Resolution No.: AC/II(22-23).3.RPS4

S.P. Mandali's

RAMNARAIN RUIA AUTONOMOUS COLLEGE

(Affiliated to University of Mumbai)

RUIA COLLEGE
Explore ● Experience ● Excel

Syllabus for: Semester III and 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 2023–2024)

GRADUATE ATTRIBUTES

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.

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

PROGRAM OUTCOMES

PO	PO Description **A student completing Masters in Science program in the subject of Botany will be able to:**
PO 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
PO 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
PO 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
PO 4	Critically evaluate the functioning of organisms at the genomic and cellular level, Relate physiological adaptations, development and reproduction of higher plants.
PO 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.
PO 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
PO 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.
PO 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
PO 9	Apply the fundamentals of Nanotechnology, Environmental biotechnology and food biotechnology in various fields
PO 10	Understand and apply the techniques of plant breeding procedures for hybridization, stress tolerance and genetic engineering of plants.
PO 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

			SEMESTER III	
S Y	**III**	**RPSBOT301**	**CYTOGENETICS**	**04**
		I	Cytology	
		II	Cytogenetics	
		III	Genetics	
		IV	rDNA Technology	
		RPSBOTP301	Practicals based on **Cytogenetics**	**02**
		RPSBOT302	**MOLECULAR BIOLOGY- I**	**04**
		I	DNA Replication	
		II	Transcription	
		III	RNA Processing	
		IV	Translation	
		RPSBOT303	**MOLECULAR BIOLOGY- II**	**04**
		I	Gene Regulation- I	
		II	Gene Regulation- II	
		III	Gene Regulation- III	
		IV	Cell Signaling	
		RPSBOTP303	Practicals based on **Molecular Biology- I and II**	**02**
		RPSBOT304 & RPSBOTP304	**RESEARCH PROJECT**	**08**
TOTAL				**24**
			SEMESTER IV	
SY	**IV**	**RPSBOT401**	**CURRENT TRENDS IN PLANT SCIENCES- II**	**04**
		I	Environmental Biotechnology	
		II	Applied Enzymology	
		III	Food Biotechnology	
		IV	Nanotechnology	
		RPSBOTP401	Practicals based on **Current Trends in Plant Sciences- II**	**02**
		RPSBOT402	**PLANT BREEDING**	**04**
		I	Plant Breeding- I	
		II	Plant Breeding- II	
		III	Molecular Plant Breeding (Transgenic crops)	

		IV	Plant Genetic Engineering	
		RPSBOT403	**PLANT BIOTECHNOLOGY**	**04**
		I	Plant Tissue Culture- I	
		II	Plant Tissue Culture- II	
		III	Plant Tissue Culture- III	
		IV	Commercial Aspects	
		RPSBOTP403	Practicals based on **Plant Biotechnology**	**02**
		RPSBOT404 & RPSBOTP404	**INTERNSHIP/ PROJECT**	**08**
Total				**24**

SEMESTER- III
Course Code: RPSBOT301

Course Title: Cytogenetics

Academic year 2023 - 24

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

RPSBOT301	Cytogenetics	Credits- 04
UNIT I	**Cytology**	**Hours- 15**
	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	**Cytogenetics**	**Hours- 15**
	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 III	**Genetics**	**Hours- 15**
	Molecular basis of transformation, transduction, conjugation; fine structure of the gene, T4 Phage, complementation analysis, deletion mapping, cis-trans tests. *Neurospora* genetics	
	Molecular biology of nitrogen fixation: Genetic engineering of nitrogenase cluster, genetic engineering of nodulation genes	
UNIT IV	**rDNA Technology**	**Hours- 15**
	Vectors in gene cloning: General information on SV-40, Vaccinia, 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	
RPSBOTP301	Practicals based on **Cytogenetics**	**Credits- 02**
1	Preparation of cytological stains, fixatives and pretreatment agents.	
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	Study of dermatoglyphics analysis.	
7	Giemsa Staining of blood sample.	
8	Blood group testing.	
9	Problems based on: Restriction map analysis and construction of restriction maps.	
10	Tetrad analysis in *Neurospora* – two genes and centromere.	
11	Deletion mapping in Bacteriophage.	

References:

1. The Cell, A molecular approach,. ASM, Washington. Karp Gerald. Cell Biology, John Wiley and Sons
2. Anderson J, Durston B H, Poole 1970. Thesis and assignment writing. Wiley eastern.
3. Bedekar V. H.1982. How to write assignment and research papers, dissertations and thesis. Kanak publications.
4. Kothari– C.R. 2004. Research Methodology –Methodsand Techniques, New Age International LTd. Publishers, New Delhi.
5. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999.Molecular Biology of Cell, Garland Publishing, Inc., New York.
6. Buchanan, B.B., Gruissem, W. and Jones, R. L. 2000 Biochemistry and Molecular Biology ofPlants. American Soc. Of Plant Physiologists, Maryland, USA
7. De Robertis, E.D.P. and De Robertis, 2017 E.M.F. Cell and Molecular Biology 8th Ed. B. I. Waverly Pvt. Ltd., New Delhi.
8. Malacinski, G. M. and Freifelder, D. 1998 Essentials of Molecular Biology (3rd Edi.)Jones and Bartiet Pub. Inc., London.
9. Russel, P. J. 1998 Genetics (5th Edi.) The Banjamin/ Cummings Publishing Com. Inc., USA
10. Sunstad, D. P. and Simmons, M. J. 2000 Principles of Genetics (2nd Edi.) John Wiley & Sons Inc., USA.
11. Tamarin, R. H. 2001 Principles of Genetics 7th Edi.The McGraw-Hill Companies.
12. Wolf, S.L. 1993. Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.
13. Gupta P K 2007 Genetics: Classical to Modern. Rastogi Publications, Meerut.

Course Code: RPSBOT302

Course Title: Molecular Biology- I

Academic year 2023-24

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

RPSBOT302	Molecular Biology- I	Credits- 04
UNIT I	**DNA Replication**	**Hours- 15**
	Molecular details of DNA replication in prokaryotes and eukaryotes.	
	DNA Repair Mechanisms.	
	Assembly of raw DNA into nucleosomes.	
	DNA Recombination- Holliday model for recombination.	
UNIT II	**Transcription**	**Hours- 15**
	Transcription- RNA synthesis, classes of RNA and the genes that code for them.	
	Transcription of protein coding genes in prokaryotes and eukaryotes, mRNA molecule.	
	Transcription of other genes, rRNA, tRNA.	
UNIT III	**RNA Processing**	**Hours- 15**
	Capping, Polyadenylation, Splicing mechanisms.	
	snRNA- Types and significance.	
	Non-coding RNAs, Ribozymes, Riboswitches, RNA localization.	
UNIT IV	**Translation**	**Hours- 15**
	Protein structure.	
	Nature of genetic code.	
	Translation of genetic message.	
	Post-translational modifications, localization, chaperones.	

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.
7. Swanson, Merz& Young. 1967. Cytogenetics. Prentice Hall India.
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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.
17. Roy. D. 2009. Cytogenetics. Alfa Science International Ltd., UK.
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: RPSBOT303

Course Title: Molecular Biology II

Academic year 2023 - 24

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

RPSBOT303	Molecular Biology II	Credits- 04
UNIT I	**Gene Regulation I**	**Hours- 15**
	Regulations of gene expression in bacteria –Lactose operon, arabinose operon, tryptophan operon	
	Regulation of gene expression in bacteriophage λ.	
UNIT II	**Gene Regulation II**	**Hours- 15**
	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**	**Hours- 15**
	Genomics, proteomics and metabolomics	
	Genetic regulation of development in *Drosophila* Developmental stages in *Drosophila* – embryonic development, imaginal discs, homeotic genes	
UNIT IV	**Cell signaling**	**Hours- 15**
	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

RPSBOTP303	Practicals based on **Molecular Biology- I & II**	**Credits- 02**
1	Analysis of proteins by two-dimensional gel electrophoresis.	
2	Genomic DNA isolation and quantification.	
3	Isolation of plasmid DNA.	
4	Quantification of plasmid DNA.	
5	Agarose gel electrophoresis separation of plasmid DNA.	
6	Restriction enzyme digestion and separation of fragments.	
7	Southern blot transfer technique.	
8	Transformation of *E. coli* cell by plasmid DNA.	
9	β-galactosidase expression and assay.	
10	Drosophila: study of genetic traits.	

References:

1) De Robertis & De Robertis, 2004. Cell and Molecular Biology. Lippincott. Williams and Wilkins. USA.
2) Freifelder, 1990. Molecular Biology, Narosa Publishing House, New Delhi.
3) Jain, H.K. 2000. Genetics, Oxford & IBH, New Delhi 13. Jocelyn E Krebs, Elliott S Goldstein, Stephen T Kilpatrick (2011). Lewin's Genes X. Jones and Bartlett Publishers
4) Mary A. Schuler Raymond and E.Zrelinski, 2005. Methods in Plant Molecular Biology, Academic Press an imprint of Elsevier
5) Peter Porella, 1998. Introduction to Molecular Biology, McGraw – Hill, New York 6) Rastogi, S.C. 2004. Cell Biology. New age International Pub. New Delhi.
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10) Swanson, C.P. 1972. Cytology and Cytogenetics. Mac Millan. New York.
11) Goodenough U, 1990. Genetics. Armugam N, 1992. Organic evolution.
12) Basu.S.B. and M.Hossain.2004. Principles of Genetics. Books and Allied (P). Ltd, Kolkatta.
13) Benjamin, Levin. 2004. Genes VIII. Oxford university press. Blackwell Science Ltd.
14) Benjamin Lewin (2000). Genes VII. Oxford university press. Blackwell Science Ltd.
15) Daniel L Hartl, Elizabeth W Jones (2009). Genetics: Analysis of genes and genomes (VII Edn). Jones and Bartlett publishers.
16) Gardner, E.J. 1972. Principles of genetics. Willey Eastern Pvt.Ltd.
17) George Ledyard Stebbins (1971). Process of Organic evolution.
18) Gupta, P.K, 2000. Gentics.Rasatogi publications, Meerut.
19) Gurbachan and S. Miglani, 2000. Basic Genetics, Narosa Publishing House, New Delhi.
20) Strickberger (2005). Genetics (III Edn). Prentice Hall of India Pvt. Ltd.

Course Code: RPSBOT304 AND RPSBOTP304

RESEARCH 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 2 out of 3	12	Unit I
Q.2)	Any 2 out of 3	12	Unit II
Q.3)	Any 2 out of 3	12	Unit III
Q.4)	Any 2 out of 3	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	RPSBOT301		RPSBOT302		RPSBOT303		RPSBOT304	Total per Course	Grand Total
	Internal	External	Internal	External	Internal	External	Research Project		
Theory	40	60	40	60	40	60	100	100	400
Practical	50		-		50		50 + 50	50	200

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SEMESTER- IV

Course Code: RPSBOT401

Course Title: Current Trends in Plant Sciences- II

Academic year 2023 - 24

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

RPSBOT401	Current Trends in Plant Sciences- II	Credits- 04
UNIT I	**Environmental Biotechnology**	**Hours- 15**
	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 canning 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)**	**Hours- 15**
	Enzymes of industrial importance (amylase, glucose isomerase, cellulase, lipase, protease, xylanase, invertase, peroxidases Thermophilic enzymes- enzymes used in various fermentation processes).	
	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	**Food Biotechnology and Biosensors**	**Hours- 15**
	Food Biotechnology	
	Methods of molecular cloning, Genetically modified foods (GMF)	
	Food Fermentation technology- bioreactors and bioprocessing, Production of yoghurt, 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 Biosensors Components of biosensors Types of biosensors Uses of biosensors Recent advances in biosensors	
UNIT IV	**Nanotechnology**	**Hours- 15**
	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	
PRACTICALS		
RPSBOTP401	Practicals based on **Current Trends in Plant Sciences- II**	**Credits- 02**
1	Biocomposting (pH, conductivity and organic matter content)	
2	Aseptic techniques, safe handling of microorganisms.	
3	Establishing pure cultures, streak plate method (T-streak and pentagon method), Pour plate, Spread plate method.	

4	Maintenance of cultures - Paraffin embedding, Lyophilization.
5	Preparation of culture medium, stock solutions.
6	Determination of cell number, viable count method (using pour plate and serial dilution technique).
7	Synthesis of nanoparticles
8	Characterization of nanoparticles by UV spectroscopy.

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.
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4) Alan Scragg, 2005. Environemntal Biotechnology. II Edition. Oxford University Press. New York.
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7) Chawla, H.S, 2000. Introduction to Biotechnology. Oxford & IBH Publishing Co Pvt. Ltd, New Delhi.
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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: RPSBOT402

Course Title: Plant Breeding

Academic year 2023 - 24

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

RPSBOT402	PLANT BREEDING	Credits- 04
UNIT I	**Plant Breeding- I**	**Hours- 15**
	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**	**Hours- 15**
	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)**	**Hours- 15**
	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**	**Hours- 15**
	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	

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: RPSBOT403

Course Title: Plant Biotechnology

Academic year 2023 - 24

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

RPSBOT403	Plant Biotechnology	Credits- 04
UNIT I	**Plant Tissue Culture I**	**Hours- 15**
	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**	**Hours- 15**
	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**	**Hours- 15**
	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**	**Hours- 15**
	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		
RPSBOTP403	Practicals based on **Plant Biotechnology**	**Credits- 02**
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: RPSBOT404

Course Title: 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 2 out of 3	12	Unit I
Q.2)	Any 2 out of 3	12	Unit II
Q.3)	Any 2 out of 3	12	Unit III
Q.4)	Any 2 out of 3	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	RPSBOT401		RPSBOT402		RPSBOT403		RPSBOT404		Total per Course	Grand Total
	Internal	External	Internal	External	Internal	External	Internal	External		
Theory	40	60	40	60	40	60	100		100	400
Practicals	50		-		50		50 + 50		50	200

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