Model of DNA. Structure of major species of RNA - mRNA, tRNA and rRNA. De novo synthesis of purine and pyrimidine nucleotides. Catabolism of purine and pyrimidine. Disorders of purine and pyrimidine metabolism. Recent advances and applications in the field.	15

Suggested Readings:

1. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, DL and Cox, MM, WH Freeman and Company (New York), ISBN: 978-1319108243.
2. Biochemistry (2017) 6th ed., Garrett RH and Grisham CM, Brooks/Cole, ISBN: 9781305577206.
3. Harper's Illustrated Biochemistry (2018) 7th ed., Rodwell VW, Bender DA, Botham KM, Kennelly, PJ and Weil PA, McGraw-Hill, ISBN: 9781259837937.
4. Lippincott's Illustrated Reviews Biochemistry (2017) 7th ed., Ferrier, Wolters Kluwer India Pvt. Ltd., ISBN: 978-9351297949.
5. Biochemistry (2019) 9th ed., Stryer L, Berg JM, Tymoczko JL, Gatto Jr. GJ, W.H. Freeman and Company, New York, USA. ISBN-10: 1-319-11467-9.

Course Name: Introduction to Microbiology					Course Code: SIAS BT 1 1 02 C 4004		
Batch:	**Programme:**	**Semester : I**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology		4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	**To provide an understanding of basic concepts and techniques in the field of Microbiology.**						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1: Demonstrate the practical skills in basic microbiological techniques.** **CO2: Designate the role of microorganisms in different ecosystems and in various industries.** **CO3: Acquiring knowledge on peculiar features of different microorganisms.**						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	History of development of Microbiology in 20th century; Golden era of Microbiology, Major scientists and their discoveries, The spontaneous generation theory and its controversy; Germ theory of disease; Methods in microbiology: Physical and chemical methods of sterilization; Pure culture techniques, Staining techniques, maintenance and preservation of microbial cultures.	15
II	Binomial nomenclature; Haeckel's three kingdom classification; Organization of archae, bacteria and eukaryotic cell; Use of DNA and r-RNA sequencing in classification of microorganisms; Woese's three kingdom classification system and its utility - archaea, eubacteria, eukarya; Different groups of acellular microorganisms - viruses, viriods and prions.	15
III	General features of microorganisms - bacteria, algae, fungi and protozoa; Bacterial growth and metabolism; Microbes in different environment: extreme environment, deep ocean, space and air. Special features of the thermophilic, methanogenic and halophilic bacteria; Photosynthetic bacteria, Cyanobacteria.	15

IV	Scope of Microbiology - Cycle of matter in nature; Microbial interactions – Symbiosis and parasitism; Biodegradation and Bioremediation; Biofilms; Microbes in composting; Biofertilizers and Biopesticides; Microbes and Industry - SCP, microbial enzymes and fermented foods, Vaccines and antibiotics. Recent advances and applications in the field.	15

Suggested Readings:

1. An Introduction to Microbiology (2019), 3rded., Tauro P, Kapoor KK, Yadav KS, and Sequeira MG. New Age International Publishers. ISBN: 0852268785.
2. Brock Biology of Microorganisms (2018), 15thed., Madigan MT, Martinko JM, Bender KS, Buckley DH, Stahl DA Pearson Education, ISBN 9781292235103.
3. Prescott's Microbiology (2017). 10th ed. Sherwood LM, Woolverton C.J McGraw-Hill Education. ISBN 9781259281594.
4. A text book of Microbiology (2013), 3rd ed. Dubey, R.C. and Maheswari, D.K. Revised S. Chand and Company Ltd, New Delhi. ISBN: 9788121926201.
5. Microbiology (2001) 5th ed., Pelczar Jr. M, McGraw Hill Education ISBN: 9780074623206.

Course Name: Genetics					Course Code: SIAS BT 1 1 04 C 4004		
Batch:	**Programme:**	**Semester : I**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology		4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To study the fundamental concepts of genetics and its role in unification of different disciplines of biology.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of basic concepts of classical genetics and genetic analysis of eukaryotes. **CO2:** Acquiring knowledge about the genetic differences in prokaryotes and eukaryotes **CO3:** Understanding the effect of different environmental factors on gene expression						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Historical background, Principles of Mendelian inheritance, detailed discussion on Mendel's findings, molecular basis of single gene inheritance, codominance, incomplete dominance, Gene interactions, interactions of genes in genetic pathways, pleiotropy, Extra chromosomal inheritance: Maternal inheritance (mitochondria and chloroplast), Sex linked inheritance, Sex influenced and Sex limited traits, lethal genes, and multiple alleles, polygenic inheritance, complementation test. Numericals based on Mendelian inheritance and gene interactions.	15
II	Linkage: complete and incomplete linkage, linkage analysis and genetic maps, Linkage and recombination of gene, Mechanism of crossing over, Genetic analysis: calculating recombination frequencies, Linkage maps, types of molecular markers, mapping with molecular markers, Gene mapping by three point test cross, Tetrad analysis, Sex determination and Dosage compensation in Mammals and Drosophila, Quantitative Genetics: Multilocus control; QTL analysis; Quantitative inheritance in plants and human. Population Genetics and Hardy-Weinberg equilibrium. Genetic maps, Physical maps. Numericals based on linkage analysis and population genetics.	15

III	Mutations: concept and types, Mechanism of spontaneous mutations, Physical and chemical mutagenesis, Selection and enrichment of mutants, Molecular mechanism of induced and spontaneous mutations, importance of mutation; detection of mutation and directed mutagenesis, types of mutations: insertion, deletion, duplication, translocation, transposition, frame-shift, mis-sense, non-sense, regulatory region mutations. Consequences of mutations. Replica plating experiment, Luria and Delbruck test, Numerical alterations of chromosomes: Ploidy and their genetic implications.	15
IV	Structure and organization of prokaryotic and eukaryotic and organellar genomes, Chromatin structure and organisation: nucleosomes, Structure of centromere and telomere, Euchromatin and heterochromatin, Polytene and lamp brush chromosomes, Chromatin remodelling, histone modifications, epigenetic inheritance. Gene transfer in prokaryotes: Transformation, Conjugation and Transduction, Transposons: types, structures and role in gene regulation, Natural and artificial competence, Operon concept in bacteria, positive and negative gene regulation, Lytic and lysogenic cell cycles in Phages, genetic switch in lambda phage. Recent advances and applications in the field.	15

Suggested Readings:

1. Principles of Genetics (2006) 8th ed. Gardner EJ, Simmons, MJ and Snustad DP, John Wiley & Sons Inc, ISBN: 8126510439.
2. Essentials of Genetics (2015) 9th ed. William S, Michael K, Cummings R, Spencer, CA and Palladino MA, Prentice Hall Internationals, ISBN-10: 0134047796
3. Genetics (2017) 9th ed. Daniel L. Hartal&B. Cochrane, ISBN: 128412293X
4. Introduction to Quantitative Genetics (1995) Falconer DS, and Mackay TFC, ISBN: 0582243025.
5. An Introduction to Population Genetics Theory and applications (2013) Nielsen R and Slatkin M, Oxford University Press, ISBN: 1605351539.
6. Evolution 4th ed. (2017) D. Futuma and M. Kirkpatrick, ISBN: 9781605356051
7. An Introduction to Genetic Analysis (2015) Griffith AJFJ, Wessler SR, Carroll SV and Doebley J, ISBN: 0-7167-3520-2.

Course Name: Analytical Techniques					Course Code: SIAS BT 1 1 05 C 4004		
Batch:	**Programme:**	**Semester : I**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology		4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To provide an advanced understanding of the core principles and applications of various techniques used in biology/biotechnology.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Demonstrate principles of various basic and advanced techniques used in biological experiments. **CO2:** Critically analyze and interpret the results obtained from biological experiments. **CO3:** Understanding of solving biological problems using various techniques						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Principle of microscopy: resolving powers of different microscopes, magnification; different types of microscopes, principle and applications of compound microscopy, dark microscopy, fluorescence microscopy, phase contrast microscopy, confocal microscopy, atomic force microscopy and electron microscopy (SEM, TEM, STEM); fixation and staining, freeze fracture/etch techniques.	15
II	Agarose gel electrophoresis, polyacrylamide gel electrophoresis (native PAGE and SDS-PAGE); Western transfer technique, iso-electric focusing (IEF), 2-Dimensional gel electrophoresis, pulse field electrophoresis; principle and applications of centrifugation, differential centrifugation, density gradient centrifugation and ultracentrifugation; principle and applications of flow cytometry.	15
III	Paper chromatography: types, principles and applications; principle and applications of thin layer chromatography (TLC), column chromatography (gel filtration, ion exchange and affinity chromatography); Adsorption and hydrophobic interaction chromatography, metal chelate chromatography, Structure, principle and applications of high performance liquid chromatography (HPLC), fast protein liquid chromatography (FPLC) and gas chromatography (GC).	15

IV	Principle and instrumentation of UV-visible, infrared spectroscopy, atomic absorption spectrophotometery, NMR spectroscopy, X-ray diffraction spectroscopy, N-terminal sequencing and peptide synthesis, introduction to proteomics, Yeast 2- hybrid and 3-hybrid systems, EMSA, CHIP, foot printing, phage display, principle of mass spectrometry, electrospray ionization MS, MALDI, tandem MS for protein identification. Recent advances and applications in the field.	15

Suggested Readings:

1. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Wilson K and Walker J, Cambridge University Press, ISBN No. 131661476X.
2. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D., Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
3. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (1982) 2nd ed., Freifelder D, W.H. Freeman and Company (New York), ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.

Course Name: Practical-I					Course Code: SIAS BT 1 1 06 C 0084		
Batch:	**Programme:**	**Semester : I**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week:8**
2021-2023	M.Sc. Biotechnology		0	0	8	4	**Total Hrs.:120**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	• To inculcate/impart skills to perform various tests/assays and experiments. • To impart skills of experiment designing, practical execution and report writing.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Improved skills to perform various tests/assays and experiments. **CO2:** Improved skills of experiment designing, practical execution and report writing. **CO3:** Ability to check the presence of adulterants in various food/feed samples						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	1. Laboratory orientation, calibration, and demonstration of equipments. 2. Preparation of solutions, pH and buffers 3. Determination of pKa of acetic acid and glycine 4. Qualitative tests for carbohydrates, lipids, amino acids, and proteins in food samples 5. Metaphase chromosome preparation with G banding and C banding from blood sample 6. Preparation of standard curve for quantitative analysis of protein/sugar samples using calorimetric methods	30
II	1. Inheritance patterns in man – numerical on pedigree analysis- autosomal patterns, X–linked patterns, Y–linked patterns, mitochondrial inheritance patterns 2. To study numerical based problems on Hardy-Weinberg equilibrium 3. To study numerical problems on linkage mapping 4. To study microscopic examination of bacteria, actinomycetes, algae, fungi and protozoa with or without staining 5. To study cell counting and cell viability assay	30

III	1. Preparation of specific media for isolation of bacteria, and fungi from natural sources 2. Production and analysis of microbial enzymes 3. Separation and purification of microbial enzymes/metabolites using various techniques 4. Biochemical characterization of microbial enzymes/metabolites. 5. To study the thermal denaturation/renaturation profile of DNA sample	30
IV	1. Separation of carbohydrates, amino acids and plant pigments using paper/thin layer chromatography 2. Isolation of genomic DNA from microbial/plants/other sources 3. Agarose gel electrophoresis for given DNA samples 4. Separation of proteins using native- and SDS-polyacrylamide gel electrophoresis 5. Analysis of protein/DNA samples using UV-VIS spectrophotometer	30

Suggested Readings:

1. An Introduction to Practical Biochemistry (2017) 3rd ed., Plummer, D.T., McGraw Hill Education, ISBN: 978-0070994874.
2. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Wilson K, and Walker J, Cambridge University Press. ISBN: 131661476X.
3. Microbes in Action: A Laboratory Manual of Microbiology (1990) 4th Addition, Harry W, Seeley, Paul JV, John J, W. H. Freeman ISBN: 978-0716721000.
4. Genetics: A Laboratory Manual, (2009) 2nd ed., American Society of Agronomy; Lab Manual edition, ISBN: 978-0891185611.
5. Infant, Child and Adolescent Nutrition: A Practical Handbook (2013) 1st ed., More J, CRC Press, ISBN: 9781444111859.
6. Laboratory Manual of Microbiology and Biotechnology (2014) 1sted.Aneja KR, Scientific International Pvt., Ltd. ISBN: 9789381714553.
7. Microbiology: A Laboratory Manual (2020), 12th ed., Cappuccino, JH, Welsh CT., Pearson Education Inc, ISBN: 9780135203996.
8. An introduction to Practical Biochemistry (2017) 3rd ed., Plummer, DT, McGraw Hill Education, ISBN: 978-0070994874.

Course Name: Principles of Biotechnology					Course Code: SIAS BT 1 1 01 GEC 4004		
Batch:	**Programme:**	**Semester : I**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology		4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To provide basic understanding of biotechnology; it's scope and applications in the agriculture, medicine, industrial, environment and advancement of biology.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Knowledge in the field of basic biotechnology. **CO2:** Understanding of major concepts in the field of biotechnology **CO3:** Understanding about the scope and applications of biotechnology in different fields.						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	An overview-definition, Scope and importance of biotechnology, Concepts of recombinant DNA technology and Gene Cloning. A brief account of microbes in industry and agriculture, Metabolic engineering for over production of metabolites.	15
II	Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction). *In-vitro* fertilization and embryo transfer in humans and livestock. Transfection techniques and transgenic and genome edited animals, Animal Cloning.	15
III	(A brief account) Biotechnology in medicine, Vaccines, Molecular diagnostics, Forensic, Gene therapy, Nano Medicine & Drug Delivery Cell & Tissue Engineering, Stem Cell therapy. (A brief account) Role of biotechnology in pollution control, Sewage treatment, Energy management, Bioremediation, Restoration of degraded lands and Conservation of biodiversity.	15
IV	An Overview, Insights and intervention into the Nano world, Important Developments, Societal implications & Ethical issues in Nanotechnology, applications of Nano-biotechnology in different areas. Biotechnology for developing countries and IPR	15

Suggested Readings:

1. Lehninger Principles of Biochemistry (2017) 7th ed., D.L. Nelson, M.M. Cox.. W.H. Freeman and Company, New York, USA, ISBN: 1-4641-2611-9.
2. Microbiology- Concepts and Applications, (1993) 6th ed., Pelczar MJ et. al., McGraw-Hill Inc, US, ISBN: 0070492581.
3. Plant Biotechnology – The genetic manipulation of plants (2017) 3rd ed., Slater A, Scott N and Fowler M, Oxford University Press, ISBN: 1138407674.
4. Animal Cell Culture Methods In: Methods in Cell Biology, (1998) Volume 57, 1st ed., Jenni P.M. and David B., Academic Press, eBook ISBN: 9780080859552.
5. Genome-4, (2017) Brown TA, Garland science, Taylor & Francis, NewYork, ISBN: 9780815345084.
6. Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine) George AJT, and Catherine EU, Humana Press, ISBN: 978-0-89603-798-4.

Course Name: Cell and Molecular Biology					Course Code: SIAS BT 1 2 01 C 4004		
Batch:	**Programme:**	**Semester : II**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology		4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					

Course Objectives	• To understand cellular organization and function at molecular level. • To provide understanding of key cellular processes of replication, transcription and translation.
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Advanced understanding of fundamental concepts of cellular and sub-cellular organization. **CO2:** Improved understanding of molecular basis of genetic information and function.

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Archea, prokaryotic and eukaryotic cell (animal and plant cells); Theory of origin of eukaryotic cells; Structure and function of nucleus - nuclear envelope, nuclear pore complex; Nuclear protein-import and export, regulation of nuclear protein import and export; Organization of golgi, lysosome, structure and functions of ER, lysosome, mitochondria, chloroplasts and peroxisomes; Fluid mosaic model, membrane proteins, membrane lipids and membrane fluidity; Transport across cell membrane, passive transport, active transport-primary (P-type, F-type, V-type ATPases, ABC transporters), co-transport-symport and antiport; Ion channels, aquaporins, pinocytosis and phagocytosis; Cells as experimental models.	15
II	Introduction to cytoskeletal proteins; Organization of cytoskeletal protein and smooth muscle and skeletal muscles, movement of vesicles-role of actin and myosin; Structure of cilia and flagella; Prokaryotic and eukaryotic cell wall, cell matrix proteins; Cell-matrix interactions and cell-cell interactions; Adherence junctions, tight junctions, gap junctions, desmosomes, hemi-desmosomes, focal adhesions and plasmodesmata; Signalling molecules, receptors and their functions – G protein	15

	coupled receptors- Cyclic-AMP, Cyclic-GMP, IP3, Calcium, Receptor tyrosine kinases - EGF, insulin.	
III	DNA as genetic material, detailed mechanisms of DNA replication in viruses, bacteria and eukaryotes, semi-conservative mode of DNA replication, theta model and rolling circle model of DNA replication, trombone model of replication. DNA polymerases and other enzymes involved in replication and proof reading function and fidelity of DNA replication. Detailed mechanisms of DNA repair (base excision repair, nucleotide excision repair, mismatch repair etc), Mechanisms of recombination (homologous, non-homologous and site specific), gene conversion.	15
IV	Prokaryotic and eukaryotic gene structure: transcription-RNA polymerase, inhibitors of transcription, detailed mechanisms of transcription in prokaryotes and eukaryotes, regulatory region and transcriptional unit of gene, transcription factors, RNA polymerases, activators and repressors, enhancers etc. Reverse transcriptase, post transcriptional processing of RNA: splicing, cap addition and polyadenylation, polynucleotide phosphorylase. Regulatory RNAs (non-coding RNAs, siRNAs, miRNAs etc), Translation: detailed mechanisms of translation in prokaryotes and eukaryotes, post -translational modifications, protein turn over and degradation. Mechanisms of gene regulation at transcriptional, post-transcriptional, translational and post-translational level. Recent advances and applications in the field.	15

Suggested Readings:

1. The Cell: A Molecular Approach (2018) 8th ed., Cooper, GM, Sinauer Associates is an imprint of Oxford University Press, ISBN: 1605357073.
2. Molecular Cell Biology (2016) 8th ed., Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D and Darnell J, W.H. Freeman &Company (New York), ISBN: 978-1-4641-0981-2 / ISBN:10: 1464183392.
3. Molecular Biology of the Cell (2008) 6th ed., Alberts B, Johnson A. Lewis J and Enlarge M, Garland Science (Princeton), ISBN: 0-8153-1619-4 / ISBN:0-8153-1620-8.
4. Lehninger Principles of Biochemistry (2017) 7th ed., Nelson DL, Cox MM, W.H. Freeman and Company, New York, USA. ISBN-10: 1-4641-2611-9.
5. Biochemistry (2019) 9th ed., Stryer L, Berg JM, Tymoczko JL, Gatto, Jr. GJ, W.H. Freeman and Company, New York, USA. ISBN-10: 1-319-11467-9
6. Genes XII, (2017) 12th Revised edition ed., Lewin B, Krebs J, Kilpatrick ST, Goldstein ES, Jones and Bartlett Publishers, Inc. Sudbury, Massachusetts, USA. ISBN No. 9781284104493.
7. Molecular Biology of the Gene (2013) 7th ed., Watson JD, Baker TA, Bell SP, Gann A, M, Levin RL and Cumming B, San Francisco, ISBN: 0321905377.

Course Name: Immunology					Course Code: SIAS BT 1 2 02 C 4004		
Batch:	**Programme:**	**Semester : II**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology		4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					

Course Objectives	To understand overall organization of the immune system and to comprehend the cellular and molecular basis of immune responsiveness.
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Advanced understanding of the working mechanisms of the immune system. **CO2:** Understanding of antibody, MHC, complement system, cytokines, hypersensitivity and immunobiology of organ transplant. **CO3:** Understanding the role of antibody/antigen in disease diagnosis

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Host-defenses, hematopoiesis, cells of the immune system, primary and secondary lymphoid organs and tissues (MALT). Anatomical barriers, cell types of innate immunity, soluble molecules and membrane associated receptors (PRR), connections between innate and adaptive immunity, chemokines and cytokines. Antigens and haptens, factors that dictate immunogenicity, B and T cell epitopes.	15
II	Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family**.** Multigene organization of Ig locus, mechanism of V region DNA rearrangement, ways of antibody diversification. Antigen independent phase of B cell maturation and selection, humoral response – T-dependent and T-independent response. ELISA, Western blot, Immunohistochemistry, Immunocytochemistry.	15

III	Complement activation by classical, alternate and MB lectin pathway, biological consequences of complement activation, regulation and complement deficiencies. General organization and inheritance of MHC, structure, distribution and role of MHC class I and class II proteins, pathways of antigen processing and presentation. Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation. General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC).	15
IV	Mechanism of tolerance and privileged sites, Organ specific and systemic autoimmune diseases, possible mechanisms of induction of autoimmunity, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity. Immunological basis of graft rejection, clinical manifestations, immunosuppressive therapy. Vaccines - active and passive immunization, types of vaccines. Recent advances and applications in the field.	15

Suggested Readings:

1. Kuby Immunology (2018) 8th ed., Punt J, Stranford S, Jones P and Owen JA, W.H Freeman and Company, ISBN: 978-1319114701.
2. Janeway's Immunobiology (2017) 9th ed., Murphy KM and Beaver C, WW Norton and Company, ISBN: 978-0815345510.
3. Roitt's Essential Immunology (2017) 13th ed., Delvis PJ, Martin SJ, Burton DR and Roitt, IM, Wiley-Blackwell, ISBN: 978-1118415771.
4. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, DL and Cox, MM, WH Freeman and Company (New York), ISBN: 978-1319108243.
5. Lippincott's illustrated Reviews Immunology (2012) 2nd ed., Doan T, Melvold R, Viselli S and Waltenbaugh, C, Wolters Kluwer India Pvt, Ltd, ISBN: 978-8184737639.

Course Name: Biosafety, Bioethics and IPR					**Course Code: SIAS BT 1 2 03 C 3003**		
Batch:	**Programme:**	**Semester : II**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 03**
2021-2023	M.Sc. Biotechnology		3	0	0	3	**Total Hrs.: 45**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To introduce the concept of intellectual property rights, patenting and emphasis on biosafety and bioethics.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding the basics of intellectual property rights. **CO2**: Understanding the importance and level of biosafety at laboratory and industrial levels. **CO3:** Understanding the ethical practices and concepts appropriate to the discipline.						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Biosafety: introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops vs cisgenic plants or products derived from RNAi, genome editing tools. Regulations: International regulations-Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations-EPA act and rules, guidance documents, regulatory framework-RCGM, GEAC, IBSC and other regulatory bodies.	12
II	Bioethics: Introduction, ethical conflicts in biological sciences-interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene	12

	therapy, transplantation. Bioethics in research - cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology-Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity - biopiracy.	
III	Patenting: Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications, PCT and conventional patent applications.	10
IV	International patenting-requirement, procedures and costs; financial assistance for patenting, introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing-outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research-backward and forward IP; benefit/Credits sharing among parties/community, commercial (financial) and non-commercial incentives. Recent advances and applications in the field.	11

Suggested Readings:

1. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
2. World Trade Organisation. http://www.wto.org
3. World Intellectual Property Organisation. http://www.wipo.int
4. International Union for the Protection of New Varieties of Plants. http://www.upov.int
5. National Portal of India. http://www.archive.india.gov.in
6. IPR, Biosafety and Bioethics (2013) Parashar S, Goel D, Pearson Publishing India, ISBN: 9788131774700.
7. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology (2017) Nambisan P, Academic Press, ISBN: 9780128092316.
8. http://dbtindia.gov.in/guidelines-biosafety

Course Name: Genetic Engineering					Course Code: SIAS BT 1 2 04 C 3003		
Batch:	**Programme:**	**Semester : II**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 03**
2021-2023	M.Sc. Biotechnology		3	0	0	3	**Total Hrs.: 45**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To provide basic and high throughput techniques in the areas of genomics and genetic engineering.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of high throughput techniques used in genomics and transcriptomics. **CO2:** To understand the concept of genetic engineering including the techniques, applications and limitations. **CO3:** Demonstrate the ability of designing recombinant molecules and conducting experiments involving genetic manipulation.						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Isolation and purification of DNA (genomic and plasmid) and RNA. Various methods of separation and quantification of nucleic acids, Southern and Northern hybridizations, PCR and its types; hot start, gradient, RT-PCR, qPCR etc. Generation of genomic and cDNA libraries. Methods for analysis of gene expression at RNA and protein level, large scale expression.	10
II	Recombinant DNA Technology: Plasmids- biology and applications in molecular cloning, phage, cosmid, BAC and YAC vectors. Features of cloning and expression vectors. Enzymes used in Recombinant DNA technology (Restriction endonucleases, DNA modifying enzymes, other nucleases, Polymerases, Ligase, kinases and phosphatases), Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors and their purification.	12

III	Methods of gene delivery (transformation, transfection, electroporation, micro-injection, biolistics, etc), Gene knock out in bacterial and eukaryotic organisms, generation of knock-out and knock-in mice, cre/lox, FLP/FRP, In-vitro mutagenesis and deletion techniques, Site-directed Mutagenesis, protein engineering. Genome editing: CRISPR-CAS9	11
IV	Applications of genetic engineering in gene therapy, diagnostics, therapeutics, vaccines, bio-pharma, crop improvement. DNA fingerprinting and its applications in forensics. Applications of transgenic animals and plants. Regulatory guidelines about transgenic organisms and their use. Recent advances and applications in the field.	12

Suggested Readings:

1. Principles of Gene Manipulation and Genomics (2016) 8th ed., Primrose, SB and Twyman, R, Wiley Blackwell, ISBN: 978-1405156660.
2. Gene Cloning and DNA Analysis: An Introduction (201978-6) 7th ed., Brown, TA, Wiley Blackwell, ISBN: 978-1119072560.
3. Genome 4 (2017) 4th Brown, TA, Garland science, ISBN 13: 978-0815345084.
4. Introduction to Genomics (2015) 2nd ed., Lesk, AM, Oxford university Press India, ISBN: 978-0198745891.
5. Genomics and Personalized Medicine: What Everyone needs to Know (2016) 1st ed., Snyder, M, OUP-USA, ISBN: 978-0190234768.

Course Name: Seminar					Course Code: SIAS BT 1 2 05 C 2002		
Batch:	**Programme:**	**Semester : II**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 02**
2021-2023	M.Sc. Biotechnology		2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 50 **CIE:** **15** Marks **TEE:** **35** Marks		**Examination Duration:** 1.5 Hrs.					
Course Objectives	To develop communication and presentation skills in the students						
Course Outcomes:	**CO1:** Students will be able to improve their presentations skills. **CO2:** Understanding of scientific papers and their presentations in their own way.						

COURSE SYLLABUS

Students will be evaluated by all the faculty members including Head of the Department based on their presentation followed by viva-voce examination

Unit No.	Contents	Contact Hrs.
I	Seminar will be of 45-minute duration during which the presentation will be followed by questions session by the audience comprising of faculty and students. Every student shall be required to submit the topic of his/her seminar in consultation with the Head of the Department/Faculty members/student advisors well in advance so that the same may be displayed on the notice board. The presenter has to write an Abstract to be distributed during Seminar in addition to two copies of write-up giving relevant details of the background of the subject, methods used and references/List of sources from where the material for presentation has been collected.	30

Suggested Readings:

1. www.pubmed.com
2. www.google.com
3. www.sciencedirect.com
4. www.tandfonline.com

Course Name: Omics in Biotechnology					**Course Code:** SIAS BT 1 2 06 C 4004		
Batch:	**Programme:**	**Semester : II**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology		4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					

Course Objectives	• To provide detailed understanding of major Omics technologies such as genomics, transcriptomics, proteomics and metabolomics etc. • To provide knowledge about the data analysis of next generation sequencing. • To provide understanding of applications of the Omics technologies.
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding of modern Omics technologies in the field of biotechnology. **CO2:** Understanding of data analysis generated through next generation sequencing. **CO3:** Better understanding of the applications of the Omics technologies in different industries.

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Introduction to omics techniques, Applications of omics in medical, agriculture, and other branches of Biotechnology, History of DNA sequencing, Early methods of DNA sequencing, Genome sequencing projects (Haemophilus, Drosophila, Yeast, Human etc.), Next Generation Sequencing, Comparative features of different sequencing platforms (Sanger, Illumina, Nanopore, PacBio etc.), Use of NGS techniques in genomics and transcriptomics, Basic steps in library preparation and analysis of genomics and transcriptomics data. Comparative and genomics, transcriptomics, Functional genomics.	15
II	Introduction to file formats used in NGS analysis, Types of genomics data e.g. WGS, WES, RNAseq, DNA-methylation, single cell sequencing data etc., Concepts of sequencing depth, coverage, phred score, N50, L50, and other metrics used in omics, Introduction to tools and databases used for omics analysis (FastQC, Bowtie, Stringtie, Tophat, Deseq etc.), Various pipelines for genomics data, Differential	15

	expression analysis, Gene Ontology, Pathway Mapping, Types of non-coding RNAs and use of high throughput sequencing methods for the analysis of non-coding RNAs, Applications of genomics and transcriptomics in marker development and candidate gene discovery.	
III	Introduction to proteomics, Discovery vs targeted proteomics, Basic techniques for protein separation and analysis (Chromatography, Gel-based, Spectroscopic), Gel-based and gel-free techniques in proteomics, Basic workflows and analysis pipelines (identification, quantification, post-translational modifications etc.), Introduction to tools used in proteomic analysis (Mascot, Proteome discoverer, MaxQuant etc.), Applications of proteomics in drug discovery, biomarker discovery, agriculture biotechnology etc.	15
IV	Introduction to metabolomics and lipidomics, Targeted vs non-targeted metabolomics, Basics tools and techniques used for metabolome and lipidome characterization and analysis, Introduction to databases and software used for analysis of metabolomics data, methods of metabolite identification and fingerprinting, Applications of metabolomics in medical and agriculture biotechnology, Integration of different omic techniques for various applications in biotechnology. Recent advances and applications in the field.	15

Suggested Readings:

1. Bioinformatics for omics data: methods and protocols (2011), Mayer, B., New York: Humana Press. ISBN 978-1617790270
2. Omics: Applications in Biomedical, Agricultural, and Environmental Sciences (2013), Barh D., Zambare V., Azevedo V. CRC Press. Taylor and Francis Group. ISBN 9781138074750
3. Applications of Advances Omics Technologies: from Genes to Metabolites (2014), Wilson and Wilsons. Elsevier. ISBN: 9780444626509
4. Genomics, Proteomics and Metabolomics in Nutraceuticals and Functional Foods (2015), Bagchi D., Swaroop A., Bagchi M. Wiley Blackwell. ISBN:9781118930427
5. Principles of Proteomics (2013), Twyman, R., Garland Science, ISBN: 978-0815344728

Course Name: Practical-II					Course Code: SIAS BT 1 2 07 C 0084		
Batch:	**Programme:**	**Semester : II**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 8**
2021-2023	M.Sc. Biotechnology		0	0	8	4	**Total Hrs.:120**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					

Course Objectives	• To inculcate/impart skills to perform various tests/assays and experiments. • To impart skills of experiment designing, practical execution and report writing.
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Improved skills to perform various tests/assays and experiments. **CO2:** Improved skills of experiment designing, practical execution and report writing.

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	1. Determination of A, B, O and Rh blood groups in human beings 2. Detection of antigen/antibody in a given sample using Enzyme Linked Immunosorbent Assay (ELISA) 3. Polyclonal antibody production in mice/rabbit and detection using antigen. 4. DNA extraction and amplification of desired gene using RT-PCR technique. 5. To study the separtation and analysis of antigen/antibody from a mixture	30
II	1. Restriction analysis and DNA finger printing methods, RAPD, SSR etc. 2. To study the extraction of RNA from given sample 3. To study introduction to basic linux commands used in omics analyses. 4. To demonstration of NGS pipeline using publically available data for transcriptome analysis. 5. Identification of non-coding RNAs – a demonstration of pipeline.	30

III	1. To study the preparation of competent cell using chemical method 2. To study the transformation efficiency of competent cells 3. To study the isolation of plasmid DNA from recombinant cell and its analysis 4. To study PCR reactions with plasmid and genomic DNA 5. To study restriction digestion analysis of a given DNA sample	
IV	1. To study market analysis of biopharmaceutical industries in India 2. To study the demonstration of LC-MS and other proteomics tools and techniques 3. To study the demonstration of data acquisition in LC-MS techniques 4. To study data analysis using MASCOT or any other software 5. To study dye decolorization using microbial/plant biomass or metabolites	30

Suggested Readings:

1. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan, D, Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN: 978-0-470-85603-1.
2. An Introduction to Practical Biochemistry (2017) 3rd ed., Plummer, D.T., McGraw Hill Education, ISBN: 978-0070994874.
3. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Wilson K, and Walker J, Cambridge University Press. ISBN: 131661476X.
4. Microbes in Action: A Laboratory Manual of Microbiology (1990) 4th Addition, Harry W, Seeley, Paul JV, John J, W. H. Freeman ISBN: 978-0716721000.
5. Genetics: A Laboratory Manual, (2009) 2nd ed., American Society of Agronomy; Lab Manual edition, ISBN: 978-0891185611.

Course Name: Pharmaceutical Biotechnology					Course Code: SIAS BT 1 2 01 DCEC 3003		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 03**
2021-2023	M.Sc. Biotechnology	II	3	0	0	3	**Total Hrs.: 45**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					

Course Objectives	• To gain insights into the process of drug discovery. • To provide understanding on the mechanisms of various biopharmaceutical products. • To gain knowledge on the approval process of biopharmaceuticals. • To provide knowledge on the market of biopharmaceuticals.
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Improved understanding on the roles of biopharmaceuticals in the treatment of diseases. **CO2:** Understanding of the regulatory mechanism for the approval of biopharmaceuticals. **CO3:** Improved insights into the products and market of biopharmaceuticals.

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Biotechnology in pharmaceutical perspective: Biology in drug discovery; Traditional drug discovery vs. rational drug discovery, rational drug discovery pipeline, concept of target based drug design and target discovery, role of plant biotechnology in edible vaccine development. Definition: Generics and its advantages; Biogenerics and Biosimilars; Why biosimilars are not (bio) generics; The advent of Biosimilars; Protein-based biopharmaceuticals; Manufacturing processes; Global market; International Non-proprietary Names (INN) nomenclature system biosimilars regulation (EU position, US pathways, Government initiatives).	12
II	Biotechnology in pharmaceutical industry: Major areas for biotechnology in the pharmaceutical industry such as antibiotics, vaccines, diagnostics, antibodies,	11

	biopharmaceuticals (insulin, interferon, GSF, CSF & therapeutic proteins etc.); Commercial aspects, priorities for future biotechnological research	
III	Industrial enzymes in drug development: Penicillin amidase, lipase, oxidoreductase, nitrilase, protease etc. Use of all these enzymes for enantioselective synthesis of pharmaceutically important drugs / drug intermediates, future directions. Approved follow-on proteins/Biosimilars; Characteristics of high-selling peptides and proteins; Products with expired patents; Challenging originator‟s patents; Target products for FOB (follow-on biologicals)/ Biosimilars development peptides; Recombinant nonglycosylated proteins; Recombinant glycosylated proteins; Industries dealing with biogenerics and its market value; World scenario; Indian scenario.	11
IV	Genomics in target discovery: Concept of genome, genes and gene expression, genome sequencing and sequence comparison methods (e.g. BLAST), gene expression comparison methods (microarray). Comparative genomics and expression genomics for target discovery of communicable diseases and lifestyle disease. Recent advances and applications in the field.	11

Suggested Readings:

1. Pharmaceutical Biotechnology (2016) Helmer E, Syrawood Publishing House, ISBN: 978-1682861066.
2. Pharmaceutical Biotechnology (2014) Sreenivasulu V, Jayaveera KN and Adinarayana K, S Chand & Company, ISBN: 978-8121942478.
3. Pharmaceutical Biotechnology Fundamentals and Application (2013) Kokare C, Nirali Prakashan, Educational Publishers, ISBN: 978-8185790688.
4. Pharmaceutical Biotechnology: Concepts and Applications (2011) Walsh G, Wiley India Pvt Ltd, ISBN: 978-8126530250.
5. Pharmaceutical Biotechnology (2002) 2nd ed. Cromelin DJA and Sindelar RD, Taylor and Francis Group, ISBN: 978-3-527-65125-2.

Course Name: Microbial Biotechnology					Course Code: SIAS BT 1 2 02 DCEC 3003		
Batch:	**Programme:**	**Semester:**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 03**
2021-2023	M.Sc. Biotechnology	II	3	0	0	3	**Total Hrs.: 45**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To introduce students to basic and advanced knowledge in the field of microbial technology and fermentation for use in human welfare.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding microbial fermentation for the production of useful products **CO2:** Understanding basic techniques related to downstream processing of alcohols, enzymes and organic acids **CO3:** Understanding basic techniques related to downstream processing of alcohols, enzymes and organic acids.						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Fermentative production of industrial alcohol, uses, raw materials, microorganisms, inoculums preparation, preparation of wort, fermentation and recovery. Fermentative production of beer – Medium components, malt, malt adjuncts, hops, water. Preparation of wort, mashing, wort boiling, microorganism, inoculum preparation, fermentation, cold storage maturation, carbonation, packing and preservation. Principles of wine making – Fruit selection, picking, crushing, sulphite addition, processing, fermentation, aging and bottling.	12
II	Fermentative production of citric acid, uses, microorganism, inoculum preparation, medium preparation, fermentation, recovery and mechanism of citric acid production. Fermentative production of vitamin B12 – Uses, structure of vit-B12, microorganisms, inoculums preparation, medium preparation, fermentation and recovery. Fermentative production of glutamic acid – Uses, microorganism, inoculum preparation, production medium, fermentation and downstream processing	11

III	Antibiotics – Commercial production of benzyl penicillin, uses, microorganism, inoculums preparation, production medium, fermentation, recovery and semi-synthetic penicillins. Fermentative production of tetracyclines-uses, chlortetracycline, oxy-tetracycline, tetracycline and semisynthetic tetracyclines, structures, microorganisms, inoculum preparation, production medium, fermentation and recovery methods.	11
IV	Production and application of microbial enzymes. – Amylases and proteases, uses, microorganisms, inoculum preparation, production medium, fermentation and recovery, steroid transformations-substrates, typical structures, microorganisms, inoculum preparation,11-hydroxylation, process and recovery. Principles of vaccine production and types of vaccines, Microbial biopesticides, microbial products from genetically modified organisms eg. insulin. Recent advances and applications in the field.	11

Suggested Readings:

1. Microbial Biotechnology: Progress and Trends (2017) 1st ed., Harzevili FD and Chen H, CRC Press; ISBN: 978-1138748699.
2. Microbial Biotechnology (2016) Cooper E, Syrawood Publishing House, ISBN: 978-1682860977.
3. Encyclopedia of Metagenomics. Genes, Genomes and Metagenomes: Basics, Methods, Databases and Tools (2015). Nelson, KE Boston, MA, Springer US, ISBN: 978-1-4899-7479-2.
4. Microbial Biotechnology: Principles and Applications. Hackensack, (2013). 2nd ed. Lee, YK, World Scientific. ISBN: 978-981-256-676-8.
5. Comprehensive Biotechnology (2011) 3rd ed., Moo-Young, M, Elsevier, ISBN: 9780444640468.

Course Name: Environmental Biotechnology					Course Code: SIAS BT 1 2 03 DCEC 3003		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 03**
2021-2023	M.Sc. Biotechnology	II	3	0	0	3	**Total Hrs.: 45**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To provide information about various factors responsible for environmental pollution and its mitigation using biotechnology.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding the source and mechanism of environmental pollution. **CO2:** Understanding the role of microbes and plants in remediation and management of environmental pollution. **CO3:** Understanding the replacement/options available for non-degradable pollutants.						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Water, Soil and Air pollutants: their sources and effects. Major pollutants and their effects on flora and fauna, Bioremediation-mechanism and process, Factors affecting the bioremediation process, Natural and engineered bioremediation, concepts of bioaugmentation, biostimulation, biodegradation, biosorption and biofilms in the bioremediation of pollutants, In-situ and ex-situ bioremediation strategies. Phytoremediation, microbial systems for heavy metal accumulation, biosorption & detoxification mechanisms.	12
II	Primary, secondary and tertiary treatment of waste water, naerobic and aerobic process of treatment; biochemistry and microbiology of aerobic and anaerobic treatment, use of genetically engineered organisms. Emerging biotechnological processes in wastewater treatment, Bioremediation of contaminated ground water; Membrane technology in waste water treatment, Bioreactors for waste water treatment, treatment of typical industrial effluents: dairy, distillery, dye, and pharmaceutical industries.	11

III	Solid waste treatment, characteristics of municipal, industrial and biomedical wastes; Aerobic and anaerobic methods, Physical and chemical treatment of solid waste, Composting and vermicomposting. Use of bacteria, fungi, plants, enzymes and genetically engineered organisms; Bioremediation of contaminated soils and waste land. Phytoremediation of soil metals; Concept of stubble burning and pollution, Wealth generation from solid agricultural residues in terms of biofuels and other value-added products. production of biogas from solid waste.	11
IV	Xenobiotic compounds: Degradation of aliphatic, aromatics, polyaromatic hydrocarbons, polycyclic aromatic compounds, pesticides, microbial treatment of oil pollution. Enzymes-types and role in biodegradation of pollutants, advantages & disadvantages of biocatalysts - isolated enzymes versus whole cell systemsImmobilized biocatalysts in bioremediation. Use of solar radiation in industrial effluent treatment; Environment friendly technologies and products: biosurfactants, biofertilizers, biopesticides, integrated waste management. Recent advances and applications in the field.	11

Suggested Readings:

1. Environmental Science and Technology, (2019) 9th ed., Stankey EM, Lewis Publishers, New York. ISBN: 1420059203.
2. Enviornmental Biotechnology: Principles and Applications (2017) 1st ed., Rittmann B and Mccarty P, McGraw Hill Education; ISBN: 978-1259002885.
3. Environmental Biotechnology: Biodegradation, Bioremediation, and Bioconversion of Xenobiotics for Sustainable Development (2016) 1st ed., Sangeetha J, Thangadurai D, David M and Abdullah MA, Apple Academic Press; ISBN: 978-1771883627.
4. Environmental Biotechnology: Basic Concepts and Applications (2011) 2nd ed., Thakur IS, I K International Publishing House Pvt. Ltd; ISBN: 978-9380578477.
5. Biodegradation and Bioremediation: (2004), Singh A. and Ward O.P., Soil Biology, Springer, ISBN: 978-3-540-21101-3.

Course Name: Biostatistics and Bioinformatics					Course Code: SIAS BT 1 3 01 C 4004		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology	III	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To introduce the students in the field of bioinformatics and enables them to understand the concepts of statistics in biology.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding the statistical analysis of biological data **CO2:** Understanding the role of computer science in predicting structure and function of biomolecules **CO3:** Understanding similarities and differences among living organisms on the basis of genetic information						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Definition of selected terms scale of measurements related to statistics; Methods of collecting data, Presentation of data statistical Tables, need for reduction of data measures of averages and location, Measures of dispersion: Range, quartile deviation, mean deviation and relative deviation. Probability: basic concepts; basic theorems of probability addition and multiplication theorems; conditional probability of Bayes Theorems. Probability mass function, probability density function, cumulative distribution function.	15
II	Probability distribution definition and applications; Binominal distribution, Poisson distribution, Normal distribution, logic of statistical standard error estimation testing of hypothesis. Tests of significance: Null hypothesis, alternative hypothesis, type I error, type II error, level of significance, and power of test. Tests for mean based on normal distribution, one sample t-test, two-sample t-test, paired-sample t-test, Chi-Squared test, and Tests for variance based on normal distribution – one sample and two-sample problem. One-way and Two-way analysis of variance (ANOVA) techniques. Correlation concept and applications, Spearman's rank correlation	15

	coefficient, regression concept and applications.	
III	Historical background. Scope of bioinformatics - genomics, proteomics, computer aided drug design (structure based and ligand based approaches), Applications of bioinformatics. Introduction to biological databases - primary, secondary and composite databases, Different formats of molecular biology data. NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB)	15
IV	Similarity, identity and homology. Alignment-local and global alignment, pairwise and multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTAL omega. Identification of open reading frames (ORF), Concept of orthology, paralogy and homology in gene and protein sequences. Methods and tools for phylogenetic analysis, maximum parsimony, maximum likelihood and distance methods; creation, evaluation and interpretation of evolutionary trees phylogenetic tree. Human Genome Project, Genome sequencing platforms, Format & Types of genomic data, Software & pipelines for NGS data analysis. Recent advances and applications in the field.	15

Suggested Readings:

1. Fundamentals of Statistics (2016) Goon, AM, Gupta, MK and Dasgupta, B. Vol. I & II. World Press, ASIN: B01LB7MH74.
2. Statistical Methods (2012) 1st ed., Das, NG. Vol I & II. Tata McGraw Hill, ISBN: 9780070263512.
3. Probability and Statistics for Engineers and Scientists (2013) 9th ed., Walpole, RE, Myers, RH, Myers, SL and Ye, Pearson Education India KE ISBN: 978-9332519084
4. Biostatistics: A Foundation. for Analysis in the Health Sciences (2012) 10th ed., Daniel, WW and Cross, CL. John Wiley & Sons, ISBN: 978-1118302798
5. Essential Bioinformatics (2006) 1st ed., Xiong J, Cambridge University Press, ISBN 13: 978-0521600828.
6. Fundamental concepts of Bioinformatics (2003) Krane DE and Raymer ML Pearson, ISBN: 978-8177587579.
7. An Introduction to Bioinformatics (2017) 1st ed., Knight R, Larsen and Keller Education, ISBN: 978-1635490459.
8. Concepts of Bioinformatics and Genomics (2016) 1st ed., Momand J, McCardy A, Heubah, S and Warter-Perez N, Oxford University Press, ISBN: 978-0199936991

Course Name: Biophysics and Nanosciences					Course Code: SIAS BT 1 3 02 C 4004		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology	III	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					

Course Objectives	• To explore the complexity of living systems with a quantitative physical approach, fundamentals of nanoscale structured materials and also discuss various biomedical & agricultural applications of different nanomaterials. • To provide understanding of the key biophysical techniques and their applications in research and diagnosis.
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Improved understanding of the core concepts of biology, chemistry and physics and how they interconnect in biophysical systems. **CO2:** Expansion of knowledge of standard molecular and biophysical techniques to design experiments in a specific research area. **CO3:** Improved understanding of fundamental principles of nanotechnology and synthesis of different nanomaterials. **CO4:** Improved insights on the emerging need of nanotechnology in environment, health; and safety.

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Introduction to Biophysics and history of Biophysics, main features of quantum theory, Elementary particles and their interactions, mechanism of molecular energy transfer, Distribution of molecular energy and velocity at equilibrium, Energy of activation, Different types of forces and stereo-chemical factors responsible for molecular conformation, defining conformation of a macromolecular chain, complex array of biomolecular structures found in DNA and proteins due to interactions. Main methods of studying the structure of proteins and DNA, protein folding pathways, Levinthal's paradox, Molten globule, Anfinsen's experiment, Methods for investigating folding: Fluorescence spectroscopy, Circular dichroism.	15

	Macromolecular interactions, Biophysical methods of interactions: Microcalorimetry (Isothermal Titration Calorimetry (ITC), Surface Plasmon Resonance (SPR).	
II	Basic concepts and laws of thermodynamics, Gibbs free energy, Enthalpy and Entropy, Energetic processes in living organism, Information and Entropy, coupling of fluxes, Coupling of Chemical Reactions, Redox potential in biological system, ATP production. Introduction to membrane Biophysics, fundamental role of biomembranes, interfacial phenomena and membranes, surface and interfacial tensions, self-assembly of membranes, molecular structure of membranes, Structure & function of membranes, Nernst equation (based on membrane permeable for a single kind of ions), Resting membrane potential, Action potential, Biophysics of synapse, patch clamping/voltage clamp and their applications to the study of biomacromolecules.	15
III	Overview of Nanotechnology - Historical perspective of integration of biology, chemistry, and material science. Opportunities and promises of Nanobiotechnology. Top down and bottom up approaches of synthesis of nanoparticles, synthesis of nanoparticles by physical, chemical and biological methods; nucleation and growth of nanosystems, factors affecting synthesis of nanoparticles, Debye-Scherrer method, particle size determination using UV absorption spectra peaks and photoluminescence peaks, dynamic light scattering (DLS), SEM. Nanomaterials used in biotechnology-nanoparticles, carbon nanotubes, quantum dots and nanofibres.	15
IV	Miniaturized Devices-nanotechnology and biomedical devices: Overview of smart devices for medical field, lab on chip concept, epipen, intelligent pill, wobbling gels. Nanotechnology and diagnostics and therapy-Nano-Biosensing-biosensors and nanobiosensors -basics, DNA aptamers for nano-biosensing. Use of nanotechnology in diagnosis of chronic diseases like diabetes and coronary heart diseases; parasitic disease like malaria. Nanotechnology in agriculture, food technology & environment: Insecticides development using nanotechnology and Nanofertilizers, nanotechnology in food processing, safety & smart packaging, applications of nanotechnology in water purification and oil spill removal. Recent advances and applications in the field.	15

Suggested Readings:

1. An introduction to Biophysics (2018), 1st ed., Burns, D, Forgotten Books, ISBN: 978-1330860212.
2. Biophysics - An Introduction (2014) 1st ed., Cotterill, R, Wiley, ISBN: 978-8126551606.
3. Biophysics: An Introduction (2012) 2nd ed., Glazer, Springer, ISBN**:** 978-3642252112.
4. Nanobiotechnology: Concepts, Applications and Perspectives (2012) 1st ed., Niemeyer, CM and Mirkin, CA, Wiley India Pvt Ltd., ISBN 13: 978-8126538409.
5. A Textbook of Nanoscience and Nanotechnology (2017) 1st ed., Pradeep T, McGraw Hill Education, ISBN: 978-1259007323.

Course Name: Medical Biotechnology and Diagnostics					Course Code: SIAS BT 1 3 03 C 4004		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology	III	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To provide an overview about the genetic diseases and the diagnostic techniques used in the medical field.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding the basics of genetic information responsible for disease development **CO2:** Understanding the classical and advanced methods used for the diagnosis of various diseases						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	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. Pathogenic mutations. Gain of function mutations: oncogenes, Huntingtons disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function -tumour suppressor, genomic, dynamic mutations - Fragile- X syndrome, myotonic dystrophy, mitochondrial diseases.	15
II	Invasive techniques - amniocentesis, fetoscopy, chorionic villi sampling (cvs), noninvasive techniques- ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood, diagnosis using protein and enzyme markers, monoclonalantibodies, DNA/RNA based diagnosis, microarray technology- genomic and cDNA arrays, application to diseases.	15
III	Overview of molecular diagnostics, molecular diagnostics: past, present, and future, History & scope, definition, principle of biosensors: classification of biosensors based on transducer & recognition element. Components & basic designing of Biosensors, different types of biosensors, nanotechnology and biosensors: carbon nanotubes, Gold nanoparticles. Latex agglutination test, enzyme linked immunosorbant assay, dot and	15

	slot blot assay.	
IV	PCR in molecular diagnostics; multiplex-PCR, quantitative real time PCR (qRT-PCR) and their applications for diagnosis of disease applications, DNA diagnostic system: molecular beacons and its variants for their applications in detection, molecular diagnostics in bacterial detection, rolling circle amplification, application of padlock and selector probes in molecular medicine, DNA aptamers for nano-biosensing, diagnostics for point-of-care and resource limited settings, smartphones in medical diagnostics, rapid diagnostic tests (lateral flow assays), concepts of microfluidics, BioMEMs in diagnostics. Recent advances and applications in the field.	15

Suggested Readings:

1. Human Molecular Genetics (2018) Strachan T and Read A, Garland Science publisher, ISBN: 9780815345893.
2. Medical Biotechnology (2013) Glick BR, Patton CL and Delovitch TL, ASM Press, ISBN: 155581705X.
3. Advances in Animal Disease Diagnosis (2021). Gahlawat, SK and Maan, S. CRC Press. ISBN 9780367530518 pp. 1-306.
4. Biotechnology in Medical Sciences (2017) Khan FA, CRC Press; ISBN: 978-1138076792
5. Biomedical Nanotechnology (2005) 1st ed., Malsch, N, CRC Press, ISBN: 978-0824725792.
6. Biosensors and Nanotechnology: Applications in Health Care Diagnostics (2018) 1st ed., Altintas Z, Wiley-Blackwell, ISBN: 978-1119065012.
7. Biosensors: Essentials (2016) 1st ed., Evtugyn, G, Springer, ISBN: 978-3662509388
8. Nucleic Acids as Molecular Diagnostics (2014) 1st ed., Keller, A, Wiley VCH, ISBN: 978-3527335565.
9. Lateral Flow Immunoassay (2009) Raphael C. Wong, Harley YT, Humana Press, ISBN: 978-1-58829-908-6.
10. Medical Biotechnology (2013) Glick BR, Patton CL and Delovitch TL, ASM Press. ISBN10 155581705X.
11. Molecular Diagnosis of Infectious Diseases (Methods in Molecular Medicine) (2004) Decker J, Reischl U, Humana Press, ISBN: 978-1-59259-679-9.
12. Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, (2006) Kayser O and Warzecha H, Wiley-Blackwell, ISBN: 978-3-527-60552.
13. Human Molecular Genetics (2018) Strachan T and Read A, Garland Science publisher, ISBN: 9780815345893.

Course Name: Fermentation and Bioprocess Technology					Course Code: SIAS BT 1 3 04 C 4004		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology	III	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To provide fundamental concepts of different fermentation strategies and to overcome the challenges of the new and emerging areas of biotechnology industry.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding basic concept of fermentation strategies **CO2:** Understanding of design and operations of a process for bio-based products **CO3:** Understanding the structure, operation and functions of various bioreactors **CO4:** Critical analysis and improvement in any bioprocess from market point of view.						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Concept of Fermentation, Different types of fermentations-Batch, Fed-batch and continuous fermentation, An overview of submerged and solid state fermentations. Factors affecting fermentation; Bioreactor- structure and applications of a laboratory bioreactor; Different types of bioreactors like - Stirred tank reactor, air-lift, packed bed, fluidized and bubble column- their structure and applications; Multiphase bioreactor system.	15
II	Sterilization (medium and air)-thermal death kinetics of microorganisms; aeration, agitation and heat transfer in bioprocess. Microbial substrates, Media formulation and optimization; Microbial growth and kinetics. Monitoring of Bioprocesses: On line data analysis for measurement and control of important physicochemical and biochemical parameters, Computer based data acquisition, Techno-economic feasibility of bioprocess.	15

III	Isolation and characterization of industrially important Microorganisms; Generation of mutant strains for fermentation. Different approaches for strain improvement for fermentation. Concept of primary and secondary metabolites, Yield coefficient and efficiency. An overview of important products like antibiotic, biofuel, enzymes, An overview of recombinant proteins.	15
IV	Biological mixture-composition and separation of different components of biological mixture-filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products: liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration; Purification of wild and recombinant proteins, Product polishing-drying; crystallization; storage and packaging. Recent advances and applications in the field.	15

Suggested Readings:

1. Bioprocess Engineering: Basic Concepts (2017) 3rd ed. Shuler, ML, and Kargi, F. Pearson Prentice Hall, ISBN: 0137062702.
2. Principles of Fermentation Technology (2016) 3rd ed. Stanbury P, Allan Whitaker, Stephen Hall. Imprint (Butterworth-Heinemann), ISBN: 9780080999531.
3. Biochemical Engineering Fundamentals (2013) 5th reprint J. E. Bailey and Ollis, D. F. McGraw-Hill Education (India) Pvt Ltd., ISBN: 0070701237.
4. Bioprocess Engineering Principles (2013) 2nd ed. Doran, P.M, Academic Press, ISBN: 978-0-12-220851-5.
5. Bioreactors Analysis and Design (2011) Panda T, Tata McGraw Hill, ISBN: 978-0-07-070424-4.

Course Name: Practical-III					Course Code: SIAS BT 1 3 04 C 0084		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 8**
2021-2023	M.Sc. Biotechnology	III	0	0	8	4	**Total Hrs.: 120**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To inculcate/impart skills on experiment designing, practical execution and report writing.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Improved skills on experiment designing, practical execution and report writing. **CO2:** Acquiring skills to get information and possible practical solution to a research problem						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	1. To study the laboratory organization and aseptic manipulations in plant and animal cell culture lab. 2. To study the isolation and culturing of animal cells from primary tissue explant. 3. To study the sub-culturing of monolayer confluent cells. 4. To study the staining of monolayer confluent cells using geimsa and crystal violet. 5. To discriminate between viable and non-viable animal cells using trypan blue. 6. To study screening of different genotypes in crops using PCR based SSR markers. 7. To study the preparation of various stock solutions of Murashige and Skoog medium.	30

	8. To study clonal multiplication of tobacco by shoot tip culture technique. 9. To study induction of embryogenic callus from rice plants.	
II	1. To study database search (GenBank, PDB) using BLAST and Sequence submission protocols. 2. To study the sequence alignments (Pair wise and Multiple), Sequence and structure prediction 3. To study the construction of phylogenetic tree and prediction 4. To study designing of SSR and SNP markers using *in silico* tools. 5. To study protein structure modelling and docking 6. To study the next generation sequencing data analysis: using freely available software & pipelines.To study the denaturation kinetics study of biomolecules using UV-VIS spectrophotometry	27
III	1. To study the structure and functions of a stirred tank bioreactor. 2. To study the production of metabolites in submerged and solid state fermentations 3. To determine Volumetric Oxygen Transfer Coefficient (kLa) in fermentation system by dynamic method/sulphite method. 4. Comparative studies on the kinetics of free and immobilized enzymes/cells. 5. To study the production of biofuel/enzyme using lignocellulosic biomass. 6. Comparative study of batch, fed-batch and continuous fermentations.	33
IV	1. To demonstrate a aptamer based diagnostic test for a disease 2. To study the use of real time PCR in the diagnosis of a disease 3. To study the western blot analysis of the proteins using antibodies 4. To study the calculation of mean, median and mode of the given biological data 5. To determine the significance (p-value) of given biological data set 6. To study the synthesis, characterization and applications of nanoparticles	30

Suggested Readings:

1. An Introduction to Practical Biochemistry (2017) 3rd ed., Plummer D. T., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), ISBN: 978-0070994874.
2. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Keith Wilson & John Walker, Cambridge University Press. ISBN: 131661476X.
3. Molecular cloning, A Laboratory Manual Vol. I-III. (2012) 4th ed., Green MR and Sambrook J, Cold Spring Harbor Laboratory Press.
4. Gene Cloning and DNA Analysis (2010) Brown TA, Wiley-Blackwell publishing.
5. Physical Biochemistry: Principles and Applications (2010) 2nd ed., Sheehan D, Wiley Blackwell (West Sussex), ISBN: 978-0-470-85602-4 / ISBN:978-0-470-85603-1.
6. A laboratory Course in Nanoscience and Nanotechnology (2014) Poinern GEJ, CRC press, ISBN: 978-1482231038.

Course Name: Animal Biotechnology					Course Code: SIAS BT 1 3 01 DCEC 3003		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 03**
2021-2023	M.Sc. Biotechnology	III	3	0	0	3	**Total Hrs.: 45**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	This course is an introduction to the theory, standard practices, and methodologies of animal biotechnology.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Improved understanding of animal tissue culture experiments. **CO2**: Understanding of gene transfer and gene manipulation methods. **CO3:** Improved understanding oftransgenic animal technology.						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Biology and characterization of cultured cells- cell adhesion, proliferation, differentiation, morphology of cells and identification. Basic technique of mammalian cell culture *in vitro*, Measuring parameters of growth in cultured cells, cell viability and cytotoxicity. Germplasm conservation and establishment of gene banks. Large-scale culture of cell lines- monolayer, suspension and immobilized cultures.	12
II	Organ and histotypic culture- technique, advantages, limitations, applications. Biotransformation - Induction of cell line mutants and mutations. 3D cultures. Whole embryo culture. Somatic cell hybridization. Stem cells: types (embryonic, adult), isolation, identification, expansion, differentiation and uses, stem cell engineering, ethical issues. Commercial applications of animal tissue culture. Hazards and safety aspects of tissue culture.	11

III	Manipulation of animal reproduction and characterization of animal genes Manipulation of reproduction in animals. Artificial insemination, embryo transfer, in-vitro fertilization. Embryo transfer in cattle and applications. Somatic cell cloning - cloning of Dolly. Ethical issues. Production of recombinant vaccines. Probiotics for disease control.	11
IV	Vectors for gene transfer in animals: retrovirus. Gene constructs- promoter/enhancer sequences for transgene expression in animals. Selectable markers for animal cells- thymidine kinase, dihydrofolatereductase, CAT. Transfection of animal cells- calcium phosphate coprecipitation, electroporation, lipofection, peptides, direct DNA transfer, viral vectors, microinjection. Methods for producing transgenic animals- retroviral, microinjection, engineered stem cell. Targeted gene transfer. Transgene integration and identification methods. Transgenic and genome edited animals. Ethical issues in transgenesis. Recent advances and applications in the field.	11

Suggested Readings:

1. Principles and Techniques of Biochemistry and Molecular Biology (2018) 8th ed. Keith Wilson & John Walker, Cambridge University Press, ISBN No: 131661476X.
2. Advances in Animal Biotechnology and its Applications. (2018). Gahlawat, S.K., Duhan, J. S., Salar, R.K., Siwach, P. and Kumar, S. and Kaur, P. Springer, Germany. pp. 1-401. ISBN978-981-10-4701-5
3. Principles of gene manipulation (2016), 8th ed. Primrose Twyman and Old. Blackwell Science, ISBN: 1405135441.
4. Animal Biotechnology (2013) Verma A and Singh A, Elsevier, ISBN: 9780124160026.
5. Molecular Biotechnology (2009), 4th ed. Glick and Pasternak, ASM Press, ISBN10: 1555814980.
6. Recombinant DNA (2006) 3rd ed., Watson JD, Richard M. Meyers, Amy AC, Jan AW, Cold Spring Harbor Laboratory Press, ISBN: 0716728664

Course Name: Agricultural Biotechnology					Course Code: SIAS BT 1 3 02 DCEC 3003		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 03**
2021-2023	M.Sc. Biotechnology	III	3	0	0	3	**Total Hrs.: 45**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	To provide knowledge of standard practices, methodologies and applications of biotechnology in agriculture.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding the classical and modern approaches of plant/crop breeding **CO2:** Understanding the manipulation of plants for improved traits responsible for stress tolerance and nutrition fortification. **CO3:** Understanding of preservation and protection of plants/crops.						

COURSE SYLLABUS

NOTE:
i)Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Plant reproduction, breeding of self-pollinated and cross-pollinated crops, Conventional methods for crop improvement, in-breeding, heterosis, heritability, gene actions. Molecular markers: definition, properties, types of molecular markers: restriction based and PCR based, RFLP, AFLP, SCAR, SSR, CAPS, SNP etc. Marker Assisted Selection (MAS), screening and validation, trait related markers. Applications of NGS in plant breeding. Quantitative traits, QTL mapping, association mapping.	12
II	Plant growth regulators; mode of action, effects on *in vitro* culture and regeneration; callus culture, suspension culture- batch and continuous culture, Protoplast culture, somatic hybridization. micropropagation, Meristem culture, shoot tip culture and production of virus free plants, somaclonal variations, in-vitro production of haploid plants – androgenesis and gynogenesis, doubled haploid production through distant hybridization, *in-vitro* and *in-vivo* pollination and fertilization, embryo culture, embryo rescue, somatic embryogenesis, artificial seeds, germplasm conservation and cryopreservation.	11

III	Development of transgenic plants: Agrobacterium mediated transformation, other methods of gene delivery, development of constructs, reporter genes, selectable markers etc. Gene pyramiding, development of knock outs, RNAi based gene silencing, CRISPR-CAS9 technology, biopesticides in agriculture (botanicals and microbials), integrated pest management, Production and applications of biofertilizers (bacterial, fungal and algal); Plant secondary metabolites: Control mechanisms and manipulation of alkaloids and industrial enzymes (Shikimate and PHA pathway), importance of secondary metabolites in agriculture.	11
IV	Genetic engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake, Genetic engineering for biotic stress tolerance (Insects, fungi, bacteria, viruses, weeds). genetic engineering for abiotic stress tolerance (drought, flooding, salt and temperature). genetic engineering for quality improvement of protein, lipids, carbohydrates, vitamins (e.g. Golden Rice) & mineral nutrients, production of antibody in plants; Plant genetic resources, GATT & TRIPS, Patenting of biological material, patenting of transgenic organisms and genes, Plant breeders rights (PBRs) and farmers rights, Concerns about GM crops – environmental, biosafety and ethics. Recent advances and applications in the field.	11

Suggested Readings:

1. Introduction to plant Biotechnology (2018) 3rd ed., Chawla HS, CRC Press, ASIN: B07LH5S4P3.
2. Applied Biotechnology in Genetic Engineering, Pharmaceuticals and Agriculture (2016) Adam J,Syrawood Publishing House, ISBN: 978-1682862766.
3. Plant Biotechnology: Recent Advancements and Developments (2017). Gahlawat, S.K., Salar, R.K., Siwach, P. and Duhan, J. S., Kumar, S. and Kaur, P. Springer, Germany. pp.1-390. ISBN 978-981-10-4732-9.
4. Molecular Markers in Plants (2012), Henry RJ, Wiley-Blackwell. ISBN: 978-0-470-95951-0.
5. Genetic Transformation of Plants-Series: Molecular Methods of Plant Analysis (2013) Vol. 23, Jackson JF and Linskens HF, Springer, ASIN: B000PY3TJ0.
6. Plant Biotechnology – The genetic manipulation of plants (2017) 3rd ed., Slater A, Scott N and Fowler M, Oxford University Press. ISBN: 1138407674.
7. Plant Transformation Technologies (2011), 1st ed., Stewart CN and Touraev, A Wiley-Blackwell. ISBN: 9780813821955

Course Name: Course title: Basics of Bioinformatics					Course Code: SIAS BT 1 3 01 GEC 4004		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 04**
2021-2023	M.Sc. Biotechnology	III	4	0	0	4	**Total Hrs.: 60**
Total Evaluation Marks: 100 **CIE:** **30** Marks **TEE:** **70** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	• To provide detailed understanding of Bioinformatics such as genomics, transcriptomic etc. • To provide knowledge about the data analysis of next generation sequencing.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1:** Understanding bioinformatics analysis of biological data. **CO2:** Improved insights into data analysis of next generation sequencing **CO3:** Better understanding of the applications of Bioinformatics in biotechnology industry.						

COURSE SYLLABUS

NOTE:
i) Question no. 1 is compulsory and to be set from the entire syllabus. It will have seven sub-parts and students need to answer any four. Each part carries three and half marks.
ii) Question nos. 2 to 5 are to be set from all four units one from each. Every question will have three sub-parts and students need to answer any two sub-parts of each question. Each part carries seven marks.

Unit No.	Contents	Contact Hrs.
I	Historical background. Scope of bioinformatics - genomics, proteomics, computer aided drug design (structure based and ligand based approaches), Applications of bioinformatics. Introduction to biological databases - primary, secondary and composite databases, Different formats of molecular biology data. NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB).	15
II	Alignment-local and global alignment, pairwise and multiple sequence alignments, alignment algorithms, amino acid substitution matrices (PAM and BLOSUM), BLAST and CLUSTAL omega. Identification of open reading frames (ORF), Concept of orthology, paralogy and homology in gene and protein sequences. Methods and tools for phylogenetic analysis, maximum parsimony, maximum likelihood and distance methods; creation, evaluation and interpretation of evolutionary trees phylogenetic tree.	15

III	Next Generation Sequencing, Comparative features of different sequencing platforms (Sanger, Illumina, Nanopore, PacBio etc.), Use of NGS techniques in genomics and transcriptomics, Basic steps in library preparation and analysis of genomics and transcriptomics data. Comparative and genomics, transcriptomics, Functional genomics.	15
IV	Introduction to file formats used in NGS analysis, Types of genomics data *e.g*. WGS, WES, RNAseq, DNA-methylation, single cell sequencing data etc., Concepts of sequencing depth, coverage, phred score, N50, L50, and other metrics used in omics, Introduction to tools and databases used for omics analysis (FastQC, Bowtie, Stringtie, Tophat, Deseq etc.), Various pipelines for genomics data.	15

Suggested Readings:

1. Fundamentals of Statistics (2016) Goon, AM, Gupta, MK and Dasgupta, B. Vol. I & II. World Press, ASIN: B01LB7MH74.
2. Statistical Methods (2012) 1st ed., Das, NG. Vol I & II. Tata McGraw Hill, ISBN: 9780070263512.
3. Probability and Statistics for Engineers and Scientists (2013) 9th ed., Walpole, RE, Myers, RH, Myers, SL and Ye, Pearson Education India KE ISBN: 978-9332519084
4. Biostatistics: A Foundation. for Analysis in the Health Sciences (2012) 10th ed., Daniel, WW and Cross, CL. John Wiley & Sons, ISBN: 978-1118302798
5. Essential Bioinformatics (2006) 1st ed., Xiong J, Cambridge University Press, ISBN 13: 978-0521600828.
6. Fundamental concepts of Bioinformatics (2003) Krane DE and Raymer ML Pearson, ISBN: 978-8177587579.
7. An Introduction to Bioinformatics (2017) 1st ed., Knight R, Larsen and Keller Education, ISBN: 978-1635490459.
8. Concepts of Bioinformatics and Genomics (2016) 1st ed., Momand J, McCardy A, Heubah, S and Warter-Perez N, Oxford University Press, ISBN: 978-0199936991

Course Name: Review Writing and Presentation skills					Course Code: SIAS BT 1 4 01 SEC 2002		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 02**
2021-2023	M.Sc. Biotechnology	IV	2	0	0	2	**Total Hrs.: 30**
Total Evaluation Marks: 50 **CIE:** **15** Marks **TEE:** **35** Marks		**Examination Duration:** 1.5 Hrs.					
Course Objectives	To inculcate/impart the writing and presentation skills.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Improved skills on review writing and presentation skills. CO2: Acquiring skills on collecting literature information to identify a research problem						

Unit No.	Contents	Contact Hrs.
I	This is the compulsory and core course for M.Sc. Biotechnology students. Students will be trained in writing review and/or research paper in this course. Supervisor allotted to each student will train him/her to get literature information on a particular topic that may be or may not be related to his/her dissertation. Every student will be asked to give two presentations on a topic related to his/her dissertation in a month in the presence of all faculty members of the department. The faculty members will assess the skills acquired by the student in each presentation and provide suitable suggestions and comments to improve it further. If a student fails to improve in his/her skills of presentation, one extra chance should be given to the student.	30

Course Name: Dissertation					Course Code: SIAS BT 1 4 02 SEC 0018		
Batch:	**Programme:**	**Semester :**	**L**	**T**	**P**	**Credits**	**Contact Hrs. per Week: 36**
2021-2023	M.Sc. Biotechnology	IV	0	0	18	18	**Total Hrs.: 500**
Total Evaluation Marks: 450 **CIE:** **135** Marks **TEE:** **315** Marks		**Examination Duration:** 3 Hrs.					
Course Objectives	• To inculcate/impart skills on experiment designing, experiment execution and research reporting. • To provide skills on writing thesis dissertation.						
Course Outcomes:	After completing this course, student is expected to learn the following: **CO1**: Improved skills to design, perform, report and present research outcomes. **CO2:** Improved skills in writing the research outcomes in the form of thesis dissertation. **CO3:** Acquiring skills to work independently as well as in group in order to solve a research based problem						

No.	Contents	Contact Hrs.
I	**Guidelines for Project File** Research experience is as close to a professional problem-solving activity as anything in the curriculum. It provides exposure to research methodology and an opportunity to work closely with a faculty guide. It usually requires the use of advanced concepts, a variety of experimental techniques, and state-of-the-art instrumentation. Research is genuine exploration of the unknown that leads to new knowledge which often warrants publication. But whether or not the results of a research project are publishable, the project should be communicated in the form of a research report written by the student. Sufficient time should be allowed for satisfactory completion of reports, taking into account that initial drafts should be critiqued by the faculty guide and corrected by the student at each stage. The file is the principal means by which the work carried out will be assessed and therefore, great care should be taken in its preparation. **In general, the File should be comprehensive and include** • A short account of the activities that were undertaken as part of the project; • A statement about the extent to which the project has achieved its stated goals. • A statement about the outcomes of the evaluation and dissemination processes engaged in as part of the project; • Any activities planned but not yet completed as part of the project, or as a future initiative directly resulting from the project; • Any problems that have arisen that may be useful to document for future reference.	500

	• The guidelines and format for dissertation is given below:	
II	**Dissertation Guidelines** 1. **GENERAL:** The manual is intended to provide broad guidelines to the M.Sc. candidates in the preparation of the dissertation report. In general, the project report shall report, in an organized and scholarly fashion an account of original research work of the candidate leading to the discovery of new facts or techniques or correlation of facts already known. **2. NUMBER OF COPIES TO BE SUBMITTED:** Students should submit three copies to the Head of the Department concerned on or before the specified date. **ARRANGEMENT OF CONTENTS OF DISSERTATION:** Dissertation material should be arranged as follows: 1. Cover Page & Title page 2. Declaration (See format below) 3. Certificate 4. Abstract (Hindi and English) 5. Acknowledgements 6. Table of Contents 7. List of Tables (optional) 8. List of Figures (optional) 9. List of Symbols, Abbreviations and Nomenclature (Optional) 10. Chapters 11. References 12. Appendices 13. One page CV The Tables and Figures shall be introduced in the appropriate places. **PAGE DIMENSIONS AND MARGIN:** The dimensions of the dissertation should be standard A4 size paper may be used for preparing the copies, **standard margin** with 1.5 line spacing. **5. MANUSCRIPT PREPARATION:** The general text of thesis shall be typed in font style Times New Roman and font size 12 with 1.5 spacing. Same quality of paper should be used for the preparation	

of the entire report/thesis; except figure, photos are shown.

5.1 **Cover Page & Title Page** - A specimen copy of the Cover page & Title page for report/thesis are given in Annexure I.

5.2 **Certificate**-The Bonafide Certificate as per the format shown in Annexure II

5.3 **Abstract**: Abstract should be an essay type (HINDI and ENGLISH) of narration not exceeding 500 words outlining the research problem, the methodology used for tackling it and a summary of the findings, typed in 1.5 line spacing.

5.4 **Acknowledgements:** The acknowledgements shall be brief and should not exceed one page. The student's signature shall be made at the right bottom above his / her name typed in capitals.

5.5 **Table of contents** - The table of contents should list all material following it as well as any material which precedes it. The title page, Bonafide Certificate and Acknowledgment will not find a place among the items listed in the Table of Contents but the page numbers in lower case Roman letters are to be accounted for them. One and a half spacing should be adopted for typing the matter under this head. A specimen copy of the Table of Contents for report / thesis is given in Annexure III.

5.6 **List of Table** - The list should use exactly the same captions as they appear above the tables in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head.

5.7 **List of Figures** - The list should use exactly the same captions as they appear below the figures in the text and the caption shall follow 'sentence case'. One and a half spacing should be adopted for typing the matter under this head

5.8 **List of Symbols, Abbreviations and Nomenclature** - One and a half spacing should be adopted for typing the matter under this head. Standard symbols, abbreviations etc. should be used.

5.9 **Chapters** - The chapters may include

Chapter I – Introduction

Chapter II – Review of Literature

Chapter III –Materials and Methods

Chapter IV- Results and Discussion

Chapter V-Summary and Conclusions

1.10. Research output/outcome if any published or presented in conference/seminar/symposium may be included.

1.11. List of References - Any works of other researchers, if used either directly or indirectly, should be indicated at appropriate places in the report/thesis. The citation may assume any one of the following forms**. APA Style.**

APA in-text citation style uses the author's last name and the year of publication, for example: (Field, 2005).

Example:

Derwing, T. M., Rossiter, M. J., & Munro, M. J. (2002). Teaching native speakers to listen to foreign-accented speech. *Journal of Multilingual and Multicultural Development,* 23(4): 245-259.

Thomas, H. K. (2004). *Training strategies for improving listeners' comprehension of foreign-accented speech* (Doctoral dissertation). University of Colorado, Boulder.

TYPING INSTRUCTIONS

6.1 General

This section includes additional information for final typing of the thesis. Some information given earlier under 'Manuscript preparation' shall also be referred. The impressions on the typed/duplicated/printed copies should be black in colour. Corrections, interlineations and crossing out of letters or words will not be permitted in any of the copies of the report/thesis intended for submission. Erasures, if made, should be neatly carried out in all copies. A sub-heading at the bottom of a page must have at least two full lines below it or else it should be carried over to the next page. The last word of any page should not be split using a hyphen. One and a half spacing should be used for typing the general text. The general text shall be typed in Font Style Times New Roman and Font Size 12 with 1.5 spacing.

Single spacing should be used for typing:

(i) Long Tables

(ii) Long quotations
(iii) Foot notes

(iv) Multilane captions
(v) References

6.2 Chapters The format for typing chapter headings, division headings and sub division headings shall be same as given in Table of Contents.

7**. Binding specification-** Thesis should be spiral or soft cover book bound, the cover of the thesis should be of blue color printed with golden ink and the text for printing should be identical as prescribed for the title page.

Format for Declaration by the candidate

DECLARATION

I ……, student of the School of Interdisciplinary and Applied Sciences, Central University of Haryana, Mahendergarh hereby declare and certify with my signature that my thesis entitled **……** submitted to the Department of Biotechnology, Central University of Haryana, India in partial fulfillment of the requirements for the award of the Degree of Masters of Science is a record of original research work done by me and the dissertation has not been the basis for the award of any degree/diploma/associateship/fellowship or similar title of any candidate of any University. I have faithfully and accurately cited all my sources, including books, journals, handouts and unpublished manuscripts, as well as any other media, such as the Internet, letters or significant personal communications.

I understand the concept of "plagiarism" and declare that while drafting this dissertation I have refrained from plagiarism. I know that plagiarism not only includes direct copying, but also the extensive use of other's ideas without proper referencing or acknowledgement (which includes the proper use of references and quotation marks).

If my dissertation found to be plagiarized at any point of time, I'll be solely responsible and will be ready to accept any decision taken by the competent authority including rejection of my dissertation.

Signature of student