RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Programme Structure and Course Details

of

M.Sc. in Molecular and Cellular Biology

Programme Code: 092

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

RAMAIAH UNIVERSITY OF APPLIED SCIENCES

M S Ramaiah University of Applied Sciences

Programme Specifications

of

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M S Ramaiah University of Applied Sciences
Faculty of Life and Allied Health Sciences Department of Biotechnology

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

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

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

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

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. Molecular and Cellular Biology

Faculty	Life and Allied Health Sciences
Department	Biotechnology
Programme Code	092
Programme Name	M.Sc. Molecular and Cellular Biology
Dean of the Faculty	Dr Soma Chaki
Head of the Department	Dr. Shruti Mathur

1. **Title of the Award:** M.Sc. Molecular and Cellular Biology
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 2026
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:**

M.Sc. Molecular and Cellular Biology is a postgraduate degree programme offered to all branches of B.Sc. Life Science student viz. Botany, Zoology, Microbiology, Life Science,

Biotechnology and Genetics. The M.Sc. programme will help students get skill viz. preparing and dispensing precisely formulated solutions even at microliter quantities, using electrophoresis, blotting, chromatography and centrifugation equipment, studying nucleic acid hybridization in a range of formats, purifying, modifying and analysing DNA, RNA and proteins, analysing microscopy with in situ hybridization, immunocytochemistry and fluorescent protein technologies to analyse gene and protein expression and function.

15. Programme Mission

This PG course in Molecular and Cellular Biology, would concentrate on the study of applied technologies in Life Science as well as researching on reliable, viable, and good quality Bioprocess solution to the society. Pursuing a research based PG course in Molecular Biology will lead to development of new concepts in Bio therapeutics. This knowledge gained shall produce manpower required by the Biopharmaceutical industries and also encourage entrepreneurship. Candidates with a Master of Science in this discipline are uniquely equipped to take on jobs in industries and academia. Thus, RUAS offers this programme with an updated curriculum, excellent infrastructure and highly experienced and knowledgeable faculty members.

16. Graduate Attributes

GA-1. Ability to apply fundamental knowledge of Biology, Biochemistry, Chemistry, Microbiology for understanding Molecular and Cellular Biology.
GA-2. Ability to analyse and correlate the cellular and molecular pathways for drug targets.
GA-3. Ability to work in basic and advanced molecular biology research laboratory environment.
GA-4. Ability to perform administrative duties in government, semi-government, private and public sector organizations
GA-5. Ability to teach in schools, colleges and universities with additional qualification and training
GA-6. Ability to understand and solve scientific problems by conducting experimental investigations
GA-7. Ability to apply appropriate tools, techniques and understand utilization of resources appropriately in various laboratories
GA-8. Ability to understand the effect of scientific solutions on legal, cultural, social and public health and safety aspects
GA-9. Ability to develop sustainable solutions and understand their effect on society and environment
GA-10. Ability to apply ethical principles to scientific practices and professional responsibilities
GA-11. 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-12. Ability to make effective oral presentations and communicate technical ideas to a broad audience using written and oral means

GA-13. 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 molecular biology 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

Molecular and Cellular Biology is a potential subject that introduces fundamental mechanisms and 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 understand the molecular basis of diseases and develop new diagnostics and therapeutic solutions. New tools and products developed by molecular biologists are useful in research, agriculture, industry and the clinic. These modern approaches provides breakthrough products and technologies to combat debilitating and rare diseases.

19. Programme Educational Objectives (PEO):

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

PEO 1: To acquire basic knowledge and expertise necessary for professional practice in Molecular Biology for higher studies and research.

PEO 2: To attain and practice technical skills to identify, analyze and solve complex problems and issues related to cell and molecular biology.

PEO 3: To possess a professional attitude as an individual or a team member with consideration for society, professional ethics, environmental factors and motivation for life-long learning.

20. Programme Specific Outcomes (PSO)

PSO 1: Understand the foundational concepts of molecular biology, 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.

PSO 3: Demonstrate proficiency in basic laboratory skills common to clinical and non-clinical research laboratories, including aseptic technique, making accurate and precise measurements using balances and macro- and micro-pipetting, using a microscope, preparing solutions, operating current instrumentation, preparing samples for various analyses, and maintaining a proper scientific laboratory notebook.

PSO 4: Apply the fundamentals of molecular biology theories, methodologies, and techniques by critically analyzing, interpreting, and presenting a recent and relevant scientific research paper that has been published in a refereed scientific journal.

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21. Programme Structure

SEMESTER I

SL.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	CBL511A	Practical I: Cell Biology & Molecular Genetics	3			6	100
7	CBL512A	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	CBC511A	Genomics and Proteomics	4	4			100
2	CBC512A	Molecular Biology I	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	CBL513A	Practical III: Molecular Biology and Immunology	3			6	100
7	CBL514A	Practical IV: Genomics, Proteomics and Bioinformatics	3			6	100
Total			20	14		12	**600**
Total number of contact hours per week			**26 hours**				

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

SEMESTER III

Sl. No	Code	Course Title	Credit	Theory (h/W/s)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks
1	CBC601A	Molecular Biology II	3	3			100
2	CBL601A	Practical V: Molecular Biology II	3			6	100
3	CBE6XXA	Elective1	3	3			100

4	CBE6XXA	Elective 2	3	3			100
5	CBM601A	Introduction to Management, Entrepreneurship and IPR	3	2	1		100
6	CBP601A	Group Project	5			10	100
		Total	**20**	**11**	**1**	**16**	**600**
Total number of contact hours per week			**27 hours**				

SEMESTER IV

S. No.	Code	Course Title	Credit	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks
1	CBP602A	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	CBE601A	Stem Cell and Regenerative Medicine
	CBE602A	Integrated Organ Systems
	CBE603A	Molecular Basis of Diseases and Diagnosis
Stream 2	CBE604A	AI in Healthcare
	CBE605A	Molecular Carcinogenesis
	CBE606A	Cognitive Neurosciences

Group Project

CBP601A

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

CBP602A

Students, under the guidance of the faculty research mentor will chooses 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

1. Face to Face Lectures using Audio-Visuals
2. Workshops, Group Discussions, Debates, Presentations
3. Demonstrations
4. Guest Lectures
5. Laboratory work/Field work/Workshop
6. Industry Visit
7. Seminars
8. Group Exercises
9. 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.

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

Sem	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	Genomics and Proteomics	3									3		
2	Molecular Biology I		3								3		
2	Immunology and Immuno techniques			3								3	
2	Bioinformatics and Structural Biology			3	2						3		
2	Research: Methodology, Ethics and Safety		3		2				3		3		3
2	Practical III: Molecular Biology and Immunology												
2	Practical IV: Genomics, Proteomics and Bioinformatics			3		3			3				3
3	Molecular Biology II	3		3						3			
3	Practical V: Molecular Biology II			3					3		3		3

3	Introduction to Management, Entrepreneurship and IPR				3		3					3	
3	Group Project					3	3	3	3		3	3	3
ELECTIVE 1													
Sem	**Course Title**												
3	Stem Cell and Regenerative Medicine		3	2								3	3
3	Integrated Organ Systems	2		3								3	
3	Molecular Basis of Diseases and Diagnosis	3								3			
ELECTIVE 2													
3	AI in Healthcare		3										3
3	Molecular Carcinogenesis		3	3									3
3	Cognitive Neurosciences	3								3			
4	Dissertation and Publication		3	3			3	3	3				3

28. 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.

29. 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.

30. 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.

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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 **8h**

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 **12h**

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 **10h**

Sex-determination and sex-linked inheritance:
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 **12h**

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 **8h**

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.

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								2			
CO-4	3								2	2		
CO-5			2							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		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		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		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

References

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xii. Krebs, J. E., Goldstein, E. S., Kilpatrick, S. T., 2018, *Lewin's GENES XII*, Jones and Bartlett Learning

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	Fundamentals of 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
5h
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 **5h**
Carbohydrate metabolism
Glycolysis; TCA Cycle; ETC chain and oxidative phosphorylation, Gluconeogenesis, Pentose phosphate pathway, Glycogen metabolism, Bioenergetics

Unit III **5h**
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 **5h**
Enzyme kinetics and inhibition
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 **5h**
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 **5h**
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

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. E resources 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	

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		

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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

6. 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. 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	

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

Course Specifications: Bioanalytical Techniques

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

1. 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 Contents

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.

4. 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														

5. 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		

1. Solving Numerical Problems	02	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		**30**

6. 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		

7. 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	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	--

8. Course Resources

a. 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

b. 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. InternationalPublishing house Pvt. Ltd, Delhi, India.
4. David Holme, Hazel Peck; 1998, *Analytical Biochemistry*.

c. E Resources and Journals

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

d. 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/

e. **Other Electronic Resources**

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

9. Course Organization

Course Code	BTD514A	
Course Title	Bioanalytical Technique	
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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M S Ramaiah University of Applied Sciences
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Dean - Academics
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Bangalore - 560 054

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

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 **3h**

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 **3h**

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 **4h**

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 **4h**

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 **4h**

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

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Unit VI

Tools and Languages in Statistics **5h**

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	PSO 4
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		
6. Model Studio		
Others		
1. Case Study Presentation		
2. Guest Lecture	03	

3. Industry/Field Visit		03
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.	Behavioural Skills	--
13.	Information Management	Assignment
14.	Personal Management	--
15.	Leadership Skills	--

10. 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. E Resources and Journals

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

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		

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Course Specifications: Practical I: Cell Biology & Molecular Genetics

Course Title	Practical I: Cell Biology & Molecular Genetics
Course Code	CBL511A
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 willbe 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 organism.

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 (succinatedehydrogenase)
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	PSO4
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		

1. Demonstration using Videos	5	5
2. Demonstration using PhysicalModels/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 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	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. E Resources 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

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10. Course Organization

Course Code	CBL511A		
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	

Course Specifications: Practical II: Microbiology & Biochemistry

Course Title	Practical II: Microbiology & Biochemistry
Course Code	CBL512A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to enable students to acquire experience in fundamental and contemporary microbiological and Biochemical laboratory techniques. The students will have training on the basis of several commonly used techniques in microbiology, including those used in bacterial identification by staining techniques and biochemical assays. They will be trained to design and interpret experiments in aseptic conditions. They will acquire experience of current scientific methodologies appropriate to microbiology. Students will be able to explain properties of various bio molecules found in living systems by performing experiments involving isolation, separation and characterization.

2. Course Size and Credits:

Number of credits	03
Total Hours of Classroom Interaction	60
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. Perform an estimation of the concentration of bio-molecules from an unknown sample

CO 2. Isolate and characterize the colony morphology of bacterial strains by staining and biochemical tests

CO 3. Isolate enzyme from different sources, and estimate its specific activities

CO 4. Production and estimation of by products from various bacterial strains.

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CO 5. Evaluate the quality of water by BOD and MPN test

CO 6. Perform enzyme kinetic studies to characterize its molecular properties

4. Course Contents

Microbiology

1. Preparation and sterilization of culture media
2. Isolation of bacteria from different sources (soil, water, air)
3. Identification of isolated bacterial colonies using microscopic & staining techniques
4. Biochemical Characterization of the isolated bacteria obtained from different source samples
5. Bacterial growth assessment by turbidometry
6. Determination of potability of water by MPN method- Presumptive and confirmatory tests for coliforms.
7. Estimation of lactate/ Citrate from bacterial culture media
8. Demonstration of antibiotic resistance
9. Estimate the amount of Biological oxygen demand in the given water sample.

Biochemistry

10. The quantitative estimation of carbohydrate
11. The quantitative estimation of protein by Biuret assay and Bradford method
12. Determination of acid number, saponification of fats.
13. Estimation of cholesterol (Zach's method)
14. Isolation and determination of specific activity of any enzyme
15. Enzyme kinetic study: Influence of substrate concentration on the rate of enzymatic reaction
16. Enzyme kinetic study: Michaelis-Menten equation: Determination of Km and Vmax
17. Enzyme kinetic study: Lineweaver Burk Plot: Determination of Km and Vmax
18. Enzyme kinetic study: Effect of pH and temperature on the rate of enzymatic reaction
19. Enzyme kinetic study: Inhibition of enzyme activity. Determination of Ki values

5. CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
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		
1. Demonstration using Videos	05	05
2. Demonstration using Physical Models/Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory	81	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		

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6. Discussing Possible Innovations		
Laboratory Examination		4
Total Duration in Hours		90

c. 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.

d. 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

1. Cappuccino, J. G., & Welsh, C. (2016). Microbiology: A laboratory manual. Benjamin Cummings Publishing Company
2. Collins, C. H., Lyne, P. M., Grange, J. M., & Falkinham III, J. (2004). Collins and Lyne's microbiological methods (8th ed.). Arnolds
3. Wilson, K., (ed.), Walker, J., (ed.) 2010, Principles and Techniques of Biochemistry and Molecular Biology, 7th edition, Cambridge University Press
4. Boyer, R.F., 2011, Biochemistry Laboratory: Modern Theory and Techniques, Pearson Publisher

b. E Resources and Journals

1. https://www.omicsonline.org/medical-microbiology-diagnosis.php
2. https://www.journals.elsevier.com/research-in-microbiology
3. https://pubs.acs.org/doi/abs/10.1021/ed072p641

Course Organization

Course Code	CBL512A		
Course Title	Practical II: Microbiology & Biochemistry		
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	

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

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Dean - Academics
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Course Specifications: Genomics and Proteomics

Course Title	Genomics and Proteomics
Course Code	CBC511A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

This course is designed to provide students with a comprehensive understanding of the advanced methodologies in Genomics and Proteomics. Participants will gain proficiency in the fundamental concepts of proteomics, empowering them to identify and compare proteins expressed in a specific genome under distinct conditions. The curriculum emphasizes the study of protein interactions, utilizing acquired knowledge to predict cellular behavior and formulate potential drug targets. Skills will be honed through training in analysis of DNA sequencing and protein mass spectrometry data .

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. Explain the genome organization in Prokaryotes and Eukaryotes.
CO 2. Detail the principles and methods of DNA sequencing and whole genome sequencing.
CO 3. Compare the different methods of estimating and separating protein
CO 4. Explain the high-throughput analysis of gene function
CO 5. Explain clinical significance of Gene and protein manipulation techniques

4. Course Contents

Unit I

Genome and manipulation of genetic material: **8h**

Organisation of prokaryotic and eukaryotic genomes, plasmids, DNA cloning basics, Polymerase chain reaction (PCR), Genome editing: CRiSPR/ Cas; DNA fingerprinting, DNA sequencing – Sanger sequencing, Pyrosequencing; Tools for genome analysis- restriction mapping, RFLP

Unit II

Genome analysis : **9h**

Genome maps – physical and genetic maps, Definition of Genomics, Comparative genomics, functional genomics,

Genome Sequencing: Human Genome Project, Shotgun & Hierarchical (clone contig) methods, genome assembly.

NGS techniques – Illumina, Oxford Nanopore etc.

Genome annotation: genome sequence analysis tools. Promoter prediction methods.

Unit III

Protein measurement and separation: **8h**

Physical interactions that determine the property of proteins, Analytical techniques to study proteins: Sedimentation analysis, gel filtration, SDS-PAGE, Native PAGE; Determination of protein sequence

Unit IV

Proteomics: **8h**

Basic concepts, Tools of proteomics- SDS PAGE, 2D PAGE, Liquid chromatography, Mass Spectrometry (ESI and MALDI), Protein identification by peptide mass fingerprinting, Applications of proteomics.

Unit V

Applications of genomics and proteomics : **7h**

Microarrays, Protein-protein interaction (Two hybrid interaction screening), mapping protein modifications, future directions

Unit VI

Other -Omics techniques : **8h**

Transcriptomics, Search for transcription factor binding sites, RNA-Seq,

Metabolomics - Fundamental concept, Tools of metabolomics- Capillary electrophoresis, Gas chromatography, Electrochemical detectors, Case studies.

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Degradomics - Approaches to identify the protease and protease-substrate repertoires, application of the same in the clinic, PROTAC.

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			2	2						3		
CO-4			3	2						3		
CO-5		2		2	1					3		
CO-6			3			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		48
Demonstrations		02
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		

1. Case Study Presentation		05
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		5
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				

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.

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

Approved by the Academic Council at its 33rd meeting held on November 21st2024

Department of Biotechnology
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Bangalore

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. Essential Reading

1. L. Stryer, 2007, *Biochemistry,* W. H. Freeman and Co., New York
2. Brown TA, 2006, *Genomes*, 3rd Edition. Garland Science.
3. Primrose. S , Twyman. R, 2006, *Principles of Gene Manipulation and Genomics*, 7th Edition, Blackwell.
4. Glick .BR , Pasternak. JJ, 2010, *Molecular Biotechnology*, ASM Press,
5. Lovric, J. 2011, *Introducing Proteomics by Josip*, Wiley-Blackwell
6. Liebler, D. C. 2002, *Introduction to Proteomics: Tools for the New Biology.* Totowa, NJ: Humana Press.

b. Magazines and Journals

1. https://www.nature.com/ncb/
2. http://mcb.asm.org/
3. https://bmccellbiol.biomedcentral.com/
4. https://www.cellsalive.com/

5. http://www.biology.arizona.edu/cell_bio/cell_bio.html
6. https://www.ncbs.res.in/course/jan-term-2018/cell-biology

10. Course Organization

Course Code	CBC511A	
Course Title	Genomics and Proteomics	
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	Sept 2024	
Next Course Specifications Review	August 2027	

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Faculty of Life & Allied Health Sciences
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Head
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

Course Specifications: Molecular Biology I

Course Title	Molecular Biology I
Course Code	CBC512A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to familiarize students with the concepts involved in cellular processes at the molecular level. Students will be able to illustrate tools involved in plant genetic engineering. Also, they will be able to outline plant tissue culture techniques and applications. They will also be able to explain the various strategies applied in plant genetic engineering and will be able to utilize biotechnological methods for maintenance of soil quality and crop health.

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. Illustrate the replication of genetic material

CO 2. Compare processes involved in recombination and repair of the genome

CO 3. Identify the regulatory differences in transcription of prokaryotes and eukaryotes

CO 4. Explain the processes involved in the post-transcriptional processing of RNA and regulation of transcription

CO 5. Summarize the mechanisms involved in the synthesis and regulation of proteins

CO 6. Outline the mechanisms involved in the regulation of genome expression

Course Content

Unit I

DNA replication in prokaryotes and eukaryotes **6h**

Modes of replication, Discovery of replication, DNA polymerase, trombone model of replication, end replication problem of linear DNA, telomerase and the Shelterin complex, early and late replicating DNA

Unit II

DNA repair and recombination **4h**

Photoreactivation, excision, recombination, and SOS pathways, recombination and transposition, models for homologous recombination- the Holliday, Meselson- Radding and RecBCD pathways, meiotic recombination- mechanism, the double-stranded DNA breaks; site-specific recombination and transposition; non-homologous recombination.

Unit III

Prokaryotic & Eukaryotic Transcription **8h**

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; RNA polymerase, Regulatory elements, Attenuation; Anti-termination; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Eukaryotic promoters and enhancers; Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors

Unit IV

Post-transcriptional processing **5h**

mRNA processing: Splicing, spliceosome assembly, role of RNA polymerase II CTD, self-splicing RNAs, mRNA capping, mRNA polyadenylation, tRNA splicing; processing of rRNA; RNA editing: editing by nucleotide deamination; mRNA stability; gene silencing by RNA interference, siRNA, miRNA Translation Repression, CRISPR/Cas9, mRNA Degradation, mRNA stability

Unit V

Translation **5h**

Ribosome composition; structure of tRNA, proof reading and editing by amino-acyl-tRNA synthetases; prokaryotic and eukaryotic translation, direction of polypeptide synthesis, genetic code and codon bias, structure of EF-Tu and EF-G, regulation by

GTPases, termination codons, release factors, Post-translational processing of proteins: Polypeptide cleavage, post-translational modifications.

Unit VI

Gene regulation **8h**

Basic concepts of gene regulation, cis and trans regulators, positive and negative gene regulation; Expression of the genome: activators and repressors, DNA-binding motifs, promoter proximal elements, enhancers, insulators and barrier elements, mediators, transcription factories, chromatin remodeling; epigenetic modifications in gene expression: DNA modifications and histone modifications, histone code; molecular basis of imprinting and X- inactivation; the role of transcription factors in cellular differentiation, identity and reprogramming.

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		1									2	
CO-5		2									2	
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		24
Demonstrations		06
1. Demonstration using Videos	05	
2. Demonstration using Physical Models / Systems	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		

1. Course Laboratory		
2. Computer Laboratory		
3. Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		05
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.

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. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P., 2014, *Molecular Biology of the Cell*, 6th Edition, W. W. Norton & Company.
2. Karp, G., 2010, *Cell and Molecular Biology: Concepts and Experiments*, 6th Edition, John Wiley & Sons. Inc.

3. De Robertis, E.D.P., and De Robertis, E.M.F., 2006, *Cell and Molecular Biology,* 8th Edition, Lippincott Williams and Wilkins, Philadelphia.
4. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D., 1994, *Molecular Biology of the Cell*, 3rd Edition, Garland Publishing.
5. Cooper, G.M. and Hausman, R.E. 2009, *The Cell: A Molecular Approach*, 5th Edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Krebs, J. E., Goldstein, E. S. and Kilpatrick, S. T. (2018) Lewin's GENES XII. Jones and Bartlett Learning.
7. Watson, J. D. et al. (2017) Molecular Biology of Gene. 7th edition. Pearson.

b. Magazines and Journals https://www.cell.com/molecular-cell/home https://www.nature.com/nrm/

10. Course Organization

Course Code	CBC512A	
Course Title	Molecular Biology I	
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	Sep 2024	
Next Course Specifications Review	Aug 2029	

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

Dean - Academics

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

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

4h

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.

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	3PO2	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		
1. Case Study Presentation		
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		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				

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

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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. 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	

Department of Biotechnology
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Bangalore - 560 054

Dean - Academics
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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 THEORY

Unit 1 Fundamentals of Bioinformatics and Biological Databases

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

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

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

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.

5 CO-PO PSO Mapping

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

e. 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

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

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

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	

Course Specfications: 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

Foundations of Research **5h**

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

Research Design **4h**

Concept and features 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

Research Proposal and Effective Presentation **4h**

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

Biosafety **4h**

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

Bioethics **4h**

Introduction to ethical conflicts in biological sciences - interference with nature, bioethics in health care; Bioethics in biotechnology research; bioethics in agricultural biotechnology.

Unit VI

Biosafety Regulations-National and International **5h**

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).

5. CO-PO-PSO mapping

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	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	01	
2. Guest Lecture	02	
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	X	X		X
CO-2	X	X		X
CO-3	X	X		X
CO-4	X		X	X
CO-5			X	X
CO-6			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. Essential Reading

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.

b. 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.com
Course Specifications Approval Date	Sept 2024	
Next Course Specifications Review	August 2027	

Department of Biotechnology
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Course Specifications: Practical III: Molecular Biology & Immunology

Course Title	Practical III: Molecular Biology & Immunology
Course Code	CBL513A
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	05
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												

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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		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 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		

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

i Sambrook, J., Russel, D.,"Molecular Cloninga Lab Manual" Vol. I, II and III, 3rd Edition, Cold spring harber lab press.

ii Walker, J.M. and Rapley, R. "Molecular Biology and Bio Technology" 4th Edition, Panima

Publishing Corporation

c. 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	CBL513A	
Course Title	Practical III: Molecular Biology & Immunology	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	
	E-mail:	
Course Specifications Approval Date	September 2024	
Next Course Specifications Review Date:	August 2027	

Practical IV: Genomics, Proteomics and Bioinformatics

Course Title	Practical IV: Genomics, Proteomics and Bioinformatics
Course Code	CBL514A
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

3. Teaching, Learning and Assessment

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

4. CO-PO PSO Mapping

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

5. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		0
Demonstrations		

1. Demonstration using Videos	02	
2. Demonstration using Physical Models		
3. Demonstration on a Computer		15
Numeracy		0
1. Solving Numerical Problems	02	
Practical Work		**100**
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		05
Total Duration in Hours		**120**

6. 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		

7. 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	--

8. 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. E Resources and Journals

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

10.Course organization

Course Code	CBL514A	
Course Title	Practical IV: Genomics, Proteomics and Bioinformatics	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	
	E-mail:	
Course Specifications Approval Date	September 2024	
Next Course Specifications Review Date:	August 2027	

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