RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Programme Structure and Course Details

of

M.Sc. in Biotechnology

Programme Code: 091

BATCH 2024 onwards

M S Ramaiah University of Applied Sciences
Faculty of Life and Allied Health Sciences
Department of Biotechnology
New Bel Road, MSR Nagar
Bengaluru-560054
Website-www.msruas.ac.in

M.S. RAMAIAH UNIVERSITY OF APPLIED SCIENCES Faculty of Life & Allied Health Sciences Bangalore 560 054

DEAN
Faculty of Life & Allied Health Sciences
M.S. RAMAIAH UNIVERSITY OF APPLIED SCIENCES
BANGALORE-560 054

Approved by the Academic Council at its 33rd meeting held on November 21st 2024

Department of Biotechnology
M S Ramaiah University of Applied Sciences
Bangalore - 560 054

Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Programme Specifications

of

M.Sc. in Biotechnology

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Faculty of Life and Allied Health Sciences

Department of Biotechnology

M.S. RAMAIAH UNIVERSITY OF APPLIED SCIENCES
Faculty of Life & Allied Health Sciences
Bangalore 560 054

University's Vision, Mission and Objectives

The M. S. Ramaiah University of Applied Sciences (MSRUAS) will focus on student-centric professional education and motivates its staff and students to contribute significantly to the growth of technology, science, economy and society through their imaginative, creative and innovative pursuits. Hence, the University has articulated the following vision and objectives.

Vision

MSRUAS aspires to be the premier university of choice in Asia for student centric professional education and services with a strong focus on applied research whilst maintaining the highest academic and ethical standards in a creative and innovative environment

Mission

Our purpose is the creation and dissemination of knowledge. We are committed to creativity, innovation and excellence in our teaching and research. We value integrity, quality and teamwork in all our endeavors. We inspire critical thinking, personal development and a passion for lifelong learning. We serve the technical, scientific and economic needs of our Society.

Objectives

1. To disseminate knowledge and skills through instructions, teaching, training, seminars, workshops and symposia in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to equip students and scholars to meet the needs of industries, business and society
2. To generate knowledge through research in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences to meet the challenges that arise in industry, business and society
3. To promote health, human well-being and provide holistic healthcare
4. To provide technical and scientific solutions to real life problems posed by industry, business and society in Engineering and Technology, Art and Design, Management and Commerce, Health and Allied Sciences, Physical and Life Sciences, Arts, Humanities and Social Sciences
5. To instill the spirit of entrepreneurship in our youth to help create more career opportunities in the society by incubating and nurturing technology product ideas and supporting technology backed business
6. To identify and nurture leadership skills in students and help in the development of our future leaders to enrich the society we live in

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7. To develop partnership with universities, industries, businesses, research establishments, NGOs, international organizations, governmental organizations in India and abroad to enrich the experiences of faculties and students through research and developmental programmes

Programme Specifications: M.Sc. Biotechnology

Faculty	Life and Allied Health Sciences
Department	Biotechnology
Programme Code	091
Programme Name	M.Sc. Biotechnology
Dean of the Faculty	Dr. Soma Chaki
Head of the Department	Dr. Shruti Mathur

1. **Title of the Award:** M.Sc. Biotechnology
2. **Mode of Study:** Full Time
3. **Awarding Institution /Body:** M. S. Ramaiah University of Applied Sciences
4. **Joint Award:** Not Applicable
5. **Teaching Institution:** Faculty of Life and Allied Health Sciences, M. S. Ramaiah University of Applied Sciences, Bengaluru
6. **Date of Programme Specifications:** September 2024
7. **Date of Programme Approval by the Academic Council of MSRUAS:** November 2018
8. **Next Review Date:** August 2029
9. **Programme Approving Regulating Body and Date of Approval:**
10. **Programme Accredited Body and Date of Accreditation:** Not Applicable
11. **Grade Awarded by the Accreditation Body:** Not Applicable
12. **Programme Accreditation Validity:** Not Applicable
13. **Programme Benchmark:** Not Applicable
14. **Rationale of the programme:**

The Biotechnology sector is being hailed as the sunrise sector of India. It has been making steady progress over the last few years and has the potential to emerge as a global leader in the biotech

industry. Today in India there are approximately 800 Biotech companies located in the major cities of India, precisely in Bangalore there are lead companies in this sector. Currently Indian Biotechnology sector holds about 2% share of the global Biotechnology industries. The revenue generated in India from the Biotechnology sector is contributed by Biopharmaceutical (61%), Bioindustries (8%), BioAgri (4%), Bioinformatics (3%), Bioservice (19%) and Biosupplies
(5%). Indian Biotechnology industry holds about 2% share of the global Biotechnology industry in 2016. The Indian Biotechnology sector is expected to grow from the current USD 5-7 billion to USD 100 billion by 2025 by a growth of about 30% (as per ABLE-Association of Biotechnology Led Enterprises). Additional to this Government of India-DBT under the Ministry of Science and Technology has initiated lots of schemes to promote Biotechnology research providing support at post graduate, PhD, Post PhD as well as in the industrial sectors.

Biotechnology has become one of the most progressive and beneficial scientific fields since last quarter century. The **scope of Biotechnology is immense in India** as we are living in the age if research where science has taken the new form. We are at a pace of making new application and innovation every day and this could be possible with combining Technology and biology together.
There are many organizations that offer decent job opportunities in India. After doing the course in Biotechnology, one can find jobs in the field of –

1. Drug and pharmaceutical
2. Public Funded laboratories
3. Chemicals
4. Energy
5. Waste Management
6. Food Biotechnology
7. Bio Processing
8. Government institutions and organizations such as Department of Biotechnology (DBT)
9. Agriculture Institutes
10. Horticulture Institutes

15. Programme Mission

RUAS, a young and progressive University with excellent teaching, learning resources and faculty base would like to offer M.Sc. in Biotechnology as a postgraduate programme with a strong aim to acquaint aspiring students with a foundation and first degree training to make them ready for research assistants/associates, marketing executives, maintenance engineers, computational analysts and even administrators in Biotechnology industries.

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16. Graduate Attributes

GA-1. Ability to apply fundamental knowledge of Biology, Biochemistry, Chemistry, Microbiology for developing Biotechnology products.
GA-2. Ability to develop bioprocesses for product development
GA-3. Ability to perform administrative duties in government, semi-government, private and public sector organizations
GA-4. Ability to teach in schools, colleges and universities with additional qualification and training
GA-5. Ability to understand and solve scientific problems by conducting experimental investigations
GA-6. Ability to apply appropriate tools, techniques and understand utilization of resources appropriately in various laboratories
GA-7. Ability to understand the effect of scientific solutions on legal, cultural, social and public health and safety aspects
GA-8. Ability to develop sustainable solutions and understand their effect on society and environment
GA-9. Ability to apply ethical principles to scientific practices and professional responsibilities
GA-10. Ability to work as a member of a team, to plan and to integrate knowledge of various disciplines and to lead teams in multidisciplinary settings
GA-11. Ability to make effective oral presentations and communicate technical ideas to a broad audience using written and oral means
GA-12. Ability to adapt to the changes and advancements in science and engage in independent and life-long learning.

17. Programme Outcome (POs)

PO 1. Technical Knowledge: Demonstrate in-depth knowledge of the scientific fundamentals and the modern technical knowledge needed to support Biotechnology research activities.

PO 2. Design/Development solution: Identify, analyse and understand the problems related to life sciences and find valid conclusions with basic knowledge acquired in the fields.

PO 3. Multidisciplinary approach: Correlate how different sub-systems co-operate with each other into current research and development in the respective fields.

PO 4. Entrepreneurship skills: Analyze manufacturing constituents and complete systems for relevant products and to enable enterprising skills for competing globally.

PO 5. Societal Responsibility: Innovate and develop sustainable solutions and understand their effect on society and environment.

PO 6. Leadership and Ethics: Apply professional Ethics, Leadership and consensus building skills relevant to the aspects of business enterprise in the respective fields.

PO 7. Lifelong learning: Adopt changes and advancements in science and engage in independent learning.

PO 8. Communication: Communicate the information effectively in scientific writing and oral presentation.

18. Programme Goal

Biotechnology is a potential multidisciplinary subject that introduces technological application in the wide domains of Biological Science. It is a promising discipline in which biological processes, organisms, cells or cellular components are exploited to develop new technologies. New tools and products developed by biotechnologists are useful in research, agriculture, industry and the clinic. Modern Biotechnology provides breakthrough products and technologies to combat debilitating and rare diseases, reduce our environmental footprint, feed the hungry, use less and cleaner energy, and have safer, cleaner and more efficient industrial manufacturing processes.

19. Programme Educational Objectives (PEO):

The objectives of the programme are to enable the students to:

PEO 1: To update, extend and deepen students' knowledge thorough a flexible, research-intensive program akin to academia and industry requirements.

PEO 2: To enhance career opportunities in industry, clinical settings both locally and globally or as a preparation for further higher education through in–house state of the art laboratory exposures and outbound dissertation activities fostering Global Competencies among Students.

PEO 3: To enable critical thinking and full-fledged grasp of essential aspects of bioethics inculcating a Value System among Students.

PEO 4: To enrich the global think tanks with right mixes of innovative ability, existing policies at generating and safeguarding the product of their intellect, equipped with entrepreneurship abilities contributing to self and national development.

20. Programme Specific Outcomes (PSO)

PSO 1: Understand the foundational concepts of biotechnology, and how these impact life science research and development in the diverse fields that span healthcare and agriculture.

PSO 2: Design, perform, and analyze results of experiments using basic molecular biology methodologies and recombinant DNA techniques, including agarose and polyacrylamide gel electrophoresis, restriction enzyme digestion, bacterial transformations, plasmid DNA protein expression, PCR, and tissue culture.

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PSO 3: Apply various facets of biotechnological approaches with strong ethical and social responsibilities in bringing solution for human health, agriculture and other welfare.

PSO 4: Students will be able to gain hands on experience in basic and advanced techniques in biotechnology research and get trained effective scientific communication. This experience would enable them to begin a career in industry as well as in research laboratories or to innovate new start up with their entrepreneurship skills.

21. Programme Structure

SEMESTER I

S. No.	Code	Course Title	Credit	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max Marks
1	BTD511A	Cell Biology and Molecular Genetics	4	4			100
2	BTD512A	Biological Chemistry	3	3			100
3	BTD513A	Concepts of Microbiology	3	3			100
4	BTD514A	Bioanalytical Techniques	2	1	1		50
5	BTD515A	Biostatistics and Data Analysis	2	2			50
6	BTL511A	Practical I: Cell Biology & Molecular Genetics	3			6	100
7	BTL512A	Practical II: Microbiology & Biochemistry	3			6	100
Total			20	13	1	12	600
Total number of contact hours per week				**25 hours**			

SEMESTER II

S. No.	Code	Course Title	Credit	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks
1	BTC511A	Bioprocess Technology	4	4			100
2	BTC512A	Molecular Biology and Recombinant DNA Technology	3	3			100
3	BTD516A	Immunology and Immuno techniques	3	3			100
4	BTD517A	Bioinformatics and Structural Biology	2	2			50
5	BTD518A	Research: Methodology, Ethics and Safety	2	2			50
6	BTL513A	Practical III: Molecular Biology and Immunology	3			6	100
7	BTL514A	Practical IV: Bioinformatics and Structural Biology	3			6	100
Total			20	14		12	**600**
Total number of contact hours per week			**26 hours**				

Exit with PG Diploma in Biotechnology

We will have an exit option after one year with PG diploma having skill sets to help them get jobs in data analysis etc.

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SEMESTER III

S. No.	Code	Course Title	Credit	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks
1	BTC601A	Plant and Animal Biotechnology	3	3			100
2	BTL601A	Practical V: Plant and Animal Biotechnology Laboratory	3			6	100
3	BTE6XXA	Elective 1	3	3			100
4	BTE6XXA	Elective 2	3	3			100
5	BTM601A	Introduction to Management, Entrepreneurship and IPR	3	2	1		100
6	BTP601A	Group Project	5			10	100
Total			**20**	**11**	1	**18**	**600**
Total number of contact hours per week			**27h**				

SEMESTER IV

S. No.	Code	Course Title	Credit	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks
1	BTP602A	Dissertation and Publication	**20**			40	300
TOTAL CREDITS (4 semesters)			**80**	**TOTAL MARKS**			**2100**

Elective Course

Two Elective courses (E1 & E2) can be chosen from any one of the following streams–

Stream/ specialization	Course Code	Elective Courses
Stream 1	BTE601A	Synthetic Biology
	BTE602A	Pharmacokinetics
	BTE603A	Medical Biotechnology
Stream 2	BTE604A	AI in Healthcare
	BTE605A	Genomics and Proteomics
	BTE606A	Biotherapeutics:Vaccines and Biosimilars

Group Project

BTP601A Students will be organized into groups, with each group consisting of no more than four members and placed under a faculty mentor. The group project will be designed to foster collaboration and encourage students to address a relevant problem in the fields of biomedical, agricultural, or environmental sciences. The project will consist of a comprehensive review and critical analysis of the current literature related to the chosen topic. Students will identify key questions in areas where knowledge gaps or uncertainties exist. Based on this question, each group will collectively formulate a research hypothesis and develop well-defined research objectives or aims to test the hypothesis. The final outcome of the project will involve the generation of preliminary data, or the development of an algorithm, product, device, or any other outcome that is relevant to the problem being addressed. This project will provide students with the opportunity to gain hands-on experience in collaborative research, critical thinking, and problem-solving, all of which are essential skills for tackling complex, real-world challenges.

Dissertation and Publication

BTP602A Students, under the guidance of the faculty research mentor will choose a research problem for the Dissertation work. After the work is completed, student will compile the work as a dissertation thesis.

Students will also learn another form of academic writing by preparing a manuscript for publication either from the research work done by the student or a review on a chosen topic.

22. **Course Delivery:** As per the Timetable

23. **Teaching and Learning Methods**

i. Laboratory work/Field work/Workshop
ii. Industry Visit
iii. Seminars
iv. Group Exercises
v. Project Work

10. Project
11. Exhibitions
12. Technical Festivals

24. **Assessment and Grading**

24.1. Components of Grading

There shall be two components of grading:

Component 1, Continuous Evaluation (CE): This component involves multiple subcomponents (SC1, SC2, etc.) of learning assessment. The assessment of the subcomponents of CE is conducted during the semester at regular intervals. This subcomponent represents the formative assessment of students' learning.

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Component 2, Semester-end Examination (SEE): This component represents the summative assessment carried out in the form an examination conducted at the end of the semester.

Marks obtained CE and SEE components have equal weightage (CE: 50% and SEE: 50%) in determining the final marks obtained by a student in a Course.

The complete details of Grading are given in the Academic Regulations.

25.1. Theory Courses

The following are the CE components:-

Theory Course CE			**Theory Course SEE**
SC1 (Midterm) 25%	**SC2 (Innovative assignment) 12.5%**	**SC3 (Written Assignment) 12.5%**	**SEE 50%**
50 Marks	**25 Marks**	**25 Marks**	**100 Marks**

In CE there shall be three subcomponents of CE (SC1, SC2, and SC3), namely Mid-term; Innovative assignments and Written assignment. Each subcomponent is evaluated individually accounting to 50% Weightage as indicated in Course Specifications. The innovative assignment subcomponents can be of any of the following types:

a) Online Test
b) Assignments/Problem Solving
c) Field Assignment
d) Open Book Test
e) Portfolio
f) Reports
g) Case Study
h) Group Task
i) Laboratory / Clinical Work Record
j) Computer Simulations
k) Creative Submission
l) Virtual Labs
m) Viva / Oral Exam
n) Lab Manual Report
o) Any other

25.3 Laboratory Course

For a laboratory course, the scheme for determining the CE marks is as under:

For a Laboratory Course	
CE (50%)	SEE (50%)
50 Marks	50 Marks

The subcomponents can be of any of the following types:

a) Laboratory / Clinical Work Record
b) Experiments
c) Computer Simulations
d) Creative Submission
e) Virtual Labs
f) Viva / Oral Exam
g) Lab Manual Report
h) Any other (e.g. combinations)

25. Student Support for Learning

1. Course Notes
2. Reference Books in the Library
3. Magazines and Journals
4. Internet Facility
5. Computing Facility
6. Laboratory Facility
7. Workshop Facility
8. Staff Support
9. Lounges for Discussions
10. Any other support that enhances their learning

26. Quality Control Measures

1. Review of Course Notes
2. Review of Question Papers and Assignment Questions
3. Student Feedback
4. Moderation of Assessed Work
5. Opportunities for students to see their assessed work
6. Review by external examiners and external examiners reports

7. Staff Student Consultative Committee meetings
8. Student exit feedback
9. Subject Assessment Board (SAB)
10. Programme Assessment Board (PAB)

27. Curricular Map

Semester	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
1	Cell Biology and Molecular Genetics	3								3			
1	Biological Chemistry	3								3			
1	Concepts of Microbiology	3	2							3			
1	Practical I: Cell Biology & Molecular Genetics	3	2							3			
1	Practical II: Microbiology & Biochemistry			3							3		
1	Bioanalytical Techniques			3							3		
1	Biostatistics and Data Analysis			3	3								3
2	Immunology and Immuno techniques	3									3		
2	Molecular Biology and RDT		3								3		
2	Bioinformatics and Structural Biology			3								3	
2	Practical III: Molecular Biology and Immunology			3	2						3		
2	Practical IV: Bioinformatics		3		2				3		3		3

2	Research: Methodology, Ethics and Safety												
2	Bioprocess Technology			3		3			3				3
3	Plant and Animal Biotechnology	3		3						3			
3	Practical V: Plant and Animal Biotechnology Laboratory			3					3		3		3
3	Entrepreneurship				3		3					3	
3	Group Project					3	3	3	3		3	3	3
ELECTIVE 1													
Semester	**Course Title**												
3	Medical Biotechnology	2		3								3	
3	Synthetic Biology	3				3							3
3	Pharmacokinetics			3			3					3	
ELECTIVE 2													
3	AI in Healthcare		3	3									3
3	Biotherapeutics:Vaccines and Biosimilars	3								3			
3	Genomics and Proteomics	3									3		
4	Dissertation and Publication		3	3			3	3	3				3

Co-curricular Activities

Students are encouraged to take part in co-curricular activities like seminars, conferences, symposia, paper writing, attending industry exhibitions, project competitions and related activities for enhancing their knowledge and networking.

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28. Cultural and Literary Activities

Annual cultural festivals are held to showcase the creative talents in students. They are involved in planning and organizing the activities.

29. Sports and Athletics

Students are encouraged to take part in sports and athletic events regularly. Annual sports meet will be held to demonstrate sportsmanship and competitive spirit.

Course Specifications: Cell Biology and Molecular Genetics

Course Title	Cell Biology and Molecular Genetics
Course Code	BTD511A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to familiarise students about the dynamic roles of cell structure and concepts of genetic mechanisms at the molecular level in coordinated function for the regulation cellular life cycle.

Students will be able to describe the structures and purposes of membranes and articulate how these cellular components are used to generate and utilize energy in cells. They will be able to illustrate the structure and organization of the genetic material. Also, they will be able to explain the mechanisms involved in the genetic recombination and sex determination. They will also be able to summarize the various alterations in the genetic composition that lead to disease. The student will be trained apply the concepts of genetic recombination for the purpose of gene mapping.

2. Course Size and Credits:

Number of credits	04
Total Hours of Classroom Interaction	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Biotechnology
Course Marks	Total Marks: 100
Pass Requirement	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Teaching, Learning and Assessment

3.Course Outcomes

After undergoing this course students will be able to:

CO 1. Explain the structure and function of the cell organelles, including their evolutionary origins, protein transport mechanisms, and their roles in cellular metabolism.

CO 2. Examine the organization of eukaryotic chromosomes and the significance of transposable elements in humans.

CO 3: Outline the dynamic organization of cytoskeletal filaments and the extracellular matrix, and their roles in maintaining cell structure and facilitating intracellular transport.

CO 4. Develop skills in cytogenetic techniques for genetic analysis
CO 5. Analyse how disruptions in the cell cycle and signalling pathways can lead to cancer development and progression.
CO 6. Assess the molecular mechanisms by which mutations cause genetic disorders and assess their impact on human health.

4. Course Contents:

Molecular Genetics

Unit I **10h**

Structural organization of chromosomes:

Structure and organization of eukaryotic chromosomes: Nucleosomes- Organization of DNA in the nucleosome, histone octamer. Transposable elements in humans and their genetic and evolutionary significance.

Unit II **15h**

Genetic Recombination, mutation and cytogenetic techniques

Mechanism of recombination, Holliday, White house and Radding models; Molecular basis of mutation – Types of mutations. Loss of function mutations, gain of function mutations, expanding repeats. Mutation studies in *Drosophila*. Mutations and human diseases. Chromosomal banding techniques, Karyotyping, Fluorescence in situ hybridization (FISH), Spectral karyotyping (SKY), somatic cell hybrids and gene mapping, Site- directed Mutagenesis.

Unit III

Sex-determination and sex-linked inheritance: **5h**

Sex-determination in Drosophila and mammals. Dosage compensation in Drosophila and mammals. Sex-Linked Disorders, Sex-Limited, Sex-Influenced Traits, Genomic Imprinting.

Cell Biology

Unit IV **10h**

Organelles and Cytoskeleton: Nucleus – Structure and function of nuclear envelope, Macromolecular trafficking; Mitochondria – Origin and evolution, transport of proteins into mitochondria, structure, organization of respiratory chain complexes, mitochondrial DNA and its significance; Chloroplast– Origin and evolution, chloroplast biogenesis, transport of proteins into chloroplasts , Photosynthesis, Chloroplast DNA and its significance; Dynamic structure of cytoskeletal filaments , Molecular motors, Extracellular matrix.

Unit V **10h**

Membrane Structure and Transport: membrane constituents- phospholipids, glycolipids, cholesterol, membrane proteins; receptors and phospholipases; fluid mosaic model.

Transport: membrane transport of small molecules, carrier proteins and active membrane transport; ion channels; anterograde and retrograde protein trafficking.

Unit VI **10h**

Cell Cycle and Signalling: Mitosis and meiosis, regulation of cell cycle, signalling through protein tyrosine kinase receptors, Non-protein tyrosine kinase receptors (JAK-STAT signalling), G-protein coupled receptors signalling and calcium signal transduction, Apoptosis and Cancer.

CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1	3								3			
CO-2	3								3			
CO-3	3								2			
CO-4	3								2	2		
CO-5			2							3		
CO-6			2							3		
3: High Influence, 2: Moderate Influence, 1: Low Influence												

Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		45
Demonstrations		05
1. Demonstration using Videos	04	
2. Demonstration using Physical Models /	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		
1. Case Study Presentation		

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2. Guest Lecture	02	05
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		05
Total Duration in Hours		60

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed				
	CE (50% Weightage)			**SEE (50% Weightage)**
	SC1	**SC2**	**SC3**	
	50 Marks	25 Marks	25 Marks	100 Marks
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
CO-6				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

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viii. Klug, W.S., Cummings, M.R., Spencer, C.A., 2009, *Concepts of Genetics*, 9th Edition, Benjamin Cummings.
ix. Russell, P. J., 2009, *Genetics- A Molecular Approach*, 3rd Edition, Benjamin Cummings.
x. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C., Carroll, S.B., 2007, 9th Edition, *Introduction to Genetic Analysis*, W. H. Freeman & Co.
xi. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., Losick, R., 2008, *Molecular Biology of the Gene*,10th Edition, Cold Spring Harbour Lab., Press, Pearson Pub.
xii. Krebs, J. E., Goldstein, E. S., Kilpatrick, S. T., 2018, *Lewin's GENES XII*, Jones and Bartlett Learning

b. Magazines and Journals

https://www.nature.com/ncb/
http://mcb.asm.org/
https://bmccellbiol.biomedcentral.com/
https://www.nature.com/ng/
https://academic.oup.com/hmg

10.Course Organization

Course Code	BTD511A	
Course Title	Cell Biology and Molecular Genetics	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	September 2024	
Next Course Specifications Review Date:	August 2027	

Course Specifications: Biological Chemistry

Course Title	Biological Chemistry
Course Code	BTD512A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The course aims to provide an advanced understanding of the core principles and topics of biochemistry. The student will be enabled to acquire specialized knowledge and understanding of selected aspects of biological chemistry. This course includes study of chemistry involved in the biological functions, from fundamental principles to recent discoveries, and opportunities to participate in research.

2. Course Size and Credits:

Number of credits	03
Total Hours of Classroom Interaction	45
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Biotechnology
Pass Requirement	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Teaching, Learning and Assessment

3. Course Outcomes

After undergoing this course students will be able to:

- **CO 1.** Demonstrate a broad knowledge of the fundamental introductory concepts of Chemistry and Biology
- **CO 2.** Describe the structures and functions of amino acids and proteins, and to characterize these at the molecular level
- **CO 3.** Explain the chemistry and functions of enzymes in order to address its catalytic activity, the process of regulation and inhibition
- **CO 4.** Describe the structures and functions of carbohydrates and lipids, and its metabolic importance in biological system
- **CO 5.** Enumerate the structure and chemistry of DNA and RNA, and its functional significance and metabolic importance in living organism

CO 6. Demonstrate proficiency in developing relevant biochemical questions and answer those questions with critical analysis and interpretation.

4. Course Content

Unit I **4 h**

Carbohydrates – Structure and diversity

Structure and Classification of Mono, di, oligo, polysaccharide; Starch; Glycogen; Derivatives of Sugars, Glycoconjugates - Peptidoglycans, glycolipids, lipopolysaccharides, glycoproteins; Protein Glycosylation and lectins

Unit II

Carbohydrate metabolism **8 h**

Glycolysis; TCA Cycle; ETC chain and oxidative phosphorylation, Gluconeogenesis, Pentose phosphate pathway, Glycogen metabolism, Bioenergetics

Unit III **12h**

Proteins – Structure and metabolism

Structure and Classifications of Amino Acids; Primary, Secondary, Tertiary, and Quaternary Structure of Protein; Absorption of UV light by Protein, Ramachandran Plot; Structure of Hemoglobin, and Myoglobin; Hill Plot of Oxygen Binding Properties of Hb; Protein Folding; Amino acid Metabolism, Transamination and deamination; Urea Cycle and its relation to TCA Cycle; One Carbon Reaction

Unit IV

Enzyme kinetics and inhibition **6h**

Chemistry and Classification of Enzymes; Mechanism of Enzyme Action; Factors affecting Enzyme Action; Enzyme Kinetics: Michaels Menten Equation, Lineweaver Burk Plot, regulation of enzyme activity; enzyme inhibition, Allosteric Mechanism

Unit V **6h**

Lipids - Structure, Function and Metabolism

Structure and Classification of Lipid; Fatty Acids; Triacylglycerol; Cholesterol, Fatty Acid Synthesis; Beta-oxidation, saturated and unsaturated fatty acid oxidation, omega and alpha oxidation

Unit VI **9h**

Nucleic Acids -Structure, Function and Metabolism

Structure and Chemistry of Nucleic Acid, Chemistry of DNA and RNA; Physical and chemical properties of DNA and RNA. Absorption of UV light by DNA and RNA; Hyperchromic shift; Genome Complexity; C-value Paradox; Cot Value, Nucleotide metabolism: Biosynthesis and degradation of Nucleic Acid; de novo and Salvage Pathways

5. CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1	3								3			
CO-2	2								3			
CO-3	2								3			
CO-4		2							1			
CO-5		2							1			
CO-6		3							1			
3: High Influence, 2: Moderate Influence, 1: Low Influence												

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		24
Demonstrations		06
1. Demonstration using Videos	05	
2. Demonstration using Physical Models /	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		05
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		10
Total Duration in Hours		45

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7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed				
	CE (50% Weightage)			**SEE (50% Weightage)**
	SC1	**SC2**	**SC3**	
	50 Marks	25 Marks	25 Marks	100 Marks
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
CO-6				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study

9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. References

1. Nelson, D.L., Lehninger, A.L. and Cox, M.M., 2008. *Lehninger Principles of Biochemistry*. Macmillan.
2. Stryer, L., 1990. *Biochemistry* 3rd Edition WH Freeman and Company. New York.
3. Horton, H.R., Moran, L.A., Scrimgeour, K.G., Perry, M.D. and Rawn, J.D., 2006. *Principles of Biochemistry*. Pearson Prentice Hall.
4. Voet, D. and Voet, J.G., 2010. *Biochemistry*. John Wiley & Sons.
5. Wilson, K. and Walker, J. eds., 2000. Principles and Techniques of Practical Biochemistry. Cambridge University Press.

b. Magazines and Journals

1. https://www.nature.com/subjects/biochemistry
2. https://www.journals.elsevier.com/process-biochemistry

10. Course Organization

Course Code	BTD512A	
Course Title	Biological Chemistry	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:** 08045366666	
	E-mail: hod.bt.ls@msruas.ac.in	
Course Specifications Approval Date	September 2024	
Next Course Specifications Review	August 2027	

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Head
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Bangalore - 560 054

Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

Course Specifications: Concepts of Microbiology

Course Title	Concepts of Microbiology
Course Code	BTD513A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of this course is to provide students the idea of Microbiology including the diversity, physiology, morphology, genetics, ecology, and applications of microorganisms. Students will be acquainted with the concepts of general Microbiology which is an integral part of Biological Sciences. Students will be able to discuss and relate the structure, function and taxonomy of microbial world including bacteria, fungi, algae, protozoa, slime molds and viruses. The course will familiarize students with the general principles of microbial growth, evolution, classification, unique characteristics, and economic importance of microorganisms.

2. Course Size and Credits:

Number of credits	03
Total Hours of Classroom Interaction	45
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Biotechnology
Pass Requirement	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Teaching, Learning and Assessment

3. Course Outcomes

After undergoing this course students will be able to:

CO 1. Explain the differences between traditional and molecular approaches to taxonomy

CO 2. Describe the cell morphology of gram positive and gram-negative bacteria

CO 3. Explain the concept of microbial growth, death rate and factors that affect the efficacy of sterilization techniques

CO 4. Differentiate between horizontal and vertical gene transfer in bacteria.

CO 5. Compare and contrast the commons methods used for culturing viruses in clinical laboratory

CO 6. Analysing the role of microorganisms in health and environment

4. Course Content

Unit I

Classification: **8h**

Types of microbes (Bacteria, Algae, Fungi, Protozoa, Viruses), Criteria for Microbial classification-morphological, staining techniques, biochemical methods, serological techniques, phage typing, fatty acid profiles, DNA base composition, rRNA sequence, Classification of bacteria according to Bergey's Manual of systematic Bacteriology, Numerical Taxonomy, Cladograms, dendrograms

Unit II

Ultrastructure of bacteria: **7h**

Cell morphology, flagella, pili, capsule, cell wall, cell membrane Peptidoglycan, Intracytoplasmic inclusions, nucleoid, plasmids, transposons, gas vacuoles, Endospores, Genomic Organisation, Extrachromosomal elements . plasmids, transposons, gas vacuoles, cellulosomes, carboxysomes, magnetosomes, phycobilisomes, parasporal crystals, reserved food materials (metachromatic granules, polysaccharide granules, poly hydroxybutyrate granules, glycogen, oil droplets, cyanophycean granules and sulphur globules), endospores and exospores. Brief study of important groups of bacteria: Cyanobacteria, Archaebacteria, Actinomycetes, Ricketisiae, Mycoplasms.

Unit III

Microbial Growth and Control: **8h**

Microbial growth, Culture media, Growth kinetics, Physical and chemical methods of controlling microbial growth, Antimicrobial agents and mechanism of action, Antimicrobial resistance.

Unit IV

Bacterial Genetics: **7h**

Recombination methods: Conjugation, Transformation and transduction; Mutations: Spontaneous and induced mutations; Mobile genetic elements: Transposons

Unit V

Virology: **10h**

Classification of viruses , Assay of viruses, Cultivation in cell culture, chick embryo and animal inoculation, Structure and importance- Viroids, Prions, Phage therapy,

Unit VI

Importance of Microrganisms: 5h

Healthcare: Infectious agents, Probiotics: Industry: Enzymes and Antibiotics;

- Environmental: Carbon and Nitrogen cycle, Bioremediation

5. CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1	3								2			
CO-2	2								2			
CO-3	3								3			
CO-4	3									2		
CO-5		2								2		
CO-6			2							2		
3: High Influence, 2: Moderate Influence, 1: Low Influence												

Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		30
Demonstrations		0
1. Demonstration using Videos	01	
2. Demonstration using Physical Models /	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		

Others		03
1. Case Study Presentation		
2. Guest Lecture	01	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations		
Term Test and Written Examination		5
Total Duration in Hours		45

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed				
	CE (50% Weightage)			**SEE (50% Weightage)**
	SC1	**SC2**	**SC3**	
	50 Marks	25 Marks	25 Marks	100 Marks
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
CO-6				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

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S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. References

1. Prescott, L.M., Harley, J.P., Klein, D.A., 2005, *Microbiology*, McGraw-Hill Higher Education.
2. Pelczar, M.J., Reid, R.D., Chan, E.C.S., 2010, *Fundamentals of Microbiology*, Oxford University Press, UK.
3. Willey, J.M., Sherwood, L.M., Woolverton, C.J., 2008, Prescott, Harley and Klein's *Microbiology*, 7th edition. McGraw Hill Higher Education.
4. Sullia, S.B., Shantharam, S., 2004, *General Microbiology*, 2nd edition (revised), Oxford and IBH Publishing.
5. Baveja, C.P., 2017, *Textbook of Microbiology*, Arya Publishing Company, India.
6. Michael T. Madigan ,Kelly S. Bender Daniel H. Buckley W Matthew Sattley David A. Stahl 2021, *Brock Biology of Microorganisms*, 16th edition, Pearson.

b. E resources and Journals

1. https://www.springer.com/life+sciences/microbiology/journal/12275
2. https://www.hindawi.com/journals/ijmicro/
3. http://mic.microbiologyresearch.org/content/journal/micro

10. Course Organization

Course Code	BTD513A	
Course Title	Concepts of Microbiology	
Course Leader/s Name		As per time table
Course Leader Contact Details		**Phone:** 08045366666
		E-mail: hod.bt.ls@msruas.com
Course Specifications Approval Date		September 2024
Next Course Specifications Review		August 2027

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Faculty of Life & Allied Health Sciences
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Head
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M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

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Course Specifications: Bioanalytical Techniques

Course Title	Bioanalytical techniques
Course Code	BTD514A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

Course Summary

The aim of the course is to orient students on different analytical techniques used for the study of biological macromolecules and cells. It gives an overview of techniques along with their theory, working principle and instrumentation. It discusses applications of these methods in both academic research and industry.

The course covers spectroscopic techniques, microscopic techniques, electrophoretic techniques and chromatographic techniques. Students will be taught to describe and interpret data with examples of high-quality research data. The course will also cover basics of protein purification and studies on protein-protein interactions.

2. Course Size and Credits:

Number of credits	02
Total Hours of Classroom Interaction	30
Number of laboratory Hours	--
Number of semester weeks	16
Department responsible	Biotechnology
Course Marks	Total Marks: 50
Pass Requirement	As per University regulations
Attendance Requirement	As per University regulations

Teaching, Learning and Assessment

3. Course Outcomes (COs)

After undergoing this course students will be able to:

CO1. List various biophysical techniques and define common terms in biophysical techniques

CO2. Differentiate between different subtypes of techniques and understand applications of each subtype.

CO3. To provide scientific understanding of analytical techniques and detail interpretation of results.

4. Course THEORY

Unit I **5h**

Separation & Identification of Biomolecules: Centrifugation, Chromatography (Gel filtration, Ion Exchange Chromatography, Affinity Chromatography, Hydrophobic interaction chromatography, Reverse phase, HPLC, Gas chromatography)

Unit II **5h**

Biomolecular characterization: Primary structure determination of proteins: Amino acid composition; Mass spectrometry – ESI, MALDI, TOF; MS-MS.

Unit III **5h**

Electrophoresis: Agarose Gel electrophoresis, PAGE – native, SDS; IEF; 2D-Gel electrophoresis, Pulsed Field Gel Electrophoresis (PFGE); biomolecular interactions – Gel shift assays, SPR.

Unit IV **5h**

Spectroscopy: Absorption Spectroscopy– Simple theory of the absorption of light by molecules, Beer-Lambert law, Spectrophotometry (UV-visible), Colorimetry, Chromophores, Fluorescence and Phosphorescence, Circular Dichroism, FT-IR

Unit V **4h**

Microscopy: Bright & Dark Field microscopy, Phase Contrast microscopy, Fluorescence microscopy, Confocal microscopy, TEM, SEM, ESEM, EDS.

5. CO-PO PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	-	1	-	-	-	-	-	-	-	3	1	2
CO2	3	2	3	-	2	-	-	-	-	-	-	-	3	1	2
CO3	3	2	3	-	2	-	-	-	-	-	-	-	3	1	2
	3: High Influence, 2: Moderate Influence, 1: Low Influence														

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		22
Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models		
3. Demonstration on a Computer		
Numeracy		02
1. Solving Numerical Problems	02	

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Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop /Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Test and Written Examination		04
Total Duration in Hours		**30**

7. Course Assessment and Reassessment

The components and subcomponents of course assessment is presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final coursemarks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed					
	CE (50% Weightage)				**SEE (50% Weightage)**
	SC1		**SC2**		
	25 Marks		25 Marks		50 Marks
CO-1					
CO-2			X		
CO-3			X		

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teachingand learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Classroom, Assignment, Examination
6.	Practical Skills	--
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Assignment
11.	Presentation Skills	Assignment
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

Essential Reading

1. Nelson, D.L. and Cox, M.M.,"Lehninger Principles of Biochemistry", 6th edition, W.H. Freeman.
2. Voet, D. and Voet, J. G., "Biochemistry" 3rd edition, John Wiley and Sons.
3. Wilson, K. and Walker, J., "Principles and Techniques of Practical Biochemistry" 5th edition, Cambridge University Press
4. Cantor, C.R., Schimmel, P.R., 1980, *Biophysical Chemistry Part I, Part II and Part III*, W. H. Freeman.
5. Manz, Andreas; Pamme,Nicole and Iossifidis, Dimitri; Bioanalytical chemistry, 2004.
6. Upadhyaya, A; Upadhyaya K; and Nath, N; 2009, Biophysical Chemistry – Principles and techniques

a. Recommended Reading

1. Daniel, M., 2003, Basic *Biophysics for Biologists*, Agrobios, Jodhpur, India.
2. Okotore, R.O., 1998, *Basic separation techniques in Biochemistry*, New Age International, India.
3. Sharma, R.K., 2010, *Basic techniques in Biochemistry and Molecular Biology*, I.K. International Publishing house Pvt. Ltd, Delhi, India.
4. David Holme, Hazel Peck; 1998, *Analytical Biochemistry*.

b. Magazines and Journals

1. http://www.cell.com/biophysj/home
2. https://www.journals.elsevier.com/biophysical-journal/

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c. **Websites**

1. https://www.biophysics.org
2. https://phy.duke.edu/undergraduate/prospective-students/learning-about-biophysics
3. http://www.biophysics.org/education-careers/education-resources/selected-topics-in- biophysics/biophysical-techniques
4. https://www.nature.com/subjects/biophysical-methods
5. https://ocw.mit.edu/courses/chemistry/5-36-biochemistry-laboratory-spring-2009/

d. **Other Electronic Resources**

1.
2. https://www.biophysics.org/what-is-biophysics
3. https://www.rose-hulman.edu/~brandt/publications/422_Manual_3rd_Ed.pdf

10. Course Organization

Course Code	BTD514A	
Course Title	Bioanalytical Techniques	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	September 2024	
Next Course Specifications Review	August 2027	

Course Specifications: Biostatistics and Data Analysis

Course Title	Biostatistics and Data Analysis
Course Code	BTD515A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

This course represents an introduction to the field and provides a survey of data and data types. Specific topics include tools for describing central tendency and variability in data; methods for performing inference on population means and proportions via sample data; statistical hypothesis testing and its application to group comparisons; issues of power and sample size in study designs; and random sample and other study types. While there are some formulae and computational elements to the course, the emphasis is on interpretation and concepts.
The purpose of the course is to give students an introduction to the discipline, an appreciation of a statistical perspective on information arising from the health arena and basic critical appraisal skills to assess the quality of research evidence.

2. Course Size and Credits:

Number of credits	02
Total hours of class room interaction	15
Number of tutorial hours	15
Number of semester weeks	16
Department responsible	Biotechnology
Course marks	As described Total Marks: 50
Pass Requirement	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Teaching, Learning and Assessment

3. Course Outcome (CO)

After undergoing this course students will be able to:

CO 1. Explain the importance of data collection and its role in determining scope of inference

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CO 2. Demonstrate an understanding of the central concepts of modern statistical theory and their probabilistic foundation

CO 3. Explain the use, and interpret results of, the principal methods of statistical inference and design

CO 4. Explain the results of statistical analyses accurately and effectively

CO 5. Enumerate an appropriate use of statistical software

CO 6. Demonstrate the use of mathematical and statistical theory underlying the application of biostatistical methods; use and interpret results from specialized computer software for the management and statistical analysis of research data

4. Course Content

Unit I

Introduction to Biostatistics **3 h**

Applications of statistics in biology, definitions (populations, samples), Introduction to probability theory, Basic concepts, definitions to understand probability and sampling; Defining sample space, computing probability

Unit II

Random Variables and Probability Distributions **3 h**

Discrete random variables, Bernoulli random variable, binomial distribution, Poisson distribution with examples Continuous random variables, Normal random variable, other continuous distributions, Central limit theorem

Unit III

Summary Statistics **4 h**

Measures of location and spread Measures of location: Arithmetic and other means, median, mode; when to use each measure of location Measures of spread: Variance and Standard Deviation, Standard Error; Skewness, Kurtosis; Quantiles

Unit IV

Framework for Statistical Analyses **4 h**

Framing hypothesis, The scientific method; deduction and induction; The Hypothetico-deductive method; Testing hypothesis, Significance and p-values; Type I and Type II errors, Introduction to frameworks for statistical analyses, Brief introduction to three main frameworks: Monte-carlo analysis, Parametric analysis, Bayesian analysis

Unit V

Data Analyses **4 h**

Computing sums of squares, standard error of differences between means, Student's T-test, Regression, ANOVA, Chi-square Test

Unit VI

Tools and Languages in Statistics **5 h**

R Programming: elementary syntax, if-else statements, for loops, data input, tables and datasets. Performing statistical analyses using R.

5. **CO-PO-PSO mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1		3								3		
CO-2		3								3		
CO-3			3							3		3
CO-4			3									3
CO-5			3									3
CO-6		3										3
3: High Influence, 2: Moderate Influence, 1: Low Influence												

6. **Course Teaching and Learning Methods**

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		10
Demonstrations		02
1. Demonstration using Videos	01	
2. Demonstration using Physical Models/Systems	01	
3. Demonstration on a Computer		
Numeracy		10
1. Solving Numerical Problems	10	
Practical Work		02
1. Course Laboratory		
2. Computer Laboratory	02	
3. Engineering Workshop/Course Workshop/Kitchen		
4. Clinical Laboratory		
5. Hospital		

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6. Model Studio		
Others		03
1. Case Study Presentation		
2. Guest Lecture	03	
3. Industry/Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Test and Written Examination		03
Total Duration in Hours		30

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed					
	CE (50% Weightage)				**SEE (50% Weightage)**
	SC1		**SC2**		
	25 Marks		25 Marks		50 Marks
CO-1					
CO-2					
CO-3					
CO-4					
CO-5					
CO-6					

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

11. Course Resources

a. References

1. Fundamentals of Biostatistics, Cengage Learning, Bernard Rosner, ISBN-10: 130526892X, ISBN-13: 978-1305268920
2. Basic Biostatistics: Statistics for Public Health Practice, Jones & Bartlett Learning, B. Burt Gerstman, ISBN-10: 9781284036015, ISBN-13: 978-1284036015
3. Biostatistics: The Bare Essentials, People's Medical Publishing House - USA, Norman and Streiner, ISBN-10: 1607951789, ISBN-13: 978-1607951780
4. Biostatistics: A Foundation for Analysis in the Health Sciences, Wiley, Daniel and Cross, ISBN-10: 1118302796, ISBN-13: 978-1118302798
5. Principles of Biostatistics, Chapman and Hall/CRC, Pagano and Gauvreau, ISBN-10: 1138593141, ISBN-13: 978-1138593145

b. Magazines and Journals

1. https://www.nature.com/subjects/biostatistics
2. https://www.elsevier.com/books/biostatistics/forthofer/978-0-12-369492-8

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11. Course Organization

Course Code	BTD515A	
Course Title	Biostatistics and Data Analysis	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone :**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	September 2024	
Next Course Specifications Review	August 2027	

Course Specifications: Practical I: Cell Biology & Molecular Genetics

Course Title	Practical I: Cell Biology & Molecular Genetics
Course Code	BTL511A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to train students to perform experiments to decipher cellular processes at the molecular level.
Students will be able to carry out basic cell biology and molecular biology experiments. The student will be able to utilize these experiments to further their understanding of basic cell biology and molecular genetics. Students will be familiarized with experimental methods and techniques applied in genetics and cell biology research.

2. Course Size and Credits:

Number of credits	03
Total Hours of Classroom Interaction	90
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Biotechnology
Pass Requirement	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Teaching, Learning and Assessment

3. Course Outcomes

After undergoing this course students will be able to:

CO 1. Describe and carry out basic cell biology and microscopy techniques.
CO 2. Evaluate cellular processes that occur in and between cells
CO 3. Describe and explain processes for the characteristics of living organisms.
CO 4. Explain cell-based methods used to expand understanding of cell biology
CO 5. Experiment with model organisms (*Drosophila*) in genetics
CO 6. Demonstrate significant genetic concepts via experimentation

4. Course Content

1. a. Study of mitosis and meiosis in onion root tip and onion buds respectively
   b. to estimate mitotic index in onion root tip
   c. to study inhibition of mitosis using colchicine
2. Preparation of mitotic chromosomes and karyotyping

3. Staining techniques: Staining blood cells, total count and differential count.
4. Isolation of chloroplasts and determining the purity of chlorophyll a and b.
5. Isolation of mitochondria from animal cell and determining the activity of SDH (succinate dehydrogenase)
6. Study of muscle activity: determination of ATPase activity
7. Study of brain cell activity: determination of acetyl choline esterase activity
8. Study of diffusion and osmosis across semipermeable membrane.
9. Microscopic cell count using hemocytometer and determination of cell viability by exclusion assay.
10. Evaluation of cell viability/toxicity using MTT assay.
11. To study initial events of apoptosis by fluorescence microscopy.
12. Morphological features of *Drosophila*/ mutant including genital plate and sex comb in *Drosophila*
13. Isolation and staining of salivary gland chromosomes in *Drosophila*
14. Banding techniques and karyotyping
15. Demonstration of Barr bodies in buccal cells
16. Chromatographic separation of eye pigments in *Drosophila*

5. CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO 2	PSO3	PSO 4
CO-1	3	3								3		
CO-2		3								3		
CO-3		3								3		
CO-4		3					2					3
CO-5		2					2					3
CO-6		2					2					3
3: High Influence, 2: Moderate Influence, 1: Low Influence												

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		
Demonstrations		5
1. Demonstration using Videos	5	
2. Demonstration using Physical Models/Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory	81	
2. Computer Laboratory		
3. Engineering Workshop/Course		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		
1. Case Study Presentation		
2. Guest Lecture		
3. Industry/Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Laboratory Examination		4
Total Duration in Hours		120

7. Course Assessment and Reassessment

The components and subcomponents of course assessment is presented in the Academic Regulations document pertaining to the program. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed			
	CE (50% Weightage)		SEE (50% Weightage)
	SC1	SC2	
	50 Marks	50 Marks	100 Marks
CO-1	x	x	x

CO-2	x	x	x
CO-3	x	x	x
CO-4	x	x	x
CO-5	x	x	x
CO-6	x	x	x

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. References

Lab Manual

Magazines and Journals

1. https://www.jove.com/science-education-library/2/basic-methods-in-cellular-and-molecular-biology
2. https://ocw.mit.edu/courses/biology/7-15-experimental-molecular-genetics-spring-2015/
3. https://bio.libretexts.org/Bookshelves/Genetics/Book%3A_Online_Open_Genetics_(Nickle_and_Barrette-Ng)/08%3A_Techniques_of_Molecular_Genetics
4. https://www.cshlpress.com/default.tpl?action=full&--eqskudatarq=399
5. https://pdfs.semanticscholar.org/ef50/4810a6318ccad1bb5ca52c630f3a9e4fcf1a.pdf

10. Course Organization

Course Code	BTL511A		
Course Title	Practical I: Cell Biology & Molecular Genetics		
Course Leader/s Name		As per time table	
Course Leader Contact Details		**Phone:**	08045366666
		E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date		September 2024	
Next Course Specifications Review Date:		August 2027	

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Course Specifications: Bioprocess Technology

Course Title	Bioprocess Technology
Course Code	BTC511A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of this course is to instil in students a critical awareness and in-depth understanding of the principles, practice and key concepts relevant to industrial biotechnology. The course will enable the student to select the correct sequence of unit operations for the production and purification of bioproducts and to understand which properties will be decisive for the choice of purification strategy and how product and purity requirements will affect the process.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Department of Biotechnology
Course marks	Total: 100
Pass requirement	As per Academic Documents
Attendance requirement	As per Academic Documents

Teaching, Learning and Assessment

3. Course Outcome (CO)

After undergoing this course students will be able to:

CO 1. Describe the principles that underlie major unit operations used in upstream and downstream processing of bioprocesses.

CO 2. Demonstrate the methods of cell culture under various conditions, strain improvement methods

CO 3. Explain how environmental conditions influence cell growth and means to achieve optimal cell growth in large scale

CO 4. Design or Select appropriate bioreactor models based upon bioproducts and cell lines and other process criteria

CO 5. Design and formulate effective strategies of downstream processing based on characteristics of biomolecules and to learn the various techniques of product capturing, isolation, purification and polishing

CO 6. Develop and formulate methods to meet the need of pure proteins, enzymes and other valuable products related to biopharmaceuticals, clinical research and development.

4. Course Content

Unit I:

Upstream biological operations: 12h

Strain improvement for the selected organism: mutation and screening of improved cultures, random and strategic screening methods, strategies of strain improvement for primary, secondary metabolites with relevant examples. Use of recombinant DNA technology, protoplast fusion techniques for strain improvement of primary and secondary metabolites. Production of recombinant molecules in heterologous system, problems associated with strain improvement programme, improvement of characters other than products and its application in the industry. Preservation of cultures after strain improvement programme.

Unit II :

Media Formulation and Sterilisation **8h**

medium formulation involving all components; medium sterilization, oxygen requirements, antifoams, medium optimization, Ingredients for mammalian cell culture and plant cell culture, probabilistic and deterministic approaches in the design; Gas sterilization, sterilization of fermenter and other ancilliaries, filter sterilization of air and media.

Unit III

Fermentation & Microbial Kinetics: **12h**

Introduction, Criteria for transfer of inoculum, development of inoculum for bacterial processes, yeast processes and mycelial processes. Inoculum development for plant fermenter, aseptic method of inoculation, achievement and maintenance of aseptic conditions. Fermentation Material and Energy balance, Microbial growth kinetics: Microbial growth cycle, measurement of growth, Batch culture, continuous culture, fed-batch culture, applications and examples

Unit IV

Design of bioreactors: **8h**

Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Process parameters and measurement techniques: measurement of temperature, pressure and pH, DO, foam etc.; flow rate of liquid and gases; Automation (processes computerization). Validation of Fermentor

Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Solid state fermenter, Animal and plant cell bioreactors. Scale up and Scale down studies of bioreactors. Heat and Mass transfer in Bioprocess, Relationship in between heat transfer, cell concentrations and stirring conditions, Measurement of KLa, Rheological properties of fermentation broths, Factors affecting broth viscosity, Mixing in Fermenters.

Unit V

Overview of Downstream Operations: **8h**

Role and importance of downstream processing in biotechnological processes. Problems and requirements of bioproduct purification. Process economy: Economics & Cost cutting strategies, process design criteria for various classes of bioproducts (high volume, low value products and low volume, high value products. Downstream Process overview: General account of downstream processing steps.

Unit VI

Separation Techniques **12h**

Cell disruption methods for intracellular products Osmotic shock, Homogenization, various types of homogenizes, Sonication, Enzyme digestion. Centrifugation: basic principles, design characteristics; ultracentrifuges; principles and applications.

Membrane based separation processes, Microfiltration; Reverse osmosis, Nanofiltration, Ultrafiltration and Affinity ultrafiltration, Membrane modules. Liquid-liquid extraction, Supercritical fluid extraction, Chromatography: Gel filtration chromatography, Ionexchange chromatography (IEC), . Affinity chromatography: Immunoaffinity purification, Immunoaffinity matrices, ligand affinity, hydrophobic interaction chromatography (HIC), HPLC, RP – HPLC.

Electrophoresis – Theory and factors affecting. Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2 D- Electrophoresis; isoeletric focusing; Pulsed field gel electrophoresis precipitation, **Crystallization and Drying:** Theory – nucleation, crystal growth; mixed product removal crystallizer with mixed suspension. Crystallization processes, Drying: drying curve, tray dryer, flash dryer, freeze drying – principle and process, freezing, primary and secondary drying.

5. CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1	1	3								**1**		3
CO-2		3										3
CO-3		3										3
CO-4			3								2	
CO-5		2	3									3
CO-6		2										3
3: High Influence, 2: Moderate Influence, 1: Low Influence												

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		39
Demonstrations		06
1. Demonstration using Videos	05	
2. Demonstration using Physical Models /	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		05
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		10
Total Duration in Hours		60

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

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Focus of Course Learning Outcomes in each component assessed				
	CE (50% Weightage)			SEE (50% Weightage)
	SC1	SC2	SC3	
	50 Marks	25 Marks	25 Marks	100 Marks
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
CO-6				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	–
11.	Presentation Skills	–
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. References

1. Peter F Stanbury, Allan Whitaker, Stephen J Hall. Principles of Fermentation Technology. (2016) Butterworth-Heinemann Press. UK.
2. El-Mansi (Ed.), "Fermentation Microbiology and Biotechnology", CRC Press, 3rd Ed., 2011.
3. Pauline M. Doran, "Bioprocess Engineering Principles", Academic Press, 2nd Ed., 2012
4. Paul A. Belter, "Bioseparations: Downstream processing for Biotechnology". Wiley Interscience, 1st Ed., 1988.
5. Roger Harrison et al., "Bioseparation Science and Engineering", Oxford Uni. Press, 2002.

b. Magazines and Journals

1. https://www.liebertpub.com/loi/ind
2. https://link.springer.com/journal/10295
3. http://www.heraldopenaccess.us/journals/Advances-in-Industrial-Biotechnology/

10. Course Organization

Course Code	BTC511A	
Course Title	Bioprocess Technology	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	September 2024	
Next Course Specifications Review	August 2027	

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Head
Department of Biotechnology
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

Course Specifications: Molecular Biology and rDNA Technology

Course Title	Molecular Biology and rDNA Technology
Course Code	BTC512A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The course aims to familiarize students with the concepts of Molecular Biology and Recombinant DNA technology. Students will be acquainted with the central principles and fundamental mechanisms for the organization, replication, expression, variation, and evolution of the genetic material, as well on methods for molecular biology analyses and gene technology. Students will be familiarized with the methodological repertoire of the basic and applied fields of recombinant DNA technology. This course will provide theoretical bases to properties and applications of versatile DNA modifying enzymes, cloning strategies, vector types, host genotype specificities for selection and screening of recombinants and recombinant transformants. The students will be facilitated with a strong foundation for more advanced cutting-edge technologies.

2. Course Size and Credits:

Number of credits	04
Total hours of class room interaction	60
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Department of Biotechnology
Course marks	Total: 100
Pass requirement	As per Academic Documents
Attendance requirement	As per Academic Documents

Teaching, Learning and Assessment

3. Course Outcome (CO)

After undergoing this course students will be able to:

CO 1. Enumerate the processes of DNA replication, repair and recombination to maintain the integrity of DNA and chromosomes

CO 2. Differentiate the tools and techniques used in recombinant DNA technology

CO 3. Compare and contrast the process of prokaryotic and eukaryotic gene expression

CO 4. Illustrate the complex mechanism behind eukaryotic and prokaryotic gene regulation

CO 5. Evaluate the methodologies involved in in-vitro construction of gene libraries

CO 6. Explain creative use of modern instrumentation and technologies for manipulation of genomic sequences

4. Course Content

Unit I

DNA Replication & Repair: **6h**

DNA Replication: Prokaryotic and eukaryotic DNA replication mechanism, Telomeres and telomerase, DNA repair: Excision repair, Mismatch repair, Post- replication repair, SOS repair.

Unit II

Transcription and Translation: **8h**

Prokaryotic and eukaryotic transcription, Regulatory elements, mRNA stability, post transcriptional processing, Genetic Code, Prokaryotic and eukaryotic translation, Regulation of translation, co-and post-translational modifications of proteins

Unit III

Regulation of gene expression: **8h**

Operon theory, lac operon, trp operon, regulation of gene expression in eukaryotes, Chromatin and gene regulation, RNA interference: siRNA and microRNA, CRISPR/Cas technology.

Unit IV

Recombinant DNA Technology: **8h**

Restriction endonucleases, DNA modifying enzymes, Vectors for cloning in E. coli: Plasmids, Bacteriophage λ, Filamentous phage vectors, cosmids, BAC, YAC and HAC vectors, Shuttle vectors, Expression vectors, Vectors designed for cloning in yeast, Vectors for cloning in Plant and animal cells

Unit V

Gene Cloning Strategies: **6h**

Cloning by restriction digestion, cloning by Gibson assembly, Construction of genomic and cDNA libraries, Isolation and purification of DNA, Transformation and transfection techniques, Methods for screening recombinant DNA

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Unit VI

Techniques in RDT: **8h**

Recombinant protein purification Affinity-tag; Solubility-tag, GFP-fusion proteins, Cytoplasmic expression and periplasmic expression of recombinant proteins in *E.coli*, Labeling of DNA and Proteins by radioactive isotopes, non-radioactive labeling, autoradiography and autofluorography, DNA sequencing methods -Sanger sequencing method, Next Generation Sequencing, Polymerase chain reaction and its applications, Different types of PCR (Hot start PCR, Multiplex PCR, Nested PCR, Real-time PCR, In Situ PCR, Inverse PCR, Reverse Transcriptase PCR, Methylation-specific PCR).

5. CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1	3									2		
CO-2	2									2		
CO-3	3									3		
CO-4			2									3
CO-5			2									3
CO-6				3								3
3: High Influence, 2: Moderate Influence, 1: Low Influence												

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		34
Demonstrations		06
1. Demonstration using Videos	05	
2. Demonstration using Physical Models /	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		

3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		05
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		10
Total Duration in Hours		45

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed				
	CE (50% Weightage)			**SEE (50% Weightage)**
	SC1	**SC2**	**SC3**	
	50 Marks	25 Marks	25 Marks	100 Marks
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
CO-6				

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The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. References

1. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J., 2004, *Molecular Cell Biology*, Scientific American Books Inc. NY.
2. Karp, G., 2010,*Cell and Molecular Biology: Concepts and Experiments*, 6thEdition, John Wiley & Sons. Inc.
3. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., Losick, R., 2008, Molecular Biology of the Gene, 10th Edition, Cold Spring Harbour Lab., Press, Pearson Pub.
4. Brown, T.A., 2006, Gene Cloning and DNA Analysis, 5th Edition, Blackwell Publishing, Oxford, U.K.
5. Glick, B.R., Pasternak, J.J., 2003, Molecular Biotechnology - Principles and Applications of recombinant DNA, ASM Press, Washington.

6. Primrose, S.B., Twyman, R.M., 2006, Principles of Gene Manipulation and Genomics, 7th edition, Blackwell Publishing, Oxford, U.K.
7. Nelson, D. L., Cox, M. M., 2008, Lehninger principles of biochemistry. 7th Edition, W.H. Freeman

b. Magazines and Journals

1. https://cmbl.biomedcentral.com/
2. http://mcb.asm.org/
3. https://www.scitechnol.com/advances-in-genetic-engineering-biotechnology.php

Course Organization

Course Code	BTC512A	
Course Title	Molecular Biology and rDNA Technology	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	September 2024	
Next Course Specifications Review	August 2027	

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Course Specifications: Immunology & Immunotechniques

Course Title	Immunology & Immunotechniques
Course Code	BTD516A
Department	Department of Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to acquaint students about the components, principles and mechanisms of the immune system, and their co-ordination to mount safe and appropriate protection against infection. Students will be able to learn and correlate the complex mechanisms involved in immune system which governs the diversity, specificity and memory to the system. The students will be facilitated to conceptualize the underlying situations of inappropriate immunity, such as allergy, autoimmunity and immune deficiency. Students will be able to consider discrimination and tuning of immune responses to meet the challenges of different anatomical sites, such as in the skin, gut and lung. Students will be taught on the current and emerging use of immune molecules in diagnostic and clinical intervention strategies, including the therapeutic manipulation of the immune system in cancer treatment, vaccine development, and transplant tolerance.

2. Course Size and Credits:

Number of credits	03
Total hours of class room interaction	45
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Department of Biotechnology
Course marks	Total: 100
Pass requirement	As per Academic Documents
Attendance requirement	As per Academic Documents

Teaching, Learning and Assessment

3. Course Outcome (CO)

After undergoing this course students will be able to:

CO 1. Explain the structure, properties and functions of antigens, antibodies, B cells, T cells, APC, MHC molecules, cytokines, surface receptors, haptens and adjuvants.

CO 2. Compare and contrast primary and secondary immune response, innate and acquired immune response, origin, maturation and general function of B and T lymphocytes, humoral and cell mediated immunity.

CO 3. Describe the mechanisms of antigen processing, hypersensitivity reactions, consequences of autoimmune disorders, immunity to infections.

CO 4. Evaluate different types of immune assay based on the principles of antigen-antibody reactions, cell proliferation assays, cytotoxicity assays

CO 5. Illustrate the importance and application of molecular mechanisms of immune responses in therapeutic approaches.

4. Course Contents

Unit I

Histology of immune system **4 h**

Innate and acquired immunity, Complement and Inflammatory responses; Cells and Organs of the immune system- primary and secondary lymphoid organs; Haematopoesis

Unit II

Immune responses **6h**

Antigens – immunogens, antigen processing and presentation- endogenous antigens, exogenous antigens , Immunoglobulins- structure and classification, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Basis of self –nonself discrimination; B cell maturation, activation and differentiation; Generation of antibody diversity; Humoral immunity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Lymphocyte circulation; Lymphocyte homing Cytokines-properties, receptors.

Unit III

MaJor Histocompatibility Complex and Transplantation **4h**

Structure and functions of MHC and HLA systems. Genetic control of immune response. Tissue transplantation-Tissue typing methods for tissue and organ transplantations. Graft versus host reaction and rejection, xenotransplantation, immunosuppressive therapy.

Unit IV

Immunotechniques: Antigen-antibody interactions **6h**

Precipitation, agglutination, RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry; Cell Cytotoxicity assays, Immunohistochemistry, Production and purification of antibodies, hybridomas.

Unit V

Immune System in Health and Disease **6h**

Immunity to Infection: Bacteria, viral, fungal and parasitic infections , Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Treatment of autoimmune diseases; Tumor immunology - Tumor antigens; Immune response to tumors and tumor evasion of the immune system; Immunodeficiency-Primary immune deficiencies; Acquired or secondary immune deficiencies.

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Unit VI

Immunotherapy **6h**

Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein-based vaccines, mRNA vaccines; Immunotherapy in cancer and HIV- Monoclonal antibodies and tumor-agnostic therapies; Non-specific immunotherapies; Oncolytic virus therapy; CAR-T-cell therapy.

5. CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1	3								3			
CO-2		3								3		
CO-3	3									3		
CO-4	3										3	
CO-5		2					2				3	
3: High Influence, 2: Moderate Influence, 1: Low Influence												

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		24
Demonstrations		06
1. Demonstration using Videos	05	
2. Demonstration using Physical Models /	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		

5. Hospital		
6. Model Studio		
Others		05
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		10
Total Duration in Hours		45

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed				
	CE (50% Weightage)			**SEE (50% Weightage)**
	SC1	**SC2**	**SC3**	
	50 Marks	25 Marks	25 Marks	100 Marks
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
CO-6				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.

Course reassessment policies are also presented in the Academic Regulations document.

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8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. References

1. Goldsby, R.A., Kindt, T.J., Osborne, B.A., 2007, *Kuby's Immunology*, 6th Edition, W.H. Freeman and Company, New York.
2. Abbas, A.K., Lichtman, A.H., Pillai, S., 2007, *Cellular and Molecular Immunology*, 6th Edition, Saunders Publication, Philadelphia.
3. Delves, P., Martin, S., Burton, D., Roitt, I.M., 2006, *Roitt's Essential Immunology*, 11th Edition, Wiley-Blackwell Scientific Publication, Oxford.
4. Murphy, K., Travers, P., Walport, M., 2008, *Janeway's Immunobiology*, 7th Edition, Garland Science Publishers, New York.

b. Magazines and Journals

The Journal of Immunology: www.jimmunol.org
immunology.sciencemag.org/
http://journals.sagepub.com/doi/pdf/10.1177/011542650301800645 1

10. Course Organization

Course Code	BTD516A	
Course Title	Immunology and Immunotechniques	
Course Leader/s Name	As per Time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	September 2024	
Next Course Specifications Review	August 2027	

M.S. RAMAIAH UNIVERSITY OF SCIENCES Faculty of Life & Allied Health Sciences Bangalore 560 054

Shruti Mathur
Head
Department of Biotechnology
M S Ramaiah University of Applied Sciences
Bangalore

Dean - Academics
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

Course Specifications: Bioinformatics and Structural biology

Course Title	Bioinformatics and Structural biology
Course Code	BTD517A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The course covers basic methods used in sequence analysis such as pairwise and multiple alignment, searching databases for sequence similarity, profiles, pattern matching, hidden Markov models, RNA bioinformatics, gene prediction methods and principles for molecular phylogeny. The course includes modern high-throughput sequencing techniques and their applications, as well as molecular biology databases and different systems to query such databases. The course considers theoretical principles as well as how existing programs are being used by bioinformaticians.

2. Course Size and Credits:

Number of credits	2
Total Hours of Classroom Interaction	32
Number of laboratory Hours	--
Number of semester weeks	16
Department responsible	Biotechnology
Course Marks	As described in the program specification
Pass Requirement	As per University regulations
Attendance Requirement	As per University regulations

Teaching, Learning and Assessment

3. Course Outcomes (COs)

After undergoing this course students will be able to:

CO1. Explain the use of bioinformatics in addressing a range of biological questions

CO2. Justify how bioinformatics methods can be used to relate sequence, structure and function

CO3. Enumerate the technologies for modern high-throughput DNA sequencing and their applications

CO4. Describe principles and algorithms of pairwise and multiple alignments, and sequence database searching

CO5. Explain how evolutionary relationships can be inferred from sequences (phylogenetics)

CO6. Explain the 3-D structure of protein, and its interaction with different ligands to draw structure function relationship

4. Course Contents

5. THEORY

Unit 1 Fundamentals of Bioinformatics and Biological Databases **4h**

Introduction to Bioinformatics, Concept of homology, paralogy, orthology, analogy and xenology, NCBI, and data retrieval European Bioinformatics Institute database search; Understanding EXPASY server; European Molecular Biology server, KEGG Pathway, PDB, PDBj

Unit 2: Sequence Alignment and Phylogenetic Analysis **10h**

Introduction to Sequence comparison, global and multiple sequence alignment, Multiple sequence alignment using FASTA, Sequence alignment using CLUSTALW, BLAST and advance BLAST, **Phylogenetics:** Concept of phylogenetic trees, reading and interpreting phylogenetic trees. Algorithms for constructing phylogenetic trees: UPGMA, Neighbor Joining, and Maximum parsimony. Judging strength of clades (with BS or PP values) in a tree. Applications of phylogenetics in molecular and evolutionary biology

Unit 3: Fundamentals of structural biology **10h**

Introduction to the 3-dimensional protein structure. Learning how to read and parse the PDB file format. Reading Dunbrack's Rotamer Library. Interpreting Ramachandran plots. Calculating backbone (phi / Φ, psi / Ψ) and sidechain (chi / X) dihedral angles for protein structures. Calculating centroids, translations and rotations of points in 3D space. Superposition of sets of points using Kabsch's algorithm. Calculating RMSD for two sets of points..

Unit 4: Protein folding and design **8h**

Introduction to the SCOP and CATH databases. Understanding the protein folding and protein design problems. Understanding simulated annealing optimization. Understanding algorithms for protein folding: SWISS-MODEL, Rosetta (ab inito design), and Alphafold. Understanding algorithms for protein design: Rosetta (fixed backbone design and all-atom relaxation). Examples of important computationally designed proteins: Top7, self-assembling nanocages, and synthetic nucleocapsids.

1. CO-PO PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	2	3	-	1	-	-	-	3	1	2	-
CO2	3	2	3	-	2	-	-	-	3	1	2	-
CO3	3	2	3	-	2	-	-	-	3	1	2	-
CO4	1	2	3	-	2	-	-	-	3	1	2	-
CO5	3	2	3	-	2	-	-	-	3	1	2	-
	3: High Influence, 2: Moderate Influence, 1: Low Influence											

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		24

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Demonstrations		02
1. Demonstration using Videos	02	
2. Demonstration using Physical Models		
3. Demonstration on a Computer		
Numeracy		02
1. Solving Numerical Problems	02	
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop /Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Test and Written Examination		04
Total Duration in Hours		**32**

7. Course Assessment and Reassessment

The components and subcomponents of course assessment is presented in the Academic Regulations document pertaining to the Programm. The procedure to determine the final coursemarks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed					
	CE (50% Weightage)				**SEE (50% Weightage)**
	SC1		**SC2**		
	25 Marks		25 Marks		50 Marks
CO-1					
CO-2			X		
CO-3			X		

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teachingand learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Classroom, Assignment, Examination
6.	Practical Skills	--
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Assignment
11.	Presentation Skills	Assignment
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15..	Leadership Skills	--

9.Course Resources

a. Essential Reading

1. Class notes
2. Higgins, Des, and Willie Taylor, eds. 2000, *Bioinformatics: Sequence, Structure and Databanks: A Practical Approach*. Vol. 236. OUP Oxford,
3. Lacroix, Zoé, and Terence Critchlow, eds. , 2003, *Bioinformatics: managing scientific data*. Vol. 6. No. 2. Academic Press.

b. websites

1. https://www.nature.com/subjects/bioinformatics
2. https://www.journals.elsevier.com/genomics-proteomics-and-bioinformatics

10. Course Organisation

Course Code	BTD517A	
Course Title	Bioinformatics and Structural biology	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	September 2024	
Next Course Specifications Review	August 2027	

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Dean - Academics
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Course Specifications: Research: Methodology, Ethics and Biosafety

Course Title	Research: Methodology, Ethics and Biosafety
Course Code	BTD518A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

This course provides a comprehensive understanding of fundamentals of research and covers essential skills in research design and statistical analysis. Additionally, the course emphasizes research proposal writing, manuscript preparation, and effective presentation techniques using established frameworks. Students will also be familiarized with the essential concepts of Biosafety and Bioethics in biotechnology research. They will learn to understand the ethical, social, and legal aspects of biotechnology regulation and importance of biosafety in this field.

2. Course Size and Credits:

Number of credits	02
Total Hours of Classroom Interaction	30
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Biotechnology
Course Marks	Total Marks: 50
Pass Requirement	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Teaching, Learning and Assessment

3. Course Outcomes (CO)

After undergoing this course students will be able to:

CO1: Describe the relevance and mandatory steps of research and out of the box thinking concepts for effective research

CO2: Prepare and Analyze research proposal, research paper and deliver effective presentations

CO3: Demonstrate knowledge of various ethical aspects related to health care and biotechnology research.

CO4: Apply the safety guidelines for Biotechnology research and products.

4. Course Content

Unit I (5 hours)
Foundations of Research:
Concept and Importance, Types of Research, Steps in the Research Process, Deductive and Inductive theory, Characteristics of scientific method, Relevance of Research for Innovation and Technology Development, Out Of the Box Thinking , Choosing a mentor and lab

Unit II (4 hours)
Research Design:
Concept and fes of good research design, Formulation of the research problem, Literature review: importance and sources, Variables in Research, Data Collection methods, Paraphrasing and Referencing

Unit III **4h**
Research Proposal and Effective Presentation:
Research Proposal: Importance and Contents, Report writing, Manuscript preparation, Journal selection and metrics, Plagiarism, Effective presentation: 4P's rule, PAMPERS rule and PEOPLE rule

Unit IV **4h**
Biosafety:
Biosafety-Introduction to biosafety levels and biological safety cabinets; primary containment for biohazards; Biomedical disposal management; principles of safety assessment of transgenic plants and animals; risk assessment – environmental risk assessment and food and feed safety assessment

Unit V **4h**
Bioethics:
Introduction to ethical conflicts in biological sciences - interference with nature, bioethics in health care; Bioethics in biotechnology research; bioethics in agricultural biotechnology.

Unit VI **4h**
Biosafety Regulations-National and International:
International regulations – Cartagena protocol, Indian regulations – EPA act and rules, Regulatory framework – RCGM, GEAC, IBSC, and other regulatory bodies; field trials and phase trials – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

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5. **CO-PO-PSO mapping**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO1	3	1							3			
CO2	3		1						3			
CO3	3							2	2			1
CO4		1	2						2		2	

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in	Total Duration in Hours
Face to Face Lectures		20
Demonstrations		02
1. Demonstration using Videos		
2. Demonstration using Physical Models/Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop/Course Workshop/Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		04
1. Case Study Presentation	02	
2. Guest Lecture	01	
3. Industry/Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	01	
6. Discussing Possible Innovations		
Term Test and Written Examination		04
Total Duration in Hours		30

7. Course Assessment and Reassessment

The components and subcomponents of course assessment is presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final

course marks is also presented in the Academic Regulations document as well.
The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed				
	CE (50% Weightage)			SEE (50% Weightage)
	SC1	SC2	SC3	
	50 Marks	25 Marks	25 Marks	50 Marks
CO-1				
CO-2				
CO-3				
CO-4				
CO-5				
CO-6				

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.
Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

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9. Course Resources

References

1. Valiela, I. (2001). *Doing science: Design, analysis, and communication of scientific research*. Oxford: Oxford University Press.
2. *On being a scientist: A guide to responsible conduct in research*. (2009). Washington, D.C.: National Academies Press.
3. Booth, W. C, Colomb and Williams, G.G (2005) *The Craft of Research*, Chicago University Press
4. William, M. K. and Trochim (2003) *Research Methods*, 2nd Edition, Biztantra Publications
5. Jonathan, G. (2004) *The Foundation of Research*, Palgrave Study Guides
6. Rugg, G. and Petre, M. (2004) *The Unwritten Rules of Ph.D. research*, Open University Press
7. Stanley, S.A., 2008, Bioethics, Wisdom educational service.
8. Sateesh, M.K., 2008, *Bioethics and Biosafety*, I.K International Pvt. Ltd.
9. Goel, D., Parashar, S., 2013, IPR, *Biosafety and Bioethics*, Pearson Education, India.

a. Magazines and Journals

1. Movie: Naturally Obsessed, The Making of a Scientist.
2. https://www.sciencedaily.com/terms/bioethics.htm

c. Websites

1. http://www.ipindia.nic.in/
2. http://cipam.gov.in/national-ipr-policy/

10. Course Organization

Course Code	BTD518A	
Course Title	Research: Methodology, Ethics and Biosafety	
Course Leader/s Name	As per Time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	September 2024	
Next Course Specifications Review	August 2027	

Course Specifications: Practical III: Molecular Biology & Immunology

Course Title	Practical III: Molecular Biology & Immunology
Course Code	BTL513A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The course aims to facilitate students on practical aspects of experimental knowledge in molecular biology, genetic engineering and Immunology. The students will be able to execute the experimental design and basic techniques commonly used in molecular biology and immunology laboratories. Students will be able to gain hands-on experience on gene cloning, protein expression and purification that enable them to begin a career in genetic engineering as well as in fundamental research.

2. Course Size and Credits:

Number of credits	03
Total Hours of Classroom Interaction	90
Number of tutorial hours	00
Number of semester weeks	16
Department responsible	Biotechnology
Pass Requirement	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Teaching, Learning and Assessment

3. Course Outcomes

After undergoing this course students will be able to:

CO 1. Isolate and characterize DNA and Plasmids for molecular weight, restriction and ligation

CO 2. Expertize in PCR and RAPD techniques for quantification of DNA

CO 3. Acquire hands-on experience on gene cloning, protein expression and detection.

CO 4. Perform cell culture and counting of immune cells and comment

CO 5. Perform assays to assess the interaction and quantification of antigen and antibody

CO 6. Perform experiments used to purify immunoglobulins from serum sample

4. Course Contents

1. Isolation, quantification and characterization of genomic DNA from bacteria (*E. coli)*
2. Isolation, quantification and characterization of plasmid DNA from bacteria.
3. Restriction digestion and ligation of DNA.
4. Determination of molecular weight and quantification of DNA and Protein
5. Preparation of competent cells, transformation of *E.coli* and screening of transformants
6. Cloning and expression of GFP gene in *E.coli*
7. Amplification of desirable gene by Polymerase chain reaction.
8. Random amplification of polymorphic DNA
9. Western blotting
10. Purification of His-Tagged protein on Ni-NTA columns.
11. Antibody titre by ELISA method
12. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion
13. Complement fixation test
14. Isolation and purification of IgG from serum
15. SDS-PAGE, Immunoblotting, Dot blot assays.
16. Blood smear identification of leucocytes by Giemsa stain.
17. Separation of leucocytes by dextran method.
18. Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation

5. CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1	3	2							3			
CO-2	3	2								3		
CO-3				2							3	
CO-4					2						3	
CO-5							3					3
CO-6				3								3

3: High Influence, 2: Moderate Influence, 1: Low Influence

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		
Demonstrations		05
1. Demonstration using Videos	05	
2. Demonstration using Physical Models/Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		81
1. Course Laboratory	81	
2. Computer Laboratory		
3. Engineering Workshop/Course		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		
1. Case Study Presentation		
2. Guest Lecture		
3. Industry/Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Laboratory Examination		4
Total Duration in Hours		90

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed			
	CE (50% Weightage)		SEE (50% Weightage)
	SC1	SC2	
	25 Marks	25 Marks	100 Marks
CO-1			
CO-2			
CO-3			
CO-4			
CO-5			
CO-6			

The Course Leader assigned to the course, in consultation with the Head of the Department, shall provide the focus of course outcomes in each component assessed in the above template at the beginning of the semester.
Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teaching and learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Assignment, Examination
6.	Practical Skills	Assignment
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	--
11.	Presentation Skills	--
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. **Course Resources**

a. References

Lab Manual

b. Essential Reading

1. Sambrook, J., Russel, D.,"Molecular Cloninga Lab Manual" Vol. I, II and III, 3rd Edition, Cold spring harber lab press.
2. Walker, J.M. and Rapley, R. "Molecular Biology and Bio Technology" 4th Edition, Panima Publishing Corporation

b. **Magazines and Journals**

1. https://www.elsevier.com/life-sciences/biochemistry-genetics-and-molecular-biology
2. https://www.cell.com/trends/genetics/fulltext/

10. Course Organization

Course Code	BTL513A	
Course Title	Practical III: Molecular Biology & Immunology	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
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Course Specifications Approval Date	September 2024	
Next Course Specifications Review Date:	August 2027	

M.S. RAMAIAH UNIVERSITY OF APPLIED SCIENCES Faculty of Life & Allied Health Sciences Bangalore 560 054

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Course Specifications: Practical IV: Bioinformatics and Structural Biology

Course Title	Practical IV: Bioinformatics and Structural Biology
Course Code	BTL514A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. **Course Summary**

This course aims to make students competent in bioinformatics methods central to conducting molecular biological research projects. The course places emphasis on bioinformatics related to the exploration of proteins and includes analyses of sequences, database searches, sequence comparison, visualization and analysis of protein structures, and introduction to phylogenetic analyses. The students will get an introduction to the theoretical foundations for a few key methods. The course will also familiarize students to analyze DNA sequences, genes and genomes, gene expression and systems biology. Students will be introduced to the python programming language in a linux environment, which will enable them to streamline many bioinformatic pipelines. Through the course students will be acquainted with basic and advanced bioinformatics tools.

2. **Course Size and Credits:**

Number of credits	03
Total Hours of Classroom Interaction	90
Number of laboratory Hours	--
Number of semester weeks	16
Department responsible	Biotechnology
Course Marks	As described in the program specification
Pass Requirement	As per University regulations
Attendance Requirement	As per University regulations

Teaching, Learning and Assessment

3. **Course Outcomes (CO)**

After undergoing this course students will be able to:

1. Analyze public database to study gene sequence through several online program
2. Demonstrate a Phylogenetic relationship between homologous, and non-homologous gene
3. Explain the sequence (nucleotide and amino acid) similarity and diversity through BLAST analysis.
4. Design a PCR primer and test an online PCR to check the validity of the primer.
5. Develop a 3-D model of protein from primary structure and its energy minimization, and validation and analyze a protein ligand interaction to study its structure-function relationship through molecular docking
6. Solve elementary as well as research-level problems using python in a linux

programming environment.

4. Course contents

1. Python: basic syntax
2. Python: if/else statements
3. Python: for loops
4. Python: lists and dictionaries
5. Python: data input and output
6. Search and analyze public database: NCBI (GenBank, GenPept, GENE), Uniprot, PDB
7. Retrieval of sequences and Sequence analysis: EMBOSS NEEDLE, EMBOSS WATER, BLAST
8. Multiple Sequence Analysis: Clustal Omega, MUSCLE, TCoffee (anyone)
9. Phylogenetic tree construction: Phylip, FIGTREE
10. Visualization and study of 3D molecular structures: PyMol
11. Homology Modeling- Swiss PDB, MODELLER
12. Energy Minimization of the molecule and Model validation through Ramachandran Plot
13. Analyzing Protein Ligand interaction to study structure-function relationship: Autodock Vina
14. Designing a PCR Primer for detection, cloning and sequencing
15. Analyzing Proteomics tools in ExPASy server
16. Analyzing KEGG pathway
17. Introduction to Ensembl, Ensembl Genes and Transcripts
18. Comparative genomics in Ensembl
19. Model organism databases: Ecocyc, Flybase etc..
20. Identification of genes and promoters

5. CO-PO PSO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	3	-	1	-	-	-	-	-	-	-	3	1	2
CO2	3	2	3	-	2	-	-	-	-	-	-	-	3	1	2
CO3	3	2	3	-	2	-	-	-	-	-	-	-	3	1	2
CO4	1	2	3	-	2	-	-	-	-	-	-	-	3	1	2
CO5	3	2	3	-	1	-	-	-	-	-	-	-	3	1	2
CO6	1	2	3	-	2	-	-	-	-	-	-	-	3	1	2
	3: High Influence, 2: Moderate Influence, 1: Low Influence														

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		0
Demonstrations		2
1. Demonstration using Videos	02	
2. Demonstration using Physical Models		
3. Demonstration on a Computer		
Numeracy		3
1. Solving Numerical Problems	03	
Practical Work		**81**
1. Course Laboratory		
2. Computer Laboratory	81	
3. Engineering Workshop / Course/Workshop /Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		
1. Case Study Presentation		
2. Guest Lecture		
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Test and Written Examination		**04**
Total Duration in Hours		**90**

7.Course Assessment and Reassessment

The components and subcomponents of course assessment is presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well.

The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

Focus of Course Learning Outcomes in each component assessed					
	CE (50% Weightage)				SEE (50% Weightage)
	SC1		SC2		
	25 Marks		25 Marks		50 Marks
CO-1					
CO-2			X		
CO-3			X		

8. Achieving Course Learning Outcomes

The following skills are directly or indirectly imparted to the students in the following teachingand learning methods:

S. No	Curriculum and Capabilities Skills	How imparted during the course
1.	Knowledge	Classroom lectures
2.	Understanding	Classroom lectures, self-study
3.	Critical Skills	Assignment
4.	Analytical Skills	Assignment
5.	Problem Solving Skills	Classroom, Assignment, Examination
6.	Practical Skills	--
7.	Group Work	--
8.	Self-Learning	Self-study
9.	Written Communication Skills	Assignment, examination
10.	Verbal Communication Skills	Assignment
11.	Presentation Skills	Assignment
12.	Behavioral Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

9. Course Resources

a. Essential Reading

1. Class notes
2. Higgins, D. and Taylor, W., "Bioinformatics – Sequence, Structure and Databanks" , Oxford University Press.
3. Lacroix, Z. and Critchlow, T., "Bioinformatics – Managing Scientific Data", Morgan Kaufmann Publishers.

b. Magazines and Journals

1. https://www.nature.com/subjects/bioinformatics
2. https://www.journals.elsevier.com/genomics-proteomics-and-bioinformatics

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10. Course Organization

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