Credit Based Semester and Grading System with effect from the academic year 2022-23

KET'S V. G. Vaze College of Arts, Science and Commerce

(Autonomous)

Syllabus for M.Sc.

(June 2021 Onwards)

Program: M.Sc.

Semester – III and IV

Course: Botany

Specialization: Cytogenetics, Molecular Biology and Plant Biotechnology

SEMESTER III

Course code	Paper Title	Credit
PSBO301	Techniques & Instrumentation I	04
PSBO302	Molecular Biology I	04
PSBO303	Plant Biotechnology I	04
PSBO304	Molecular Biology & Cytogenetics I	04
PSBOP301	Practical based on PSBOP301 (Paper I)	02
PSBOP302	Practical based on PSBOP302 (Paper II)	02
PSBOP303	Practical based on PSBOP303 (Paper III)	02
PSBOP304	Practical based on PSBOP304 (Paper IV)	02

SEMESTER IV

Course code	Paper Title	Credit
PSBO401	Techniques & Instrumentation II	04
PSBO402	Molecular Biology II	04
PSBO403	Plant Biotechnology II	04
PSBO404	Molecular Biology & Cytogenetics II	04
PSBOP401	Practical based on PSBOP401 (Paper I)	02
PSBOP402	Practical based on PSBOP402 (Paper II)	02
PSBOP403	Practical based on PSBOP403 (Paper III)	02
PSBOP404	Practical based on PSBOP404 (Paper IV)	02

1. Syllabus as per Choice Based Credit System

i) **Name of the Programme** : **M. Sc Botany**

ii) **Course Code** : **Semester III**

PSBO301

PSBO302

PSBO303

PSBO304

iii) **Course Title** : Botany - Cytogenetics, Molecular Biology

Plant Biotechnology

iv) **Semester wise Course Contents** : Copy of the syllabus Enclosed

v) **References and additional references** : Enclosed in the Syllabus

vi) **Credit structure** :

No. of Credits per Semester : 24

vii) **No. of lectures per Unit** : 15

viii) **No. of lectures per week** : 16

ix) **No. of Practicals per week** : 04 (per batch of 20 students)

2.**Scheme of Examination** : 60 Marks External assessment

40 Marks Internal Assessment

3.**Special notes, if any** No

4.**Eligibility, if any** As laid down in the College Admission brochure / website

5.**Fee structure** As per College Fee Structure specifications

6.**Special Ordinance/Resolutions, if any** : No

Programme: M.Sc. Botany **Semester**: III

Course: Techniques & Instrumentation I **Course code**: PSBO301

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA) 40 marks					End Semester Examination	Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Written**	
16	-	12	6	15	15	10	-	-	60	100
Max. Time, End Semester Exam (Theory) -2Hrs.										

Course Objectives
To Understand the concept of buffer making and its applications in experiments.
To Understand the principle, working and application of centrifugation, Microscopy and chromatography techniques.

Course Outcomes
Students would be able to understand the process of buffer making and technique of electrophoresis. .
They will be well acquainted with principle, working and application of Fluorescent and electron microscopy, centrifugation and chromatography in various fields

Semester III

Paper I

PSBO301	Module	Techniques and Instrumentation I	Credits 04
Unit I		**pH and Buffers and Electrophoresis**	**Lectures 15**
	I	pH and buffer solutions, acids and bases, strong acids and bases, hydrogen ion concentration, dissociation of acids and bases measurement of pH, titration curves.	
	II	Electrophoresis : theory and applications	
	III	PAGE (Native and SDS) and AGE, 2D Electrophoresis	
Unit II		**Centrifugation**	**Lectures 15**
	I	Basic principle of Sedimentation	
	II	Types of Rotors	
	III	Differential and density gradient centrifugation	
	IV	Preparative centrifugation and applications; analytical centrifugation and application	
Unit III		**Microscopy**	**Lectures 15**
	I	Principles, instrumentation, working and applications of fluorescence microscope, Electron microscopy: scanning and transmission electron microscopy	
	II	Biological sample preparation for electron microscopy, application of electron microscopy.	
Unit IV		**Chromatography**	**Lectures 15**
	I	General Principle of Chromatography	
	II	Techniques and applications of Affinity chromatography and HPLC, GC	
	III	Application and validation of herbal drugs using HPTLC	

PSBOP301	Practicals : Techniques and Instrumentation I	Credits 02
1.	SDS PAGE - Poly acryl Amide Gel Electrophoresis.	
2.	Agarose Gel Electrophoresis.	
3.	Separation of cell organelles using Density gradient centrifugation.	
4.	Separation of phytochemicals using column chromatography.	
5.	Separation of amino acids by two dimensional chromatography	
6.	Separation of plant pigments by two dimensional chromatography	
7.	Visit to Research Institute/Instrumentation laboratory to study advanced microscopy / chromatography techniques.	

References :

1. Wilson & Walker 1986. Practical biochemistry: Principles & Techniques. Cambridge Univ.Press.
2. Berlyn GP and Miksche JP. 1976. Botanical microtechnique and cytochemistry.
3. Chang R (1971). Basic principles of spectroscopy. McGraw Hill.

4. Garry D Christian, James E O'reilly (1986). Instrumentation analysis. Alien and
5. Bacon, Inc. Gordon MH and Macrae M. 1987. Instrumental analysis of the biological sciences.
6. Henry B Bull (1971). An Introduction to physical biochemistry. F A Davis Co.
7. Stanford J R (1975). Foundation of Biophysics. Academic press.
8. Wilson K and Walker JM.1994. Principles and techniques of practical biochemistry.
9. Allan Peacock, H. 1966. Elementary Microtechnique. Edward Arnold Publ.

Programme: M.Sc. Botany **Semester**: III

Course: Molecular Biology I **Course code**: PSBO302

Teaching Scheme (Hrs/Week)				**Continuous Internal Assessment (CIA) 40 marks**					**End Semester Examination**	**Total**
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Written**	
16	-	12	6	15	15	10	-	-	60	100
Max. Time, End Semester Exam (Theory) -2Hrs.										

Course Objectives
To Develop basic understanding of cellular and molecular biology, understand various molecular mechanisms of replication, RNA processing and translation.
To Distinguish between molecular mechanisms of prokaryotes and eukaryotes.

Course Outcomes
The study on Replication, Transcription and Translation will develop a keen understanding of the molecular mechanisms involved in these processes.

Paper II

PSBO302	Module	Molecular Biology I	Credits 04
Unit I		**DNA Replication**	**Lectures 15**
	I	Molecular details of DNA replication in prokaryotes and eukaryotes. Assembly of raw DNA into nucleosomes.	
	II	DNA recombination, holliday model for recombination.	
Unit II		**Transcription**	**Lectures 15**
	I	Transcription, RNA synthesis, classes of RNA and the associated genes.	
	II	Transcription of protein coding genes in prokaryotes and eukaryotes, mRNA molecules.	
	III	Transcription of other genes: ribosomal RNA, and ribosomes, tRNA.	
Unit III		**RNA processing**	**Lectures 15**
	I	Capping, polyadenylation, splicing, introns and exons.	
	II	snRNAs : Types and Significance, snRNA in Spliceosome	
Unit IV		**Translation**	**Lectures 15**
	I	Protein structure, nature of genetic code, translation of genetic message.	
	II	Post-translational modification, Localization and Chaperons	

PSBOP302	Practicals: Molecular Biology	Credits 02
1.	Aseptic techniques, safe handling of microorganisms, establishing pure cultures, streak plate method, Maintenance of cultures - Paraffin embedding, Lyophilisation.	
2.	Preparation of culture medium, stock solutions and growth curve, determination of viable cells, determination of cell number.	
3.	Isolation of Genomic DNA and Quantification	
4.	Agarose Gel Electrophoresis	

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, Boca Raton, Florida.
6. Sybenga. J. 1973. General Cytogenetics. American Elsevier Pub. Co., New York.
7. Swanson, Merz& Young. 1967. Cytogenetics. Prentice Hall India.
8. Lewis. K.R. & John. B. 1963. Chromosome Marker. J & A Churchill Co., London
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. HarperCollins College Publishers., 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 Chromosome Function. Springer, New York.
16. Russel. P.J. 2009. Genetics – A Molecular Approach. 3rd Edition. Pearson Benjamin Cummings, San Francisco, USA.
17. Russel. P.J. 2009. Genetics – A Molecular Approach. 5th Edition. Pearson Benjamin Cummings, San Francisco, USA.
18. Roy. D. 2009. Cytogenetics. Alfa Science International Ltd., UK.
19. Gupta. P.K. 1995. Cytogenetics. Rastogi& Co., Meerut.
20. Sybenga. J. 1992. Cytogenetics in Plant Breeding. Springer London Ltd.
21. Swanson. M. & Young. 1982. Cytogenetics. Prentice Hall, India.

Programme: M.Sc. Botany **Semester**: III

Course: Plant Biotechnology I **Course code**: PSBO303

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA) 40 marks					End Semester Examination	Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Written**	
16	-	12	6	15	15	10	-	-	60	100
Max. Time, End Semester Exam (Theory) -2Hrs.										

Course Objectives
To Understand the basic concepts, technical skills, hands-on experience and training in plant tissue culture.
To Develop competency in production and enhancement of secondary metabolites.
To Understand advanced methods of biotransformation for product enhancement.
To Apply the fundamental principles of transgenic plants in phytoremediation and in vitro germplasm conservation.
To Understand the basic principles of effective bioreactor design for large scale production of metabolites

Course Outcomes
Tissue culture methodology will make the students acquainted with different culturing methods, factors affecting in-vitro and Ex-vitro cultivation.
Study of Cell cultures will help in understanding the role of suspension cultures and elicitors in increasing the production of secondary metabolites.
Tissue culture techniques will also help in conservation of germplasms of endangered plants.
Students will also understand the commercial applications of Plant Tissue Culture which will open new avenues in the field of entrepreneurship.

Paper III

PSBO303	Module	Plant Biotechnology I	Credits 04
Unit I		**Plant Tissue Culture-I**	**Lectures 15**
	I	Micropropagation of floricultural and medicinal plants using organogenesis and embryogenesis.	
	II	Factors responsible for *in vitro* and *ex vitro* hardening.	
	III	Plant improvement through somaclonal variations, anther culture.	
	IV	Metabolic engineering: production of useful secondary Metabolites through biosynthetic pathway in cell and tissue suspension culture	
Unit II		**Plant Tissue Culture-II**	**Lectures 15**
	I	Plant cell cultures as chemical factories: Cell suspension, enhancement of product formation using biotic and abiotic elicitors, immobilization, permeabilization and product recovery.	
	II	Plant cell culture systems: A potential source of flavors, fragrances and colourants	
	III	Biotransformation using cell cultures for e.g. Vanillin production from *Capsicum* cell cultures.	
Unit III		**Plant Tissue Culture-III**	**Lectures 15**
	I	*In vitro* storage of germplasm, cryopreservation.	
	II	Studies on *Agrobacterium* mediated transformed root cultures.	
	III	Transgenic plants in phytoremediation	
	IV	Scale-up of secondary metabolites from hairy roots	
Unit IV		**Commercial applications of plant tissue culture**	**Lectures 15**
	I	The quest for commercial production from plant cell scaling up of cell cultures.	
	II	Bioreactors: important factors for bioreactor design, pneumatically agitated bioreactors, comparison of bioreactors, operating mode, batch, fed-batch, semicontinuous, two-stage operation, continuous cultivation, facts for growth in bioreactors	
	III	Study of Shikonin production by *Lithospermum erythrorhizon* cell cultures.	

PSBOP303	Practicals: Plant Biotechnology	Credits 02
1.	Seed sterilization, callus induction and regeneration, hardening and field transfer of any suitable material.	
2.	Encapsulation of axillary buds.	
3.	Establishment of callus of any suitable material and estimation of biomass accumulation and any one measurable product as a function of time.	

4.	Isolation of bioactive compounds from callus and plant source using TLC.	
5.	Enhancement of product formation using biotic and abiotic elicitors(Total Phenolics / Flavonoids)	
6.	Visit to industry/research lab to see various types of fermenters and report writing (Short summary of visit in your own words).	

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. ShuklaY. M, Patel N. J. ,Jithendra J D, Bhatnagar R, Talati J. G , Kathiria K. B. 2009, Plant Secondary Metabolites, New India Publishing Agency, Gujarat.

Programme: M.Sc. Botany **Semester**: III

Course: Molecular Biology & Cytogenetics I **Course code**: PSBO304

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA) 40 marks					End Semester Examination	Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Written**	
16	-	12	6	15	15	10	-	-	60	100
Max. Time, End Semester Exam (Theory) -2Hrs.										

Course Objectives
To understand the structure of the cell membrane, its function and cell-cell Interactions.
The study of different banding techniques will help in understanding the karyotype related to human syndromes. To study the principle, technique and applications of FISH, CGH, SKY
To understand the role of different factors causing cancer, the role of stem cells and regenerative medicine in cancer treatment.
To understand the components of the immune system and applications in health care.
To understand the role of genetic counseling and gene therapy in solving the problems of genetic disorders.
To study the nature of various biochemical and sex linked disorders.

Course Outcomes
The students will be able to acquaint the structure and function of the cell membrane and cell-cell interactions. The students will understand the role of genetic counseling and gene therapy in resolving genetic disorders.
The study related to factors causing cancer, role of stem cells and regenerative medicine in cancer treatment will make the students aware of studies related to cancer biology.
Study of the immune system will help students to understand its application in healthcare.
The students will be familiar with different various molecular cytogenetic methods like FISH, CGH, SKY.
The students will understand the role of genetic counseling and gene therapy in resolving genetic disorders.

Paper IV

PSBO304	Module	Molecular Biology and Cytogenetics I	Credits 04
Unit -I		**Cytology**	**Lectures 15**
	I	**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.	
	II	**Karyotype studies:** Analysis of Nomenclature, Banding Techniques- Giemsa banding, C-banding and R- banding. Techniques of detecting human syndromes.	
	III	**Molecular Cytogenetics Methods**: Principle, Technique and Applications of FISH, CGH, SKY.	
Unit -II		**Cancer Biology**	**Lectures 15**
	I	Cancer cells: Characteristics, division, spread, treatment. Course of cancer cell formation,	
	II	Carcinogens: radiations, chemicals, and oncogenic viruses.	
	III	Cancer and mutations, reproductive properties of transformed animal cells in culture, oncogenes, proto-oncogenes and their conversion. Oncogenes and growth factors.	
	IV	Stem cells, Regenerative medicines	
Unit-III		**Immune System**	**Lectures 15**
	I	Phylogeny of immune system, innate and acquired immunity, nature and biology of antigens, major histocompatibility complex cells of immune system, regulation of immune responses. Production of antibodies by plant cells and organs.	
	II	Immunity in Health and Diseases: Immunodeficiency and AIDS	
Unit-IV		**Genetic Disorders**	**Lectures 15**
	I	Genetic disorders (Down syndrome, Thalassemia, Tay-Sachs Disease, Sickle Cell Anaemia)	
	II	Sex linked disorders (Colour blindness and Haemophilia)	
	III	Biochemical disorders (Phenylketonuria)	
	IV	genetic counselling and gene therapy	

PSBOP304	Practicals: Molecular Biology and Cytogenetics I	Credits 02
1.	Effect of PDB on cytological changes in the cells (Onion root tips), preparation of permanent slides.	
2.	Culturing of *Drosophila* and study of genetic traits.	
3.	Blood group testing.	
4.	Study of meiosis in using suitable flower buds	

5.	Project will be allotted in third semester and students will submit project work having introduction, Review of Literature, Materials and Methods, Expected outcomes and References	

References:

1. Glick. B.R. & Thompson. J.E. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
2. Sybenga. J. 1973. General Cytogenetics. American Elsevier Pub. Co., New York.
3. Swanson, Merz& Young. 1967. Cytogenetics. Prentice Hall India.
4. Lewis. K.R. & John. B. 1963. Chromosome Marker. J & A Churchill Co., London.
5. Alberts. B., Breyer. D., Hopkin. K., Johnson. A.D., Lewis. J., Raff M., Roberts. K. & Watter. P. 2014. Essential Cell Biology. 4th Edition. Garland Publishers, New York
6. Karp. G. 2013. Cell and Molecular Biology – Concepts and Experiments. 7th Edition. Wiley Global Education, USA.
7. De Robertis and De Robertis 2005 (Eight edition) (Indian) Cell and Molecular Biology, Lippincott Williams, Philadelphia. [B.I Publications Pvt. Ltd. New Delhi].
8. Sadova David – 2004 (First Indian Edition). Cell Biology, New Delhi.
9. Albert Etal 2002 (Fourth Edition). Molecular Biology of the cell, Garland Science (Iaylar and Francis) New York Group (wt)
10. LodishEtal 2004 (Fifth Edition). Molecular Cell Biology, W H Freeman and company, New York.
11. Powar C.B 2005 (Third Edition). Cell Biology, Himalaya Publishing, Mumbai
12. Roy S.C and KKDe 2005 (Second Edition). Cell Biology, New central Book Agency Private Ltd., Kolkata.
13. Verma P.S and Agarwal V.K 2006 Cell Biology, Genetics, Molecular Biology, Evolution, Ecology. S.Chand and Company, New Delhi.
14. Gerald Karp 1999 Cell and Molecular Biology- Concept and Expts. John Wiley and ScneIne., USA.
15. Swanon. M. & Young. 1982. Cytogenetics. Prentice Hall, India
16. Snustad. P & Simmons. M.J. 2003. Principles of Genetics. 3rd Ed. John Wiley & Sons Inc., USA

1. Syllabus as per Choice Based Credit System

i) Name of the Programme	:	**M. Sc Botany** - Cytogenetics, Molecular Biology Plant Biotechnology
ii) Course Code	:	**Semester IV** PSBO401 PSBO402 PSBO403 PSBO404
iii) Course Title	:	Botany - Cytogenetics, Molecular Biology Plant Biotechnology
iv) Semester wise Course Contents	:	Copy of the syllabus Enclosed
v) References and additional references	:	Enclosed in the Syllabus
vi) Credit structure	:	
No. of Credits per Semester	:	24
vii) No. of lectures per Unit	:	15
viii) No. of lectures per week	:	16
ix) No. of Practicals per week	:	04 (per batch of 20 students)
2.Scheme of Examination	:	60 Marks External assessment 40 Marks Internal Assessment
3.Special notes, if any		No
4.Eligibility, if any / website		As laid down in the College Admission brochure
5.Fee structure		As per College Fee Structure specifications

6.Special Ordinance/Resolutions, if any No

Programme: M.Sc. Botany **Semester**: IV

Course: Techniques & Instrumentation II **Course code**: PSBO401

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA) 40 marks					End Semester Examination	Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Written**	
16	-	12	6	15	15	10	-	-	60	100
Max. Time, End Semester Exam (Theory) -2Hrs.										

Course Objectives
To study the principle, working and applications of various Spectroscopy techniques.
To study the principle and applications of tracer techniques in Biology
To understand the concepts of membrane biophysics and plant growth in microgravity

Course Outcomes
The students will gain knowledge about various techniques and applications of spectroscopy and autoradiography.
They will get acquainted with the role of membrane biophysics in human disease research. Students will understand the importance of microgravity in plant growth.

Paper I

PSBO401	Module	Techniques and Instrumentation II	Credits 04
Unit- I		**Spectroscopy**	**Lectures 15**
	I	Infra Red, Gas Chromatography-Mass Spectrometry, Atomic Absorption Spectroscopy, Plasma Emission Spectroscopy,	
	II	Nuclear Magnetic Resonance, Mass Spectroscopy	
Unit-II		**Tracer techniques**	**Lectures 15**
	I	Principle and application of tracer techniques in biology	
	II	Radioactive isotopes and autoradiography	
	III	Geiger Muller and Liquid Scintillation Counter	
Unit-III		**Membrane Biophysics**	**Lectures 15**
	I	Conformational properties of membranes.	
	II	Modifications of cell membrane and Biophysical importance	
Unit- IV		**Plant growth in microgravity**	**Lectures 15**
	I	Isolation and characterization of plant membranes.	
	II	Effect of microgravity on plant growth.	

PSBOP401	Practicals: Techniques and Instrumentations II	Credits 02
1.	DNA Amplification using PCR (Demonstration)	
2.	Isolation of Plasma membrane	
3.	Project submission	

References :

1. Berlyn GP and Miksche JP. 1976. Botanical microtechnique and cytochemistry
2. Chang R (1971). Basic principles of spectroscopy. McGraw Hill.
3. Garry D Christian, James E O'reilly (1986). Instrumentation analysis. Alien and Bacon, Inc. Gordon MH and Macrae M. 1987. Instrumental analysis in the biological sciences.
4. Henry B Bull (1971). An Introduction to physical biochemistry. F A Davis Co.
5. Stanford J R (1975). Foundation of Biophysics. Academic press.
6. Wilson K and Walker JM.1994. Principles and techniques of practical biochemistry.
7. Allan Peacock, H. 1966. Elementary Microtechnique. Edward Arnold P
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

Programme: M.Sc. Botany **Semester**: IV

Course: Molecular Biology II **Course code**:PSBO402

Teaching Scheme (Hrs/Week)				Continuous Internal Assessment (CIA) 40 marks					End Semester Examination	Total
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Written**	
16	-	12	6	15	15	10	-	-	60	100
Max. Time, End Semester Exam (Theory) -2Hrs.										

Course Objectives
To Compare expression of gene regulation in prokaryotes and eukaryotes.
To Understand the working of the operon models
To understand the basics of cell signaling and different forms of signaling
To Analyze different signaling pathways which play an important role in metabolism and development of the organism

Course Outcomes
The study of gene regulation will make students understand the various factors responsible for regulation of gene expression in prokaryotes and eukaryotes.
Students will get acquainted with various signaling pathways in the cell and will also understand the interactions of different signals (Ligand) to its receptor.

Paper II

PSBO402	Module	Molecular Biology II	Credits 04
Unit-I		**Gene Regulation- I**	**Lectures 15**
	I	Regulations of gene expression in bacteria – *trp* operon, arabinose Operon, Lactose Operon	
Unit-II		**Gene Regulation- II**	**Lectures 15**
	I	Regulation of gene expression in bacteriophage λ.	
	II	Gene Editing – CRISPER-cas technology	
Unit-III		**Gene Regulation -III**	**Lectures 15**
	I	Genetic regulation of development in *Drosophila,* Developmental stages in *Drosophila*- Embryonic development, imaginal discs, homeotic genes	
Unit-IV		**Cell signalling**	**Lectures 15**
	I	Bacterial and plant two component systems, bacterial and chemotaxis and quorum sensing	
	II	Light signalling in plants	

PSBOP402	Practicals: Molecular Biology II	Credits 02
1.	Isolation of plasmids.	
2.	Quantification of Plasmid DNA	
3.	Restriction Enzymes digestion and separation of Fragments	
4.	Culturing of *Drosophila* and study of genetic traits	
5.	Transformation of *E. coli* cell by plasmid DNA	
6.	β-galactosidase expression and assay.	

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.Zielinski, 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.
7. Robert J Brooker (2009). Genetics: analysis and principles (III Edn). McGraw Hill.
8. Schuler MA and Selinski, R. 1989. Methods in molecular Biology
9. David A Micklos, Greg A Freyer with David A Crotty (2003). DNA Science: A first course (II Edn).
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, Kolkata.

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. Wiley Eastern Pvt.Ltd.

Programme: M.Sc. Botany **Semester**: IV

Course: Plant Biotechnology II **Course code**: PSBO403

Teaching Scheme (Hrs/Week)				**Continuous Internal Assessment (CIA) 40 marks**					**End Semester Examination**	**Total**
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Written**	
16	-	12	6	15	15	10	-	-	60	100
Max. Time, End Semester Exam (Theory) -2Hrs.										

Course Objectives
To develop ideas and technologies for increasing production and use of biofuels and biological sources of energy.
To develop a deeper understanding of different forms of IPR's, procedures and process of patent filing, the need for protection of traditional knowledge.
To understand the rapidly developing field of nanotechnology and developing skills for advanced research endeavors in nanotechnology.
To understand the pros and cons of nanotechnology and applicability of the same in various fields.
To comprehend the requirements and technologies involved in food biotechnology and implementation of quality control parameters.

Course Outcomes
Students will get acquainted with the role of biofuels and biological energy resources as an alternative form of energy.
The knowledge with respect to IPR will make the students understand the process of patent filing and its role in protection of traditional knowledge.
The study of various concepts of nanotechnology will develop the skills of application of nanoparticles in various fields of science.
The studies related to biotechnology will make the students aware of the applications of different factors in the Food industry.

Paper III

PSBO403	Module	Plant Biotechnology II	Credits 04
Unit-I		**Environmental Biotechnology**	**Lectures 15**
	I	Biosorption: Use of fungi, algae and biological components.	
	II	Biomass for energy: sources of Biomass, advantages and disadvantages, Ethanol from biomass and lingo-cellulosic residue.	
	III	Solid waste treatment.	
Unit-II		**IPR's**	**Lectures 15**
	I	Biotechnology and the law – objective, evolution, commercial potential of biotech inventions, rationale for IPR protection.	
	II	Protection of traditional knowledge – objective, concept of traditional knowledge, holders, issue concerning, bioprospecting and biopiracy.	
	III	WTO and and Indian Patent Laws.	
	IV	International Depositary authority, Gene patenting, Plant variety protection, trade secrets and plant breeders right.	
Unit-III		**Nanotechnology**	**Lectures 15**
	I	Introduction, synthesis of nanomaterials.	
	II	Green synthesis of Nano-materials: Use of microbial system and plant extracts, use of proteins and templates like DNA.	
	II	Application of nanomaterials in food, cosmetics, agriculture, environment management and medicine.	
	III	Risk of Nanomaterials to human health and Environment.	
Unit-IV		**Food Biotechnology**	**Lectures 15**
	I	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.	
	II	Factors affecting spoilage.	
	III	Quality control of foods.	

PSBOP403	Practicals: Plant Biotechnology	Credits 02
1.	Ethanol production using ligno-cellulosic biomass.	
3.	Patent search and filing of a patent form.	
4.	Carrying out a patent search for the given invention.	
5.	Determination of Iodine Number of fats	
6.	Determination of Acid number of edible oil	

7.	Synthesis and analysis of Nanoparticles- UV Visible spectra analysis.	
8.	Visit to fermentation unit (Food/ Drink) and report writing.	

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. Environmental 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. Hamilton, C.(2006) Biodiversity, Biopiracy and Benefits: What allegations of Biopiracy tell us about intellectual property. Blackwell publishing Ltd., Oxford.
9. Heink, U and Kowarik,I. (2010) What criteria should be used to select biodiversity indicators . Biodiversity Conservation 19:3769-3797.
10. Ram Reddy,S. Surekha ,M. and Krishna Reddy,V (2016). Biodiversity Traditional Knowledge Intellectual Property Rights .Scientific Publishers.
11. Unnikrishna,P and Suneetha,M. (2012). Biodiversity ,traditional knowledge and community health : strengthening linkages .Institute for Advanced Studies, United Nations University ,Tokyo
12. Wood ,A., Pamela, S.E.and Johanna, M.(2000). The root causes of biodiversity loss. United Kingdom: Early –Scan Publications.
13. Bagchi, D., Lau, F.C. and Ghosh, D.K. (Eds.). 2010. Biotechnology in functional foods and nutraceuticals. CRC Press, Boca Raton, Florida, USA.
14. 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.
15. 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.
16. Katsilambros, K. 2011. Clinical nutrition in practice. John Wiley & Sons, New York. USA.
17. Nestle, M. 2002. Food politics. University of California Press, Berkeley, USA.
18. Pathak, Y.V. (Ed.) 2010.Handbook of nutraceuticals. vol. 1: Ingredients, formulations, and applications. CRC Press, Boca Raton, Florida, USA.
19. Shahidi, F. and Naczk, M. (EDs.) 2003. Phenolics in food and nutraceuticals. 2nd edition. CRC Press, Boca Raton, Florida, USA.
20. J. Draper 1988. Plant Genetic Transformation and Gene Expression Blackwell Scientific Publications, Oxford.

21. R.W. Old, S.B. Primrose. 2004. Principles of Gene Manipulation. An Introduction to Genetic Engineering. Fifth Edition, Blackwell Science Publications.

Programme: M.Sc. Botany **Semester**: IV

Course: Molecular Biology and Cytogenetics II **Course code**: PSBO404

Teaching Scheme (Hrs/Week)				**Continuous Internal Assessment (CIA) 40 marks**					**End Semester Examination**	**Total**
L	**T**	**P**	**C**	**CIA-1**	**CIA-2**	**CIA-3**	**CIA-4**	**Lab**	**Written**	
16	-	12	6	15	15	10	-	-	60	100
Max. Time, End Semester Exam (Theory) -2Hrs.										

Course Objectives
To understand the fundamental aspects of plant breeding and hybridization along with the latest molecular techniques.
To apply the principles of plant breeding for large scale production of high yielding, abiotic and biotic stress resistant plants in agriculture and horticulture.
To outline various applications and achievements of distant hybridization in crop improvement
To apply DNA-based molecular marker aided breeding techniques in plant genetic engineering.

Course Outcomes
Studies related to plant breeding and hybridization along with the help of molecular techniques will help in understanding the importance of plant breeding in crop improvement.
Application of Gene Transfer techniques will help in understanding the role of transgenic plants.
Use of molecular markers will make the students understand the difference between pure line and hybridized lines or transgenics.

Paper IV

PSBO404	Module	Molecular Biology and Cytogenetics II	Credits 04
Unit-I		**Plant Breeding I**	**Lectures 15**
	I	Aims and objectives, plant introductions and acclimatization.	
	II	Selection – mass, pure line and clonal	
	III	Hybridization techniques, hybridization in self pollinated and cross pollinated plants	
	IV	Genetic control and manipulation of breeding systems including male sterility and apomixis.	
Unit-II		**Plant Breeding-II**	**Lectures 15**
	I	Distant hybridization: In nature. In plant breeding – Barriers to the production of distant hybrids; Unreduced gametes in distant hybridization; Sterility in distant hybrids; Consequences of segregation in distant hybrids	
	II	Applications and Achievements of distant hybridization in crop improvement; Limitations of distant hybrids.	
Unit-III		**Population Genetics**	**Lectures 15**
	I	Genetic Structure of Population - Genotypic frequencies, Allele frequencies.	
	II	Hardy-Weinberg's Law - Assumptions, predictions and derivatization of law, Random, Genetic Drift in Natural Population, Mutations, Natural Selection, Migration.	
	III	Fitness and Co-efficient of Selection, Mating, Inbreeding, Speciation	
Unit-IV		**Plant Genetic Engineering**	**Lectures 15**
	I	Production of biopharmaceuticals in transgenic plants.	
	II	DNA-based molecular marker aided breeding: RAPD, RFLP, AFLP, STS, ISSR, Microsatellites	
	III	Edible vaccines and plantibodies.	

PSBOP404	Practicals: Molecular Biology and Cytogenetics II	Credits 02
1.	Presentations based on some advanced techniques, research in Botany with well-defined materials and methods, research methodology, results and discussions, conclusions, applications and References. (Project work and dissertation)	

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. Wiley 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 Univ.

Eligibility Criteria :

A learner who has passed Bachelor's Degree examination of any recognised University in Science with one of the following as a major subject.

1. With Botany as a main / major / principal subject as the B.Sc. Degree examination of any recognised University.

2. With 3 units of Botany at T.Y.B.Sc. in combination with any other subject with 3 units at T.Y.B.Sc.

Passing Standard: As per the University of Mumbai.

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	10 Marks	Unit I
Q.2)	Any 1 out of 2	10 Marks	Unit II
Q.3)	Any 1 out of 2	10 Marks	Unit III
Q.4)	Any 1 out of 2	10 Marks	Unit IV
Q.5)	Any 4 out of 5	20 Marks	All Units