

DEPARTMENT OF BOTANY
SCHOOL OF LIFE SCIENCES

UNIVERSITY OF KERALA



M.Sc. PROGRAMME IN
GENETICS AND PLANT BREEDING
PROGRAMME HANDBOOK & SYLLABUS

(Under Credit and Semester System with effect from 2017 Admission)

ABOUT THE DEPARTMENT

Department of Botany, University of Kerala, was established in the year 1959 at Kariavattom, Thiruvananthapuram, Kerala by Late Prof. (Dr.) A. Abraham, a visionary, an institution builder and a doyen in Cytogenetics and Plant Breeding. The Department actively serves the society through dissemination of knowledge and training the younger generation through unique courses and offering training in frontier areas of Plant Sciences. The Department is internationally known for its major contributions in Cytogenetics and Cytotaxonomy and for running a novel postgraduate programme in Genetics and Plant Breeding. The Department is also active in Plant Biotechnology research and has well established Cell/Tissue culture and Molecular Biology Laboratories. More than 180 students/teachers have taken PhD from the Department on various and diverse topics and more than 230 students have successfully completed their M. Phil programme in Advanced Botany.

The Vision....

- To serve the society through dissemination and field orientation of knowledge and training the best talents in Plant Sciences.

The Mission....

- To provide quality education in Life Sciences;
- To develop human resources with hands on experience on basic/ applied Plant Science research;
- To act as a centre for mining of biomolecules, genes and technologies of immense practical application for human welfare;
- To undertake basic, strategic and applied research for generating fool-proof technologies for the advancement of plant science and
- To become a Center of Excellence in Plant Science teaching and research in next five years

Courses Offered

M.Sc Genetics and Plant Breeding: A unique course with superb amalgamation of classical and applied aspects of plant science.

M.Phil. Advanced Botany: Two-semester programme covers Methods in Research, Advanced topics in Botany, Plant Breeding and Biotechnology. A project work as partial fulfillment of the course, term papers and seminars are the major attractions of the Course.

PhD Botany: Areas of Research

- ❖ Biosystematics
- ❖ Biotechnology/ Tissue culture/ Cell Culture Technology
- ❖ Phytochemistry
- ❖ Plant Reproductive Biology

Admission Procedure

- ❖ PhD Admission: is scheduled in January/ July. Qualification: M.Phil. PhD Qualifying Test, UGC-CSIR NET/KSCSTE Fellowship
- ❖ M. Phil Advanced Botany: The Course begins in November Ist. Admission based on entrance Examination (50%) with 50% for the Masters Degree.
- ❖ M.Sc Genetics and Plant Breeding: Admission based on an Entrance Examination held in May every year. 50% of marks for Graduate Degree and 50% for the entrance test.

Faculty

1. Dr. Swapna T.S, Professor & Head
2. Prof (Dr.) P.M. Radhamany
3. Prof (Dr.) Suhara Beevy S
4. Prof (Dr.) A. Gangaprasad
5. Prof (Dr.) Shiburaj S
6. Dr. E.A. Siril
7. Dr. Bindu R. Nair
8. Dr. R. Rajalakshmi

Research Activities

- Conservation of Tropical Plant Diversity, Evaluation and Genetic characterization
- Biosystematics and Evolution
- Chemical / Gene prospecting
- Crop Genomics
- Plant Tissue culture and Molecular Biology of Medicinal and Crop Plant relatives
- Cytogenesis, Cytotoxicity and Cytotaxonomy
- Plant Reproductive Biology, Breeding and Palynology

Facilities available

1. Botanic Garden: A well-maintained, fully organized garden was established in the Department which support researchers and students. The garden is recognized by Botanic Garden Conservation International (BGCI). The garden includes medicinal plant conservatory, nurseries, green houses, water plant conservatories, horticulture and topiary garden.

2. Herbarium: Department herbarium has a collection of 7000 Angiosperm specimens from Western Ghats, 21 Gymnosperms and 715 Pteridophytes.

3. Seed bank: Established through a joint project by University of Kerala and Kerala State Biodiversity Board. Seed bank aimed to conserve wild relatives of crop plants, underutilized crops plants and medicinal plants.

4. Library and Information Services: The Department Library has over 15,000 books and 15 subscribed National and International journals. The library provides inflibnet and science@direct facility.

5. Molecular Biology Laboratory Facility: A centralized lab facility established through KSCSTE-SARD, DST-FIST, and UGC Plan fund with modern sophisticated instruments. Some of the important instruments are; PCR, RT-PCR, Gel documentation, Gel electrophoresis vertical and horizontal, , Nanophotometer, biophotometer, UV-VIS spectrophotometers, Nitrogen analyzer, protein purification system, Cryostat, ELISA reader, Fluorescence microscope, phase contrast microscope, Image analyzers, Stereomicroscope, Gas chromatography unit, HPLC unit, High speed centrifuges, , Lyophilizer, homogenizers etc...

6. Computer lab facility: Established through DST-FIST Programme. Computers with high speed broadband internet connection and LAN facility. INFLIB Net facility is provided for deep literature search.

7. Department Auditorium: Department has an auditorium (A/C) with modern Audio Visual Facility.

The Kerala University Botany Alumni Association (KUBAA)

The Botany Department of the University of Kerala is located in the Kariavattom Campus, about 14kms from the Thiruvananthapuram city. It was established in 1959 by the late Prof. (Dr.) A. Abraham. Since its inception, the Department has been focusing its attention mainly on PhD programmes and other research activities. The main activity of the Department is to undertake research projects and guide researchers for PhD and M. Phil degrees. Alumni Association was established in the year 2003 with Prof. (Dr.) C.A. Ninan & Prof. P.M. Mathew (Former Head of the Department) as Patrons. Dr. P.M. Dr. Suhara Beevy S, Associate Professor & Head, Department of Botany is the present chairperson of the Association and Dr. Bindu R. Nair is the Secretary. The Association has around 150 members who actively participate and generously contribute to all its activities. The Alumni Association proposes to conduct annual seminars with a view to encourage and enhance the interactions between its many members. It may thus serve as a platform for the exchange of ideas, both academic and social, by its members, thus effectively reduce the generation gap between the older acclaimed scientist and today's young researchers. The Alumni Association is proud to announce that many of the members of the Association are working in reputed research labs, across the country and abroad. Some of them frequently visit the Department, hold discussions with the students and even provide numerous valuable insights. Furthermore, the Alumni Association encourages their members to exchange their expertise and ideas among themselves and to the students of the Department, thereby providing scope for the generation of new ideas which may act as an impetus to research as whole.

For membership and other details please Contact:-

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DEPARTMENT OF BOTANY

SCHOOL OF LIFE SCIENCES UNIVERSITY OF KERALA

M.Sc. Programme in Genetics and Plant Breeding

Programme Objectives

- The programme opens up an interdisciplinary approach to applied genetics and plant breeding and provides opportunity to work in the greenhouse, field and lab.
- The students are exposed to different facets of Genetics right from a foundation course in Mendelian Genetics to the advanced courses such as Plant Biotechnology and Genetic Engineering.
- The programme also offers an opportunity to understand the genetic basis of plant breeding, provides skill development in conventional and contemporary breeding practices and also application of biotechnology in plant improvement.
- Students are given appropriate training in crop management for strict identity preservation required to work with regulated transgenic traits under field conditions.
- Students are exposed to important topics such as demands for value-added traits, renewable energy resources, enhanced crop nutritional value and improved crop performance on lands exposed to new environmental stresses.
- The program aims to achieve a more diverse, technology-rich and integrated research and training experience with opportunities for regular interaction with commercial plant breeding programs through study visits to research and agricultural institutes throughout the state and adjacent states.
- The students will be benefitted greatly with this type of diverse training that is essential for all their future endeavours, either to pursue a career in research, enter government or private sector crop breeding institutes and move into industry or into academic positions.

Structure of the Programme

SEM No.	Course code	Course Title	No. of credits
I	CORE COURSES		
	BOT-C- 411	Mendelian Genetics	4
	BOT-C- 412	Techniques in Cell Biology	4
	BOT-C- 413	Cytology	4
	INTERNAL ELECTIVE BOT-E-414	Biophysics	2
	CORE COURSES		
II	BOT-C-421	Molecular Genetics	4
	BOT -C-422	Cytogenetics	4
	BOT-C-423	Plant Breeding	4
	BOT-C-424	Plant Biochemistry	4
	INTERNAL ELECTIVE BOT-E-425	Bioinformatics	2
	CORE COURSES		
III	BOT-C-431	Genetic Engineering	4
	BOT-C-432	Plant Biotechnology	4
	BOT-C- 433	Environmental Genetics	4
	BOT--C-434	Modern Methods in Crop Breeding	4
	INTERNAL ELECTIVES		
	BOT-E-435	Applied Palynology	2
	BOT-E-436	Phytochemistry	2
IV	CORE COURSES		
	BOT-C-441	Population & Evolutionary Genetics	4
	BOT-C-442	Developmental Genetics	4
	BOT-C-443	Biosystematics	4
	DISSERTATION BOT-D-444	Dissertation	4
EXTRA DEPARTMENTAL ELECTIVE COURSES			
I	BOT-X-411	Plant Tissue Culture	2
II	BOT--X-421	Plant Cell Culture Technology	2
	BOT-X-422	Principles of Gardening	2
III	BOT-X-431	Transgenic Plants	2
	BOT -X-432	Ethnobotany	2

Semester : **I**
Course Code : **BOT- C- 411**
Course Title : **MENDELIAN GENETICS**
Credits : **4**

AIM: To familiarize Mendel's experiments and quantitative genetics.

OBJECTIVES

To get knowledge about Mendel's Experimental approach

To study the patterns of inheritance.

To understand concepts on linkage, sex determination mechanisms, extra-nuclear inheritance and quantitative genetics.

COURSE CONTENT

MODULE I: Mendelism: Mendel's experimental approach to study the pattern of inheritance, Monohybrid cross-the principles of dominance and segregation, Dihybrid cross-the principle of independent assortment. Applications of Mendel's principles, Trihybrid cross, Test Cross, Back Cross, Punnet square, Forkedline method.

MODULE II: Testing genetic hypothesis, Laws of probability, Binomial theorem, Chi-Square analysis, Pedigree analysis. Human disorders follow Mendelian patterns of inheritance, Genetic counseling, Genome imprinting, Gene amplification.

MODULE III: Extending Mendelian Genetics-Modified Mendelian ratios, Incomplete dominance, Codominance, Multiple alleles. Lethal alleles. Epistasis, X linkage in *Drosophila*, X-linkage in humans, Sex limited and sex influenced inheritance, Hollandric genes, Penetrance and expressivity, Pleiotropy.

MODULE IV: Quantitative Genetics- Quantitative traits in Mendelian terms, frequency distribution, measures of central tendency (mean, median, mode), measures of variability (standard error, standard deviation, variance), correlation coefficient, regression. Heritability, partitioning variance, broad and narrow sense heritability, artificial selection, overview on QTL Analysis.

MODULE V: Sex determination and Sex Linkage-Mechanism of sex determination in *Drosophila*, humans and plants, XY, ZW and XO mechanism. Barr bodies, Lyon's hypothesis, dosage compensation in *Drosophila*. Chromosome theory of heredity, Experimental evidence linking inheritance to chromosomes, The chromosomal basis of Mendel's Principles of segregation and independent assortment, Coupling and repulsion theory, Non-disjunction as a proof of chromosome theory. Sex linked gens in Humans, Genes on the Human Y chromosomes. Linkage, Cytological basis of crossing over, Works of Stern in *Drosophila*, Creighton and McClintock in Maize, Chromosome mapping, two factor crosses, three factor crosses, Interference.

MODULE VI. Cytoplasmic inheritance: Introduction, characteristic features, genetic significance. Classes of cytoplasmic inheritance - Maternal effects, inheritance involving infective particles, maternal inheritance, uniparental inheritance. Genetics of mitochondria and chloroplasts, mutations of mitochondria and human disorders

PRACTICALS

1. Problems related to Mendel's laws, Probability, Pedigree analysis
2. Problems related to codominance, multiple alleles, lethal alleles, epistasis, X linkage, sex limited and sex influenced inheritance.

3. Problems related to statistical analysis of polygenic traits, artificial selection and heritability.
4. Problems related linkage: Two-point test cross, three point mapping in *Drosophila*, Determination of gene sequences, Interference
5. Sex determination in *Drosophila*, humans and plants
6. Problems related to Maternal inheritance, Uniparental inheritance, Infectious heredity, Maternal effect

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Model question paper

**UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY**

First Semester M.Sc (CSS1) Degree Examination

Branch: Genetics and Plant Breeding

BOT- C- 411 MENDELIAN GENETICS

Time: Three hours

Maximum marks: 40

I. Answer all questions in one word or sentence

1. Who discovered linkage?
2. Define the law of independent assortment
3. What are Barr bodies?
4. What is the sex of *Drosophila* with AAXXY genotype?
5. To determine the homozygosity, the organism has to be crossed with which parent? What will be genotypic ratio of the progenies?
6. Give an example for sex limited trait in humans
7. Write the term for plant which produces only one type of gamete
8. What will be the genotype of progenies of a homozygous male parent with a homozygous female parent?
9. What is narrow sense heritability?
10. What is maternal inheritance?

(10X1= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 50 words.

11. Differentiate between coupling phase and repulsion phase. Predict the outcome of progenies in both cases
12. Define chromosome theory of heredity. Who proposed it?
13. What is codominance?
14. Explain penetrance
15. Rats homozygous for yellow alleles for coat colour will survive or not? Explain
16. Compare quantitative and qualitative traits. What are quasi-quantitative traits?
17. Describe the inheritance of 'poky trait' in *Neurospora*

(5X2= 10 marks)

III. Answer any *four* of the following Each answer not exceeding 150 words

18. Explain the experiments conducted by Calvin Bridges to discover sex determination in *Drosophila*
19. Morgan crossed red eyed female *Drosophila* with white male flies. What was the result obtained in F1 and F2 generation? What is the result of reciprocal cross? Give a genetic explanation for the results.
20. An actress with O type blood accused a producer with AB type blood of being the father of her child in a paternity suit. The child was also O type. How do you provide evidence for the case?
21. What is the difference between dominance and epistasis? Explain two types of epistasis with examples of the respective altered dihybrid ratio
22. What is the difference between uniparental inheritance, maternal inheritance and maternal effect?
23. What is heritability? What is the relation of phenotypic and genotypic variance with heritability?

(4X3= 12 marks)

IV. Answer any *one* of the following, not exceeding 350 words

24. Singed bristles (*sv*), crossveinless wings (*cv*) and vermilion eye colour (*v*) are due to recessive mutant alleles of three X linked genes in *Drosophila*. When a female heterozygous for each of the three genes was test crossed with a singed, crossveinless, vermilion male the following progenies were obtained.

Singed, crossveinless, vermilion	-3
Crossveinless, vermilion	-392
Vermilion	-34
Crossveinless	-61
Singed, crossveinless	-32
Singed vermilion	-65
Singed	-410
Wild type	-3
Total	-1000

What is the correct order of these three genes on X chromosome? Construct the genetic map.

What is the interference?

25. Explain the phenomenon of extra nuclear inheritance with the help of suitable examples. What are the diagnostic criteria that are used to identify extra nuclear traits?

(1X8= 8 marks)

Semester : **I**
Course code : **BOT-C- 412**
Course Title : **TECHNIQUES IN CELL BIOLOGY**
Credits : **4**

AIM: To familiarize various tools and techniques used in the modern cell biology investigations

OBJECTIVES

To study the process of basic and advanced microtechniques for plant tissue processing

To cognize various biological stains and staining methods

To know methods in histochemical and histoenzymological localization of plant samples

To get exposure to tissue processing methods involved in electron microscopy and confocal microscopy

COURSE CONTENT

MODULE I: Plant Cell and Tissue processing-Killing and fixing- staining- principles and purposes, important chemicals in the preparation of fixatives and their properties, common fixatives- composition, preparation, specific uses- properties of chemical reagents used-Composition, properties and use of Flemming's fluid, FAA, Carnoy's fluid, Chrome acetic, Nawaschins fluid, Zircle's fluid.

MODULE II: Dehydration- Principles, important dehydrating agents, ethyl alcohol, chloroform, glycerin, isopropyl alcohol, butyl alcohol. Clearing agents, their properties and uses, mounting media used in microtechnique. Types of micro-slide preparation, temporary semi-permanent and permanent – smears and squashes-Methods of embedding plant materials in paraffin wax: Tertiary- Butyl Alcohol method (TBA), Ethyl alcohol-xylene method, Alcohol- chloroform method. Techniques of sectioning: Materials embedded in paraffin wax using rotary microtome: Fixing blocks on microtome, cutting serial sections, Different types of adhesives and their preparation, Mounting and spreading ribbons on slides, microtomes, Types of Microtome: Rotary, Sledge, Sliding microtome, Freezing microtome -Cryotome.

MODULE III: Stains and Staining- principles and purpose of staining, Natural Dyes: Haematoxylin, carmine, orcein; Synthetic Dyes: Fast green, Orange G, Safranin, Crystal Violet, Basic fuchsine, Eosin, Cotton blue. Technique of staining: Single staining, Double staining, Triple staining, Significance, Methods of double staining of free hand sections using the following combinations: Safranin-fast green; Crystal violet-Orange G. Preparation of whole mounts and macerations: Glycerin- xylene method for whole mounts; Principles and techniques of maceration; methods of staining paraffin sections using safranin – fast green; Crystal violet-Orange G.

MODULE IV: Sample Preparation for Scanning Electron Microscopy- Introduction-Sample Collection and Selection - Preparation Tools - Support materials-Sample Embedding and Mounting- Exposure - Dehydration -Sample Stabilization for Imaging in the SEM- Stabilization to Preserve Chemical Identity - Sample Cleaning -Sample Surface Charge Elimination -Sample Artifacts and Damage. Sample preparation for Transmission electron microscopy (TEM)- Support film on TEM grids -Sectioning with ultramicrotome -Positive staining- Immuno-gold labeling- Cryo techniques/Low temperature, Semi thin sectioning (1 µm) with Toluidine blue stain, Ultrathin sectioning (50 – 70 nm) of resin embedded material (Epoxy, LR White, and Lowicryl)- Cryo- ultrathin sectioning for Tokuyasu- method (sucrose- infiltrated) - Cryo- ultrathin sectioning for X- ray microanalysis (unfixed)- Freeze substitution followed by resin embedding – Immuno-labeling of sections (resin and frozen)- Positive staining - Preparation of samples for X- ray microanalysis - Coating of grids- Image processing (software iTEM and TIA) -Preparing Sample for Confocal Microscopy- Fixation – Permeabilization – Staining Choosing a Fluorescent Label – Mounting.

MODULE V: Histochemical Localization of Cellular Components- Principle and methods of histochemistry, cytochemistry- Quantitation in Histochemistry - general Considerations- Absorption Photometry- Fluorimetry - Reflection Contrast Photometry- Interferometry- Spectral Analysis- Applications of quantitative and qualitative histochemistry.

MODULE VI: Histochemical localization Carbohydrates -Periodic Acid–Schiff’s reagent [PAS] method, Starch -Iodine –Potassium iodide method (IKI). Cellulose –IKI method, Pectin –Non esterified pectin- Ruthenium red method, Calcium pectate- Tannic acid-Ferric chloride method, Esterified pectin - hydroxyle amine hydrochloride method, Lignin- Phloroglucinol method, Mucopolysaccharides- Alcian Blue method. Protein-Coomassie Brilliant Blue (CBB) and Mercuric Bromo phenol Blue (MBB) methods, Lipids- Sudan dye (Sudan red III, IV or Sudan black) method, Phospholipids -Orange G and Aniline Blue. Cutin- Azure B method, Auramine O method, Suberin-Phosphate buffer method, Nucleic acids–Azure B method, Feulgen Reaction and toluidine blue method. Histo-enzymology- General principle and methods. Enzyme activity staining-application of histo-enzymology. Histo-enzymological localization of Acid Phosphatase, Cytochrome oxidase, Dehydrogenase, Esterase, Lipase and Pectinase.

PRACTICALS

Preparation of permanent double stained freehand sections of plant tissue (5 permanent preparations to be submitted).Dehydration of plant tissue using TBA method, embedding and Preparation of Paraffin blocks and preparation of serial sections. Preparation of whole mounts (1 whole mount preparation to be submitted)- Preparation of fixatives (FAA, Carnoy’s fluid), Histochemical localization of starch, cellulose, pectin, protein, nucleic acid and lipids, lignin, cutin and suberin, Histo-enzymological localization of esterase and pectinase, Vital staining (e.g., Janus green B staining), Sectioning by using cryotome (demonstration only), Photo-documentation of micro-preparation by using image analyser.

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ADDITIONAL REFERENCES

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- <https://www.jove.com/science-education/5039/histological-sample-preparation-for-light-microscopy>
- <https://www.sciencelearn.org.nz/resources/500-preparing-samples-for-the-electron-microscope>
- <http://www.biologicalelectronmicroscopy.com/biological-sample-preparation>
- http://www.seas.upenn.edu/~confocal/sample_prep_12.html
- <http://www.biologydiscussion.com/microscope/microscopy-principles-and-specimen-preparations-with-diagram>

Model question paper

**UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY**

First Semester M.Sc (CSS1) Degree Examination

Branch: Genetics and Plant Breeding

BOT-C- 412 TECHNIQUES IN CELL BIOLOGY

Time: Three hours

Maximum marks: 40

- I. Answer all questions briefly
1. Explain the processes of Clearing
 2. What is FAA?
 3. Explain the use of Carnoy's fluid
 4. What is the source of carmine?
 5. Write composition of Clarke's solution
 6. Differentiate between smear and squash
 7. Explain the use of mordant in microtechnique
 8. What is a whole mount?
 9. Expand DPX
 10. What is the use of Haupt's adhesive?

(10X1=10 marks)

II. Answer any *five* questions. Each answers not exceeding 50 words.

11. Write notes on embedding
12. Write procedure for cytochemical localization of protein
13. What are the principles involved in staining?
14. Give a brief account on dehydrating agents
15. Name two natural dyes and their source.
16. Briefly describe the working of sledge microtome
17. Give an account on preparation of Schiff's reagent

(5X2=10 marks)

III. Answer any *four* of the following. Each answers not exceeding 150 words.

18. Explain the procedure for the cytochemical localization of lignin, suberin and pectin
19. Why dehydration is need for tissue processing? Describe the different methods of dehydration
20. Describe the principle and methodology of Feulgen staining for DNA
21. Describe the working and use of cryotome
22. What is meant by enzyme localization? Specify enzyme substrates used in the localization of alcohol dehydrogenase, acid phosphatase and lipases
23. Write method for the localization of insoluble polysaccharides

(4X3= 12 marks)

IV. Answer any *one* of the following, not exceeding 350 words

24. Give an account of the classification of stains used in microtechnique with examples and applications.
25. Give an account on the working and use of different types of microtomes.

(1X8= 8 marks)

Semester : **I**
Course Code : **BOT –C-413**
Course Title : **CYTOLOGY**
Credits : **4**

AIM: To introduce the basic principles of Cytology

OBJECTIVES

To get an insight into the ultrastructure and functional features of the cell organelles.

To understand a detailed account on the general chromosome organization in addition to information on some special types of chromosomes.

To learn the karyotype preparation method for depicting chromosome morphology. To provide an account on the mechanism of cell division

COURSE CONTENT

MODULE I: Cell Organelles: Ultrastructure, chemistry, functions, interrelationships and origin: Cell-wall, Plasma membrane, Cytoplasm: endoplasmic reticulum, ribosomes, golgi-bodies, plastids, mitochondria, centrioles, lysosomes, peroxisomes, spherosomes. Cytoskeletal structures: microtubules, microfilaments, intermediate filaments. Nucleus: nuclear envelope, nucleoplasm, nucleolus, chromatin reticulum.

MODULE II: Chromosomes: Morphology: size and shape. Structure: chromatid, chromonema, chromomeres, centromere and kinetochore, telomere, secondary constriction, nucleolar organizers, satellite. Material of the chromosomes: euchromatin and heterochromatin, unique and repetitive sequences. Chromosomal proteins, Molecular structure: Packaging of DNA in chromosomes- formation of nucleosome, solenoid fiber, scaffold loop, chromatid. Functions of chromosomes. Special types of chromosomes: Polytene, Lampbrush and B-chromosomes.

MODULE III: Karyotype and Pachytene analysis: Karyotype.- Standard parameters for karyotype analysis, Morphological classification and categorization of chromosomes, Natural karyotype, Current modifications in the system, Karyogram and Idiogram, Karyotype differentiation and evolution, Factors affecting karyotype variations such as changes in chromosome number, structural alterations, centromere position, degree and distribution of heterochromatin. Unimodal and Bimodal karyotype. Significance of chromosomal banding. Pachytene analysis - Chromosomal parameters utilized for analysis, Idiogram, Chromosomal behaviour such as pairing and synapsis in pachytene and factors affecting the pairing.

MODULE IV: Cell division- Current concepts and molecular evidences. Interphase stages-Major events during interphase (G₀, G₁, S, G₂). Discovery of regulatory and catalytic proteins, role of cell division proteins and checkpoints. Replication of chromosomes, structure and function of centrioles and microtubules. Genetic significance of mitosis and meiosis.

MODULE V: Mitosis - Major events during prophase, prometaphase, metaphase, anaphase and telophase - spindle structure modification, microtubule organizing centers, motor proteins, other regulatory proteins and their functions. Cytokinesis- Mechanism of cytokinesis and proteins involved in plants, animals and bacteria. A brief review of cell division and life cycle of bacteria, fungi, algae,

bryophytes and pteridophytes. Variations from the normal mitotic plan - endoreduplication and endomitosis, C-mitosis, somatic reduction and genetic consequences of the above variations.

MODULE VI: Meiosis - Major events during prophase, metaphase, anaphase and telophase of Meiosis I and Meiosis II. Role of spindle and regulatory proteins. Molecular structure of the synaptonemal complex and its functions in normal pairing and synapsis. Variations in the pairing mechanism – Asynapsis, desynapsis, exchange pairing, non-homologous pairing, secondary pairing and somatic pairing. Chiasma formation and genetic recombination. Single-strand and double-strand-break models. Proteins (cohesins, securins, separase) involved in sister chromatid separation and terminalization.

PRACTICALS

The given list of plants may be used to study the mitosis and meiosis. Observations should be recorded for all the division stages in the materials provided.

Fifteen permanent slides of the countable metaphase spreads to be prepared and submitted at the end of semester I.

Plant material	Gametic chr. number	Somatic chr. Number
<i>Chlorophytum heynei</i>	7	14
<i>C. ignoratum</i>	7	14
<i>C. laxum</i>	8	16
<i>C. elatum</i>	14	28
<i>C. comosum</i>	14	28
<i>C. malabaricum</i>	21	42
<i>C. orchidastrum</i>	21	42
<i>Allium cepa</i>	8	16
<i>Zea mays</i>	10	20
<i>Aloe sp.</i>	7	14
<i>Capsicum annum</i>	12	24
<i>Trigonella foenumgraceum</i>	8	16
<i>Crotalaria sp.</i>	8	16

Endomitosis: *Cocos nucifera* endosperm to be used to study endomitosis

Karyotypic preparation and ideogram construction of somatic metaphase chromosomes of any material given in the Table.

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Model Question Paper

UNIVERSITY OF KERALA DEPARTMENT OF BOTANY

First Semester M.Sc (CSS1) Degree Examination

Branch: Genetics and Plant Breeding

BOT –C-413 CYTOLOGY

Time: Three hours

Maximum marks: 40

- I. Answer all questions in one word or sentence
1. Define idiogram
 2. What is nucleoplasm?
 3. What do you mean by endocytosis?
 4. What is kinetochore?
 5. What are peroxysomes?
 6. Distinguish between bimodal and unimodal karyotype
 7. What is blepharoplast?
 8. Define endomitosis
 9. What are cohesins?
 10. What do you mean by synapsis?

(10X1= 10 marks)

- II. Answer any *five* questions. Each answer *not* exceeding 50 words
11. Distinguish between euchromatin and heterochromatin
 12. Give the functions of golgibodies
 13. Describe the major events in different phases of interphase stage
 14. Describe the role of different proteins in chromatid separation and terminalization
 15. What is basic chromosome number? How does it differ from gametic number?
 16. What is the significance of pachytene analysis?
 17. Give an account on membrane lipids

(5X2= 10 marks)

- III. Answer any *four* of the following Each answer *not* exceeding 150 words
18. 'The chromosome number remains constant in a species by meiosis, through successive generations of progenies' substantiate it using the life cycle of bryophytes
 19. Describe the molecular structure of centromere
 20. Describe the ultra-structure of chloroplast
 21. Write a note on Levanet *al.* system of chromosome classification
 22. Give an account on polytene chromosomes.
 23. What is C mitosis? Describe its genetic consequences

(4X3= 12 marks)

- IV. Answer any *one* of the following, *not* exceeding 350 words
24. What is chiasma? Briefly explain the molecular mechanisms of genetic recombination
 25. Briefly describe the various factors affecting karyotype variation and discuss their significance in evolution

(1X8= 8 marks)

Semester : I
Course Code : BOT-E-414
Course Title : BIOPHYSICS
Credits : 2

AIM: To equip the students with the skills to determine the physical phenomena which influence living organisms. They scrutinise the physical patterns within atoms, cells, and environments, and how these determine the biological processes existent in everyday life.

OBJECTIVES

To familiarize the operation of equipments used in the lab
To study the principle and applications of equipments used for the biological research and studies.

COURSE CONTENT

MODULE I: Physical forces and chemical bonds -Ionic bond, covalent bond, electrostatic bond hydrogen bond, hydrophobic bond and Van der Waals forces. Examples of biological molecules. Principles of biophysical chemistry: pH, buffer, reaction kinetics, thermodynamics, colligative properties. Photobiological phenomena: Fluorescence, phosphorescence, Birefrinence and dichroism. Bioenergetics: Concepts of entropy, free energy, enthalpy, redox potential.

MODULE II: Principles and applications of light, phase contrast, fluorescence, polarizing, scanning and transmission electron microscopy: Cytophotometry and flow cytometry, video-micrometry, camera lucida and photomicrography.

MODULE III: Centrifugation and chromatographic techniques: Basic principles of sedimentation – Types of centrifuges and their uses – Preparative and Analytical centrifuge – Sedimentation equilibrium method, Sedimentation velocity method – Density Gradient Centrifugation – Isokinetic and isopycnic centrifugation – Differential centrifugation. General principles–Adsorption and Partition Chromatography–Thin layer chromatography, paper chromatography, Gas-liquid chromatography (GLC), High performance liquid chromatography (HPLC), Ion-Exchange Chromatography and Affinity Chromatography.

MODULE IV: General principles – apparatus, methods and applications – Moving boundary electrophoresis and zone electrophoresis – Paper electrophoresis starch gel, agarose gel and polyacrylamide gel electrophoresis – SDS, Non-SDS, DISC electrophoresis Isoelectric focusing, Istotachophoresis and immuno electrophoresis.

MODULE V: Spectroscopic techniques: General principles, Types of spectra and their biochemical usefulness, visible and UV spectrophotometry, Infra-red (IR) Circular Dichroism (CD), NMR, ESR and mass spectroscopy, Spectro-fluorimetry, Luminometry, Atomic/Flame spectrophotometry, Atomic absorption and plasma emission spectroscopy. X-ray diffraction– Braggs equation, X-ray diffraction analysis powder method and crystal method. Production of X-ray and analysis of diffraction pattern.

MODULE VI: Detection and measurement of different types of radioactive isotopes normally used in biology— Geiger-Muller, Liquid Scintillation Counting, ionization chamber, Pocket dosimeters-film badge. Incorporation of radioisotopes in biological tissues and cells, molecular imaging and radioactive material, safety guidelines. Application of isotopes and radioisotopes in biological research, radioisotope tracer technique and autoradiography

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Model question paper

**DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA**

First Semester M.Sc (CSS1) Degree Examination

Branch: Genetics and Plant Breeding

BOT-E-414 BIOPHYSICS

Time: Three hours

Maximum marks: **60**

I. Answer *all* questions in one word or sentence

1. Define partition coefficient
2. What is retention time?
3. Explain moving boundary electrophoresis
4. Define two way chromatography
5. What is ligand?
6. What is sedimentation co-efficient?
7. Name various types of media used for electrophoresis
8. What is redox couple?
9. Explain differential centrifugation
10. What is entropy?

(10X1=10 marks)

II. Answer any *five* questions. Each answers not exceeding 50 words

11. Give an account on different types of centrifuges
12. Explain affinity chromatography
13. Give an account on the various applications of radioisotopes in biology
14. Explain procedure of immuno-electrophoresis
15. Write method for the calculation of redox potential
16. Explain isotachophoresis
17. Briefly explain film badge

(5X3= 15marks)

III. Answer any *five* of the following. Each answer not exceeding 150 words

18. Explain density gradient centrifugation
19. Derive Braggs equation and write its applications
20. Briefly explain iso-electro-focusing
21. Give an account on the Geiger-Muller counter
22. Explain the working of light microscope
23. Give an account on the various types of interactions found in a protein
24. Give an account on autoradiography

(5X5= 25marks)

IV. Answer any *one* of the following, not exceeding 350 words

25. Give an account on the polyacrylamide gel electrophoresis
26. Briefly explain the working of HPLC. How is it different from G.C? Write its applications also

(1X10= 10marks)

Semester : **II**
Course Code : **BOT-C-421**
Course Title : **MOLECULAR GENETICS**
Credits : **4**

AIM: To familiarize students about concepts of Molecular genetics

OBJECTIVES

To give an overview of organization of genetic material to the students.
To impart knowledge about gene mapping.
To bestow practical skill in gene mapping.
To understand molecular mechanism of gene expression.
To study detailed knowledge about genomics.

COURSE CONTENT

MODULE I: Genetic organization-DNA structure, Chemistry of nucleotides, organization of the polynucleotide strand, Importance of double helical structure of DNA, Watson-Crick model-Conformational changes in DNA structure, Types of DNA, Organization of the Eukaryotic DNA, Repetitive DNA, DNA variation in organisms- DNA replication, Semi-conservative replication in prokaryotic and eukaryotic organisms- enzymes in replication, DNA polymerase I, II, III, DNAgyrases, topoisomerases, ligases, RNA polymerase (primase) and replisome complex- current concept of DNA replication in prokaryotes and eukaryotes.

MODULE II: Gene mapping- Introduction to bacterial culture, serial dilution, identification and classification of microorganisms-Recombination and mapping in Bacteria, Viruses and Fungi- Bacteria -Mechanism of genetic recombination, Transformation, Transduction and Conjugation, Mapping the bacterial chromosome, Interrupted and uninterrupted conjugation, recombination mapping, complementation and deletion mapping- Viruses, Types, genetic fine structure, inter- and intra-genic recombination and mapping, role of rII locus of phage in mapping, complementation and deletion mapping- Fungi, Ascomycetes - *Neurospora crassa*: ordered tetrads, tetrad-analysis, recombination mapping-*Saccharomyces cerevisiae* - unordered tetrads, parental and non-parental di-types, recombination mapping.

MODULE III: Gene expression: Evolution of the Gene Concept, Functional definition, One gene-one metabolic block, one gene-one enzyme, one gene-one polypeptide- Structural and operational definition of gene- Molecular Biology of gene expression, Brief overview of the Central Dogma and Teminism- Transcription in prokaryotes and eukaryotes- Types and structure of RNA polymerase- Different types of RNA- mRNA, tRNA, rRNA, snRNA, snoRNA, miRNA, Xist, RNA, siRNA, shRNA, antisense RNA- Regulatory sequences and transcription factors involved- Mechanism- Initiation, elongation and termination- Post transcriptional modification of RNA, Split genes and RNA splicing in eukaryotes, RNA editing, Ribozymes- Translation in prokaryotes and eukaryotes- Basic structure of proteins, ribosomes, tRNA-Genetic code Experiments conducted to decipher the genetic code, salient features, exceptions, wobble-hypothesis, genetic code in mitochondria and ciliate protozoans, Mechanism of translation- Chain initiation, elongation and termination, proteins involved, factors affecting translation accuracy.

MODULE IV: Molecular mechanism of Gene Regulation in Prokaryotes- Constitutive, Inducible and Repressible expression, positive and negative control- Induction and catabolite repression in *lac* operon, repression and attenuation in *trp* operon, lysogenic and lytic switches in lambda phage, Translational and post translational regulation.

MODULE V: Molecular mechanism of Gene Regulation in Eukaryotes- Controlled transcription of DNA, Alternate splicing of RNA, Cytoplasmic control of mRNA stability, Induction of transcriptional

activity by environmental and biological factors- Temperature-Heat shock proteins, Genes that respond to hormones- Proteins involved in control of transcription, transcriptional factors, activator proteins, enhancers, silencers, eukaryotic transcription complex, chromatin remodeling during gene expression, alternative promoter-Post transcriptional regulation, RNA interference, siRNAs, miRNAs, untranslated regions (UTRs), nonsense mediated decay, chromatin remodeling, DNA methylation, Imprinting.

MODULE VI: Genomics: Structural genomics-sequence analysis, next generation sequencing technologies, history of genome projects, gene families, genome assembly and annotation, genome-scale sequence analysis, human genome sequencing project, regulatory and epigenetic landscapes of mammalian genomes. Functional genomics- transcriptome, proteome and metabolome, types of microarrays (gene-chips), expression analysis, functional enrichment and network inference, pharmacogenomics, identifying the genomic basis of rare diseases, Comparative genomics - basis of molecular evolution, nucleotide substitutions (synonymous and non-synonymous), functional and evolutionary relationships between prokaryotes and eukaryotes, orthologues and paralogues, neo functionalization, phylogenetic tree- Metabolomics- Identification and quantification of cellular metabolites in biological samples.

PRACTICALS

- (i) Aseptic transfer of micro-organisms for subculturing
- (ii) Isolation of discrete colonies from mixed cultures
- (iii) Identifying and classifying the given micro-organisms
- (iv) Serial dilution agar plate method to quantitative viable cells
- (v) Isolation of plasmid DNA from *E. coli* using alkaline lysis method.
- (vi) Problems relevant to the above units

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ADDITIONAL REFERENCES

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- Hugo: [http:// ash. gene. ncl. ac .nk.](http://ash.gene.ncl.ac.uk)
- DNA learning center: [http://tor. cshl. org](http://tor.cshl.org).
- Genome Databases: [http://www. gdb. org](http://www.gdb.org).
- National Centre for Genome Resources. [http://www. neg r. org](http://www.ncgr.org).
- Washington Univ. Dept. of Genetics. [http://www. genetics. wustl. edu](http://www.genetics.wustl.edu).
- Genome Sequencing Center. [http://genome. imb-jena. dc](http://genome.imb-jena.de).
- <https://swayam.gov.in/course/1391-human-molecular-genetics>

Model question paper

**UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY**

Second Semester M.Sc (CSS2) Degree Examination

Branch: Genetics and Plant Breeding

BOT-C-421 MOLECULAR GENETICS

Time: 3hrs

Maximum marks: 40

I. Answer all the questions in one word or sentence.

1. Write function of repressible type of effector molecule
2. What is the function of ribosomal A and P site
3. Define Enhancers
4. Nuclear splicing
5. What is Pribnow box?
6. What is hybrid dysgenesis?
7. Define centromere mapping
8. What are SnRNPs?
9. Define Teminism
10. What is the specific function of sigma factor in prokaryotic transcription?

(10X1= 10 marks)

II. Answer any *five* questions. Each answer not exceeding 50 words

11. What are the two mechanisms which control the rate of transcription of *trp* operon?
12. Elucidate the physiology and genetic defect associated with phenylketonuria
13. Explain central dogma of molecular biology
14. What are Kozak sequences and Shine-Dalgarno sequences?
15. What is the difference between first division and second division segregation pattern in the tetrads of *Neurospora*?
16. Give an account on the various subunits of prokaryotic RNA polymerase enzyme
17. Give a comparative account on different types of RNA polymerase enzymes

(5X2= 10 marks)

III. Answer any *four* of the following. Each answer not exceeding 150 words

16. Describe Beadle and Tatum's experiment from which the 'one-gene-one-enzyme concept' evolved. Why was the concept further modified to the 'one-gene-one-polypeptide' concept?
17. Explain the different mechanisms of genetic recombination in bacteria.
18. Describe various mode of mRNA splicing
19. Describe the mechanism of transcription attenuation in the *trp* operon
20. What are transcription factors? How do the transcription factors help in the process of transcription regulation?
21. Give short descriptions for all the enzymes involved in DNA replication in prokaryotes
22. Describe ultra-structural organization of eukaryotic ribosome. What are its major sites?

(4X 3 = 12marks)

IV. Answer any *one* of the following not exceeding 350 words

24. What are transposons? How do they differ from retrotransposons? With the help of suitable examples, describe the different types of transposons detected in the different model organisms
25. What is the genetic code? Enlist the important features of the genetic code. Explain the steps involved in gene translation in prokaryotes

(1X 8=8marks)

Semester : II
Course Code : BOT-C-422
Course Title : CYTOGENETICS
Credits : 4

AIM: To provide knowledge on structural and numerical aberrations of chromosomes, banding techniques, nucleic acid hybridization, transposons - human cytogenetics-sex determination mechanism in plants and animals

OBJECTIVES

To study the numerical and structural aberrations of chromosomes and their applications in plant breeding programmes.

To understand aneuploids and their role in evolution.

To get the concepts on chromosomal structural aberrations and their effects

To understand chromosome banding and various types of nucleic acid hybridization techniques

To study transposons in different organisms and their role in breeding programmes

To get the knowledge on human cytogenetics and sex determination mechanism in plants and animals.

COURSE CONTENT

MODULE I: Haploidy: Terminology and classification: Euhaploids- monohaploids- polyhaploids- aneuhaploids- disomic haploids- addition haploids- substitution haploid--nullisomic haploid and misdivision haploid. Spontaneous occurrence-twin seedlings-androgenetic and gynogenetic haploids-induction of haploids. Morphology and cytology of haploids and practical value in plant breeding. Polyploidy: Types of euploids- autopolyploids- allopolyploids- segmental allopolyploid-, autoallopolyploids and agmatoploids – origin and cytogenetic basis of different types of polyploids – meiosis in polyploids (triploids and tetraploids), morphological- physiological and genetical characters of polyploids. Induction of polyploids-cytological effects of colchicines. Role of polyploids in plant breeding. Allopolyploids – genetic regulation of chromosome pairing- allo polyploidization of autopolyploids- genome analysis – genetic consequences – deviation segregation- aneuploids in allopolyploids-identification of homologous chromosomes. Segmental allopolyploids- fertility – Higher polyploids- diploidization- agmatoploids

MODULE II: Aneuploidy: Hyperploids – trisomics- tetrasomics- double tetrasomics – Trisomics-types of trisomics- primary trisomics- secondary trisomics- tertiary trisomic- acrocentric trisomics-fragment trisomics- compensating trisomics – meiosis in trisomics- morphology-physiology and biochemistry of trisomics. Transmission of extra chromosome in trisomics. Elimination of extra chromosome during meiosis. Hypoploids: monosomic- nullisomics. Meiosis in aneuploids, Role of aneuploids in the evolution. Transmission and genetic consequences – transmission of the extra chromosome through the female and male – morphology- physiology- anatomy and biochemistry of trisomics, Hypoploids. Aneuploidy of sex chromosome.

MODULE III: Structural aberrations: Deficiency – origin- cytological behavior- genetic effects, pseudo dominance; Duplication – origin- types of duplications: tandem- reverse tandem- displaced, cytological behavior- position effect. Inversion – origin- types of inversion (paracentric and pericentric)- meiotic behavior. Translocations- origin- types of translocations- meiotic behavior- Translocation complex in *Rhoeo*, *Oenothera*- Renner effect. Identification of chromosome segments and their alterations.

MODULE IV: Quinacrine banding- Giemsa banding (G-banding)- Reverse fluorescent banding- C-banding- Fielgen banding- Silver banding (AG- NOR banding)- N- banding- Orcein banding. Nucleic acid hybridization: Fluorescence *in Situ* Hybridization (FISH)- *Genomic in Situ* Hybridization (GISH)- *Multicolor Genomic in Situ* Hybridization (Mc GISH).

MODULE V: Transposable elements - Historical background- General features,- Types- Transposons in bacteria (IS elements, Composite elements)- Maize (Ac/ Ds elements, Spm / En elements)- *Drosophila* (P elements)- Mechanism of transposition- Genetic and evolutionary significance. Retro transposons - Mechanism of reverse transcription- Types - Retro viruses- Retroposons in yeast (Ty elements)- *Drosophila* (Copia elements)- mammals (LINES, SINES)- Retro elements and C-value paradox. Transposon mediated molecular techniques: S-SAP (Sequence Specific – Amplified Polymorphism- IRAP (Inter-retrotransposon – Amplified polymorphism)- REMAP (Retrotransposon – Microsatellite Amplification)- RBIP (Retrotransposon – Based insertional polymorphism)- Evolutionary implications of Transposable Elements- Applications of transposons and retroposons in breeding programmes.

MODULE VI: Cytogenetics of sex (a) Sex chromosomes; types of sex chromosomes – undifferentiated, structurally heteromorphic and multiple sex chromosomes, sex chromosomes in plants and animals- Evolution of sex chromosomes- origin of the sex chromosome mechanisms; (b) Sex chromatin: chromosomal and genetic mechanisms- sex determination in dioecious plants and animals- role of ‘sry’ genes in mammalian sex determination- inter sexes- gynandromorphic,- sex reversal- environmental influence in sexual dimorphism- evolution of dioecism. Human Cytogenetics: Human chromosome culture technique- Normal karyotype in man- chromosome aberrations associated with congenital defects in man. Turner’s syndrome- Klinefelter’s syndrome- triple X syndrome- hermaphroditism- Down’s syndrome- trisomy D1 and trisomy 18 syndromes

PRACTICALS

1. Polyploid :Cytology of polyploid series of *Chlorophytum*
2. Colchiploid production - *Capsicum*
3. Aneuploidy -*Datura*
4. Structural aberrations: Inversion – *Eleuthrine bulbosa*,
Translocation - *Rhoeo*
5. Sex chromosomes in plants -Demonstration
6. Human cytogenetics - Demonstration
 - (a) Human chromosome culture technique
 - (b) Normal human karyotype
 - (c) Chromosomal aberrations

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Model question paper

**UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY**

Second Semester M.Sc (CSS2) Degree Examination

Branch: Genetics and Plant Breeding

BOT-C-422 CYTOGENETICS

Time: 3 hrs

Maximum 40 marks

I. Answer all questions in one word or sentence

1. What is autopolyploid?
2. What is meant by parthenogenesis?
3. Define Lyon's hypothesis?
4. Which stain is used for G banding?
5. Which chromosomal aberration does cause pseudo dominance?
6. Name a congenital defect in man which is associated with aberration in sex chromosome?
7. What is nullisomics?
8. What are LINES and SINES?
9. What is apogamy?
10. What do you mean by non-disjunction?

(10X1=10 marks)

II. Answer any *five* questions. Each answer not exceeding 50 words

11. What are acrocentric trisomics?
12. What is Turner's syndrome?
13. What is segmental allopolyploids?
14. What do you mean by translocation?
15. Give a short account on 'sry' gene
16. How do the insertion sequences differ from composite transposon?
17. Describe the causes and symptoms of triple X syndrome

(5X2=10 marks)

III. Answer any *four* of the following. Each answer not exceeding 150 words

18. Describe the structure of human karyotype
19. Write down the meiotic behavior of polyploids
20. Give an account on prenatal diagnosis of genetic disorders
21. Explain the phenomenon of sex reversal in mammals
22. Explain the experiment which led to the discovery of transposons in Maize. What were the other types of transposons detected in Maize later on ?
23. Explain C- value paradox

(4X3=12 marks)

IV. Answer any *one* of the following, not exceeding 350 words

24. What are inversions? Explain the meiotic behaviour of paracentric and pericentric inversion
25. Explain the role of allopolyploidy in crop evolution

(1X8=8 marks)

Semester : II
Course Code : BOT-C- 423
Course Title : PLANT BREEDING
Credit : 4

AIM: To impart theoretical knowledge and practical skills about plant breeding

OBJECTIVES

To acquire knowledge on history of Plant Breeding,

To understand modes of reproduction and genetic consequences

To study breeding methods for crop improvement.

To provide information about collection, evaluation, documentation, maintenance and use of plant genetic resources for crop improvement

COURSE CONTENT

MODULE I: Introduction-History of plant breeding, Green Revolution, nature of plant breeding, the disciplines to be known by a breeder, activities in plant breeding, some important achievements, undesirable consequences. Centres of origin: Different centres and their significance. Types of crops: Cereals, Millets, pulses, oil yielding plants. Fibre crops, narcotics, beverages (botanical names and economic part). Plant introduction, procedure, quarantine period, Phytosanitary certificate, Role of plant genetic resources in plant breeding, PG database management, PBR, Intellectual property rights.

MODULE II: Domestication: selection under domestication, changes in plant species under domestication. Germplasm: different types of germplasm, gene pool concept, genetic erosion, germplasm collections-requisites for a gene bank, genetic erosion in gene banks, constraints of gene bank. . Germplasm conservation : - *in situ* and *ex-situ* conservation- seed banks, plant gene banks, shoot tip gene banks, cell and organ gene banks, DNA banks, germplasm evaluation- cataloguing-multiplication and distribution, germplasm utilization.

MODULE III: Modes of reproduction: Vegetative and sexual reproduction. Different methods-budding, grafting, layering, apomixis- classification with examples. Sexual reproduction- mechanism promoting self-pollination and cross pollination, genetic consequences of self and cross pollination. Relevance of mode of pollination. Breeding methods in self and cross pollinated crops : Selection: History of selection, pureline selection, mass selection, pedigree selection, bulk method of selection, backcross method of selection procedure, applications, merits, demerits and achievements of each type. Transfer of recessive and dominant gene through back cross. Modifications of back cross method.

MODULE IV: Hybridization: Types of hybridization, procedure, emasculation – different methods, consequences of hybridization. Distant hybridization: History, barriers in production of distant hybrids-failure of zygote formation-failure of zygote development- lethal genes-phenotypic disharmony between two parental genomes- chromosome elimination- incompatible cytoplasm- endosperm abortion-failure of hybrid seedling development. Application of distant hybridization in crop improvement alien chromosome addition and substitution lines–transfer of small chromosome segment–achievements and limitations.

MODULE V: Incompatibility: Different types, self-incompatibility- homomorphic and heteromorphic, gametophytic and sporophytic incompatibility, mechanism of self-incompatibility, pollen- stigma interaction, pollen tube -style interaction, pollen tube -ovary interaction–Genetic, biochemical and molecular basis of incompatibility, significance of self-incompatibility in plant breeding, methods to overcome self-incompatibility. Male sterility: types of male sterility, Cytoplasmic male sterility, genetic male sterility –origin of male ms alleles, site of action of ms alleles, molecular mechanism of ms action, Phenotypic expression of male sterility, cytoplasmic genetic male sterility, development of new male sterile and restorer lines, photoperiod sensitive cytoplasmic-genetic male sterility, utilization in plant breeding, origin of male sterile line, limitations of cytoplasmic genetic

male sterility system, approach to minimize the undesirable consequences of male sterile cytoplasm, chemically induced sterility, features of chemical hybridizing agents (CHA), some important CHAs, hybrid seed production based on CHAs, advantages and limitations of CHAs.

MODULE VI: Classes of seed- Basic nucleus seed, breeder seed, foundation seed, certified seed. Seed processing- Drying, grading, testing, treating, bagging and labeling. Seed certification – genetic purity, physical purity, germination, moisture content, freedom from weeds and diseases. National Seed Corporation, State Seed Certification Agencies, Activities of seed industry, Seed multiplication.

PRACTICALS

I Germplasm collection

1. Cereals - Paddy
2. Vegetables - *Capsicum*
3. Pulses - Green gram, Black gram, Red gram

II Plant propagation

1. Vegetative
 - a. Layering: (1). Air layering (2). Mound layering
 - b. Grafting
 - c. Budding – T – budding (wild rose and *Hibiscus*)
 2. Apomixis
 - a. Polyembryony: Mango seedlings
 - b. Vivipary - *Alpinia* and grass

III Hybridization

- a. Notes on types of hybridization
- b. Floral biology in self and cross pollinated species
- c. selfing and crossing techniques
- d. Emasculation in Solitary flower
 1. 'V' cut method
 2. Slit method
 3. Round cut method

IV Incompatibility – Pollen viability test

- In vitro*
- a. Brewbaker's medium preparation
 - b. Staining test in acetocarmine
- In vivo* – Pollen Germination on stigma
- Pollen germination through style
- Pollen germination through ovule

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Model question paper

**UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY**

Second Semester M.Sc (CSS2) Degree Examination

Branch: Genetics and Plant Breeding

BOT-C- 423 PLANT BREEDING

Time: Three hours

Maximum marks: 40

I. Answer *all* questions in one word or sentence

1. Define emasculation
2. Name any two cereals with botanical nomenclature
3. What do you mean by combination breeding?
4. Write down the contribution of Thomas Fairchild?
5. What is introgression?
6. What is introduction?
7. What is gene bank?
8. Define androgenic haploid
9. Explain gametophytic incompatibility
10. Differentiate between grafting and layering

(10X1= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 50 words.

11. Write the difference between mass selection and pureline selection
12. What are the genetic consequences of crosspollination?
13. Give the features of a good chemical hybridizing agent
14. With suitable example, explain mound layering
15. Explain the genetics of distyly and tristyly in plants
16. Distinguish between single cross and double cross
17. Briefly explain the features of gametophytic incompatibility

(5X2= 10 marks)

III. Answer any *four* of the following Each answer not exceeding 150 words

18. Explain the procedure of approach grafting
19. Explain the procedure of transferring recessive genes by backcross method
20. Describe the steps involved in a hybridization programme
21. Describe the various steps involved in plant introduction
22. Briefly explain the different types of genetic male sterility
23. Give an account on the various centers of origin of plants

(4X3= 12 marks)

IV. Answer any *one* of the following, not exceeding 350 words

24. Give an account on various plant conservation methods
25. Describe the procedure for distant hybridization

(1X8= 8 marks)

Semester : II
Course Code : BOT-C- 424
Course Title : PLANT BIOCHEMISTRY
Credits : 4

AIM: To acquire an in depth knowledge on biomolecules and physiological processes in plants.

OBJECTIVES

To get the knowledge on general composition and properties of biomolecules
To explain synthesis, storage, function and degradation of biochemical constituents
To understand the biochemistry of plant developments
To trace the relationship between biochemical pathways in plants and the physiological processes.
To understand secondary metabolites and their potential applications in pharmaceutical industry

COURSE CONTENT

MODULE I: Carbohydrates - General composition and properties- solubility, reducing and non-reducing optical isomerism, stereoisomerisms, mutarotation, Classification- Monosaccharides, their structure, occurrence, role, their derivatives by oxidation, reduction and substitution, Oligosaccharides- Disaccharides, tetrasaccharides their structure, occurrence and role in glycosidic bond formation, Polysaccharides- Homo and heterosaccharides, structural and storage polysaccharides – starch, glycogen, cellulose, hemicellulose, pectic substances, chitin, agar, gum -synthesis and breakdown of glycosidic bonds, Amylase, invertase and phosphorylase action, Synthesis and degradation of Carbohydrates – Starch and Sucrose synthesis, Metabolism of Carbohydrates: Glycolysis, Fermentation, inter conversions of monosaccharides, pentose phosphate pathway and gluconeogenesis.

MODULE II: Proteins and Enzymes-Classification of Amino acids, structure of common amino acids, physio-chemical properties of amino acids, Synthesis and breakdown of peptide bonds, oxidation, reductive amination, transamination, and deamination. Proteins- Classification, General accounts, Functions of protein, Classification of protein according to solubility characteristics and chemical nature. Structure – primary, secondary, quaternary structure, Ramachandran plot, Protein sequencing, prototype enzymes. Enzymes- General account: Importance of enzymes in biological sciences, the classification and nomenclature of enzymes with examples, key to numbering classification of enzymes, Mode of enzyme action, derivation of Michaeli's constant, models for explaining enzyme action, energy of activation, various factors affecting the enzyme activity, Properties of enzymes, Competitive and non-competitive enzyme inhibition and types. Coenzymes- Introduction, structure and classification. Brief account on important coenzymes- NAD, NADP, ATP, Cytochromes, Coenzyme –A, lipoic acid, thiamine pyrophosphate.

MODULE III: Lipids, Vitamins and Hormones-Classification of lipids: triacylglycerols, waxes, phospholipids (membrane lipids), glycerolipids, glycolipids, sphingolipids, isoprenoids, carotenoids, steroids. Chemistry and structure of terpenes, (eg. hemi, mono, sesqui, di and poly-terpenes), Fatty acids- classification and systematic naming system, essential fatty acids, non-essential fatty acids, omega 3 and omega 6 fatty acids, Lipid metabolism- Synthesis of fatty acids, oxidation of fatty acids- α and β oxidation, Vitamins: Water soluble and lipid soluble vitamins, structure and role of vitamin A, D, tocopherol, thiamin, riboflavin, nicotinic acid, panthothenic acid, folic acid, ascorbic acid, lipoic acid, PABA, Plant hormones- Chemical structure and synthesis of hormones in plants, transport, mode of action and physiological effects of Auxin, Gibberellin, Cytokinins, Abscisic acid and Ethylene in plants.

MODULE IV: Photosynthesis & Respiration- Plant pigments-Chemistry of photosynthesis and plant product, chemistry, structure and role of chlorophyll, carotenoids and anthocyanin, light absorption and energy transfer, light and dark reaction, Hill reaction O_2 evolution, photosynthetic unit and reaction centre, Emerson enhancement effect, photosystems, electron transport system, mechanism of photophosphorylation, quantum requirements of quantum yield, CO_2 fixation, Calvin cycle, Hatch and

Slack pathway, CAM pathway, Bacterial photosynthesis, photorespiration. Biochemical oxidation: Substrate of respiration, respiratory quotient, difference between respiratory quotient and photosynthetic quotient, Aerobic oxidation of pyruvic acid, Electron Transport System, terminal oxidation of reduced coenzymes, Oxidative phosphorylation. ATP Synthetase structure and chemistry, Structure and function of electron carriers in ETC. Mechanism of oxidative phosphorylation- various theories to explain ATP synthesis. Cyanide resistant respiration.

MODULE V: Nitrogen Metabolism-General aspects of nitrogen economy; Nitrogen cycle, nitrate and nitrite reduction, denitrification, Non symbiotic and symbiotic N₂ fixation, Biological N₂ fixation, Structure of nodules, nod genes, *nif* genes; Structure, function and regulation of nitrogenase; Leghaemoglobin; Nodulins; Regulation and enhancement of nitrogen fixation. Biochemistry of nitrogen fixation. Chemoautotrophy in rhizobia and nitrifying bacteria, Pathways of ammonia assimilation, biosynthesis of amino acids, reductive amination, transamination, GDH and GS/ GOGAT pathways.

MODULE VI: Secondary metabolites - Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis, major pathways of secondary-metabolite biosynthesis, Major types– terpenes, phenolics-simple phenolics, flavonoids- anthocyanins, flavones, flavonols, isoflavones, lignins, tannins and nitrogen-containing compounds- alkaloids, cyanogenic glycosides, glucosinolates, and nonprotein amino acids, Roles for secondary metabolites in plants, Applications of Plant Secondary Metabolites in pharmaceutical industry.

PRACTICALS

I. Quantitative tests for Carbohydrates

1. Molisch's Test
2. Benedict's Test
3. Fehling's Test
4. Seliwanoff's Test
5. Iodine Test for starch

II. Acid hydrolysis of starch

III. Qualitative and quantitative tests for proteins

1. Million's Reaction
2. Xanthoproteic Reaction
3. Ninhydrin Test
4. Biuret Test
5. Precipitation Test
6. Estimation of protein using Lowry's method.

IV. Qualitative Test for fats

1. Sudan IV Test
2. Formation of Acrolein from fat

V. Qualitative Tests for Biological Compounds

1. Test for biological compounds in plant tissues
2. Tests for the chemical nature of milk.

VI. Calorimetric estimation of carbohydrates and proteins.

VII. Enzymes

1. Demonstration of polyphenoloxidase in plant tissue.
2. Action of invertase on sucrose.
3. Effect of temperature on enzyme activity.
4. Action of salivary enzyme on starch.

VIII. Photosynthesis Pigments

1. Separation of the green and yellow pigments

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- <http://biology.jbpub.com/botany/4e/>
- <http://plantfacts.osu.edu/>
- [http://study.com/directory/category/Biological and Biomedical Sciences/Botany/PlantPhysiology.html](http://study.com/directory/category/Biological%20and%20Biomedical%20Sciences/Botany/PlantPhysiology.html)
- <http://www.tau.ac.il/~ibs/teaching.html>
- <https://ocw.mit.edu/courses/biology>
- <https://www.online.colostate.edu/courses/BZ/BZ440.dot>
- <https://www.umb.edu/academics/csm/biol>

Model question paper

UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY
SECOND SEMESTER M.Sc (CSS2) DEGREE EXAMINATION
Branch: Genetics and Plant Breeding
BOT-C- 424 PLANT BIOCHEMISTRY

Time: Three hours

Maximum marks: 40

I. Answer *all* questions in one word or sentence

1. What are waxes?
2. What is the structural formula of DHA?
3. Write specific function of leghaemoglobin in root nodules of leguminous plants
4. What are homo polysaccharides with an example?
5. What is a peptide bond? How it is formed?
6. Define enzyme inhibitors
7. Define energy of activation and allosteric modulation
8. What is meant by substrate level phosphorylation?
9. What is NAD? Give its structural constituents
10. Name major anaerobic pathways occurring in organisms

(10X1= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 50 words

11. What are different classes of terpenes?
12. Write a note on different respiratory substrates
13. What are auxins? Describe important plant response that are influenced by auxins
14. Explain the concept of Km
15. Define inorganic cofactor, prosthetic group, apoenzyme and coenzyme and conjugated proteins
16. What is Hill reaction?
17. Compare C3 and C4 plants

(5X2= 10 marks)

III. Answer any *four* of the following. Each answer not exceeding 150 words

18. Write an account on synthesis of glycerol
19. Explain the role of nitrogenase enzyme in biological nitrogen fixation
20. Indicate some of the major features of EMP pathway in terms of reactants, products and type of reactions
21. Briefly describe the secondary structure of protein
22. With the help of suitable illustrations, explain chemiosmotic theory
23. Briefly explain the steps involved in the oxidation of fats

(3X4= 12 marks)

IV. Answer any *one* of the following, not exceeding 350 words

24. Briefly explain the classification of amino acids. Illustrate with the structure of one amino acid in each group.
25. What is the function of ETS? How does it work and from what source does it derive the reducing power for operation

(1X8= 8 marks)

Semester : II
Course Code : BOT –E-425
Course Title : BIOINFORMATICS
Credits : 2

AIM: To educate students in the area of computational biology

OBJECTIVES

To provide an overview on the topic.

To expose the students to the bioinformatic resources in the World Wide Web.

To introduce the bioinformatic software for data mining

COURSE CONTENT

MODULE I: Introduction to Bioinformatics-Overview: Definition of technical terms, role of internet in knowledge discovery and data mining. Applications: Biotechnology and pharmaceutical industry, business, employment opportunities.

MODULE II: Bioinformatics resources -NCBI: NCBI data model, FASTA formats, Biological databases- organism, sequence structure and mapping databases, submitting sequences-Sequin, information retrieval-Entrez. Biomark up languages-HTML, XML, BioPerl

MODULE III: Bioinformatics software-Database mining: Database similarity searches - comparing nucleotide and amino acid sequences - BLAST, Pairwise and Multiple sequence alignments, molecular phylogenetic programmes. CLUSTAL W, OLIGO, PHYLIP, PAUP, TREEVIEW.

MODULE IV: Predictive methods using DNA sequences and proteins: Gene finding strategies - Detecting open reading frames, Gene prediction programs: Hidden Markov model based gene discovery softwares-GENSCAN, GLIMMER, GENEMARK, Artificial neural network based gene discovery softwares- GRAIL, GENE PARSER, NETGENE.

MODULE V: Predictive methods using DNA proteins: Phylogenetic analysis-, Secondary databases of functional domains - Structure analysis tools- RASMOL, PYMOL, Tools at Ex Pasy–Motifs and patterns PROSITE, Pfam, BLOCKS, CDD, Protein sequence analysis tools- PEPTOOL, Predictive methods – PREDATOR, PSIPRED, SOPMA.

MODULE VI: Pharmacogenomics and drug designing, drug designing tools- ARGUSLAB. Molecular docking software- HEX.

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Human Genome Project; [http:// www.ornl.gov](http://www.ornl.gov).

Hugo: <http://ash.gene.ncl.ac.uk>

DNA learning center: <http://tor.cshl.org>

Genome Databases : <http://www.gdb.org>

National Centre for Genome Resources. <http://www.negr.org>

Washington Univ. Dept. of Genetics. <http://www.genetics.wustl.edu>

Genome Sequencing Center. <http://genome.imb-jena.de>

Model question paper

**DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA**

Second Semester M.Sc (CSS2) Degree Examination

Branch: Genetics and Plant Breeding

BOT –E-425 BIOINFORMATICS

Time: Three hours

Maximum marks: 60

I. Answer *all* questions in one word or sentence

1. Expand the term 'PHYLIP'
2. Name one exon finder tool.
3. Give the website address of NCBI
4. What is PAM?
5. Name one biomarkup language
6. What is HMM?
7. What are ligands?
8. Mention the utility of SWISS-PROT database
9. Expand the term CADD
10. What is KEGG?

(10X1 =10 marks)

II. Answer any *five* of the following. Each answer not exceeding 150 words

11. Compare 'orthologues' and 'paralogues'.
12. What is the difference between local and global alignment?
13. What is a database? Describe the different types of databases.
14. Describe the process of querying the database with ENTREZ
15. What is the role of 'sensitivity and specificity' in gene prediction programmes?
16. Describe homology modeling.
17. Mention at least five journals in the field of bioinformatics

(5X3 =15 marks)

III. Answer any *five* of the following. (Each answer not exceeding 250 words)

18. What is data-mining? Discuss the role of internet in data-mining and knowledge discovery
19. Give a short account on the bio-programming languages
20. Explain the gene finding strategies. Give examples of softwares that are used to predict genes in DNA sequences
21. Name the different types of protein databases
22. Explain the role of the molecular visualization tools in structure analysis.
23. What is the utility of BLAST in sequence analysis?
24. Discuss the role of PDB in protein studies

(5X5 = 25 marks)

IV. Answer any *one* of the following (Each answer not exceeding 500 words)

25. Highlight the importance of sequence analysis in biological research. Add a note on molecular phylogeny. Describe the operation of CLUSTAL W in phylogenetic analysis
26. Describe the process of computer aided drug-designing and molecular docking Explain the role of ARGUS Lab in drug-designing

(1X10=10 marks)

Semester : **III**
Course Code : **BOT-C-431**
Course Title : **GENETIC ENGINEERING**
Credits : **4**

AIM: To familiarize students about concepts of Genetic Engineering and get exposure to tools and techniques for gene transfer.

OBJECTIVES

To get an overview of fundamentals of Genetic engineering.

To provide in depth knowledge about gene cloning and recombinant DNA technology.

To impart knowledge in selection of clones.

To introduce applications and developments in animal and microbial biotechnology

COURSE CONTENT

MODULE I: Gene Cloning - Nucleic acid sample preparation for downstream analysis: Purification and extraction of nucleic acids, Techniques for the isolation of plasmid DNA, plant genomic DNA and total cellular RNA. Nucleic acid cleanup, quality and purity considerations, downstream applications. Vectors-Plasmids, phages, cosmids, phasmids, corny bacterial plasmids. *Agrobacterium* Ti and Ri plasmids, plant viruses and animal viruses; Special vectors such as shuttle vectors, expression vectors, dominant selectable vectors, amplifiable vectors, integrating vectors, artificial mini chromosomes, broad host range vectors.

MODULE II: Recombinant DNA technology- Cutting and Joining DNA - Restriction enzymes, nomenclature, types, specificity; Ligation- Enzymes involved and optimization conditions; Modification of restriction fragments - Linkers, Adaptors. Gene transfer technology- Introducing genes into prokaryotes and eukaryotes, *Agrobacterium* mediated gene transfer in plants, Recombinant viral technique, DNA mediated gene transfer method, protoplast fusion, microcell fusion technique, metaphase chromosome transfer, liposomes, microinjection technique, electroporation and Biolistics.

MODULE III: Identification of the right clone, Recombinant selection-Insertional inactivation of the antibiotic resistance gene marker genes, *lacZ* gene, λ CI gene and on the basis of λ genome size, Spi phenotype and growth on minimal medium. Identification of the clones from a gene library - Immunochemical methods, Hybrid-arrested translation, Hybrid-selected translation, Marker rescue techniques, nucleic acid hybridization and blotting techniques- colony, plaque and dot-blot hybridization. Probes and Tests- DNA, RNA, antigen and antibody probes, methods for the preparation of probes, homologous and heterologous probes. Radioactive and non-radioactive labeling methods.

MODULE IV: Molecular Analysis: Tools & Techniques- Construction of DNA libraries: Genomic and cDNA libraries: Objectives of constructing genomic library, determination of size of DNA library, steps and enzymes involved, method of screening libraries, screening expression libraries, preparation of BAC/YAC library, Polymerase Chain Reaction (PCR): Concept of PCR, Various kinds of PCR, Real Time PCR. Blotting techniques: Southern, Northern and Western blotting techniques, RAPD fingerprinting, Ligation Chain Reaction, Applications of PCR. Mapping of DNA: restriction mapping, DNA foot-printing, gel retardation analysis, chromosome walking and jumping, DNA fingerprinting, RAPD, RFLP, AFLP, SSR, ISSR, Single nucleotide polymorphisms (SNPs)-DNA sequencing-Maxam-Gilbert method, Sanger-Caulson method, Messy's shot gun method, Genome annotation at different levels, Comparative genome sequencing, pyrosequencing, second generation DNA sequencing methods, third generation sequencing methods- single molecule sequencing (SMS) methods, Automated sequencing, DNA sequencer. RNA sequencing, next generation sequencing- Protein engineering and proteome analysis- Objectives of protein engineering, Techniques of protein engineering, chemical modifications, applications of protein engineering, Proteome analysis, Protein arrays and their applications- Biosensors and Biochips- Essential components of biosensors, type of biosensors, applications of biosensors,

MODULE V: Animal Biotechnology-Objectives of gene transfer in animals Gene constructs. Transfection methods- calcium phosphate precipitation, DEAE-Dextran mediated transfection, microinjection, stem cell mediated gene transfer- Embryonic stem cell transfer, targeted gene transfer, trans gene integration, recovery of genes transferred into animals cell, expression of cloned proteins in animal cells, detection of transgene function. Current status of transgenic animal production- Applications in the pharmaceutical industry, targeted production of pharmaceutical proteins, drug production, specific proteins- insulin, somatotropin, vaccines, genetically engineered hormones, to increase milk yield, meat production; genetic engineering of livestock and developing animals specially created for use in xenografting. Bioethics: Animal welfare and ethics.

MODULE VI: Microbial biotechnology- Major products of industrial microbiology, Fermentation technology for production of industrially important compounds for use in medicine and health- antibiotics, amino acids, organic acids, enzymes, sex hormones and ionophores-Applications in microbiology: biopolymers, biosurfactants and biopesticides. Bioconversion processes- biotransformation, biodegradation and bioleaching-Hazards and impact of microbes: Biosafety considerations, Biological risks, ethical issues, economic issues, legal issues associated with microbes, Experiments with microorganisms, biosafety levels- general (standard) laboratory practices, special laboratory practices, laboratory facilities and requirements for ensuring biosafety-GMO regulatory procedures in India, Biotechnology regulatory authority of India.

PRACTICALS

1. Genomic DNA isolation from plant tissues by CTAB method.
2. Isolation of proteins from plant tissue samples
3. Standard RAPD protocol with arbitrary primers
4. Electrophoresis: Separation of DNA
5. SDS PAGE for proteins.
6. Problems related to above topics.

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Model question paper

UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY
THIRD SEMESTER M.Sc (CSS3) DEGREE EXAMINATION
Branch: Genetics and Plant Breeding
BOT-C-431 GENETIC ENGINEERING

Time: Three hrs

Maximum marks: 40marks

I. Answer all the questions in one word or sentence

1. What is the role of *cI* gene in the lysogenic pathway of lambda bacteriophage?
2. How are plasmids different from cosmids?
3. Name any two artificial chromosomes
4. Name one DNA sequencing method
5. What is bioleaching?
6. How will you calculate minimum number of clones required to construct genomic library of an organism?
7. What is site-directed mutagenesis?
8. What is the utility of lyophilization?
9. What is micro-injection?
10. Give the expansion of the term AFLP

(10X1=10 marks)

II. Answer any *five* questions. Each answer not exceeding 50 words

11. What is the difference between Hybrid selected translation and Hybrid arrested translation?
12. Describe the process of 'insertional inactivation' using the blue white screening method
13. What is meant by chromosome jumping? Explain
14. Explain the CTAB method for the isolation of plant genomic DNA
15. What is PCR? Explain major steps involved in PCR process
16. Give a short description of restriction enzymes and their nomenclature.
17. What is ELISA? How is this analytical technique used in identification of the recombinant clone?

(5X2=10 marks)

III. Answer any *four* of the following. Each answer not exceeding 150 words

18. Give an account on any three vectors used for gene cloning experiments
19. Explain the steps involved in the construction of a genomic DNA library. How does it differ from a cDNA library?
20. Define chromosome walking. Explain process involved in chromosome walking
21. Give a short note on the bioconversion processes using microbial transformation
22. Enlist objectives of protein engineering
23. Discuss the utility of microarrays in gene expression studies

(4X3=12 marks)

IV. Answer any *one* of the following, not exceeding 350 words

24. Give an overview of the procedures involved in the production of transgenic organisms
25. Discuss the advances made in genetic engineering studies in the past decade

(1X8= 8 marks)

Semester : III
Course Code : BOT-C- 432
Course Title : PLANT BIOTECHNOLOGY
Credits : 4

AIM: To acquire an in depth knowledge on Plant biotechnology and its application

OBJECTIVES

To get the knowledge on tissue culture techniques and its application in plant science
To understand the production of secondary metabolite through various *in vitro* techniques
To understand the concepts on somaclonal variation, transgenic plant production and its application in crop breeding
To apply the knowledge for the conservation of germplasm

COURSE CONTENT

MODULE I: Plant Tissue Culture Techniques -Historical aspects and significance: Introduction, history, and scope. Development of organ, tissue and cell culture, exploitation of totipotency. Laboratory requirements for plant tissue culture: Designing of plant tissue culture laboratory. Lab maintenance and fumigation. Culture vessels and their washing, Basic aspects of plant tissue culture: Sterilization techniques, different culture media components, growth regulators, undefined supplements, surface sterilization of explants, inoculation, subculturing etc. Types of Cultures: Cyto differentiation, organogenic differentiation, callus culture, callus mediated organogenesis, cell suspension culture- different types, measurements of growth pattern of cells in suspension, isolation of single cells, culture methods of single cells, testing viability of cells. Application of cell suspension and callus culture with special reference to medicinal and aromatic plants, *in vitro* techniques for micropropagation: Axillary bud proliferation approach, meristem and shoot tip culture. Production of virus free plants, shoot meristem culture, thermotherapy and meristem culture, cryotherapy, chemotherapy, virus indexing, maintenance of virus free stocks, applications and limitations, phases of micropropagation, micropropagation of tree species, medicinal and aromatic plants. Organogenesis via callus formation.

MODULE II: Applications of plant tissue culture - Cell Suspension Culture: Types of suspension culture, batch culture, continuous culture, open continuous, closed continuous, semi continuous, growth measurements, techniques for single cell culture, production of secondary metabolites, secondary products found in plants, method of production – factors affecting yield. Immobilized cell systems, bioreactors. Secondary metabolites detected in plant tissue culture. Root and hairy root culture. Methods of enhancement of secondary metabolite production in culture. Problem associated with secondary metabolite production. Meristem culture: explant, culture medium, environment during culture, browning of medium, rooting of shoots, deflasking and transfer of plantlets into soil. Somatic embryogenesis: Principle and concept, ontogeny and development of somatic embryos. Factors affecting embryo formation. Application of somatic embryogenesis. Artificial- synthetic Seeds: Introduction to synseed, production of synthetic seed encapsulation, steps of commercial artificial seed production, artificial seed propagation, applications. *In vitro* production of Haploids: *In vitro* production of haploids and uses of haploids, androgenic methods, anther culture, microspore (pollen) culture, pathways of development, factors governing the success of androgenesis, explant genotype, culture medium, growth regulators, physiological status of the donor plants, stages of pollen, pretreatment of anthers, other factors, Process of androgenesis. The ploidy level and chromosome doubling, diploidisation, Uses of haploids in plant breeding, gynogenic haploids, Factors affecting gynogenesis. Embryo rescue techniques recovery of interspecific hybrids, ovary, ovule, endosperm and embryo culture. *In vitro* pollination and test tube fertilization, methodology, factors affecting seed set application. Green pod culture of orchids, applications.

MODULE III: Protoplast Isolation and Culture- Protoplast isolation- different methods-mechanical method, enzymatic method, production of protoplasts, osmoticum, protoplast viability and density, protoplast purification. Culture of Protoplast: Culture techniques, culture medium and environmental

factors, protoplast culture, cell wall formation, growth, division and regeneration of plants, protoplast fusion, somatic hybridization, different types, fusion methods, spontaneous fusion, induced fusion, different types of fusagen, mechanism of fusion, identification and selection of hybrid cells, verification and characterization of somatic hybrids, chromosome status of fused protoplasts, cybrids, achievements and limitations, significance of protoplast culture and somatic hybridization, somatic hybridization for crop improvement, problems and limitations of somatic hybridization, genetic modification of protoplasts, direct genetic transformation of DNA into protoplasts, particle bombardment, transformation of protoplast by electroporation, microinjection and microprojectiles.

MODULE IV: Somaclonal and gametoclonal variations and importance. Origin and causes-regeneration system, type of tissue, explant source, media components, duration and number of culture cycles; Technique for detection and isolation of somaclonal variants; Characterization of variants, molecular basis of somaclonal variation; Factors controlling somoclonal variation and its applications and achievements in plant breeding, limitations.

MODULE V: Transgenic Plants-Introduction, brief account of vector mediated and vectorless mediated gene transfer, application of transgenic plants, transgenic plants for crop improvement (dicots and monocots), Insect resistance, resistance to virus, resistance to other diseases, recombinant DNA techniques for the production of transgenic plants, procedure and protocols of producing transgenic plants. Transgenics for quality, improved storage, flower color and shape, terminator seed, Commercial transgenics crops, Uses and applications of transgenic plants, new products, pharmaceuticals. Bioremediation, edible vaccines, antiviral proteins, Current status of transgenics, biosafety norms and controlled field trials and release of transgenics.

MODULE VI: Germplasm Storage and Cryopreservation - Conservation of germplasm, *In vitro* strategies, short, medium and long term (cryopreservation) preservation application, techniques of cryopreservation, choice of material, preculture, cryoprotection, freezing, thawing, reculture, vitrification, encapsulation dehydration, determination of survival and viability, plant growth and regeneration, applications of cryopreservation, Cryopreservation of vegetative propagated and recalcitrant seed species, Large-scale utilization of cryopreservation for germplasm conservation, cryopreservation-progress and prospects.

PRACTICALS

1. Preparation of stock solutions of MS and Mitra media
2. Preparation of solid and liquid media
3. Sterilization of culture media
4. Techniques of isolation, surface sterilization and inoculation of different explants.
5. Direct and indirect organogenesis (Medicinal plant)
6. Introduction of callus and organogenesis
7. Preparation of artificial seeds
8. Green pod (embryo culture) culture of orchid (*Spathoglottis plicata*).
9. Protoplast isolation by enzymatic method
10. Anther culture

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Model question paper

UNIVERSITY OF KERALA DEPARTMENT OF BOTANY

Third Semester M.Sc (CSS3) Degree Examination

Branch: Genetics and Plant Breeding

BOT-C- 432 PLANT BIOTECHNOLOGY

Time: Three hours

Maximum marks: 40

I. Answer *all* questions in one word or sentence

1. What is bioreactor?
2. Expand PEG
3. Define callus
4. What are secondary metabolites?
5. Explain diploidization
6. What is fusogen?
7. Define totipotency
8. Define cytodifferentiation
9. Explain clonal propagation
10. What is embryo rescue technique?

(10X1= 10 marks)

II. Answer any *five* questions. Each answer not exceeding 50 words

11. Give an account on plant growth regulators
12. Explain the application of micropropagation
13. Name two organic compound present in MS medium
14. Discuss the significance of ovule culture
15. What are synseeds? Add a note on their applications
16. Describe hairy root culture
17. Give an account on plant growth regulators

(5X2= 10 marks)

III. Answer any *four* of the following. Each answer not exceeding 150 words

18. Discuss the application of tissue culture in the conservation of RET plants
19. What are the major constituents in a tissue culture medium?
20. Explain somaclonal variation and its applications?
21. Discuss the steps involved in cryopreservation
22. How is plant secondary metabolites obtained through tissue culture?
23. Discuss the procedure of different kinds of suspension culture

(4X3= 12 marks)

IV. Answer any *one* of the following, not exceeding 350 words

24. Briefly explain the production of *Bt* cotton and its application in crop improvement
25. Explain the methods of cell fusion and add a note on their importance in crop improvement

(8X1= 8 marks)

Semester : III
Course code : BOT-C- 433
Course title : ENVIRONMENTAL GENETICS
Credits : 4

AIM: To study environmental factors on gene expression and to study mutation

OBJECTIVES

To know the effect of environment on gene expression
To analyze chromosome- structural and numerical variations and their effects on human
To familiarize various mutation detection methods
To study DNA repair mechanism

COURSE CONTENT

MODULE I: Environmental factors affecting genes and their expression-Heritable changes: Spontaneous and induced mutations Luria Delbruck fluctuation Test, Somatic mutation and germinal mutation, genetic mosaics, Environmental Mutagens: Physical- Corpuscular radiations-Alpha particles, Beta particles, and Neutrons. Electromagnetic radiations - Gamma rays, X rays and ultra violet radiations, Properties of radio nucleotides, Radiation units. Chemical- Alkylating agents, Base analogues, Acridines, deaminating agents-

MODULE II: Chromosomal mutations - Variation in chromosome number – Gamete formation in autotetraploids, aneuploid segregation in plants, Monosomy, Cri-du-Chat syndrome Trisomy, Down syndrome, Patau Syndrome, Edward syndrome, Chromosome structure mutations- Deletion, Duplication- Bar eye in *Drosophila*, Inversion-Consequences of inversions, Translocation- Familial Down syndrome, Fragile sites in Humans

MODULE III: Molecular basis of mutations-Molecular Mutations: Tautomeric shifts, transitions and transversions, back mutations, suppression mutations, Silent mutations, Neutral mutation, Missense mutations, Nonsense mutations and Frame shift mutations.

MODULE IV: Mutation detection systems: Specific locus test, Ames test, *CIB* method, Muller-5 method, Attached X-Chromosomes, mutation detection in humans, mutation frequency, Mutational hot spots, DNA repair mechanisms: Photoreactivation, Excision repair, Post replication recombination, Mismatch repair, SOS repair.

MODULE V: Human mutations- Understanding of mutations in Humans, ABO blood types, Muscular Dystrophy, Fragile X syndrome, Huntigton's disease, Xeroderma pigmentosum. Site-directed Mutagenesis, Knock out mutations and transgenes, *cre/lox* system for targeted deletion of gene. Chromosomes in malignant diseases in man.

MODULE VI: Molecular Tools for screening and diagnosis of human diseases – Prenatal Diagnosis of Genetic Disorders and Congenital Defects, Somatic Chromosome mutation, environmental carcinogenesis.

PRACTICALS

1. Problems related to radiation dose and mutation frequency.
2. Problems related to chromosome variations in number and structure.
3. Problems related to variation in genetic code and protein synthesis
4. Problems related with point mutations and frame shift mutations
5. Problems with mutation detection systems in plants, *Drosophila* and humans.
6. Problems related with DNA repair mechanisms.
7. Problems with mutations in humans

8. Chromosomal aberrations due to the effects of mutagens e.g. EMS, 2,4-D or acridine orange in *Allium cepa* or *Vicia faba*

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Model question paper
UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY
Third Semester M.Sc (CSS) Degree Examination
Branch: Genetics and Plant Breeding
BOT-C- 433 ENVIRONMENTAL GENETICS

Time: Three hours

Maximum marks: 40

- I. Answer all questions in one word or sentence
1. Name a non-ionizing radiation which causes mutation.
 2. What is RAD?
 3. Name a radioisotope
 4. Name the base analog for adenine
 5. Name a human disorder caused by trisomy in chromosome 21
 6. How many gametes can be formed from autotetraploid?
 7. What is the phenotype effect produced by translocation between chromosome 8 and 9 in maize?
 8. Define photoreactivation
 9. Cytogenetic position of FMR1
 10. Define slippage mutation

(10X1= 10 marks)

- II. Answer any *five* questions. Each answers not exceeding 50 words.
11. Explain Muller 5 *Drosophila* flies. How it can be used to detect mutation?
 12. Explain how acridine dyes cause frame shift mutations.
 13. What is suppressor mutator mutations?
 14. Explain molecular genetic aspect of Huntington's disease
 15. Write gene locus and molecular genetic aspects of Duchenne muscular dystrophy
 16. Define site directed mutagenesis. Write steps involved in oligonucleotide directed mutagenesis
 17. Write functional features and fucosyltransferase

(5X2= 10 marks)

- III. Answer any *four* of the following Each answer not exceeding 150 words
18. Explain transition and transversion mutation
 19. Explain the molecular basis of bar eye formation in *Drosophila*
 20. Why nitrous acid is known as a potent mutagen?
 21. With the help of schematic representation explain nuclear excision repair mechanism
 22. Define gene knock out. Explain steps involved in the development of knock out mouse
 23. Give an account of environmental carcinogens

(4X3= 12 marks)

- IV. Answer any *one* of the following Each answer not exceeding 350 words
24. The antisense (non coding) strand of DNA is
5' ATGGATAAAGTTTAAACAGAGAGGAATCT 3'
What is the **a.** Sense strand **b.** mRNA transcribed **c.** Polypeptide that is transcribed **d.** If a base "C" deleted on 4th position in the sense strand, what happens to the polypeptide?
 25. Explain types, disease syndrome, cytogenetics and molecular genetics of xeroderma pigmentosum

(1X8= 8 marks)

Semester : **III**
Course Code : **BOT-C-434**
Course Title : **MODERN METHODS IN CROP BREEDING**
Credits : **4**

AIM: To get an awareness about crop evolution and the breeding methods and techniques used in crop breeding

OBJECTIVES

To familiarize different modern breeding techniques, such as mutation breeding, quality breeding, ideotype breeding and resistance breeding.

To understand different aspects associated with crop breeding and its control measures

To understand the evolution of crops

COURSE CONTENT

MODULE I: Heterosis and Inbreeding: Definitions. Inbreeding depression – effect of inbreeding – degree of inbreeding depression – homozygous and heterozygous balance. Heterosis and luxuriance – manifestation of heterosis. Genetic basis – dominance hypothesis- over dominance hypothesis – similarities and differences. Physiological basis of heterosis- mitochondrial complementation – fixation of heterosis. Recurrent selection- types- simple- recurrent selection for general combining ability – for specific combining ability – reciprocal recurrent selection.

MODULE II: Hybrids and synthetic varieties: Procedure – development of inbreds – methods for evaluation of inbreds–production of hybrid seeds- double cross and polycross hybrids. Role of cytoplasmic genetic male sterility and self-incompatibility in hybrid seed production. Improvement of inbred lines- pedigree selection- backcross method – convergent improvement – gametic selection- somatic hybridization, somaclonal variation, Genetic engineering- merits and demerits – achievements. Methods for the production of synthetic varieties – Merits and demerits of synthetic varieties.

MODULE III : Mutation Breeding: Introduction –effects of mutation, Procedure for mutation breeding,-objectives, selection of material for the treatment, Factors affecting radiation effects- biological, environmental , water content, temperature and chemical factors, part of the plant to be treated, dose of the mutagen, mutagen treatment, handling of mutagen treated population, procedure for breeding of oligogenic and polygenic traits , precautions, applications of mutation breeding, limitations and achievements. Polyploidy breeding: Auto and allopolyploids. Aneuploidy- Origin and production, morphological and cytological features, aneuploid analysis for locating genes on particular chromosomes-nullisomic analysis, monosomic analysis, trisomic analysis-limitations of aneuploid analysis. Monosomic and haploids and its relevance in plant breeding. Autopolyploidy -origin and production of doubled chromosome numbers, Colchicine treatment-morphological features of autopolyploids. Application of autopolyploidy in crop improvement—Triploids and tetraploids- limitations of autopolyploidy, Allopolyploidy- origin and production of allopolyploids, morphological and cytological features of allopolyploids, role of allopolyploidy in evolution. Applications of allopolyploidy in plant breeding. Limitations of allopolyploidy.

MODULE IV: Quality breeding: Introduction. Quality traits – morphological- nutritional – biological – organoleptic- other qualities. Quality traits of crops like rice, wheat, cotton and tomato. Breeding for nutritional quality, elimination of toxic substances-lathyrism- protein and mineral content and quality. Breeding approaches for the improvement of quality- evaluation of germ plasm, mutagenesis, hybridization, somaclonal variation and genetic engineering - problems and prospects of quality breeding. Marker assisted selection- Marker system selection, Mapping strategies-Recombinant Inbred Lines (RILs), Bulk Segregant Analysis (BSA), Near –Isogenic Lines (NILs), Mapping disease resistance genes, Mapping Quantitative trait Loci (QTLs) Application of molecular markers. Molecular breeding. Advantages and limitations of molecular markers.

MODULE V: Ideotype breeding: Ideotype concepts, types, development of ideotypes, Characters of a crop ideotype, Steps in development—identification of traits for analysis- determination value of traits, choice of traits for evaluation- ideotype breeding method- limitations. Resistance breeding: Historical account, loss due to disease, variability in pathogen. Physiological races and pathotypes. Genetics of pathogenicity- disease development-disease escape-disease resistance, susceptible reaction- immune reaction, resistance-tolerance. Vertical and Horizontal resistance- Mechanism of disease resistance—mechanical, hypersensitivity and nutritional. Genetics of disease resistance – oligogenic inheritance, gene for gene relationship—molecular basis for gene for gene relationship – polygenic inheritance. Methods of breeding for disease resistance: Testing for disease resistance – Disease epidemics, Insect resistance, mechanism of resistance, breeding methods, screening techniques, problems in insect, resistance breeding. Breeding for stress resistance: Drought resistance; introduction – types of abiotic stresses – minimizing drought resistance – breeding methods – Genetics of drought resistance – Problems. Mineral stresses: Salt affected soil- alkali soil, breeding for salinity resistance – effect of salinity stress, water stress, salt toxicity – salinity resistance, sources of salinity resistance breeding approach- Problems.

MODULE VI: Breeding of Crop plants:

Origin, taxonomy, cytogenetics and evolution of the following crops

1. Cereals	-Rice, Wheat, Maize
2. Tuber Crops	-Tapioca, Potato
3. Fiber yielding	-Cotton
4. Plantation Crops	-Rubber
5. Sugar yielding	-Sugar cane
6. Narcotics	- <i>Nicotiana</i>
7. Vegetables	- <i>Allium</i> , Tomato
8. Oil yielding	- <i>Brassica</i> , <i>Arachis</i>
9. Pulses	- <i>Vigna</i>
10. Beverages	-Coffee, Tea

PRACTICALS

1. Heterosis Breeding

i). Pepper

Uthirankotta X Cheriakaniakkaden



Panniyur

ii). Maize cob

iii). Sorghum

2. Mutation breeding

- Capsicum* seed treated with chemicals. Drawings of control & treated seedlings showing morphological variations
- Demonstration for mutation breeding– sunflower, tapioca

3. Polyploidy breeding

- Autopolyploids- colchicines treatment –i.*Capsicum*seed and seedling
- Polyploids
- Evolutionary chart of the following crops

- i). Wheat – *Triticumaestivum*
 - ii) Triticale
 - iii). Cotton
 - iv) *Nicotiana, Brassica*
4. **Ideotype**:-Rice
 5. **Disease resistance**: Identification of plant diseases and their pathogen– viral, bacterial and fungal diseases
 6. **Crops**: Description on taxonomy, cytogenetics and evolution of all the above mentioned crops.

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Model Question Paper

UNIVERSITY OF KERALA DEPARTMENT OF BOTANY

Third Semester M.Sc (CSS3) Degree Examination Branch: Genetics and Plant Breeding BOT-C-434 MODERN METHODS IN CROP BREEDING

Time: Three hours

Maximum marks: 40

- I. Answer all questions in one word or sentence
1. What is nullisomic?
 2. What do you mean by spontaneous mutation?
 3. Define ideotype
 4. What is luxuriance?
 5. Define vertical resistance
 6. What are autopolyploids?
 7. What is meant by double cross hybrid?
 8. What is lathyrism?
 9. What do you mean by directed mutagenesis?
 10. Define trait analysis

(10X1= 10 marks)

- II. Answer any *five* questions. Each answer not exceeding 50 words
11. What are the sources used in salinity resistance breeding approach?
 12. Describe the characteristics of crop ideotype
 13. Write short note on hypersensitivity
 14. What is mitochondrial complementation?
 15. Describe the method of bulked segregant analysis?
 16. Briefly describe the origin of rice
 17. Distinguish between hybrid and synthetic varieties

(5X2= 10 marks)

- III. Answer any *four* of the following Each answer not exceeding 150 words
18. Describe the molecular basis of heterosis?
 19. Discuss the role of self incompatibility in hybrid seed production
 20. Distinguish between dominance and over dominance hypothesis
 21. What are the steps involved in the production of an ideotype?
 22. Write short note on genetics of pathogenecity.
 23. Briefly describe the morphological and cytological changes observed in polyploids

(4X3= 12 marks)

- IV. Answer any *one* of the following, not exceeding 350 words
24. What are mutagens? Briefly explain the procedure of mutation breeding. Discuss its application in crop improvement
 25. Briefly explain the origin, cytogenetics and evolution of sugarcane

(1X8= 8 marks)

Semester : **III**
Course Code : **BOT- E - 435**
Course Title : **APPLIED PALYNOLOGY**
Credits : **2**

AIM: To elucidate various aspects of pollen and spores, and their applications

OBJECTIVES

To study the characters in basic palynological studies
To study the applications of palynology in day to day life
To analyse the role of palynology in tackling taxonomic problems

COURSE CONTENT

MODULE I: Anther and pollen-Pollen mother cell, Pollen wall ontogeny. Pollen wall development-exine growth phase -primexine model, undulation model-intine growth phase, production and deposition of sporopollinin-distribution, chemistry and function of sporopollinin Surface coatings on pollen and spore-pollenkit, Tryphine, Perine, Glycocalyx, Viscin Threads, Elaters.

MODULE II: Pollen units: Monad, dyad, tetrad, polyad, pseudomonad, pollinium and massula. Polarity: Apolar, isopolar, hetropolar. Symmetry: Symmetric -Radially symmetric or Bilaterally symmetrical- Asymmetric; Shape: Pollen shape (tertiary): Radio symmetrical, bilateral, shape index in radio symmetrical grains (P/E X100). Shape types- oblate, suboblate, oblate-spheroid, spherical, prolate-spheroidal, subprolate, prolate, perprolate. Major evolutionary trends in shape of pollen. Size: Based on Walker and Doyle (1975). Apertures: Various types of apertures, NPC system of aperture classification-subdivision of pollen surface, Evolutionary trends in aperture.

MODULE III: Exine surface ornamentation (secondary): projection types- spinate, spinulate, verrucate, gemmate, bacculate, tuberculate. Depression types- reticulate, lophate, fossulate, scrobiculate, punctate, pilate, psilate. Evolutionary trends in exine ornamentation, Exine strata: intine, exine with endo exine (base layer), mid exine (columella layer) and extoexine (the tetum, tegillum and supra tegillum).

MODULE IV: Systematic palynology-role of palynology in taxonomy, Evolution of aperture and exine ornamentation in general and evolutionary trends among pollen grains with special reference to Compositae, Acanthaceae, Verbenaceae.

MODULE V: Palynological Techniques-Laboratory equipments. Processing of pollen-Acetolysis, chlorination and mounting-staining, microscopy and measurements, Palynograms and illustrations, Photomicrography, LO-analysis, Collection and analysis of fossil pollen and spores, Trapping aerospora and processing of honey.

MODULE VI: Applied Palynology -Geo or Palaeopalynology-Pollen spectrum, Climatic chronology, Exploration of coal and oil- aeropalynology, Melittopalynology, iatropalynology, pharmacopalynology, copropalynology and forensic palynology.

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Model question paper

**DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA**

Third Semester M.Sc (CSS3) Degree Examination

Branch: Genetics and Plant Breeding

BOT- E - 435 APPLIED PALYNOLOGY

Time: Three hours

Maximum marks: **60**

I. Answer *all* questions in one word or sentence

1. What is sporopollinin?
2. Explain prime exine
3. Explain columella
4. What is annulus?
5. What is margo?
6. Explain the term polytrema
7. What is colporate pollen?
8. What is apocolpium?
9. What is confervoid pollen?
10. Explain the features of gemmate ornamentation

(10X1=10 marks)

II. Answer any *five* of the following. Each answer not exceeding 150 words

11. Explain the features of various types of amb
12. Explain various types of aperture characters
13. What is polarity of pollen grain
14. Give a short account on Forensic palynology
15. Write the functions of various wall layers of pollen
16. Write the importance of mellicolpium palynology
17. Write the procedure of acetolysis method

(5X3 =15marks)

III. Answer any *five* of the following. Each answer not exceeding 150 words

18. Give an account on the various types of surface coatings on pollen and spore
19. Explain the NPC system of aperture classification
20. Give an account on Iatropalynology
21. Explain the various shape and size classes of pollen
22. Briefly explain the ontogeny of pollen wall development and structure of mature pollen wall
23. Explain various types pollen units
24. Give an account on the Pharmacopalynology

(5X5=25marks)

IV. Answer any *one* of the following, not exceeding 350 words

25. Write an account on various applications of geo-palynology
26. Briefly explain the features of any ten types of pollen ornamentations

(1X10=10marks)

Semester : III
Course Code: BOT- E- 436
Course Title : PHYTOCHEMISTRY
Credits : 2

AIM: To understand about Phytochemicals and their applications.

OBJECTIVES

To familiarize different phytochemicals and their classes.

To understand about extraction techniques and its uses in different fields such as disease prevention, nutraceuticals and cosmetics.

To get knowledge about phytochemical databases.

COURSE CONTENT

MODULE I: Major classes of plant chemicals-terpenoids, alkaloids and other nitrogen containing metabolites, phenolic compounds.

MODULE II: Extraction techniques. Separation and Purification techniques-chromatography TLC, HPLC and GC. Detection techniques-UV-Vis spectroscopy, Infrared spectroscopy (IR) and Mass spectroscopy (MS), NMR spectroscopy.

MODULE III: Phytochemicals in disease prevention: Utility in treatment of cancer, diabetes, cardiovascular diseases. Mode of action-antioxidants, hormonal action, stimulation of enzymes, interference with DNA replication, antibacterial and antifungal effects, blocking and suppressing agents, phytoestrogens, isoflavanoids and lignans. Toxins such as glycoalkaloids, fucocoumarins, miscellaneous toxicants. Drug discovery and development.

MODULE IV: Nutraceuticals and cosmetics: With special reference to vegetables and fruits from plant families such as Liliaceae, Cruciferae, Solanaceae, Umbelliferae, Compositae and Rutaceae. Brief description of properties and constituents of plants and plant parts used as Cosmetics and in Aromatherapy.

MODULE V: Biotechnology and Phytochemical production: Engineering the plant metabolism. Methods of expression of foreign proteins in plants, production of pharmaceuticals and industrial enzymes, expression of whole proteins and pharmaceutically active peptides. Isolation and purification from plants.

MODULE VI: Phytochemical databases: Dr. Duke's Phytochemical and ethnobotanical databases, NAPRALERT, MEDFLOR.

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Model Question Paper
DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA
Third Semester M.Sc (CSS3) Degree Examination
Branch: Genetics and Plant Breeding
BOT- E- 436 PHYTOCHEMISTRY

Time: Three hours

Maximum marks: 60

I. Answer *all* the questions in one word or sentence.

1. What are phytoestrogens?
2. What is Charakasamhita?
3. What are glycoalkaloids?
4. Expand the term 'HPLC'
5. What is aromatherapy?
6. Name a hydrosol
7. What is an antioxidant?
8. Name a Phytochemical database
9. What are sesquiterpenes?
10. Give an example for tannin

(10X1=10 marks)

II. Answer any *five* of the following. Each answer not exceeding 150 words

11. How do the secondary metabolites help in plant defence? Describe the role of phytoalexins during plant infections
12. Discuss the application of bioinformatics in drug designing
13. Explain the utility of metabolic engineering in secondary metabolite production
14. Give a short note on biosynthesis of terpenoids
15. What is curcumin? Discuss the role of curcumin in cancer cure
16. Briefly describe the classification of secondary metabolites
17. What is green tea? The consumption of green tea is considered beneficial. Justify

(5X3=15 marks)

III. Answer any *five* of the following. Each answer not exceeding 150 words

18. Describe the application of spectroscopic techniques in the characterization of plant secondary metabolites
19. Enlist the chromatographic techniques used for the isolation of phytochemicals
20. Name the different types of nitrogen compounds in plants along with a short description on each
21. Discuss the utility of new generation hyphenated techniques in the area of natural product chemistry.
22. What are nutraceuticals? Discuss their role in disease prevention
23. Give an account on at least five different plants which are used in cosmetics
24. What are essential oils? Explain the process of essential oil extraction.

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 350 words

25. What is ethnobotany? How is ethnobotanical information utilized in the drug discovery process?
26. Discuss the role of herbal medicines in disease prevention and cure

(1X10=10 marks)

Semester : **IV**
Course Code : **BOT-C – 441**
Course Title : **POPULATION & EVOLUTIONARY GENETICS**
Credits : **4**

AIM: To introduce the basic principles of Population and evolutionary genetics

OBJECTIVES

To introduce to the concept of Population Genetics.
To explain the Hardy- Weinberg principle with suitable examples.
To elucidate the applications of the Hardy- Weinberg principle.
To explain the factors likely to change the Hardy- Weinberg equilibrium.
To explain the perception of evolutionary genetics.

COURSE CONTENT

MODULE I: Genetic Composition of Mendelian Population: Basic concepts - History and origin of Population Genetics, Gene and Genotype frequencies, Gene pool.

MODULE II: Hardy-Weinberg equilibrium: Random mating and Hardy-Weinberg Law, Assumptions, predictions and derivation of Hardy-Weinberg Law, Calculating gene and genotype frequencies for – codominant alleles, dominant-recessive alleles, autosomal loci with multiple alleles and blood types, sex-linked alleles – codominant and dominant-recessive alleles.

MODULE III: Applications of Hardy-Weinberg Law - Test for Random mating (chi-square analysis), Test for sex-linked genes, Test for carrier gene frequency, Test for mode of inheritance, Test for multiple genes. Non – random mating - Positive and Negative non-random mating.

MODULE IV: Factors affecting gene frequencies in natural populations -Factors affecting random mating population: Migration, Mutation – non-recurrent and recurrent mutations, Selection - Fitness, gametic selection, zygotic selection, Selection against dominant genotype, Selection against recessive genotype, Selection in favour of heterozygote, Mutation-selection balance, Random drift, Genetic Load, Founder effect, Bottleneck effect.

MODULE V: Consanguinity in natural populations: Inbreeding/consanguinity- Overview, Types of inbreeding, pedigrees of inbreeding and calculation of inbreeding co-efficient, Harmful genetic effects of inbreeding.

MODULE VI: Evolutionary Genetics - Synthetic theory of evolution, Adaptive radiation; Isolating mechanisms - Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution, evolution of multi-gene family. Molecular evolution: Concept of neutral evolution, molecular divergence and molecular clocks, Human evolution.

PRACTICALS

Problems to prove the Hardy-Weinberg Law
Problems that test the various applications of Hardy-Weinberg Law.
Problems that test the factors affecting Hardy-Weinberg Law
Problems related to consanguinity in populations

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Model question paper
UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY
Fourth Semester M.Sc (CSS 4) Degree Examination
Branch: Genetics and Plant Breeding
BOT-C – 441 POPULATION & EVOLUTIONARY GENETICS

Time: 3 hrs

Maximum 40 marks

I. Answer *all* questions in one word or sentence

1. What is gene pool?
2. What is chi- square test?
3. What is effective population?
4. What is non – recurrent mutation?
5. How is ‘degrees of freedom’ calculated?
6. Define the term species
7. What is positive nonrandom mating?
8. What is the formula for calculating genotype frequency?
9. What is linkage disequilibrium?
10. What is consanguinity?

(10X1=10 marks)

II. Answer any *five* questions. Each answers not exceeding 50 words

11. Explain mutation selection balance
12. Give a short account on ‘molecular clock’
13. What are sex-influenced traits?
14. Explain negative non-random mating and its consequences in evolution
15. Explain genetic load. Describe mutational and segregational load in populations
16. What is gene frequency? How is the gene frequency calculated for codominant and dominant recessive autosomal loci
17. How does recurrent mutation affect gene frequency in a random mating population?

(5X2=10 marks)

III. Answer any *four* of the following. Each answer not exceeding 150 words

18. How does migration change gene frequency in a random mating population, if the migration is recurrent? What will be the difference in gene frequency between a donor and a recipient population after sixth generation of migration when compared to first generation?
19. Describe the different modes of speciation
20. Describe the consequence of gene erosion and its remedies
21. What is meant by the term ‘founder effect’?
22. Define inbreeding coefficient. What are the major genetic effects of inbreeding?
23. Write an account on origin and evolution of humans

(4X3=12 marks)

IV. Answer any *one* of the following, not exceeding 350 words

24. State the Hardy-Weinberg equilibrium and its applications
25. Describe gametic selection and zygotic selection and their effects in populations

(1X8=8 marks)

Semester : **IV**
Course Code : **BOT-C-442**
Course Title : **DEVELOPMENTAL GENETICS**
Credits : **4**

AIM: To enlighten students about genetics of growth and development.

OBJECTIVES

To impart knowledge about cell differentiation, growth and developmental mechanisms.

To introduce mechanism of cell signaling and immunology to the students.

To get detailed knowledge about regulation of cancer and carcinogens

COURSE CONTENT

MODULE I: Cell differentiation, growth and development- Basic concepts of development-Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients, cell fate and cell lineages, stem cells, genomic equivalence and the cytoplasmic determinants, imprinting, mutants and transgenics in analysis of development-General characteristics of cell differentiation, effects of mutations in developmental processes, antennapedia complex, the bithorax complex, segmental genes, Gap genes and pair rule genes in *Drosophila*, Effects of nuclear and cytoplasmic factors in development, environmental effects, maternal effects, nuclear cytoplasmic interactions with particular reference to *Acetabularia*.

MODULE II: Growth and Development in Plants- Patterns of growth and differentiation- Gene expression and mutations regulating meristem function, embryogenesis, seedling, root, leaf and flower development. Homeotic genes, ABCD model in *Arabidopsis* flower, hormonal control of plant tissue development, effect of auxins on root and root formation, gibberellin promoted growth of plants, ethylene and triple response mutants, brassinosteroids and photomorphogenesis.

MODULE III: Cell signaling & communications-Types of signals and signaling molecules, Cell surface receptors, G protein coupled receptors, Signal transduction pathways- ras/map kinase pathway, phosphoinositide pathway, receptor serine kinases, secondary signal molecules, two component regulatory systems, bacterial chemotaxis, quorum sensing. Immunology- Structure and function of different classes of immuno-globulins, lymphoid system, B cells and T-cells, natural immunity and acquired immunity, vaccine development and immunization, immune disorders, super antigenicity and diseases associated with superantigen production.

MODULE IV: Developmental mechanisms-Biological Rhythms-Spectrum of biological rhythms, Circadian rhythms, factors affecting rhythmic responses, molecular mechanism of rhythmic responses in model organisms – *Synechococcus*, *Neurospora*, *Drosophila*, mammals. Sex differentiation- Sex as a developmental phenotype, factors influencing sex differentiations, environmental effects, hormonal effects, effects of ploidy, monoecious and dioecious plants. Ageing-Cellular and molecular changes in ageing, Theories of ageing – Genetic, Neuroendocrine, Free-radical, Membrane, HayFlick-limit, Mitochondrial decline, Cross-linking, Telomerase, Wear and tear theories. Difference between necrosis and apoptosis- Processes, pathways and proteins involved in apoptosis regulation- Factors and signals inducing cell death.

MODULE V: Regulation of Cancer-Tumorigenesis in plants- Characteristics of Crown Gall Tumour (CGT) cells, crown gall and plant transformation, Interaction between wound cell and bacteria, plasmids as tumour inducing principle. Viruses that cause cell transformation-DNA tumour virus - papova virus, adenoviruses, RNA tumour virus, oncogenic retrovirus, Characteristics of cancer cells, cytological changes, Theories of carcinogenesis - Multiple Mutations in Cancer, Oncogenes and cancer, Oncogene families, Functional classes of oncogenes, cell division signals and oncogenes, Characteristics of individual oncogenes-*src*, *myc*, *ras*, *erb A* & *erb B*, *sis* and *fms*. Tumour suppressor

genes- Properties of Tumor Suppressor Genes- *rb*, *p53*, Wilms' tumor suppressor gene (*wt-1*), Adenomatous polyposis coli (*apc*) gene, BRCA 1 & 2. Identification of tumor suppressor genes.

MODULE VI: Carcinogens - Chemical carcinogens- Metabolic activation of chemical carcinogens, Donors of simple alkyl groups, Cytochrome p-450-mediated activation, 2-acetylaminofluorene, Other aromatic amines, Polycyclic aromatic hydrocarbons, Interaction of chemical carcinogens with oncogenes and tumor suppressor genes, Central dogma of tumor progression. Radiation as carcinogens- Ionizing radiation and UV radiation. Teratomas, teratocarcinomas, teratogenesis.

PRACTICALS

1. Study of various developmental stages and polytene chromosomes of *Drosophila*
2. *Drosophila* various developmental stages
3. Preparation of sex chromatin from cheek cells
4. Angiosperm embryo development using bean/ *Tridax/ Vinca* seeds
5. Early plant development – Pollen tube formation
6. Study of plant tumours – galls
7. Study of human cancers using permanent slides
8. ABC model flower development
7. Problems: nuclear cytoplasmic interactions with particular reference to *Acetabularia*

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ADDITIONAL REFERENCES

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- <http://labs.biology.ucsd.edu>
- www.mdpi.com
- <http://advances.sciencemag.org>
- <http://mcb.asm.org>
- www.dnalc.org
- <https://swayam.gov.in>

Model question paper
DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA
FOURTH SEMESTER M.Sc (CSS4) DEGREE EXAMINATION
Branch: Genetics and Plant Breeding
BOT-C-442 DEVELOPMENTAL GENETICS

Time: Three hours

Maximum marks: 40

I. Answer *all* questions in one word or sentence

1. What is white-collar complex?
2. What is senescence?
3. What is *Zeitgeber*?
4. Explain the term 'free-running period'
5. What are Biological Rhythms?
6. Define E-box
7. What are NIH3T3 and He La cell lines?
8. What are growth factors and growth factor receptors?
9. What is MHC?
10. Give the role of SOD in aging

(10X1= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 50 words

11. Define tumour suppressor gene. What are the important activities of p53? Explain
12. Give an example of DNA tumour virus. Describe its structure, genomic organization and involvement in tumour formation
13. Give an account on G-protein
14. Explain two theories concerning the ageing
15. Write role of *gap* gene in development
16. Give the relation between the rhythmic bioluminescence in *Gonyaulax* to light signals
17. What are the effects of maternal genes in the development of *Drosophila*?

(5X2= 10 marks)

III. Answer any *four* of the following. Each answer not exceeding 150 words

18. Enumerate important characters of cancer cells
19. Why *Sxl* gene considered to be the master-switch in the sex determination of *Drosophila melanogaster*
20. Discuss the genetic impact in *Caenorhabditis elegans* sex determination
21. Explain the genetics of circadian clock mechanism in insects
22. Describe ABC model of flower development
23. The immune system is considered to be most appropriate model system for studying the cellular and molecular mechanism of aging. Explain

(4X3= 12 marks)

IV. Answer any *one* of the following. Each answer not exceeding 350 words

24. Briefly describe the organization of Ti plasmid with special reference to its T-DNA and *vir* regulon. Explain the mechanism of T-DNA transfer into plant genome
25. Write an account on signal transduction pathway

(8X1= 8 marks)

Semester : **IV**
Course Code : **BOT-C-443**
Course Title : **BIOSYSTEMATICS**
Credits : **4**

AIM: To develop knowledge and skill for the basic and modern concepts of plant systematics to students

OBJECTIVES

To impart the basic information about plant systematics

To understand the concepts on botanic gardens, herbariums and their roles in taxonomic studies

To elucidate macroscopic and microscopic evidences of morphological-anatomical-embryological-cytological palynological characters in taxonomic studies.

To gain knowledge on numerical taxonomy- chemotaxonomy, serotaxonomy and molecular systematics.

To get the practical skill in identification of plants and herbarium preparation

COURSE CONTENT

MODULE I: History and development of Plant classification in India- Brief study of Artificial (Linnaeus)-Natural (Bentham and Hooker) and Modern systems of Classification (APG)- Plant nomenclature- ICBN- author citation- type concept- publication of names- rule of priority- definition of nomenclatural terms- autonym- homonym- basionym- tautonym and nomen nudum. Classification of taxonomic literature- floras- icons- monographs- reviews and journals.

MODULE II: Botanic gardens-definition- role in taxonomic studies- National and International Botanic Gardens- special reference to Royal Botanic Garden, Kew- Indian Botanic Garden, Calcutta-JNTBG & RI, Trivandrum. Herbarium-definition- importance- history and development of herbarium- kinds of herbarium-steps in herbarium techniques-important herbarium in India and World.

MODULE III: Macroscopic vegetative and floral identifying features-: Brief account on roots-types-modifications, stem-modifications, leaves-types-venation-phyllotaxy-modifications, inflorescence-racemose-cymose-special types, flowers-symmetry-floral whorls-arrangements-variations, fruits-simple-aggregate-multiple types, Seeds- structure-shapes, microscopic or ultra-structural morphological characters- trichomes- stomata- types of stomata- pollen wall ornamentation- seed surface pattern.

MODULE IV: Anatomy in relation to taxonomy: Applications of anatomical features- vegetative and floral anatomy in relation to taxonomy and phylogeny-e.g.,- Apocynaceae, Caesalpiniaceae - Papilionaceae, Ranunculaceae- Leaf anatomy in relation to taxonomy e.g., Myrtaceae. Embryology in relation to taxonomy: Basic embryological characters of taxonomic significance- e.g.,-Loranthaceae. Cyperaceae.*Trapa*.-*Paeonia*. Cytology in relation to taxonomy: Chromosome number - morphology and relative size-heterochromatin- chromosome behaviour at meiosis- Importance of genomic characters for biosystematics-cytological data for the identification of following angiosperm families - Zingiberaceae, Liliaceae, Malvaceae. Cucurbitaceae, Araceae, Rubiaceae and Araliaceae. Palynology in relation to taxonomy--evolution of pollen morphological characters-role of palynology in relation to taxonomy. e.g.- Acanthaceae, Rubiaceae, Scrophulariaceae, Rutaceae and Malvaceae.

MODULE V: Chemotaxonomy- definition- importance- role of secondary metabolites in systematics of plants- plant to plant variation- chemistry and plant identification - chemosystematics of Apiaceae-essential oils of Asteraceae and Lamiaceae, pigments of Gesneriaceae. Serotaxonomy- definition-

history- methods-.role of serology in taxonomy. Numerical taxonomy- definition- OTU's- principles of numerical taxonomy- merits and demerits of numerical taxonomy- applications of numerical taxonomy.

MODULE VI: Molecular systematics: Molecules and genomes in plant systematics- Techniques used in molecular taxonomy- Chloroplast DNA and plant phylogeny- present status and future prospects- Use of chloroplast DNA rearrangements in reconstructing plant phylogeny- Mitochondrial DNA in plant systematics- Applications and limitations- Ribosomal RNA as a phylogenetic tool in plant systematics. E.g. Asteraceae, Onagraceae, *Brassica*, Nymphaeaceae- Molecular approaches to plant evolution- Intraspecific cpDNA variation in systematic and phylogenetic implications. Molecular evidence and plant introgression- molecular data and polyploid evolution in plants. Molecular systematics and crop evolution- rice, wheat, maize, potato, *Brassica*, *Nicotiana*.
Cytogeography and biosystematics: Cytogeography and structure of a group of related taxa. E.g., *Ranunculus plantagieus*, *Polycarpon polycarpoides*, *Erysimum grandiflorum*. Cytogeography and historical botanical geography, occurrence of other biosystematic methods on cyto geography.

PRACTICALS

Preparation of herbarium and identification of plants belonging to the following families (Minimum 15 families and 25 herbarium sheets)

Ranunculaceae, Magnoliaceae, Annonaceae, Cruciferae, Caryophyllaceae, Tiliaceae, Sterculiaceae, Clusiaceae, Rutaceae, Meliaceae, Menispermaceae, Anacardiaceae, Bixaceae, Fabaceae, Caesalpiniaceae, Mimosaceae, Combretaceae, Myrtaceae, Lythraceae, Cucurbitaceae, Umbelliferae, Rubiaceae, Asteraceae, Sapotaceae, Apocyanaceae, Asclepiadaceae, Convolvulaceae, Solanaceae, Scrophulariaceae, Acanthaceae, Lamiaceae, Verbenaceae, Amaranthaceae, Euphorbiaceae, Zingiberaceae, Heliconaceae, Poaceae, Arecaceae, Orchidaceae

Taxonomic key preparation

REFERENCES

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ADDITIONAL REFERENCES

- Journal - Taxon
- Journal- Plant Systematics and Evolution
- Journal- Rheedea

Model question paper

**DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA**

Fourth Semester M.Sc (CSS4) Degree Examination

Branch: Genetics and Plant Breeding

BOT-C-443 BIOSYSTEMATICS

Time: 3hrs

Maximum 40 marks

I. Answer *all* questions in one word or sentence

1. What is genome?
2. Expand ELISA
3. What is cryptic structural polyploidy?
4. What is nexine?
5. What do you mean by stenopalynous?
6. What is amphimixis?
7. What is phenetics?
8. Define molecular systematics
9. What is a cytotype?
10. What are semantides?

(10X1=10 marks)

II. Answer any *five* questions. Each answer should not exceed 50 words

11. What is the application of serotaxonomy?
12. What is cluster analysis?
13. Distinguish between orthotropous and amphitropous ovule
14. Describe the structure of ITS
15. List out the applications of molecular systematics
16. Describe the types of stomata in angiosperms
17. Differentiate between reticulate and psilate type of ornamentation

(5X2=10 marks)

III. Answer any *four* of the following. Each answer not exceeding 150 words

18. Describe the role of chemotaxonomy in biosystematics
19. What is apomixis? Describe the different types of apomixis with examples
20. Describe the functions of herbarium
21. Chloroplast genomes are widely used for phylogenetic studies. Why?
22. What are the major embryological characters useful in plant taxonomy?
23. What are taxonomic keys? How will you prepare key for taxa based on morphological characters giving emphasis to trichomes?

(4X3=12 marks)

IV. Answer any *one* of the following, not exceeding 350 words

24. Discuss the applications of numerical taxonomy, its principles, merits and demerits
25. What are the methods available for the generation and interpretation of molecular data in plant taxonomy?

(1X8=8 marks)

Semester : IV
Course code : BOT-D-444
Course Title : DISSERTATION
Credits : 4

AIM: The aim of this course is to train students to plan and execute research experiments relevant to life sciences

OBJECTIVES:

To encourage the students to come up with creative ideas and to give opportunities to experiment various concepts they have assimilated.

To prepare the students to read the pertinent literature and come up with a proper plan of research work relevant to the field of study.

To get the skill for observation, analysis and interpretation

Semester : I
Course code : BOT-X-411
Course title : PLANT TISSUE CULTURE
Credits : 2

AIM: To acquire an in depth knowledge on plant tissue culture and its application

OBJECTIVES

To develop knowledge and skill on plant tissue culture

To know basic principles of plant tissue culture, different types of culture

To get awareness in application of tissue culture technologies to plant improvement,

To get detailed knowledge in somatic embryogenesis and production of artificial seeds, and conservation of germplasm through short term and long term preservation.

COURSE CONTENT

MODULE I: Introduction- Historical aspects and significance: Introduction, history, and scope. Development of organ, tissue and cell culture, exploitation of totipotency

MODULE II: Basic techniques and principle, General laboratory requirements for plant tissue culture: Designing of plant tissue culture laboratory. Lab maintenance and fumigation. Culture vessels and their washing, Basic aspects of plant tissue culture: Sterilization techniques, different culture media media components, growth regulators, undefined supplements, surface sterilization of explants, inoculation, subculturing etc.

MODULE III: Different types of cultures, callus culture- characteristic features, Cyto differentiation, significance. Suspension culture -different types, growth patterns, significance, Secondary metabolites detected in plant tissue culture. Root and hairy root culture. Methods of enhancement of secondary metabolite production in culture. Problem associated with secondary metabolite production.

MODULE IV: Application of culture technologies to plant improvement, Micropropagation protocol and application, production of pathogen free plants-meristem culture and its applications, Anther culture protocol and applications, protoplast culture and somatic hybridization protocols and applications. Somaclonal and gametoclonal variations and importance. Origin and causes- regeneration system, type of tissue, explant source, media components, duration and number of culture cycles; Factors controlling somoclonal variation and its applications.

MODULE V: Somatic embryogenesis, Embryo culture and artificial seed, Ovary, ovule, endosperm and embryo culture, application of embryo culture, embryo rescue technique, Green pod culture of orchid, embryogenesis. Chemical and physical factors, pathway of development, Artificial seeds-applications

MODULE VI: Germplasm Storage and Cryopreservation, Conservation of germplasm, *In vitro* strategies, short, medium and long term (cryopreservation) preservation application, techniques of cryopreservation, choice of material, preculture, cryoprotection, freezing, thawing, reculture, vitrification, encapsulation dehydration, determination of survival and viability, plant growth and regeneration, applications of cryopreservation, Large-scale utilization of cryopreservation for germplasm conservation, cryopreservation-progress and prospects.

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Model question paper

**DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA**

First Semester M.Sc (CSS1) Degree Examination

Branch: Genetics and Plant Breeding

BOT-X-411 PLANT TISSUE CULTURE

Time: Three hours

Maximum marks: **60**

I. Answer **all** questions in one word or sentence

1. Define an explant
2. Expand PEG
3. What are cryoprotectants?
4. Define cellular totipotency
5. What is embryo rescue technique?
6. What is dedifferentiation?
7. Define cybrid
8. Expand DMSO
9. Define totipotency
10. Define gynogenic haploid

(10X1= 10 marks)

II. Answer any **five** questions. Each answers not exceeding 50 words.

11. Write short notes on shoot tip culture
12. Give an account of plant growth regulators
13. Explain synthetic seed preparation
14. List out the application of cryopreservation
15. Describe different types of sterilization techniques.
16. What is somaclonal variation?
17. What are different sterilization methods used in plant tissue culture?

(5X3= 15 marks)

III. Answer any **five** of the following. Each answer not exceeding 150 words

18. How are protoplast induced to regenerate into whole plant?
19. What is a callus? What is its application?
20. Explain procedure for micropropagation
21. What are the advantages of protoplast culture?
22. Explain the scope of plant tissue culture
23. What are the constituents of a tissue culture medium?
24. How do you set a tissue culture laboratory?

(5X5= 25 marks)

III. Answer any **one** of the following, not exceeding 350 words

25. Discuss the *in vitro* production of haploids through anther and pollen culture and its application.
26. What are the application and types of cell suspension culture?

(1X10= 10 marks)

Semester : II
Course code : BOT-X- 421
Course title : PLANT CELL CULTURE TECHNOLOGY
Credits : 2

AIM: To familiarize plant cell culture based methods for the production of various metabolites

OBJECTIVES

To familiarize *in vitro* methods for the culture of plant cells

To get exposure to specialized techniques for the enhanced production of metabolites

To introduce bioreactor based scale up production of metabolites and model production systems

To acquaint hairy root cultures in the enhancement of metabolites

To explore role of biotransformation and metabolic engineering in the production of metabolites

COURSE CONTENT

MODULE I: Introduction- plant metabolites and their importance, Cell culture techniques- basic procedure, Different types of *in vitro* cultures, callus culture, suspension culture- growth & maintenance, factors influencing cell suspension. Production of secondary metabolites through cell culture technique. Measurement of growth- and productivity. Enhancement of metabolite production- optimization of medium and culture conditions, development of high yielding cell lines, cell line selection- Bergmann's technique of cell plating, Fluorescence Assisted Cell Sorting (FACS), Elicitors- mechanism of action, selection of elicitors.

MODULE II: Large scale culture of plant cells- Bioreactors (Stirred tank reactors), principle, types, working, need of bioreactors in cell cultures, Cell immobilization, immobilized bioreactors.

MODULE III: Specialized techniques for the production of metabolites - Use of organ culture and two-phase systems. *In vitro* mutagenesis and induction of polyploids- protoplast fusion, somatic cell hybridization- Addition of Precursors and Biotransformation, Genetic engineering of secondary metabolites, Metabolic engineering - advantages and limitations.

MODULE IV: Hairy root culture- *Agrobacterium rhizogenes* and *Ri* plasmid – culture method- development of hairy root lines- production of metabolites- advantages and limitations.

MODULE V: Secondary metabolite classes & groups- Alkaloids- morphines, codeine, quinine, nicotine, cocaine, hyoscyamine, lysergic acid, taxol, Terpenoids- menthol, camphor, carotenoid, pigments, Polyterpenes- rubber, Phenyl propanoids- anthocyanin, coumarins, flavanoids, isoflavonoids, stilbenes, tannins, Quinones- anthraquinones, benzoquinones, naphthoquinones, Steroids- diosgenin, sterols, ferruginol.

MODULE VI: Large scale exploitation of secondary metabolites- model systems- Commercial production of shikonicin, berberine, diosgenin, taxol, vincristine, vinblastine, scopolamine, ajmaline and anthraquinones.

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Model Question Paper

**DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA**

Second Semester (CSS2) Degree Examination

Branch: Genetics and Plant Breeding

BOT-X- 421 PLANT CELL CULTURE TECHNOLOGY

Time: Three hours

Maximum marks: 60

I. Answer *all* questions in one word or sentence

1. Define cell line
2. What is axenic culture?
3. Define secondary metabolites
4. Name important macronutrients present in cell culture medium
5. What is an explant?
6. Define aseptic condition
7. What is meant by surface sterilization?
8. Define plant cell immobilization
9. Expand STRs
10. Write expansion and use of EMS

(10X1=10 marks)

II. Answer any *five* questions. Each answer not exceeding 50 words

11. What are the major problems encountered in large-scale cultivation of plant cells?
12. What is biotransformation? Give examples
13. Define metabolic engineering. What are the major steps involved in metabolic engineering?
14. Describe the process of shikonin production
15. Enlist two major antitumour drugs extracted from plants. Name the source plants
16. What are steroids? Give examples for plant derived steroids
17. Explain the process of berberine production

(5X3=15 marks)

III. Answer any *five* of the following. Each answer not exceeding 150 words

18. Enlist major requirements of a cell culture laboratory
19. Explain the design of an immobilized bioreactor. Enumerate major advantages of immobilized bioreactor
20. What is meant by two phase culture system? Write its advantages
21. What are hairy root cultures? How they are developed? Enlist its major advantages
22. What are alkaloids? Explain important classes of alkaloids
23. Discuss major advantages and limitations of biochemical production from cultured plant cells
24. Explain sterilization techniques used in cell culture laboratory

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 350 words

25. Define cell culture technology. What are important strategies to improve metabolite production in a cell culture system?
26. What is bioreactor? What are important types of bioreactors used in plant cell culture technology

(1X10=10 marks)

Semester : **II**
Course Code : **BOT-X-422**
Course Title : **PRINCIPLES OF GARDENING**
Credits : **2**

AIM: To learn the basic principles of gardening and to acquire some horticultural skills

OBJECTIVES

To understand the terminology involved in horticulture.
To distinguish the different types of plants and their habitats.
To understand the importance that plants, chemicals and fertilizers have on our environment
To design a vegetable home garden

COURSE CONTENT

MODULE I: Introduction. Scope and importance of horticulture. Divisions- pomology, olericulture, ornamental horticulture, floriculture, arboriculture, silviculture. Classification of ornamental plants - annual, biennial and perennial, herbs, shrubs and trees, succulents, palms, ferns and conifers, hanging plants, climbers and creepers.

MODULE II: Commercial flowers- examples, Common cut flowers. Scope of cut flowers in Indian scenario. Allied horticultural industry, National and Regional agencies involved in promotion of horticultural industry in India.

MODULE III: Common plant management techniques for horticultural crops - Soil structure, Macro and micro nutrients. Fertilizers- organic, inorganic and chemical, bio fertilizers, vermi composting, diseases and pests of ornamentals, methods of disease and pest control, weed control. manuring – organic and inorganic manures. Methods of irrigation, fertigation.

MODULE IV: Propagation-definitions, types. Seed propagation- merits and demerits- Ornamentals propagated through seeds. Vegetative propagation- merits and demerits-cutting, layering, grafting and budding- stock/scion relationship. Specialized parts of propagation - (bulbs, tubers, offsets, runners, suckers, slip, corms).Specialized structures for propagation-mist chamber, net house, hardening chamber- Micro propagation – Applications.

MODULE V: Special types of garden- vertical garden, roof garden, bog garden, sunken garden, rock garden, clock garden, and temple garden, sacred groves

MODULE VI: Characteristics of home garden. Benefits of home garden. General principles of vegetable gardening – Choosing a site, designing, garden tools, growing popular garden crops, Applying management techniques, extending harvest

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Model Question Paper

**DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA**

Second Semester (CSS2) Degree Examination

BOT-X-422 PRINCIPLES OF GARDENING

Time: Three hours

Maximum marks: 60

I. Answer *all* questions in one word or sentence

1. Define parthenocarpy
2. What are biofertilizers?
3. What is polyembryony?
4. Give an example of a hanging plant
5. What do you mean by de-shooting?
6. Write down the advantage of mist chamber for growing plants
7. What is grafting?
8. What is leaf bud propagation?
9. Name the process in which breaching of natural seed coat occurs by mechanical method
10. What do you mean by monoecious plant?

(10X1=10 marks)

II. Answer any *five* questions. Each answer should not exceed 50 words

11. Distinguish between runners and offset
12. Write down the merits and demerits of seed propagation
13. Describe the scope of horticulture
14. Briefly classify the horticultural crops based on the nature of flowers
15. Write short note on presowing treatment
16. Describe the procedure of layering
17. What are the peculiarities of succulents

(5X3=15 marks)

III. Answer any *five* of the following. Each answer not exceeding 150 words

18. Briefly describe the role of national agencies involved in the promotion of horticultural industry in Kerala
19. Describe the methods adopted for pest management in garden plants
20. Write a note on common cut flowers
21. Give an account on nutritive value of horticultural crops
22. What is micro propagation? Describe its applications
23. Briefly explain the types of specialized structures used for the propagation of plants
24. Briefly describe the role of micronutrients in plant growth

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 350 words

25. Briefly describe the different types of artificial vegetative propagation by citing its merits and demerits
26. Explain the various management practices used for the cultivation of horticultural crops

(1X10=10 marks)

Semester : III
Course code : BOT-X- 431
Course title : TRANSGENIC PLANTS
Credits : 2

AIM: To familiarize production of transgenic plants by applying direct and indirect gene transfer methods

OBJECTIVES

To study various steps involved in the production of transgenic plants
To acquaint with technique of vector mediated gene transfer in plants.
To explore direct gene transfer methods for the production of transgenic plants
To examine applications of transgenic technology in the welfare of human
To analyze biosafety issues and regulations associated with transgenic plants

COURSE CONTENT

MODULE I: Basic concept of genetic engineering -Genetic transformation of plants, Transgenic techniques, Steps for developing new crop varieties

MODULE II: Gene transfer methods-DNA Vectors for Plant Transformation Components for Efficient Gene Expression in Plants Vector mediated gene transfer, creating recombinant DNA- Site-Specific DNA Recombination- Vector Design- Targeted Transgene Insertions- Targeted Transgene Insertions- Marker Genes and Promoters-

MODULE III: *Agrobacterium* mediated gene transfer -Tumor inducing principle and the *Ti* plasmid-*Agrobacterium* mediated - agro infection, Genetic engineering through disarmed *Ti* plasmids- T-DNA integration into chromosomal, DNA-Viral Vectors.

MODULE IV: Vector less or direct DNA transfer - Physical gene transfer methods, Particle bombardment/ microprojectile/ biolistic, Macroinjection, Microinjection, Protoplasts, Whole-Tissue Electroporation, Silicon Carbide Whiskers, Laser Micropuncture, Nanofiber Arrays

MODULE V: Application of transgenic plants, transgenic plants for crop improvement (dicots and monocots), Insect resistance, resistance to virus, resistance to other diseases, recombinant DNA techniques for the production of transgenic plants, procedure and protocols of producing transgenic plants. Transgenics for quality, improved storage, flower color and shape, terminator seed, Commercial transgenics crops, Uses and applications of transgenic plants, new products, pharmaceuticals, bioremediation, edible vaccines, antiviral proteins. Prospects of transgenic plants- zinc-finger nucleases- the future of food fuel, and pharmaceuticals.

MODULE VI: Regulations and Biosafety-Introduction -Regulation of GE USDA FDA Genetic Engineering Appraisal Committee (GEAC) of MoEF, Govt. of India. Controversy of Transgenic plants-debates- Process versus product -health concerns -environmental concerns -consumer choice- Field testing of transgenic plants-Environmental Risk Assessment (ERA) Process- Proof of safety versus Proof of Hazard –Proof of benefits: agronomic performance

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Model question paper

**DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA**

Third Semester M.Sc (CSS3) Degree Examination

Branch: Genetics and Plant Breeding

BOT-X-431 TRANSGENIC PLANTS

Time: Three hours

Maximum marks: **60**

I. Answer *all* questions in one word or sentence

1. What is gene cloning?
2. Mention uses of zinc finger nucleases
3. Expand MoEF
4. What are promoters?
5. Write about *npt II* gene
6. Define transgenesis
7. Explain disarmed Ti plasmids
8. Write about golden rice
9. Explain pharming
10. Define biolistics

(10X1=10 marks)

II. Answer any *five* questions. Each answers not exceeding 50 words

11. Write a note on a transgenic crops with improved
12. Write about targeted transgene insertions
13. Give an account on edible vaccines
14. Write about green fluorescent protein
15. Explain how flower colour can be changed by transgenesis
16. Write about nanofiber arrays
17. Write about terminator seeds

(5X3= 15marks)

III. Answer any *five* of the following. Each answer not exceeding 150 words

18. Give an account on controversies of transgenic plants
19. Write about Genetic Engineering Appraisal committee
20. Explain how a crop variety with increased pesticide resistance can be produced.
21. Explain agrobacterium mediated gene transfer
22. Explain importance of transgenic plants for bioremediation and pharmaceutical production
23. Write a note on marker genes.
24. Explain how a recombinant DNA can be constructed.

(5X5= 25marks)

IV. Answer any *one* of the following, not exceeding 350 words

25. Give an account on application of transgenesis for crop improvement.
26. Describe vector less DNA transfer

(1X10= 10marks)

Semester : III
Course Code : BOT-X-432
Course Title : ETHNOBOTANY
Credits : 2

AIM: To study about the traditional knowledge and practices of various ethnic communities and applications of ethno medicines in health care needs.

OBJECTIVES

To know about various ethnic communities in Kerala and their practices-
To know their role in conservation of our ecosystem-
To understand the uses of various plant resources for our daily needs.
To study about the contributions of famous Indian ethno botanists and the centres of ethno botanical studies in India.
To understand the methods of ethno botanical data collection and documentation –
To attain knowledge about the importance of ethno medicine for modern drug development.

COURSE CONTENT

MODULE I: Definition, history and scope of ethno botanical studies. Selected national, regional works in Ethnobotany. Contributions of major Indian Ethnobotanists- Janaki Ammal, S.K. Jain Dr.P.Pushpangadan.

MODULE II: Ethnic Societies in Kerala - Major tribes in Kerala Kani- Mannan- Kurichya- Paniya- Malaarayar- Chola naikar- Malampandaram. Role of tribals in conservation of ecosystem.

MODULE III: Centres of Ethno botanical studies in India AICRPE-All India Coordinated Research Project on Ethno biology, FRLHT- Foundation for the Revitalisation of Local Health Traditions. Contribution of AICRPE and FRLHT to ethno biology of India.

MODULE IV: Classification of ethno botanical uses: utilization of plant resources for food- shelter- furniture- antidote- fibre- agricultural implements- natural dyes- manure- wild edibles and vegetables- medicine- minor forest produce.

MODULE V: Method of documentation of ethnobotanical studies- Ethnobotanical studies in Kerala- Relevance of ethnobotany in modern context- Role of ethno medicine and its scope in modern times.

MODULE VI: Plant used in ethno medicine- e.g.: *Trichopus zeylanicus*- *Ocimum sanctum*- *Aegle marmelos*- *Janakia arayalpatra*- *Phyllanthus niruri*- *Cissampelos pareira*- preparation and uses

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Model question paper
DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA
Third Semester M.Sc (CSS3) Degree Examination
Branch: Genetics and Plant Breeding
BOT-X-432 ETHNOBOTANY

Time: Three hours

Maximum marks: 60

- I. Answer *all* questions in one word or sentence
1. Define ethnobotany
 2. Expand FRLHT
 3. What are NWFP?
 4. Define Herbal medicine
 5. What is Folk medicine?
 6. What is herbal technology?
 7. Explain CBD
 8. Name a tribal community in Kerala
 9. Give the ethnobotanical significance of *Trichopus zeylanicus*
 10. Write ethnobotanical use of *Embllica officinalis*

(10X1=10 marks)

- II. Answer any *five* questions. Each answers not exceeding 50 words.
11. Explain the role of ethnomedicine and its scope in modern time
 12. Write short notes on natural dyes
 13. Give an account on Indigenous knowledge
 14. Give an account of wild edibles used by the tribal people of Kerala
 15. What is herbal technology
 16. Describe the major contribution of S.K. Jain in the field of Ethnobotany
 17. Write short notes on two wild edible plants

(5X3=15 marks)

- III. Answer any *five* of the following. Each answer not exceeding 150 words
18. Explain the methodology of ethnobotanical studies
 19. Give a brief account of the wild fruit yielding plants
 20. Briefly describe the minor forest produce
 21. What are the major tribes in Kerala?
 22. Explain the role of FRLHT in revitalizing the local health traditions
 23. Evaluate ethnobotany as an interdisciplinary science
 24. Describe the role of pharmacology with ethnomedicine

(5X5=25 marks)

- IV. Answer any *one* of the following, not exceeding 350 words
25. Briefly describe the role of tribal in conservation of the ecosystem
 26. Write a brief account on the ethnobotanical studies done in Kerala

(1X10=10 marks)