Resolution No.: AC/II(21-22).2.RPS4

S.P. Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore ● Experience ● Excel

Syllabus for: Semester I to IV

Program: M. Sc.

Program Code: Botany (RPSBOT)

Specialization: Molecular Biology, Cytogenetics and Plant Biotechnology

(Credit Based Semester and Grading System for the academic year 2021–2022)

PROGRAM OUTCOMES

In the post graduate courses, S. P. Mandali's Ramnarain Ruia Autonomous College is committed to impart conceptual and procedural knowledge in specific subject areas that would build diverse creative abilities in the learner. The College also thrives to make its Science post graduates research/ job ready as well as adaptable to revolutionary changes happening in this era of Industry 4.0.

PO	PO Description A student completing Masters in Science program will be able to:
PO 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.
PO 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.
PO 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.
PO 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.
PO 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.
PO 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.
PO 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.
PO 8	Understand cross disciplinary relevance of scientific developments and relearn and reskill so as to adapt to technological advancements.

PROGRAM SPECIFIC OUTCOMES

PSO	PSO Description A student completing Masters in Science program in the subject of Botany will be able to:
PSO 1	Gain adequate knowledge on major groups of plants -Cryptogams to Phanerogams, learn the inter-relationships, phylogeny and evolutionary concepts , biodiversity in relation to habitat correlate with climate change, land and forest degradation and Paleobotany to trace the evolution of plants
PSO 2	Comprehend the concepts of plant taxonomy with respect to principles of ICN, evolution, concept of characters and methods to illustrate evolutionary relationships. Familiarize with the latest classification system and role of BSI
PSO 3	Gain core knowledge of foundational concepts of anatomy, developmental botany, ultra-structure and function of cell membranes cyto-genetics, physiology and ecology and their application in contemporary research/biological systems
PSO 4	Critically evaluate the functioning of organisms at the genomic and cellular level, Relate physiological adaptations, development and reproduction of higher plants.
PSO 5	Outline the utilization of various plant groups, ethnobotanical aspects, active constituents and medicinal uses of plants with special reference to usage as mentioned in different Pharmacopoeia.
PSO 6	Apply the skills in handling scientific instruments in planning and executing biological research, demonstrate proficiency in the experimental techniques and methods of analysis appropriate for their area of specialization
PSO 7	Apply the principles of biostatistics and bioinformatics in biological research, evaluate the scientific content, apply the scientific methods in formulating hypothesis and data analysis.
PSO 8	Apply the technique of plant tissue culture for the propagation of the plants which is the need in the society /industry, apply the methods of *in vitro* techniques for product enhancement
PSO 9	Apply the fundamentals of Nanotechnology, Environmental biotechnology and food biotechnology in various fields
PSO 10	Understand and apply the techniques of plant breeding procedures for hybridization, stress tolerance and genetic engineering of plants.
PSO 11	Develop critical and logical thinking capacity and prepare themself to qualify various competitive exams like MPSC, UPSC,SET, GATE, CSIR and UGC NET

PROGRAM OUTLINE

YEAR	SEM	COURSE CODE	COURSE TITLE	CREDITS
FY	I	**RPSBOT 101**	**PLANT DIVERSITY – I**	**04**
		I	Phycology I	
		II	Phycology II	
		III	Mycology I	
		IV	Mycology II	
		RPSBOT 102	**PLANT DIVERSITY- II**	**04**
		I	Bryophyta	
		II	Pteridophyta and Paleobotany	
		III	Gymnosperms	
		IV	Origin of Angiosperms	
		RPSBOT 103	**DEVELOPMENTAL BOTANY AND RESEARCH METHODOLOGY**	**04**
		I	Developmental Botany	
		II	Palynology	
		III	Research Methodology I	
		IV	Research Methodology II	
		RPSBOT 104	**INSTRUMENTATION AND TEHNIQUES**	**04**
		I	Centrifugation and chromatography	
		II	Microscopy and spectroscopy	
		III	Tracer techniques and PCR	
		IV	pH, Buffers and Electrophoresis	
			PRACTICAL	
		RPSBOTP 101	Plant Diversity- I	**02**
		RPSBOTP 102	Plant Diversity –II	**02**
		RPSBOTP 103	Developmental Botany and Research Methodology	**02**
		RPSBOTP 104	Instrumentation and Techniques	**02**
		RPSBOT 201	**PLANT DIVERSITY- II**	**04**
		I	Angiosperms I	
		II	Angiosperms II	
		III	Anatomy I	
		IV	Anatomy II	
		RPSBOT 202	**PLANT PHYSIOLOGY- I**	**04**
		I	Photosynthesis I (Eukaryotes)	
		II	Photosynthesis II (Prokaryotes)	
		III	Protein structure	
		IV	Plant Hormones	

FY	**II**	**RPSBOT 203**	**PLANT PHYSIOLOGY- II**	**04**
		I	Stress Physiology	
		II	Seed Physiology	
		III	Environmental Botany I	
		IV	Environmental Botany II	
		RPSBOT 204	**CURRENT TRENDS IN BOTANY**	**04**
		I	Medicinal botany dietetics	
		II	Traditional knowledge and IPR	
		III	Biostatistics	
		IV	Bioinformatics	
			PRACTICAL	
		RPSBOTP 201	Plant diversity- II	**02**
		RPSBOTP 202	Plant physiology- I	**02**
		RPSBOTP 203	Plant physiology- II	**02**
		RPSBOTP 204	Current Trends in Botany	**02**
			SEMESTER III	
S Y	**III**	**RPSBOT301**	**PLANT BIOTECHNOLOGY I**	**04**
		I	Plant Tissue Culture I	
		II	Plant Tissue Culture II	
		III	Plant Tissue Culture III	
		IV	Commercial Aspects	
		RPSBOT302	**PLANT BIOTECHNOLOGY II**	**04**
		I	Environmental Biotechnology	
		II	Industrial and clinical uses of enzymes (Applied Enzymology)	
		III	Nanotechnology	
		IV	Food Biotechnology and Biosensors	
		RPSBOT303	**PLANT BREEDING**	**04**
		I	Plant Breeding I	
		II	Plant Breeding II	
		III	Molecular Plant Breeding	
		IV	Plant Genetic Engineering	
		RPSBOT304	INTERNSHIP / PROJECT	**04**
			PRACTICAL	
		RPSBOTP 301	Plant Biotechnology I	**02**
		RPSBOTP 302	Plant Biotechnology II	**02**
		RPSBOTP 303	INTERNSHIP / PROJECT	**02**
		RPSBOTP 304		**02**
			SEMESTER IV	
		RPSBOT401	**MOLECULAR BIOLOGY I**	**04**
		I	DNA Replication	
		II	Transcription	
		III	RNA Processing	
		IV	Translation	
		RPSBOT402	**MOLECULAR BIOLOGY II**	**04**

SY	**IV**	**I**	Gene regulation I	
		II	Gene regulation II	
		III	Gene regulation III	
		IV	Cell signaling	
		RPSBOT403	**CYTOGENETICS I**	**04**
		I	Cytology	
		II	Cancer Biology	
		III	Immune Systems	
		IV	Membrane biophysics and plant growth in microgravity	
		RPSBOT404	**CYTOGENETICS II AND MOLECULAR BIOLOGY III**	**04**
		I	Cytogenetics	
		II	Molecular Biology	
		III	Recombinant DNA technology	
		IV	Genetic Disorders	
			PRACTICAL	
		RPSBOTP 401	Molecular Biology I	**02**
		RPSBOTP 402	Molecular Biology II	**02**
		RPSBOTP 403	Cytogenetics II and Molecular Biology III	**02**
		RPSBOTP 404	Plant Breeding	**02**
Total				**96**

Resolution No.: AC/II(20-21).2.RPS4

S.P. Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

(Affiliated to University of Mumbai)

Syllabus for: Semester I & II

Program: M. Sc.

Program Code: Botany (RPSBOT)

(Credit Based Semester and Grading System for the academic year 2021–2022)

SEMESTER I

Course Code	UNIT	TITLE	Credits	Lectures/ Week
RPSBOT 101	**PLANT DIVERSITY – I**			
	I	Phycology I	**4**	**1**
	II	Phycology II		**1**
	III	Mycology I		**1**
	IV	Mycology II		**1**
RPSBOT 102	**PLANT DIVERSITY- II**			
	I	Bryophyta	**4**	**1**
	II	Pteridophyta and Paleobotany		**1**
	III	Gymnosperms		**1**
	IV	Origin of Angiosperms		**1**
RPSBOT 103	**DEVELOPMENTAL BOTANY AND RESEARCH METHODOLOGY**			
	I	Developmental Botany	**4**	**1**
	II	Palynology		**1**
	III	Research Methodology I		**1**
	IV	Research Methodology II		**1**
RPSBOT 104	**INSTRUMENTATION AND TECHNIQUES**			
	I	Centrifugation and chromatography	**4**	**1**
	II	Microscopy and spectroscopy		**1**
	III	Tracer techniques and PCR		**1**
	IV	pH, Buffers and Electrophoresis		**1**
RPSBOTP 101	Plant Diversity I		**02**	**04**
RPSBOTP 102	Plant Diversity – II		**02**	**04**
RPSBOTP 103	Developmental Botany and Research Methodology		**02**	**04**
RPSBOTP 104	Instrumentation and Techniques		**02**	**04**
			24	

SEMESTER II

Course Code	UNIT	TITLE	Credits	Lectures/ Week
RPSBOT 201	**PLANT DIVERSITY – III**			
	I	Angiosperms I	**4**	**1**
	II	Angiosperms II		**1**
	III	Anatomy I		**1**
	IV	Anatomy II		**1**
RPSBOT 202	**PLANT PHYSIOLOGY – I**			
	I	Photosynthesis I (Eukaryotes)	**4**	**1**
	II	Photosynthesis II (Prokaryotes)		**1**
	III	Protein structure		**1**
	IV	Plant Hormones		**1**
RPSBOT 203	**PLANT PHYSIOLOGY II**			
	I	Stress Physiology	**4**	**1**
	II	Seed Physiology		**1**
	III	Environmental Botany I		**1**
	IV	Environmental Botany II		**1**
RPSBOT 204	**CURRENT TRENDS IN BOTANY**			
	I	Medicinal botany dietetics	**4**	**1**
	II	Traditional knowledge and IPR		**1**
	III	Biostatistics		**1**
	IV	Bioinformatics		**1**
RPSBOTP 201	Plant Diversity – III		**02**	**04**
RPSBOTP 202	Plant Physiology-I		**02**	**04**
RPSBOTP 203	Plant Physiology – II		**02**	**04**
RPSBOTP 204	Current trends in Botany		**02**	**04**
			24	

SEMESTER I

Course Code: RPSBOT 101

Course Title: Plant Diversity-I

Academic year 2021-22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the morphology, structure, reproduction, classification and evolution of Algae and Fungi.
CO 2	Comprehend the detailed study of commercial cultivation technologies and industrial applications of Algae.
CO 3	Evaluate the interrelationships between various groups and analyze reasons behind the same.
CO 4	Gain knowledge of plant diseases, identify and apply suitable control measures in an environmentally sustainable manner.
CO 5	Apply the fundamental knowledge of importance of fungi in various fields.

Detailed Syllabus

RPSBOT 101	Title: Plant Diversity – I	Credits – 4
UNIT I	**Phycology I**	**15 Lectures**
	Classification of Algae upto orders as proposed by Gilbert M. Smith	
	Origin and Evolution of Sex in Algae	
	Fossil Algae	
UNIT II	**Phycology II**	**15 Lectures**
	Techniques in commercial Cultivation of Algae for Protein and Secondary metabolites, Carbon credit, Antibiotics, Biofuel	
	Detrimental Algae and their control	
	Toxic Algae, Parasitic Algae	
	Water Blooms and Red Tides in India and across the world, Utility,	
	Disadvantages and Control of Algal blooms	
	Algae as a Source of Pharmaceuticals and Nutraceuticals	
	Algal collection and preservation	
UNIT III	**Mycology I**	**15 Lectures**
	Classification of fungi, upto orders, according to the system proposed by Alexopoulos	
	Sexuality in Fungi	
	General account of spore bearing organs and their arrangements in various groups of fungi; spore release and dispersal.	
	History of plant pathology, Host-parasite relationship	

	Classification of plant diseases based on symptoms	
	Study of the following diseases with reference to symptoms, causal organism and disease cycle : Late blight of potato Covered smut of barley, Citrus canker, Leaf curl	
UNIT IV	**Mycology II**	**15 Lectures**
	Economic importance of fungi: Application of fungi with respect to - agriculture, industries, food and medicine, Harmful activities.	
	Mycorrhiza: type, distribution and significance with reference to agriculture and forestry.	
PRACTICALS		
RPSBOTP 101	**Plant Diversity-Cryptogams I**	**Credits – 2**
1	Study of following type with reference to their systematic position, thallus and reproductive structures: *Scytonema, Lyngbya, Anabaena, Volvox, Oedogonium, Scenedesmus, Ulothrix, Ulva, Pithophora, Closterium, Nitella, Padina* and *Gracilaria*.	
2	Extraction of algal pigments and their separation by paper chromatography.	
3	Culturing of algae / Estimation of metabolites	
4	Study of algal growth curve	
5	Students are to collect and identify algae from different habitat and prepare a key based on 5 characters or visit an Algal research station. Prepare and submit a report of the field work/research station visit.3 and 4 project(submission)	
6	**Mycology:** *Stemonitis, Saprolegnia, Phytophthora, Xylaria, Peziza, Daedalea, Ganoderma, Alternaria* and *Trichoderma.*	
7	Collection and identification of common forest fungi (5 types).	
8	**Plant diseases:** Late blight of potato Covered smut of barley, Citrus canker, Leaf curl	
9	**Economic Importance of fungi**: *Beauveria, Verticillium, Penicillium , Yeast, Ganoderma, Mycorrhiza*	

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Course Code: RPSBOT 102

Course Title: Plant Diversity – II

Academic year 2021 - 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Develop critical understanding about the classification of Bryophytes and Pteridophytes as well as their origin and evolution.
CO 2	Outline the economic importance of Bryophytes and Pteridophytes.
CO 3	Demonstrate the cultivation techniques and maintenance of ornamental ferns.
CO 4	Understand the structures of fossil forms and correlate the same in evolutionary studies..
CO 5	Develop critical understanding about the classification of Gymnosperms and comprehend the affinities and interrelationships between various orders
CO 6	Differentiate between gymnosperms and angiosperms, as well as their origin and evolution in various eras.

Detailed Syllabus

RPSBOT 102	Title: Plant Diversity – II	Credits – 4
UNIT I	**Bryophyta**	**15 Lectures**
	Classification of Bryophyta, up to orders, according to the system proposed by G.M.Smith and recent systems of classification.	
	Alternation of generation in Bryophyta.	
	Origin and evolution of Bryophyta with reference to habitat and form	
	Evolution of the gametophyte and sex organs in Bryophytes	
	Evolution of the Sporophyte in Bryophyta	
	Economic importance of Bryophytes	
UNIT II	**Pteridophyta and Paleobotany**	**15 Lectures**
	Classification of Pteridophyta, up to orders, according to the system proposed by G.M.Smith.	
	Cultivation and maintenance of ornamental Ferns	
	Economic importance of Pteridophytes.	
	The geological time scale and a study of fossil Pteridophytes and Gymnosperms (*Horneophyton, Cladoxylon*, *Sphenophyllum*, *Glossopteris*, *Williamsonia, Medullosa*)	
UNIT III	**Gymnosperms**	**15 Lectures**
	Classification of gymnosperms upto orders according to the system proposed by C. J. Chamberlain, recent systems of classification.	
	General characters; affinities and interrelationships of Cycadofilicales, Bennettitales and Cordaitales.	

UNIT IV	Origin of Angiosperms	15 Lectures
	Origin and evolution of angiosperms	
	The primitive angiospermic flower; primitive and advanced character in angiosperms.	
PRACTICALS		
RPSBOTP 102	**Plant Diversity – Spermatophyta I**	**Credits – 2**
1	**Bryophyta:** Study of following type with reference to systematic position, thallus and reproductive structures: *Targionia, Plagiochasma, Fimbraria, Pellia, Poganatum.*	
2	**Pteridophyta:** Study of following type with reference to their systematic position, thallus and reproductive structures: *Isoetes, Ophioglossum, Pteris, Angiopteris, Lygodium*and *Azolla*	
3	**Economic Importance Pterdiophytes :** *Lycopodium*, *Azolla*	
4	**Study of fossils:** *Horneophyton, Cladoxylon*, *Sphenophyllum*, *Glossopteris*, *Williamsonia, Medullosa, Cordaites*	
5	**Gymnosperms:** Study of following type with reference to their systematic position, vegetative and reproductive structures: *Auraucaria, Cupressus , Podocarpus* and *Juniperus*	
6	**Angiosperms**: Preparation of a cladogram with selected members of a family	

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Course Code: RPSBOT 103

Course Title: Developmental Botany and Research Methodology

Academic year 2021– 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the fundamentals of the development of male and female gametophytes, embryo and fertilization.
CO 2	Understand the structure of Angiosperm pollen and analyze the special relationships of pollen grains in pollen tetrads as well as the phylogeny of Angiosperm pollen
CO 3	Apply palynological information to plant systematics, agriculture and horticulture
CO 4	Develop the ability to design good research hypothesis and select an appropriate data analysis method.
CO 5	Recognize the resources for accessing scholarly articles, published papers, abstract writing and bibliographic management.
CO 6	Understand methods of data collection, tools for data analysis and ethical issues in educational research.

Detailed Syllabus

RPSBOT 103	Title: Developmental Botany and Research Methodology	Credits – 4
UNIT I	**Developmental Botany**	**15 Lectures**
	Male gametophyte: Gene expression, male sterility sperm dimorphism and hybrid seed production; pollen storage; pollen embryos.	
	Female gametophyte: Types of embryo sacs; structure of embryo sac cells.	
	Pollination, pollen-pistil interaction and fertilization: floral characteristics	
	Seed development and fruit growth; endosperm development during Early, Maturation and Desiccation stages; embryogenesis, ultrastructure and nucellar cytology; cell lineage during late embryo development; storage proteins of endosperm and embryo; apomixis; embryo culture; dynamics of fruit growth; biochemistry and molecular biology of fruit maturation	
UNIT II	**Palynology**	**15 Lectures**
	Special relationships of pollen grain in pollen tetrads: • Young Microspores: their arrangement and number in tetrads. • Pollen Wall: o Ultrastructure o Morphogenesis: Formation of Aperture Pattern, Primexine formation, Exine and Intine development, Pollen attaching vehicles.	

	Phylogeny of Angiosperm Pollen: • Evolutionary Trends among pollen grains based on Palynotaxonomic work: Evolutionary trends in Aperture, Ornamentation and Stratification. • Phylogenetic Considerations: o Pollen Evolution in Early Angiosperms, o Phylogeny of Dicotyledons, and Monocotyledons, o Role of Pollen Morphology in Phylogeny and Plant Taxonomy.	
	Applications of Palynology in Agriculture and Horticulture	
UNIT III	**Research Methodology I**	**15 Lectures**
	Introduction: Research design principles, execution of work, interpretation of results.	
	R**eview of literature** • Library: Structure of a scientific library, journals, books, Digital library and E books • Catalogue: • Classification of books (Universal Decimal System). • Journals: Indexing journals, H-index, abstracting journals, research journals,review journals, e-journals. • Impact factor of journals, NCBI-Pub Med. • Reprints, Secondary storage devices, Internet, open access initiative, INFLIBNET, INSDOC. Google Scholar • Preparation of index cards: Author index and subject index; Open source, bibliography management system.	
UNIT IV	**Research Methodology II**	**15 Lectures**
	Research and sampling design	
	Measurement of scaling technique	
	Methods of data collection	
	Data analysis –SPSS and MS Excel	
	Ethics in research	
PRACTICALS		
RPSBOTP 103	**Developmental Botany and Research Methodology**	**Credits – 2**
1	A study of Microsporogenesis and megasorogenesis with the help of permanent sides	
2	*In vitro* germination of pollen grains	
3	Effect of temperature on pollen viability	
4	Effect of temperature on short - term storage of pollen	
5	Study of pollen attaching vehicles	
6	Study of the morphology of the pollen (using Chitale's and acetolysis method) from the families; Malvaceae, Asteraceae, Convolvulaceae, Labiatae and Graminae.	
7	Visit a scientific library or documentation centre and submit a report	
8	Present a literature review	

References:

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14. Kothari– C.R. 2004. Research Methodology –Methods and Techniques, New Age International LTd. Publishers, New Delhi.

Course Code: RPSBOT 104

Course Title: Instrumentation and techniques

Academic year 2021 - 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the basic principles, working and applications of centrifugation and chromatography.
CO 2	Apply the principles, working and applications of fluorescence microscopy, electron microscopy and spectroscopy.
CO 3	Apply electrophoretic techniques for separation of macromolecules.
CO 4	Understand the basic principles of tracer techniques and PCR and their applications
CO 5	Understand the science behind the preparation of various buffers and its applications in experiments.

Detailed Syllabus

RPSBOT 104	Title: Instrumentation and techniques	Credits – 4
UNIT I	**Centrifugation and Chromatography**	**15 Lectures**
	Basics principle of Sedimentation	
	Types of rotors	
	Differential and density gradient centrifugation	
	Preparative centrifugation and Applications; Analytical centrifugation and applications.	
	General Principle of chromatography.	
	Techniques and applications of Ion exchange, Affinity Chromatography and HPLC	
	Application / validation of herbal drugs using HPTLC.	
UNIT II	**Microscopy and Spectroscopy**	**15 Lectures**
	Principles, instrumentation, working and applications of Fluorescence microscope, TEM, SEM.	
	Biological sample preparation for electron microscopy.	
	IR, GC MS, LC MS, AAS, ICP- AES, Plasma Emission spectroscopy, NMR, 2D NMR, MS	
UNIT III	**Tracer techniques and PCR**	**15 Lectures**
	Radioactive isotopes and autoradiography	
	Principle, instrumentation &technique: Geiger-Muller counter, Liquid scintillation counters	
	Applications of isotopes in biology: Tracer techniques	

	PCR: Principle, Steps in PCR, Constraints in PCR, Modifications of PCR techniques and its applications	
UNIT IV	**pH , Buffers and Electrophoresis**	**15 Lectures**
	pH and buffer solutions, acids and bases, strong acids and bases, hydrogen ion concentration, dissociation of acids and bases, measurement of pH, titration curves.	
	Electrophoresis: Theory and application	
	PAGE (Native & SDS) and AGE , 2D Electrophoresis	
PRACTICALS		
RPSBOTP 104	**Instrumentation and techniques**	**Credits - 2**
1	Preparation of buffers (phosphate and acetate)	
2	Determination of pKa	
3	Density gradient centrifugation	
4	Separation of proteins by Ion exchange chromatography	
5	Separation of phytochemicals using chromatographic techniques..	
6	Separation of amino acids/ Plant pigments by two dimensional chromatography.	
7	Separation of seed proteins using PAGE.	
8	DNA Amplification using PCR (Demonstration)	
9	Viscosity studies of proteins: standard BSA and varying concentrations of urea	

References

1) Berlyn GP and Miksche JP. 1976. Botanical micro-techniques and cytochemisty
2) Chang R (1971). Basic principles of spectroscopy. McGraw Hill.
3) Garry D Christian, James E O'reilvy (1986). Instrumentation analysis. Alien and Bacon, Inc.
4) Gordon MH and Macrae M. 1987. Instrumental analysis in the biological sciences.
5) Henry B Bull (1971). An Introduction to physical biochemistry. F A Devis Co.
6) Wilson K and Walker JM.1994. Principles and techniques of practical biochemistry.
7) Allan Peacock, H. 1966. Elementary Microtechnique. Edward Arnold Publ.
8) Duddington, C.L, 1960. Practical microscopy. Pitman publ.
9) Perkampus H (1992). UV-VIS Spectroscopy and its applications. Springer-Verlag.
10) Pesce A J, Rosen C G, Pasty T L. Fluorescence Spectroscopy: An introduction for Biology
11) Vanholdem K.E. and W.C.Johnson, 1998. Principles of Physical Biochemistry

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MODALITY OF ASSESSMENT

Theory Examination Pattern:

A) Internal Assessment - 40%: **40 marks.**

Sr No	Evaluation type	Marks
1	Seminar presentation/ Survey report/ Literature review/ Short Project presentation / Photo documentation report of field visit/ Industry Visit Report /Presentation based on Research papers and references/ Case study/ Class test	40

B) External examination - 60 %

Semester End Theory Assessment - 60 marks

i. Duration - These examinations shall be of **2½ hours** duration.
ii. Paper Pattern:
   1. There shall be **05** questions each of **12**. On each unit there will be one question & last question will be based on all the **04** units.
   2. All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1)	Any 1 out of 2	12	Unit I
Q.2)	Any 1 out of 2	12	Unit II
Q.3)	Any 1 out of 2	12	Unit III
Q.4)	Any 1 out of 2	12	Unit IV
Q.5)	3 short notes out of 5	12	All Units

Practical Examination Pattern:

(A) External (Semester end practical examination):

Particulars	Practical 1
Laboratory work and /or *Viva voce*	50
Total	**50**

PRACTICAL BOOK/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	RPSBOT101		RPSBOT 102		RPSBOT 103		RPSBOT 104		Total per Course	Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External		
Theory	40	60	40	60	40	60	40	60	100	400
Practical	50		50		50		50		50	200

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SEMESTER II

Course Code: RPSBOT 201

Course Title: Plant Diversity-III

Academic year 2021– 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand Rules of nomenclature according to ICN.
CO 2	Comprehend evolutionary relationships among Angiosperms, learn concept of character weighing, methods of illustrating evolutionary relationships
CO 3	Understand the basic concepts in anatomy regarding origin of tissue systems and organogenesis.
CO 4	Demonstrate wood primitive and evolved wood elements and photosynthetic systems in leaves
CO 5	Classify plants to their respective families based on morphological and palynological characters.

Detailed Syllabus

RPSBOT 201	Title: Plant Diversity –III	Credits – 4
UNIT I	**Angiosperms I**	**15 Lectures**
	An International Code of Nomenclature **(I.C.N)** History and basic Principles.	
	Principles for assessment of relationships, delimitation of taxa and attribution of rank: a. criteria b. guidelines c. practical considerations, d. use of categories	
	APG system of classification	
	Botanical Survey of India	
UNIT II	**Angiosperms II**	**15 Lectures**
	Evolution, Variation and speciation, Biosystematic categories, Biotypes and Ecotypes.	
	Concept of characters: Introduction, type function values of taxonomic importance. Variations; OTUs, character weighting and coding; cluster analysis; Phenograms, cladograms (definitions and differences), methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).	
UNIT III	**Anatomy I**	**15 Lectures**
	Meristems: Definition type of meristems, apical cell theory, histogen theory and Tunica corpus theory	
	Sensory and tactile tissue system: Tactile sense organs,	

	gravitational and optical sense organs	
UNIT IV	**Anatomy II**	**15 Lectures**
	Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristems; shoot and root development, Quiescent centre; Root cap, origin of lateral root.	
	Leaf development and phyllotaxy; transition of flowering, floral meristems and floral development in *Arabidopsis* and *Antirrhinum*	
PRACTICALS		
RPSBOTP 201	**Plant Diversity- III**	**Credits - 2**
1	**Angiosperms:** A study of the following plant families their morphological peculiarities and economic importance: Menispermaceae, Portulacaceae, Guttiferae, Passifloraceae, Meliaceae, Sapindaceae, Lythraceae, Boraginaceae, Chenopodiaceae, Liliaceae, Scitaminae, Cyperaceae	
2	Identification of genus and species with the help of flora volumes. (In addition to the above mentioned families, all families studied in undergraduate classes are included)	
3	Study of wood elements in *Annona, Michelia, Sterculia* and *Thuja*, using the maceration technique.	
4	Study of the following leaves with respect to leaf surface characters (wax, cuticle, epidermis, stomata, epidermal outgrowth): *Pistia , Ficus, Avicennia* and *Peperomia*	
5	Photosynthetic system in *Pinus* (arm palisade): *Cyperus, Ficus,* and *Oxalis*	

References:

1. Grant, V. 1971.Plant Speciation, Columbia University press, London.
2. Grant W. F. 1984. Plant Biosystematics.Academic press, London.
3. Harisson, H.J. 1971. New concept in flowering plant Taxonomy. Hickman educational books Ltd. London.
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12. Mauseth, J.D. 1988. Plant Anatomy - The Benjamin Cumming Publishing Co.

Course Code: RPSBOT 202

Course Title: PLANT PHYSIOLOGY- I

Academic year 2021 - 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Compare and contrast photosynthetic pathways involved in Eukaryotes and Prokaryotes.
CO 2	Understand protein dynamics
CO 3	Comprehend plant hormone production, utilization and destruction.
CO 4	Discuss and apply the physiological processes of plants in other research fields.

Detailed Syllabus

RPSBOT 202	Title: Plant Physiology- I	Credits – 4
UNIT I	**Photosynthesis I (Eukaryotes)**	**15 Lectures**
	Regulation of C_3, C_4 and CAM pathways of photosynthesis: Role of light in the activation of dark phase enzymes, regulation of RUBISCO, PEPcase, light effect, modulators and coordination of light , dark phase.	
	C_4 Photosynthesis: inter and intra-cellular transport of metabolites, carbonic anhydrase, PEPcase, NADP-MDH and PPDK.	
	Regulation of CAM through transport of metabolites.	
	Pentose Phosphate Pathway and its importance	
	Artificial photosynthesis	
UNIT II	**Photosynthesis II (Prokaryotes)**	**15 Lectures**
	Photosynthesis of prokaryotes: Pigment systems in bacteria and Cyanobacteria, light harvesting mechanisms, reductive TCA cycle.	
UNIT III	**Protein structure**	**15 Lectures**
	Primary, secondary, tertiary and quaternary structural features and their analysis – Theoretical and experimental; Classification of Proteins, bonds involved in protein structure- Polypeptide backbone, covalent and non-covalent interactions, Configuration details of Primary, Secondary tertiary and quaternary structures : structural features, Ramachandran plot, structure function relation of protein ex. Haemoglobin, chemical modification and cross-linking in proteins, dynamic properties and mechanisms of protein folding, Denaturation of proteins	
	Protein folding – biophysical and cellular aspects, Chaperones in protein folding	

UNIT IV	**Plant hormones**	
	Biosynthesis, storage, breakdown and tr... Gibberellins, Cytokinins, Ethylene, Abscisic acid, I...nositol, Jasmonic acid, Brassinosteroids). Bioassay techniques.	
	Phytohormones in signal transduction, plant hormone recep...	
	PRACTICALS	
RPSBOTP 202	**Plant Physiology- I**	
1	Enzyme kinetics : Determination of Km and Vmax of the enzyme amylase purified amylase)	
2	Extraction of cellulase from a suitable fungal culture and study of enzyme activity by DNSA method	
3	Immobilisation of yeast cells and study of invertase activity.	
4	Quantitative study of diurnal fluctuation in titratable acid number (TAN) in a CAM plant.	
5	Extraction and estimation of GOT and GPT from suitable plant material.	
6	Separation of organic acids by paper chromatography.	
7	Separation of sugars by paper chromatography	
8	A study of the enzyme polyphenol oxidase, from potato peels.	
9	Solvent extraction of chlorophyll a/b, xanthophylls and study of absorption pattern	

Stress physiology added

REMOVE!

Credits - 2

References:

1. William G. Hopkins, 1999. Introduction to Plant Physiology, 2nd edition, John Wiley A Sons, Inc.
2. Lincoln Taiz and Eduardo Zeiger, 2002. Plant Physiology 2nd edition, Sinauer Associates, Inc. Publishers Sunderland, Massachusetts.
3. Frank B. Salisbury and Cleon W.Ross, 2002. Plant physiology 3 rd edition CBS publishers and distributors.
4. Noggle G.R. and Fritz G. J., 1986 Introductory Plant Physiology Prentice Hall.
5. Goodwin Y.W. and Mercer E.I., 2003 Introduction to Plant Biochemistry, 2nd edition. CBS Publishers and distributors.
6. Bajracharya, D. 1999. Experiments in Plant Physiology: A Laboratory Manual. Narosa Publishing House, New Delhi.
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9. Dennison C. 1999.A guide to Protein Isolation. Kluwer Academic Publishers, Dordrecht,The Netherland.
10. Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.

Course Code: RPSBOT 203

Course Title: Plant Physiology- II

Academic year 2021 - 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Develop a deeper understanding of responses of plants to abiotic and biotic stresses.
CO 2	Distinguish key physiological processes underlying seed germination.
CO 3	Analyze the physiological factors that regulate growth and development processes of plants.
CO 4	Understand the basic concepts of population ecology and biogeography.
CO 5	Develop a deeper understanding of ecological principles and apply the same for conservation methodologies.

Detailed Syllabus

RPSBOT 203	Title: Plant Physiology- II	Credits – 4
UNIT I	**Stress Physiology**	**15 Lectures**
	Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanism of resistance to biotic stress and tolerance to abiotic stress. Role of phytoalexins in plant disease resistance.	
UNIT II	**Seed Physiology**	**15 Lectures**
	Physiology and biochemistry of seed germination mobilization of food reserves, germination and growth factors, seed dormancy, control and release of dormancy	
	MADS - box genes	
UNIT III	**Environmental Botany I**	**15 Lectures**
	The Environment: Physical environment; biotic environment; biotic and abiotic interactions.	
	Habitat and Niche: concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.	
	Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of meta-population–demes and dispersal, interdemic extinctions, age structured population.	
UNIT IV	**Environmental Botany II**	**15 Lectures**
	Species interactions: types of interactions, interspecific competition, herbivory, carnivory, pollination and symbiosis	
	Biogeography: Major terrestrial biomes, theory of island	

DIY!

	biogeography; biogeographical zones of India.	
	Environmental Botany- Present concern: Conservation resources, gene pools land races, Global warming ecosystems.	
	Depletion of forest cover, threats to mangroves. Urbanization and plant cover	
	PRACTICALS	
RPSBOTP 203	**Plant Physiology- II**	**Credits - 2**
1	Breaking of seed dormancy by Physical and Chemical methods	
2	Effect of water and salinity stress on chlorophyll content of leaves.	
3	Effect of water and salinity stress on Proline content of leaves	
4	Comparison of two population of a species collected from two areas.	
5	Determination of primary production of an area by harvest method (Terrestrial/ aquatic).	
6	Determination of primary production of an area by chlorophyll method.	
7	Determination of Nygard index of algae in a water body.	
8	Determination of dust load on leaves of roadside plant.	
9	Determination of Stomatal Index of leaves	
10	Determination of epidermal architecture of leaves.	
11	Determination of LAI of different types of trees.	
12	Assessment of pollution in ambient air, on the basis of injured leaf area.	
13	**Field exercises:** Practical exercises are planned for better understanding of the state of environment, rather than 5-hour units. Field exercises are expected to be completed during excursion and field diaries maintained for submission during tests. Other practical work can be carried out in the laboratory with help of plant and soil samples collect from the field. Assessment of erosion status of land along a 'stream' on a slope or on flat land Assessment of status of waste land, on the basis of its appearance and visible plant growth. Assessment of degradation of a forest on the basis of its canopy cover and height, strata and species diversity	

Self-study !

References:

1. William G. Hopkins, 1999. Introduction to Plant Physiology, 2nd edition, John Wiley A Sons, Inc.
2. Lincoln Taiz and Eduardo Zeiger, 2002. Plant Physiology 2nd edition, Sinauer Associates, Inc. Publishers Sunderland, Massachusetts.
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19. Hutchinson GE 1978, An introduction to population ecology. Yale Univ. Press.
20. Kochhar PL 1986 Plant Ecology Ratanprakashan, Mandi, Agra.
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23. May RM (ed) 1981 Theoretical Ecology, Blackwell
24. Odum EP 1963 Ecology Holt Reinhart and Winston Inc.
25. Odum EP 1983 Basic Ecology, Saunders Publ Philadelphia.
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27. Silverton JW 1982 Introduction to plant population ecology, Longman.
28. Southwick CH 1983 (ed) Global Ecology Sinauer.
29. Whittaker RH 1975 Communities and Ecosystems (2nded) MacMillan, New York

Course Code: RPSBOT 204

Course Title: CURRENT TRENDS IN BOTANY

Academic year 2021 - 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand basic principles of traditional forms of medicine and therapeutic value of medicinal plants and Indian plant foods.
CO 2	Critically evaluate medicinal herbs for quality parameters and adulterants.
CO 3	Develop a deeper understanding of different forms of IPR's, procedures and process of patent filing, the need for protection of traditional knowledge
CO 4	Apply biostatistical tools in order to collect, tabulate, analyze and interpret data and develop competence in hypothesis testing.
CO 5	Apply tools of bioinformatics in retrieving, aligning sequences, in order to derive sequence properties, elucidate structures and relate it with function.

Detailed Syllabus

RPSBOT 204	Title: Current trends in Botany	Credits – 4
UNIT I	**Medicinal Botany and Dietetics**	**15 Lectures**
	History, scope and importance of medicinal botany	
	Principles of traditional systems of medicines: Ayurveda, Siddha and Unani	
	Monograph of Drugs with respect to Botanical Source, Geographical distribution, Macroscopic and microscopic Characters, Chemical constituents, therapeutic uses, and adulterants of a) *Terminalia chebula* (fruits), b) *Terminalia bellerica* (fruits) and c) *Butea monosperma* (Flowers, leaves and bark), d) *Foeniculum vulgare (fruits)* e) *Tinospora cordifolia* (stem)	
	Essential oils (*Eucalyptus* and *Citronella*), fatty oil (Sesame, and coconut), and Medicinal uses of the above.	
	Food as Medicine for the treatment of –Arthritis, Renal Disease (Kidney Stone and nephrotoxicity), Constipation, Piles, blood pressure and female reproductive disorders.	
	Therapeutic value of Indian Plant Foods: • Cereals –Oats and Ragi; • Pulses – Green Gram, Black Gram and Soyabean; • Fruits – Jambul, Amla, Guava, Mulberry and Ber; • Spices and Condiments – Coriander, Cumin, Asafoetida and Clove	
UNIT II	**Traditional Knowledge and IPR**	**15 Lectures**

	Different property rights & IPR in India	
	IPR: Objectives, process & scope	
	TRIPS & Patent laws: Introduction & standards for patent protection	
	WTO& Indian Patent Laws	
	Protection of traditional knowledge– objective, concept of traditional knowledge, holders, issue concerning, bio-prospecting and biopiracy; Advantages of IPR , some case studies	
	International Depository authority ,Gene patenting, plant variety protection, trade secrets & plant breeders right	
UNIT III	**Biostatistics**	**15 Lectures**
	Hypothesis testing: Theory of errors – Type I and Type II errors, Null Hypothesis,	
	z-test	
	Test of significance.	
	Introduction to ANOVA, One-way & two way ANOVA,	
	Dunett's test.	
	Randomized Block Design and Latin Square. (5 problems to be solved in each category)	
UNIT IV	**Bioinformatics**	**15 Lectures**
	Specialized databases: EST, GSS, KEGG, OMIM	
	System biology and Bioinformatics, Biological pathway analysis • System biology database and tools: Reactome, Plant Reactome, Pathway commons	
	Conserved regions in nucleotide and protein sequences • Gene finding and motif finding	
	Prediction of Secondary and tertiary structure of protein • Tertiary structure prediction methods: Homology modelling, Threading, Ab-initio methods. • Introduction to Markov chain and Hidden Markov Model. • Use of Hidden Markov model in Protein structure prediction	
PRACTICALS		
RPSBOTP 204	**Current trends in Botany**	**Credits - 2**
1	A study of the following medicinal plants/plant parts with respect to their pharmacognostic characters for authentication of the drug source: a) *Terminalia chebula* (fruits), b) *Terminalia bellerica* (fruits) c) *Butea monosperma* (Flowers, leaves and bark), d) *Foeniculum vulgare* (Fruit) e) *Tinospora cordifolia* (stem)	
2	Estimation of total ash content, extractive values in solvents of varying polarities and using different extraction techniques from any medicinal plant material as per Indian Pharmacopeia standards.	
3	Patent search	
4	Patent filing	
5	Hypothesis testing, Normal deviate test.	
6	ANOVA- one way & two way	
7	Randomized block Design and Latin square	
8	Visualization of biological pathway- KEGG Pathway, Plant Reactome	

9	Use of BLAST and its variants
10	Motif finding using MEME
11	Protein structure prediction: Homology modelling based structure prediction tool-SWISS model
12	Protein profiling using SWISSPROT : MASCOT

References:

1. Sambamurthy AVSS and Subramanyan N S 2000 Economic Botany of Crop Plants Asiatech publishers.
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3. Hand Book on Ayurvedic Medicines, H. Panda, National Institute of Industrial Research, New Delhi 2000.
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6. Vaidya, B. 1982. Some controversial drugs in Indain medicine. ChaukambicaOrientalia, Varanasi.
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28. Wood ,A., Pamela, S.E.and Johanna, M.(2000). The root causes of biodiversity loss. United Kingdom: Early –Scan Publications.

MODALITY OF ASSESSMENT

Theory Examination Pattern:

A) Internal Assessment - 40%: 40 marks.

Sr No	Evaluation type	Marks
1	Seminar presentation/ Short Project presentation / Photo documentation report of field visit/ Industry Visit Report /Presentation based on Research papers and references/Class Tests/ Case study/ Survey report/Class test	40

B) External examination - 60 %

Semester End Theory Assessment - 60 marks

i. Duration - These examinations shall be of **2½ hours** duration.
ii. Paper Pattern:
1. There shall be **05** questions each of **12** marks .On each unit there will be one question & last question will be based on all the **04** units.
2. All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1)	Any 1 out of 2	12	Unit I
Q.2)	Any 1 out of 2	12	Unit II
Q.3)	Any 1 out of 2	12	Unit III
Q.4)	Any 1 out of 2	12	Unit IV
Q.5)	3 short notes out of 5	12	All Units

Practical Examination Pattern:

(A) External (Semester end practical examination):

Particulars	Practical 1
Laboratory work and /or *Viva voce*	50
Total	**50**

PRACTICAL BOOK/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- II

Course	RPSBOT 201		RPSBOT 202		RPSBOT 203		RPSBOT 204		Total per Course	Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External		
Theory	40	60	40	60	40	60	40	60	100	400
Practical	50		50		50		50		50	200

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Resolution No.: AC/II(20-21).2.RPS4

S.P. Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

Syllabus for: Semester III and IV

Program: M. Sc.

Program Code: Botany (RPSBOT)

(Credit Based Semester and Grading System for the academic year 2021 – 2022)

SEMESTER III

Course Code	UNIT	TOPICS	Credits	Lectures/ Week
RPSBOT 301	PLANT BIOTECHNOLOGY I			
	I	Plant Tissue Culture I	4	1
	II	Plant Tissue Culture II		1
	III	Plant Tissue Culture III		1
	IV	Commercial Aspects		1
	PLANT BIOTECHNOLOGY II			

RPSBOT 302	**I**	Environmental Biotechnology	**4**	**1**
	II	Industrial and clinical uses of enzymes (Applied Enzymology)		**1**
	III	Nanotechnology		**1**
	IV	Food Biotechnology and Biosensors		**1**
RPSBOT 303	**PLANT BREEDING**			
	I	Plant Breeding I	**4**	**1**
	II	Plant Breeding II		**1**
	III	Molecular Plant Breeding		**1**
	IV	Plant Genetic Engineering		**1**
RPSBOT 304				
	INTERNSHIP / PROJECT		**4**	
RPSBOTP 301		PLANT BIOTECHNOLOGY I	**02**	**04**
RPSBOTP 302		PLANT BIOTECHNOLOGY II	**02**	**04**
RPSBOTP 303		**INTERNSHIP / PROJECT**	**04**	
RPSBOTP 304				
			24	

SEMESTER IV

Course Code	UNIT	TOPICS	Credits	Lectures/ Week
RPSBOT 401	**MOLECULAR BIOLOGY I**			
	I	DNA Replication	**4**	**1**
	II	Transcription		**1**
	III	RNA Processing		**1**
	IV	Translation		**1**

RPSBOT 402	**MOLECULAR BIOLOGY II**			
	I	Gene regulation I	**4**	**1**
	II	Gene regulation II		**1**
	III	Gene regulation III		**1**
	IV	Cell signaling		**1**
RPSBOT 403	**CYTOGENETICS I**			
	I	Cytology	**4**	**1**
	II	Cancer Biology		**1**
	III	Immune Systems		**1**
	IV	Membrane biophysics and plant growth in microgravity		**1**
RPSBOT 404	**CYTOGENETICS II AND MOLECULAR BIOLOGY III**			
	I	Cytogenetics	**4**	**1**
	II	Genetics		**1**
	III	Recombinant DNA technology		**1**
	IV	Genetic Disorders		**1**
PRACTICALS				
RPSBOTP 401		MOLECULAR BIOLOGY I	**02**	**04**
RPSBOTP 402		MOLECULAR BIOLOGY II	**02**	**04**
RPSBOTP 403		CYTOGENETICS I	**02**	**04**
RPSBOTP 404		CYTOGENETICS II AND MOLECULAR BIOLOGY III	**02**	**04**
			24	

SEMESTER III

Course Code: RPSBOT 301

Course Title: Plant Biotechnology I

Academic year 2021 - 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the basic concepts, technical skills, hands-on experience and training in plant tissue culture.
CO 2	Develop competency in production and enhancement of secondary metabolites
CO 3	Understand advanced methods of biotransformation for product enhancement
CO 4	Apply the fundamental principles of transgenic plants in phytoremediation and *in vitro* germ plasm conservation.
CO 5	Understand the basic principles of effective bioreactor design for large scale production of metabolites.

Detailed Syllabus

RPSBOT 301	Plant Biotechnology I	Credits – 4
UNIT I	**Plant Tissue Culture I**	**15 Lectures**
	Plant improvement through soma-clonal variations.	
	Plant cell culture systems: a potential renewable source of flavours, fragrances, and colorants	
	Metabolic engineering: Production of useful secondary metabolites through regulation of biosynthetic pathway in cell and tissue suspension culture	
	Protoplast culture and Somatic hybridization & its applications.	
UNIT II	**Plant Tissue Culture II**	**15 Lectures**
	Plant cell cultures as chemical factories: Cell suspension, enhancement of product formation using biotic and abiotic elicitors, immobilization, permeabilization and product recovery.	
	Biotransformation using: Freely suspended plant cells and Immobilized plant cells	
	Biotransformation for Vanillin production from *Capsicum* cell cultures	
UNIT III	**Plant Tissue Culture III**	**15 Lectures**

	In vitro storage of Germplasm, Cryopreservation	
	Studies on *Agrobacterium* mediated transformed root cultures.	
	Transgenic plants in phytoremediation	
	Scale –up of secondary metabolites from hairy roots	
	Risk assessment and the regulatory frame work	
UNIT IV	**Commercial aspects**	**15 Lectures**
	The quest for commercial production from plant cell: scaling up of cell cultures	
	Bioreactors: factors for bioreactor design, pneumatically agitated bioreactors, comparison of bioreactors, operating mode, batch, fed-batch, semi continuous, two stage operation, continuous cultivation.	
	Factors for growth in Bioreactors.	
	Shikonin production by *Lithospemum erythrorhizon* cell cultures.	
PRACTICALS		
RPSBOTP 301	**Plant Biotechnology I**	**Credits - 2**
1	Preparation of stock solutions	
2	Preparation of MS basal medium & Defined medium	
3	Callus induction	
4	Regeneration of the callus	
5	Micropropagation	
6	Isolation of bioactive compounds from callus and plant source using TLC.	
7	Enhancement of product formation using biotic or abiotic elicitor (Total phenolics/ flavonoids).	
8	Types of Bioreactors.	
9	*Agrobacterium* mediated transformed root cultures	

References:

1) Bhojwani. S.S. &Razdan. M.K. 1996. Plant Tissue Culture: Theory and Practice (Rev.Ed.). Elsevier Science Publishers, New York.
2) Chawla. H.S 1999. Introduction to Plant Biotechnology. Oxford & IBH.
3) Collin. H.A & Edwards. S. 1998. Plant Cell Culture. Bioscientific Publishers, Oxford, UK.
4) Gamborg& Phillips. Plant Cell, Tissue and Organ Culture. Narosa Publications.
5) Jain. S.M., Sopory. S.K. &Valleux. R.E. 1996. In Vitro Haploid Production in Higher Plants. Volumes 1 to 5. Fundamental Aspects and Methods. Kluwer Academic Publishers, Dordrecth, Netherlands.
6) Kalyan Kumar De. 1997. Plant Tissue Culture. NCB Agency, Kolkata.
7) Ramawat. K.G. &Merillon. J.M. 2007. Biotechnology: Secondary Metabolites. 2nd Ed. Science Pub., Netherlands.
8) Razdan. M.K. 2003. An Introduction to Plant Tissue Culture. Oxford & IBH, New Delhi
9) ShuklaYM,PatelNJ,JithendraJD,BhatnagarR,Talati JG ,Kathiria KB 2009, Plant Secondary Metabolites, New India Publishing Agency, Gujarat.

Course Code: RPSBOT 302

Course Title: Plant Biotechnology II

Academic year 2021 - 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Develop ideas and technologies to increase production and use of biofuels and biological source of energy.
CO 2	Comprehend the methods for isolation, purification, modification of different industrial and clinical enzymes.
CO 3	Discover the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products.
CO 4	Understand the rapidly developing field of nanotechnology and developing skills for advanced research endeavors in nanotechnology.
CO 5	Understand the pros and cons of nanotechnology and applicability of the same in various fields.
CO 6	Comprehend the requirement and technologies involved in food biotechnology and implementation of quality control parameters.

Detailed Syllabus

RPSBOT 302	Plant Biotechnology II	Credits – 4
UNIT I	**Environmental Biotechnology**	
	Biosorption: use of fungi, algae and biological components	
	Biomass for energy: Sources of biomass, advantages & disadvantages, uses of biomass	
	Biogas production from food processing waste: vegetable waste, flour, molasses etc.	
	Bio-composting	
	Ethanol from biomass and Ligno-cellulosic residues	
	GMO's	
UNIT II	**Industrial and clinical uses of enzymes (Applied Enzymology)**	**15 Lectures**
	Enzymes of industrial importance (amylase, glucose isomerase, cellulase, lipase, protease, xylanase, invertase, peroxidases Thermophilic enzymes- enzymes used in various fermentation processes).	

Remove GMOs DIY Some changes to be added Concepts & applications to be added

	Clinical enzymes – Enzymes as thrombolytic agents, anti-inflammatory agents, cholinesterase, amylase, phosphatase, Serum enzymes in health and disease - diagnostic and therapeutic applications	
	Enzyme Technology-Production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase. ELIZA.	
	Isolation and purification of enzymes and criteria of purity.	
	Enzyme engineering - modifying enzymes to make them stable and heat resistant. Enzyme engineered for new reactions-novel catalyst for organic synthesis.	
	Case studies: thermozymes cold adopted enzymes, Ribozymes, hybrid enzymes, diagnostic enzymes, therapeutic, inteins. Designer enzymes- Abzymes, Ribozymes	
UNIT III	**Nanotechnology**	**15 Lectures**
	Introduction, properties of nano-materials.	
	Green synthesis of nano-materials, biological methods, use of	
	microbial system & plant extracts, use of proteins & templates like DNA	
	Characterization of nanoparticles (FTIR, SEM, TEM, STEM, Scanning Tunneling Microscope, Atomic Force Microscope, UV-Vis,)	
	Application of nano-materials in food, cosmetics, agriculture, environment management and medicine	
	Risk of Nanomaterial to human health and Environment	
UNIT IV	**Food Biotechnology and Biosensors**	**15 Lectures**
	Food Biotechnology	
	Methods of molecular cloning, Genetically modified foods (GMF)	
	Food Fermentation technology- bioreactors and bioprocessing, Production of food flavour, colour. polysaccharides, amino acids, vitamins, baker's yeast, brewer's yeast, Single Cell Protein and Single Cell Oil(any one example from each).	
	Factors affecting food spoilage	
	Biosensors	
	Introduction to Biose Components of biose Types of biosensors Uses of biosensors Recent advances in biosensors	
	PRACTICALS	

Biosensors in food technology (DIY)

RPSBOTP 302	Plant Biotechnology II	Credits - 2
1	Biogas production from food processing waste	
2	Biocomposting (pH, conductivity and organic matter content)	
3	Market survey on the availability of Genetically modified foods (GMF).	
4	Microbial production and downstream processing of an enzyme, e.g. amylase.	
5	Synthesis of nanoparticles	
6	Characterization of nanoparticles by UV spectroscopy.	
7	Production of yoghurt using Direct into Vat cultures	
8	Development of a fermented food/drink utilizing plant products /animal products or byproducts as substrate	

References:

1) Botkin, D.B. and E.A. Keller. 2004. Environmental Science. 5th ed. John Wiley and Sons.
2) Bernhardsen, T. 1999. Geographic Information System: An Introduction. 02nd Edition, John Wiley and Sons.
3) Canter, L.W. 1996. Environmental Impact Assessment. McGraw Hill, New York.
4) Alan Scragg, 2005. Environemntal Biotechnology. II Edition. Oxford University Press. New York.
5) Bernard R. Glick and Jack J. Pasternak, 2001. Molecular Biotechnology – 2nd edition, ASM press Washington DC.
6) Brown, C.W, I.Campbell and F.G. Priest, 1987. Introduction to Biotechnology. Blackwell scientific publications, Oxford
7) Chawla, H.S, 2000. Introduction to Biotechnology. Oxford & IBH Publishing Co Pvt. Ltd, New Delhi.
8) Wood ,A., Pamela, S.E.and Johanna, M.(2000). The root causes of biodiversity loss. United Kingdom: Early –Scan Publications.
9) Bagchi, D., Lau, F.C. and Ghosh, D.K. (Eds.). 2010. Biotechnology in functional foods and nutraceuticals. CRC Press, Boca Raton, Florida, USA.
10) Duggan, C., Watkins, J.B. and Walker, W.A. (Eds.). 2008. Nutrition in pediatrics: basic science and clinical applications. People's Medical Publishing House, Hamilton, USA.
11) Government of Canada, 2013. Nutraceuticals / Functional Foods and Health Claims on Foods. Policy Paper. Hasler, C.M. (Ed.) 2005. Regulation of functional foods and nutraceuticals: A global perspective. IFT Press and Wiley-Blackwell, Ames, Iowa, USA.
12) Katsilambros, K. 2011. Clinical nutrition in practice. John Wiley & Sons, New York. USA.
13) Nestle, M. 2002. Food politics. University of California Press, Berkeley, USA.
14) Pathak, Y.V. (Ed.) 2010.Handbook of nutraceuticals. vol. 1: Ingredients, formulations, and applications. CRC Press, Boca Raton, Florida, USA.
15) Shahidi, F. and Naczk, M. (EDs.) 2003. Phenolics in food and nutraceuticals. 2nd edition. CRC Press, Boca Raton, Florida, USA.
16) J. Draper 1988. Plant Genetic Transformation and Gene Expression Blackwell Scientific Publications, Oxford.
17) R.W. Old, S.B. Primrose. 2004. Principles of Gene Manipulation. An Introduction to Genetic Engineering. Fifth Edition, Blackwell Science Publications.

Course Code: RPSBOT 303

Course Title: Plant Breeding

Academic year 2020 - 21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the fundamental aspects of plant breeding and hybridization along with the latest molecular techniques.
CO 2	Apply plant breeding principles for large scale production of high yielding, abiotic and biotic stress resistant plants in agriculture and horticulture.
CO 3	Outline various applications and achievements of distant hybridization in crop improvement.
CO 4	Apply DNA-based molecular marker aided breeding techniques in plant genetic engineering.
CO 5	Explore the major contributions of plant breeding institutes in India.

Detailed Syllabus

RPSBOT 303	PLANT BREEDING	Credits – 4
UNIT I	**Plant Breeding I**	**15 Lectures**
	Aims and objectives, plant introductions and acclimatization.	
	Selection – mass, pure line and clonal.	
	Hybridization techniques, hybridization in self-pollinated and cross pollinated plants.	
	Genetic control and manipulation of breeding systems including male sterility and apomixes	
UNIT II	**Plant Breeding II**	**15 Lectures**
	Distant hybridization: In nature (plant breeding) – Barriers to the production of distant hybrids; Unreduced gametes in distant hybridization; Sterility in distant hybrids; Consequences of segregation in distant hybrids;	
	Applications and Achievements of distant hybridization in crop improvement; Limitations of distant hybrids.	
UNIT III	**Molecular plant Breeding (Transgenic Crops)**	**15 Lectures**
	Natural method of gene transfer (*Agrobacterium* and virus), selectable markers	

	Artificial methods of gene transfer: Direct DNA uptake by protoplast, electroporation, liposome mediated and particle gun transformation	
	Production of Transgenic plants :virus resistant & Herbicide – resistant, plants, Bt Cotton, Golden rice	
UNIT IV	**Plant Genetic Engineering**	**15 Lectures**
	Production of bio pharmaceuticals in transgenic plants.	
	Edible vaccines & Plantibodies	
	DNA-based molecular marker aided breeding: RAPD, RFLP, AFLP, STS, ISSR, Microsatellites	
	Contribution of plant breeding institutes in India	
PRACTICALS		
RPSBOTP 303	**INTERNSHIP / PROJECT**	**Credits - 2**

References:

1) Al Chaudhari, H.K. (1984). Elementary principles of plant breeding Oxford IBH..New Delhi lards R W (1995). Principles of Plant Breeding. John Wiley and Sons, Inc.
2) Allard, R.W, 1960. Principles of plant breeding. John Willeg, New York.
3) Chaudhary, H. K. (2001) Plant Breeding Theory and Practice, Oxford IBH Ltd, New Delhi, India
4) David Allen Sleper, John Milton. (2006). Breeding Field Crops. Blackwell Publishing
5) Dwivedi and Singh (1980) Essentials of Plant Techniques, 2nd Ed., Scientific Publishers. Moan Bhavan Udaipur, India.
6) Gardner, E.J. (1972). Principles of genetics. Willey Eastern Pvt.Ltd.
7) Ghahal G S and Gosal S S (2002). Principles and procedures of Plant Breeding. Narosa Publishing House.
8) Hays, K.K. Immer, F.R. and Smith, D.C. (1985). Methods in plant breeding .Tata McGraw Hill.Newyork.
9) Neal.C.Stopskopf. (1999). Plant Breeding Theory & Practices. Scientific Publ, Jodhpur.
10) Sharma J R (1994). Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers
11) Singh,B.D. 2001. Plant Breeding, Principles and Methods.Kalyani Publications,
12) Swaminathan, M.S, P.K.Gupta and V.Singa. (1983). Cytogenetics of crop plants. Macmillan India Ltd, New Delhi.
13) Sharma J R (1994). Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers
14) Potrykus and G.Spangenberg, 1995 Gene Transfer to plants Springer, Berlin. Heidelberg
15) J. Sambrook, E.F.Fritsch and T.Maniatis 1989. Molecular Cloning - A Laboratory Manual
16) Adrian Slater, Nigel Scott and Mark Flower, 2000 Plant Biotechnology -The GeneticManipulation of Plants,Oxford University Press,).

Course Code: RPSBOT304 AND RPSBOTP304

INTERNSHIP / PROJECT

MODALITY OF ASSESSMENT

Theory Examination Pattern:

A) Internal Assessment - 40%: 40 marks.

Sr No	Evaluation type	Marks
1	Seminar presentation/ Survey report/ Literature review/ Short Project presentation / Photo documentation report of field visit/ Industry Visit Report /Presentation based on Research papers and references/ Case study/ Class test	40

B) External examination - 60 %

Semester End Theory Assessment - 60 marks

i. Duration - These examinations shall be of **2½ hours** duration.
ii. Paper Pattern:
    1. There shall be **05** questions each of **12** marks. On each unit there will be one question & last question will be based on all the **04** units.
    2. All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1)	Any 1 out of 2	12	Unit I
Q.2)	Any 1 out of 2	12	Unit II
Q.3)	Any 1 out of 2	12	Unit III
Q.4)	Any 1 out of 2	12	Unit IV
Q.5)	Any 3 out of 5	12	All Units

Practical Examination Pattern:

External (Semester end practical examination):

Particulars	**Practical 1**
Laboratory work / Viva	50
Total	**50**

PRACTICAL BOOK/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- III

Course	**RPSBOT 301**		**RPSBOT 302**		**RPSBOT 303**		**RPSBOT 304**	**Total per Course**	**Grand Total**
	Internal	**External**	**Internal**	**External**	**Internal**	**External**	**Internship/ Project**		
Theory	**40**	**60**	**40**	**60**	**40**	**60**	**100**	**100**	**400**
Practical	**50**		**50**		**Internship/ Project 50 + 50**			**50**	**200**

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SEMESTER IV

Course Code: RPSBOT 401

Course Title: Molecular Biology I

Academic year 2021 - 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Develop basic understanding of cellular and molecular biology, understand various molecular mechanisms of replication, RNA processing and translation.
CO 2	Distinguish between molecular mechanisms of prokaryotes and eukaryotes.
CO 3	Gain insights about recent advances in molecular biology.
CO 4	Build a career in the field of molecular biology.

Detailed Syllabus

RPSBOT 401	Molecular Biology I	Credits – 4
UNIT I	DNA Replication	
	Molecular details of DNA replication in prokaryotes	
	Assembly of raw DNA into nucleosomes.	
	DNA recombination, Holliday model for recombination.	
UNIT II	Transcription	15 Lectures
	Transcription, RNA synthesis, classes of RNA and the genes that code for them.	
	Transcription of protein coding genes, prokaryotes and eukaryotes, mRNA molecule.	
	Transcription of other genes, ribosomal RNA, tRNA.	
UNIT III	RNA processing	15 Lectures
	Capping, polyadenylation, splicing, introns and exons.	
	snRNA, Types and significance of snRNA, snRNA in spliceosome,	
	Non coding RNAs, ribozyme, riboswitches, RNA localization.	
UNIT IV	Translation	15 Lectures
	Protein structure, nature of genetic code, translation of genetic message.	

DNA Repair mechanisms

	Post translational modifications, localization, chaperons.	
PRACTICALS		
RPSBOTP 401	**Molecular Biology I**	**Credits - 2**
1	Aseptic techniques, safe handling of microorganisms.	
2	Establishing pure cultures, streak plate method (T-streak and pentagon method), Pour plate, spread plate.	
3	Maintenance of cultures - Paraffin embedding, Lyophilisation.	
4	Preparation of culture medium, stock solutions	
5	Determination of cell number, viable count method (using pour plate and serial dilution technique).	
6	Separation of seed proteins using PAGE.	
7	Analysis of proteins by one and two dimensional gel electrophoresis.	
8	Genomic DNA isolation and quantification.	

References:

1. Lewin B. 2000. Genes VII. Oxford University Press, New York.
2. Alberts, B., Bray, D Lewis, J., Raff, M., Roberts, K and Walter 1999. Molecular Biology of the Cell. Garland Publishing, Inc., New York.
3. Wolfe S.L 1993 Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.
4. Gupta. P.K. 1995. Cytogenetics. Rastogi& Co., Meerut.
5. Glick. B.R. & Thompson. J.E. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boc Raton, Florida.
6. Sybenga. J. 1973. General Cytogenetics. American Elsevier Pub. Co., New York.
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9. Wilson. J.,& Hunt. T. 2007. Molecular Biology of the Cell. 5th Edition. The Problems Book. 2nd Edition. Garland Publisher, New York.
10. Celis. J.E. (Ed.). 2006. Cell Biology: A Laboratory Hand Book. 3rd Edition. Elsevier, USA.
11. Lodish. H., Berk. A., Kaiser. C.A., Kreiger. M., Scott. P.M., Bretcher. A., Ploegh. H.,&Matsudaira. P. 2004. Molecular Cell Biology. 5th Edition. W.H. Freeman and Co., New York.
12. Kleinsmith. L.J. & Kish. V.M. 1995. Principles of Cell and Molecular Biology. 2nd Edition. Harper Collins College Publishes., New York, USA.
13. William. K., Cummings. S., Spencer. M.R.,& Charlotte. A. 2013. Essentials of Genetics. Pearson Books, Delhi.
14. Hartwell L. 2011. Genetics: From Genes to Genomes, Study Guide and Solution Manual. 4th Edition. Nero.
15. Bass. H. &Birchler. J. 2011. Plant Cytogenetics: Genome Structure and Chrmosome Function. Springer, New York.
16. Russel. P.J. 2009. Genetics – A Molecular Approach. 3rd Edition. Pearson Benjamin Cummings, San Francisco, USA.
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18. Gupta. P.K. 1995. Cytogenetics. Rastogi& Co., Meerut.
19. Sybenga. J. 1992. Cytogenetics in Plant Breeding. Springer London Ltd.
20. Swanon. M. & Young. 1982. Cytogenetics. Prentice Hall, India.

Course Code: RPSBOT 402

Course Title: Molecular Biology II

Academic year 2020 - 21

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Compare expression of gene regulation in prokaryotes and eukaryotes.
CO 2	Understand the working of the operon.
CO 3	Students will be exposed to the basics of cell signaling and can classify different forms of signaling.
CO 4	Understand the concepts of "omoics"
CO 5	Analyze different signaling pathways which play an important role in metabolism and development of the organism.
CO 6	Apply this knowledge in various research fields.

Detailed Syllabus

RPSBOT 402	Molecular Biology II	Credits – 4
UNIT I	**Gene Regulation I**	
	Regulations of gene expression in bacteria –Lactose arabinose operon, tryptophan operon	
	Regulation of gene expression in bacteriophage λ.	
UNIT II	**Gene Regulation II**	**15 Lectures**
	Control of gene expression in eukaryotes, Transcriptional control, RNA processing control, mRNA translocation control, mRNA degradation control, protein degradation control	
	Gene editing-(CRISPR-cas technologies - Biotechnology application)	
UNIT III	**Gene Regulation III**	**15 Lectures**
	Genomics, proteomics and metabolomics	
	Genetic regulation of development in *Drosophila* Developmental stages in *Drosophila* – embryonic development, imaginal discs, homeotic genes	
UNIT IV	**Cell signaling**	**15 Lectures**

Principles of gene regulation

	Hormones and their receptors: cell surface receptor, intracellular receptor, signaling through G-protein coupled receptors, signal relay pathways-signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.	
	Forms of signaling (paracrine, synaptic, autocrine, endocrine, cell to cell contact)	
PRACTICALS		
RPSBOTP 402	**Molecular Biology II**	**Credits - 2**
1	Isolation of plasmid DNA	
2	Quantification of plasmid DNA	
3	Agarose gel electrophoresis separation of plasmid DNA	
4	Restriction enzyme digestion and separation of fragments	
5	Southern blot transfer technique	
6	Transformation of *E. coli* cell by plasmid DNA	
7	β-galactosidase expression and assay	
8	Drosophila: study of genetic traits.	

References:

1) De Robertis & De Robertis, 2004. Cell and Molecular Biology. Lippincott. Williams and Wilkins. USA.
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Course Code: RPSBOT 403

Course Title: Cytogenetics I

Academic year 2021 - 22

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Understand the structure of the cell membrane, its function, regulatory aspects of cell division and PCD.
CO 2	Gain knowledge about the nature, development and causes of cancer.
CO 3	Acquire knowledge about the components of the immune system and applications in health care.
CO 4	Understand the conformational properties, isolation and characterization of plant membranes.
CO 5	Develop understanding on plant research in microgravity.

Detailed Syllabus

RPSBOT 403	Cytogenetics I	Credits – 4
UNIT I	**Cytology**	**15 Lectures**
	Cell membrane and permeability: Molecular models of cell membrane, cell permeability. Differentiation of cell membrane, intercellular communications and gap junctions. Cell coat and cell recognition, cell surface.	

	Cell Cycle and Apoptosis: Check points during cell cycle-G1 to S, progression of S phase, G2 to M phase, Anaphase check points and components involved as regulators of check points, role of cyclins and CDKs, synthesis and degradation of cyclins, structural features of CDKs and cyclins, activation and inactivation of cyclin dependent kinases; role of RBs, E2Fs, and DP proteins, P53, different types of Cyclin dependent CDKs, CDC25, CAKs, Wee1 proteins, nim-proteins, SCFs, Anaphase Promoting Complexes APC (cyclosomes), Centrosome activation- structure, duplication of centrosomes, Role of nucleophosmins, organization of mitotic apparatus, binding of tractile fibers to kinetochore complexes, molecular motors involved in movement of chromosomes to equatorial plate and in anaphase movement; cytokinesis by cleavage and phragmoplast formation- different gene products and structures involved and the mechanisms of cytokinesis. Cell Plate formation, PCD.	
	Organization and function of mitochondrial and chloroplast genomes.	
UNIT II	**Cancer Biology**	**15 Lectures**
	Cancer cells: Characteristics, division, spread, treatment. Course of cancer cell formation, Carcinogens: radiations, chemicals, oncogenic virus	
	Cancer and mutations, reproductive properties of transformed animal cell in culture, oncogenes, protoncogenes and their conversion. Oncogenes and growth factors.	
	Stem cells, Regenerative medicine	
UNIT III	**Immune System**	
	Phylogeny of immune system, innate and acquired [illegible] nature and biology of antigens, major histocompati[illegible]ility complex cells of immune system, regulation of immune resp[illegible]onses.	
	Immunity in Health and Disease: Immunodeficiency [illegible] and AIDS	
UNIT IV	**Membrane biophysics and plant growth in M[illegible]icrogravity**	**15 Lectures**
	Conformational properties of membranes, lipid com[illegible]position of the membranes, lipid rafts, role of lipid rafts, diseases [illegible]associated with rafts.	
	Modification of cell membrane and Biophysical importance.	
	Isolation and characterization of plant membranes.	
	Effect of microgravity on plant growth.	
RPSBOTP 403	**PRACTICALS**	**Credits - 2**
1	Preparation of cytological stains, fixatives and pretreatment agents.	

Plant vaccines Plantibodies

2	Study of mitotic index.
3	Squash preparation from pre-treated root tips (colchicines/ Paradichlorobenzene/ Aesculin
4	Squash preparation from mutagen treated root tips for study of aberrations.
5	Smear preparation from any suitable plant material.
6	Cancer study: Acute myeloid leukemia
7	Isolation of plasma membrane
8	Study of SDH activity from isolated plasma membrane.

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Course Code: RPSBOT 404

Course Title: CYTOGENETICS II AND MOLECULAR BIOLOGY III

COURSE OUTCOMES:

COURSE OUTCOME	DESCRIPTION Upon successful completion of this course, learners will be able to;
CO 1	Describe and interpret the genomic technologies, events involved in generating recombinant DNA molecules.
CO 2	Carry out karyotype analysis, rDNA technology and dermatoglyphics.
CO 3	Understand the molecular biology of nitrogen fixation
CO 4	Outline the genomic technologies- events involved in generating recombinant DNA molecules.
CO 5	Apply the knowledge of genetic disorders for genetic counseling and therapy.

Detailed Syllabus

RPSBOT 404	Title: CYTOGENETICS II AND MOLECULAR BIOLOGY III	Credits – 4
UNIT I	**Cytogenetics**	**15 Lectures**
	Karyotype Studies: Analysis and Nomenclature, Banding Techniques- Giemsa banding, R- banding, C- banding, Techniques of Detecting human syndromes	
	Molecular Cytogenetics Methods: Principle, Technique and Applications of FISH, CGH, SKY	
	Dermatoglyphics: Meaning and terminology. Finger patterns – types, ridge count. Different types of palmer patterns, soles and flexion creases. Methods of observation and printing of dermal ridges.	
	Dermatoglyphic analysis: Its uses and limits. Finger printing in Forensic Analysis. Dermatoglyphic features of syndromes. Abnormal dermatoglyphics	
UNIT II	**Genetics**	
	Molecular basis of transformation, transducti… structure of the gene, T4 Phage, complementat… mapping, cis-trans tests. *Neurospora* genetics	
	Molecular biology of nitrogen fixation: Ge… nitrogenase cluster, genetic engineering of nodu…	
UNIT III	**Recombinant DNA Technology**	**15 Lectures**
	Vectors in gene cloning: General information on SV-40, Vaccinia,	

Population genetics

	Baculovirus & retroviral vectors. pUC19, phage, cosmid, BAC and YAC vectors, High and low copy number plasmids and its regulation. Use of YAC or YEp of yeast (*Saccharomyces cervisiae*) as effective cloning vectors because of their high copy numbers in production of HBsAg vaccine. Use of BAC and its advantages	
	Application of recombinant DNA technology for production of herbicide resistant plants, insect resistant plants, improving seed storage proteins and golden rice **Strategies to create Transgenic plants with herbicide resistance:** Following strategies to be studied in detail with reference to herbicide Glyphosate resistance: a) Overexpression of the target protein by using a strong promoter. b) Improved plant detoxification resulting in a more and faster conversion of toxic herbicide to non-toxic or less toxic compound. c) Detoxification of herbicide by using a foreign gene. d) Mutation of target protein Methods of modifying the Diazotrophs (N2 fixing bacteria) by Gene alterations in Rhizobium sp. to a) Improve nitrogen fixing efficiency and bacteria host plant interaction. b) Induce symbiotic relationship with non- leguminous plants such as wheat , rice and corn	
UNIT IV	**Genetic disorders**	**15 Lectures**
	Genetic disorders, genetic counselling and gene therapy	
	Biochemical disorders, sex linked disorders	
	Cardiovascular disorders.	
PRACTICALS		
RPSBOTP 404	**CYTOGENETICS II AND MOLECULAR BIOLOGY III**	**Credits - 2**
1	Study of dermatoglyphics analysis	
2	Giemsa Staining of blood sample	
3	Blood group testing.	
4	Problems based on: Restriction map analysis and construction of restriction maps	
5	Tetrad analysis in *Neurospora* – two genes and centromere	
6	Deletion mapping in Bacteriophage	
7	Identification of genetic diseases by chemical tests.	
8	Karyotypes of genetic disorders.	

References

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MODALITY OF ASSESSMENT

Theory Examination Pattern:

A) Internal Assessment - 40%: **40 marks.**

Sr No	Evaluation type	Marks
1	Seminar presentation/ Survey report/ Literature review/ Short Project presentation / Photo documentation report of field visit/ Industry Visit Report /Presentation based on Research papers and references/ Case study/Class test	40

B) External examination - 60 %

Semester End Theory Assessment - 60 marks

i. Duration - These examinations shall be of **2½ hours** duration.
ii. Paper Pattern:
   1. There shall be **05** questions each of **12** marks. On each unit there will be one question & last question will be based on all the **04** units.
   2. All questions shall be compulsory with internal choice within the questions.

Questions	Options	Marks	Questions on
Q.1)	Any 1 out of 2	12	Unit I
Q.2)	Any 1 out of 2	12	Unit II
Q.3)	Any 1 out of 2	12	Unit III
Q.4)	Any 1 out of 2	12	Unit IV
Q.5)	Any 3 out of 5	12	All Units

Practical Examination Pattern:

External (Semester end practical examination):

Particulars	**Practical 1**
Laboratory work /Viva	50
Total	**50**

PRACTICAL BOOK/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- IV

Course	RPSBOT 401		RPSBOT 402		RPSBOT 403		RPSBOT 404		Total per Course	Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External		
Theory	40	60	40	60	40	60	40	60	100	400
Practicals	50		50		50		50		50	200

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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.

In case the pandemic situation gets prolonged, permission is sought from the BOS for shifting Sem III with Internship to Sem IV and Sem IV topics to Sem III for this academic year 2021-22.