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 2022 onwards

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

Approved by the Academic Council at its 26th meeting held on 14th July 2022

DEAN
Faculty of Life & Allied Health Sciences
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Bangalore - 560 054

Registrar
M.S. Ramaiah University of Applied Sciences
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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
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

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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 Krishnamurthy J
Head of the Department	Dr. Soma Chaki

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 2019
7. **Date of Programme Approval by the Academic Council of MSRUAS:** November 2018
8. **Next Review Date:** August 2021
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 Biotherapeutics. 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

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industries and academia. Thus RUAS offers this programme with a 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.

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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

S. No.	Code	Course Title	Credit	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks
1	BTD501A	Fundamentals of Cell Biology	3	3			100
2	BTD502A	Principles of Molecular Genetics	3	3			100
3	BTD503A	Biological Chemistry	3	3			100
4	BTD504A	Concepts of Microbiology	3	3			100
5	CBL501A	Practical I: Cell Biology & Molecular Genetics	4			8	100
6	CBL502A	Practical II: Microbiology & Biochemistry	4			8	100
7	BTD505A	Biostatistics	2	1	1		50
Total			**22**	**13**	**1**	**16**	**650**
Total number of contact hours per week			**30 hours**				

SEMESTER II

S. No.	Code	Course Title	Credit	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks
1	CBC501A	Molecular Biology I	3	3			100
2	CBC502A	Infection and Immunity	3	3			100
3	BTD506A	Bioinformatics	3	3			100
4	CBC503A	Genomics and Proteomics	3	3			100
5	CBL503A	Practical III: Molecular Biology I & Immunology	4			8	100
6	CBL504A	Practical IV: Genomics, Proteomics and Bioinformatics	4			8	100
7	BTD507A	Research Methodology	2	2			50
Total			22	14		**16**	**650**
Total number of contact hours per week			**30 hours**				

SEMESTER III

S. No.	Code	Course Title	Credit	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks
1	CBC504A	Molecular Biology II	3	3			100
2	CBL505A	Practical V: Molecular Biology II	4			8	100
3	CBE5XXA	*Refer Elective Course Table*	3	3			100
4	CBE5XXA	*Refer Elective Course Table*	3	3			100
5	CBM501A	Entrepreneurship Skill Development	2	2			50
6	CBP501A	Group Project	8			16	100
Total			**23**	**11**		**24**	**550**
Total number of contact hours per week			**35 hours**				

SEMESTER IV

S. No.	Code	Course Title	Credit	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max. Marks
1	CBP502A	Dissertation and Publication	**23**				300
TOTAL CREDITS (4 semesters)			**90**	**TOTAL MARKS**			**2150**

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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	CBE501A	Stem Cells and Regenerative Medicine
	CBE502A	Synthetic Biology
	CBE503A	Molecular Basis of Diseases and Diagnosis
	CBE504A	Bio separation Techniques
	CBE505A	Biosafety Regulation, Bioethics and IPR
Stream 2	CBE506A	Upstream Processing
	CBE507A	Bioanalytical Techniques
	CBE508A	Plant Secondary Metabolites
	CBE509A	AI in Health Care
	CBE510A	Molecular Carcinogenesis

Group Project

CBP501A A group shall have up to 5 students. The purpose of group project is that the group should be able to design a product in their area of specialization and develop it. The students are required to develop a report for assessment and also need to demonstrate the working of the product. The IPR rights of all such work lies with the University only. The students are required to sign an agreement before the commencement of the project. The project should be approved by a committee of examiners before the start of the project. Students can choose a project from the database of projects available with the concerned department.

Dissertation and Publication

CBP502A A student chooses a topic for the Dissertation based on relevance and need. The detail procedure of executing and assessing Dissertation is available as a standard template.

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

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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

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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

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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)
11. Programme Assessment Board (PAB)

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27. Curricular Map

Semester	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
1	Fundamentals of Cell Biology	3								3			
1	Principles of Molecular Genetics	3								3			
1	Biological Chemistry	3	2							3			
1	Concepts of Microbiology	3	2							3			
1	Practical I: Cell Biology & Molecular Genetics			3							3		
1	Practical II: Microbiology & Biochemistry			3							3		
1	Biostatistics			3	3								3
2	Molecular Biology I	3									3		
2	Infection and Immunity		3								3		
2	Bioinformatics			3								3	
2	Genomics and Proteomics			3	2						3		
2	Practical III: Molecular Biology I & Immunology		3		2				3		3		3
2	Practical IV: Genomics, Proteomics and Bioinformatics				3							3	
2	Research Methodology			3		3			3				3
3	Molecular Biology II	3		3						3			
3	Practical V: Molecular Biology II			3					3		3		3
3	Entrepreneurship Skill Development				3		3					3	
3	Group Project					3	3	3	3		3	3	3
	ELECTIVE 1												
3	Stem Cells and Regenerative Medicine		3	2								3	3
3	Synthetic Biology	2		3								3	
3	Molecular Basis of Diseases and Diagnosis	3				3							3
3	Bio separation Techniques		3								3	3	
3	Biosafety Regulation, Bioethics and IPR			3			3					3	3

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ELECTIVE 2													
Semester	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
3	Upstream Processing		3										3
3	Bioanalytical Techniques		3	3						3			3
3	Plant Secondary Metabolites			3						3			
3	AI in Health Care			3	3		2						3
3	Molecular Carcinogenesis	3								3			
4	Upstream Processing		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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SEMESTER 1

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Course Specifications: Fundamentals of Cell Biology

Course Title	Fundamentals of Cell Biology
Course Code	BTD501A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to familiarize students on the structures and functions of basic components of prokaryotic and eukaryotic cells and the dynamic roles of each structure in a cell to result in coordinated function for the regulate cell life cycle.

Students will be able to describe the structures and purposes of macromolecules, membranes and cellular organelle structures and articulate how these cellular components are used to generate and utilize energy in cells. The Students will also be trained to apply their knowledge of cell biology to selected examples of changes or losses in cell function which can include responses to environmental or physiological change.

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 bimolecular composition, organization and function of different organelles like cell membrane systems, nucleus, mitochondria, peroxisomes, ER, chloroplast, Golgi complex

CO 2. Enumerate the differences between the integral and peripheral proteins of membrane, active and passive transport across membrane, intercellular and intracellular signaling in apoptosis

CO 3. Delineate the involvements of cytoskeleton in cellular motility, mitochondria in energy production, hormones in maintaining homeostasis, signal receptors in growth and development

CO 4. Explain the internal and external factors that influence the cell cycle control system and relate them with cancer

CO 5. Illustrate various signaling pathways and it's components involved in maintaining cellular homeostasis by controlling cellular proliferation, growth, cell death, and cellular motility

CO 6. Explain the methods of studying cell structure, function and activity.

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4. Course Contents

Unit I

Cell Theory & Methods of Study: Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM), Electron tunneling and Atomic Force Microscopy.

Unit II

Organelles: Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Macromolecular trafficking; Chromatin organization and packaging; Mitochondria – structure, organization of respiratory chain complexes, ATP synthase, Structure- function relationship; Mitochondrial DNA and male sterility; Origin and evolution; Chloroplast– Structure-function relationship; Chloroplast DNA and its significance; Chloroplast biogenesis; Origin and evolution.

Unit III

Membrane: membrane constituents- phospholipids, glycolipids, cholesterol, membrane proteins; receptors and phospholipases; Phospholipid bilayer- structure, asymmetry, fluid mosaic model of random diffusion of membrane components, domains in membrane- natural and artificial membranes, passive movements of solutes.

Transport: membrane transport of small molecules, carrier proteins and active membrane transport; ion channels; intracellular compartments and protein sorting; compartmentalization of cells;transport of proteins into mitochondria and chloroplasts; peroxisomes; the endoplasmic reticulum. membrane anchorage of proteins. Vesicular traffic in the secretary and endocytic pathway; transport from the ER through the Golgi apparatus; transport from the Trans Golgi Network; Transport from Plasma membrane via Endosomes; endocytosis; transcytosis

Unit IV

Cytoskeleton and Cellular Motility: Self-assembly and dynamic structure of cytoskeletal filaments, Intermediate filaments; Molecular motors, cytoskeleton and cell behavior. Extracellular matrix in plants and animals. Cell shape and motility; Actin-binding proteins and their significance; Muscle organization and function.

Unit V

Cell Cycle: Cell division and cell cycle: Cell division cycle general strategies of the cell cycle, Mitosis and meiosis, cytokinesis, their regulation, steps in cell cycle and control of cell cycle. Apoptosis and Cancer.

Unit VI

Cell signaling: Hormones and their receptors. Signaling through G-protein coupled receptors (The cAMP Signaling Pathway: Second messengers and Protein Phosphorylation). Signaling through protein tyrosine kinase receptors: Activation of phospholipase C and calcium signal transduction

Non-protein tyrosine kinase receptors (JAK-STAT signaling); NF-kB signaling pathways and its role in inflammation, cell proliferation and cell death; Toll-like receptor signaling and their role in early innate immune response; Insulin signaling pathway and regulation of blood glucose levels; Integrin signaling: cell migration, proliferation and survival; Down regulation of cell signaling: receptor desensitization and receptor down regulation.

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

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7. Course Assessment and Reassessment

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

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

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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. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J., 2004, *Molecular Cell Biology*, Scientific American Books Inc. NY.
3. Karp, G., 2010, *Cell and Molecular Biology: Concepts and Experiments*, 6th Edition, John Wiley & Sons. Inc.
4. Cooper, G.M. and Hausman, R.E. 2009, *The Cell: A Molecular Approach*, 5th Edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. De Robertis, E.D.P., and De Robertis, E.M.F., 2006, *Cell and Molecular Biology*, 8th Edition, Lippincott Williams and Wilkins, Philadelphia.
6. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P., 2009, *The World of the Cell*,7th Edition. Pearson Benjamin Cummings Publishing, San Francisco.

b. Magazines and Journals

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

10. Course Organization

Course Code	BTD501A	
Course Title	Fundamentals of Cell 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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Principles of Molecular Genetics

Course Title	Principles of Molecular Genetics
Course Code	BTD502A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to familiarize students with the concepts of genetic mechanisms at the molecular level.

Students 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	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. Illustrate the structure and organization of the genetic material

CO 2. Classify the mobile genetic elements

CO 3. Summarize the various alterations in the genetic composition that lead to disease

CO 4. Compare mechanisms involved in the genetic recombination and sex determination

CO 5. Outline the various techniques applied in the study of molecular genetics

CO 6. Apply the concepts of genetic recombination for gene mapping

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4. Course Content

Course Content

Unit I

Structural organization of chromosomes:

Structure and organization of eukaryotic chromosomes: Super coiled loops, domains and scaffolds in eukaryotic chromosome. Difference between interphase chromatin and mitotic chromosomes. Heterochromatin, euchromatin and telomeres. Nucleosomes- Organization of DNA in the nucleosome, histone octamer. Fine structure of the Gene- Cistron, muton and recon. Organization of genes in the genome - Split genes and overlapping genes, gene families, C-value paradox, Repetitive DNA.

Unit II

Mobile genetic elements:

Transposons – Transposable elements in prokaryotes and eukaryotes – IS elements, Composite transposons, Tn3 elements, Ac and Ds elements, P elements, Retrotransposons and their significance. Transposable elements in humans and their genetic and evolutionary significance.

Unit III

Alterations in genetic material:

Overview of Human chromosomal aberrations, karyotype analysis- normal and abnormal karoyotype. Molecular basis of mutation – spontaneous and induced mutation. Types of mutations. Loss of function mutations, gain of function mutations, expanding repeats. Mutation studies in *Drosophila*. Mutations and human diseases. Mutation in mitochondria and chloroplast.

Unit IV

Genetic Recombination:

Mechanism of recombination, Holliday, White house and Radding models, Enzymes involved in homologous and site specific recombination. Breakage and reunion of DNA at specific sites. Synapsis of homologous duplexes, role of RecA in recombination. Recombination in Bacteria-Transformation, conjugation, transduction, plasmids and episomes- Application in genome mapping of *E. coli*.

Unit V

Sex-determination and sex-linked inheritance:

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

Unit VI

Molecular genetic and Cytogenetic Techniques

Chromosomal banding techniques, Karyotyping, Fluorescence in situ hybridization (FISH), Comparative genomic hybridization (CGH), Spectral karyotyping (SKY), somatic cell hybrids and gene mapping, Site-directed Mutagenesis.

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5. CO-PO-PSO mapping

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

6. Course Teaching and Learning Methods

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

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7. Course Assessment and Reassessment

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

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CO-2	×	×		×
CO-3	×	×		×
CO-4	×		×	×
CO-5			×	×
CO-6			×	×

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

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

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

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

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9. Course Resources

a. References

1. **Snustad, D.P., Simmons, M.J., 2009, *Principles of Genetics*, 5th Edition, John Wiley and Sons Inc.**
2. **Klug, W.S., Cummings, M.R., Spencer, C.A., 2009, *Concepts of Genetics*, 9th Edition, Benjamin Cummings.**
3. Russell, P. J., 2009, *Genetics- A Molecular Approach*, 3rd Edition, Benjamin Cummings.
4. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C., Carroll, S.B., 2007, 9th Edition, *Introduction to Genetic Analysis*, W. H. Freeman & Co.
5. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., Losick, R., 2008, *Molecular Biology of the Gene*,10th Edition, Cold Spring Harbour Lab., Press, Pearson Pub.
6. Krebs, J. E., Goldstein, E. S., Kilpatrick, S. T., 2018, *Lewin's GENES XII*, Jones and Bartlett Learning.

a. Magazines and Journals

1. https://www.nature.com/ng/
2. https://academic.oup.com/hmg

10. Course Organization

Course Code	BTD502A	
Course Title	Principles of 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	Aug 2019	
Next Course Specifications Review Date:	June 2021	

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Course Specifications: Biological Chemistry

Course Title	Biological Chemistry
Course Code	BTD503A
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.

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4. Course Content

Unit I

Structure and Chemistry of Protein

Structure and Classifications of Amino Acids; Primary, Secondary, Tertiary, and Quaternary Structure of Protein; Ramachandran Plot; Structure of Hemoglobin, and Myoglobin; Hill Plot of Oxygen Binding Properties of Hb; Protein Folding ; Absorption of UV light by Protein

Unit II

Chemistry and Kinetics of Enzyme

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

Unit III

Structure and Chemistry of Nucleic Acid

Chemistry of DNA and RNA; Structure 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; $C_o t$ Value

Unit IV

Structure and Chemistry of Carbohydrate and Lipid

Structure and Classification of Mono, di, oligo, polysaccharide; Starch; Glycogen; Derivatives of Sugars; Protein Glycosylation; Structure and Classification of Lipid; Fatty Acids; Triacylglycerol; Cholesterol

Unit V

Metabolism of Carbohydrate and Lipid

Glycolysis; TCA Cycle; Oxidative Phosphorylation, Electron Transport Chain; Glycogen Metabolism; Neoglucogenesis; Pentose Phosphate Pathway; Fatty Acid Synthesis; Beta-oxidation, saturated and unsaturated fatty acid oxidation, omega and alpha oxidation, Bioenergetics

Unit VI

Metabolism of Protein and Nucleic Acid

Transamination and deamination, Amino acid Metabolism; Urea Cycle and its relation to TCA Cycle; One Carbon Reaction; Biosynthesis and degradation of Nucleic Acid; *de novo* and Salvage Pathways

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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

Approved by the Academic Council at its 26th meeting held on 14th July 2022

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7. Course Assessment and Reassessment

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	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	--

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9. Course Resources

a. References

1. Nelson, D.L. and Cox, M.M.,"Lehninger Principles of Biochemistry", 6th edition, W.H. Freeman.

2. Stryer, L., "Biochemistry" 4th edition, W. H. Freeman.

3. Horton, H.R., Moran, L.A., Ochs R.A., Rawn, J. D. and Scrimgeor, R.S., "Principles of Biochemistry" 3rd edition Prentice Hall,.

4. Voet, D. and Voet, J. G., "Biochemistry" 3rd edition, John Wiley and Sons.

5. Wilson, K. and Walker, J., "Principles and Techniques of Practical Biochemistry" 5th edition, Cambridge University Press

b. Magazines and Journals

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

10. Course Organization

Course Code	BTD503A	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Concepts of Microbiology

Course Title	Concepts of Microbiology
Course Code	BTD504A
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. Identify the differences between traditional and molecular approaches to taxonomy

CO 2. Describe the cell morphology of gram positive, gram negative, archea and mycoplasmas

CO 3. Demonstrate the phases of microbial growth curve and determine the relation to generation time

CO 4. Differentiate the general characteristics , structure and reproduction of eukaryotic microorganisms

CO 5. Compare and contrast the commons methods used for culture in the clinical laboratory for viruses that infect humans

CO 6. Explain the methods of strain improvement for the production of economically important microbial products

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4. Course Content

Unit I

Classification of Bacteria:

Conventional and molecular methods; 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:

Different cell morphology; flagella, pili, capsule, cell wall, cell membrane, cytoplasm, Intracytoplasmic inclusions: nucleoid, 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:

Principles of Microbial growth, Culture media - composition and uses of solid, liquid, simple, complex, differential and selective media, bacterial growth kinetics;
Sterilization methods and sterility testing, Physical and chemical methods of controlling bacterial growth. Antibiotic targets and action.

Unit IV

Eukaryotic Microorganisms:

General characters, Structure and Reproduction: Fungi (Saccharomyces), Algae (Spirulina), Protozoa (Plasmodium), Control of fungal growth, Mycotoxins and their actions, Media for culture of algae and protozoa

Unit V

Virology:

Discovery of viruses, assay of viruses, Classification of viruses based on genetic material, structure of typical viruses - Bacteriophage T4, TMV, HIV. Bacteriophages as antibiotics, Cultivation and enumeration of viruses; cultivation in cell culture, chick embryo and animal inoculation, Structure and importance- Viroids, Prions.

Unit VI

Microbial products for commercial use:

Organic acids (Citric acid, lactic acid). Amino acids (lysine, glutamic acid), Solvents (acetone, ethanol), Antibiotics (Cephalosporin, Streptomycin), Microbial polysaccharides (xanthan) and polyesters (PHB). Hormones (insulin), anticholesterol compound (Lovastatin), Vaccines (recombinant), and Microbial insecticides. Strain improvement methods: recombination using mutagens, protoplast fusion, r-DNA technology, selection of improved strains: Enrichment technique.

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5. CO-PO-PSO mapping

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CO-1	3								2			
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CO-6			2							2		
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Teaching and Learning Methods	Duration in hours	Total Duration in Hours
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5. Hospital		
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2. Guest Lecture	02	
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4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		10
Total Duration in Hours		45

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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	--

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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, 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.

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	BTD504A	
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		Aug 2019
Next Course Specifications Review		June 2021

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Course Specifications: Practical I: Cell Biology & Molecular Genetics

Course Title	Practical I: Cell Biology & Molecular Genetics
Course Code	CBL501A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

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

2. Course Size and Credits:

Number of credits	04
Total Hours of Classroom Interaction	120
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 culture and microscopy

CO 2. Evaluate cellular processes that occur in and between cells

CO 3. Describe and explain processes for the characteristics of living organisms.

CO 4. Explain cell-based methods used to expand understanding of cell biology

CO 5. Experiment with model organisms (*Drosophila*) in genetics

CO 6. Demonstrate significant genetic concepts via experimentation

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4. Course Content

1. Study of mitosis and meiosis in plants and animals
2. Preparation of mitotic chromosomes and karyotyping
3. Staining techniques: Staining blood cells, total count and differential count.
4. Isolation of chloroplasts and determining the purity of chlorophyll a and b.
5. Isolation of mitochondria from animal cell and determining the activity of SDH (succinate dehydrogenase)
6. Study of muscle activity: determination of ATPase activity
7. Study of brain cell activity: determination of acetyl choline esterase activity
8. Cell membrane permeability assay
9. Cell viability assay
10. MTT assay
11. Morphological features of *Drosophila*
12. Mounting genital plate and sex comb in *Drosophila*
13. Isolation and staining of salivary gland chromosomes in *Drosophila*
14. Mutants of *Drosophila*
15. Micronucleus test in mice
16. Banding techniques and karyotyping
17. Demonstration of Barr bodies in buccal cells
18. Study of human blood groups
19. Chromatographic separation of eye pigments in *Drosophila*

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												

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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		10
1. Demonstration using Videos	10	
2. Demonstration using Physical Models/Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		100
1. Course Laboratory	110	
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		10
Total Duration in Hours		120

7. Course Assessment and Reassessment

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

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. References

Lab Manual

b. Magazines and Journals

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

10. Course Organization

Course Code	CBL501A		
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		Aug 2019	
Next Course Specifications Review Date:		June 2021	

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Course Specifications: Practical II: Microbiology & Biochemistry

Course Title	Practical II: Microbiology & Biochemistry
Course Code	CBL502A
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	04
Total Hours of Classroom Interaction	120
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 byproducts from various bacterial strains.

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

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

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4. Course Contents

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.
10. The qualitative estimation of carbohydrate
11. The quantitative estimation of protein by Biuret assay and Bradford method
12. Determination of acid number, iodine value in fats.
13. Estimation of cholesterol (Zach's method)
14. Isolation and determination of specific activity of Urease, Alkaline Phosphatase, Amylase, LDH
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		10
1. Demonstration using Videos	10	
2. Demonstration using Physical Models/Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		100
1. Course Laboratory	110	
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		10
Total Duration in Hours		120

7. Course Assessment and Reassessment

The components and subcomponents of course assessment are presented in the Academic Regulations document pertaining to the Programme. The procedure to determine the final course marks is also presented in the Academic Regulations document as well. The assessment questions are set to test the course learning outcomes. In each component or subcomponent, certain Course Outcomes are assessed as illustrated in the following Table.

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

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

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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

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. Magazines 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

10. Course Organization

Course Code	CBL502A	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Biostatistics

Course Title	Biostatistics
Course Code	BTD505A
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

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4. Course Content

Unit I

Introduction to Biostatistics

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

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

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

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

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

Unit VI

Tools and Languages in Statistics

Programming Features; GNU Package; Basics of C, and Fortran, R Programming; Interfaces; Comparison with SAS, SPSS and Stata; The R Journal

5. CO-PO-PSO mapping

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

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

7. Course Assessment and Reassessment

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. **References**

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

b. **Magazines and Journals**

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

10. Course Organization

Course Code	BTD505A	
Course Title	Biostatistics	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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SEMESTER 2

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Course Specifications: Molecular Biology I

Course Title	Molecular Biology I
Course Code	CBC501A
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

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4. Course Content

Unit I

DNA replication in prokaryotes and eukaryotes: Modes of replication: conservative, semi-conservative and dispersive, Meselson and Stahl's experiment; replicon and the origins of replication; leading and lagging strand synthesis; DNA polymerase and replication machinery in prokaryotes and eukaryotes; processes of initiation, elongation and termination; trombone model of replication; end replication problem of linear DNA, telomerase and the Shelterin complex; early and late replicating DNA; coordinating regulation of DNA replication initiation with the prokaryotic and eukaryotic cell division cycle.

Unit II

DNA repair and recombination: factors affecting DNA bases, identification and molecular characterization of repair enzymes in photoreactivation, excision, recombination, and SOS pathways, recombination and transposition, models for homologous recombination- the Holliday, Meselson-Radding and RecBCD pathways and their experimental supports; meiotic recombination- mechanism, the double-stranded DNA breaks; site-specific recombination and transposition); non-homologous recombination.

Unit III

Prokaryotic & Eukaryotic Transcription

Prokaryotic Transcription; Transcription unit; Promoters- Constitutive and Inducible; Operators; Regulatory elements; Initiation; Attenuation; Termination-Rho-dependent and independent; Anti-termination; Transcriptional regulation-Positive and negative; Operon concept-lac, trp, ara, his, and gal operons; Transcriptional control in lambda phage; Transcript processing; Processing of tRNA and rRNA. Eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; Eukaryotic promoters and enhancers; General Transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); Activators and repressors

Unit IV

Post-transcriptional processing: Splicing: splicing mechanism and splicing signals, spliceosome assembly and function, role of RNA polymerase II CTD, self-splicing RNAs, tRNA splicing; mRNA capping: cap structure, synthesis and function; mRNA polyadenylation: function of poly(A), mechanism of polyadenylation, polyadenylation signals, poly(A)polymerase and turnover of poly(A); coordination of mRNA processing events: effect of individual events on the other events, coupling transcription termination with mRNA_3'- end processing, mechanism of termination; processing of rRNA; RNA editing, editing by nucleotide deamination; mRNA stability; gene silencing by RNA interference, siRNA, miRNA Translation Repression, mRNA Degradation.

Unit V

Translation: Ribosome composition and structure; structure of tRNA, recognition during translation (second genetic code), proof reading and editing by amino-acyl-tRNA synthetases; prokaryotic translation initiation: tRNA charging, dissociation of ribosomes, formation of initiation complexes, control of translation at the level of initiation; eukaryotic translation initiation: initiation factors, scanning model of initiation, regulation of translation at the level of initiation; prokaryotic and eukaryotic translation elongation and termination: direction of polypeptide synthesis, genetic code and codon bias, steps in elongation, structure of EF-Tu and EF-G, regulation by GTPases, termination codons, release factors; dealing with aberrant termination. Post-translational processing of proteins: Polypeptide cleavage, post-translational modifications.

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Unit VI

Gene regulation: 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 during transcription; epigenetic modifications and their role 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		05
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		10
Total Duration in Hours		45

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7. Course Assessment and Reassessment

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

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

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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	CBC501A	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Infection and Immunity

Course Title	Infection and Immunity
Course Code	CBC502A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

This course will provide students with a fundamental understanding of immunology and infectious diseases. Students will learn about the immune system and how it can fight infection. They will also learn how an immune response can fail. Students will be exposed to examples of different types of clinically relevant infectious agents and the type of immunity they activate. In addition, students will learn how infectious agents can overcome the natural immune response and cause disease. The course will also illustrate how the immune response against these agents can be manipulated through the use of vaccines.

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. Describe the molecular and cellular mechanisms that underpin the pathogenesis and control of infections, and the interaction of pathogens with the immune system.

CO 2. Explain the pathogenesis of microbial and viral infections and apply this knowledge to any specific infectious disease

CO 3. Illustrate how cells interact with other cells in the body, as well as with pathogens

CO 4. Elaborate on an advanced level human immunity and the development of immune responses that are important in the prevention and development of disease

CO 5. Elucidate immunological events occurring in response to various infectious agents

CO 6. Explain the basis behind vaccinology and vaccine development and other immunotherapy

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4. Course Content

Unit I

Infection: Infection and disease, Natural history of infection, Biology of prokaryotic and eukaryotic pathogens; Antimicrobial agents

Immunity: Basic immunology including morphology and general functions of the cells, proteins and organs of the immune system. Maturation, interactions and regulations of innate and adaptive immune responses.

Unit II

Selected human infectious diseases in detail:

Survival in macrophages: *Mycobacterium tuberculosis* and the disease TB; Gastro-intestinal disease: Diarrheagenic *Escherichia coli;* Salmonellosis: *Salmonella enterica* serovars Typhimurium and Typhi; Colonisation of the stomach mucosa by *Helicobacter pylori*; Intracellular survival and spread: The food-borne pathogen *Listeria monocytogenes* and listeriosis; Plasmodium spp and Malaria; *Vibrio cholerae* and Campylobacter ; Streptococcus pneumonia; HIV, Oncovirus

Unit III

Basic concepts of microbial pathogenicity and virulence:

Colonisation and invasion of the host: Routes of entry and exit, Host surface defences and bacterial mechanisms of colonisation and invasion, Specific examples of diseases associated with colonisation via pili: uropathogenic *Escherichia coli* and *Neisseria gonorrhea*, The normal microbiota & opportunistic infections

Unit IV

Encounter with immunity:

Innate Immunity: Phagocytic effector cells and complement, mechanisms of microbial killing. Microbial strategies for overcoming innate immune defenses; Encounter with adaptive immunity: Pathogen adaptation to growth in the host and antibody avoidance; Cell biology of antigen processing and presentation; molecular recognition of antigen; molecular and cellular bases of inflammation; signal transduction in immune cells; characteristics and functions of cytokines; mechanisms of immunoregulation; cellular communication and leukocyte traffic through tissues.

Unit V

Hypersensitivity – Type I-IV; Autoimmunity; Types of autoimmune diseases; Mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; 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

Control and prevention of infections: Strategies for the design and use of vaccines and gene therapy. Infectious disease treatment: The main classes of antibiotics: History, targets and resistance

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

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

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7. Course Assessment and Reassessment

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

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. References

1. Gerald P., Jeffrey L., Lee W., 2004, *Immunology, Infection, and Immunity*, 2004 , ASM Press.
2. John, P., Gregory, B., 2013, *Infection and Immunity*, 4th Edition., Oxford press.
3. 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.
4. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J., 2004, *Molecular Cell Biology*, Scientific American Books Inc. NY.
5. Prescott, L.M., Harley, J.P., Klein, D.A., 2005, Microbiology, McGraw-Hill Higher Education.
6. Pelczar, M.J., Reid, R.D., Chan, E.C.S., 2010, Microbiology, Oxford University Press, UK.
7. Goldsby, R.A., Kindt, T.J., Osborne, B.A., 2007, *Kuby's Immunology*, 6th Edition, W.H. Freeman and Company, New York.
8. Abbas, A.K., Lichtman, A.H., Pillai, S., 2007, *Cellular and Molecular Immunology*, 6th Edition,Saunders Publication, Philadelphia.

b. Magazines and Journals

https://www.cell.com/molecular-cell/home
https://www.nature.com/nrm/

10. Course Organization

Course Code	CBC502A	
Course Title	Infection and Immunity	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Bioinformatics

Course Title	Bioinformatics
Course Code	BTD506A
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	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 use of bioinformatics in addressing a range of biological questions

CO 2. Justify how bioinformatics methods can be used to relate sequence, structure and function

CO 3. Enumerate the technologies for modern high-throughput DNA sequencing and their applications

CO 4. Describe principles and algorithms of pairwise and multiple alignments, and sequence database searching

CO 5. Explain how evolutionary relationships can be inferred from sequences (phylogenetics)

CO 6. Explain the 3-D structure of protein, and its interaction with different ligands to draw structure-function relationship

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4. Course Content

Unit I

Fundamentals of Bioinformatics

Introduction to Bioinformatics, Concept of homology, paralogy, orthology, analogy and xenology, NCBI, and data retrieval

Unit II

Database and Server of Bioinformatics

European Bioinformatics Institute database search; Understanding EXPASY server; European Molecular Biology server, KEGG Pathway, PDB, PDBj

Unit III

Sequence Alignment and Analysis

Introduction to Sequence comparison, global and multiple sequence alignment, Multiple sequence alignment using FASTA, Sequence alignment using CLUSTALW, BLAST and advance BLAST

Unit IV

Construction of Phylogenetic Tree and Analysis

Concept of tree, reading and interpreting phylogenetic trees, distance-based and character-based methods for the construction of phylogenetic trees, judging strength of clades (with BS or PP values) in a tree

Unit V

Fundamentals of 3-D Structure of Protein

Introduction to 3-dimensional protein structure, superposition of molecules, RMS deviation, classification family of proteins and fold, SCOP, MSD

Unit VI

Building 3-D Structure of Protein and Its Analysis

Secondary, tertiary and quaternary structure prediction –concept of propensity in Chou Fasman method; Homology modeling, threading and ab initio method; Docking – rigid and flexible, protein-protein and protein-ligand

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5. CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1	2								3			
CO-2	1		3							3		
CO-3			3							3		
CO-4			3							3		
CO-5			3				3				2	3
CO-6			3				3					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		06
1. Demonstration using Videos	05	
2. Demonstration using Physical Models /	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		05
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		10
Total Duration in Hours		45

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7. Course Assessment and Reassessment

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

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

Focus of Course Learning Outcomes in each component assessed				
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	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	--

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9. Course Resources

a. References

1. Higgins, D. and Taylor, W., "Bioinformatics – Sequence, Structure and Databanks" , Oxford University Press.

2. Lacroix, Z. and Critchlow, T., "Bioinformatics – Managing Scientific Data", Morgan Kaufmann Publishers.

3. Bourne, E.,P. and Weissig H., "Structural Bioinformatics"' John Wiley and Sons.

4. Campbell, A.M., and Heyer, I.J., "Discovering Genomics, Proteomics and Bioinformatics"' Benjamin Cummings.

5. Mount D.W., "Bioinformatics – Sequence and Genome Analysis" Cold Spring Harbor Lab. Press.

6. Pevsner, J., "Bioinformatics and Functional Geonomics"' John Wiley & Sons.

b. Magazines and Journals

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

10. Course Organization

Course Code	BTD506A	
Course Title	Bioinformatics	
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		Aug 2019
Next Course Specifications Review		June 2021

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Course Specifications: Genomics and Proteomics

Course Title	Genomics and Proteomics
Course Code	CBC503A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

Genomics and Proteomics investigates how genes and gene products affect and are affected environment. The course will cover recombinant DNA and protein technologies of Gene and protein manipulation and their use thereof in human betterment.

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 genome organization in Eukaryotes.

CO 2. Explain the various techniques of gene manipulation for research applications

CO 3. Evaluation and application of gene manipulation techniques.

CO 4. Compare the different methods of estimating and separating protein

CO 5. Illustrate Protein manipulation techniques and its application in research

CO 6. Explain clinical significance of Gene and protein manipulation techniques

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4. Course Contents

Unit I

Genome Organization:

Structural organization of genome in Prokaryotes and Eukaryotes: Concept of Gene, Genome and Gene expression.

Unit II

Recombinant DNA technology: DNA cloning basics, Polymerase chain reaction, DNA fingerprinting, DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD,
PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit III

Genome analysis:

Human genome project and the genetic map. Comparative genomics, functional genomics, expression sequence tags (ESTs), serial analysis of gene expression (SAGE) and targeting induced local lesions in genome (TILLING).
Next Generation Sequencing techniques and the techniques in development.
Microarrays technology- Principles and applications, transcriptome analysis and SNPs determination.

Unit IV

Protein measurement and separation

Measurement of concentration, amino-acid composition, N-terminal sequencing;
Introduction and scope of proteomics; Protein separation techniques: ion-exchange, size exclusion and affinity chromatography techniques.

Unit VI

Applications of proteome analysis

Protein-protein interaction (Two hybrid interaction screening) , Application of genomics and proteomics- mining genome proteomes, protein expression profiles, mapping protein modifications, future directions

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												

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Approved by the Academic Council at its 26th meeting held on 14th July 2022

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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		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			×	×

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. References

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.

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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	CBC503A	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Practical III: Molecular Biology I & Immunology

Course Title	Practical III: Molecular Biology I & Immunology
Course Code	CBL503A
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	04
Total Hours of Classroom Interaction	120
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 for concentration, molecular weight, and restriction mapping
CO 2.	Expertise in AGE and SDS-PAGE techniques for quantification of DNA
CO 3.	Acquire hands-on experience on molecular biology techniques
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

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4. Course Contents

1. Isolation, quantification and characterization of genomic DNA from bacteria (*E. coli)*
2. Isolation, quantification and characterization of genomic DNA from plant tissue
3. Quality and Quantitative analysis of DNA by UV spectrophotometer, AGE
4. Extraction of DNA from Gel
5. Restriction mapping and determination of molecular weight of digested DNA fragment
6. Study of proteins by native gel electrophoresis- serum proteins (serum albumin)
7. Determination of molecular weight of Proteins by SDS PAGE
8. Study of conjugation in E.coli
9. Estimation of DNA by diphenyl amine method
10. Estimation of RNA by orcinol method
11. Selection of animals, preparation of antigens, immunization and methods of blood collection, serum separation and storage.
12. Antibody titre by ELISA method
13. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion
14. Complement fixation test
15. Isolation and purification of IgG from serum
16. SDS-PAGE, Immunoblotting, Dot blot assays.
17. Blood smear identification of leucocytes by Giemsa stain.
18. Separation of leucocytes by dextran method.
19. Separation of mononuclear cells by Ficoll-Hypaque and their cryopreservation
20. Lymphocyte Culture

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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				2				3				3
CO-5				2								3
CO-6		3						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		10
1. Demonstration using Videos	10	
2. Demonstration using Physical Models/Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		100
1. Course Laboratory	110	
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		10
Total Duration in Hours		120

7. Course Assessment and Reassessment

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. References

Essential Reading

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

b. Magazines and Journals

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

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10. Course Organization

Course Code	CBL503A	
Course Title	Practical III: Molecular Biology I & Immunology	
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		Aug 2019
Next Course Specifications Review		June 2021

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Course Specifications: Practical IV: Genomics, Proteomics and Bioinformatics

Course Title	Practical IV: Genomics, Proteomics and Bioinformatics
Course Code	CBL504A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim for this course is to make students competent in the use of bioinformatics methods central to conduction of molecular biological research projects.

The course has emphasis on bioinformatics related to 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 analyse DNA sequences, genes and genomes, gene expression and systems biology. Through the course students will be acquainted with basic and advanced bioinformatics tools.

2. Course Size and Credits:

Number of credits	04
Total Hours of Classroom Interaction	120
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. Analyze public database to study gene sequence through several online program

CO 2. Demonstrate a Phylogenetic relationship between homologous, and non-homologous gene

CO 3. Explain the sequence (nucleotide and amino acid) similarity and diversity through BLAST analysis

CO 4. Develop a 3-D model of protein from primary structure and its energy minimization, and validation

CO 5. Analyze a protein ligand interaction to study its structure-function relationship through molecular docking

CO 6. Design a PCR primer and test an online PCR to check the validity of the primer

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4. Course Contents

Course Content

1. Search and Analyze public database: PubMed, NCBI
2. Search and Analyze public database: DDBJ, EMBL
3. Search and Analyze public database: UniProt, PDB
4. Retrieval of sequences and Sequence analysis: BLASTn
5. Retrieval of sequences and Sequence analysis: BLASTp
6. Retrieval of sequences and Sequence analysis: BLASTx
7. Multiple Sequence Analysis: Clustal Omega (JalView)
8. Multiple Sequence Analysis: MUSCLE, TCoffee
9. Phylogenetic tree construction: Phylip
10. Phylogenetic tree construction: FIGTREE
11. Visualization and study of 3D molecular structures: PyMol
12. Visualization and study of 3D molecular structures: RASMOL
13. Homology Modeling- Swiss PDB, MODELLER
14. Energy Minimization of the molecule and Model validation through Ramachandran Plot
15. Docking Study (Protein Ligand interaction): Autodock Vina
16. Analyzing Protein Ligand interaction to study structure-function relationship
17. Designing a PCR Primer, Test run a PCR to validate the PCR Primer
18. Analyzing Proteomics tools in ExPASy server
19. Analyzing KEGG pathway
20. Exploring ZINC database

5. CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1		2		3						2		
CO-2		1		3							3	
CO-3				3							2	
CO-4				2							3	2
CO-5				3							3	2
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		10
1. Demonstration using Videos	10	
2. Demonstration using Physical Models/Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		100
1. Course Laboratory	110	
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		10
Total Duration in Hours		120

7. Course Assessment and Reassessment

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

Essential Reading

1. Introduction to Bioinformatics: A Theoretical And Practical Approach, Editors: Stephen A. Krawetz, David D. Womble, Humana, ISBN-10: 1588290646, ISBN-13: 978-1588290649
2. Practical Protein Bioinformatics, Florencio Pazos, Mónica Chagoyen, Springer, ISBN-10: 3319381849, ISBN-13: 978-3319381848
3. Bioinformatics: A Practical Approach, Shui Qing Ye, Chapman and Hall/CRC, ISBN-10: 9781584888109, ISBN-13: 978-1584888109
4. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, Andreas D. Baxevanis, B. F. Francis Ouellette, Wiley-Blackwell, ISBN-10: 0471383902, ISBN-13: 978-0471383901
5. Practicals in Bioinformatics, P. Shanmughavel, Pointer, ISBN-10: 8171325955, ISBN-13: 978-8171325955

a. **Magazines and Journals**

1. https://www.hindawi.com/journals/abi/
2. https://academic.oup.com/bioinformatics
3. https://www.worldscientific.com/worldscinet/jbcb
4. https://www.inderscience.com/jhome.php?jcode=ijbra

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b. **Websites**
http://pevsnerlab.kennedykrieger.org/bioinformatics/bioinf14_mainbioinf.htm

c. **Other Electronic Resources**
http://www.scfbio-iitd.res.in/

10. Course Organization

Course Code	CBL504A	
Course Title	Practical IV: Genomics, Proteomics and Bioinformatics	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Research Methodology

Course Title	Research Methodology
Course Code	BTD507A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The course aims to give a background on the history of science, emphasizing the methodologies used to do research. Students will be trained to use the framework of these methodologies for understanding effective lab practices and scientific communication. They will be acquainted about the framework of these methodologies to understand and appreciate scientific ethics.

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. Describe the value, scope, relevance and mandatory steps of research as well as principles of effective research

CO 2. Demonstrate the application and utility of the Systematic approach and out of the box thinking concepts for research to be effective

CO 3. Demonstrate the procedures outlined for a systematic Literature Review

CO 4. Analyze and prepare well structured research proposal and research paper invoking clearly outlined principles

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4. Course Content

Unit I

History of Science and Foundations of Research:

Empirical science; The scientific method; Interrogative perturbation experiments and controls; Deductive and inductive reasoning; Descriptive science; Reductionist vs holistic biology; Definitions of Research, Mandatory Steps in Research, Types of Research, Relevance of Research for Innovation and Technology Development, Effective Research and Self Discipline

Unit II

Preparation for Research:

Out Of the Box Thinking and Systematic approach in Research – Transformation to Impossible Thinking, Convergent and Divergent Thinking, Generation, Evaluation and Selection of Ideas; Choosing a mentor, lab and research question; Maintaining a lab notebook with date-wise entry

Unit III

Literature Review – Importance of Literature Review, Constituents of Good Literature Review, Strategies for Literature Search, Referencing, Paraphrasing, and Summarizing, Academic Standards and Ethics

Unit IV

Statistical methods and data analysis:

Hypothesis test with regression; Hypothesis tests with ANOVA; Analyses of variance, and Partitioning of Sum of Squares, Assumptions; Constructing F-Ratios; Analyses of categorical data, Two-way contingency tables; Fitting data to a linear model; Variances and co-variances; least-square parametric estimates

Unit V

Technical communication and Research Proposal:

Research paper for publication – significance of problem statement and its scope, formulation of hypothesis, adequacy of methodology, significant of presentation and discussion of results, relevance and importance of references, Ethical issues; Scientific misconduct, Plagiarism; Structure of a Good Research Proposal, Getting Started, Tips for Compilation of Good Research Proposal

Unit VI

Effective presentation:

Preparation, templates, balance between good design and good content, planning and sequencing, pampers, (projection, articulation, modulation, punctuation, enunciation, repetition and speed) rule, people (position and gestures, eye contact,, orientation, proximation, looks and appearance, and expressions and emotion) rule, 4P's rule (plan, prepare, practice and present), essentials of effectiveness, effective pausing and inclusive answering

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

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7. Course Assessment and Reassessment

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

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9. Course Resources

a. References

1. Valiela, I. (2001). *Doing science: Design, analysis, and communication of scientific research*. Oxford: Oxford University Press.
2. *On being a scientist: A guide to responsible conduct in research*. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. (n.d.). The Science of Scientific Writing. *American Scientist, 78*(Nov-Dec 1990), 550-558.
4. Mohan, K., & Singh, N. P. (2010). *Speaking English effectively*. Delhi: Macmillan India.
5. Booth, W. C, Colomb and Williams, G.G (2005) *The Craft of Research*, Chicago University Press
6. William, M. K. and Trochim (2003) *Research Methods*, 2nd Edition, Biztantra Publications
7. Jonathan, G. (2004) *The Foundation of Research*, Palgrave Study Guides
8. Wisker, G. (2001) *The Post Graduate Research Handbook*, Palgrave Study Guides
9. Rugg, G. and Petre, M. (2004) *The Unwritten Rules of Ph.D. research*, Open University Press

b. Magazines and Journals

Movie: Naturally Obsessed, The Making of a Scientist.

10. Course Organization

Course Organization

Course Code	BTD507A	
Course Title	Research methodology	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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SEMESTER 3

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Course Specifications: Molecular Biology II

Course Title	Molecular Biology II
Course Code	CBC504A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to familiarize the students with the concepts and methodologies used in recombinant DNA technologies. Outline a general strategy for making a recombinant DNA library, screening a recombinant DNA library, and analyzing the DNA fragment identified and design a general strategy for harnessing a gene of interest using recombinant DNA techniques.

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.** Understand the basic principles and methodologies of recombinant DNA technology
- **CO 2.** Explain Gene amplification, screening and Expression systems.
- **CO 3.** Enumerate the strategies of cloning in E. Coli and yeast with reference to applications.
- **CO 4.** Analyze methodologies of the Human Genome project and its implication on present day Human genomics
- **CO 5.** Illustrate various gene manipulation techniques in plants , their uses, implications and future
- **CO 6.** Applications of Recombinant genome technology in human welfare and future directions.

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4. Course Content

Unit I

The Basic Principles of Gene Cloning and DNA Analysis:

Principles and methods of recombinant DNA technology-, cloning physical and chemical methods – Lipofection – Electroporation – Gene Bombardment., sequencing, polymerase chain reaction, hybridization; cloning in E.coli, plasmids, bacteriophages and cosmid vectors, cloning strategies, genomic and cDNA library; expression of cloned genes in E. coli, products made in E. coli by genetic engineering Construction of cDNA and genomic DNA library – Screening of libraries. Blotting Techniques (Southern, Northern and Western blot), Hybridization –plaque, colony hybridization

Unit II

Sequencing and Hybridisation techniques

Sequencing, polymerase chain reaction, hybridization; cloning in E.coli, plasmids, bacteriophages and cosmid vectors, cloning strategies, genomic and cDNA library; expression of cloned genes in E. coli, products made in E. coli by genetic engineering Construction of cDNA and genomic DNA library – Screening of libraries. Blotting Techniques (Southern, Northern and Western blot), Hybridization – plaque, colony hybridization.

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Unit III

Cloning and Expression vectors

Cloning in yeast: transformation in yeast, yeast vector development: Yep, YRp, YCp and YIp, 2m plasmid, yeast artificial chromosome (YAC), retrovirus like vector (Ty) in yeast/shuttle vector; features of yeast promoter and expression of cloned genes; yeast 2-hybrid system; plasmid shuffling to explore interactive domains of multimeric proteins; the cassette model for mating type switches and silencing of genes

Unit IV

Sequencing

The Applications of Gene Cloning and DNA Analysis: Sequencing Genes and Genomes Chain termination, Next generation sequencing, Third-generation sequencing; Shotgun sequencing of prokaryotic genomes, Haemophilus influenza, eukaryotic genomes, The hierarchical shotgun approach.

Unit V

Transgenics

Transgenic science and genetic improvments: transformation of plants, manipulating gene expression in plants, selectable markers and reporter genes, Agrobacterium tumefaciens; Genetic elements present on the Ti plasmid, genetic engineering of the Ti plasmid, vectors used to introduce foreign DNA into plant cells- binary cloning vector, disarmed Ti plasmid, cointegrate cloning vector; comparison of methods for transfer of DNA to plants, manipulation of gene expression in plants; production of transgenic plants without reporter or marker genes

Unit VI

Application in Human welfare

Therapeutic products for use in human health care- insulin, growth hormones, TPA, alpha interferon, Hepatitis B vaccine and Factor VIII. Medical and forensic applications of rDNA technology- DNA Profiling, Multiplex PCR, Diagnosis of inherited disorders and infectious diseases, diagnosis and management of cancer. Treatment using rDNA technology- gene therapy. Gene therapy for ADA and cystic fibrosis.

5. CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1	3								3			
CO-2	3								3			
CO-3	3								3			
CO-4			3							2		
CO-5			3							2		
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		24
Demonstrations		06
1. Demonstration using Videos	05	
2. Demonstration using Physical Models /	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		05
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		10
Total Duration in Hours		45

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7. Course Assessment and Reassessment

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

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

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

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

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

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8. Achieving Course Learning Outcomes

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

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

9. Course Resources

References

1. Primrose, S. B. and Twyman, R. M., 2006, *Principles of Gene Manipulation and Genomics*, Blackwell Scientific Publications.
2. Brown,TA., 2006, *Gene Cloning and DNA Analysis. An Introduction*, Blackwell Scientific Publications.
3. Janitz,M., 2008, *Next-Generation Genome Sequencing* , Wiley-Blackwell Publications.
4. Sambrook, J., Russell, D.W., 2001, *Molecular cloning: A Laboratory Manual* , Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.
5. Comprehensive Biotechnology (Vol.1-4) (2004) by Moo-Young, Robinson Howell.

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Magazines and Journals

1. https://ocw.mit.edu/courses/biology/7-01sc-fundamentals-of-biology-fall-2011/recombinant-dna/development-of-recombinant-dna/
2. http://mcb.asm.org/
3. https://bmccellbiol.biomedcentral.com/

10. Course Organization

Course Code	CBC504A	
Course Title	Molecular Biology II	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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Approved by the Academic Council at its 26th meeting held on 14th July 2022

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Course Specifications: Practical V: Molecular Biology II

Course Title	Practical V: Molecular Biology II
Course Code	CBL505A
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. The students will be able to execute the experimental design and basic techniques commonly used in molecular biology 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	04
Total Hours of Classroom Interaction	120
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 RNA 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 the techniques of Southern and Western blotting

CO 5. Acquire hands-on experience on AGE, PAGE and formaldehyde gel electrophoresis

CO 6. Analyze DNA sequence data

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4. Course Contents

1. Isolation of total RNA and analysis by formaldehyde gel electrophoresis
2. Isolation, quantification and characterization of plasmid DNA from bacteria.
3. Restriction digestion and ligation of plasmid DNA.
4. Analysis of protein pattern during seed germination using SDS-PAGE
5. Determination of molecular weight and quantification of DNA, RNA and Protein
6. Spectroscopic determination of melting temperature(Tm) of calf thymus DNA
7. Preparation of competent cells, transformation of *E.coli* and screening of transformants
8. Cloning and expression of GFP gene in *E.coli*
9. Amplification of desirable gene by Polymerase chain reaction.
10. Random amplification of polymorphic DNA
11. Western blotting
12. Southern blotting
13. Purification of His-Tagged protein on Ni-NTA columns.
14. Phage Titration
15. The effect of Mutation in E. coli
16. Curing of plasmid from a Bacterial Culture
17. Automated DNA sequencing data observations and analysis.

5. CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1			3							3		
CO-2			3							3		
CO-3			3							3		
CO-4								3				3
CO-5								3				3
CO-6				2								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		10
1. Demonstration using Videos	10	
2. Demonstration using Physical Models/Systems		
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		100
1. Course Laboratory	110	
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		10
Total Duration in Hours		120

7. Course Assessment and Reassessment

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. **Essential Reading**

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

b. **Magazines and Journals**

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

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10. Course Organization

Course Code	CBL505A	
Course Title	Practical V: Molecular Biology II	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Entrepreneurship Skill Development

Course Title	Entrepreneurship Skill Development
Course Code	CBM501A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of this course is to develop the entrepreneurial skills of students in preparing realistic proposal for a new business startup. Students are taught on the need for identifying new venture opportunities, prepare and present business plans. The focus is on the analytical thinking and skills that are relevant for seeking new venture financing and making investment decisions. This course provides the framework for learning the practical sides of school knowledge, illustrating ways in which it can become tools for life as well as business.

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. Outline the basic concepts in entrepreneurship, identification of opportunities, business evaluation and analysis.

CO 2. Conduct a market-analysis, a distribution- and sales analysis, as well as a marketing plan

CO 3. Illustrate the differences in issues and challenges in science-based industries related to entrepreneurship and innovation

CO 4. Identify the own personal entrepreneurial potential, ability, and competences

CO 5. Create and execute marketing, biotechnology development and strategic plans that integrate technological development with evolving international customer requirements

CO 6. Compose and write a business plan offering a convincing presentation of a biotech venture. The element of the business plan should reflect skillful application of theories and tools from the course

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4. Course Content

Unit I

Introduction to Entrepreneurship skill development:

Concept and theories of Entrepreneurship, Entrepreneur, Importance of entrepreneurship, skills for successful entrepreneur. Entrepreneurship in Biotechnology, Scope and opportunities in bio entrepreneurship; types of bio-industries – biopharma, bioagri, bioservices and bioindustrial. Entreprenuership development programs of public and private agencies (MSME, DBT, BIRAC, BCIL, Startup & Make in India); patent landscape, IP protection & commercialization strategies.

Unit II

Project management: Concept of project and classification, project identification, project formulation, project design, business feasibility analysis by SWOT, socio-economic costs benefit analysis; Business plan preparation; statutory and legal requirements for starting a company/venture.

Unit III

Accounting and Finance: Basics in accounting practices, concepts of balance sheet, Ratio analysis, Investment process, Profitability analysis, Break even analysis, double entry, bookkeeping; Budget and planning process, collaborations & partnerships; information technology for business administration and expansion. Funds/support from Government agencies like MSME/banks and private agencies like venture capitalists:/angel investors for bioentrepreneurship; biotech policy initiatives.

Unit IV

Business Strategy: Entry and exit strategy; pricing strategy; negotiations with financiers, bankers, government and law enforcement authorities; dispute resolution skills; external environment/ changes; avoiding/managing crisis; broader vision–global thinking; mergers & acquisitions.

Unit V

Marketing: Market conditions, segments, prediction of market changes; identifying needs of customers; Market linkages, branding issues; developing distribution channels - franchising; policies, promotion, advertising; branding and market linkages for 'virtual startup company'.

Unit VI

Biotech enterprises: Setting up Small, Medium & Large scale industry, steps for starting a small industry, incentives and subsidies, exploring export possibilities; innovation centers, research institutions (public & private) and business incubators; R&D for technology development and upgradation; regulations for transfer of foreign technologies; technology transfer agencies; Quality control in Biotech industries, Understanding of regulatory compliances and procedures (CDSCO, NBA, GLP, GCP, GMP).

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5. CO-PO-PSO mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1		2									3	
CO-2			3	3			3				3	
CO-3				3			3					3
CO-4				3		2						3
33: 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		03
1. Case Study Presentation		
2. Guest Lecture	03	
3. Industry/Field Visit		
4. Brain Storming Sessions		
5. Group Discussions		
6. Discussing Possible Innovations		
Term Test and Written Examination		03
Total Duration in Hours		30

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7. Course Assessment and Reassessment

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	25 Marks		25 Marks		50 Marks
CO-1	▯				▯
CO-2	▯				▯
CO-3	▯		X		▯
CO-4	▯		▯		▯

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

8. Achieving Course Learning Outcomes

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

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

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9. Course Resources

a. References

1. **Adams, D. J., & Sparrow, J. C. (2008). Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion.**
2. Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
3. Onetti, A., & Zucchella, A. (n.d.). Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge. Routledge
4. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
5. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.

b. Magazines and Journals

1. https://www.nature.com/bioent/index.html
2. https://www.birac.nic.in/desc_new.php?id=274
3. http://dbtindia.gov.in/

10. Course Organization

Course Code	CBM501A	
Course Title	Entrepreneurship Skill Development	
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		Aug 2019
Next Course Specifications Review		June 2021

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Course Specifications: Group Project

Course Title	Group Project
Course Code	CBP501A
Programme	M.Sc. Biotechnology
Department	Biotechnology
Faculty	FLAHS

1. Course Summary

This Course is intended to apply and synergise the learning outcomes of M.Sc. in Biotechnology programme through a group project. The group project will focus on the application of appropriate tools and techniques for development of Biotechnology and the use of relevant university resources for definition and execution of the project. The group project will enable the students to apply the theoretical and practical aspects of New Generation Sequencing data analysis, Clinical research data analysis and interpretation and Critical Analysis of Classical Papers which will enable them to apply the knowledge gained during the programme.

2. Course Size and Credits:

Number of credits	08
Total hours of class room and laboratory interaction	240
Number of semester weeks	16
Department responsible	Biotechnology
Course marks	As described Total Marks: 100
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. Work in a team and undertake a project in the area of Genomics, NGS, Clinical data analysis, Critical analysis of papers by using analytical research approach

CO 2. Apply Biotechnology principles and techniques for executing the project

CO 3. Apply appropriate research methodology while formulating a project

CO 4. Define Specifications, Synthesize, Analyse, Develop and Evaluate a project

CO 5. Develop a report which explains the project and make a presentation and document the work

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4. Course Contents

Need for undertaking project, design specifications, analysis, evaluation and presentation of either of the followings:

- New Generation Sequencing (NGS) data analysis and interpretation
- Clinical Research data analysis and interpretation
- Critical analysis of classical papers

Team building, Teamwork, Leadership skills

5. CO-PO-PSO mapping

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

Topics	Teaching methods	Hours
Critical Review, Problem Formulation and stating Objectives	Reading Journal papers , books and Other relevant materials and problem formulation	80
	Presentation to Reviewers	04
Design	Group work with supervisors guidance	25
Analysis	Group work with supervisor sguidance	25
Testing and Evaluation	Group work with supervisors guidance	20
Verification/Validation	Group work with supervisors guidance	25
Drawing Conclusions	Group work with supervisors guidance	05
Presentation , Thesis/Report Writing and Viva Voce	Presentation and Vivavoce-Group	01
	Thesis/Report writing - Group	50
	Tests/Examinations/Presentations	05
	Total	240

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7. Method of Assessment

There are two components for assessment in this Course:

Component- 1: 50%weight
Presentations
Component- 2:50%weight
Project Report

Theassessmentquestionsaresettotestthelearningoutcomes.Ineachcomponenta certain learning outcomes are assessed. The following table illustrates the focus of learning Outcome in each component assessed:

No.	Intended Learning Outcome	Mode of Assessment	
		Component 1 (Continuous Evaluation)	Component 2
1	Work in a team and undertake a project in the area of Genomics, NGS, Clinical data analysis, Critical analysis of papers by using analytical research approach	X	X
2	Apply Biotechnology principles and techniques for executing the project	X	X
3	Apply appropriate research methodology while formulating a project	X	X
4	Define Specifications, Synthesize, Analyse, Develop and Evaluate a project	X	X
5	Develop a report which explains the project and make a presentation and document the work	X	X

- **Meeting Programme Objectives Through Course Objectives**

The various skills are directly or indirectly imparted to the students using the teaching and learning methods as follows:

S.No	Curriculum and Capabilities Skills	How imparted during the Course
1.	Knowledge	Group Project work
2.	Understanding	Group Project work
3.	Critical Skills	Group Project work
4.	Analytical Skills	Group Project work
5.	Problem Solving Skills	Group Project work
6.	Practical Skills	Group Project work
7.	Group Work	Group Project work
8.	Self Learning	Group Project work
9.	Written Communication Skills	Report writing
10.	Verbal Communication Skills	Presentation
11.	Presentation Skills	Presentation
12.	Behavioural Skills	Group Project work
13.	Information Management	Group Project work
14.	Leadership Skills	Effective management of learning, time management, achieving the learning outcomes

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9. Course Resources

a. Essential Reading

1. Assigned reading relevant to the group project.

10. Course Organization

Course Code	CBP501A	
Course Title	Group Project	
Course Supervisors Name	Allotted on project basis	
Course Supervisors Contact Details	**Phone:**	080-49066666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	Aug 2019	
Next Course Specifications Review Date:	June 2021	

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Course Specifications: Molecular Basis of Disease and Diagnosis

Course Title	Stem Cell and Regenerative Medicine
Course Code	CBE501A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

To understand the concept of potency and regeneration and employ the understanding in therapeutic implications. Stem cells are endorsed with indefinite cell division potential, can transdifferentiate into other types of cells, and have emerged as frontline regenerative medicine source in recent time. Stem cells pave foundation for all tissue and organ system of the body and mediates diverse role in disease progression, development, and tissue repair processes

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. Identify characteristic features of Stem cells, their origin, maintenance and regulation.

CO 2. Explain the properties of stem cells and their therapeutic implication.

CO 3. Illustrate the clinical uses of stem cells as an alternative treatment modality.

CO 4. Explain the pros and cons of stem cell treatment in cancer therapeutics

CO 5. Exemplifying the methods of bio-amplification of stem cells for therapeutic use

CO 6. Focus on building perspective on the future of stem cell therapy and regenerative medicine.

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4. Course Contents

Unit I

Introduction to Stem cells

Basics of stem cells and principles of potency, Overview of different stem cell types (embryonic, fetal, adult/tissue and cancer).

Biology of stem cells: Cell cycle regulation in stem cells, Mechanisms of differentiation, Signal transduction, Metabolism of stem cells. Stem Cell niches; Extrinsic factors in the regulation of stem cell function. Biological, physio-mechanical properties of stem cell micro-environment

UNIT II

Hematopoietic stem cells:

Description of the hematopoietic system and the properties of its components, including the concept of the HSC niche; the markers and techniques used to isolate HSCs and the in vitro and vivo assays used to assess them; the ontogeny of HSCs, their regulation, and their therapeutic use in human disease.

Tissue-specific stem cells

Skin as an example; structure and development; experimental evidence for different types of stem cells that contribute to skin homeostasis, the effects of injury and disease on skin stem cells, and potential therapeutic applications

UNIT III

Clinical applications of stem cells

The need for cell therapy, Current status with reference to discussion of some of the most advanced Embryonic Stem cells generated in phase 1 clinical trials (e.g. ACT and London Eye project: retinal pigmented epithelium). Reference to established HSC and prototype MSC therapies.

UNIT IV

Cancer stem cells

Controversy and identification of cancer stem cells; impact on anti-cancer therapies; methods to control cancer stem cells

UNIT V

Tissue engineering

Ex vivo expansion of stem cells, Ex vivo construction of tissues, scaffolds, bioreactors

UNIT VI

Stem cells in clinic: uses of stem cell for metabolic, genetic diseases, cancers and trauma; Potential application of stem cells in clinic and present clinical use. Hurdles and future directions.

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5. CO-PO Mapping

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

6. Course Teaching and Learning Methods

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

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7. Course Assessment and Reassessment

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

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

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9. Course Resources

a. References

Essential Reading

1. Lanza, R. and Atala, R(2013). Essentials of Stem Cell Biology (Eds.). 3rd Edition. Academic Press
2. Black, JMW. (2017). The science of stem cells. 1st, Edition, Wiley Blackwell publishers.
3. Warburton, D. (2014). Stem Cells, Tissue Engineering and Regenerative Medicine. 1st Edition. World Scientific publishing Co. Pvt. Ltd.
4. Sell, S. (2013). Stem Cells Handbook. 1st edition. 2013.
5. Burgess, R. (2016). Stem Cells: A Short Course . 1stEdition, Wiley Blackwell Publishers.
6. Lanza, R. Langer, R. Vacanti, J. Principles of Tissue Engineering (2013). 4th edition. Academic Press.
7. Bronzino, JD., Peterson, DR. (2015). The Biomedical Engineering Handbook 4th edition. CRC Press Taylor & Francis.

Magazines and Journals

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

Websites

1. https://www.cellsalive.com/
2. http://www.biology.arizona.edu/cell_bio/cell_bio.html

10. Course Organization

Course Code	CBE501A	
Course Title	Stem Cell and Regenerative Medicine	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.bl@msruas.ac.in
Course Specifications Approval Date	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Synthetic Biology

Course Title	Synthetic Biology
Course Code	CBE502A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The objectives of this module will be to teach students the new areas that make up Synthetic Biology which include engineering biology, engineering principles, mathematical modeling, microbiology, molecular biology, biochemical engineering and chemistry.
In addition to academic learning the students will learn how to design specific elements in Synthetic Biology though group and individual work. They will gain experience of verbal, written and visual communication of the designs and topics.

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 how naturally occurring organisms regulate the expression of their genes

CO 2. Describe how the regulation of the genes and properties of gene products can be altered with synthetic biology methods

CO 3. Justify how synthetic biology alters the properties of the cell or the organism

CO 4. Develop a scientific approach to the planning, execution, reporting and interpretation of advanced projects with the aim at creating replicating systems with new properties that can be regulated, and to critically analyse the results and generate testable hypotheses from these experiments

CO 5. Develop a critically analytical skill, present and defend scientific literature in synthetic biology, including practical applications such as metabolic engineering

CO 6. Develop a scientific approach to entirely synthesize *Escherichia coli* with a recoded genome

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4. Course Content

Unit I
Key Regulators of Molecular Biology
Biological Parts – Promoters, Regulators, Genes, Terminators, Proteins

Unit II
Optimization of Gene Expression
Controlling Gene Expression and Protein Production, Artificial Gene Circuits, Noise in Gene Expression

Unit III
Advanced Biotechnological Methods and Bioinformatics Analysis
Basics of cloning, mutagenesis, polymerase chain reaction, synthesis of nucleic acids, DNA sequence determination, Recombinant DNA technologies, DNA synthesis and Assembly, Bioinformatics analysis and characterization of genes and biomolecules

Unit IV
Genome Editing Technologies
Transposons, Recombinases, Zinc Fingers, TALEN's, CRISPR/Cas9

Unit V
Metabolic Engineering
Introduction to Metabolism, Metabolic Pathways, Determination of Metabolic Flux, Techniques, Applications, Challenges

Unit VI
Recoding Genome
Accelerated Evolution Systems - MAGE, PACE, Synthetic Cells - Recoded E. coli and JCVIsyn

5. CO-PO 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					2				3	
CO-5		2					2			1	3	
CO-6		3					2			1	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		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. **Synthetic Biology, Academic Press, Editors: Huimin Zhao, ISBN: 9780123944306**
2. **Synthetic Biology: Tools for Engineering Biological Systems, Cold Spring Harbor Laboratory Press, Edited by Daniel G. Gibson, J. Craig Venter Institute; Clyde A. Hutchison III, J. Craig Venter Institute; Hamilton O. Smith, J. Craig Venter Institute; J. Craig Venter, J. Craig Venter Institute, ISBN 978-1-621821-18-2**
3. Synthetic Biology - A Primer (Revised Edition), Imperial College Press, Baldwin, Bayer, ISBN: 9781783268795, 1783268794
4. Synthetic Gene Networks: Methods and Protocols, Springer Protocol, Editors: Wilfried Weber, Martin Fussenegger, ISBN-10: 1493962248, ISBN-13: 978-1493962242

b. Magazines and Journals

1. https://www.nature.com/subjects/synthetic-biology
2. https://www.journals.elsevier.com/current-opinion-in-systems-biology

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10. Course Organization

Course Code	CBE502A	
Course Title	Synthetic 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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Title	Molecular Biology of Disease and Diagnostics
Course Code	CBE503A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

To decipher the origin and mechanism of development of various diseases and use biotechnology is designing effective tools for diagnosis.

To study infectious, physiological, metabolic diseases and the genetic basis of inherited diseases applying the knowledge of anatomy, physiology, pathology, immunology, molecular biology, genetics and biochemistry.

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 different classes of diseases namely infectious, metabolic, genetic and physiological diseases

CO 2. Enumerate on the molecular biology and immunology of disease

CO 3. Classify the Immunological, Molecular and Biochemical techniques of diagnosis of diseases

CO 4. Compare the nucleic acid, protein, genetic and cytogenetic based diagnostic techniques for diseases

CO 5. Illustrate the genetic basis of cancer, current and prospective diagnostic and ameliorative approaches

CO 6. Outline the principles of Gene therapy, its applications, prospects and Challenges

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4. Course Content

Unit I

The mechanism , symptom, prevention and cure of the following Infectious and physiological Diseases

Infectious- bacterial, viral, protozoan and fungal.

Physiological–cardiovascular, Glaucoma, Hemochromatosis, Diabetes

Unit II

Study the causes and possible amelioration of :

Genetic disorders- Single gene inheritance, Multifactorial inheritance, Chromosome abnormalities, Mitochondrial inheritance.

Metabolic- Glucose, lipid, iron and water electrolyte imbalances.

Unit III

Molecular Biology of Inflammation and response

Acute and Chronic inflammation, mechanism and mediators, systemic effects of inflammation Cancer genetics- Molecular basis of cancer, oncogenes, tumour suppressor genes. Gene therapy and other molecular based therapeutic approaches

Unit IV

Study the following techniques of diagnosis

Detection and quantification of sugar, albumin, urea, protein, globulin,Vitamin; Diagnostic tests of - Duchenne Muscular Dystrophy (DMD), (Creatine phosphokinase-CPK) , Phenylketonuria-PKU (phenylketone), G6PD deficiency syndrome (G6PD) , Mucopolysaccharidosis ; Endocrine disorders related to thyroid and reproduction (TSH, T3, T4, Estradiol, Testosterone, LH, FSH) Immunological diagnostics: Enzyme Linked Immunosorbant Assay, radioimmunoassay, dot and slot blot assay, HLA typing

Unit V

Genetically engineered immunotherapeutic agents: Fusion protein, production of antibodies in E. coli, purification and application, chemically linked monoclonal antibodies, human monoclonal antibodies, hybrid human-mouse monoclonal antibodies, catalytic antibodies. Treatment-products from recombinant and non-recombinant organisms, Interferons, Antisense therapy, cell penetrating peptides

DNA diagnostics: Hybridization probes, diagnosis of malaria and other diseases, non-isotopic hybridization procedure, detection of mRNA by in situ hybridization, hapten-labeling of nucleic acid probes. PCR application in genetic and diseases diagnosis, Ribozymes: Synthesis, application and clinical potentials

Unit VI

Gene Therapy: Positional cloning, getting closer to diseases causing genes, genes based medicines, genetic immunization, human somatic cell gene therapy, *ex-vivo* and *in-vivo* gene therapy, antisense therapy, germ line gene therapy, future and fears, HIV therapy.

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5. CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1	3											3
CO-2	3											3
CO-3	3											3
CO-4				3							2	3
CO-5				3							2	
CO-6	1		2							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		06
1. Demonstration using Videos	05	
2. Demonstration using Physical Models /	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		05
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		10
Total Duration in Hours		45

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7. Course Assessment and Reassessment

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

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Approved by the Academic Council at its 28th meeting held on 14th July 2022

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9. Course Resources

a. References

1. Kumar, V. Abbas, A.K. Fausto, N. and Aster, J. 2015. *Robbins and Cotran Pathologic Basis of Disease*. 9th edition. Elsevier Saunders.
2. Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J., 2004, *Molecular Cell Biology*, Scientific American Books Inc..
3. Buckingham, L. and Maribeth, L.F., 2007. Molecualr Diagnostics: Fundamentals, Methods and Clinical Application", F.A. Davis.
4. Cooper, G.M. and Hausman, R.E. 2009, *The Cell: A Molecular Approach*, 5th Edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Primrose S.B. Twyman, R. ; 2006, Principles of Gene Manipulation and Genomics 7th Edition, Blackwell Publishing

b. Magazines and Journals

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

10. Course Organization

Course Code	CBE503A	
Course Title	Molecular Biology of Disease and Diagnostics	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	
Course Specifications Approval Date	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Bio-separation Techniques

Course Title	Bio-separation Technique
Course Code	CBE504A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The course gives a fundamental knowledge of molecular separation theories, and its extraction procedures to characterize the biomolecules at the molecular level.
This will also add a theoretical as well as a practical introduction to principles and techniques of several chromatography: thin layer chromatography (TLC), column liquid chromatography including HPLC, gas chromatography, ion exchange and size exclusion chromatography. Additionally, more specialized topics may be briefly presented, e.g.: sample preparation (solid phase extraction, SPE), coupled chromatography-spectroscopy, chromatographic chiral separations.

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.** Understand from the scratch of techniques to bring out the bio-products from the cell wall; to remove the insoluble particles; to confirm the product availability
- **CO 2.** Understand more knowledge about the precipitation, types of extraction, methods and applications
- **CO 3.** Explain the types of liquid chromatography; gas chromatography, their principle, working mechanism, applications. The way to bring out the products to market with all final crystallization and making into powder
- **CO 4.** Enumerate the fundamental concepts & theories of separation techniques in HPLC, and to identify the strength & limitations of each type of HPLC technique
- **CO 5.** Delineate the fundamental application of ion exchange chromatography, and the use of different matrix to purify biomolecules
- **CO 6.** Evaluate the strengths and limitations of the most important chromatographic separation and detection methods in relation to the properties of the sample and of the analysis task

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4. Course Content

Unit I

Separation theories

Introduction to separation, Pre-concentration. Classification of separation methods depending on the basis of separation. Classical separation methods. Introduction to the developed method of separation

Unit II

Extraction Techniques

Extraction techniques, theory and applications on liquid-liquid, liquid–solid, soild-pahse micro extractions and stir-bar sorptive extraction techniques. Comparison of the efficiency of various techniques, and methods improvement

Unit III

Thin Layer Chromatography (TLC)

Chromatographic theory chromatographic methods, mechanism of separation. Column efficiency, Band broadening and resolution, (HETP) theoretical plates, Thin layer chromatography (TLC), principle, application

Unit IV

Gas Chromatography (GC-MS)

Gas chromatography, instrumental design, gas type selection, methods of sample introducing or injection (split, splitless , split-splitless and purge and trap. Types of detectors, (ECD, FID, NPD, PID) and connection to MS. Columns (capillary and packed), chemically bonded and comparing the efficiency. Temperature programmed (oven) and quantitative analysis (applications)

Unit V

High performance Liquid Chromatography (HPLC)

HPLC- theory of operation, instrumental design, function of various parts of the machine, solvent delivery (pumps), types of pumps and requirements. Column specification and polarity, column selection, detectors (UV-Vis., Fluorescence , RI, Diode array,,) and connectivity to MS. Operational modes of HPLC (Reverse and Normal phase) quantitative analysis and applications

Unit VI

Ion-exchange, Size exclusion, Affinity column chromatography

Ion chromatography, cation and anion exchange resin, and size exclusion chromatography, affinity chromatography, principle, and application, Electrophoresis, its principle and application

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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			2								3	
CO-5		2									3	
CO-6	1									1	3	
3: High Influence, 2: Moderate Influence, 1: Low Influence												

6. Course Teaching and Learning Methods

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

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7. Course Assessment and Reassessment

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

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

8. Achieving Course Learning Outcomes

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

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

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9. Course Resources

a. References

1. **Daniel C. H., 2010, *Quantitative Chemical Analysis*, 8th edition, W. H. Freeman & Co., New York, ISBN: 9781429218153**
2. **David H., 2000, *Modern Analytical Chemistry*, , McGraw-Hill, 1st ed, ISBN: 0–07–237547–7**
3. Francis R., Annick R., 2007, *Chemical Analysis: Modern Instrumentation Methods and Techniques*, John Wiley & Sons, 2nd ed,.ISBN: 0470859040, 9780470859049
4. D. A. Skoog, F. J., Holler, S.R., Crouch, B. C., 2006, *Principles of Instrumental Analysis*, 6th edition, ISBN: 0495012017 , 978-0495012016

b. Magazines and Journals

1. https://www.nature.com/articles/243106a0
2. https://www.journals.elsevier.com/methods

10. Course Organization

Course Code	CBE504A	
Course Title	Bioseparation Techniques	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Biosafety Regulation, Bioethics and IPR

Course Title	Biosafety Regulation, Bioethics and IPR
Course Code	CBE505A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to provide basic knowledge on biosafety, Bioethics and intellectual property rights and risk assessment of the products derived from Biotechnology and Life Sciences research and regulation of such products. Students will be familiarized with the rules and regulations of biosafety at different levels. They will be acquainted with the laws and regulation of ethical issues in biological research. Students will be taught thoroughly on intellectual property rights and their implications in biological research and product development.

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 different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents.

CO 2. Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environment release of genetically modified organisms, national and international regulations.

CO 3. Describe ethical aspects related to biological, biomedical, health care and biotechnology research.

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4. Course Content

Unit I: Biosafety

Biosafety and Biosecurity - introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs; principles of safety assessment of transgenic plants – sequential steps in risk assessment; concepts of familiarity and substantial equivalence; risk – environmental risk assessment and food and feed safety assessment; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; risk assessment of transgenic crops *vs* cisgenic plants or products derived from RNAi, genome editing tools.

Unit II: Biosafety Regulations-National and International

International regulations – Cartagena protocol, OECD consensus documents and Codex Alimentarius; Indian regulations – EPA act and rules, guidance documents, regulatory framework – RCGM, GEAC, IBSC and other regulatory bodies; Draft bill of Biotechnology Regulatory authority of India - containments – biosafety levels and category of rDNA experiments; field trails – biosafety research trials – standard operating procedures - guidelines of state governments; GM labeling – Food Safety and Standards Authority of India (FSSAI).

Unit III: Bioethics

Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy

Unit IV: Introduction to IPR

Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS; plant variety protection and farmers rights act; concept of „prior art": invention in context of "prior art"; patent databases - country-wise patent searches (USPTO, EPO, India); analysis and report formation.

Unit V: Patenting

Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application; role of a Country Patent Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting-introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.

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5. CO-PO Mapping

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CO-2			3							1		
CO-3			3									2
CO-4		1				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		24
Demonstrations		06
1. Demonstration using Videos	05	
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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		
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Others		05
1. Case Study Presentation		
2. Guest Lecture	02	
3. Industry / Field Visit		
4. Brain Storming Sessions		
5. Group Discussions	02	
6. Discussing Possible Innovations	01	
Term Test and Written Examination		10
Total Duration in Hours		45

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7. Course Assessment and Reassessment

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	SC1	SC2	SC3	
	50 Marks	25 Marks	25 Marks	100 Marks
CO-1	×	×		×
CO-2	×	×		×
CO-3	×	×		×
CO-4	×		×	×

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

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

8. Achieving Course Learning Outcomes

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

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

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9. Course Resources

a. References

1. Ganguli, P. (2001). *Intellectual property rights: Unleashing the knowledge economy*. New Delhi: Tata McGraw-Hill Pub.
2. *Complete Reference to Intellectual Property Rights Laws*. (2007). Snow White Publication Oct.
3. Kuhse, H. (2010). *Bioethics: An anthology*. Malden, MA: Blackwell.

b. Magazines and Journals

1. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
2. World Trade Organization. http://www.wto.org
3. World Intellectual Property Organization. http://www.wipo.int
4. International Union for the Protection of New Varieties of Plants. http://www.upov.int
5. National Portal of India. http://www.archive.india.gov.in
6. National Biodiversity Authority. http://www.nbaindia.org
7. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
8. Guidelines and Standard Operating procedures for confined field trials of regulated genetically engineered plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp.

10. Course Organization

Course Code	CBE505A	
Course Title	Biosafety Regulation, Bioethics and IPR	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	
Course Specifications Approval Date	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Upstream Processing

Course Title	Upstream Processing
Course Code	CBE506A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of this course is to instil in students a critical awareness and in-depth understanding of the principles, practice and key concepts relevant to industrial biotechnology. It broadly focuses on the applied biocatalysis in homogeneous and heterogeneous systems, solid-state and submerged culture Fermentation. This course thus offers a broad-spectrum exposure to such a rapidly advancing field as biotechnology and hence includes various strategies for bioprocess development, control, optimization and scale-up, starting from the strain/clone to the final marketable product / technology. Considering tremendous commercial potential of bioprocesses as cost-competitive and environment friendly alternatives to chemical processes, the course emphasizes on the bioreactor design, configuration and various operational strategies for microbial and animal cells.

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. Describe the principles that underlie major unit operations used in upstream processing of biotechnological and biopharmaceuticals.

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

CO 3. Apply engineering principles to address issues in bioprocesses

CO 4. Analyze molecular biology elements used to construct recombinant cell lines and identify potential genetic instability in bioprocesses

CO 5. Explain how environmental conditions influence cell growth and means to achieve optimal cell growth in large scale

CO 6. Design or Select appropriate bioreactor models based upon bioproducts and cell lines and other process criteria

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4. Course Content

Unit I

Microbial Strain improvement:

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

Unit II

Upstream biological operations:

Reactant processing for thermo stable and thermo labile systems; medium formulation involving all phases; medium sterilization, oxygen requirements, antifoams, medium optimization, Ingredients for mammalian cell culture and plant cell culture, probabilistic and deterministic approaches in the design; Gas sterilization, sterilization of fermenter and other ancillaries, filter sterilization of air and media.

Unit III

Fermentation & Microbial Kinetics:

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

Unit IV

Design of bioreactors:

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

Unit V

Bioreactor configurations and types:

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

Unit VI

Enzymes in industry:

Production of Restriction enzymes, Extreme enzymes (Taq DNA polymerase and keratinase), bifunctional enzymes. Enzyme immobilization and its application: Enzymes used in food (proteases and amylases) and beverage (amylases and invertases) industries, detergent industry, leather industry, wool industry, paper industries. application in food, dairy (proteases), beverage and pharma industry. Yeast expression systems for production of therapeutical agents: HepatitisB surface antigen, Human platelet derived growth factor B.

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5. CO-PO Mapping

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

6. Course Teaching and Learning Methods

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

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7. Course Assessment and Reassessment

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. References

1. **Peter, F. S., Allan, W., Stephen, J., 2016, *Principles of Fermentation Technology*, Butterworth-Heinemann Press. UK.**
2. El-Mansi (Ed.), 2011, *Fermentation Microbiology and Biotechnology*, CRC Press, 3rd Ed.
3. Pauline M. Doran, 2012, *Bioprocess Engineering Principles*, Academic Press, 2nd Ed.
4. Peppler, H. J., 2014, *Microbial Technology: Fermentation Technology*.

b. Magazines and Journals

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

Course Organization

Course Code	CBE506A	
Course Title	Upstream Processing	
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		Aug 2019
Next Course Specifications Review		June 2021

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Course Specifications: Bio-analytical Technique

Course Title	Bio-analytical Technique
Course Code	CBE507A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

This course is introduced to bridge the gap between academics, research and industry. This course begins with a review of basic bio analytical technique and an introduction to general terminologies. This course contains bio-analytical techniques along with their theory, working principal, common instrumentation and possible applications.

This course will be equally beneficial to various scientific areas including, life science, chemical science, material science and environmental science.

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.** Discuss the principles involved in undertaking standard sample preparation procedures, and recognize the critical importance of rigorous instrumental calibration procedures and the use of standards and reference materials
- **CO 2.** Describe the process of cell disruption followed by separation of intracellular organelles
- **CO 3.** Explain the character of intracellular components under microscopic observation
- **CO 4.** Explain the molecular behavior of purified molecules through chromatographic analysis and its characterization through spectroscopic, radio-labelled, and immunochemical methods
- **CO 5.** Critically appraise the techniques and methods adopted by scientific researchers

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4. Course Content

Unit I

Solution and Buffer

Molarity, Normality, The Concept of pH, Acids and Bases, Henderson–Hasselbalch Equation, Determination of p*Ka*, Buffers

Unit II

Cell Disruption and Centrifugation

Cell Disruption- Barriers for Cell Disruption, Mechanical Methods of Cell Disruption, Non-Mechanical Methods of Cell Disruption, Analysis of Cell Disruption

Centrifugation techniques- Basic principles, different types of centrifuges, analytical and preparative ultracentrifugation methods

Unit III

Microscopy

Microscopy- Dark-field, phase contrast, fluorescence, confocal, polarization, scanning and transmission electron microscopy.

Unit IV

Chromatography and Spectroscopy

Chromatographic methods- General principles, ion exchange, gel filtration, Affinity, HPLC and gas chromatography techniques

Spectroscopic Techniques- UV-Visible, fluorescence, circular dichroism, nuclear magnetic resonance, isothermal titration calorimetry, atomic spectroscopy

Unit V

Radioisotpe technique and Immunochemical technique

Radioisotope techniques- Basic concepts, GM and scintillation counter, autoradiography, RIA, applications in biological science

Immunochemical Techniques- Introduction, Production and Purification of Antibodies, Immunoassay Techniques, Advances in Immunochemical Techniques

5. CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
CO-1		3							3			
CO-2		3	3						3			
CO-3			3						2			
CO-4			3									3
CO-5			3									3
CO-6		2										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		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	SC4	
	25 Marks	25 Marks	25 Marks	25 Marks	100 Marks
CO-1	▯	▯			▯
CO-2	▯	▯			▯
CO-3	▯	▯			▯
CO-4	▯		▯	▯	▯
CO-5			▯	▯	▯
CO-6			▯	▯	▯

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. References

1. **I. D. Campbell, *1984., Biological spectroscopy,* Benjamin/Cummings Pub. Co, Menlo Park, Calif,**
   Biophysical techniques series.
2. **K. Wilson, J. M. Walker, Eds., 2009, *Principles and techniques of biochemistry and molecular biology* (Cambridge University Press, Cambridge, UK : New York, 7th ed..**
3. R. F. Boyer, 2012, *Biochemistry laboratory: modern theory and techniques*, Prentice Hall, Boston, 2nd ed.
4. R. Katoch, 2011, *Analytical techniques in biochemistry and molecular biology*, Springer, New York.
5. D. L. Spector, R. D. Goldman, Eds., 2006, *Basic methods in microscopy: protocols and concepts from cells: a laboratory manual,* Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y.
6. R. L. Switzer, 1999, *Experimental biochemistry*, W. H. Freeman and Co, New York, 3rd ed.

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b. **Magazines and Journals**

1. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/biochemical-techniques
2. https://www.nature.com/subjects/biological-techniques

10. Course Organization

Course Code	CBE507A	
Course Title	Bio-analytical 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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Plant Secondary Metabolites

Course Title	Plant Secondary Metabolites
Course Code	CBE508A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to familiarize students with the currently relevant subject of plant derived natural compounds in medicine and health promotion.
Students will be able to explain the health benefits of plant secondary metabolites. They will be able to relate the bioactivities of plant secondary metabolites to development of effective therapeutics.

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.** Classify important plant secondary metabolites
- **CO 2.** Explain the significance of plant secondary metabolites in plant functions
- **CO 3.** Compare the health promoting bioactivities of food derived compounds
- **CO 4.** Relate the bioactivities of plant secondary metabolites to development of effective therapeutics
- **CO 5.** Demonstrate the biotechnological approaches for the production of secondary metabolites
- **CO 6.** Choose the techniques used for purification and characterization of natural compounds

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4. Course Content

Unit I

Introduction to plant secondary metabolites: Primary Vs Secondary Metabolites Classes of secondary plant metabolites: terpenes, phenolics, and nitrogen-containing compounds. Basic biosynthetic pathways.

Unit II

Role of secondary metabolites in plants: Defense - induced plant defenses against insect herbivores, plant defenses against pathogens.

Unit III

Bioactivity of secondary metabolites: Overview of the bioactivities shown by natural compounds; Biologically active compounds from food - Resveratrol (grapes), Sulforaphane (broccoli), Xanthohumol (Hops), Epigallocatechin 3-Gallate (Green Tea), Allicin (Garlic), Other Polyphenol-Rich Foods.

Unit IV

Secondary metabolites in medicine: Medicinal plants as source of bioactive natural products; role of plant-derived natural products in drug discovery, Current plant-derived natural products in therapeutic use and clinical trials: Galantamine, Artemisinine, Paclitaxel, Calanolide A etc.

Unit V

Biotechnology and Secondary Metabolites:

Plant cell culture for the production of secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavonoids, alkaloids; mechanism and manipulation of shikimate pathway; Production of secondary metabolites e.g. ginkgolides from cell cultures of Ginkgo biloba L; Genetic manipulation of flavonoid pathway, Terpenoid and Polyketoid pathways in plants and their value addition with significance in horticulture, agriculture and medicine.

Unit VI

Overview of techniques used for isolation and purification: Extraction, separation and characterization methods, Chromatographic techniques, IR, NMR, Mass Spectroscopy.

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

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7. Course Assessment and Reassessment

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

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

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9. Course Resources

a. **References**

b. Crozier, A., Clifford, M.N., Ashihara, H., (Eds.), *Plant Secondary Metabolites, Occurrence, Structure and Role in the Human Diet*, 2006, Blackwell Publishing Ltd.

c. Liang, X-T., Fang, W-S., (Eds.), 2006, *Medicinal chemistry of bioactive natural products*, John Wiley & Sons.

d. Ramzan, I., (Ed.), 2015, *Phytotherapies, efficacy, safety, and regulation*, John Wiley & Sons.

e. Rogers, K., 2012, *Out of nature: Why drugs from plants matter to the future of humanity*, University of Arizona Press.

f. Herwig, O.G., Müller, L.J., 2014, *Plant natural products: synthesis, biological Functions and practical applications*, John Wiley & Sons.

10. Course Organization

Course Code	CBE508A	
Course Title	Plant Secondary Metabolites	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: AI in Health Care

Course Title	AI in Health Care
Course Code	CBE509A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of this course is to trail the students on the role of artificial intelligence in various health care systems.
The students will be familiarized with the needs applications, innovations and challenges to AI in health care systems.

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. Demonstrate the understanding and knowledge regarding to the needs of AI in healthcare
CO 2. Describe the possibilities of applications of AI to healthcare
CO 3. Describe the ethical issues related to AI in health care sector
CO 4. Explore methods to overcome the challenges of AI in the healthcare domain; and ways in which AI will support and assist towards better healthcare

4. Course Contents

Unit I
Introduction to AI, Basics of AI- important concepts such as machine learning, deep learning, natural language processing (NLP), robotics, role of AI in healthcare, benefits and risks
Unit II
AI in Health Care and Research; AI in medical diagnosis, AI in major healthcare specialties such as Radiology, Pathology, Surgery, Cardiology, Pharmacy and Orthopaedics, AI in early detection, medical treatment and public health
Unit III
Application of machine learning and deep learning in healthcare, machine learning in radiology, AI for computational pathology
Unit IV
Challenges of AI in Health care, Ethical and social issues related to AI and Health care

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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		2									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		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.

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

1. Mahajan MD, Parag Suresh (2018) Artificial Intelligence in Healthcare, Paperback.
2. Panesar, Arjun (2019), Machine learning and AI for Healthcare-Big Data for Improved Health Outcomes, APress.
3. Recommended Journal Papers.
4. Eric Topol (2019), Deep Medicine: How Artificial Intelligence Can Make Healthcare Human Again, Paperback.
5. Tom Taulli (2019), Artificial Intelligence Basics: A Non-Technical Introduction, Apress

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10. Course Organization

Course Code	CBE509A	
Course Title	AI in Health Care	
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	Aug 2019	
Next Course Specifications Review Date:	June 2021	

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Course Title	Molecular Carcinogenesis
Course Code	CBE510A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to familiarize students with the field of cancer genetics and giving them an insight into the current developments in cancer therapeutics.
Students will be able to outline the various causes of cancer and will also be able to describe the aberrant genetic processes that underlie the disease development and progression. They will be able to outline the current approaches with respect to cancer therapeutics and identify the key challenges in the development of effective therapeutics.

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. Classify cancer types and the causal agents

CO 2. Relate particular chromosomal aberrations that underlie specific cancer types

CO 3. Summarize the types of genetic mutations that are key to causing cancer

CO 4. Explain the processes involved in the initiation and progression of cancer

CO 5. Outline the current developments in cancer diagnostics and therapy

CO 6. Distinguish molecular pathways which form suitable targets for therapeutic applications

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4. Course Content

Unit I

Introduction to Cancer: cancer-a complex genetic disorder, origin, types (types of tumors, stages of malignancy), basic terminology. Hallmarks of Cancer: Basic mechanisms regulating normal tissue homeostasis: regulation of cell-proliferation, growth, differentiation and apoptosis; aberrations in regulatory mechanisms that result in cancer.

Unit II

Causes of cancer: Pre-disposing factors, Cancer viruses: discovery, mechanism of action of commonly seen viruses such as HPV, EBV, HBV, HCV. Familial cancer syndromes: NF1, FAP, VHL, etc. Sporadic cancers.

Unit III

Cancer Cytogenetics: Cytogenetics in cancer diagnosis (karyotyping), Clones and clonal evolution, types of chromosomal aberrations, composite karyotypes, chromosome markers found in different Lymphomas and leukemias (CML, AML, APML, myelodysplastic syndromes etc.,) and solid tumors (Sarcomas and carcinomas).

Unit IV

Genetic Alterations in Cancer: The nature of commonly occurring mutations in cancerous tissue: gain of function, loss of function, copy number variation (CNV); signaling pathways commonly affected in cancers; oncogenes: mechanisms of activation and action, different functions of oncogenes. Tumor suppressor genes: mechanisms of loss of function, loss of heterozygosity, Knudsen's two hit hypothesis, different functions of tumor suppressor genes. Caretaker and gatekeeper genes. Epigenetic alterations: role of the Polycomb group (PcG) and Trithorax (Trx) proteins in carcinogenesis.

Unit V

Cancer progression: Molecular mechanisms of metastasis: Different steps and cellular state transitions in metastases; genes responsible for metastases; organ specific metastases. Tumor microenvironment: Composition of the tumor microenvironment; mechanisms of tumor angiogenesis, mechanisms of immune evasion. Metabolic reprogramming in cancer: The phenomenon known as Warburg effect.

Unit VI

Cancer therapy: Methods of tumor detection, tumor markers, treatment of cancer-chemo therapy, radio therapy, immunotherapy and gene therapy. Targets for therapy-cell proliferation and survival, angiogenesis, metastasis, immune evasion etc.; The development of therapeutic resistance, the occurrence of a relapse; current developments in treating cancers.

Meeting. 4/90

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

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7. Course Assessment and Reassessment

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

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9. Course Resources

a. References

1. Weinberg, R. A., 2013,*The Biology of Cancer*, 2nd edition, Garland Science.
2. Alberts, B., et al., 2014,*Molecular Biology of the Cell*, 6th edition, W. W. Norton & Co.
3. Ross, D.W., 1998, *Introduction to Oncogenes and Molecular Cancer Medicine*, Springer-Verlag.
4. Franks, L. M., Teich, N.M., 1997,*Introduction to Cellular and Molecular Biology of Cancer*, Oxford University Press.
5. Larionow, L., 2003, *Cancer Chemotherapy*, Pergamon Press.

b. Magazines and Journals

https://www.cell.com/cancer-cell/home

https://cancerres.aacrjournals.org/

10. Course Organization

Course Code	CBE610A	
Course Title	Molecular Carcinogenesis	
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	Aug 2019	
Next Course Specifications Review	June 2021	

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SEMESTER 4

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Course Specifications: Dissertation and Publication

Course Title	Dissertation and Publication
Course Code	CBP502A
Department	Biotechnology
Faculty	FLAHS

1. Course Summary

This Course is intended to give an insight to the students on application of principles of research methodology, preparation of research project proposal, research project management, execution of research project and effective technical communication and presentation. It also emphasizes the need and the relevance of a structured approach to identify a research topic and undertake research. This Course provides an opportunity for students to apply theories and techniques learnt during programme work. It involves in-depth work in the chosen area of study.

2. Course Size and Credits:

Number of credits	23 (20 -Dissertation + 3-Publication)
Total hours of interaction	690 in 16 weeks
Department responsible	Biotechnology
Course marks	Total Marks: 300 (200 Marks for Dissertation + 100 Marks for Paper publication) **Dissertation: 200 marks** Component-1: 50% weight Presentations and Viva voce: 50%Weight Component-2: 50% weight Project Thesis: 50%Weight **Paper Publication: 100 marks** Paper Preparation and Submission: 50 % Weight Paper Submission after peer team review: 50% Weight
Pass requirement	A student is required to score overall 40% for successful completion of the course and learning of the credits.
Attendance requirement	As per Academic Regulations

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Teaching, Learning and Assessment

3. Course Outcome (CO)

After undergoing this course students will be able to:

- **CO 1.** Critically review scholarly literature collected from various sources for the project purpose and formulate a research problem
- **CO 2.** Prepare and present a research proposal
- **CO 3.** Conduct research to achieve research objectives
- **CO 4.** Propose new ideas/methodologies or procedures for further improvement of the research undertaken
- **CO 5.** Create research document and write research papers for publications
- **CO 6.** Defend the research findings in front of scholarly audience

4. Course Contents

The Dissertation will cover the following:

i. Defining / Identification of the Research Problem
ii. Literature review/ Information search, retrieval and review

iii. Framing Research Methodology
iv. Problem solving - Evaluation, Interpretations and drawing conclusions

v. Proposing ideas or methods for further work

vi. Thesis writing
vii. Oral presentation/ Viva voce

Publishing will cover the following:

I. Journal / Conference Identification
II. Writing journal paper based on research findings
III. Submission to Journal / Conference

5. CO-PO Mapping

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

Topics	Teaching methods	Hours
Information search, retrieval and review, Project definition and project planning	Reading Journal papers, books and other relevant materials and problem formulation	100
	Presentation to Reviewers	40
Use of methodology and execution of experiments	Individual work with supervisors guidance	150
Problem solving and Evaluation	Individual work with supervisors guidance	100
Interpretations and drawing conclusions	Individual work with supervisors guidance	100
Proposing ideas or methods for furtherwork	Individual work with supervisors guidance	50
Presentation, Thesis/Report Writing and Viva Voce, Authoring Research paper/ preparing manuscript/ poster presentation/conference publication	Presentation and Viva voce	30
	Thesis/Report writing, Authoring research paper/	100
Tests/Examinations/presentations		20
Total		690

7. Method of Assessment

There are two components for assessment in this Course:

Component-1: 50% weight
Presentations (Pre, Interim and Final with Viva-Voce and submission of research paper)

Component-2: 50% weight
Project Thesis (will be moderated by a second examiner) and Paper publication presentation to peer-team
The assessment questions are set to test the learning outcomes. In each component a certain learning outcomes are assessed. The following table illustrates the focus of learning outcome in each component assessed:

Course Outcome	CO1	CO2	CO3	CO4	CO5	CO6
Component-1	X	X	X	X	X	X
Component-2	X	X	X	X	X	X

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8. Achieving Course Learning Outcomes

The various skills are directly or indirectly imparted to the students using the teaching and learning methods as follows:

S.No	Curriculum and Capabilities	How imparted during the Course
1.	Knowledge	Dissertation work
2.	Understanding	Dissertation work
3.	Critical Skills	Dissertation work
4.	Analytical Skills	Dissertation work
5.	Problem Solving Skills	Dissertation work
6.	Practical Skills	Dissertation work
7.	Group Work	Dissertation work
8.	Self-Learning	Dissertation work
9.	Written Communication Skills	Report writing
10.	Verbal Communication Skills	Presentation
11.	Presentation Skills	Presentation
12.	Behavioural Skills	Dissertation work
13.	Information Management	Dissertation work
14.	Leadership Skills	Effective management of learning, time management, achieving the learning outcomes

9. Course Resources

a. Essential Reading

1. Lecture Sessions on Dissertation, Thesis Preparation delivered by the concerned Head of Department

10. Course Organization

Course Code	CBP502A	
Course Title	Dissertation and Publication	
Project Supervisors Name	Allotted on project basis	
Project Supervisors Contact Details	**Phone:**	080-49066666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	Aug 2019	
Next Course Specifications Review Date:	June 2021	

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