AC/II(23-24).2.RPS3

(Credit Based Semester and Grading System for academic year 2024–2025)

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

Syllabus for Program: M.Sc. Biotechnology

Program: MSc II

Program Code: (RPSBTK)

(As per the guidelines of NEP2020-Academic year 2024-25)

GRADUATE ATTRIBUTES

S. P. Mandali's Ramnarain Ruia Autonomous College has adopted the Outcome Based Education model to make its science graduates globally competent and capable of advancing in their careers. The Bachelors Program in Science also encourages students to reflect on the broader purpose of their education.

GA	GA Description **A student completing Master's Degree in Science program will be able to:**
GA 1	Demonstrate in depth understanding in the relevant science discipline. Recall, explain, extrapolate and organize conceptual scientific knowledge for execution and application and also to evaluate its relevance.
GA 2	Critically evaluate, analyze and comprehend a scientific problem. Think creatively, experiment and generate a solution independently, check and validate it and modify if necessary.
GA 3	Access, evaluate, understand and compare digital information from various sources and apply it for scientific knowledge acquisition as well as scientific data analysis and presentation.
GA 4	Articulate scientific ideas, put forth a hypothesis ,design and execute testing tools and draw relevant inferences. Communicate the research work in appropriate scientific language.
GA 5	Demonstrate initiative, competence and tenacity at the workplace. Successfully plan and execute tasks independently as well as with team members. Effectively communicate and present complex information accurately and appropriately to different groups.
GA 6	Use an objective, unbiased and non-manipulative approach in collection and interpretation of scientific data and avoid plagiarism and violation of Intellectual Property Rights. Appreciate and be sensitive to environmental and sustainability issues and understand its scientific significance and global relevance.
GA 7	Translate academic research into innovation and creatively design scientific solutions to problems. Exemplify project plans, use management skills and lead a team for planning and execution of a task.
GA 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM OUTCOMES

PO	Description **A student completing Master's Degree in Science program in the subject of Biotechnology will be able to:**
PO 1	Perceive the fundamental and advanced concepts in depth in the areas of biochemistry, molecular biology, immunology, medical microbiology and applying the conceptual knowledge to address the real time problems and exploring plausible solutions.
PO 2	Annotate the vast amount of biological data by retrieving, processing and analyzing through various tools of bioinformatics and biostatistics.
PO 3	Criticize and assess the phases encountered from laboratory to premarketing stages in clinical research along with reviewing case studies.
PO 4	Identify local and global environmental issues and establish scientific strategies to devise economical solutions converging towards sustainable development
PO 5	Comprehend the process of patent documentation .Employ the relevance of legal and ethical implications in intellectual property rights, GMO ,developmental biology and other fields of biotechnology.
PO 6	Outline, execute ,Analyze experimental procedures and research proposal thus ameliorate their scientific writing temperament and soft skills consequently refining their abilities to troubleshoot any research problems.
PO 7	Deduce the underlying principle of nanotechnological and biotechnological processes and develop the skills to offer contemporary solutions.

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	Type of Course	COURSE TITLE	CREDITS
M.Sc. II	**III**	RPSBTKO601	Discipline Specific Core I	Medical Microbiology	3
		RPSBTKPO601	Practical DSC I	Practicals based on RPSBTKO601	1
		RPSBTKO602	Discipline Specific Core II	Environmental Biotechnology and GMO	3
		RPSBTKPO602	Practical DSC II	Practicals based on RPSBTKO602	1
		RPSBTKO603	Discipline Specific Core III	Tissue Culture	3
		RPSBTKPO603	Practical DSC III	Practical based on RPSBTKO603	1
		Students should select any one of the following course			
		RPSEBTKO604	Discipline Specific Elective	Clinical Data Management	3
		RPSEMICO604	Discipline Specific Elective	Clinical Microbiology and Epidemiology	3
		RPSEBCHO604	Discipline Specific Elective	Plant Biochemistry	3
		RPSEBTKPO604/ RPSEMICPO604/ RPSEBCHPO604	Practical on DSE	Practicals based on RPSEBTKO604/ RPSEMICO604/ RPSEBCHO604	1
		RPSRPBTKO605	RP	Research Project	6

.	**IV**	RPSBTKE611	Discipline Specific Core I	Bioprocess Technology	3
		RPSBTKPE611	Practical DSC I	Practicals based on RPSBTKE611	1
		RPSBTKE612	Discipline Specific Core II	Biostatistics	3
		RPSBTKPE612	Practical DSC II	Practicals based on RPSBTKE612	1
		Students should select any one of the following course			
		RPSEBTKE613	Discipline Specific Elective	Bioinformatics	3
				Agricultural Biotechnology	3
		RPSEBTKPE613	Practical on DSE	Practicals based on RPSEBTKE613	1
		RPSINTBTKE614	OJT	Internship	10

Semester III

DISCIPLINE SPECIFIC CORE

Course Code (DSC-I): RPSBTKO601
Course Title: Medical Microbiology

COURSE OUTCOMES: On course completion, the student should be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Identify chromosomal disorders through karyotyping and chromosome analysis techniques.
CO 2	Develop an understanding of various disease related issues of medical microbiology
CO 3	Describe stages in biofilm formation and the significance of quorum sensing.
CO 4	Assess the impact of biofilms on medical devices and treatment outcomes.
CO 5	Analyse and interpret the molecular techniques involved in medical microbiology
CO 6	Formulate and develop molecular diagnostic techniques for various infections

Course Code	Unit	Course/ Unit Title	Credit/Hours 3/45
RPSBTKO601	**I**	**Cytogenetics** Chromosomal disorders, Karyotyping, G-banding, Chromosome analysis, variations, Chromosome painting, Molecular Cytogenetics, FISH,CGH	**15**

	II	**Medical microbiology and Biofilms** Infections of Respiratory tract- Pneumonia, GI tract infection- , Shigella, Vibrio,Salmonella, Nosocomial- S.pyogenes, Klebsiella. Viral infections- HIV, Hepatitis (ELISA), Fungal- Candidiasis. Parasitic: Malaria, Leishmania and Dengue, Ebola, SARS, Nipah, Corona Virus Biofilms in medicine: Outline specifications: Stages in biofilm formation, Quorum sensing, biofilm in medical devices- implants & treatments, biofilms in pathogenesis, biofilm forming organisms- *E.coli, Pseudomonas spp, S.aureus*	15
	III	**Molecular diagnostics** Introduction to molecular diagnostics, pros and cons, importance, molecular techniques, amplification based techniques (probe, signal and target amplification). Molecular diagnostics for Pneumonia, Tuberculosis, Pseudomonas, HIV, Hepatitis. Candidiasis	**15**

References:

1. Industrial Microbiology an Introduction Michael, Neil, John & ;Gary
2. DiagnosticMicrobiology 5thedition Elmer Koneman,StephenAllen Lippincott
3. Molecular Microbiology: Diagnostic Persing, Tenover, ASM press Washington
4. Principles & Practice (2004) Versalone DC
5. Pharmaceuticalmicrobiology7thed.,(2004)HugoRussell'sEditedbySte phenP.Denyer, Hodges and Sean P.Gorman

Course Code: RPSBTKPO601
Course Title: Practicals based on RPSBTKO601

DETAILED SYLLABUS

Course Code	Course/ Unit Title	Credits
RPSBTKPO601	1. Medical diagnostic – Identification of organisms from specimens a) *Pseudomonas aeruginosa* b) *Klebsiella pneumonia* c) *Streptococcus pneumoniae* d) *Streptococcus pyogenes* 2. Staining of Biofilms 3. ELISA for Hepatitis 4. PCR based diagnosis for Malaria 5. Identification of Sars-CoV 2 through antigen-antibody reaction test. 6. Karyotyping with giemsa staining. 7. Diagnosis of Kala Azar- Kit based 8. Diagnosis of Dengue - Kit based	**1**

Course Code (DSC-II): RPSBTKO602
Course Title: ENVIRONMENTAL BIOTECHNOLOGY & GMO

COURSE OUTCOMES: On course completion, the student should be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Identify various sources of environmental waste and associated risks.
CO 2	Analyze major, trace, and rare earth elements' roles and impacts.
CO 3	Understand the interplay of biogeochemical factors in maintaining environmental equilibrium.
CO 4	Assess the use of physical, chemical, and biological unit operations for efficient wastewater treatment.
CO 5	Explain carbon credit, sequestration, and footprinting principles in environmental management.
CO 6	Evaluate the development and implications of genetically modified organisms in various applications.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/Hours 3/45
RPSBTKO602	**I**	**Introduction to Environmental Biotechnology** Introduction, Sources and Hazards of Wastes; Testing of environmental carcinogenicity; Major, trace, and Rare Earth Elements (REE); Negative implications caused due to imbalance of some trace elements; Biogeochemical Factors involved in environmental health	**15**

	II	**Environmental Monitoring** Environmental problems; Monitoring of environmental pollution and its management using microbes and biosensors. Carbon Credit, Carbon Sequestration, Carbon Footprinting. Biotechnological approach in waste-water treatment: Physical unit operations (screening, racks, mixing, flocculation, sedimentation, flotation, vacuum filtration and incineration), Chemical unit operations (chemical precipitation, aeration and gas transfer process, adsorption and disinfection), Biological unit operations (aerobic and anaerobic cycles, aerobic & anaerobic waste treatment)	
	III	**Research on Genetically Modified Organisms** Development of Stress-tolerant plants; Applications of rDNA technology in health and disease, recombinant proteins, Factor VIII, erythropoietin, vaccines, gene therapy, genetically modified crops	**15**

References

1. Manahan, S.E. 1997. Environmental Science and Technology. Lewis, New York.

2. Metcalf and Eddy (Eds). 2003, Wastewater Engineering: Treatment and Reuse, Tata McGraw-Hill, New Delhi.

3. Evans, G.M. and Furlong J.C. 2003. Environmental Biotechnology: Theory and Application. John Wiley and Sons

4. Environmental Biotechnology (2nd Edition, 2005) Alan Scragg Oxford UniversityPress

5. Environmental Biotechnology- Basic Concepts and Applications (2006)InduShekhar Thakur I. K. International Pvt.Ltd.

6. Environmental Biotechnology M. H. Fulekar Oxford & IBHPublishing

Course Code: RPSBTKPO602
Course Title: Practicals based on RPSBTKO602

Course Code	Course/ Unit Title	Credits
RPSBTKPO602	1. Bioremediation- isolation of heavy metal tolerant organisms & study their growth characteristics and pattern. 2. GMO validation – kit based/demo 3. Isolation of pesticides degrading microorganisms and performing cultural studies for the same. 4. Pollution indicators- Detection and Identification. 5. Removal of organic amines from wastewater using peroxidases. 6. RAPD analysis of different plant varieties. 7. Physico-chemical characterization of industrial effluents based on the following parameters: a) BOD b) COD c) Temperature d) Colour e) Hydrogen Ion Concentration f) Odour g) Total Suspended Solids h) Total Dissolved Solids	**1**

Course Code(DSC- III): RPSBTKO603
Course Title: TISSUE CULTURE

COURSE OUTCOMES: On course completion, the student should be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Discuss the basic requirements of a tissue culture laboratory
CO 2	Design and carry out minor experiments in PTC, ATC following the required norms and protocols
CO 3	Make use of the safety and precaution controls in these labs
CO 4	Formulate and conduct simple experiments in ATC, PTC labs
CO 5	Understand the fundamental principles of stem cell biology and regenerative medicine
CO 6	Formulate and illustrate the essential methodologies in ATC andPTC

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Hours 3/45
RPSBTKO603	**I**	**Plant tissue culture** Introduction to primary and secondary metabolism, important pathways leading to biosynthesis of secondary metabolites in plants, Metabolic products produced from in vitro culturing of plant cells ,selection of plant cells/ tissues for production of a specific products, culture system in secondary plant product .Biotransformation of precursors by cell culturing, metabolic	**15**

		engineering for production of secondary metabolites, Hairy root culture, elicitation Cryopreservation -Principle and types. Germplasm conservation. Plant-based meat and Cell-based Meat	
	II	**Animal tissue culture-I** Biology of cultured cells, Culture vessels, Culture Media, Microbial contamination, cross contamination. Cryopreservation, Primary culture: Types, isolation of tissues, culturing of different cells. Cell lines: Development, Subculture and propagation, Immortalization of cell line, cell line designation, selection of cell lines, routine maintenance, Cytotoxicity, Transformation, Culture of tumor cells	**15**
	III	**Stem Cells and regenerative medicines** Scaffolds for Tissue Engineering: Classification of scaffold materials, examples, criteria for ideal scaffold, control of architecture, Scaffold design and fabrication techniques. Introduction to Stem Cell and Regenerative Therapy, Tissue regeneration driven by growth hormones, Basic Properties of Stem Cells, Classification and Types. Stem Cells as source in regeneration of tissues. Mechanochemical Behavior of Stem Cell Behavior. 3D printing of tissue, cells and organs. Bioartificial heart, Bioartificial kidney. Bioethocal Issues.	**15**

References:

1. Plant Cells in liquid culture (1991) Author : Payne Shuler, HanserPublishers
2. BiochemistryandmolecularbiologyofplantsbyBuchanan,Gruissem,Jones;1st Edi ; I.K Internationalpublishers
3. Textbook of Plant Pharmaceuticals by Chandrakant Kokate; 1 st edition;Elsevier
4. Plant Biotechnology by K.G. Ramawat , 1 st Ed. S.Chand andCompany
5. Culture of Animal Cells: A Manual of Basic Techniques by IanFreshney

Course Code: RPSBTKPO603
Course Title: Practicals based on RPSBTKO603

Course Code	Course/ Unit Title	Credits
RPSBTKPO603	1. Explant preparation and inoculation 2. Callus induction and characterisation 3. Synthetic seed 4. Establishment of suspension cultures. (Periodic subculture of callus can be done on solid media/ semisolid media / liquid media) 5. Candling and Dissection of chick embryo 6. Monolayer formation (fibroblast) and passaging. 7. To assay the radical scavenging activity of tissue hydrolysate- DPPH method 8. Techniques for cell preservation 9. Toxicology MTT Assay 10. Sterility Checking of ATC Culture Medium and Laboratory	**1**

DISCIPLINE SPECIFIC ELECTIVES (DSE)

(Biotechnology, Microbiology, Biochemistry)

Course Code : RPSEBTKO604

Course Title: Clinical Data Management (Offered by Department of Biotechnology)

COURSE OUTCOMES: On course completion, the student should be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Discuss the ethical issues in human subjects research
CO 2	Imagine and understand the different phases of clinical trials
CO 3	Analyze the roles and responsibilities of the investigator and the institution
CO 4	Examine various regulatory issues related to clinical studies
CO 5	Recall the companies and organizations associated in this field
CO 6	Develop interest on medical writing and design a clinical study report

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSEBTKO604	I	**Drug discovery and Preclinical toxicology** Pre Clinical toxicology: General Principals, Systemic toxicology, (Single dose and repeat doset oxicity studies), Carcinogenicity, Mutagenicity,Tera togenicity, Reproductive toxicity, Local toxicity, Genotoxicity, animal toxicity requirements	**15**

	II	**Introduction to Clinical trials** Introduction to clinical trials, Historical guidelines in clinical research (Nuremberg code, Declaration of Helsinki and Belmonte report), ICH-GCP guidelines (E6-R1), Phases of clinical trials.	
	III	**Clinical Study Design** Clinical study methodology and regulations: Principles, types (single blinding, double blinding, open access, randomized trials and their examples), Design of protocol, CRF, e-CRF, IB, ICF and preparation of trial reports, Regulations involved (ICMR guidelines) and ethics.	**15**

References:

1. EC R1 guidelines.
2. ICMR ethical guidelines.
3. D & C Rules – Schedule Y.
4. Law Of Intellectual Property Rights Shiv Sahai Singh Deep & Deep Publications (p) Ltd.
5. WTO And Intellectual Property Rights By Talwar Sabanna (2007) Serials Publications.

6 IPR: Unleashing the Knowledge Economy(2003) Prabuddha Ganguli Tata Mcgraw Hill publication.

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Course Code: RPSEBTKPO604
Course Title: Practicals based on RPSEBTKO604

DETAILED SYLLABUS

Course Code	Course/ Unit Title	Credits
RPSEBTKPO604	1. Action query based on various scenarios: vendor data query, eCRF data query, date Mis-Match query in ERCF on AE form and study conclusion form. 2. Design and Raise a query as per given scenario: data missing query, out of sequence data on AE/ CONMED (Adverse Event/ concomitant medication log) form missing labs query on visits already performed etc. 3. Designing eCRF form based on given protocol (only particular sections of protocol will be given) 4. Designing of eCRF completion guidelines based on given protocol. 5. Perform Screening process of various drug molecules from plant, algal and marine sources before performing preclinical toxicity study. 6. Perform preclinical toxicity study on cell lines and microorganisms using drugs screened in exp no.5 7. Various ways to resolve vendor issues.	**1**

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Course Code: RPSEMICO604
Course Title: Clinical Microbiology and Epidemiology (Offered by Department of Microbiology)

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Apply appropriate methodologies to tackle the threat of antibiotic resistance
CO 2	Perform and analyse all kinds of clinical microbiological tests associated with antibiotic susceptibility testing
CO 3	Demonstrate a basic understanding of epidemiological strategies, study designs and evaluate the data for its statistical relevance.
CO 4	Discuss and understand the strategies to detect & monitor biological agents used for bioterrorism & exemplify the significance of biosecurity.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
RPSEMICO604		**CLINICAL MICROBIOLOGY AND EPIDEMIOLOGY**	**03/45**
I		**Clinical Microbiology- General principles**	**15**
	1.1	**General Principles of Clinical Microbiology**	**5**
		a) Laboratory Safety and Preventing the Spread of Disease b) Design of the Clinical Microbiology Laboratory c) Quality in the Clinical Microbiology Laboratory d) Legal and Ethical Issues	
	1.2	**Clinical microbiology- Processes and Recent trends**	**10**

		a) Phases of the diagnostic cycle b) Overview of Specimen Collection and Processing c) Specimen management and workup- Overview of classical and modern bacterial Identification Methods and Strategies d) Decontamination, Disinfection, and Sterilization during surgeries e) Automation and HTS in diagnosis f) Point of care diagnostics	
II		**Clinical Microbiology- Antibiotic resistance and Antibiotic susceptibility testing**	**15**
	2.1	a) Antibiotic resistance in microbes	**07**
		a) Antimicrobial resistance- General principles b) Mechanisms of antibiotic resistance in bacteria and fungi - overview c) Transfer of antibiotic resistance d) Maintaining antibiotic resistance through Selective Pressure e) Methods for detection of resistance f) Antimicrobial stewardship, surveillance of antimicrobial consumption, and its consequences	
	2.2	b) Antibiotic susceptibility testing	**08**
		a) General considerations- selection, Indications, b) Pharmacokinetic and pharmacodynamics Principles, Clinical relevance of antibiotic sensitivity tests, Serum killing curves c) Susceptibility Test Methods: Dilution and Disk Diffusion Methods- standardization, QC, Procedures and interpretation d) Antimicrobial Susceptibility Testing Systems e) Special methods- Bactericidal tests, Testing antibiotic combinations	
III		**Epidemiology**	**15**
	3.1	**Introduction to Epidemiology**	**07**
		a) Historical aspects-definition b) Descriptive Epidemiology-aims and uses c) Recent Applications of Epidemiology d) Introduction e) Observational Versus Experimental approaches in Epidemiology f) Overview of study designs used in Epidemiology	

		g) Ecologic Studies h) Cross-Sectional studies i) Case-Control studies	
	3.2	**Public health surveillance**	**04**
		a) Purpose and characteristics b) Identifying health problems for surveillance c) Collecting data for surveillance d) Analysing and interpreting data e) Disseminating data and interpretation f) Evaluating and improving surveillance	
	3.3	**Healthcare-associated infections**	**04**
		a) Surveillance for HAIs b) Major types of HAIs c) The need for integrated infection control programs	

REFERENCES:

a. Patricia M. Tille, Bailey and Scott's Diagnostic Microbiology, 13th ed, 2014, Mosby Inc

b. Dawey et al., Antimicrobial Chemotherapy, 7th ed. 2014, Oxford Univ Press

c. Ed by Jorgensen et al., Manual of Clinical Microbiology, 11th ed., 2015, ASM Press Volume 1

and 2

d. Lieseke, Zeibig, Essentials of Medical Laboratory Practice, 2012, F.A. davis Co.

e. Brenda Wilson, Abigail Salyers et al, "Bacterial Pathogenesis- A molecular approach", 3rd ed,

ASM press, 2011

f. J. Vandepitte, J. Verhaegen et al, "Basic laboratory procedures in clinical bacteriology", 2nd

ed, WHO, Geneva, 2003

g. Gary Procop, Elmer Koneman et al, "Koneman's Color Atlas and Textbook of Diagnostic

Microbiology", 7th Edition, Wolters Kluwer, 2017

h. Principles of epidemiology in public health practices 3rd Ed.

(www.cdc.gov/training/products/ss1000)

i. Ann Aschengrau, George R Seage, Essentials of Epidemiology in Public Health, 3rd Ed.

i. Robert H. Friis and Thomas A. Sellers, Epidemiology for Public Health Practice, Jones & Bartlett Learning, LLC, 5th ed.

j. Kenrad E. Nelson, Infectious Disease Epidemiology – Theory and Practice, 3rd ed.

Course Code: RPSEMICPO604

Practicals based on: RPSEMICO604

a) QC of laboratory media b) QC of laboratory reagents c) Antimicrobial susceptibility testing- disc method according to CLSI guidelines d) QA of Antibiotic Susceptibility Test- disc method e) Antibiotic Susceptibility Test – microdilution methods according to CLSI guidelines f) Checkerboard assay g) E-test h) Octa-disc method for AST	1 credit

Course Code: RPSEBCHO604
Course Title: Plant Biochemistry (Offered by Department of Biochemistry)

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION **A student completing this course will be able to:**
CO 1	Study the structural details of the plant cell
CO 2	Illustrate the chemistry of different plant pigments in order to explore their isolation, characterization and applications in various fields
CO 3	Explain and understand the biochemistry of photosynthetic process and its relation to man and its environment.
CO 4	Understand the mechanism of Nitrogen fixation and its importance in agricultural production and environment
CO 5	Acquire knowledge about the importance of secondary metabolites and its industrial applications.
CO 6	Identify the class and functions of secondary metabolites and appreciate their role in physiology of plants
CO 7	Know the significance of plant growth regulators in the development of plants
CO8	Understand the basics of plant tissue culture as it is an important tool for both basic and applied aspects of plant-based research
CO9	Become competent to explain relation between Photosynthesis, growth hormones and Plant growth
CO10	Develop skills and knowledge to conduct basic research work in the field of Plant Biochemistry

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title Plant Biochemistry	Credits/ Hours

RPSEBC HO604			3 Credits
	1	**Overview of Plant cell structure, plant pigments & plant metabolism**	**15L**
	1.1	Plant cell wall (structure), Overview of Leaf structure – Upper epidermis, palisade mesophyll, spongy mesophyll, lower epidermis, Guard cells and stomata	
	1.2.1	Specialized plant cells (in brief) – Parenchyma, Sclerenchyma, Collenchyma, Xylem and phloem, Bulliform cells	
	1.2.2	Concept of apoplast, apoplastic and symplastic pathways	
	1.2	Plant pigments –	
I	1.2.1	Primary pigment - Chlorophyll (Types and function)	
	1.2.2	Role of accessory pigments and their biological significance Carotenoids, Xanthophylls, Betalains, Anthocyanins and other flavonoids	
	1.3	Plant Micronutrients	
	1.4	Nitrogen metabolism	
	1.4.1	Sources of Nitrogen, different forms of nitrogen in plants	
	1.4.2	Conversion of nitrate to nitrite & finally to ammonia, biological nitrogen fixation in plants	
	1.4.3	Sulphur metabolism, Phosphorous metabolism	
	2	**Photosynthesis, Photorespiration and plant movements**	**15L**
	2.1	Photosynthesis	
II	2.2.1	Light reactions: Light harvesting complexes, Absorption of light, Photophoshorylation: Cyclic and Non-cyclic (Z scheme)	
	2.2.2	Dark reactions: Calvin cycle, regulation of Calvin cycle	

	2.3	C4 cycle and CAM pathway	
	2.4	Synthesis of glucose, starch, sucrose	
	2.5	Photorespiration, Photoperiodism and photoinhibition	
	2.6	Physiology of plant movements Physical movements – Xerochasy, Hydrochasy Vital movements – Protoplasmic streaming, paratonic movements Tactic movements – Chemotaxis, Phototaxis, Thermotaxis Tropic movements – Chemo / geo / hydro / photo / thigmo tropism Nastic movements – Seismonasty, Nyctynasty, Photonasty, Chemonasty, Thermonasty	
III	**3**	**Regulation of plant growth, secondary metabolites and Sexual reproduction in plants**	**15L**
	3.1	Plant Growth Substances Structure and Function of - Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic Acid	
	3.2	Secondary metabolites of plants Nitrogen containing compounds (Alkaloids), Terpenes & Phenolic compounds – Shikimic acid pathway, Mevalonic acid pathway, MEP Pathway	
	3.3	Reproduction in plants and PTC	
	3.3.1	Asexual reproduction in gymnosperms. Life Cycle of Gymnosperms.	
	3.3.2	Sexual Reproduction in angiosperms: Structure of plant gametes. Life cycle of angiosperm	
	3.3.3	Double fertilization in plants	
	3.4	Post fertilization events in plants	

References:

1. Biochemistry & Molecular Biology of Plants - Bob B. Buchanan - Wilhelm Gruissem and Russel L. Jones .

2. Plant Biochemistry - Heldt H.-W., Piechulla B.

3. Methods in plant biochemistry and molecular biology - Dashek, William V

4. Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet - Alan Crozier

5. Plant Physiology - Taiz and Zeiger - Sinauer Associates Inc.

6. Plant Biochemistry - Caroline Bowsher, Martin steer, Alyson Tobin - Garland science

7. Plant Biochemistry - P.M Dey and J.B. Harborne - Academic Press 8.

Biochemical methods - S Sadashivam and A Manickam - New Age International publishers

Course Code: RPSEBCHPO604
Practicals based on RPSEBCHO604

1 2 3 4 5 6 7	Phytochemical analysis – Qualitative test Quantitative estimation of Total Phenolic content Quantitative estimation of Alkaloids content Quantitative estimation of Flavonoids content Quantitative estimation of Saponins content Estimation of antioxidant capacity of plant extract Study of effect of Eutrophication on water quality	1 Credit

Course Code: RPSRPBTKO605

Course Title: Research Project

Course Outcomes	DESCRIPTION A student completing this course will be able to:
CO1	Conduct a comprehensive literature review using existing knowledge
CO2	Formulate a research proposal and establish a hypothesis and research objectives
CO3	Devise an appropriate experimental design including different data collection techniques
CO4	Analyse and interpret research findings.
CO5	Apply different statistical tools and softwares to analyse data

Credits-6

The students will be working in groups of 3 or 4 on a project and will be presenting the same for evaluation in the form of a thesis.

Modality of Assessment

RPSBTKO601, RPSBTKO602 , RPSBTKO603 (DSC)

&

RPSEBTKO604 (DSE)

Theory Examination Pattern:

A) Internal Assessment- 40%- 30 Marks

Sr No	Evaluation type	Marks
1	Class Test	20
2	Presentation	10
	TOTAL	**30**

B) External Examination (Semester End)- 60%- 45 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1	7/8 marks questions with option to any one	15	UNIT I
Q2	7/8 marks questions with option to any one	15	UNIT II
Q3	7/8 marks questions with option to any one	15	UNIT III
	TOTAL	**45**	

Practical Examination Pattern:

External Examination (Semester End)- 25 Marks

Semester End Theory Examination:

1. Duration – The duration for these examinations shall be of **two hours**.
2. Theory question paper pattern:

Paper Pattern:

Question		Marks
1	Lab work	20
2	Viva/Journal/Spots	5
	TOTAL	**25**

Modality of Assessment

RPSRPBTKO605

The students will be working in groups of 3 or 4 on a project and will be presenting the same for evaluation in the form of a thesis.

Marks Distribution:

Internal Examiner	External Examiner	Internal Guide	Total Marks
50	**50**	**50**	**150**

SEMESTER IV

DISCIPLINE SPECIFIC CORE

Course Code (DSC- I): RPSBTKE611
Course Title: Bioprocess Technology

COURSE OUTCOMES: On course completion, the student should be able to:

DETAILED SYLLABUS

COURSE OUTCOME	CO DESCRIPTION
CO 1	Explain the effect of process parameters on fermentation and their measurement and control.
CO 2	Differentiate between the rheological properties of various food textures.
CO 3	Comprehend on enzyme functions and reactions in the food process.
CO 4	Analyze the role of microbes in processing the food and developing commercial food products.
CO 5	Summarize the mechanism of enzyme reactions in detail and the role of inhibitors on them.
CO 6	Elucidatethebasicmechanismofdifferenttypesofenzymesandthe ir widespreadapplications.

Course Code/ Unit	Unit	Course/ Unit Title	Credits /Hours 3/45

RPSBTKE 611	I	**Aeration and agitation in bioprocess** Large scale animal and plant cell cultivation; Aeration and agitation in bioprocess; KLa, Measurement and control of bioprocess parameters. Introduction to Food Rheology, Food rheology vs Food texture, Rheology of food dispersion, Food polymers and gels, foams and dough rheology, processing and food rheology, test and application of food rheology.	15
	II	**Microbial Products in Industries** National Institutes of Health Office of Dietary Supplements (ODS) for sources, activity of vitamins,Production, deficiency disorders, overconsumption effects of Vitamins: Water soluble- B1, 2,3,5,6,7,12 Fat soluble- A, D, E, K Microbes and their use in producing colours and flavours.Bacteriocins from lactic acid bacteria - Production and applications in food preservation and as antibiotics.	15
	III	**Enzymology** Enzyme – Concept and kinetics, active site formation and its significance, Michaelis- Menten Equation – Derivation and transformation, Enzyme inhibition and types of inhibitors, control of enzyme activity, allosteric regulations, parameters affecting enzyme activity. Types of enzymes: isoenzymes, ribozymes, abzymes, substrate specificity and coenzymes Enzymic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein and their downstream processing; baking by amylases, deoxygenation and desugaring by glucose oxidase.	15

References:

1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall,Engelwood Cliffs,1991.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2ndEdition, Prentice Hall, Engelwood Cliffs,2002.
3. Stanbury RF and Whitaker A., Principles of FermentationTechnology,Pergamon press, Oxford,1997.
4. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2ndEdition, McGraw- Hill Book Co., New York,1986.

5. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2ndEdition, University of Tokyo press,Tokyo,1973.
6. Comprehensive Biotechnology: The Principles, Applications and Regulations of BiotechnologyinIndustry,AgricultureandMedicine,Vol1,2,3and4.YoungM.M., Reed Elsevier India Private Ltd, India,2004.
7. El-Mansi, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK,2007.
8. Biochemistry, L Stryer, Freeman and Co,NY
9. Principlesofbiochemistry,Lehninger,5thedition,CoxandNelson,W.H.Freeman company.

Course Code: RPSBTKPE611
Practicals based on RPSBTKE611

DETAILED SYLLABUS

Course Code	Course/ Unit Title	Credits
RPSBTKPE611	1. Spectrophotometric estimation of Vitamin A. 2. Demonstration of Placket Burman design for formulation of fermentation media. 3. Pigment production and isolation from microbial source (yeast/fungi/bacteria) 4. Detection of different food enzymes by simple tests (amylase, catalase ,invertase, papain, pectinase and pepsin). 5. Extraction of enzymes from different biological sources (yeast/fungi/bacteria/plants) and estimation of its enzyme activity for a) Amylase b) Invertase 6. Study of the effect on enzyme kinetics for the enzymes (amylase and invertase) based on the following parameters: a) Substrate concentration b) pH c) Temperature d) Inhibitors	**1**

Course Code (DSC-II): RPSBTKE612
Course Title: Biostatistics

COURSE OUTCOMES: On course completion, the student should be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Calculate standard normal scores and resulting probabilities
CO 2	Interpret and explain a p-value
CO 3	Perform a two-sample t-test and interpret the results; calculate a 95% confidence interval for the difference in population means
CO 4	Discuss and interpret results from Analysis of Variance (ANOVA), a technique used to compare means amongst more than two independent populations
CO 5	Analyse and interpret relative risks and odds ratios when comparing two populations
CO 6	Evaluate correlation and regression

Course Code	Unit	Course/ Unit Title	Credits/ Hours 3/45
RPSBTKE612	**I**	**Introduction to Statistics** Statistical population, sample from population, Random sample. Central Tendency: Mean, Median and Mode, Standard Deviation Confidence intervals	**15**
	II	**Gaussian distribution and normality** Gaussian Distribution and testing for normality, Nonparametric tests (Sign test, Wilcoxon test, Mann- Whitney Test, Krushkal-Whllis test,), transforming data to create Gaussian Distribution	**15**

	III	**Hypothesis testing & ANOVA** Test of Significance. Hypothesis testing:- Theory of errors - Type I and Type II errors, Null hypothesis, P values-one v/s two tail P values,t test (paired & unpaired), z-test, Chi square test, contingency table Comparing three or more groups- Introduction to ANOVA, One way ANOVA, repeated measures ANOVA, Friedman Test. Correlation and Regression: Linear and multiple Correlation and Regression	**15**

References:

1. Introduction to Biostatistics (Second Edition-2005) N. Gurumani M J P Publishers
2. Basic Biostatistics (2008) B. Burt Gerstman Jones and Bartlet Publishers
3. Biostatistics: A foundation For Analysis In Health Sciences (7th Edition 1999) Wayne W. Daniel John Wiley &; Sons Inc.
4. Fundamentals of Biostatistics (2006) Veer Bala Rastogi Ane Books India
5. Biostatistics- The Bare Essentials (Second Edition 2000) Nosman Streiner B.C.Decker Inc.

Course Code: RPSBTKPE612
Course Title: Practicals based on RPSBTKE612

Course Code	Course/ Unit Title	Credits
RPSBTKPE612	1. Problems on one-way ANOVA (computer-based) 2. Problems on two-way ANOVA (computer-based) 3. Problems on Correlation (computer-based) 4. Problems on Regression (computer-based) 5. Working of GraphPad Prism 6. Working with data in R software. 7. Creating various types of graphs using SPSS	**1**

DISCIPLINE SPECIFIC ELECTIVES (DSE)

Course Code: RPSEBTKE613
Course Title: Bioinformatics

COURSE OUTCOMES: On course completion, the student should be able to:

COURSE OUTCOME	CO DESCRIPTION
CO 1	Classify different types of biological databases.
CO 2	Summarize about various computational methods and tools used for protein secondary structure prediction and genome analysis
CO 3	Describe various sequence alignment tools and its significance**.**
CO 4	Identify and understand important terms in evolution and population genetics
CO 5	Compare different bioinformatic tools for phylogenetic analysis.
CO 6	Evaluate the use of different biological databases used in drug designing.

Course Code	Unit	Course/ Unit Title	Credits/Hours 3/45
RPSEBTKE613	I	**Introduction to Bioinformatics – Sequence Analysis** Database search using ENTREZ (G Query) , Hidden Markov Model, Equation (Ex :Gene finding/ exon-intron finding, Signalpeptide finding), Motif finding using HMM, ANN(Ex:Prosite) Sequence alignment, MSA- algorithm under Clustal W ,Protein sequence analysis,Protein structure analysis, Secondary, (Chou Fasman algorithm, GOR algorithm, Tertiary (Homology modelling, Threading, Ab initio, Structure prediction) Reactome,	**15**

	II	**Applications of Bioinformatics** Human genome project and specialised databases under NCBI (Eg OMIM, chromosome, PubMed),Proteomics, Consensus sequence, PSSM,Sequence Logo. Introduction to molecular docking , Types of docking, preparation of ligand, Interaction Profiling, softwares used for molecular docking- Autodock Vina, Swiss Dock, UCSF Chimera, ClusPro, Online docking servers, Applications and case studies of docking. Drug design: types structure based, Virtual screening: ligand based, optimization methods. Detection of 3-D structures using bioinformatics tools.	15
	III	**Phylogenetics** Darwinism and neo Darwinism theories of evolution. Bioinformatics tools for MSA and phylogenetic tree analysis. Types of trees and applications, Population genetics and different forces acting on it. Comparative genomics- Case Study like emergence of Sars-CoV 2	15

References:

1. Bioinformatics – A practical guide to the analysis of genes and proteins byA.D. Baxvanis
2. Bioinformatics by N. Gautam(2006)
3. Bioinformatics:SequenceandGenomeAnalysis(SecondEdition2004),David W. Mount , (Coldspring Harbor Laboratory Press)
4. Bioinformatics and Functional Genomics (2003), Jonathan Pevsner, JohnWileyandsons.
5. iGenetics by Peter J.Russel, 3rd Edition, PearsonPublications
6. Handbook of Vitamins:https://ods.od.nih.gov/factsheets/list-VitaminsMineral

Course Code: RPSEBTKPE613

Course Title: Practicals based on RPSEBTKE613 (Bioinformatics)

Course Code	Title	Credits
RPSEBTKPE613	1. Classification of biological databases specially cover NCBI andINSDC 2. Phylogenetic tree usingBootstrap 3. BLAST – orthologs, paralogs and homologs 4. Motiffinding 5. KEGG 6. Structure Of Proteins–identification chains helices, special groups, metal ions etc. 7. CATH/SCOP classification of a given protein 8. Homology Modelling 9. Primer Designing. 10. Preparation of protein structure. 11. Protein- ligand docking. 12. Protein - ligand interaction profiling. 13. 3-D Structure Prediction for Drug Discovery	1

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Course Code: RPSEBTKE613
Course Title: AGRICULTURE BIOTECHNOLOGY

COURSE OUTCOMES: On course completion, the student should be able to:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the principles of agricultural biotechnology and its applications.
CO 2	Identify and evaluate the role of beneficial microorganisms in agriculture.
CO 3	Recognize different types of problem soils and their morphological characteristics.
CO 4	Develop strategies for managing acid soils and biological soil sickness.
CO 5	Evaluate advancements in agricultural biotechnology for crop quality improvement and pest/disease control.
CO 6	Analyse the data obtained through different agriculturally important bioinformatic databases.

DETAILED SYLLABUS

Course Code	UNIT	TOPICS	Credits/Lectures 3/45
RPSEBTKPE613	**Unit I**	**introduction to Agricultural Biotechnology** Introduction to Agricultural Biotechnology, Beneficial microorganisms in Agriculture: Biofertilizer (Bacterial Cyanobacterial and Fungal), Agrobacterium and Extremophiles in agricultural biotechnology. Biopesticides.	**15**
	Unit II	**Soil and Water Problems in Agriculture & its Management** Area and distribution of problem soils-acidic, saline and physically degraded soils; Morphological features and characterization of saline, sodic and saline-sodic soils; Monitoring of soil salinity in the field; Acid soils -nature of soil acidity, sources of soil acidity; effect on plant growth, lime requirement of acid soils; management of acid Soils; biological sickness of soils and its management.	**15**

	Unit III	**Applications of Agricultural Biotechnology** Advancements of biotechnological methods in improving the quality of crops, Chloroplast manipulations for production of therapeutic proteins, vaccines, antibodies and increased production, Control of pests and diseases of horticultural crops by biotechnological methods. Agricultural Bioinformatics- Impact of genome sequencing in agriculture; Agriculturally important biological databases; Role of Model Organisms in Plant Genomics. Introduction to Regenerative Agriculture	**15**

Course Code: RPSEBTKPE613

Course Title: Practicals based on RPSEBTKE613 (Agriculture Biotechnology)

Course Code	Course/ Unit Title	Credits
	1. Estimation of ions: sulphates, and chlorides in ground water and soil samples. 2. Colorimetric estimation of carbon content in soil samples. 3. Preparation of biofertilizer and checking its efficacy. 4. Study of effect of abiotic stress on plants (root length, shoot length, average number of leaves). 5. Microbial analysis of compost. 6. Microscopic examination of diseased parts in some of the affected plant species. 7. Study of Bioinformatics Tools a) Rice Genome Database b) Plant Tribes 2.0 c) *Arabidopsis thaliana* Database	**1**

Course Code: RPSINTBTKE614

Course Title: INTERNSHIP

Course Outcomes	DESCRIPTION A student completing this course will be able to:
CO1	Demonstrate proficiency in laboratory techniques, experimental design, and data analysis relevant to biotechnology.
CO2	Develop critical thinking and problem-solving skills by identifying, analysing, and proposing solutions to challenges encountered during the internship.
CO3	Gain hands-on experience in working on projects in different research institutes or industries.
CO4	Conduct effective documentation of experimental procedures, results interpretation, and presentation of findings.
CO5	Identify and address potential ethical concerns in the research plans developed.

Credits-10

The students will be working in different research institutes / industries and will be presenting their work for evaluation in the form of a thesis.

Modality of Assessment

RPSBTKE611, RPSBTKE612 (DSC)

&

RPSEBTKE613 (DSE)

Theory Examination Pattern:

C) Internal Assessment- 40%- 30 Marks

Sr No	Evaluation type	Marks
1	Class Test	20
2	Presentation	10
	TOTAL	**30**

D) External Examination (Semester End)- 60%- 45 Marks

Semester End Theory Examination:

3. Duration – The duration for these examinations shall be of **two hours**.
4. Theory question paper pattern:

Paper Pattern:

Question	Options	Marks	Questions Based on
Q1	7/8 marks questions with option to any one	15	UNIT I
Q2	7/8 marks questions with option to any one	15	UNIT II
Q3	7/8 marks questions with option to any one	15	UNIT III
	TOTAL	**45**	

Practical Examination Pattern:

External Examination (Semester End)- 25 Marks

Semester End Theory Examination:

3. Duration – The duration for these examinations shall be of **two hours**.
4. Theory question paper pattern:

Paper Pattern:

Question		Marks
1	Lab work	20
2	Viva/Journal/Spots	5
	TOTAL	**25**

Modality of Assessment

RPSINTBTKE614

The students will be working in different research institutes / industries and will be presenting their work for evaluation in the form of a thesis.

Marks Distribution:

Internal Guide	External Examiner	Principal Investigator	Panel Presentation	Total Marks
60	**60**	**50**	**80**	**250**