M S Ramaiah University of Applied Sciences

Programme Structure and Course Details

of

M.Sc. in Biotechnology

Programme Code: 091

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

M S Ramaiah University of Applied Sciences

Programme Specifications

of

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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

Programme Specifications: M.Sc. Biotechnology

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

1. **Title of the Award:** M.Sc. Biotechnology
2. **Mode of Study:** Full Time
3. **Awarding Institution /Body:** M. S. Ramaiah University of Applied Sciences
4. **Joint Award:** Not Applicable
5. **Teaching Institution:** Faculty of Life and Allied Health Sciences, M. S. Ramaiah University of Applied Sciences, Bengaluru
6. **Date of Programme Specifications:** September 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:

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

Biotechnology has become one of the most progressive and beneficial scientific fields since last quarter century. The **scope of Biotechnology is immense in India** as we are living in the age if research where science has taken

the new form. We are at a pace of making new application and innovation every day and this could be possible with combining Technology and biology together.

There are many organizations that offer decent job opportunities in India. After doing the course in Biotechnology, one can find jobs in the field of –

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

15. Programme Mission

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

16. Graduate Attributes

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

17. Programme Outcome (POs)

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

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

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

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

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

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

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

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

18. Programme Goal

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

19. Programme Educational Objectives (PEO):

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

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

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

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

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

20. Programme Specific Outcomes (PSO)

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

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

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

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

21. Programme Structure

SEMESTER I

S. No.	Code	Course Title	Credit	Theory (h/W/S)	Tutorials (h/W/S)	Practical (h/W/S)	Max.
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	BTL501A	Practical I: Cell Biology & Molecular Genetics	4			8	100
6	BTL502A	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	BTC501A	Immunology & Immunotechniques	3	3			100
2	BTC502A	Molecular Biology and rDNA Technology	3	3			100
3	BTD506A	Bioinformatics	3	3			100
4	BTC503A	Plant and Agricultural Biotechnology	3	3			100
5	BTL503A	Practical III: Molecular Biology & Immunology	4			8	100
6	BTL504A	Practical IV: 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	BTC504A	Animal Biotechnology	3	3			100
2	BTL505A	Practical V: Plant and Animal Biotechnology	4			8	100
3	BTE5XXA	Refer Elective Table	3	3			100
4	BTE5XXA	Refer Elective Table	3	3			100
5	BTM501A	Entrepreneurship Skill Development	2	2			50
6	BTP501A	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	BTP502A	Dissertation and Publication	**23**				300
TOTAL CREDITS (4 semesters)			**90**	**TOTAL MARKS**			**2150**

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	BTE501A	Stem Cells and Regenerative Medicine
	BTE502A	Synthetic Biology
	BTE503A	Medical Biotechnology
	BTE504A	Genomics and Proteomics
	BTE505A	Biosafety Regulation, Bioethics and IPR
Stream 2	BTE506A	Downstream Processing
	BTE507A	Drug Design and Development
	BTE508A	Biotherapeutics
	BTE509A	AI and Health Care
	BTE510A	Molecular Carcinogenesis

Group Project

19BTG599A 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

19BTG600A 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

24. Assessment and Grading

24.1. Components of Grading

There shall be two components of grading:

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

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

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

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

25.1. Theory Courses

The following are the CE components:.

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

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

a) Online Test
b) Assignments/Problem Solving
c) Field Assignment
d) Open Book Test
e) Portfolio
f) Reports

g) Case Study
h) Group Task
i) Laboratory / Clinical Work Record
j) Computer Simulations
k) Creative Submission
l) Virtual Labs
m) Viva / Oral Exam
n) Lab Manual Report
o) Any other

25.3 Laboratory Course

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

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

The subcomponents can be of any of the following types:

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

25. Student Support for Learning

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

26. Quality Control Measures

1. Review of Course Notes
2. Review of Question Papers and Assignment Questions
3. Student Feedback
4. Moderation of Assessed Work

5. Opportunities for students to see their assessed work
6. Review by external examiners and external examiners reports
7. Staff Student Consultative Committee meetings
8. Student exit feedback
9. Subject Assessment Board (SAB)
10. Programme Assessment Board (PAB)

27. Curricular Map

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	Immunology & Immunotechniques	3									3		
2	Molecular Biology and rDNA Technology		3								3		
2	Bioinformatics			3								3	
2	Plant and Agricultural Biotechnology			3	2						3		
2	Practical III: Molecular Biology & Immunology		3		2				3		3		3
2	Practical IV: Bioinformatics												
2	Research Methodology			3		3			3				3
3	Animal Biotechnology	3		3						3			
3	Practical V: Plant and Animal Biotechnology			3					3		3		3
3	Entrepreneurship Skill Development				3		3					3	
3	Group Project					3	3	3	3		3	3	3
ELECTIVE 1													

Semester	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PSO1	PSO2	PSO3	PSO4
3	Stem Cells and Regenerative Medicine		3	2								3	3
3	Synthetic Biology	2		3								3	
3	Medical Biotechnology	3				3							3
3	Genomics and Proteomics		3								3		
3	Biosafety Regulation, Bioethics and IPR			3			3					3	
ELECTIVE 2													
3	Downstream Processing		3										3
3	Drug Design and Development		3	3									3
3	Biotherapeutics			3									3
3	AI in Health Care			3									3
3	Molecular Carcinogenesis	3								3			
4	Dissertation and Publication		3	3			3	3	3				3

28. Co-curricular Activities

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

29. Cultural and Literary Activities

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

30. Sports and Athletics

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

M S Ramaiah University of Applied Sciences

Course Specifications

of

M.Sc. in Biotechnology

Programme Code: 091

BATCH 2022 onwards

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

SEMESTER 1

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
Course Marks	Total Marks: 100
Pass Requirement	As per the Academic Regulations
Attendance Requirement	As per the Academic Regulations

Teaching, Learning and Assessment

3. Course Outcomes

After undergoing this course students will be able to:

CO 1. Explain the 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.

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 behaviour. 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.

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

7. Course Assessment and Reassessment

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

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. References

1. **Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P., 2014, *Molecular Biology of the Cell*, 6th Edition, W. W. Norton & Company**.
2. 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*, 6thEdition, 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*,7thEdition*.* 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/

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	

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

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.

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

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. **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

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		Aug2019	
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.

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

5. CO-PO-PSO mapping

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

6. Course Teaching and Learning Methods

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

7. Course Assessment and Reassessment

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

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

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

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

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

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. References

1. Nelson, D.L. 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

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.

5. CO-PO-PSO mapping

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

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. **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	BTL501A
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

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												

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.

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	BTL501A	
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	BTL502A
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

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.

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	BTL502A	
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

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												

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			×		×

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

Course Specifications: Immunology & Immunotechniques

Course Title	Immunology & Immunotechniques
Course Code	BTC501A
Department	Department of Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to acquaint students about the components, principles and mechanisms of the immune system, and their co-ordination to mount safe and appropriate protection against infection.

Students will be able to learn and correlate the complex mechanisms involved in immune system which governs the diversity, specificity and memory to the system. The students will be facilitated to conceptualize the underlying situations of inappropriate immunity, such as allergy, autoimmunity and immune deficiency. Students will be able to consider discrimination and tuning of immune responses to meet the challenges of different anatomical sites, such as in the skin, gut and lung. Students will be taught on the current and emerging use of immune molecules in diagnostic and clinical intervention strategies, including the therapeutic manipulation of the immune system in cancer treatment, vaccine development, and transplant tolerance.

2. Course Size and Credits:

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

Teaching, Learning and Assessment

3. Course Outcome (CO)

After undergoing this course students will be able to:

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

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

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

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

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

4. Course Contents

Unit I

Fundamental concepts of immune system

History and development of immunology; Components of innate and acquired immunity; Phagocytosis; Complement and Inflammatory responses; Haematopoesis; Organs and cells of the immune system-primary and secondary lymphoid organs; Lymphatic system; Mucosal and Cutaneous associated Lymphoid tissue (MALT & CALT).

Unit II

Immune responses

Immunity- innate and aquired; Antigens - immunogens, antigen processing and presentation-endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system.

Immunoglobulins-basic structure, classes & subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Basis of self –non-self discrimination; B cell maturation, activation and differentiation; Generation of antibody diversity; Humoral immunity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Lymphocyte circulation; Lymphocyte homing Cytokines-properties, receptors.

Unit III

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

Unit IV

Immunotechniques: Antigen-antibody interactions

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques- RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; Surface plasmon resonance, Biosensor assays for assessing ligand – receptor interaction, lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Immunohistochemistry-Apoptosis, Production and purification of antibodies, hybridomas.

Unit V

Immune System in Health and Disease

Immunity to Infection : Bacteria, viral, fungal and parasitic infections (with examples from each group); 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

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.

5. CO-PO Mapping

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		24
Demonstrations		06
1. Demonstration using Videos	05	
2. Demonstration using Physical Models /	01	
3. Demonstration on a Computer		
Numeracy		
1. Solving Numerical Problems		
Practical Work		
1. Course Laboratory		
2. Computer Laboratory		
3. Engineering Workshop / Course/Workshop / Kitchen		
4. Clinical Laboratory		
5. Hospital		
6. Model Studio		
Others		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. Goldsby, R.A., Kindt, T.J., Osborne, B.A., 2007, *Kuby's Immunology*, 6th Edition, W.H. Freeman and Company, New York.
2. Abbas, A.K., Lichtman, A.H., Pillai, S., 2007, *Cellular and Molecular Immunology*, 6th Edition, Saunders Publication, Philadelphia.
3. Delves, P., Martin, S., Burton, D., Roitt, I.M., 2006, *Roitt's Essential Immunology*, 11th Edition, Wiley-Blackwell Scientific Publication, Oxford.
4. Murphy, K., Travers, P., Walport, M., 2008, *Janeway's Immunobiology*, 7th Edition, Garland Science Publishers, New York.

b. Magazines and Journals

The Journal of Immunology: www.jimmunol.org
immunology.sciencemag.org/
http://journals.sagepub.com/doi/pdf/10.1177/0115426503018006451

10. Course Organization

Course Code	BTC501A	
Course Title	Immunology and Immunotechniques	
Course Leader/s Name	As per Time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.ls@msruas.ac.in
Course Specifications Approval Date	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Molecular Biology and rDNA Technology

Course Title	Molecular Biology and rDNA Technology
Course Code	BTC502A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

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

2. Course Size and Credits:

Number of credits	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. Enumerate the processes of DNA replication, repair and recombination to maintain the integrity of DNA and chromosomes

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

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

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

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

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

4. Course Content

Unit I

Genome Organization, Replication & Repair:

Supercoiling of DNA, Linking numbers, repetitive DNA, C-value paradox, Kinetics of hybridization, Cot curves, Rot curves, Organelle genomes.

DNA Replication: Prokaryotic and eukaryotic DNA replication mechanism, enzymes and accessory proteins involved in DNA replication.Telomeres, telomerase and end replication. Role of telomerase in aging and cancer.

DNA Damage and repair: Spontaneous and Induced mutations – Physical and Chemical mutagenesis, Molecular mechanisms of mutagenesis,Direct reversal, Excision Repair, Mismatch Repair, Post- replication Repair, SOS Repair.

Unit II

Gene Expression:

Prokaryotic transcription, eukaryotic transcription, RNA polymerases, Structure of bacterial promoters, types of sigma factor, General and specific transcription factors, Regulatory elements and mechanisms of transcription regulation, 5' Cap formation, Transcription termination, 3'end processing and polyadenylation, nuclear export of mRNA, mRNA stability

RNA splicing: Nuclear splicing, spliceosome, group I and group II introns, tRNA splicing, alternate splicing.

Genetic Code, Prokaryotic and eukaryotic translation - wobble hypothesis, variation in the codon usage, Ribosomes, aminoacylsynthetases, Mechanism of initiation, elongation and termination, Regulation of translation, co-and post-translational modifications of proteins,Protein targeting and protein localization

Unit III

Regulation of gene expression:

Induction and repression, operon theory, lac operon, trp operon, positive and negative control, catabolite repression, andattenuation.Britten-Davidson model of gene regulation, regulation of gene expression in eukaryotes,Galactose (GAL) gene regulation in yeast cells, hormone regulated gene expression in animal cells, light regulated gene expression in plants, phytohormone induced gene expression

RNA interference: RNA silencing in cytoplasm and genome level, ds RNA mediated RNA interfence (Si RNA and micro RNA), RNAi pathways, Functions and potential therapeutic use of RNAi.Molecular mechanism of antisense molecules.Applications of antisense and ribozyme technologies, CRISPR/Cas technology.

Unit IV

Recombinant DNA Technology:

History of RDT, Enzymes used in rDNA technology, Restriction endonucleases, DNA polymerase, Reverse transcriptase, Polynucleotide kinase, DNA ligase, DNAse, RNAse, Terminal deoxynucleotidyltransferase, Alkaline phosphatase. Characteristics of E. coli as host for cloning, Basic design of a cloning vector, Vectors for cloning: Plasmids, Bacteriophage λ, Filamentous phage vectors, cosmids, BAC, YAC and HAC vectors, Shuttle vectors, Expression vectors, Types of vectors designed for cloning in yeast, Vectors for cloning in Plant and animal cells, Ti plasmid, SV40.

Unit V

Gene Cloning Strategies: Construction of genomic and cDNA libraries, Isolation and purification of DNA, restriction digestion, end modification, Ligation of DNA fragments, homopolymer tailing, linkers and adaptors. Transformation and transfection techniques, preparation of competent cells of bacteria, calcium chloride precipitation method, liposome mediated method, Electroporation, Microinjection, gene gun method. Transformation and transfection efficiency. Screening methods, Genetic selection, insertional inactivation, chromogenic substrates, complementation of defined mutations, nucleic acid hybridization, PCR screening protocols, immunological screening,

Unit VI

Techniques in RDT: Protein purification; His-tag; GST-tag; MBP-tag, Labeling of DNA, and Proteins by radioactive isotopes, non-radioactive labeling, autoradiography and autofluorography,DNA sequencing methods -Sanger sequencing method, Polymerase chain reaction and its applications, Different types of PCR (Hot start PCR, Multiplex PCR, Nested PCR, Real-time PCR, In Situ PCR, Inverse PCR, Reverse Transcriptase PCR, Methylation-specific PCR). Site-directed mutagenesis and Methods of nucleic acid hybridization; Southern, Northern and Western Blotting techniques.

5. CO-PO Mapping

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		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. **Lodish, H., Baltimore, D., Berk, A., Zipursky, B.L., Mastsydaira, P., Darnell, J., 2004, *Molecular Cell Biology*, Scientific American Books Inc. NY.**
2. Karp, G., 2010,*Cell and Molecular Biology: Concepts and Experiments*, 6th Edition, John Wiley & Sons. Inc.
3. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., Losick, R., 2008, Molecular Biology of the Gene, 10th Edition, Cold Spring Harbour Lab., Press, Pearson Pub.
4. **Brown, T.A., 2006, Gene Cloning and DNA Analysis, 5th Edition, Blackwell Publishing, Oxford, U.K.**
5. Glick, B.R., Pasternak, J.J., 2003, Molecular Biotechnology - Principles and Applications of recombinant DNA, ASM Press, Washington.
6. Primrose, S.B., Twyman, R.M., 2006, Principles of Gene Manipulation and Genomics, 7th edition, Blackwell Publishing, Oxford, U.K.
7. Nelson, D. L., Cox, M. M., 2008, Lehninger principles of biochemistry. 7th Edition, W.H. Freeman

b. Magazines and Journals

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

10. Course Organization

Course Code	BTC502A	
Course Title	Molecular Biology and rDNA Technology	
Course Leader/s Name		As per time table
Course Leader Contact Details		**Phone:** 08045366666
		E-mail: hod.bt.ls@msruas.ac.in
Course Specifications Approval Date		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

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

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

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

2. Lacroix, Z. andCritchlow, 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.ac.in
Course Specifications Approval Date	Aug 2019	
Next Course Specifications Review	June 2021	

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Course Specifications: Plant and Agricultural Biotechnology

Course Title	Plant and Agricultural Biotechnology
Course Code	BTC503A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to familiarize students with the biotechnological concepts involved in plant genetic engineering as applied to agriculture. 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.** Outline plant tissue culture techniques and applications
- **CO 2.** Illustrate the tools involved in plant genetic engineering
- **CO 3.** Explain the role of genetic modification in improving crops
- **CO 4.** Classify the genetic markers applied in genetic engineering of plants
- **CO 5.** Summarize technologies involved in improvisation of post-harvest produce maintenance
- **CO 6.** Utilize biotechnological methods for maintenance of soil quality and crop health

4. Course Content

Unit I

Plant Tissue Culture: Overview of plant anatomy; Plant growth regulators, auxin, gibberlins, cytokinins, abscisic acid, acetylene; Plant tissue culture: historical perspective; totipotency; organogenesis; Somatic embryogenesis; establishment of cultures – callus culture, cell suspension culture, media preparation – nutrients and plant hormones; sterilization techniques; applications of tissue culture - micropropagation; somaclonal variation; androgenesis and its applications in genetics and plant breeding, production of haploid plants and homozygous cell lines; germplasm conservation and cryopreservation; synthetic seed production; protoplast culture and somatic hybridization - protoplast isolation; culture and usage; somatic hybridization - methods and applications; cybrids and somatic cell genetics; plant cell cultures for secondary metabolite production; Selection and maintenance of cell lines.

Unit II

Plant genetic engineering: Mechanism of DNA transfer: Agro bacterium mediated gene transfer, Ti and Ri plasmids as vectors, role of virulence genes; design of expression vectors; 35S promoter, genetic markers, reporter genes; viral vectors. Direct gene transfer methods: particle bombardment, electroporation and microinjection. Binary vectors, plasmid vectors, Transgene stability and gene silencing. Mutagenesis in plants: T-DNA/transposon mutagenesis, selection of mutants from random library, promoter/enhancer trap, gene-trap constructs.

Unit III

GM Crops: Crop improvement, productivity, performance and fortification of agricultural products–Bt cotton, Bt brinjal; Herbicide resistance, viral resistance, bacterial resistance, fungal resistance in crops; Golden rice and transgenic sweet potato; genetic manipulation of crop yield by enhancement of photosynthesis; Transgenic plants: tolerance towards stresses such as salinity, drought and high temperature; Importance of integrated pest management and terminator gene technology; Ethical issues associated with GM crops.

Unit IV

Molecular Mapping & Marker Assisted Selection: Molecular markers - hybridization and PCR based markers RFLP, RAPD, STS, SSR, AFLP, SNP markers; DNA fingerprinting-principles and applications; introduction to mapping of genes/QTLs; marker-assisted selection - strategies for Introducing genes of biotic and abiotic stress resistance in plants.

Unit V

Post-harvest technology: RNAi and antisense RNA technology for extending shelf life of fruits and flowers (ACC synthase gene and polygalactoronase); delay of softening and ripening of fleshy fruits (tomato, banana, watermelons); Post-harvest protection of cereals, millets and pulses.

Unit VI

Biofertilizers and Biopesticides: Bioinsecticides: *Bacillus thuringienis*, Baculoviruses, uses, genetic modifications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (e.g. Trichoderma, Pseudomonas fluorescens); Biofertilizers: Symbiotic systems between plants – microorganisms: nitrogen fixing symbiosis (Rhizobium, Azotobacter, Actinorhiza); mycorrhiza fungi symbiosis, Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects and problems in application; Vermicomposting technology.

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		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. Slater, A., Scott, N., Fowler, M., 2008, Plant biotechnology: the genetic manipulation of plants, 2nd Edition, Oxford university press.
2. Dodds, J.H., Roberts, L.K., 1982, *Experiments in Plant Tissue Culture*, Cambridge University Press.
3. Bhojwani, S.S., Dantu, P.K., 2013, *Plant tissue culture: An Introductory text*, Springer, India
4. Kyte, L., Kleyn, J., Scoggins, H., Bridgen, M., 2013, *Plants from Test Tubes: An Introduction to Micropropagation*, 4th Revised Edition, Timber Press.
5. Smith, R.H., 2012, *Plant tissue culture: Techniques and Experiments*, 3rd Edition, Academic
6. Chrispeels, M. J., Sadava, D.F., (eds.), 2003, *Plants, Genes and Crop Biotechnology*, 2nd Edition, Jones and Bartlett Press.
7. Hammond, J.H., Mcgarvey, P., Yusibov, V., (eds.), 2000, *Plant Biotechnology*, Springer Verlag, Heidelberg.

b. Magazines and Journals

https://www.nature.com/subjects/plant-biotechnology

https://www.omicsonline.org/scholarly/agricultural-biotechnology-journals-articles-ppts-list.php

10. Course Organization

Course Code	BTC503A	
Course Title	Plant and Agricultural Biotechnology	
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 III: Molecular Biology & Immunology

Course Title	Practical III: Molecular Biology & Immunology
Course Code	BTL503A
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 and Plasmids for molecular weight, restriction and ligation

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

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

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

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

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

2. Course Contents

1. Isolation, quantification and characterization of genomic DNA from bacteria (*E. coli)*
2. Isolation, quantification and characterization of plasmid DNA from bacteria.
3. Restriction digestion and ligation of DNA.
4. Determination of molecular weight and quantification of DNA and Protein
5. Preparation of competent cells, transformation of *E.coli* and screening of transformants
6. Cloning and expression of GFP gene in *E.coli*
7. Amplification of desirable gene by Polymerase chain reaction.
8. Random amplification of polymorphic DNA
9. Western blotting
10. Purification of His-Tagged protein on Ni-NTA columns.
11. 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

5. CO-PO-PSO mapping

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		
Demonstrations		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.
Course reassessment policies are also presented in the Academic Regulations document.

8. Achieving Course Learning Outcomes

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

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

9. Course Resources

a. References

Lab Manual

b. Essential Reading

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

b. **Magazines and Journals**

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

10. Course Organization

Course Code	BTL503A	
Course Title	Practical III: Molecular Biology & Immunology	
Course Leader/s Name	As per time table	
Course Leader Contact Details	**Phone:**	08045366666
	E-mail:	hod.bt.bl@msruas.com
Course Specifications Approval Date	Aug 2019	
Next Course Specifications Review Date:	June 2021	

Course Specifications: Practical IV: Bioinformatics

Course Title	Practical IV: Bioinformatics
Course Code	BTL504A
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

4. Course Contents

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

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		
Demonstrations		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.
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. **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
6. 10th International Conference on Practical Applications of Computational Biology & Bioinformatics, Editors: Saberi Mohamad, Mohd, Miguel P. Rocha, Florentino Fdez-Riverola, Domínguez Mayo, Francisco J., De Paz, Juan F., Springer, ISBN-10: 3319401254, ISBN-13: 978-3319401256
7. Bioinformatics: Principles and Applications, Zhumur Ghosh, Bibekanand Mallick, OUP India, ISBN-10: 0195692306, ISBN-13: 978-0195692303

b. 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
5. http://www.scfbio-iitd.res.in/

10. Course Organization

Course Code	BTL504A	
Course Title	Practical IV: Bioinformatics	
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: 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

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

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

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	--

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 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.ac.in
Course Specifications Approval Date	Aug 2019	
Next Course Specifications Review	June 2021	

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SEMESTER 3

Course Specifications: Animal Biotechnology

Course Title	Animal Biotechnology
Course Code	BTC504A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

This course aims to acquaint students with principles and use of biotechnology in the area of animal production and health care.

Students will be familiarized with a broad range of technical know-how for the genetic improvement of animal species, by understanding and implementing critical technologies of cloning and genetic engineering. They will be trained on the concepts of cellular mechanisms, manipulations of biological systems and production processes. Students will be introduced to state of the art technologies in Animal Biotechnology.

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.** Comprehend the fundamental concepts of animal cell culture, and its importance.
- **CO 2.** Illustrate stem cell culture emphasizing its application in tissue engineering
- **CO 3.** Discuss the significance of transgenesis with reference to animal models
- **CO 4.** Explain the principles and applications of animal cloning and gene therapy
- **CO 5.** Discuss on the ethical concerns on animal biotechnology principles and applications

4. Course Contents

Unit I

Animal Cell and Tissue Culture: Principles and Applications

Types of Tissue Culture Media ; Types of Cell Culture-Primary and Secondary ;Cell Transformation; Cryopreservation ; Contamination

Unit II

Stem cells and Tissue Engineering

Scope, embryonic and adult stem cells, properties, identification, stem cells culture, techniques and their applications in modern clinical sciences. Tissue engineering, biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering - skin, bone and neuronal tissues; 3-D printing in organogenesis

Unit III

Animal Transgenesis

Principles and Applications of Gene Transfer Technology; Methods of Gene Transfer; Viral Vectors: SV-40, Retroviral Vector, Adenovirus Vector, Adeno-associated Virus, Vaccinia Virus Vector; Physical Methods for Gene Delivery; Chemical Methods for Gene Delivery

Unit IV

Animal Models for Transgenesis

Production of Transgenic Mouse Model to Study Human Diseases ; Strategies to create Knock-out, Knock-in and Conditional Knock-out Mice; Transgenic Animals as Bioreactors

Unit V

Animal Cloning and Gene Therapy

Cloning of Animals and its Application; Gene Therapy-Types, Approaches and Applications of Gene Therapy

Unit VI

Ethical Issues Associated with Animal biotechnology

Use of cell cultures as alternative for animal models for research. Testing of drugs on human volunteers, use of animals for research and testing; animal and human cloning- ethical and social issues, organ transplantation and xeno transplantation

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										
CO-4		3									2	
CO-5				1								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

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

1. **Animal Biotechnology by Varun Mehta. Publisher: Campus Book International, 2011.**
2. **Ranga, M.M., 2007, *Animal Biotechnology,* 3rd Edition, Agrobios publishers, India**
3. T.A. Brown. Gene Cloning and DNA Analysis (6th Edition) by John Willey & Sons Inc, USA, 2010.
4. Lewin's Gene XI (11th Edition) by Krebs JE, Kilpatrick ST and Goldstein ES. Jones and Bartlett Publishers, Inc, 2013.
5. Sashidhara, R., 2015, *Animal Biotechnology*, MJP Publishers, TN, India.
6. Dubey R.C., 2005, *Textbook of Biotechnology*, S. Chand publishers.
7. Satyanarayana U., 2009, *Biotechnology*, Krishna Prakashan.

a. Magazines and Journals

1. https://www.nature.com › subjects
2. https://www.aboutbioscience.org › topics › animal-biotechnology
3. https://www.bio.org

10. Course Organization

Course Code	BTC504A		
Course Title	Animal Biotechnology		
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: Practical V: Plant and Animal Biotechnology

Course Title	Practical V: Plant and Animal Biotechnology
Course Code	BTL505A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of the course is to train students with the skills and techniques involved in Plant and Animal Biotechnology. Students will be acquired with a comprehensive knowledge of the skills relevant to plant and animal biotechnology. The students will be able to identify and practise the particulars relevant to acquire, elaborate and analyse information pertaining to the course. The students will be able to utilize these experiments to further their understanding of plant and animal biotechnology. Students will be familiarized with experimental methods and techniques applied in biotechnology.

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 preparations for plant and animal cell culture

CO 2. Maintain cell cultures in proper aseptic conditions

CO 3. Describe and explain processes for the characteristics of cultured cells

CO 4. Characterize function of cultured cells

CO 5. Identify species with standard molecular biology approaches

CO 6. Demonstrate significant functions of plant and animal cells under different stress conditions

4. Course Content

1. Plant tissue culture – types of media, Preparation of Culture media & Reagents - Media composition, Nutrition, Hormones
2. In vitro Culture - Washing & Sterilization, preparation of explant, surface sterilization of plant material, basic procedures for Aseptic tissue transfer, incubation of culture
3. Preparation of plant tissue culture media and Organ culture (Shoot tip, nodal and leaf culture)
4. Callus culture: Initiation and regeneration
5. Anther culture for the production of haploids
6. Isolation, culture and fusion of protoplasts
7. Vermicomposting
8. DNA finger printing methods, RAPD, RFLP
9. Biofertilizer and biopesticides
10. Isolation of plant genomic DNA from pea shoot tip/ Cauliflower by CTAB method
11. Agrobacterium culture, selection of transformants
12. Packing and sterilization of glass and plastic wares for cell culture
13. Preparation of reagents and media for animal cell culture
14. Primer culture technique: chicken embryo fibroblast/Isolation of lymphocytes and cultivation of lymphocytes
15. Cell viability and counting by trypan blue method
16. Cultivation of continuous cell lines
17. Cryopreservation of primary cell cultures and cell lines
18. Determination of GST enzyme activity in cytotoxicity induced cells
19. Estimation of lipid peroxides (Malondialdehyde) in cytotoxicity induced cells
20. MTT assay
21. PCR for identification of animal species
22. Polymerase chain reaction for detection of pathogens in blood and other animal tissues

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				2				3		
CO-5			3				2				3	
CO-6				3	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		
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.
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. Lab Manual
2. Freshney RI. 2005.Culture of Animal Cells. Wiley Liss.
3. Portner R. 2007.Animal Cell Biotechnology. Humana Press
4. Decker J &Reischl. U, Molecular Diagnosis of infectious diseases, 2nd Edition, Humana Press, 2004.

b. Magazines and Journals

1. https://www.nature.com › subjects
2. https://www.aboutbioscience.org › topics › animal-biotechnology
3. https://www.bio.org

10. Course Organization

Course Code	BTL505A	
CourseTitle	Practical V: Plant and Animal Biotechnology	
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: Entrepreneurship Skill Development

Course Title	Entrepreneurship Skill Development
Course Code	BTM501A
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

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).

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

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	--

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	BTM501A	
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	BTP501A
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

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

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

9. Course Resources

a. Essential Reading

1. Assigned reading relevant to the group project.

10. Course Organization

Course Code	BTP501A	
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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ELECTIVE 1

Course Specifications: Molecular Basis of Disease and Diagnosis

Course Title	Stem Cell and Regenerative Medicine
Course Code	BTE501A
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.

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.

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

6. Course Teaching and Learning Methods

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

7. Course Assessment and Reassessment

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

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

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

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

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

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. 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	BTE501A	
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	BTE502A
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

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												

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

10. Course Organization

Course Code	BTE502A	
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 Specifications: Medical Biotechnology

Course Title	Medical Biotechnology
Course Code	BTE503A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

This course aims to familiarize students with the biotechnological advancements in medicine, including diagnostics, therapeutics and health care strategies. The students will get acquainted with the emerging trends in the field of medical biotechnology. They will also gain insight on the future trends and prospects in biotechnological research pertaining to the field of medicine.

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. Outline the biotechnological tools in disease diagnosis

CO 2. Distinguish various molecular therapeutic approaches to diseases

CO 3. Explain the role of microbes in therapeutic applications

CO 4. Summarize the recent trends in medical biotechnology

CO 5. Illustrate strategies and techniques used in drug development

CO 6. Discuss the importance of clinical research in medicine

4. Course Content

Unit I

Disease diagnosis-probe: PCR, LCR immunological assay. Detection of genetic, Neurogenetic disorders involving Metabolic and Movement disorders. Detection of mutations in neoplastic diseases PCR, SSCP, DGGE, HET, PTT, ASO etc.

Unit II

Molecular therapeutics: Gene therapy, barriers to gene delivery, overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery. Cellular therapy; use of stem cells. Streptokinase and urokinase in thrombosis. Medical products developed by using biotechnology tools -Antibiotics, Recombinant Insulin, Erythropoietin, Vaccines, Monoclonal antibodies, Bioengineered tissues, Adult stem cell therapy.

Unit III

Application of microbes in Medical biotechnology: Antimicrobial drugs, Antibiotic production, Penicillin production, Streptomycin production, Synthesis of vitamin B12 using microbes, Production of enzymes by using microbes, Microbial biotransformation - Biotransformation of antibiotics, Biotransformation of steroids, Challenges of treating microbial infections - Mechanism of drug resistance, Drug-resistant microorganisms, Solution for drug-resistant microorganisms.

Unit IV

Trends in Medical biotechnology: Embryonic stem cells, Human genome project and its significance, RNA interference technology, Phage therapy, Recombinant DNA technology, Biochips, Liposome-based drug delivery, Nanobiotechnology **-** introduction, types and synthesis of nanomaterials, protein-based nano structures, DNA-based nano structures, Applications of nanomaterials, nano biosensors, drug and gene delivery, disease diagnostics and therapy, risk potential of nanomaterials.

Unit V

Drug development: Introduction, Drugs, drug receptors, Relationship between drug concentration and response, agonists, drug clearance, biological half-life, drugs accumulation, basic concepts of toxic effect: Conventional drug design approaches, irrational Vs rational, Lipinski's rule of five, ADME, Calculation of LD 50 and ED 50. Acute, subacute and chronic toxicity studies. Irwin profile test, Drug development process (Preclinical, clinical and toxicological studies). Novel Drug Development approaches - QSAR (quantitative structure activity relationship), High throughput screening.

Unit VI

Clinical Research: Importance of clinical research, Mile stones of regulations. FDA, US, Indian clinical research, global scenario of clinical research, Regulatory agency. Designing clinical trials- History, principles, scheme for conducting clinical trials, planning defining, objectives, variables, study populations, testable hypothesis, prediction of errors and bioselection of appropriate study design, Execution steps. Ethical Issues in clinical research- Introduction, codes, declaration and guidelines, Informed consent, special issues, Roles and responsibilities of IRBS, issues with ethics review. ICH-GCP-History of ICH, Objectives, ICH structure, Guidelines, Future of ICH.

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	
CO-5	1				3							3
CO-6			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	
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. Pongracz, J., Keen, M., 2008, *Medical Biotechnology*, 1st Edition, Elsevier publications.
2. Jogdand, S.N., 2008, *Medical Biotechnology*, 2nd Edition, Himalaya publishers.
3. Katzung, B.G., 2004, *Basic and Clinical Pharmacology*, 9th Edition, Mc Graw Hill Publications.

a. Magazines and Journals

https://www.nature.com/nbt/
http://www.imedpub.com/scholarly/medical-biotechnology-journals-articles-ppts-list.php

10. Course Organization

Course Code	BTE503A	
Course Title	Medical Biotechnology	
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: Genomics and Proteomics

Course Title	Genomics and Proteomics
Course Code	BTE504A
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

4. Course Contents

Course Content

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 V

Protein isolation and identification

Strategies for protein identification; Protein sequencing; Protein modifications and proteomics. proteomics technologies: 2D-PAGE, isoelectric focusing, Image analysis of 2D gels, mass spectrometry, MALDI-TOF, yeast 2-hybrid system, proteome databases.

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		3								3		
CO-4		3								3		
CO-5	2		2								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	
	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

9. Course Resources

a. Essential Reading

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

b. Magazines and Journals

1. https://www.nature.com/ncb/
2. http://mcb.asm.org/
3. https://bmccellbiol.biomedcentral.com/
4. https://www.cellsalive.com/
5. http://www.biology.arizona.edu/cell_bio/cell_bio.html
6. https://www.ncbs.res.in/course/jan-term-2018/cell-biology

10. Course Organization

Course Code	BTE504A	
Course Title	Genomics and Proteomics	
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: Biosafety Regulation, Bioethics and IPR

Course Title	Biosafety Regulation, Bioethics and IPR
Course Code	BTE505A
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.

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.

5. CO-PO Mapping

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

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. 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	BTE505A	
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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ELECTIVE 2

Course Specifications: Downstream Processing

Course Title	Downstream Processing
Course Code	BTE506A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

The aim of this course is to instil in students a critical awareness and in-depth understanding of the principles, practice and key concepts relevant to industrial biotechnology. The course will enable the student to select the correct sequence of unit operations for the purification of bioproducts and to understand which properties will be decisive for the choice of purification strategy. Likewise, the student will obtain an insight into the methods of analysis that are applied in the purification process and how product and purity requirements will affect the process. Thus, the student will be enable to combine and upscale a purification process.

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 downstream processing of biotechnological and biopharmaceuticals.

CO 2. Discuss a suitable scheme of bioproduct separations based upon the molecular characteristics of the product and other process criteria

CO 3. Demonstrate the suitable downstream approaches comprising of new concepts and emerging technologies that are likely to benefit product recovery for small and large scale in the future.

CO 4. Explain the principles of various types of high resolution techniques for valuable product purification.

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

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

4. Course Content

Unit I

Overview of Downstream Operations:

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

Unit II

Methods for extraction of proteins:

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

Unit III

Filtration (batch and continuous):

Membrane based separation processes, Microfiltration; Reverse osmosis, Nanofiltration, Ultrafiltration and Affinity ultrafiltration, Membrane modules. Liquid-liquid extraction, Supercritical fluid extraction, precipitation, distillation, drying of product.

Unit IV

Separation techniques:

Chromatography: Gel filtration chromatography, Ionexchange chromatography (IEC), Chromatofocusing. Affinity chromatography: Immunoaffinity purification, Immunoaffinity matrices, ligand affinity, hydrophobic interaction chromatography (HIC), HPLC, RP – HPLC.

Electrophoresis – Theory and factors affecting. Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2 D- Electrophoresis; isoeletric focusing; Pulsed field gel electrophoresis.

Unit V

Crystallization and Drying:

Theory – nucleation, crystal growth; mixed product removal crystallizer with mixed suspension. Crystallization processes, Drying: drying curve, tray dryer, flash dryer, freeze drying – principle and process, freezing, primary and secondary drying, application. Downstream processing for the following products: Antibiotics, organic acids, vitamins, insulin.

Unit VI

Analysis of the final product:

Protein-based contaminants, Removal of altered forms of the protein of interest from the product stream, Product potency, Determination of protein concentration, Amino acid analysis, Peptide mapping, N-terminal sequencing, Analysis of secondary and tertiary structure. Detection of protein-based product impurities: rapid methods for detection of specific organisms and toxins (immunological/molecular methods).

5. CO-PO Mapping

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

6. Course Teaching and Learning Methods

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

b. Magazines and Journals

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

10. Course Organization

Course Code	BTE506A	
Course Title	Downstream 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: Drug Design and Development

Course Title	Drug Design and Development
Course Code	BTE507A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

This course provides concepts of the basics of microbiology, the pharmacology and principles of antimicrobial use and the use of synthetic chemistry to alter the properties of drugs. The course follows the evolution of drugs through time covering the principles of drug discovery in the areas of pharmacognosy and natural products; synthetic medicinal chemistry and the development of medicinal substances; the development of modern and innovative therapeutic substances including biopharmaceuticals; and future trends in drug discovery. The course will focus on chemistry of molecules/compounds and in particular how the chemical structure of a drug relates to its biological activity. Structure-activity relationships of drug families will include the discovery, development and design of antibiotics.

The drug development pipeline from lead discovery to clinical trials will be introduced. Introductory concepts around regulatory affairs, patenting, registration and marketing will be covered in the context of new drug discovery.

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 key principles of pharmacognosy and natural products and their role in shaping the pharmaceutical industry, including Traditional, Complementary and Alternative Medicines
- **CO 2.** Explain the role of synthetic chemistry in the development of pharmaceutical agents; and the modification of chemical structures to develop new drug molecules
- **CO 3.** Explain the chemical structure of a pharmaceutical agent and determine the chemical group/s responsible for a given biological effect
- **CO 4.** Delineate the modern and innovative discovery of biopharmaceuticals as it relates to today's healthcare and future trends in modern drug discovery globally
- **CO 5.** Develop an understanding of drug targets as a recognition site for pharmaceutical agents; how the chemical structure of a substance influences interaction with a drug target; and the identification of new drug targets for future drug discovery
- **CO 6.** Develop key concepts of the drug discovery process including regulatory affairs, patenting, registration and marketing in a global context

4. Course Content

Unit I

Introduction to Drug Discovery and Development

An Overview of Modern Methods and Principles, Target Selection: The First Step Forward, Hit Identification: Finding a Starting Point, Identify a Clinical Candidate: Juggling the Properties

Unit II

Classical Targets in Drug Discovery

Protein Structure, Enzymes, Inhibition of Enzymes, G-Protein-Coupled Receptors (GPCRs) Ion Channels, Membrane Transport Proteins (Transporters), Emerging Targets

Unit III

In vitro Screening Systems

The Language of Screening: Basic Terms, Streptavidin and Biotin, Biochemical versus Cellular Assays, Assay Systems and Methods of Detection, Radioligand Assay Systems, Enzyme-Linked Immunosorbent Assay (ELISA), Fluorescence-Based Assay Systems, Reporter Gene Assays, Kinetic Fluorescent Measurement Systems

Unit IV

Medicinal Chemistry

Structure–Activity Relationships and Structure–Property Relationships, The Role of Chirality, Push and Pull in structure–activity relationships, Quantitative Structure–Activity Relationships, The Pharmacophore, Developing an SAR Data Set, Structure–Activity Relationship, Selectivity And Physicochemical Properties

Unit V

In vitro ADME and In vivo Pharmacokinetics

Absorption, Distribution, Elimination Pathways, In vitro ADME Screening Methods, In Vivo Pharmacokinetics

Unit VI

Basics of Clinical Trials and Patenting

Before the Clinic, Drug Supply, Delivery Methods, Formulation, Investigational New Drug Application, Different Phases of Clinical Trials;Regulatory affairs, patenting, registration

5. CO-PO Mapping

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

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. **Basic Principles of Drug Discovery and Development, Academic Press, Elsevier, Blass Dr., Benjamin, ISBN-10: 012411508X, ISBN-13: 978-0124115088**
2. **A Practical Guide to Drug Development in Academia: The SPARK Approach, Springer, Editors: Daria Mochly-Rosen and Kevin Grimes, ISBN-10: 3319022008, ISBN-13: 978-3319022000**
3. Biopharmaceutical Drug Design and Development, Springer, Wu-pong, ISBN-10: 8184897022, ISBN-13: 978-8184897029
4. Drug Safety and Pharmacoepidemiology, Foster Academics, Editor: Avianna Stokes, ISBN-10: 1632425785, ISBN-13: 978-1632425782

b. MagazinesandJournals

1. https://www.nature.com/nrd/
2. https://www.elsevier.com/books/drug-discovery-and-development/hill/978-0-7020-4299-7

10. Course Organization

Course Code	BTE507A	
Course Title	Drug Design and 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: Biotherapeutics (Elective)

Course Title	Biotherapeutics (Elective)
Course Code	BTE508A
Department	Biotechnology
Faculty	Life and Allied Health Sciences

1. Course Summary

This course aims to educate students on the uses of molecular advances in the discovery of protein and other biomolecular drug candidates and their development into biotherapeutics.

The course will provide students with a comprehensive understanding of the development of biotherapeutics, beginning with pre-clinical modelling and target identification together with antibody engineering, biochemical and biophysical characterization and development issues for bioprocessing. The course focuses on the pre-clinical development of new biologic-based approaches to treat immune-based disorders. Diseases that will be highlighted include (but are not limited to) cardiovascular disease, metabolic disorders and inflammatory diseases. Students will obtain knowledge on and experience in the development of state-of-the-art biologic-based therapies, by focusing on novel biologics such as vaccines, nucleic acids, cellular therapy and therapeutic proteins and peptides.

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. Conceptualize biopharmaceuticals and pharmaceutical biotechnology, Biopharmaceuticals: current status and future prospects, generic and branded biopharmaceuticals

CO 2. Explain formulation of biotherapeutics, formulation recipients: solubility enhancers, anti aggregating agents, buffers, cryoprotectants, antioxidants and preservatives

CO 3. Conceive the responsive or smart drug delivery system

CO 4. Describe Novel drug delivery systems for biopharmaceuticals (rate controlled and site specific), Nanotechnology based miniaturization of biopharmaceuticals and therapeutics, peptides

CO 5. Justify discovery of protein or peptide based therapeutics: In-silico, pharmaco-informatics. Pre-clinical toxicity assessment, Clinical trial phases and design, clinical data management

4. Course Contents

Unit I: Introduction to Biotherapeutics

Introduction to Biopharmaceuticals and pharmaceutical biotechnology, Biopharmaceuticals: current status and future prospects, generic and branded biopharmaceuticals, overview of life history for development of biopharmaceuticals. Discovery of protein or peptide based therapeutics: In-silico, pharmaco-informatics. Pre-clinical toxicity assessment, Clinical trial phases and design, clinical data management, concept of Pharmacovigilance

Unit II: Immunotherapeutic & Immunodiagnostics

Overview of antibody-based therapeutics, biologics for autoimmunity and inflammation, vaccine-adjuvant technology, genetically engineered vaccines, cancer vaccines, present and future biologics. Principles of immunodiagnostic assay based on solid phase system: Malarial & HIV diagnostic kits as case study. Fluorescent ligands and radio-isotope tracers, principles and instrumentation for molecular diagnostics (Time resolved fluorescence immunoassay, light scattering principles), PCR and nucleic acid based diagnostics, imaging techniques.

Novel drug delivery systems for biopharmaceuticals (rate controlled and site specific), Nanotechnology based miniaturization of biopharmaceuticals and therapeutics, peptides

Unit III: Drug Delivery Systems

Intracellular targeting, delivery of nucleic acids and therapeutic peptides, concept of responsive or smart drug delivery system

5. CO-PO Mapping

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

6. Course Teaching and Learning Methods

Teaching and Learning Methods	Duration in hours	Total Duration in Hours
Face to Face Lectures		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. Gary Walsh. *Biopharmaceuticals: Biochemistry and Biotechnology*, 2nd Edition, John Wiley & Sons, Inc. 2003.
2. Daan J A Crommelin. *Pharmaceutical Biotechnology*, 2nd Edition, Taylor & Francis Group, 2010.
3. Rodney J. Y. Ho. *Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs*, 2nd Edition, John Wiley & Sons, Inc, 2013.
4. Gary Walsh. *Pharmaceutical Biotechnology: Concepts and Applications*. John Wiley & Sons, Inc, 2007.
5. OliverKayser, HeribertWarzecha. *Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications*, 2nd Edition. John Wiley & Sons, Inc, 2012.

b. Magazines and Journals

1. https://www.biotherapeuticsinc.com/
2. sorrentotherapeutics.com
3. https://www.g1therapeutics.com

10. Course Organization

Course Code	BTE508A	
Course Title	Biothearapeutics	
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	BTE509A
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

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.

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

10. Course Organization

Course Code	BTE509A	
Course Title	Animal Biotechnology	
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	BTE510A
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

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.

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

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. Weinberg, R. A., 2013,*The Biology of Cancer*, 2nd edition, Garland Science.
2. Alberts, B., et al., 2014,*Molecular Biology of the Cell*, 6thedition, 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	BTE510A	
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

Course Specifications: Dissertation and Publication

Course Title	Dissertation and Publication
Course Code	BTP502A
Programme	M.Sc. Biotechnology
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

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												

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

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	BTP502A	
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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