Resolution No. AC/I(21-22).2(II).RPS2

S. P. Mandali's

Ramnarain Ruia Autonomous College

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore • Experience • Excel

Syllabus for

Program: MSc I

Program Code: RPSBCH

(Credit Based Semester and Grading System
for academic year 2022-23)

GRADUATE ATTRIBUTES

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, analyse, 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 BIOCHEMISTRY will be able to:**
PO 1	Acquire necessary knowledge and skills to undertake a career in research, either in industry or in an academic set up.
PO 2	Compare and contrast the breadth and depth of scientific knowledge in the broad range of fields including Protein biochemistry, Bioenergetics, Diagnostic Biochemistry, Hormonal Biochemistry, Molecular Biology, Nutritional Biochemistry, and Nanotechnology.
PO 3	Extrapolate and comprehend the regulatory role of metabolic processes and understand the underlying cause of metabolic disorders
PO 4	Acquire thorough knowledge of Biochemical Techniques, Advanced Immunology, Physiology, Genetic Engineering, and Biotechnology
PO 5	Describe and express the biochemical basis of human diseases, protein structure and conformation, non-invasive diagnostics, clinical research, and its importance in drug development. Usage of this knowledge further for multitude of laboratory applications.
PO 6	Integrate and apply the techniques in Biophysics, Analytical Biochemistry, Clinical biochemistry, Microbiology, Molecular Biology and Basics in Bioinformatics
PO 7	Gain proficiency in laboratory techniques in both Biochemistry and Molecular Biology, and be able to apply the scientific method to the processes of experimentation and Hypothesis testing
PO 8	Develop and enhance skills & improve employability through academic, research and internship opportunities
PO 9	Gain exposure to basic research through the provision of PG research based project.
PO 10	Learn to work as a team as well as independently to compile and interpret Biological data, carry out Research investigations and draw conclusions

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
MSc I	I	Core 1	Membrane Biochemistry & Bioenergetics	4
		Core 2	Protein Biochemistry & Enzymology	4
		Core 3	Biostatistics and Ecology	4
		DSE	Plant Biochemistry OR Clinical Microbiology and Epidemiology OR Clinical Data Management	4
		AECC	Emotional Wellbeing through Logic-based thinking	2
			Practicals based on core 1	2
			Practicals based on core 2	2
			Practicals based on core 3	2
			Practicals based on DSE	2
	II	Core 1	Industrial Biotechnology	4
		Core 2	Genetics	4
		Core 3	Instrumentation and Analytical Techniques	4
		DSE	Nutraceutical & Functional Foods OR Microbial Approaches to Quality Management OR Nanotechnology	4
		AECC	Research methodology & Bioinformatics	2
			Practicals based on Core 1	2
			Practicals based on Core 2	2
			Practicals based on Core 3	2
			Practicals based on DSE	2

Semester I

Course Code: RPSBCH101

Course Title: Membrane Biochemistry & Bioenergetics

Academic year 2022-23

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Understand composition and structure of bio-membranes
CO 2	Recognize the importance of transport mechanisms and cellular trafficking across biological membranes
CO 3	Describe different types of transporters and explain their mechanisms
CO 4	Comprehend the different modes of communication between cells including signal reception, transduction, amplification, and response.
CO 5	Know about Bioenergetics, mechanisms of oxidative phosphorylation
CO 6	Learn the concept and mechanism of ATP synthesis

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Membrane Biochemistry & Bioenergetics RPSBCH101	Credits/ Lectures 4 Credits
I	**1**	**Membrane Fluidics & Dynamics**	**15L**
	1.1	Overview of membrane biochemistry	2L
	1.2	Membrane fluidity	2L
	1.2.1	Importance of membrane fluidity	
	1.2.2	Maintenance of membrane fluidity- Concept of transition temperature & general characteristics	
	1.3.1	Lipid rafts- Composition significance & its role role of lipid rafts in maintaining membrane & membrane signalling	4L
	1.3.2	Specialized lipid rafts- Caveolae (Formation of Cavolins, Cavins and its significance in endocytosis & other mechanisms	
	1.4	Membrane dynamics Membrane bilayer mobility- Frye Edinin Experiment & FRAP analysis	2L
	1.5	Membrane asymmetry- Lateral membrane asymmetry- Lipids & proteins Transverse membrane asymmetry Role of Flippase, Floppase and Scramblase in maintaining asymmetry	2L
	1.6	Membrane domain and cell polarity-	2L
	1.7	Study of RBC cell- model for cell membrane	1L
II	**2**	**Membrane Transport & cellular trafficking**	**15L**
	2.1	Passive transport – Passive diffusion (Polar & Non polar), diffusion and osmosis, facilitated diffusion of ions and molecules	3L
	2.2.1	Ion channels- Ligand gated, mechanical gated, Voltage gated, Anion transporter (band 3)	
	2.2.2	Molecule channels- (Glucose transporters)	
	2.3	Primary Active transport Atpases pump- Na^+-K^+ Pump, Ca^{2+}-K^+ Pump, ABC transporter (CFTR) Light driven – Bacteriorhodopsin	4L
	2.4	Secondary active transports-	3L

		Symport (Mechanism of Absorption of peptides by enterocytes), Mechanism of Cytosolic pH maintenance	
	2.5	Specialized ion channels - Aquaporins, Ionophores: gramicidin, & valinomycin	
	2.6	Antiport - Absorption of peptides by enterocytes, Antiporter in cardiac muscle cell with effect of Ouabain & digoxin	2L
	2.7	Cellular trafficking	2L
	2.7.1	The Molecular Mechanisms of Membrane Transport and the Maintenance of Compartmental Diversity	
	2.7.2	Gated, vesicular and transmembrane transport	1L
III	**3**	**Cell-cell communication**	**15L**
	3.1	Introduction to Cell-cell communication & its Biological Significance	1L
	3.2	Cell Adhesion and Cell adhesion molecules	4L
	3.2.1	Importance of cell adhesion and cell adhesion molecules	
	3.2.2	Cadherins, Lectins and selectins (Their role and importance in cell adhesion with one significant example)	
	3.3	Cell-cell junction	3L
	3.3.1	Classification	
	3.3.2	Adherence junction- Focal adhesion, Hemidesmosome, desmosome and their role in Wnt pathway, tissue integrity	
	3.3.4	Tight junction- Role of JAM (claudins and occludins) its role in glucose transport across intestine	2L
	3.3.5	Gap junction- connexon & its role in electrical synapse	1L
	3.4	Extracellular matrix in plants and animals	4L
	3.4.1	Structure and Biological significance of Collagen, Elastin, fibronectin, Laminins and integrins	
IV	**4**	**Oxidative Phosphorylation & its regulation**	**15L**
	4.1	Oxidative phosphorylation	2L
	4.2	Electron transfer reactions in mitochondrion	
	4.2.1	Universal electron acceptors – Role in biological oxidation-reduction reactions	

	4.2.2	Membrane-bound carriers (Ubiquinone, Cytochromes, Fe-S proteins, Rieske Fe-S proteins) – Structure and mechanism of electron transfer	2L
	4.3.1	Methods for determining the sequence of electron carriers	4L
	4.3.2	Structure and function of each complex of mitochondrial respiratory chain	
	4.3.3	Separation of functional complexes of respiratory chain	
	4.3.4	Flow of electrons and protons through the complexes of respiratory chain	
	4.4	Proton motive force	1L
	4.5	Alternative mechanism in plant mitochondria	
	4.6.1	Phosphoryl group transfers and ATP	1L
	4.6.2	ATP synthesis by binding-change model for ATP synthase	3L
	4.6.3	Role of luciferin in firefly flashes	
	4.6.4	Chemical uncouplers of oxidation and phosphorylation	
	4.7	Alternative respiratory pathway in plant	
	4.8	Regulation of oxidative phosphorylation	2L
	4.8.1	Regulation based on energy demands, in oxidative stress, In brown fat and integrated regulation in metabolism	
		Practicals RPSBCH101	2 Credits
	1	Separation of RBC membrane proteins by SDS-PAGE	
	2	Effect of temperature and molecular weight on diffusion	
	3	Effect of tonicity on cell membrane	
	4	Mitochondrial respiration and effect of different Inhibitors for ETC (Dry lab)	
	5	In-vitro study of RBC membrane stabilization	
	6	Isolation of lipids from plant and animal source and their utilization in the formation of artificial membrane vesicle	
	7	Graphical study of hydropathy plot and FRAP analysis (Dry lab)	
	8	Sums based on Bioenergetics	
	9	Study of cell membrane using electron micrograph	

References:

1. Molecular Cell Biology (2016) 8th ed., Lodish, H., Berk, A., Kaiser, C.A., Krieger, M.,Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P., W.H. Freeman & Company (New York).
2. Biochemistry (2016) 6th ed., Garret, R. H. and Grisham, C.M., Cengage Learning (Boston).
3. Lehninger: Principles of Biochemistry (2017) 7th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman and Company (New York).
4. Molecular Biology of the Cell (Sixth Edition) by by Bruce Alberts
5. Essential Cell Biology – Alberts, Bray, Hopkin, Johnson, Lewis, Raff, Roberts, Walter (4th Edition)
6. Principles of Biochemistry (2008) 3rd ed., Voet, D.J., Voet, J.G. and Pratt, C.W., John Wiley & Sons, Inc. (New York), ISBN:13: 978-0470-23396-2
7. Biochemical methods, S Sadashivam and A Manickam, new age international publishers
8. Laboratory Manual in Biochemistry, 2003, J. Jayaraman, New Age International

Course Code: RPSBCH102

Course Title: Protein Biochemistry & Enzymology

Academic year 2022-23

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Understand details of protein structure such as protein organization, end group analysis and stabilizing bonds
CO 2	Know Various techniques used in the study of protein biochemistry
CO 3	Learn Protein folding & Protein Engineering and their research - oriented applications
CO 4	Analyse Ramachandran plot and other plots with respect to kinetics of different enzymes
CO 5	Determine optimum temperature, pH for the activity of an enzyme.
CO 6	Determine Km and Vmax of enzymes and to analyse enzyme kinetics.
CO 7	Understand enzyme inhibition with more complexity.

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Protein Biochemistry & Enzymology RPSBCH102	Credits/ Lectures 4 Credits
I	**1**	**Introduction to Proteins & Protein Structure**	**15L**
	1.1	Organization of protein structure into primary, Secondary, Tertiary and Quaternary structures	2L
	1.2.1	Primary structure determination of protein	2L
		End group analysis-N & C terminal amino acid analysis – By Dansyl chloride, Sanger's Reagent, Edman's degradation, Exopeptidase	
	1.2.2	Cleavage of disulphide bond	
	1.3	Mass spectrometry for protein analysis, Tandem MS, Solid phase peptide synthesis	3L
	1.4	Nature of stabilizing bond – covalent and non-covalent.	
	1.5	The peptide bond length & configuration-Dihydral angle psi and phi, Helices, sheets and turns – Ramachandran plot	2L
	1.6	Techniques used to study 3D Structures- X-ray diffraction, NMR	2L
	1.7	Supersecondary structures: Motifs and domains	2L
	1.8	Tertiary and quaternary structures- Structure of haemoglobin and myoglobin	2L
II	**2**	**Protein folding & Protein Engineering**	**15L**
	2.1	Protein denaturation and folding (Ribonuclease A)	2L
	2.1.1	Importance of primary structure in folding	
	2.2	Molecular mechanism of protein folding	2L
	2.3	Role of chaperons, chaperonins & PDI in protein folding	2L
	2.4	Disorders related to protein folding- Alzheimer's and prion disease	2L
	2.5	Protein Engineering	3L
	2.5.1	Basic principles, Types and Methods	
	2.5.2	Strategies in protein engineering (Directed evolution, Comparative design, Rational design)	4L
	2.5.3	Applications and case studies.	
III	**3**	**Enzyme kinetics and inhibition**	**15L**
	3.1	Introduction to enzymes, mechanism of enzyme action	3L

	3.2	Types of enzyme catalysis – Acid base, Covalent & metal ion	
	3.3	Enzyme kinetics	4L
	3.3.1	The Relationship between Substrate Concentration and Reaction Rate- Michaelis-Menten Kinetics of monosubstrate enzyme reaction, LB Plot, Einsethal Cornish Bowden Plots & Eadie- Hofstee plot	
	3.4	Enzyme inhibition	4L
		Types of inhibitors- Competitive, Non-competitive and Uncompetitive, Mixed, Suicidal inhibition and their mode of action and experimental determination considering suitable example	
	3.5	Allosteric enzymes	4L
		Mechanism of action, deviation from MM equation and allosteric regulation	
		Allosteric interactions- protein ligand binding, co-operativity, Hill & Scatchard plot	
IV	**4**	**Enzyme regulation and modifications**	**15L**
	4.1	Enzyme regulation- Product inhibition, Feedback control, Enzyme induction and repression	3L
	4.2.1	Enzyme modification reactions (Phosphorylation, Adenylation, Uridylylation, ADP-ribosylation, Methylation)	3L
	4.2.2	Regulation of enzymes by proteolytic cleavage	
	4.3	Enzymatic action and biological role of following – Hexokinase, Chymotrypsin, Carboxypeptidase A	2L
	4.4	Immobilized enzymes	2L
	4.4.1	Relative practical and economic advantage for industrial use	
	4.4.2	Methods of immobilization- Ionic bonding, Adsorption, Covalent bonding (based on R group of amino acids), Microencapsulation and Gel entrapment.	4L
	4.4.3	Immobilization of multienzyme system	1L

		Practicals – RPSBCHP102	2 Credits
	1	Plotting graphs using computer tools	
	2	Estimation of proteins using Lowry method	
	3	Study of Ramachandran plot (Dry lab)	
	4	Study of protein denaturation – change in isoelectric pH	
	5	Colorimetric assay for cysteine	
	6	Determination of optimum pH & temperature of β-Amylase/Invertase/Urease	
	7	Determination of Km and Vmax of β-Amylase/Invertase/Urease	
	8	Assay to determine enzyme activity and specific activity	
	9	Study the effect of inhibitor on β-Amylase/Invertase/Urease	
	10	Comparative assessment of the β-Amylase/Invertase/Urease activity in free and immobilized state	
	11	Reusability & Storage stability of immobilized Amylase/Invertase/Urease	

References:

1. A.L., Lehninger, Principles of Biochemistry (1982), Worth Publishers, Inc. New York.
2. Harper's Biochemistry – Murray, Granner, Mayes, and Rodwell – Prentice Hall International Inc.
3. Textbook of medical physiology: A. C. Gyton, and J. E HallSaunders Elsevier Publications, A division of Reed Elsevier India Pvt .Ltd.New Delhi ISBN 81-8147-084-2
4. Advances in Enzymology and Related Areas of Molecular Biology, Mechanism of Enzyme Action, Daniel Purich
5. Medical Biochemistry by Ramakrishnan (2012)
6. ENZYMES: Catalysis, Kinetics and Mechanisms by N.S. Punekar
7. Molecular and cellular enzymology by Jeannine Yon-Kahn, G. Hervé.
8. Biochemical methods, S Sadashivam and A Manickam, new age international publishers
9. J. Jayaraman , Laboratory Manual in Biochemistry, 2003, New Age International

Course Code: RPSBCH103

Course Title: Biostatistics and Ecology

Academic year 2022-23

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Acquire hands-on practical training to plan biological experiments with requisite sample size. After completion of experiments based on different sample sizes students will be able to perform proper statistical analysis of the data using mean, median, mode, Range, percentiles, variance, SD, Mean deviation and Coefficient of variation
CO 2	Apply the principles of biological data management in real life situations.
CO 3	Learn R software and this training will improve computational, mathematical and computer skills of the students.
CO 4	Make the use of Hypothesis testing, Chi-square, Correlation & Regression, Normal distribution, ANOVA, Probability in their research work.
CO 5	Know statistical methods and it will help them in improving their analytical and interpretation skills
CO 6	Understand different concepts in population studies and ecology

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Biostatistics and Ecology RPSBCH103	Credits/ Lectures 4 Credits
I	**1**	**Descriptive statistics and Probability**	**15L**
	1.1	Descriptive statistics:	5L
	1.1.1	Measures of central tendency - Mean, Median and mode	
	1.1.2	Measures of dispersion- Range, percentiles, variance, SD, Mean deviation, Coefficient of variation	5L
	3.1	Probability	5L
	3.1.1	Operations on events and probability	
	3.1.2	Conditional probability	
	3.1.3	Addition & Multiplication laws	
	3.1.4	Concept of odds in favour and odds against	
II	**2**	**Normal distribution, Hypothesis testing and ANOVA**	**15L**
	2.1.1	Normal distribution and skewness	3L
	2.1.2	Normal variate & its significance	
	2.2	Hypothesis testing –	4L
		z-test – one sample, two samples	
		One sample t-test	
		Independent and Paired t-test	5L
	2.3	Standard error	
	2.4	ANOVA – characteristics and types One way ANOVA testing	3L
III	**3**	**Chi-square, Correlation & Regression and Introduction to R-software**	**15L**
	3.2	Chi-square	2L
	3.2.1	Test of population variance	
	3.2.2	Test of goodness of fit	3L
	3.2.3	Test of association - 2 x 2 Table, Yates' correction	
	1.2	Correlation	4L
	1.2.1	Introduction to Correlation, Bivariate & multivariate distributions,	
	1.2.2	Types of correlation	
	1.2.3	Measure of correlation – Karl Pearson, Spearman rank order and scatter plot	
	1.3	Regression	3L

	1.3.1	Concept of regression, Types of regression	
	1.3.2	Regression coefficient and equation	
	1.3.3	Simple & multiple regression	
	3.3	Introduction & application of R-software	3L
IV	**4**	**Ecology**	**15L**
	4.1	Introduction to ecology	1L
	4.2	Habitat and Niche	3L
		Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement	
	4.3	Population Ecology	4L
		Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations	
	4.4	Species Interactions	3L
		Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis	
	4.5	Community Ecology	4L
		Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones	
		Practicals – RPSBCHP103	2 Credits
	1	Introduction & application of R-software	
	2	Descriptive statistics using Microsoft excel/ R-software	
	3	Hypothesis testing of means & Hypothesis testing of difference between means using excel/ R-software	
	4	ANOVA & Chi-square test using excel/ R-software	
	5	Correlation & Regression using excel/ R-software	
	6	Study of Gause principle using *Paramecium* species (K-strategies) as study model	
	7	Study of logistic vs exponential growth curve and problems on population ecology	
	8	Graphical study of Lotka Voltera competition equation	

References:

1. Biostatistics by Arora
2. B.K. Mahajan. Jaypee brothers, Methods in biostatistics for medical & research workers. 6thedition, Medical Publishers (P) ltd.
3. Wayne Daniel, Biostatistics: A Foundation for Analysis in Health Sciences, 10th edition, 2013, Wiley.
4. Analysis of Biological Data, M. Whitlock and D. Schluter (2009); Roberts and company publishers
5. Statistical Modeling: A Fresh Approach by Daniel Kaplan
6. Research methodology Methods and Techniques by C.R. Kothari
7. OdumE.P. Fundamentals of Ecology, sauders publication; Indian edition, Nataraj Publications Dehradun, 1998.
8. Verma, P.S. and Agarwal, V.K. Concept of ecology (Environmental Biology), S.Chand & Co. Ltd., New Delhi 2004.

Course Code: Discipline Specific Elective - 1

Course Title: Plant Biochemistry

Academic year 2022-23

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
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	Unit	Course/ Unit Title Plant Biochemistry	Credits/ Lectures 4 Credits
I	**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	3L
	1.2.1	Specialized plant cells (in brief) – Parenchyma, Sclerenchyma, Collenchyma, Xylem and phloem, Bulliform cells	2L
	1.2.2	Concept of apoplast, apoplastic and symplastic pathways	1L
	1.2	Plant pigments –	3L
	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	1L
	1.4	Nitrogen metabolism	5L
	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	
II	**2**	**Photosynthesis, Photorespiration and plant movements**	**15L**
	2.1	Photosynthesis	3L
	2.2	Light reactions: Light harvesting complexes, Absorption of light, Photophoshorylation: Cyclic and Non-cyclic (Z scheme)	
	2.2.1	Dark reactions: Calvin cycle, regulation of Calvin cycle	5L
		C4 cycle and CAM pathway	
		Synthesis of glucose, starch, sucrose	
	2.2.2	Photorespiration, Photoperiodism and photoinhibition	4L
		Physiology of plant movements Physical movements – Xerochasy, Hydrochasy	3L

		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	2L
	3.2	Secondary metabolites of plants Nitrogen containing compounds (Alkaloids), Terpenes & Phenolic compounds – Shikimic acid pathway, Mevalonic acid pathway, MEP Pathway	4L
	3.3	Reproduction in plants and PTC	7L
	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	
		Post fertilization events in plants	
	3.4	Plant Tissue Culture Principles & techniques of PTC	2L
IV	**4**	**Phytoremediation**	**15L**
	4.1	Concept of Phytoremediation Process and mechanism contaminant removal, General contaminants of air, water and soil	4L
	4.2	Mechanisms of Phytoremediation	5L
	4.2.1	Phytoextraction, phytostabilization, phytotransformation, phytostimulation, phytovolatalization and Rhizofiltration	
	4.2.2	Enzymes involved in phytoremediation	
	4.3	Control of environmental pollution by Phytoremediation. Criteria for selection of plants	6L
	4.4	Phytoremediation of air, water and soil pollutants and their Case studies	
	1	**Practicals – RPSBCHP104** Study of medicinal plants for human health and their health benefits	2 Credits

	2	Extraction of essential oils from plants	
	3	Phytochemical analysis – Qualitative test	
	4	Quantitative estimation of Total Phenolic content	
	5	Study of effect of Eutrophication on water quality	
	6	Preparation of growth media using plant waste	
	7	Total carbohydrate content by Anthrone method	
	8	Estimation of Vitamin C Content in plant by dye method.	
	9	Effect of phytohormones on plant growth.	

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.

Modality of Assessment (SEMESTER I)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

B) External Examination- 60%- 60 Marks
Semester End Theory Examination: (Deviation from the usual modality)
Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

1. Duration - These examinations shall be of **02 ½ HOURS** duration.
2. Theory question paper pattern:

Paper Pattern:

Questions	Pattern	Marks	Question based on
Q.1 A)	Any 1 out of 2	8	Unit I
Q.1 B)	compulsory	7	
Q.2 A)	Any 1 out of 2	8	Unit II
Q.2 B)	compulsory	7	
Q.3 A)	Any 1 out of 2	8	Unit III
Q.3 B)	compulsory	7	
Q.4 A)	Any 1 out of 2	8	Unit IV
Q.4 B)	compulsory	7	
	TOTAL	60M	

Practical Examination Pattern:

Semester End Practical Examination:

Particulars	Practical I, II, III & DSE - 1
Laboratory work	40
Viva	5
Journal	5
Total	**50**

Overall Examination & Marks Distribution Pattern

Semester I

Course	101			102			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals		50	50		50	50	100

Course	103			104			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals		50	50		50	50	100

Course Code: Discipline Specific Elective - 2

Course Title: Clinical Microbiology and Epidemiology

Academic year 2022-23

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the layout, workflow and documentation in a Clinical Microbiology laboratory
CO 2	Understand different classical and modern processes in a Clinical Microbiology laboratory and their significance
CO 3	Comprehend the threat of Antimicrobial resistance
CO 4	Apply appropriate methodologies to tackle the threat of antibiotic resistance
CO 5	Perform and analyse all kinds of clinical microbiological tests associated with antibiotic susceptibility testing
CO 6	Demonstrate a basic understanding of epidemiological strategies, study designs and evaluate the data for its statistical relevance.
CO 7	Discuss and understand the strategies to detect & monitor biological agents used for bioterrorism & exemplify the significance of biosecurity.
CO8	Understand the significance of health care associated infections, molecular and genetic epidemiology and apply it
CO 9	Become aware and get sensitized to the ethics of epidemiological studies involving human participants

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
DSE 1		**CLINICAL MICROBIOLOGY AND EPIDEMIOLOGY**	**04/60**
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 surgical procedures e) Automation and HTS in diagnosis f) Point of care diagnostics	
II		**Clinical Microbiology- Antibiotic resistance and Antibiotic susceptibility testing**	**15**
	2.1	**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	**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 I**	**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) Analyzing and interpreting data e) Disseminating data and interpretation f) Evaluating and improving surveillance	
	3.3	**Bioterrorism**	**03**
		a) Introduction b) Threat Agents by category c) Sentinel Laboratory response to bioterrorism d) The Potential for Misuse of Biotechnology e) Some examples of biological agents as warfare – Bacillus anthracis, Yersinia pestis	
	3.4	**Biosecurity**	**01**
		a) Introduction b) Constituents of a Biosecurity hazard	
II		**EPIDEMIOLOGY II**	**15**
	2.1	**Healthcare-associated infections**	**04**
		a) Surveillance for HAIs b) Major types of HAIs c) The need for integrated infection control programs	
	2.2	**Molecular and Genetic Epidemiology**	**07**
		a) Definition – Molecular v/s Genetic epidemiology b) Epidemiologic evidence of genetic factors c) Causes of Familial Aggregation d) Gene Mapping: Segregation and Linkage analysis e) Genome Wide Association Studies (GWAS) Applications of genes in Epidemiologic designs	
	2.3	**Ethics in Research involving Human Participants**	**03**
		a) Introduction	

		b) Historical perspective c) International Ethical and Research Practice guidelines d) Contemporary examples e) The informed Consent process	
	2.4	**Epidemiology as a Profession**	**01**

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.

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

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

PRACTICALS: DSE 1 (60 CONTACT HRS)

a) QC of laboratory media
b) QC of laboratory reagents
c) Use of chromogenic media for detection of antibiotic resistant bacteria
d) Detection of Beta lactamase producing *S.aureus* using nitrocefin disc's
e) Antimicrobial susceptibility testing- disc method according to CLSI guidelines
f) QA of Antibiotic Susceptibility Test- disc method
g) Antibiotic Susceptibility Test – microdilution methods according to CLSI guidelines
h) Checkerboard assay
i) E-test
j) Octa-disc method for AST
k) Case Studies of epidemiological strategies
l) Data analysis of epidemiological surveys
m) Group project on collecting data for surveillance

Modality of Assessment:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	40

B) External Examination- 60%- 60 Marks per paper

1. Duration- These examinations shall be of **two hours and thirty minutes**.
2. Theory question paper pattern-
    a. There shall be **five** questions each of **12** marks. On each unit there shall be one question and the fifth question will be based on all the three units.
    b. All questions shall be compulsory with internal choice within the questions.

Paper pattern:

Question	Options	Marks	Questions based on
Q.1)	Any 2 out of 3	12	Unit 1
Q.2)	Any 2 out of 3	12	Unit 2
Q.3)	Any 2 out of 3	12	Unit 3
Q.4)	Any 2 out of 3	12	Unit 4
Q.5) a)	Any 4 out of 5	04	All four units
Q.5) b)	Any 4 out of 5	04	All four units
Q.5) c)	Any 2 out of 3	04	All four units

II) Practical Examination Pattern

	Paper I	Paper II	Paper III	Paper IV
Journal	05	05	05	-
Viva	05	05	05	-
Quiz	05	05	05	25
Laboratory work	35	35	35	-
Literature Review	-	-	-	25
Total	**50**	**50**	**50**	**50**

Journal

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination. In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / Incharge of the department; failing which the student will not be allowed to appear for the practical examination.

Overall Examination and Marks Distribution Pattern

Semester I

Course	101			102			103			104			
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	Grand total
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**40**	**60**	**100**	**40**	**60**	**100**	**400**
Practicals	**-**	**50**	**50**	**-**	**50**	**50**	**-**	**50**	**50**	**-**	**50**	**50**	**200**

Semester End Examination: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

Course Code: Discipline Specific Elective - 3

Course Title: Clinical Data Management

Academic year 2022-23

COURSE OUTCOMES:

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	Analyse 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
DSE	I	**Drug discovery and Preclinical toxicology** Pre-Clinical toxicology: General Principals, Systemic toxicology, (Single dose and repeat dosetoxicity studies), Carcinogenicity, Mutagenicity,Teratogenicity, 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.	**15**
	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**
	IV	**Medical Writing** Medical Writing: Literature search and medical articles, contract writing, publication, abstracts, bibliography clinical study reports, principles and softwares in CDM	**15**

References:

1. EC R1 guidelines

2. ICMR ethical guidelines

3. D & C Rules – ScheduleY

4.LawOfIntellectualPropertyRightsShivSahaiSinghDeep&DeepPublications (p) Ltd

5. WTO And Intellectual Property Rights By Talwar Sabanna (2007)Serials Publications.

6.IPR:UnleashingtheKnowledgeEconomy(2003)Prabuddha Ganguli Tata Mcgraw Hillpublication

PRACTICALS (02 credits):-

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/commed 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 before performing preclinical toxicity study.

6. Perform preclinical toxicity study on cell lines and microorganisms using drugs screened in expt no.5

7. Various ways to resolve vendor issues.

Modality of Assessment

Semester I

Theory Examination Pattern

A) Internal assessment -40%-40 Marks

Sr.No.	Evaluation Type	Marks
1	One Assignment /case study/project based/Written assignment/Presentations	20
2	One class test (Multiple choice questions)	20

B) External Examination- 60%-60 Marks
Semester End Theory Examination:

1. Duration: These examinations shall be of 2.5 hrs
2. Theory question paper pattern
   - There shall be 4 questions each of 15 Marks. On each unit there will be one question
   - All questions shall be compulsory with internal choice within the questions

Paper Pattern:

Questions	Pattern	Marks	Question based on
Q.1 A)	Any 1 out of 2	8	Unit I
Q.1 B)	compulsory	7	
Q.2 A)	Any 1 out of 2	8	Unit II
Q.2 B)	compulsory	7	
Q.3 A)	Any 1 out of 2	8	Unit III
Q.3 B)	compulsory	7	
Q.4 A)	Any 1 out of 2	8	Unit IV
Q.4 B)	compulsory	7	
	TOTAL	60M	

Practical Examination Pattern:

A) External Examination- 50 Marks
Semester End Practical Examination

Particulars	Paper
Laboratory Work	40
Journal	05
Viva	05
Total	50

Overall Examination and Marks distribution Pattern

Semester I

Course	**RPSBTK101/102/103/ 104**			**Grand total**
	Internal	**External**	**Total**	
Theory	**40**	**60**	**100**	**400**
Practicals		**50**	**50**	**200**

Semester II

Course Code: RPSBCH201

Course Title: Industrial Biotechnology

Academic year 2022-23

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the fermentation process, inoculum development and fermentation media.
CO 2	Acquire information about large scale production and purification of various industrially important produces.
CO 3	Procure information about types and applications of biosensors in the field of biology.
CO 4	Obtain knowledge about production of different types of vaccines
CO 5	Realize the importance and identify the requirements for the compliance of QC, QA, GMP and GLP

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Industrial Biotechnology RPSBCH201	Credits/ Lectures 4 Credits
I	**1**	**Industrial Importance of Carbohydrates, Proteins & Lipids**	**15L**
	1.1	Carbohydrates of industrial importance	2L
	1.1.1	Manufacturing and refining of cane sugar, pectin & cellulose	
	1.1.2	Manufacturing of polysaccharides-Plant polysaccharide (Gum Arabic), microbial polysaccharides– modified starches & celluloses	3L
	1.2	Lipids of industrial importance	3L
	1.2.1	Extraction and refining of vegetable oils and animal fats & essential oils	
	1.2.2	Extraction and applications of chlorophyll, carotene, lycopene Turmeric	2L
	1.3	Proteins of industrial importance	5L
	1.3.1	Hormones – conventional & engineered-Insulin, Erythropoietin, Growth hormones	
	1.3.2	Non – catalytic industrial proteins – casein, whey proteins, Egg proteins, wheat germ proteins.	
II	**2**	**Biosensors & Vaccine Technology**	**15L**
	2.1	Biosensors	2L
	2.1.1	Beneficial features of biosensors	
	2.1.2	Basic components of biosensor	
	2.2	Types: Electrochemical, Thermometric, Optical, Piezoelectric, Whole cell, Immunobiosensor (Construction and development) Types of biosensors, their construction, working and application in various industries and medicine	2L
	2.2.1	Calorimetric biosensor – Enzyme based sensors (Importance in clinical diagnosis)	3L
	2.2.2	Potentiometric biosensor- Ion selective electrode (Importance in environmental monitoring)	
	2.2.3	Amperometric biosensor- (Glucose monitoring) Optical biosensor- Chromogenic reaction	
	2.2.4	Piezo-electric biosensor –Crystal study	1L
	2.2.5	Immunosensor - ELISA	

	2.3	Production of vaccine	2L
	2.3.1	Vaccine derived from whole organism Attenuated & Inactivated vaccine	
	2.3.2	Vaccine derived from macromolecules purified from pathogenic organism – Use of Bacterial polysaccharide, Toxoid, Proteins, Synthetic peptide for vaccine development	3L
	2.3.3	Recombinant vector vaccine	
	2.3.4	Multivalent subunit vaccine- (SMAA complex & ISCOM)	2L
	2.3.5	DNA vaccine (Production & applications)	
	2.3.6	Anti-Idiotype vaccine (Use of hybridoma technology)	
III	**3**	**Bioprocess technology**	**15L**
	3.1	Upstream processing:	2L
	3.1.1	Strains and Strain Improvement of industrial microorganisms	
	3.1.2	Isolation of industrially important microorganisms	
	3.1.3	Improvement of industrial microorganisms a) Selection of induced mutants for primary metabolite b) Isolation of induced mutants for secondary metabolites	3L
	3.1.4	Sterilization i) Introduction ii) Media sterilization	
	3.1.5	Design and methods of batch sterilization	2L
	3.1.6	Design and methods of continuous sterilization	
	3.2	Downstream processing	5L
	3.2.1	Recovery & Purification of fermentation products: i. Introduction, Precipitation, Filtration - theory, filter-aids, batch filters (Plate and frame filters), continuous filters (Rotary vacuum), Centrifugation: flocculating agent, range of centrifuges - Basket, tubular bowl. ii. Cell disruption: Physico-chemical. iii. Liquid – Liquid extraction, Solvent recovery, iv. Chromatography, Ultrafiltration, reverse osmosis, liquid membranes, drying, crystallization, Whole broth processing.	
	3.3	Environmental aspects	3L
	3.3.1	Effluent treatment and regulations for fermentation industry	
	3.3.2	Modern methods of effluent treatment	

IV	**4**	**Total Quality Management (QC, QA, GLP, GMP)**	**15L**
	4.1	Importance of Laboratory Quality	2L
	4.1.1	Overview of the quality management system	
	4.2	Introduction and Concept (in labs & production processes) of -	3L
	4.2.1	QC – Types, Requirement to implement QC, Control materials	
	4.2.2	QA – SOP, Calibration, Auditing and checking compliance	3L
	4.2.3	GMP – Sanitation and Hygiene, Qualification and validation, Documentation of GMP practices	3L
	4.2.4	GLP – Protocol, Standard Operating Procedures (SOPs), Validation of methods, Audits and Inspection	4L
		Practicals – RPSBCHP201	2 Credits
	1	Estimation of Total Carbohydrates by anthrone method	
	2	Colorimetric estimation of fructose	
	3	Isolation of pectin form apples	
	4	Isolation of cellulose by acidified sodium chlorite treatment	
	5	Plant protein extraction by TCA-Acetone method	
	6	Isolation of Lecithin & Cholesterol from egg yolk	
	7	Extraction of oils using Soxhlet apparatus and it's analysis	
	8	Bioassay of vitamin B_{12}	
	9	Quality control experiments	
	10	Virtual Lab – Bioreactor modelling & Simulation Lab	

References:

1) L.E.Casida, Industrial Microbiology, New Age International publishers
2) Biosensors: Fundamentals and Applications, Bansi Dhar Malhotra and Chandra Mouli Pandey (Smithers Rapra)
3) Handbook of Good Laboratory Practices (GLP), Second Edition – World Health Organization
4) Quality Assurance - A Practical Guide to the Design and Implementation of Assessments and Monitoring Programmes, Jamie Bartram and Gareth Rees, World Health Organization
5) M. Pelczar, E.C.S. Chan and M.R. Krieg, MICROBIOLOGY, McGraw Hill Inc., Singapore (1997).
6) L. E. Casida, Industrial microbiology, New age international publishers
7) Industrial Fermentation by Paul Allen
8) Biochemical methods, S Sadashivam and A Manickam, new age international publishers
9) J. Jayaraman, Laboratory Manual in Biochemistry, 2003, New Age International

Course Code: RPSBCH202

Course Title: Molecular Biology

Academic year 2022-23

COURSE OUTCOMES:

After completion of the course, a student will be able to achieve these outcomes

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the mechanism of cell cycle, relationship of cell cycle and programmed cell death via intracellular and extracellular control mechanisms
CO 2	The students will learn about nucleic acid as genetic information carriers, Possible modes of replication, and roles of helicase, primase, gyrase, topoisomerase, DNA Polymerase, DNA ligase, and Regulation of replication.
CO 3	The student will be able to illustrate the mechanism of prokaryotic and eukaryotic replications
CO 4	The student will learn & understand different types of mutations, agents causing mutations and disorders resulting from mutations.
CO 5	Comprehend the mechanism and regulation of transcription in prokaryotes along with Reverse transcription.
CO 6	The student will be able to describe synthesis of protein from gene with the help of regulatory protein
CO 7	The student will be able to explain the Post transcriptional & translational modifications & their significance in stability

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title Molecular Biology RPSBCH202	Credits/ Lectures 4 Credits
I	**1**	**Cell Cycle and its regulation & DNA Replication**	**15L**
	1.1	Cell cycle and its regulation	3L
	1.1.1	Phases of cell cycle and its regulation (Cyclins & CDKs)	
	1.1.2	State of DNA in different phases of cell cycle	
	1.2	Replication of DNA	2L
	1.2.1	Structural overview of DNA Replication	
	1.2.2	Enzymes and proteins involved in replication	2L
	1.2.3	Mechanism of Bacterial DNA replication	
	1.3	Replication of DNA in yeast	2L
	1.3.1	Eukaryotic DNA polymerases	
	1.3.2	Proteins and accessory molecules essential in the initiation, and elongation steps	
	1.3.3	Mechanism (Pre-RC assembly, Initiation, elongation & termination)	2L
	1.3.4	Concept of Okazaki fragment maturation & stalled replication fork	3L
	1.3.5	End replication problem and role of telomerases	
	1.4	Comparative overview of DNA replication in prokaryotes and eukaryotes	1L
II	**2**	**Prokaryotic and eukaryotic Transcription & Post-transcriptional Modifications**	**15L**
	2.1	Overview of Transcription	1L
	2.2.1	Role of Prokaryotic RNA polymerase and promoter; Upstream regulatory sequences	4L
	2.2.2	Stages of transcription: Initiation, elongation and termination (Rho dependent & Rho independent)	
	2.2.3	Significance of Sigma factor, Concept of Abortive initiation	
	2.3	Transcription in eukaryotes	3L
	2.3.1	Role of promoter & regulatory elements	
	2.3.2	Eukaryotic RNA polymerases	
	2.3.3	Mechanism of RNA transcription in eukaryotes - Formation of pre-initiation complex, initiation, elongation and termination, Phosphorylation of RNAPII	

	2.4	RNA Modification	1L
	2.4.1	Mechanism of addition of 5'-cap & formation of poly A tail, 5'-cap of snRNA	
	2.4.2	Molecular mechanism of mRNA Splicing	1L
	2.4.3	RNA Processing of rRNA & tRNA	1L
	2.4.4	RNA editing - Base modifications, role of snoRNA	1L
	2.5	Role of Inhibitor -Rifampicin, Actinomycin D, α-Amanitin	1L
	2.6	Reverse transcription (Mechanism, significance & application)	2L
	3	**Prokaryotic and eukaryotic Translation & Post-translational Modifications**	**15L**
	3.1	Genetic basis of protein biosynthesis – Concept of structural gene & Protein, Characteristics of Genetic code	4L
	3.2	Ribosome assembly & structure (Comparison between prokaryotic & eukaryotic ribosome)	
	3.3	tRNA – structural features and tRNA synthetase, initiator tRNA, activation of amino acids	2L
III	3.4.1	Mechanism of translation in prokaryotes: Initiation, elongation & termination	3L
	3.4.2	Concept of Polyribosome	
	3.5	Mechanism of eukaryotic translation: Initiation, elongation & termination	2L
	3.6	Inhibitors of translation (prokaryotes & eukaryotes)	1L
	3.7	Post translational modifications of proteins	1L
	3.8.1	Signal hypothesis	2L
	3.8.2	Role of signal peptide & its role in Protein sorting	
	3.9	Protein localization in Nucleus	
	4	**Gene regulation in prokaryotes and Eukaryotes**	**15L**
	4.1	Gene regulation in prokaryotes	7L
	4.1.1	Principles of gene regulation, Constitutive & inducible genes, one cistron-one subunit concept	
	4.1.2	Negative and positive regulation	
IV	4.2	Concept of operons, regulatory proteins, activators, repressors, DNA binding domains, allosteric site	
	4.3	Lac, Tryptophan and Arabinose operon – Structure, inducers (allolactose, IPTG), Negative control & Positive control of lac operon	
	4.4	Gene regulation in Eukaryotes	8L

	4.4.1	Role of regulatory transcription factors in eukaryotic gene regulation-general TF and Regulatory TF, TFIID and Mediator	
	4.4.2	Regulation of galactose metabolism in yeast	
	4.4.3	Regulatory RNAs in eukaryotes: synthesis and mechanism of siRNA and miRNA	
		Practicals – RPSBCHP202	2 Credits
	1	To hydrolyze DNA and separate nucleotide bases by paper chromatography	
	2	Isolation of chromosomal DNA from E coli cells	
	3	Qualitative Analysis of DNA by AGE	
	4	Designing of Oligonucleotide primers for PCR	
	5	Amplification of a DNA fragment by PCR	
	6	Cytochemical staining of RNA by Methyl Green Pyronin.	
	7	Total RNA isolation from Bacterial Cells	

Course Code: Discipline Specific Elective 1

Course Title: Nutraceutical and Functional Foods

Academic year 2022-23

COURSE OUTCOMES:

After completion of the course, a student will be able to

COURSE OUTCOME	DESCRIPTION
CO 1	Understand the Basics of Nutraceuticals as Science
CO 2	Comprehend the Properties, structure and functions of various Nutraceuticals
CO 3	Demonstrate the use of Nutraceuticals as remedies
CO 4	Develop Novel Food and food Ingredients: Polysaccharides, low caloric sweeteners
CO 5	Illustrate the effect of Anti-nutritional factors and Limitations of Nutraceuticals & Functional foods

DETAILED SYLLABUS

Course Code/ Unit	Unit	Course/ Unit Title	Credits/ Lectures 4 Credits
I	**1**	**Nutraceutical Science**	**15L**
	1.1	Introduction to Nutraceuticals as Science	1L
	1.2	Classification, scope & future prospects of the Nutraceutical Science	3L
	1.3	Sources of Nutraceuticals.	3L
		Plant sources, Animal sources, Microbial sources and Minerals	
	1.4	Applied aspects of the Nutraceutical Science.	1L
	1.5	Relation of Nutraceutical Science with other Sciences	4L
	1.5.1	Medicine, Human physiology, genetics, food technology, chemistry and nutrition.	
	1.6	Analysis of nutraceuticals- Techniques (Spectroscopic, Voltammetric, Chromatographic)	3L
II	**2**	**Bioceuticals**	**15L**
	2.1	Properties, structure and functions of various Nutraceuticals	3L
	2.1.1	Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine alpha ketoglutarate	
	2.1.2	Use of proanthocyanidins, grape products, flaxseed oil, minor millets as Nutraceuticals.	3L
	2.3	Development of Novel Food and food Ingredients:	6L
	2.3.1	Naturally produced flavour modifiers, Single Cell Proteins, Marine Algae as food supplements.	
	2.4	Food supplements and food ingredients as by products – Fishery, poultry/animal husbandry and agriculture/dairy industries.	3L
III	**3**	**Food remedies**	**15L**
	3.1	Food as a remedy	
	3.1.1	Nutraceuticals bridging the gap between food and drugs.	3L
	3.1.2	Nutraceuticals in treatment for cognitive decline	2L
	3.1.3	Nutraceutical remedies for common disorders like Arthritis, Bronchitis, circulatory problems, hypoglycemia, Nephrological disorders, Liver disorders, Osteoporosis, Psoriasis and Ulcers	4L

	3.2	Brief idea about some Nutraceutical rich supplements	6L
	3.2.1	Bee pollen, Caffeine, Green tea, Lecithin, Mushroom Extract.	
	3.2.2	Chlorophyll, Kelp and Spirulina.	
IV	**4**	**Anti-nutritional Factors & Limitations of Nutraceuticals**	**15L**
	4.1	Anti-nutritional factors present in foods	
	4.1.1	Types of inhibitors present in various foods and how they can be inactivated	2L
	4.2	General idea about role of Probiotics and Prebiotics as nutraceuticals. Recent advances in techniques & feeding of substrates.	4L
	4.3	Assessment of nutritional status and Recommended Daily allowances.	2L
	4.4	Non Nutrient Effect of Specific Nutrients : Proteins and Peptides and Nucleotides, Trans fats, Vitamins, Minerals	4L
	4.5	Issues on functional foods and nutraceuticals in animals	3L
		Practicals 1. To determine the lactose present in the Soy-milk by Cole's method 2.Determination of reducing sugars by Nelson: Somogyi Method 3.Protein Estimation by Bradford's method 4. Determination of Hardness of water 5.Estimation of Cholorogenic acid (Anti-Nutritional Factor) 6.Estimation of phytic acid by Heubner and Stadler Method 7.Estimation of Vitamin C by Folin Phenol method 8. Optimization and Analysis of probiotics 9.Comparative assessment of Fat content in Full cream milk and low fat milk.	2 Credits

References:

1. Nutraceuticals: Efficacy, Safety and Toxicity by Ramesh C. Gupta
2. Nutraceuticals: The Complete Encyclopedia of Supplements, Herbs, Vitamins and Healing Foods by Arthur J. Roberts, Genelle Subak-Sharpe, et al.
3. Advances in Nutraceutical Applications in Cancer: Recent Research Trends and Clinical Applications (Nutraceuticals) by Sheeba Varghese Gupta and Yashwant V Pathak

4. Nutraceuticals in Health and Disease Prevention (Infectious Disease and Therapy Book 6) by PETER. PAUL HOPPE, Klaus Kramer, et al.
5. Nutrigenomics and Nutraceuticals: Clinical Relevance and Disease Prevention by Yashwant V. Pathak and Ali M. Ardekani
6. Pharmaceuticals to Nutraceuticals: A Shift in Disease Prevention by Dilip Ghosh and R.B.Smarta
7. Handbook of Nutraceuticals and Functional Foods (Modern Nutrition) by Robert E.C. Wildman and Richard S. Bruno

Modality of Assessment (SEMESTER II)

Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

B) External Examination- 60%- 60 Marks
Semester End Theory Examination: (Deviation from the usual modality)
Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

1. Duration - These examinations shall be of **02 ½ HOURS** duration.
2. Theory question paper pattern:

Paper Pattern:

Questions	Pattern	Marks	Question based on
Q.1 A)	Any 1 out of 2	8	Unit I
Q.1 B)	compulsory	7	
Q.2 A)	Any 1 out of 2	8	Unit II
Q.2 B)	compulsory	7	
Q.3 A)	Any 1 out of 2	8	Unit III
Q.3 B)	compulsory	7	
Q.4 A)	Any 1 out of 2	8	Unit IV
Q.4 B)	compulsory	7	
	TOTAL	60M	

Practical Examination Pattern:

Semester End Practical Examination:

Particulars	Practical I, II, III & DSE - 1
Laboratory work	40
Viva	5
Journal	5
Total	**50**

Overall Examination & Marks Distribution Pattern

Semester II

Course	201			202			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals		50	50		50	50	100

Course	203			204			Grand Total
	Internal	External	Total	Internal	External	Total	
Theory	40	60	100	40	60	100	200
Practicals		50	50		50	50	100

Course Code: Discipline Specific Elective - 2

Course Title: Microbial Approaches to Quality Management

Academic year 2022-23

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Execute collection, processing and microbiological analysis of food, water, pharmaceutical and cosmetic samples
CO 2	Implement monitoring protocols for the quality of food and water using principles of HACCP
CO 3	Apply basic knowledge of microbial analysis and standards to evaluate current techniques and improvise technology in industries like food, bottled water, cosmetic and pharmaceutical manufacturing units
CO 4	Recall the principles and terminologies used in pharmaceutical industry
CO 5	Design experiments on bioburden determination
CO 6	Execute microbial and sterility testing of pharmaceutical products
CO 7	Monitor the factors which affect the quality of a pharmaceutical product
CO 8	Outline the process of validation and audit validation
CO 9	Design effective antimicrobial preservation methods for cosmetic products

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
DSE 2		**MICROBIAL APPROACHES TO QUALITY MANAGEMENT**	**04/60**
I		**Introduction to Quality Control and Quality Assurance**	**15**
	1.1	Basics of Quality and Audits a) Introduction to Basics of Quality b) Total Quality Management c) Quality Assurance d) Audits e) Manufacturing Audits: Control of Processing Operations	**08**
	1.2	Good Manufacturing Practices and HACCP a) Plant Sanitation: Good Manufacturing Practice Audits b) Hazard Analysis and Critical Control Points	**07**
II		**Quality Control and Quality Assurance in Food and Water Industry**	**15**
	2.1	Quality Assurance in Food Industry a) Food Safety Assurance and Standards b) Microbiological Examination Methods for food c) Role of International and National Organisations	**09**
	2.2	Quality Assurance in Water Industry a) General considerations and principles b) A conceptual framework for implementing the Guidelines c) Verification of drinking-water quality d) Drinking-water regulations and supporting policies and programmes	**06**
III		**Quality Control and Quality Assurance in Pharmaceutical Industry**	**15**
		A. Laboratory management and design B. Microbiological examination of nonsterile products C. Sterility Testing D. Antibiotic Potency Testing	
III		**Quality Control and Quality Assurance in Pharmaceutical and Cosmetic Industry**	**15**

		A. Pyrogen Testing and Bioburden determination B. Antimicrobial Effectiveness Testing and Preservation of Cosmetics a) Preservative Effectiveness Testing b) Preservation of cosmetics c) Aspects of cosmetic preservation	8 7

REFERENCES:

a) Rosamund M.Baird, Norman A.Hodges, Stephen P.Denyer, Handbook of Microbiological Quality Control: Pharmaceuticals and Medical Devices Taylor and Francis

b) Food And Drug Administration, Office Of Regulatory Affairs, Office of Regulatory Science, Document Number:ORA.007, Pharmaceutical Microbiology Manual, Revision #: 02 Revised: 25 Aug 2020

c) Tim Sandle, "Pharmaceutical Microbiology- Essentials for Quality Assurance and Quality control", Woodhead Publishing, Elsevier, 2016

d) Philip A,Taylor and Francis, "Cosmetic Microbiology a practical approach", 2nd Ed. 2006

e) WHO drinking water guidelines, Manual For Packaged Drinking, Water Bureau Of Indian Standards, January 2005

f) Food Safety Management Programs by Debby Newslow

g) Microbiological Examination Methods for Food and Water by Neusely da Silva

h) Food Safety Management A Practical Guide for the food Industry by Yasmine Motarjem

i) Quality Assurance for Food Industry- A Practical Approach. 3rd Edition, J. Andres Vasconcellos

PRACTICAL: DSE 2 (60 CONTACT HRS)

a) Sterility testing and reporting (as per Pharmacopeia)

b) Preparation of cosmetic product and its stability study

c) Microbial load in cosmetic product as per IS 14648:2011 w.r.t heterotrophic counts, presence of *Pseudomonas spp, Staphylococcus spp, P.acne*

d) Efficacy testing of preservatives like parabens as per ISO 11930

e) Performance of an audit of a test with proper documentation

f) Bioburden determination of manufacturing unit

g) Determination of efficacy of sterilization methods.

h) Demonstration of endotoxin/pyrogen testing

i) Microbiological load in carrot and apple juice, salad, mayonnaise

j) Quality Assessment and Analysis of Raw and Pasteurized milk

k) To detect coliform and faecal coliform bacteria in water by the membrane filtration method

l) Study of efficiency of water purifiers and comparative assessment
m) MIC of food preservative
n) Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT)
o) Potability testing of drinking Water.
p) Film medium for detection of coliforms in water and food
q) Dip slide technique for detection of organisms from food and water samples

Modality of Assessment:

I) Theory Examination Pattern:

A) Internal Assessment- 40%- 40 Marks

Sr No	Evaluation type	Marks
1	One Review writing/ Review paper presentation/Research paper presentation and Assignment / Long Answer/ Case Study or any other	40

B) External Examination- 60%- 60 Marks per paper

1. Duration- These examinations shall be of **two hours and thirty minutes**.
2. Theory question paper pattern-
    a. There shall be **five** questions each of **12** marks. On each unit there shall be one question and the fifth question will be based on all the three units.
    b. All questions shall be compulsory with internal choice within the questions.

Paper pattern:

Question	Options	Marks	Questions based on
Q.1)	Any 2 out of 3	12	Unit 1
Q.2)	Any 2 out of 3	12	Unit 2
Q.3)	Any 2 out of 3	12	Unit 3
Q.4)	Any 2 out of 3	12	Unit 4
Q.5) a)	Any 4 out of 6	04	All four units
Q.5) b)	Any 4 out of 6	04	All four units
Q.5) c)	Any 2 out of 3	04	All four units

II) Practical Examination Pattern

	Paper I	Paper II	Paper III	Paper IV
Viva	05	05	10	-
Quiz	-	10	-	-
Laboratory work	25	35	40	20
Proposal Writing	-	-	-	30
Research Proposal Presentation	20	-	-	
Total	**50**	**50**	**50**	**50**

Journal

1. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.
2. In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head/ Co-ordinator / In charge of the department; failing which the student will not be allowed to appear for the practical examination.

Research Proposal writing

Candidates are required to present duly certified Research proposal and make the PowerPoint presentation of the research proposal for evaluation by the examiner.

Overall Examination and Marks Distribution Pattern

Semester II

Course	201			202			203			204			
	Internal	External	Total	Internal	External	Total	Internal	External	Total	Internal	External	Total	Grand total
Theory	**40**	**60**	**100**	**40**	**60**	**100**	**40**	**60**	**100**	**40**	**60**	**100**	**400**
Practicals	**-**	**50**	**50**	**-**	**50**	**50**	**-**	**50**	**50**	**-**	**50**	**50**	**200**

Semester End Examination: (Deviation from the usual modality)

Owing to the pandemic situation prevailing in 2020 and continuing in 2021, the external examinations (Semester End) may be conducted online as per the instructions/circulars received from the University of Mumbai and Maharashtra State notifications from time to time. The conventional mode of external examination will commence again only after the declaration of normalcy by the Government authorities.

Course Code: Discipline Specific Elective - 3

Course Title: Nanotechnology

Academic year 2022-23

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION
CO 1	Discuss the basics of nanotechnology, tools used for characterizing nanomaterials and specific applications of nanotechnology.
CO 2	Examine the nanorobotics devices of nature.
CO 3	Analyze and interpret the latest developments in nanotechnology in the field of medical sciences.
CO 4	Explain drug delivery systems using nanotechnology.
CO 5	Apply nanomaterials in food, cosmetics, agriculture, environment management.
CO 6	Assess and appreciate the thrust in the domain and encourage it to take ahead in research.

DETAILED SYLLABUS

Course Code	Unit	Course/ Unit Title	Credits/ Lectures
DSE	I	**Introduction to nanotechnology - principles and applications** Introduction, synthesis of nanomaterials, biological methods, use of microbial systems & plant extracts, useofproteins&templateslikeDNA.Characterization of nanomaterials, analysis techniques, properties of nanomechanical, optical, magnetic properties,electrical conductivity, thermal conductivity.	**15**
	II	Carbon nanotubes, Nanorobotics devices of nature: ATP synthase, the kinen, myosin, dynein, flagella modulated motion	**15**
	III	**Nanomedicine** Nanomedicine : biopharmaceuticals ,implantable materials,implantable chemicals,surgicals aids,diagnostic tools ,nanosensors and nanoscanning,nano enabled drug delivery system,nanorobotics in medicine	**15**
	IV	**Applications of nanotechnology** Application of nanomaterials in food, cosmetics, agriculture, environment management.	**15**

References:

1. TheNanoscopeencyclopediaofnanoscienceandnanochehnology,VolI,VandVI (2005) Dr.ParagDiwan and Ashish Bhardwaj Pentagon Press NewDelhi.
2. Nano forms of carbon and its applications (2007) Prof.Maheshwar Sharon and Dr.Madhuri Sharon Manad Nanotech Pvt.Ltd.
3. Biotech Nanotechnology lessons from Nature (2004) David Goodsell Wiley-Liss A John Wiley and sons.
4. Nanotechnology- Basic science and emerging technologies (2005) WillsonKannangava, Smith, Simmons, RaguseOverseasePress.
5. Textbook of Biotechnology (2005) R. C. Dubey S. Chand andCo.

6. Nanotechnology- Principles and practices S. K. Kulkarni Capital PublishingCo.

PRACTICALS (02 credits):-

1.Antibacterial studies of silver nanoparticles by MIC method.

2. Testing the cell viability of metal oxide nanoparticles using tissue culture technique.

3.Synthesis of Metal Nanoparticles by Chemical reduction method and their UV-VIS absorption studies.

4. Synthesis of nanoparticles using bacterial system and their UV-VIS absorption studies.

5. Synthesis of nanoparticles using plant extract and their UV-VIS absorption studies.

6. Synthesis of nanoparticles using fungal system and their UV-VIS absorption studies.

7. Analysis of nanoparticles using UV vis spectrophotometer , TEM ,SEM -data interpretation

Modality of Assessment

Semester II

Theory Examination Pattern

A) Internal assessment -40%-40 Marks

Sr.No	Evaluation Type	Marks
1	One Assignment /case study/project based/Written assignment/Presentations	20
2	One class test (Multiple choice questions)	20

B) External Examination- 60%-60 Marks
Semester End Theory Examination:

1. Duration: These examinations shall be of 2.5 hrs
2. Theory question paper pattern
   - There shall be 4 questions each of 15 Marks. On each unit there will be one question
   - All questions shall be compulsory with internal choice within the questions

Paper Pattern:

Questions	Pattern	Marks	Question based on
Q.1 A)	Any 1 out of 2	8	Unit I
Q.1 B)	compulsory	7	
Q.2 A)	Any 1 out of 2	8	Unit II
Q.2 B)	compulsory	7	
Q.3 A)	Any 1 out of 2	8	Unit III
Q.3 B)	compulsory	7	
Q.4 A)	Any 1 out of 2	8	Unit IV
Q.4 B)	compulsory	7	
	TOTAL	60M	

Practical Examination Pattern:

B) External Examination- 50 Marks
Semester End Practical Examination

Particulars	Paper
Laboratory Work	40
Journal	05
Viva	05
Total	50

Overall Examination and Marks Distribution Pattern

Semester II

Course	**RPSBTK201/202/203/204**			**Grand Total**
	Internal	**External**	**Total**	
Theory	**40**	**60**	**100**	**400**
Practicals	**-**	**50**	**50**	**200**