Learning Outcomes-based Curriculum Framework (LOCF)for Post-graduate Programme

NAME OF THE PROGRAMME

M.Sc. GENETICS AND PLANT BREEDING

(Syllabus effective from 2024 Admission)

UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY

2024

PREAMBLE

The role of higher education is vital in securing the gainful employment and providing further access to higher education comparable to the best available in the world-class institutions elsewhere. The improvement in the quality of higher education, therefore, deserves to be given top-most priority to enable the young generation of students to acquire skill, training and knowledge to enhance their thinking, comprehension and application abilities and prepare them to compete, succeed and excel globally. Sustained initiatives are required to reform the present higher education system for improving and upgrading the academic resources and learning environments by raising the quality of teaching and standards of achievements in learning outcomes across all undergraduate programs in science, humanities, commerce and professional streams of higher education.

One of the significant reforms in the undergraduate education is to introduce the Learning Outcomes- based Curriculum Framework (LOCF) which makes it student-centric, interactive and outcome- oriented with well-defined aims, objectives and goals to achieve. The University Grants Commission (UGC) took the initiative of implementing the LOCF in the Colleges and the Universities of the country. Accordingly, the University of Kerala has decided to implement the LOCF in all its departments under the auspices of Internal Quality Assurance Cell (IQAC). A series of teacher training workshops were organized by IQAC and the office of the Credit and Semester System (CSS), and the departments have revised the syllabus accordingly, through workshops and in consultation with academic experts in the field.

GRADUATE ATTRIBUTES (GAs)

The Graduate Attributes (GAs) reflect particular qualities and abilities of an individual learner including knowledge, application of knowledge, professional and life skills, attitudes and human values that are required to be acquired by the graduates of University of Kerala. The graduate attributes include capabilities to strengthen one‘s professional abilities for widening current knowledge and industry-ready skills, undertaking future studies for global and local application, performing creatively and professionally, in a chosen career and ultimately playing a constructive role as a socially responsible global citizen. The Graduate Attributes define the characteristics of learners and describe a set of competencies that are beyond the study of a particular area and programme.

The GAs of University of Kerala

- Continue life-long learning as an autonomous learner
- Continuously strive for excellence in education
- Apply and nurture critical and creative thinking
- Promote sustainable development practices
- Promote co-operation over competition
- Balance rights with responsibilities
- Understand and respect diversity and difference
- Not be prejudiced by gender, age, caste, religion, or nationality
- Use education as a tool for emancipation and empowerment of humanity

ABOUT THE DEPARTMENT

Department of Botany was established in the year 1959 at Kariavattom, Thiruvananthapurm, Kerala with Late Prof (Dr.) A Abraham, visionary, an institution builder and a doyen in Cytogenetics and Plant Breeding, as Professor and Head of the Department. He believed that, the goal of science is to seek the simplest explanations of complex facts. His emphasis on –learning by doing‖ continues to be at the heart of the Department's educational mission. The commitment of the Department to innovations has led it to a host of scientific break-through, which includes the discovery of highest chromosome number of 1260 in *Ophioglossum reticulatum*, introduction of the most popular tapioca variety M-4 in Kerala, from Malaysia to meet the food shortage, introduction of hybrids of *Mussaenda* from Philippines as an ornamental plant and so on by Prof (Dr.) A Abraham and his research team. Fueled by optimism, ingenuity and the sense of responsibility from Professor Abraham, and a galaxy of eminent Professors like Dr. C A Ninan, Dr. P M Mathew, Dr. A. N Namboodiri, Dr Susan Abraham, Dr. P I Kuraichan and Dr. B Vijayavalli made continue to make envious strides in research at the Department in Cytology, Genetics and Plant Breeding. Since 1980s, faculties in the Department have focused on morphogenesis, reproductive biology and genetic diversity analysis especially on crop species. Plant tissue culture laboratories and molecular biology labs were opened during this period. The modernization of facilities gained momentum due to support of the UGC in the form of COSIST and SAP programs. Infrastructure facilities were greatly augmented in the last decade under the headship of Dr. G.M Nair, Dr. Omanakumari and Dr. Ashalatha S Nair. SAP phase II, SARD programme of KSCSTE and DST-FIST were implemented during the period resulting in the addition of sophisticated equipments and facilities in the Department. The Department has been delivering research-led student education with a strong suite of two post graduate programmes (i) M Sc Genetics and Plant Breeding and (ii) M Sc Biodiversity Conservation. A dynamic research environment for plant research in the areas of Biosystematics, Biotechnology, Phytochemistry and Plant Reproductive Biology is being provided in the Department. The Department has added to its credit more than 250 doctoral degree holders, working in reputed research labs, across the country and abroad.

Vision

Our vision is to become a premier academic institution recognized internationally for its sustainable contribution to the environment and society through the pursuit of cutting edge research and academic expertise

Mission

- To produce highly competent and service oriented generations of students in Life Sciencethat will best serve the Nation and world in the coming years
- To transform education through academic rigour, practical orientation and outcome-basedteaching
- To undertake impactful research addressing local, national and global challenges in PlantScience Research

Courses Offered

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

M.Sc. Botany (specialization in Biodiversity Conservation): A unique course designed to get mastery in Biodiversity and conservation strategies.

PhD Botany: ***Areas of Research***

- ❖ Conservation of Tropical Biodiversity and Sustainable Utilization
- ❖ Cytogenetics and Biosystematics
- ❖ Biotechnology/ Tissue culture/ Cell Culture Technology
- ❖ Phytochemical and gene prospecting
- ❖ *In vitro* secondary metabolite production & Bioreactor studies
- ❖ Bioprospecting of Microbial Resources
- ❖ Plant Reproductive Biology and Seed Biology

Admission Procedure

- ❖ PhD Admission: is scheduled in January/ July. Qualification: M.Phil/ PhD Qualifying Test/UGC-CSIR NET/KSCSTE Fellowship.
- ❖ M.Sc. Genetics and Plant Breeding, M.Sc. Botany (specialization in Biodiversity Conservation): Admission based on an Entrance Examination held in May every year.

Faculty

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

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
- • Plants and Microbes for bioactive molecules

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 plantconservatory, nurseries, green houses, water plant conservatories, fernery, Dr. M. Kamarudheen Memorial Biosystematics Garden, green houses, water plant conservatories, healing garden, butterfly garden, sensory garden, Miyawaki forest, horticulture and topiary garden.

2. **Herbarium:** Department herbarium has a collection of 11000 Angiosperms, 21 Gymnosperms and 2000 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, Biofermentor, 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. **Microbiology Laboratory with BSL I & II facility:** Biosafety levels I and II were established at the Microbiology laboratory. This facility enables to testing of antimicrobial and anti-biofilm properties of biomolecules from plant and microbial origin.

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

8. **Department Auditorium:** Department has an auditorium (A/C) with modern Audio VisualFacility.

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. E.A. Siril Professor & Head, Department of Botany is the present chairman of the Association and Dr. Bindu R. Nair is the Secretary. The Association has around 350 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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UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY

Syllabus for M.Sc. Programme in Genetics and PlantBreeding
Programme code: 815

Programme Specific Outcomes (PSO) for M Sc Genetics and Plant breeding

PSO 1	**Understand the interdisciplinary approach of Genetics and Plant breeding**
PSO 2	**Develop skills in breeding practices, crop management strategies, improvement in crop characters under stress**
PSO 3	**Gain experience in technology rich and integrated research and training**
PSO 4	**Pursue a career in Academic and Research Institutes as well as Industry**

Programme Structure of
M.Sc Genetics and Plant Breeding
Programme Code 815

Semester	Course Code	Name of the course	Credits
	Core Courses (CC)		
I	**BOT-CC- 511**	Mendelian Genetics	**3**
	BOT-CC- 512	Biophysics and Biological Techniques	**3**
	BOT-CC- 513	Cell Biology	**3**
	BOT-CC- 514	Practical I	**3**
	Discipline-Specific Elective (DE)		
	BOT-DE- 515	Research Methodology and Biostatistics	**2**
	BOT-DE-516	Plant Metabolism & Metabolic Engineering	**2**
II	**Core Courses (CC)**		
	BOT-CC-521	Molecular Genetics	**3**
	BOT-CC-522	Cytogenetics	**3**
	BOT-CC-523	Plant Breeding	**3**
	BOT-CC-524	Plant Physiology and Biochemistry	**3**
	BOT-CC-525	Practical II	**4**
	Discipline-Specific Elective (DE)		
	BOT-DE-526	Diversity in Cryptogamae and Gymnospermae	**2**
	BOT-DE-527	Climate Change and Ecosystem Resilience	**2**
III	**Core Courses (CC)**		
	BOT-CC-531	Genetic Engineering	**3**
	BOT-CC-532	Plant Biotechnology	**3**
	BOT-CC- 533	Biosystematics	**3**
	BOT-CC-534	Modern Methods in Crop Breeding	**3**
	BOT-CC-535	Practical III	**4**

	Discipline-Specific Elective (DE)		
	BOT-DE-536	Bioinformatics	**2**
	BOT-DE-537	Phytochemistry	**2**
	Core Courses (CC)		
IV	**BOT-CC-541**	Population & Evolutionary Genetics	**3**
	BOT-CC-542	Developmental Genetics	**3**
	BOT-CC-543	Ecology and Conservation Biology	**3**
	BOT-CC-544	Practical IV	**3**
	DISSERTATION BOT-D-545	**Dissertation**	**6**
Any semester (I-IV)	**Generic Courses (GC)**		
	BOT-GC-501	Plant Tissue Culture	**2**
	BOT-GC-502	Microbial Technology	**2**
	BOT-GC-503	Plant Cell Culture Technology	**2**
	BOT-GC-504	Principles of Gardening	**2**
	BOT-GC-505	Transgenic Plants	**2**
	BOT-GC-506	Ethnobotany	**2**
	BOT-GC-507	Herbal Cosmetics	**2**
Any semester (I-IV)	**Skill Enhancement Elective (SE)**		
	BOT-SE-501	Plant Propagation and Nursery Management	**2**

SEMESTER I	Course Code: BOT- CC- 511	Credits: 3

NAME OF THE COURSE: MENDELIAN GENETICS

COURSE OUTCOMES (CO)

CO1 : Assess the variations in the inheritance pattern and apply this skill in the day today life.

CO2 : Analyse the data in the genetics using basic statistical methods.

CO3 : List out various types of sex determination mechanisms in different organisms and there by develop new strategy for propagation and improvement.

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 Mendelian Genetics, Trihybrid cross, Test Cross, Back Cross, Punnet square, Forked line 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, Holandric 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, 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 genes 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, coefficient of coincidence and negative 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.

LEARNING RESOURCES:

REFERNCES

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- Hartl D. L. and Jones E.W. (2001). Genetics an analysis of Genes and Genomes (5thedition). Jones & Bartlett Publishers, Boston
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- Russell, P.J. (2005). Genetics A Molecular Approach (2^{nd} edition). Pearson/Benjamin Cummings, San Francisco.
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- Verma, P. S., & Agarwal, V. K. (2009). Genetics, (Multicolour Edition). S. Chand Publishing
- Weaver, R. F and Hedrick P.W. (1997). Genetics (3^{rd} edition), Wm. C Brown Publishers.Toronto.
- Wei, W., & Stewart Jr, C. N. (Eds.). (2021). Gene flow: monitoring, modeling and mitigation. CABI.
- William Stansfield (2020), Schaum'S Easy Outline of Genetics 1st Edition

Online Resource Table

Resource	Link	Description
NCBI Education	https://www.ncbi.nlm.nih.gov/education/	Educational materials and resources related to genetics.
National Human Genome Research Institute	https://www.genome.gov/	Mendelian inheritance.
National Geographic society	https://www.nationalgeographic.org/ https://images.nationalgeographic.org/image/upload/t_edhub_resource_key_image/videos/posters/Genetics%20101	Genetics
Genomics education programme	http://www.genomicseducation.hee.nhs.uk/blog/mendel-influence-and-inheritance/ https://hee.nhs.uk/	Mendel: Influence and inheritance

Model question paper

UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY

First Semester M.Sc. (CSS1) Degree Examination

Branch: Genetics and Plant Breeding

BOT- CC- 511 MENDELIAN GENETICS

Time: Three hours **Maximum marks: 60**

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

1. Who discovered linkage?
2. State the law of independent assortment
3. Explain the importance of 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 the genotypic ratio of the progenies?
6. Give an example for sex limited traits in humans.
7. Write the term for the plant that 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 term narrow sense heritability?
10. Define maternal inheritance

(10X1= 10 marks)

II. Answer any *five* questions. Each answer not exceeding 150 words.

11. Differentiate between coupling phase and repulsion phase. Predict the outcome of progenies in both cases
12. Define the chromosome theory of heredity. Who proposed it?
13. With suitable example explain the phenomenon of 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*

(5X3= 15 marks)

III. Answer any *four* of the following Each answer not exceeding 250 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 a 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. Differentiate dominance and epistasis. Explain two types of epistasis with examples of the respective altered dihybrid ratio
22. Write the distinguishing features of uniparental inheritance, maternal inheritance, and maternal effect.
23. Explain the term heritability. Write the relationship between phenotypic and genotypicvariance with heritability.

24. *Melandrium album* is a dioecious plant showing a clear-cut correlation between the phenotypic sex and the presence of heteromorphic sex chromosomes. Point out the sex determination mechanism in this plant.

(5X5= 25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. 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
Crossveinles, 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?

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

(1X10= 10 marks)

SEMESTER I	Course Code: BOT- CC- 512	Credits: 3

NAME OF THE COURSE: BIOPHYSICS AND BIOLOGICAL TECHNIQUES
COURSE OUTCOMES (CO)
CO1: Demonstrate an understanding of the fundamental principles of biophysics
CO2: Gain knowledge about the principle and use the equipment for solving research problems
CO3: Acquire knowledge on biological techniques
CO4: Develop practical skillsin the area

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: Instrumentation in biology-Principles and applications of light, phase contrast, fluorescence, polarizing, scanning and transmission electron microscopy, STEM, Scanning tunneling microscopy, Confocal microscopy-Principle and application, Focused ion beam and scanning probe microscopy: Photomicrography, Flow cytometry. Sample Preparation for Scanning Electron Microscopy (SEM) and Transmission electron microscopy (TEM), Immuno-labeling of sections, Preparation of samples for X- ray microanalysis, Preparing Sample for Confocal Microscopy. Spectroscopy- principles, types of spectra and their biochemical usefulness, visible and UV spectrophotometry, Infra-red (IR), Circular Dichroism (CD), NMR, ESR and mass spectroscopy, X-ray diffraction. Detection and measurement of radiation -– Geiger-Muller counter, 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.

MODULE III: Analytical techniques in biology-Centrifugation principles of sedimentation Preparative and Analytical centrifuges. Sedimentation equilibrium method, Sedimentation velocity method – Density Gradient Centrifugation – Isokinetic and isopycinic centrifugation – Differential centrifugation. Chromatography principles–Adsorption and Partition Chromatography– Thin layer chromatography, Gas chromatography (GC), High performance liquid chromatography (HPLC), Ion-Exchange Chromatography and Affinity Chromatography. Electrophoresis principle-agarose and polyacrylamide gel electrophoresis, Isoelectric focusing, Istotachophoresis and immuno electrophoresis.

MODULE IV: Plant Cell and Tissue processing-Killing and fixing- common fixatives-composition, preparation, e.g., Flemming's fluid, FAA, Carnoy's fluid, Chrome acetic, Nawaschins fluid, Zircle's fluid. Dehydration- Principles, important dehydrating agents. Clearing agents, mounting media used in microtechnique. Types of micro-slide preparation, temporary semi-permanent and permanent –smears and squashes-Tissue embedding in paraffin wax- Tertiary- Butyl Alcohol method (TBA), Ethyl alcohol-xylenemethod, Alcohol-chloroform method. Sectioning: using rotary microtome: adhesives and their preparation,

Microtomes- Rotary, Sledge, Sliding microtome, Freezing microtome - Cryotome.

MODULE V: 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 Preparation of whole mounts and macerations: Glycerin- xylene method for whole mounts; Techniques of smear, squash and tissue maceration.

MODULE VI: Histochemical Localization of Cellular Components- Principle and methods of histochemistry, cytochemistry- Fluorimetry Histochemical localization insoluble poly saccharides -Periodic Acid–Schiff's reagent [PAS] method, Starch -Iodine –Potassium iodide method (IKI). Cellulose –IKI method, Pectin, Protein-Coomassie Brilliant Blue (CBB), Lipids- Sudan dye III method, Nucleic acids -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.

LEARNING RESOURCES
REFERENCES

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Biological Techniques

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ONLINE RESOURCES:

- http://www.biomedlabs.org/introduction-to-immunohistochemistry-techniques-course-outline.html.
- 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_l2.html
- http://www.biologydiscussion.com/microscope/microscopy-principles-and-specimen- preparations-with-diagram

Online Resource Table

Resource	Link	Description
Biophysical Society	https://www.biophysics.org/education-careers/education-resources/selected-topics-in-biophysics/biophysical-techniques	Lessons, videos
National Mission on Education through ICT(NME-ICT) **e-PG Pathshala**	https://epgp.inflibnet.ac.in/Home https://youtu.be/aawDYbpWZC4	Scattering of X-rays, diffraction of X-rays from one-, two- and three dimensional array of atoms, X-ray sources and detectors
	https://epgp.inflibnet.ac.in/Home https://youtu.be/l-uELw3mQvs	Working Principles of HPLC and its application
	https://epgp.inflibnet.ac.in/Home https://youtu.be/fr0qt0D7bQE	Introductions, Principles & types of centrifugation
	https://epgp.inflibnet.ac.in/Home https://youtu.be/tc7bkZXRaz8	Differential Centrifugation and Density Gradient Centrifugation
	https://epgp.inflibnet.ac.in/Home https://youtu.be/86OrpD1nZqg	Ultracentrifugation
	https://epgp.inflibnet.ac.in/Home https://youtu.be/VjxNgkCi7Nc	Preparative Ultracentrifugation
	https://epgp.inflibnet.ac.in/Home https://youtu.be/VdjHZfC7Us4	Analytical Ultracentrifugation
	https://epgp.inflibnet.ac.in/Home https://youtu.be/-FJJ4LL5nbQ	Introductions & Types of Chromatography
	https://epgp.inflibnet.ac.in/Home https://youtu.be/hANish35GkE	Gas chromatography: principles and application
	https://epgp.inflibnet.ac.in/Home https://youtu.be/JYbSJwvGFZk	Ion-exchange chromatography: Principle, Methodology & applications
	https://epgp.inflibnet.ac.in/Home https://youtu.be/fydYLuEl9vE	Affinity Chromatography: Principle, Methodology & Applications
	https://epgp.inflibnet.ac.in/Home https://youtu.be/LMaPg8BaXKo	Recent Advances in Chromatography

UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY

First Semester M.Sc. (CSS1) Degree Examination

Branch: Genetics and Plant Breeding

BOT- CC- 512 BIOPHYSICS AND BIOLOGICAL TECHNIQUES

Time: Three hours **Maximum marks: 60**

I. Answer *all* questions briefly

1. Suggest the use of egg white in plant microtechnique.
2. Mention the principle of the Periodic Acid–Schiff's reagent (PAS) method?
3. Define measures of dispersion
4. What is chemical shift?
5. Which chromatographic separation method you will use for the separation ofantibody from a mixture?
6. What is IPR?
7. How would you define a redox couple in the context of redox reactions?
8. As a part of the research project, you are planning to determine the percentage of pollen viability of the flower you are working with. What type of staining method you are expected to adopt? Can you suggest any of the commonly used stains for the purpose?
9. Can you explain the concept of entropy in thermodynamics?
10. Nitrogen molecule (N_2) is a highly stable molecule. In nitrogen how many electrons are shared to achieve this stability? Which type of bond is constituted by electron sharing in this case?

(10X1=10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Write notes on embedding
12. Write procedure for cytochemical localization of protein
13. Give a brief account on dehydrating agents
14. How is the Coomassie Brilliant Blue (CBB) method used for the histochemical localization of proteins?
15. Schiff's reagent is used for the staining of insoluble polysaccharides and nucleicacid. What is the principle of this staining method?
16. Explain principle and applications of affinity chromatography
17. Give an account on the various applications of radioisotopes in biology

(5X3=15 marks)

III. Answer any *four* of the following. Each answers not exceeding 250 words.

18. Briefly describe the working of rotary microtome
19. Which centrifugation method you will use for the separation ofheterogeneous mixture of pollen grains. Explain principle and applications of this technique
20. What is histo-enzymology? Explain its principle with an example.
21. Explain the Feulgen Reaction method for the histochemical localization of nucleic acids. Discuss its principle and staining procedure.
22. Explain the principle of agarose gel electrophoresis. Discuss its applications and advantages.
23. Describe the principle and applications of immuno-electrophoresis.
24. Describe a scenario in which high performance liquid chromatography (HPLC) would be preferred over gas chromatography (GC) for the separation of constituents in a phytoextract.

(5X5= 25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. Give an account of the classification of stains used in microtechnique with examples and applications.
26. Give an account on the principle, instrumentation, and application of spectrophotometry

(1X10= 10 marks)

SEMESTER I	Course Code: BOT- CC- 513	Credits: 3

NAME OF THE COURSE: CELL BIOLOGY

COURSE OUTCOMES (CO)

CO1: Develop a deep knowledge on the ultra structure and functions of cell organelles.

CO2: Gain deep knowledge on the events of cell division

CO3: Develop a skill in the cytological preparation and karyotype analysis andthereby assess the evolutionary pattern of the plant.

COURSE CONTENT:

MODULE I: Cell Organelles: Ultrastructure, chemistry, functions, interrelationships and origin**:** Cell-wall, Plasma membrane, Cytoplasm: endoplasmic reticulum, ribosomes, Golgibodies, 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. 3D chromatin structure, 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. Chromosome combing, chromosome painting, Digital karyotyping, Spectral karyotyping (SKY), SNP array and virtual karyotyping, electrophoretic karyotyping, DECIPHER-software. 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.

LEARNING RESOURCES:

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- Watson RR, Preedy VR (Editors) (2016) Genetically Modified Organism in Food-

Production, Safety, Regulation and Public Health. Academic Press, New York

Online Resource Table

Resource	Link	Description
National geographic	https://education.nationalgeographic.org/resource/resource-library-cell-biology	Lessons, videos-Cell biology
US National Science foundation	https://www.nsf.gov/news/mmg/mmg_disp.jsp?med_id=72073	Animated tour of a cell
e-PG Pathshala National Mission on Education through ICT(NME-ICT)	https://epgp.inflibnet.ac.in/Home https://youtu.be/gs2hoDbhsKo	Cell cycle
	https://epgp.inflibnet.ac.in/Home https://youtu.be/YZHhjfd8rTg	Cell membrane and Cellular transport I
	https://epgp.inflibnet.ac.in/Home https://youtu.be/KgO9C3qzltg	Cell wall
	https://epgp.inflibnet.ac.in/Home https://youtu.be/wzeJn3UH6ZA	Chloroplast and mitochondria
	https://epgp.inflibnet.ac.in/Home https://youtu.be/o_oLfPzcOUY	Cytoskeleton
	https://epgp.inflibnet.ac.in/Home https://youtu.be/8BKTDwzraeM	Endoplasmic reticulum
	https://epgp.inflibnet.ac.in/Home https://youtu.be/WF5V7i8cp-E	Golgi complex:
	https://epgp.inflibnet.ac.in/Home https://youtu.be/0Aeb-unEDDk	Glyoxysomes and Peroxisomes
	https://epgp.inflibnet.ac.in/Home https://youtu.be/HMDvpXJd67Q	Lysosomes
	https://epgp.inflibnet.ac.in/Home https://youtu.be/B4XaQuC1H4M	nucleus
	https://epgp.inflibnet.ac.in/Home https://youtu.be/0HPCIpVuEZk	VACUOLES
	https://epgp.inflibnet.ac.in/Home https://youtu.be/FM6hq5_LzAo	Plasmodesmata

Model Question Paper

UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY

First Semester M.Sc. (CSS1) Degree Examination

Branch: Genetics and Plant Breeding

BOT-CC-513 CELL BIOLOGY

Time: Three hours **Maximum marks: 60**

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

1. Name the important structural constituents of the plasma membrane.
2. Draw out the relation between autophagy and crinophagy.
3. Explain the role of kinetochore?
4. Write the features of peroxysomes.
5. Distinguish between bimodal and unimodal karyotype.
6. Write the importance of blepharoplast.
7. Define endomitosis.
8. Mention the key principles of the cell theory and why this theory is not applicable to viruses.
9. What do you mean by synapsis?
10. Define ideogram.

(10X1= 10 marks)

II. Answer any five questions. Each answer not exceeding 150 words

11. Tabulate the difference between heterochromatin and euchromatin.
12. With the help of diagrams explain the structure and functions of Golgi bodies.
13. Analyse the role of different proteins in chromatid separation and terminalization.
14. Deduce the basic chromosome number by citing an example.
15. Write the significance of pachytene analysis.
16. Give an account on membrane lipids.
17. Write the significance of pachytene analysis.

(5X3= 15 marks)

III. Answer any *four* of the following. Each answer *not* exceeding 250 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. Explain the formation of endosperm in coconut. Try to discuss this in the light of the chromosome constitution of coconut endosperm.
20. Describe the ultra-structure of chloroplast
21. Compare Levan *et al.* system of chromosome classification with that of Stebbins
22. Write about the development and structure of polytene chromosomes.
23. What is C mitosis? Describe its genetic consequences
24. Imagine you are tasked with diagnosing a genetic disorder using karyotype analysis. What are the modern molecular cytogenetics tools available for the purpose?

(5X5= 25 marks)

IV. Answer any *one* of the following, *not* exceeding 500 words

25. Write the importance of chiasma. Briefly explain the molecular mechanisms ofgenetic recombination.
26. Karyotype is a tool to assess the interrelationships of organisms. Justify.

(1X10= 10 Marks)

SEMESTER I	Course Code: BOT- CC- 514	Credits: 3

NAME OF THE COURSE: PRACTICAL I

MODULE I: Problems related to Mendel's laws, Probability, Pedigree analysis, codominance, multiple alleles, lethal alleles, epistasis, X linkage, sex limited and sex influenced inheritance. statistical analysis of polygenic traits, artificial selection and heritability. linkage: (Two-point test cross, three point mapping in *Drosophila*, Determination of gene sequences, Interference), Sex determination in *Drosophila,* humans and plants, Maternal inheritance, Uniparental inheritance, Infectiousheredity, Maternal effect.

MODULE II: 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). **Submission:** 5 permanent slides – including 1 whole mount, 4 double stained preparations.

MODULE III: Histochemical localization of starch, cellulose, protein, nucleic acid and lipids, Histo-enzymological localization of esterase and pectinase, Vital staining (e.g., Janus green B staining), Sectioning by using cryotome (demonstration only),

MODULE IV: Photo-documentation of micro- preparation by using image analyser. Colorimetric/ spectrophotometric estimation of protein, density gradient centrifugation - separation of pollen grains, DNA separation using agarose gel electrophoresis.

MODULE V: Fifteen permanent slides of the countable metaphase spread to be prepared and submitted at the end of semester I.

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

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

MODULE VI: Endomitosis: *Cocos nucifera* endosperm to be used to study endomitosis.

SEMESTER I	Course Code: BOT- DE- 515	Credits: 2

NAME OF THE COURSE: RESEARCH METHODOLOGY AND BIOSTATISTICS

COURSE OUTCOMES (CO)

CO1: Prepare scientific reports, proposals and research papers
CO2: Take up research problems with confidence
CO3: Design an experiment and analyze the data using suitable statistical tools

COURSE CONTENT

MODULE I: Research methodology- Introduction, Need for research, stages of research; Generation of a research problem, execution of work, and interpretation of results. Review of literature Books, Journals: Indexing journals, abstracting journals, research journals, review journals, e-journals. Impact factor of journals, NCBI-Pub Med, Web of Science, Scopus, J gate. Other sources of references, open access initiative, INFLIBNET, INSDOC. Bibliography management system-Mendeley, End Note, Bib Tex.

MODULE II: Preparation of project proposals, Presentation and publication of research outcomes Preparation of a dissertation, Preparation of research paper, Preparation of review articles. Proof reading – standard abbreviations for proof correction. Presentation of research findings in seminars and workshops. Plagiarism- Plagiarism checking software. Significance of scientific research–environmental impacts and ethical issues – ethical committees – commercialization – copy right – royalty – Intellectual property rights and patent law – Trade related aspects of intellectual property rights.

MODULE III: Biostatistics: Definition, scope, functions of biostatistics, its applications in biological research; Data: Primary and secondary Data; Methods of collection of Data; Sampling techniques; Frequency distribution table. Presentation of Data: Tabulation - general rules for Tabulation, Parts of Tables and types of Tables; Diagrammatic presentation: Line, bar and pie; Graphic representation: Histogram, frequency polygon, frequency curve and Cumulative frequency curve.

MODULE IV: Analysis of Data: Measures of central tendency: Mean, Median and Mode; Measures of Dispersion: Range of variation, quartìle deviation,Standard deviation and Standard error and Relative measures of dispersion - coefficient of variation. Probability basic principles - types - rules of probability - addition and multiplication rules applications-Probability distribution. Patterns of probability distribution; binomial, multinomial, normal and poisson distributions.

MODULE V: Tests of significance- formulation and testing of hypothesis Chi-square test for goodness of fit; Null hypothesis, level of Significance - Level of significance; P – value Degrees of Freedom. Student ‘t’ test – paired sample and mean differences ‘t’ tests. ANOVA (Analysis of variance)- one way and two way method, F test, F value calculation, F table. Basic introduction to Multivariate Analysis of Variance (MANOVA). Correlation and regression Correlation - types of correlation - methods of study of correlation - testing the significance of the coefficients of correlation. Regression and types. Rank correlation. Lines of regression- coefficient of regression.

MODULE VI: Design of experiments- replication and randomization. Common designs in biological experiments: Completely randomized design, randomized block design, Latin square design, and Factorial design. Statistical softwares- SPSS, Use of software packages like SPSS, SAS, R, SPAR, MINITAB. etc. for the above tests and designs of experiments for analysis.

LEARNING RESOURCES:
REFERENCES

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Online Resource Table

Resource	Link	Description
National mission on education through ICT (NME- ICT)	https://youtu.be/y_2mhI6DEvI	Introduction to biostatistics
	https://youtu.be/t9ytURd8ukA	Probability basics
	https://youtu.be/HOxgU3sa-b0	Random variables
	https://youtu.be/mpaXEx2JAPA	Block design analysis
	https://youtu.be/6r6i3gH-fDY	Block design analysis
	https://youtu.be/5kdTTwc1MEs	one way ANOVA
	https://youtu.be/N8Kshscv-Ck	one way ANOVA using R
	https://youtu.be/cCidPgNIxPw	Introduction to multivariate analysis
	https://youtu.be/jqrnBDjZc1w	Sample size determination

Model Question Paper

DEPARTMENT OF BOTANYUNIVERSITY OF KERALA
First Semester M.Sc. (CSS1) Degree Examination
Branch: Genetics and Plant Breeding
BOT-DE-515 Research Methodology and Biostatistics (Elective)

Time: Three hours **Maximum marks: 60**

I. Answer all questions in one word or sentence

1. What is meant by plagiarism? Name any two plagiarism checking software
2. Define binomial probability distribution
3. List out any two methods of secondary data collection
4. Define standard deviation
5. Define randomized block design
6. What is the significance of journal impact factor?
7. Define coefficient of regression
8. What is the significance of p value
9. What is IPR?
10. What are INFLIBNET and INSDOC? **(10x1=10marks)**

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Discuss the features of student 't' test
12. Explain MANOVA
13. Give an account on general rules of tabulation
14. Explain rules of probability
15. What is proof reading? What are standard abbreviations used in proof reading?
16. Discuss the significance of scientific research in environmental impacts and ethical issues
17. What are the features of Chi-square test?

(5x3=15 marks)

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

18. Explain the statistical analysis of data and its significance
19. Give an account on journals and its different types
20. Explain the in detail about the patterns of probability distribution
21. Describe the common experimental designs used in biological studies.
22. Discuss the components of a research paper.
23. Give an account on measures of dispersion
24. Differentiate between correlation and regression analysis. **(5X5= 25 marks)**

IV. Answer any *one* of the following, not exceeding 500 words

25. Discuss the major components of a project proposal. Explain how a project proposal can be prepared with example.
26. Explain in detail about the scope, functions and applications of biostatistics in biological research. **(1X10= 10 marks)**

SEMESTER I	Course Code: BOT- DE- 516	Credits: 2

NAME OF THE COURSE: PLANT METABOLISM & METABOLIC ENGINEERING

COURSE OUTCOMES (CO)

CO1: Distinguish various types of plant secondary metabolites

CO2: Familiarize with the genetic engineering techniques to improve the production of plant secondary metabolite

CO3: Explain the applications of plant genetic engineering in the field of agriculture, medicine, environment and industry

COURSE CONTENT

MODULE 1: Plant Secondary metabolism: Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis, major pathways of secondary-metabolite biosynthesis.

MODULE II: Major types– terpenes, phenols, flavonoids- anthocyanins, flavones, flavonols, isoflavones, and nitrogen-containing compounds- alkaloids, cyanogenic glycosides, glucosinolates, and nonprotein amino acids, Role of secondary metabolites in plants. Applications of Plant Secondary Metabolites in pharmaceutical industry.

MODULE III: Metabolic Engineering: Definition, objectives of Plant Metabolic Engineering (PME), basic tools, Plant genomics, and metabolomics.

MODULE IV: Strategies in Metabolic Engineering: Homologous Over expression of Pharmaceutical molecule- Over expression of Single Gene, Co-expression of Multiple Genes. Ectopic expression of biosynthetic genes to produce pharmaceutical molecules, Suppression of competitive pathways, regulating the expression of transcription factors, regulating the levels of endogenous phytohormones involved in the biosynthesis of a specific metabolite, regulating related primary metabolism.

MODULE V: Case studies: i. Taxol precursor over production- ME Approach, ii. Anthraquinone over production by overexpression of key gene iii. Crop nutritional quality enhancement. Synthetic biology and metabolic engineering- future avenues. Inverse metabolic engineering, Synthetic metabolic pathway construction., cell free synthesis of metabolites and peptides.

MODULE VI: Emerging strategies in Plant metabolic engineering- Genome editing tools for PME: Homologous recombination, Zinc finger nucleases (ZFNs), Transcription activatorlike effector nucleases (TALENs), Tetratricopeptide repeat proteins, Clustered regularly interspaced short palindromic repeats (CRISPR)-CRISPR associated protein 9 (Cas9), Adenine base editor, Ribonucleic acid interference (RNAi), Site-directed sequence editing, Oligonucleotide directed mutagenesis, Cisgenesis, Intragenesis, Plastid genome and synthetic genomics. miRNA- and RNAi-Mediated Metabolic Engineering.

LEARNING RESOURCES
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Online Resource Table

Resource	Link	Description
National mission on education through ICT (NME- ICT)	https://youtu.be/PW798deDIZM	Use of RNAi as a tool for crop improvement.
	https://youtu.be/0NnaZceEuBw	Tools in genetic engineering
Youtube	https://youtu.be/HqloaZpfLkU	ANOVA and MANOVA

Model question paper
UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY
First Semester M.Sc. (CSS1) Degree Examination
Branch: Genetics and Plant Breeding
BOT-DE-516 Plant Metabolism and Metabolic Engineering (Elective)

Time: Three hours **Maximum marks: 60**

I. Answer all questions in one word or sentence

1. Define metabolic engineering
2. What is meant by 'TALENs'?
3. Define RNAi
4. Site two examples of cyanogenic compounds
5. What is intragenesis?
6. Define isoflavones
7. Define metabolomics
8. What is meant by Site-directed sequence editing?
9. Define Homologous recombination
10. Explain 'CRISPR' **(10x1=10marks)**

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Interpret the co-expression of multiple genes as a useful strategy in metabolic engineering
12. Differentiate between plastid genome and synthetic genome
13. Explain nitrogen containing secondary metabolites with suitable examples.
14. Discuss the applications of plant secondary metabolites in pharmaceutical industry
15. Explain the interrelationship between basic metabolic pathways and secondary metabolite biosynthesis
16. Describe the objectives of Plant Metabolic Engineering (PME)
17. Explain Inverse metabolic engineering **(5x3=15 marks)**

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

18. Discuss the role of secondary metabolites in plants
19. Describe the basic tools used in Plant Metabolic Engineering (PME)
20. Demonstrate 'crop nutritional quality enhancement' with suitable case study
21. Discuss the ectopic expression of biosynthetic genes.
22. Discuss the future avenues of synthetic biology and metabolic engineering.
23. Give an account on secondary metabolism and discuss the importance of Alkaloids in Medicine and Agriculture.
24. Explain cell free synthesis of metabolites and peptides. **(5X5= 25 marks)**

IV. Answer any *one* of the following, not exceeding 500 words

25. Explain the over expression of a single gene. Demonstrate using suitable case study as example.
26. Explain different genome editing tools used in plant metabolic engineering

(1X10= 10 marks)

SEMESTER II	Course Code: BOT- CC- 521	Credits: 3

NAME OF THE COURSE: MOLECULAR GENETICS

COURSE OUTCOMES (CO)

CO1: Gain knowledge on organization of nucleic acids and mechanism of DNA replication in prokaryotes and eukaryotes
CO2: Identify the location of genes in the genomes of bacteria, viruses,fungi and yeast by recombination mapping techniques.
CO3: Predict the expression and regulation of genes inprokaryotes and eukaryotes
CO4: Get a conceptual knowledge of the genome sequencing projects, transcriptome, proteome and metabolomes ofdifferent organisms
CO5: Translate this knowledge for improvement of human health.

COURSE CONTENT

MODULE I: Genetic organization-DNA structure, Chemistry of nucleotides, organization of the poly nucleotide 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- currentconcept 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 anddeletion 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 cereviscea* - unordered tetrads, parentaland 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 geneexpression, 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: Classification of genomics, structural, functional and integrative genomics, Structural genomics-Sequence analysis, history of genome projects, gene families, genome assembly and annotation, human genome sequencing project; Functional genomics- transcriptome, proteome and metabolome. Microarrays and gene expression studies, Comparative genomics - basis of molecular evolution, nucleotide substitutions (synonymous and non- synonymous), functional and evolutionary relationships between prokaryotes and eukaryotes, orthologues and paralogues, phylogenetic tree; Pharmacogenomics-Genomic basis of rare diseases.

LEARNING RESOURCES:

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ONLINE RESOURCES

- Human Genome Project; http:// www.ornl.gov.
- Hugo: http:// ash. gene. ncl. ac .nk..
- DNA learning center: http://tor. cshl. org.
- Genome Databases: http:www. gdb. org.
- National Centre for Genome Resources. http://www. neg r. org.
- Washington Univ. Dept. of Genetics. http://www. genetics. wustl. edu.
- Genome Sequencing Center. http://genome. imb-jena. dc.
- https://swayam.gov.in/course/1391-human-molecular-genetics

Online Resource Table

Resource	Link	Description
National Center for Biotechnology Information (NCBI)	https://www.ncbi.nlm.nih.gov/	Provides extensive databases including GenBank, PubMed
European Bioinformatics Institute (EBI))	https://www.ebi.ac.uk/	Provides databases, bioinformatics tools, and resources for molecular biology and genetics research.
ExPASy - Swiss Institute of Bioinformatics	https://www.expasy.org/	Access to databases and tools for molecular biology and genetics research.
pubmed	https://pubmed.ncbi.nlm.nih.gov/	MEDLINE database of references and abstracts on life sciences and biomedical topics.

Model question paper
UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY
Second Semester M.Sc (CSS2) Degree Examination
Branch: Genetics and Plant Breeding
BOT-CC-521 MOLECULAR GENETICS

Time: 3hrs **Maximum marks: 60**

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. What is Pribnow box?
5. Can you explain the structure of a bacteriophage.
6. Define the concept of nuclear splicing.
7. Mention the role of DNA gyrase in DNA replication.
8. Why eukaryotes are called monocistronic and prokaryotes polycistronic?
9. An RNA is generated from the DNA. Name the phenomenon and who reported this phenomenon for the first time?
10. During the course of prokaryotic transcription, free core assembly of RNA polymerase was present. In this system, what will be the regulating factor to occur transcription inits maximum capacity?

(10X1= 10 marks)

II. Answer any *five* questions. Each answer not exceeding 150 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. Name the three nucleotide databases and their geographical locations? What is gene annotation?

(5X3= 15 marks)

III. Answer any *four* of the following. Each answer not exceeding 250 words

18. 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?
19. Explain the different mechanisms of genetic recombination in bacteria.
20. Describe various modes of mRNA splicing.
21. Describe the mechanism of transcription attenuation in the *trp* operon.
22. What are transcription factors? How do the transcription factors help in the process of transcription regulation?
23. What is phylogeny? Describe the different approaches in the preparation of a phylogenetic tree.
24. Describe the role of RNA interference (RNAi) in post-transcriptional gene regulation. Provide examples of how small RNAs (siRNAs and miRNAs) regulate gene expression.

(5X 5= 25 marks)

IV. Answer any *one* of the following not exceeding 500 words

25. What is genome sequencing? Write a historical account of the human genome sequencing project.
26. What is the genetic code? Enlist the important features of the genetic code. Explain the steps involved in gene translation in prokaryotes.

(1X 10=10 marks)

SEMESTER II	Course Code: BOT- CC- 522	Credits:3

NAME OF THE COURSE: CYTOGENETICS

COURSE OUTCOMES (CO)

CO1: Analyze the different types, origin and cytogenetic consequences ofstructural and numerical chromosomal variations in organisms.

CO2: Interpret the chromosomal variations through chromosome bandingtechniques

CO3: Comprehend the molecular features, types, genetic and evolutionary consequences of transposons in different organisms and their specific applications in crop breeding programmes.

CO4: Create awareness about human syndromes and remedy them through genetic counseling

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. Polyploidy: Types of euploids- autopolyploids- allopolyploids- segmental allopolyploid-, auto allopolyploids and agmatoploids – origin and cytogenetic basis of different types of polyploids – meiosis in polyploids (triploids and tetraploids), morphological- physiological and genetical characters of polyploids. Allopolyploids – genetic regulation of chromosome pairing-allopolyploidization of autopolyploids- genome analysis – genetic consequences – deviation segregation- aneuploids in allo-polyploids-identification of homologous chromosomes. Segmental allopolyploids- fertility – Higher polyploids- diplodization-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- Feulgen banding- silver banding (AG- NOR banding)- N- banding-Orcein banding. Nucleic acid hybridization: Fluorescence *In Situ* Hybridization (FISH)-

Genomic In Situ Hybridization (GISH)- *Multic*olor 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: Evolution of sex chromosomes- origin of the sex chromosome mechanisms; Sex chromatin: chromosomal and genetic mechanisms- 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.

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Online Resource Table

Resource	Link	Description
European Society of Human Genetics (ESHG)	https://www.eshg.org/	Lessons, videos
National Library of Medicine	https://ghr.nlm.nih.gov/primer#chromosomes	Information about the effects of genetic variation on human health, including cytogenetic disorders.
SWAYAM Government of India	https://swayam.gov.in/ https://youtu.be/qnqg_UvKQTs	Basic human genetics

Model question paper

UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY

Second Semester M.Sc. (CSS2) Degree Examination

Branch: Genetics and Plant Breeding

BOT-CC-522 CYTOGENETICS

Time: 3 hrs **Maximum 60 marks**

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

1. Which stain is used for G banding?
2. Name a congenital defect in man which is associated with aberration in sex chromosome?
3. What are nullisomics?
4. Name any four transposon-mediated molecular techniques
5. What is the term for the failure of chromosome pairs to separate properly during cell division?
6. How would you describe a condition where an organism has multiple sets of chromosomes from the same species?
7. What is the term used for the development of an organism from an unfertilized egg?
8. Can you explain the hypothesis proposed by Mary Lyon regarding X chromosome inactivation in females?
9. Which chromosomal aberration does cause pseudodominance?
10. Name the process in which a plant produces a gametophyte from a somatic cell without fertilization? **(10X1=10 marks)**

II. Answer any *five* questions. Each answer not exceeding 150 words

11. What are acrocentric trisomics?
12. Which chromosomal disorder is characterized by the presence of only one X chromosome in females, leading to specific physical and developmental features?
13. What is segmental alloploids?
14. What do you mean by translocation?
15. Give a short account on *'sry'* gene
16. How do the IS elements differ from the compositetransposons?
17. Describe the causes and symptoms of triple X syndrome **(5X3=15marks)**

III. Answer any *four* of the following. Each answer not exceeding 250 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 subsequently?
23. Explain C- value paradox
24. How can you identify the location of specific genes within a genome using labeled probes that bind to complementary DNA sequences? **(5X5=25 marks)**

IV. Answer any *one* of the following, not exceeding 500 words

25. What are inversions? Explain the meiotic behaviour of paracentric and pericentric inversion
26. Evaluate the impact of allopolyploidy on the breeding and improvement of crops, with specific examples of commercially important allopolyploid plants.

(1X10=10 marks)

SEMESTER II	Course Code: BOT- CC- 523	Credits: 3

NAME OF THE COURSE: PLANT BREEDING

COURSE OUTCOMES (CO)

CO1: Gain knowledge about the types of crops

CO2: Collect, conserve, evaluate and utilize crop germplasm

CO3: Get the skill in vegetative propagation methods and Hybridization techniques

CO4: Evaluate the types, genetics, biochemical and molecular basis of incompatibility and sterility between genotypes and devise methods to overcome them

CO5: Analyze the types of seeds and identify methods of seed processing and seed certification

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). Germplasm introduction, procedure, quarantine period, Phytosanitary certificate, plant quarantine check-implications of World Trade Organizations (WTO), Role of plant genetic resources in plant breeding, role of international agricultural research centers in plant genetic resource conservation (PGR)-national and regional PGR centers, PG database management, PBR, General Agreement on Trade and Tariff (GATT), Intellectual property rights, Trade Related Intellectual Property Rights (TRIPs).

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 genebanks, 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, soilless smart agriculture systems (SSAS),digital agriculture-roles in genetic conservation.

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. Transgressive segregation, Distant hybridization: History, barriersin 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. Mechanisms of uniparental genome elimination and modern methods of haploid production. 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, 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, Genetic male sterility-Cytoplasmic male sterility, Cytoplasmic 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 Transgenic male sterility- barnase/barstar system- male sterility through hormonal engineering, pollen self-destructive engineered male sterility, male sterility using pathogenesis-related protein genes, RNAi and male sterility, mitochondrial rearrangements for CMS, mtDNA recombination and cyto-nuclear interaction, regulation of CMS transcripts via RNA editing, accumulation of toxic protein products, chloroplast genome engineering for CMS, use of male sterility in plant breeding, male sterility and hybrid seed production, important CHAs (Chemical hybribizing agents), 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.

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Online Resource Table

Resource	Link	Description
Youtube	https://youtu.be/GpDbKfTLLzs	Activities in plant breeding.
	https://youtu.be/iyCIj1zaQQg	Self Incompatibility in plants

Model question paper
UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY
Second Semester M.Sc. (CSS2) Degree Examination
Branch: Genetics and Plant Breeding
BOT-CC- 523 PLANT BREEDING

Time: Three hours **Maximum marks: 60**

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

1. Define emasculation.
2. List 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. Define gene bank?
8. Define the term 'androgenic haploid'.
9. Explain gametophytic incompatibility
10. Differentiate between grafting and layering

(10X1= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Describe the selection procedure to produce a homozygous population in a crop?
12. What are the genetic consequences of crosspollination?
13. Give the features of a good chemical hybridizing agent.
14. Describe the propagation technique adopted to produce more plantlets from a mother plant.
15. Explain the genetics of floral heteromorphism in plants
16. Distinguish between single cross and double cross.
17. Briefly explain the features of gametophytic incompatibility

(5X3= 15 marks)

III. Answer any *four* of the following Each answer not exceeding 250 words

18. Explain the procedure of approach grafting
19. Discuss in detail about the procedure of transferring recessive genes by backcross method.
20. Homozygous rice plants can produce heterozygous progenies. Substantiate your answer.
21. Describe the various steps involved in plant introduction.
22. Briefly explain about different types of genetic male sterility.
23. Give an account on the various centers of origin of plants.
24. Differentiate between *in situ* and *ex-situ* germplasm conservation with examples.

(5X5= 25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. Give an account on various plant conservation methods.
26. Describe the method for the production of interspecific hybrids.

(1X10= 10 marks)

SEMESTER II	Course Code: BOT- CC- 524	Credits: 3

NAME OF THE COURSE: PLANT PHYSIOLOGY AND BIOCHEMISTRY

COURSE OUTCOMES (CO)

CO1: Gain knowledge on the chemical constitution, synthesis, storage, function and degradation of carbohydrates, proteins, enzymes, lipids, vitamins and hormones in plants.

CO2: Analyze the physiological and biochemical mechanisms of photosynthesis, respiration and nitrogen metabolism

CO3: Classify the plant secondary metabolites and decipher their application in pharmaceutical industries to manage human health

COURSE CONTENT

MODULE I: Photosynthesis and 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, C3 and C4 photosynthesis, conversion of C3 system into C4. Biochemical oxidation: Substrate of respiration, respiratory quotient, difference between respiratory quotient and photosynthetic quotient, Aerobic oxidation ofpyruvic 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. Cynanide resistant respiration. Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

MODULE II: Nitrogen Metabolism-General aspects of nitrogen economy; Nitrogen cycle, nitrate and nitrite reduction, denitrification, Non symbiotic and symbiotic N_2 fixation, Biological N_2 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. Chemoautrotrophy in rhizobia and nitrifying bacteria, Pathways of ammonia assimilation, biosynthesis of amino acids, reductive amination, transamination, GDH and GS/ GOGAT pathways.

MODULE III: Carbohydrates - General composition and properties- solubility, reducingand non-reducing optical isomerism, stereoisomerisms, mutarotation, Classification-Monosaccharides, their structure, occurrence, role, their derivatives by oxidation, reductionand 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 monosaccarides, pentose phosphate pathway and gluconeogenesis.

MODULE IV: 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, proteotype 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 V: Lipids, Vitamins and Hormones-Classification of lipids: triacylglycerols, waxes, phospholipids (membrane lipids), glycerolipids, glycolipids, sphingolipids, isoprenoids, carotenoids, steroids. Chemistry and structure of terpenes, (e.g. 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- and 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 VI: Secondary metabolites - Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis, major pathways of secondary-metabolite biosynthesis, Major types– terpenes, phenols, 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.

LEARNING RESOURCES:

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ONLINE RESOURCES:

- http://biology.jbpub.com/botany/4e/
- http://plantfacts.osu.edu/
- http://study.com/directory/category/Biological andBiomedical Sciences/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

Online Resource Table

Resource	Link	Description
National Mission on Education through ICT(NME-ICT) **e-PG Pathshala**	https://epgp.inflibnet.ac.in/Home https://youtu.be/7mA_fYqQIyk	Enzyme Structure
	https://epgp.inflibnet.ac.in/Home https://youtu.be/JlXJ_b8Qqpk	Models for Enzyme Action
	https://epgp.inflibnet.ac.in/Home https://youtu.be/mfTLMswoNH8	Enzyme Inhibition
	https://epgp.inflibnet.ac.in/Home https://youtu.be/2d0gmjz64CM	Enzyme compartmentalization in cells and tissues
	https://epgp.inflibnet.ac.in/Home https://youtu.be/OVHWLozJAxM	Applications of Enzyme
	https://youtu.be/NoLD2MVjpII	Lipids: An introduction
	https://youtu.be/S4FvelN7D5U	Fatty Acids
	https://youtu.be/krwUAGPLzFs	Phospholipids
	https://youtu.be/0hlRCDfvi3w	Glycolipids and Waxes
	https://youtu.be/VlFts0czkx8	Steroids
	https://youtu.be/IneAKOq2tAM	Lipid Soluble Vitamins
	https://youtu.be/FcyRP4jNBQM	Biomembranes I

Model Question Paper
DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA
Second Semester M.Sc. (CSS) Degree Examination
Branch: Genetics and Plant Breeding
BBC-CC-524 PLANT PHYSIOLOGY AND BIOCHEMISTRY

Time: 3 Hours **Maximum Marks: 60**

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

1. Define allelopathy.
2. If you provide a deciduous tree with extra auxin, it will not shed its leaves during winter. Why? Mention the consequence.
3. Some leaf molds secrete a chemical that causes guard cells to accumulate K. How does this help the mold infect the plant?
4. ……. are released at a site of infection that triggers the development of general resistance to pathogens.
5. Mention the class of enzyme which transfers a chemical group from one substance to another.
6. Give two examples of unsaturated fatty acids.
7. How do the nitrogen-fixing bacteria of root nodules benefit from their symbiotic relationship with plants?
8. Name the two pathways for synthesis of terpenoids.
9. What is a buffer?
10. A particular short-day plant wont flower in the spring. Suppose a short dark interruption splits the long-light period of spring into two short-light periods. What result do you predict?

(10X1=10 marks)

II. Answer any *five* questions. Each answer not exceeding 150 words.

11. Contrast the forces that move xylem sap with the forces that move phloem sap.
12. How do the roles of ubiquinone and cytochrome c differ from the other components of electron transport chain?
13. Discuss the function of amino acids.
14. Given that the function of egg yolk is to nourish and support the developing chick, explain why egg yolks are so high in fat, protein, and cholesterol.
15. Comment on enzyme commission number.
16. Point out the various applications of vernalization.
17. Although floral evocation occurs at the apical meristems of the shoots, some of the events that result in floral evocation are triggered by biochemical signals arriving at the apex from other parts, especially the leaves. Summarize the biochemical signaling involved in flowering.

(5X3= 15 marks)

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

18. Carbohydrates are the most abundant biomolecules on earth. How are carbohydrates classified?
19. Describe the structure of ATP synthase. Explain the chemiosmotic theory of ATP synthesis.
20. Give a detailed account on the regulation of enzyme activity.

21. Why do plant seedlings require the glyoxylate cycle and mention the action of the two key enzymes in the cycle.
22. Comment on the physiological response of plants to drought.
23. Illustrate and explain gluconeogenesis.
24. Proteins fold into stable three-dimensional shapes, or conformations, that are determined by their amino acid sequence. Discuss the four levels of protein structure.

(5X5= 25 marks)

IV. Answer any one of the following, not exceeding 500 words

25. "A major function of secondary metabolites in plants is protection against herbivory". Giving specific examples and evidence from plant-insect interactions, write an essay supporting the statement.
26. What is photorespiration? Prepare a schematic representation of photorespiration process. Add a note on significance of photorespiration.

(1X10= 10 marks)

SEMESTER II	Course Code: BOT- CC- 525	Credits: 4

NAME OF THE COURSE: PRACTICAL II

MODULE I: Aseptic transfer of micro-organisms for sub culturing, Isolation of discrete colonies from mixed cultures, Identifying and classifying the given micro-organisms, Serial dilution agar plate method to quantitative viable cells, Isolation of plasmid DNA from *E. coli* using alkaline lysis method, Production of enzymes using microorganisms, Antimicrobial screening and assays, Problems relevant to the modules.

MODULE II:

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

MODULE III:

I. Germplasm collection
   a. Cereals- Paady
   b. Vegetables- *Capsicum*
   c. Pulses- Green gram, Red Gram

II. Plant propagation
   I. Vegetative
      1. Layering: (1). Air layering (2). Mound layering
      2. Grafting
      3. Budding: T – budding (wild rose and H*ibiscus*)
   II. Apomixis
      1. Polyembryony: Mango seedlings
      2. Vivipary- *Alpinia* and grass

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

MODULE IV:

Incompatibility – Pollen viability test

In vitro

a. Brewbaker's medium preparation
b. Staining test in acetocarmine

In vivo

a. Pollen Germination on stigma
b. Pollen germination through style
c. Pollen germination through ovule

MODULE V:

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.
4. Qualitative Test for fats
    a. Sudan IV Test
    b. Formation of Acrolein from fat
5. Qualitative Tests for Biological Compounds
    a. Test for biological compounds in plant tissues
    b. Tests for the chemical nature of milk.
6. Calorimetric estimation of carbohydrates and proteins

MODULE VI:

I. Enzymes
    a. Demonstration of polyphenoloxidase in plant tissue.
    b. Action of invertase on sucrose.
    c. Effect of temperature on enzyme activity.
    d. Action of salivary enzyme on starch.
II. Photosynthesis Pigments
    Separation of the green and yellow pigments.

SEMESTER II	Course Code: BOT- DE- 526	Credits: 2

NAME OF THE COURSE: DIVERSITY IN CRYPTOGAMAE AND GYMNOSPERMAE

COURSE OUTCOMES (CO)

CO1: Exemplify the structure and classification of Algae, Fungi, Lichen, Bryophyta, Pteridophyta and Gymnospermae
CO2: Get knowledge in process of evolution, life cycle pattern, reproduction of Cryptogamae and Gymnospermae
CO3: Compare life cycles, morphological and anatomical variations indifferent Groups
CO4: Assess the economic, ecological and evolutionary significance of non flowering plants

COURSE CONTENT

MODULE I: Algae**-** Principles and modern trends in taxonomy of algae; Classification of Algae (Fritsch F. E. 1935). Salient features of major groups, economic importance of Algae, Structure, reproduction and life cycle of the following types: *Ulva, Nitella, Padina, Gracilaria.* Introduction to Blue Green Algae (Cyanobacteria), Classification of Cyanobacteria according to Desikachary (1959), economic importance. Structure, and reproduction of *Chroococcus,* and *Anabaena.*

MODULE II: Fungi- International Code of Nomenclature for algae, fungi and plants: Major changes in the Melbourne Code that will affect fungal nomenclature. Principles and modern trends of classification of Fungi- (Alexopoulosetal.1996); Classification of true fungi (down to the level of class) according to the current 'AFTOL' scheme (Hibbett et al. 2007); current taxonomic concepts regarding straminipilan fungi and protistan fungi. Salient features of major groups, the economic importance of Fungi. Thallus structure, reproduction and life cycle of the following types: *Phytophthora, Polyporus, Colletotrichum.*

MODULE III: Lichens **-**Classification, thallus structure, reproduction, ecological significance and economic importance of Lichens. Type study: *Parmelia.*

MODULE IV: Bryophyta**-** General characters and recent systems of classification (Shofield, 1985); salient features of major groups, economic importance of Bryophya. Life cycle study of the following types: *Cyathodium, Anthoceros, Polytrichum.*

MODULE V: Pteridophyta- General characters, Telome theory, classification (Bierhost, 1971) salient features of major groups, economic importance of Pteridophytes; Structure, reproduction and life cycle of the following types: *Angiopteris, Lygodium, Salvinia.*

MODULE VI: Gymnosperms-General characters and classification (Sporne, 1965); salient features of major groups, economic importance of Gymnosperms. Structure, reproduction and life cycle of the following types: *Araucaria, Podocarpus, Ephedra.*

LEARNING RESOURCES:

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ONLINE RESOURCES

- https://epgp.inflibnet.ac.in/

Model question paper

DEPARTMENT OF BOTANY

UNIVERSITY OF KERALA

Second Semester M.Sc. (CSS2) Degree Examination

Branch: Genetics and Plant Breeding

BOT-DE-526 Diversity in Cryptogamae and Gymnospermae

Time: Three hours **Maximum marks: 60**

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

1. Point out identifying features of Ascomycetes
2. Define epimatium
3. Differentiate between mycelium and Pseudomycelium
4. Write about male flower in *Ephedra*
5. What is a sporocarp?
6. Mention the ecological significance of *Salvinia*
7. Lichens are ecologically significant. Explain how?
8. What is protonema?
9. How can you identify *Padina* from a group of algae?
10. Define alternation of generation?

II. Answer any *five* questions. Each answers not exceeding 150 words

11. Explain how *Cyathodium* is reproduced.
12. Discuss the economic importance of *Gracilaria.*
13. Give an account on pathological significance of *Phytophthora*.
14. What is the function of heterocyst?
15. Gymnosperms are economically important. Substantiate the statement.
16. Explain heterospory and its significance.
17. Briefly explain asexual reproduction in *Lygodium*

(5X3= 15marks)

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

18. Explain telome theory.
19. Describe the salient features of major groups of Bryophyta.
20. Briefly explain the structure and reproduction in *Polyporus.*
21. Give an account on reproduction in *Polytrichum*
22. Explain the life cycle of *Anthoceros.*
23. Explain how Gymnosperms are classified?
24. *'Salvinia* can spread in a water body very fast. True or False? Give reasons for your answer.

(5X5= 25marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. Give an account on classification of algae.
26. Briefly explain anatomical structure, reproduction and life cycle of *Ephedra*.Mention economic importance.

(1X10= 10marks)

SEMESTER II	Course Code: BOT- DE- 527	Credits: 2

NAME OF THE COURSE: CLIMATE CHANGE AND ECOSYSTEM RESILIENCE
COURSE OUTCOMES (CO)

CO1: Gain knowledge in the basics of climate change and its impact
CO2: Familiarize the environmental issues related to climate change
CO3: Analyse the socio-economic impact of climate change
CO4: Assess different crop management strategies that mitigate the impact of climate change

COURSE CONTENT

MODULE I: Introduction to Climate Change- Greenhouse gases and alteration of climate. Abiotic changes and its consequences. Effects on biotic interactions: Responses of populations, species and ecosystems to climate change, the ozone layer and climate change.

MODULE II: Environmental issues of climate change- Effects of Global warming on aquatic and terrestrial ecosystem of India with particular reference to Western Ghats. Action plans to reverse the Climate Change**.**

MODULE III: Socio-economic aspects of climate change impacts: Environmental pollution and associated hazards to animals and humans.

MODULE IV: Ecology and its Relevance-Physical and social environment as factors of crop distribution and production. Agro ecology- cropping pattern as indicators of environment.

MODULE V: Impact of Climate Change in Agriculture-Impact on soil-soil microbial activity, soil moisture availability and soil degradation. Impact of climate change on soil productivity-increase in temperature, increase in CO_2.Effects of extreme climatic events on yield crops. Impacts of climate change on insects and pests.

MODULE VI: Impacts of Climate Change and Crop Management-Design of crop simulation models, Development of econometric models, Simulation studies for determining the need of agronomic practices in crop production. Role of Genetic engineering in raising stress tolerant crops as part of climate mitigation strategies. Crop ecosystem response to climate change with examples: Rice, Coconut, Tapioca, Cashew, Pulses, Rubber, Spices, Tea & Coffee.

LEARNING RESOURCES:
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Model Question Paper

DEPARTMENT OF BOTANY

UNIVERSITYOFKERALA

Second Semester M.Sc. (CSS2) Degree Examination

Branch: Genetics and Plant Breeding

BOT-DE-527 Climate Change & Ecosystem Resilience (Elective)

Time: Three hours **Maximum marks: 60**

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

1. Define ecosystem.
2. What is climate?
3. What is greenhouse effect?
4. What is global warming?
5. What is an aerosol?
6. How do clouds affect the Earth's climate?
7. What is agroecology?
8. What is a biological pump?
9. Define electromagnetic spectrum.
10. Expand CFC

(10x1= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Explain briefly the use of genetic engineering to develop stress resistant cultivar.
12. Enlist greenhouse gases and explain its effects.
13. What are the main indicators of climate change?
14. Describe the effects of global warming in the aquatic ecosystem
15. What are the components in the climate system?
16. Write a note on biotic interaction of global warming.
17. How is climate change related to soil productivity?

(5x3= 15 marks)

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

18. What are the remedial measures to reduce the harmful effects of climate change?
19. Briefly explain socio-economic aspects of climate change.
20. Describe briefly the components included in crop simulation studies.
21. Explain the impact of climate change in crop ecosystem response.
22. How do humans have a major impact on the climate change?
23. What is climate –smart agriculture?
24. "Climate change will have some good effects", Comment.

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. Write an essay on natural resources, their sustainable management and conservation?
26. Comment on environmental pollution and associated hazards to crops. Suggest some controlmeasures to override the detrimental effects of pollution.

(1X10= 10 marks)

SEMESTER III	Course Code: BOT- CC- 531	Credits: 3

NAME OF THE COURSE: GENETIC ENGINEERING

COURSE OUTCOMES (CO)

CO1: Identify the characteristics of vectors and their significance in the production of transgenic plants/animals
CO2: Outline the process in gene transfer technology
CO3: Analyse the process involved in animal and microbialbiotechnology
CO4: Discuss the production of industrially and pharmaceuticallyimportant compounds using recombinant DNA technology.
CO5: Get practical skills in Plasmid DNA isolation, plant DNA isolation, protein isolation and separation
CO6: Get the knowledge on the tools and techniques for molecularanalysis
CO7: Evaluate the ethical, legal and biosafety issues in geneticengineering

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, mRNA preparation, C-DNA synthesis. Nucleic acid cleanup, quality and purity considerations, downstream applications. Vectors- Plasmids, phages, cosmids, phasmids, corny bacterial plasmids, BAC vectors. *Agrobacterium* Ti and Ri plasmids, plant viruses and animal viruses-lentivirus; 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, *lac*Z gene, λcI 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, 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, SCoT, Single nucleotide polymorphisms (SNPs)- DNA sequencing-Maxam- Gilbert method, Sanger-Caulson method, Messey's shot gun method. Next generation sequencing-pyrosequencing, second generation DNA sequencing methods, third generation sequencing methods- single molecule sequencing (SMS) methods, Automated sequencing, DNA sequencer. RNA sequencing - Genotype by sequencing (GBS), DNA barcoding, RNAi, non-coding RNAs, transcriptome analysis. Protein engineering and proteome analysis- Objectives of protein engineering, Techniques of protein engineering, chemical modifications, applications of protein engineering, Site-directed mutagenesis & Error-prone PCR, Proteome analysis, 1D-2D electrophoresis, Maldi-TOF, LC-MS, Protein arrays and their applications.

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 -antibiotics, amino acids, organic acids, enzymes. Types of Fermentation, SSF, SmF, Fed-Batch Fermentations; Upstream and Down Stream processing. Applications in microbiology: biopolymers, biosurfactants and biopesticides. Probiotics, Prebiotics, Synbiotis& Problems of Antimicrobial resistance. Bioconversion processes-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.

LEARNING RESOURCES:

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ONLINE RESOURCES:

http://www.moef.nic.in

http://www.bch.cbd.int/database

http://www.ncbi.nlm.nih.gov

http://www.csu.edu.au

http://www2.le.ac.uk

https://swayam.gov.in

http://www.protocol- online.org

http://www.bioethics.net/ https://www.microbes.info/https://epgp.inflibnet.ac.in/

Online Resource Table

Resource	Link	Description
Genetic Literacy Project	https://geneticliteracyproject.org/	Resources on genetic engineering, biotechnology, and related topics.
e-PG Pathshala National Mission on Education through ICT(NME-ICT)	https://epgp.inflibnet.ac.in/Home https://youtu.be/jY-hCW1g8cc	*Agrobacterium tumefaciens* and *Agrobacterium rhizogenes* in genetic engineering
	https://epgp.inflibnet.ac.in/Home https://youtu.be/3655sKQEggs	Choice of promoters for targeted expression of transgene, synthetic promoters
	https://epgp.inflibnet.ac.in/Home https://youtu.be/Em1-mctJsfs	Co-integrate and binary vectors
	https://epgp.inflibnet.ac.in/Home https://youtu.be/q5K_WLhhwLg	Direct gene transfer strategies
	https://epgp.inflibnet.ac.in/Home https://youtu.be/JJXCRVKYC7A	Host genes in entry and integration of T-DNA
	https://epgp.inflibnet.ac.in/Home https://youtu.be/ILH9bkE4QhE	Selectable and Screenable Markers
	https://epgp.inflibnet.ac.in/Home https://youtu.be/Oq8jZkLVGDQ	Strategies for the development of marker-free transgenics
	https://epgp.inflibnet.ac.in/Home https://youtu.be/x7mXe6cQNN4	Techniques used for analysis of transgenics
	https://epgp.inflibnet.ac.in/Home https://youtu.be/0NnaZceEuBw	Tools for genetic engineering – REs, ligases, kinases. phosphatases, topoisomerases
	https://epgp.inflibnet.ac.in/Home https://youtu.be/PW798deDIZM	Use of RNAi as tool for crop improvement

Model question paper

UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY

Third Semester M.Sc. (CSS3) Degree Examination

Branch: Genetics and Plant Breeding

BOT-CC-531 GENETIC ENGINEERING

Time: Three hrs. **Maximum marks: 60 marks**

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. Mention the use of ddNTPs.
5. How will you calculate minimum number of clones required to construct genomic library of an organism?
6. Suggest a method to precisely induce mutation in a particular site of the genome
7. What is the utility of lyophilization?
8. In what scenarios would micro-injection be an effective technique, and why?
9. Give the expansion of the term AFLP
10. Could you mention the concept of bioleaching

(10X1=10 marks)

II. Answer any *five* questions. Each answer not exceeding 150 words

11. What is the difference between Hybrid selected translation and Hybrid arrested translation?
12. You are provided a collection different clone bearing 20 kb fragments of genomic DNA. To sequentially arrange these clones which method you will use. Write principle with the help of suitable schematic diagram
13. Explain the CTAB method for the isolation of plant genomic DNA
14. How can PCR be used in forensic investigations to analyze DNA evidence and establish genetic profiles for identification purposes?
15. Enlist the basic requirements of gene cloning and expression vectors. Illustrate the characteristic features of any one vector of your choice.
16. What is ELISA? How is this analytical technique used in identification of the recombinant clone?
17. Describe the process of 'insertional inactivation' using the blue white screening method.

(5X3=15 marks)

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

18. Explain the steps involved in the construction of a genomic DNA library. Howdoes it differ from a cDNA library?
19. Define chromosome jumping. Explain process involved in chromosome jumping
20. Give a short note on the bioconversion processes using microbial transformation
21. Enlist objectives of protein engineering
22. Discuss the utility of microarrays in gene expression studies
23. Discuss the importance of understanding restriction enzyme properties, such as cleavage sites and enzyme specificity, in designing effective molecular cloning experiments and genetic engineering projects.

24. Explain the importance of microbial biotechnology in the production of probiotics and their potential health benefits, highlighting key considerations in selecting probiotic strains for commercial use.

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. Discuss the advances made in genetic engineering studies in the past decade
26. Explain the production of transgenic organisms, detailing the methodologies involved, ethical considerations, potential applications across various fields, and the impact of recent advancements in genetic engineering technologies on this process.

(1X10= 10 marks)

SEMESTER III	Course Code: BOT- CC- 532	Credits: 3

NAME OF THE COURSE: PLANT BIOTECHNOLOGY

COURSE OUTCOMES (CO)

CO1: Describe the techniques and types of plant tissue culture
CO2: Analyse the application of tissue culture in secondary metabolite production
CO3: Gain practical skills in the preparation of tissue culture and *invitro* culture technique
CO4: Apply cryopreservation technique as a strategy for the conservation of rare, endangered and threatened plants

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, diplodisation, Uses of haploids in plant breeding, gynogenichaploids, 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 andcharacterization 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 andvectorless mediated gene transfer, application of transgenic plants, transgenic plants for crop improvement (dicots and monocots), Insect resistance, resistance to virus, resistanceto 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, biosaftynorms and controlled field trials and release of transgenics**.**

MODULE VI: Germplasm Storage and Cryopreservation - Conservation Biotechnology
- Eco- restoration Conservation of germplasm, *In vitro* strategies, short, medium and longterm (cryopreservation) preservation application, techniques of cryopreservation, choice of material, preculture, cryprotection, 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.

LEARNING RESOURCES:

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ONLINE RESOURCES: VIDEO LINK

https://www.khanacademy.org/science/high-school-biology/hs-molecular- genetics/hs- biotechnology/v/introduction-to-genetic-engineering

https://swayam.gov.in/nd1_noc19_bt15/...(https://www.youtube.com/watch?v=Yh9w_fy vpUk)

Model question paper
UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY
Third Semester M.Sc. (CSS) Degree Examination
Genetics and Plant Breeding
BOT-CC-532 PLANT BIOTECHNOLOGY

Time: **3 hours** Maximum marks: **60**

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

1. *Agrobacterium* is known as natural genetic Engineer. Can you name two of its species.
2. Hope you can draw a simple diagram of a gene construct (starting from promoter) for producing a transgenic plant.
3. Mention desirable properties of a gelling agent used in tissue culture.
4. How will you produce fertile homozygous diploids from sexually sterile haploid plants obtained through pollen culture?
5. Name the father of plant tissue culture.
6. Is there any significance for pH of plant tissue culture medium? If yes, mention it.
7. Internodal elongation of in vitro plants can be achieved by supplementing ……. to the culture medium.
8. Expand HEPA filter.
9. Specify the plant growth regulator which releases the axillary buds from apical dominance during nodal culture.
10. Name a commonly used surface sterilant in plant tissue culture. Why explant surface Sterilization is a sensitive step in tissue culture.

(10X1= 10 marks)

II. Answer any *five* questions. Each answer not exceeding 150 words

11. *Bacillus thuringiensis* is a bacterium that is pathogenic for many insect pests. What is its role in Genetic Engineering?
12. Differentiate close continuous culture and open continuous culture.
13. Sucrose, is a very important constituent of plant tissue culture media. Suppose you forgot to add sucrose while preparing media for micropropagation. How will it affect the growth of the explant?
14. 'Immobilizing the cells creates a new set of options for the plant biotechnologist to explore.' Comment.
15. Specify how embryo rescue helps in crop improvement.
16. Mention the different stages of micropropagation.
17. Write a short account on any two types of bioreactors.

(5X3= 15 marks)

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

18. There are vector mediated and vector-less gene transfer methods. Discuss the vector-less gene transfer methods in plants.
19. Somatic hybridization is a technique that has been used to tap the potential of related or distant species/genera of crops for creating novel combinations of nuclear and/or cytoplasmic genomes. Schematically represent the steps involved in the technique.
20. Prepare a protocol for production of synthetic seeds.
21. Briefly explain the composition of Murashige and Skoog media.

22. Pests and pathogens cause economic losses to agricultural and horticulural crops. A good amount of this damage iscaused by virus infections. Can you suggest some *in vitro*strategies for production of virus-free plants?
23. Citing suitable examples, explain the role of elicitors in *in vitro* secondary metabolite production.
24. Give a brief account on the construction of a typical plant tissue culture laboratory.

(5X5= 25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. There is a never ending controversy on Terminator genes. Briefly explain it.
26. Reduction of frequency of subcultures to a bare minimum is a basic requirement for the practical feasibility of plant tissue culture method in the preservation of germplasm. Mention the technique employed for the long term preservation of plant germplasm in which the cells can be stored for unlimited period without a subculture. Enumerate the steps involved in the technique.

(10X1= 10 marks)

SEMESTER III	Course Code: BOT- CC- 533	Credits: 3

NAME OF THE COURSE: **BIOSYSTEMATICS**

COURSE OUTCOMES (CO)

CO1: Analyze systems of plant nomenclature and plant classificationCO2 : Familiar with common botanic garden and herbarium
CO3: Apply various tools – morphological, anatomical, phytochemical and molecular characters for solving taxonomic problems.
CO4: Assess various tools that can be used for more accurate systematization ofplant kingdom.
CO5: Get familiarized with common plants in the adjacent localities, use suitabletools in the plant identification and preservation through herbarium
CO6: Develop skill in identification of plants

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 numen 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 -Papilonaceae, 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, Rubiaceace, 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*, Nymphaceae- 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 cytogeography.

LEARNING RESOURCES:

REFERENCES

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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-CC-533 BIOSYSTEMATICS

Time: 3hrs **Maximum 60 marks**

I. Answer all questions in one word or sentence

1. Define genome
2. Expand ELISA
3. What is cryptic structural polyploidy?
4. What is nexine?
5. What do you mean by stenopalynous?
6. Define amphimixis.
7. Explain phenetics
8. Define molecular systematics
9. What is a cytotype?
10. Define semantides? (1**0x1=10marks)**

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Discuss the application of serotaxonomy.
12. Explain cluster analysis.
13. Differentiate between orthotropous and amphitropous ovule.
14. Describe the structure of ITS.
15. List out the applications of molecular systematics.
16. What does the author citation indicates in the binomial *Ipomoea purpurea* (L.) Roth.
17. State the differences between reticulate and psilate type of ornamentation.

(5x3=15 marks)

III. Answer any *five* of the following. Each answer not exceeding 250 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. Analyse the major embryological characters used in plant taxonomy?
23. What are taxonomic keys? How will you prepare key for taxa based on morphological characters giving emphasis to trichomes?
24. Substantiate the limitations of Ribosomal RNA as a phylogenetic tool with suitable examples.

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

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

(1X10=10 marks)

SEMESTER III	Course Code: BOT- CC- 534	Credits: 4

NAME OF THE COURSE: MODERN METHODS IN CROP BREEDING

COURSE OUTCOMES (CO)

CO1 : List out various breeding methods and their applications in theimprovement of crops

CO2 : Suggest the breeding methods to be adopted to produce biotic andabiotic stress resistant varieties

CO3 : Compare the method of production of hybrids and synthetic varieties

CO4 : Discuss the applications of mutation breeding polyploidy breeding and ideotype breeding in crop improvement

CO5 : Identify various types of plant diseases, their pathogen and mode ofproduction of resistant varieties

CO6 : Analyse the evolution of selected crops on the basis of cytogenetics

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, maintenance breeding and variety release-breeders trial, crop registration, cultivar/variety maintenance, DUS testing (Distinctness, uniformity, stability).

MODULE III: Mutation Breeding: Introduction –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, effects of mutation, 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. 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. Synthetic allopolyploids.

Aneuploidy- Origin and production, 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, 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), Bulked Segregant Analysis (BSA), Near –Isogenic Lines (NILs), Mapping disease resistance genes, Mapping Quantitative trait Loci (QTLs) Application of molecular markers. Molecular marker assisted breeding, Next generation molecular breeding, New systems biology, Precision agriculture-technologies, role of robots and AI in agriculture.

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	*Nicotiana*
7. Vegetables	*Allium*, Tomato
8. Oil yielding	*Brassica*, *Arachis*
9. Pulses	V*igna*
10. Beverages	Coffee, Tea

LEARNING RESOURCES:

REFERENCES

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ADDITIONAL REFERENCES

- Journal - Taxon
- Journal- Plant Systematics and Evolution
- Journal- Rheedia

Online Resource Table

Resource	Link	Description
Food and Agriculture Organization (FAO	http://www.fao.org/3/I9500EN/i9500en.pdf	Modern crop breeding methods and their implications for global food security.
Crop Science Society of America (CSSA):	https://www.crops.org/	Crop breeding techniques, research articles, and educational materials.
American Society of Agronomy (ASA):	https://www.agronomy.org/	Crop genetics, breeding methods, and agricultural sustainability.
International Maize and Wheat Improvement Center (CIMMYT):	https://www.cimmyt.org/	Focuses on improving maize and wheat through innovative breeding techniques.
European Plant Science Organisation (EPSO):	https://www.epsoweb.org/	Resources on plant science, including crop breeding technologies and developments.

Model Question Paper

UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY

Third Semester M.Sc (CSS3) Degree Examination

Branch: Genetics and Plant Breeding

BOT-CC-534 MODERN METHODS IN CROP BREEDING

Time: Three hours **Maximum marks: 60**

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

1. What is nullisomic?
2. What do you mean by spontaneous mutation?
3. Define ideotype and give an example of its application in crop improvement.
4. Describe how luxuriance can be utilized to enhance agricultural productivity.
5. Define vertical resistance
6. Provide an example of autopolyploidy in plants.
7. What is meant by double cross hybrid?
8. What is lathyrism?
9. Name a non-ionizing radiation which causes mutation.
10. Define trait analysis **(10X1=10 marks)**

II. **Answer any *five* questions. Each answer not exceeding 150 words**

11. What are the sources used in salinity resistance breeding approach?
12. Describe the characteristics of crop ideotype
13. Describe the role of hypersensitivity in plant breeding.
14. Explain the concept of mitochondrial complementation.
15. Describe the method of bulked segregant analysis?
16. Briefly describe the origin of rice
17. Distinguish between hybrid and synthetic varieties

(5X3=15 marks)

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

18. Describe the breeding method to be adopted to produce disease resistant variety
19. Discuss the role of self-incompatibility in hybrid seed production
20. Distinguish between dominance and over dominance hypothesis
21. Describe the steps involved in developing an ideotype for a specific crop. Discuss the challenges that breeders may face during this process and how they can be overcome?
22. Explain the genetics of pathogenicity and discuss how understanding these genetic mechanisms can aid in developing disease-resistant crops.
23. Briefly describe the morphological and cytological changes observed in polyploids
24. Compare and contrast missense, nonsense, and silent mutations.

(5X5=25 marks)

II. Answer any *one* of the following, not exceeding 500 words

25. What are mutagens? Briefly explain the procedure of mutation breeding. Discuss its application in crop improvement
26. Discuss the significance of cytogenetics in the evolution of wheat.

(1X10= 10 marks)

SEMESTER III	Course Code: BOT- CC- 535	Credits: 4

NAME OF THE COURSE: PRACTICAL III

MODULE I:

1. Genomic DNA isolation from plant tissues by CTAB method.
2. Isolation of proteins from plant tissue samples
3. ISSR PCR
4. Electrophoresis: Separation of DNA
5. SDS PAGE for proteins.
6. Primer design and PCR
7. Cloning and Expression in *E.coli*, Plasmid isolation, Restriction digestion, Ligation, transformation, Agarose gel electrophoresis.
8. Protein analysis: Protein quantification, SDS-PAGE, Coomassie & Silver staining
9. Problems related to above topics

MODULE II:

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 (*Spathoglotis plicata*).
9. Protoplast isolation by enzymatic method
10. Anther culture

MODULE III: Preparation of herbarium and identification of plants belonging to the followingfamilies (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

MODULE IV:

1. **Heterosis Breeding**

i). Pepper

Uthirankotta X Cheriakaniakkaden

↓

Panniyur

ii). Maize cob

iii). Sorghum

MODULE V:

1. Mutation breeding

i. *Capsicum* seed treated with chemicals. Drawings of control & treated seedlingsshowing morphological variations
ii. Demonstration for mutation breeding– sunflower, tapioca

2. Polyploidy breeding

a. Autopolyploids- colchicines treatment – *Capsicum* seed and seedling
b. Polyploids
c. Evolutionary chart of the following crops
   i. Wheat – *Triticum aestivum*
   ii. Triticale
   iii. Cotton
   iv. *Nicotiana, Brassica*

MODULE VI*:*

I. **Ideotype:**- Rice
II. **Disease resistance:** Identification of plant diseases and their pathogen– viral, bacterialand fungal diseases
III. **Crops:** Description on taxonomy, cytogenetics and evolution of all the abovementioned crops.

SEMESTER III	Course Code: BOT- DE- 536	Credits: 2

NAME OF THE COURSE: BIOINFORMATICS

COURSE OUTCOMES (CO)

CO1: Develop technical skills to retrieve and submit nucleic acid sequence data, align them and identify sequence similarities
CO2: Analyze the bioinformatic resources in the public domain forderiving phylogenetic relationships
CO3: Predict gene and protein structure and study drug interactions.

COURSE CONTENT

MODULE I: Introduction to Bioinformatics, Definition, Terminology, Applications: Biotechnology and Pharmaceutical industry, Business, Employment opportunities, Journals in Bioinformatics

MODULE II: Bioinformatics resources –NCBI, NCBI data model, File formats-FASTA,PIR Format, Biological databases- Organism, Sequence (Primary and Secondary, Nucleotide and Protein), Structure and Mapping databases; Biological data-mining, Information retrieval-Entrez; Submitting sequences-Sequin; Biomarker up languages-HTML, XML, Bio-Programming languages

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

MODULE IV: Secondary databases of functional domains - Structure analysis tools-RASMOL, PYMOL, Tools at Ex Pasy–Motifs and patterns PROSITE, Pfam, Protein sequence analysis tools- PEPTOOL, Predictive methods, Protein Identity based on composition, Physical properties Based on Sequences, Secondary structure analysis – PSIPRED, SOPMA, GORIV, Protein Structure Prediction: Homology modeling and Ab initio, Protein structure validation.

MODULE V: Phylogenetic analysis-Sequence similarity searches - Comparing nucleotide and amino acid sequences - Distance metrics. Similarity and homology. Scoring matrices. Methods of sequence alignment- Nucleotide BLAST, Protein BLAST, PSI-BLAST, Pairwise and Multiple sequence alignments, Methods of phylogenetic analysis: UPGMA, WPGMA, Neighbour joining method, Fitch/Margoliash method, Character Based Methods Molecular phylogenetic programmes. CLUSTAL, MEGA,PHYLIP, PAUP, PHASE, TREEVIEW.

MODULE VI: Scope and applications of in silico modeling in modern biology**.** Pharmacogenomics and drug designing, admit properties and toxicity, and drug designing tools- Auto doc Vina, Pirex, Schrodinger.

LEARNING RESOURCES:

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Online Resource Table

Resource	Link	Description
National Mission on Education through ICT(NME-ICT) **e-PG Pathshala**	https://epgp.inflibnet.ac.in/Home **https://youtu.be/AApGrb8Fh9U**	Overview of Bioinformatics
	https://epgp.inflibnet.ac.in/Home **https://youtu.be/3v3DkA3XlVs**	Molecular Database Concepts
	https://epgp.inflibnet.ac.in/Home https://youtu.be/xFRhptX4DcI	Molecular Sequence Databases
	https://epgp.inflibnet.ac.in/Home **https://youtu.be/EztZSegmjcM**	Basic Local Alignment Search Tool - BLAST

Model question paper

DEPARTMENT OF BOTANY

UNIVERSITY OF KERALA

Second Semester M.Sc. (CSS2) Degree Examination

Branch: Genetics and Plant Breeding

BOT –DE-525 BIOINFORMATICS

Time: Three hours **Maximum marks: 60**

I. Answer all questions in one word or sentence

1. Expand the term _PHYLIP
2. Name one gene prediction program.
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. What is a FASTA format?
10. Name the different versions of CLUSTAL. **(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 utility of 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 topredict 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?

(5X5 = 25 marks)

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

24. Highlight the importance of sequence analysis in biological research. Add anote on molecular phylogeny. Describe the operation of CLUSTAL in phylogenetic analysis
25. Describe the process of computer aided drug-designing and molecular dockingExplain the role of ARGUS Lab in drug-designing

(1X10=10 marks)

SEMESTER III	Course Code: BOT- DE- 537	Credits: 2

NAME OF THE COURSE: PHYTOCHEMISTRY

COURSE OUTCOMES (CO)

CO1 : Identify and classify the various phytochemicals CO2 : Discuss the methods of phytochemical extraction

CO3 : Compile the applications of phytochemicals in pharmacology, nutraceuticaland cosmetic development

CO4 : Analyse phytochemical data bases

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 Lilieaceae, 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.

LEARNING RESOURCES:

REFERENCES

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secondary products. Imperial College Press and World Scientific Publishing Co. Pvt. Ltd. London.

Online Resource Table

Resource	Link	Description
Phytochemical Society of Europe**:**	https://www.phytochemicalsociety.org/	Resources on phytochemistry, including publications and information on conferences.

Model question paper

UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY

Third Semester M.Sc. (CSS1) Degree Examination

Branch: Genetics and Plant Breeding

BOT- DE- 537 PHYTOCHEMISTRY

Time: Three hours **Maximum marks: 60**

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

1. What class of plant chemicals includes compounds like limonene and menthol?
2. Mention the main purpose of HPLC in analytical chemistry?
3. Name a hydrosol.
4. What does NMR stand for in analytical chemistry?
5. Give an example for tannin.
6. Name a common source of dietary phytoestrogens.
7. In the context of plant secondary metabolites, which class includes compounds like saponins and steroids, often involved in signaling and defense.
8. Which class of compounds does caffeine belongs to?
9. Name a Phytochemical database
10. Key phytochemical found in turmeric shows potential for cancer prevention. Name the Phytochemical.

(10X1=10 marks)

II. Answer **any *five* questions. Each answer not exceeding 150 words**

11. Identify two plants from the Umbelliferae family used in cosmetics and describe their properties.
12. How do the secondary metabolites help in plant defence? Describe the role of phytoalexins during plant infections
13. Discuss the application of bioinformatics in drug designing
14. Give a short note on biosynthesis of terpenoids
15. What is green tea? The consumption of green tea is considered beneficial. Justify
16. Briefly describe the classification of secondary metabolites
17. What are nutraceuticals? Discuss their role in disease prevention

(5X3=15 marks)

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

18. Discuss the role of flavonoids in disease prevention and give two examples of diseases they may help prevent.
19. Discuss the utility of new generation hyphenated techniques in the area of natural product chemistry
20. Discuss the environmental and health impacts of using plant toxins in medicine.
21. Describe the application of spectroscopic techniques in the characterization of plant secondary metabolites
22. Enlist the chromatographic techniques used for the isolation of phytochemicals
23. What are essential oils? Explain the process of essential oil extraction
24. Analyze the role of biotechnology in the production of phytochemicals. Discuss methods like genetic engineering and plant cell culture for producing pharmaceuticals and industrial enzymes.

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 500 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- CC- 541	Credits: 3

NAME OF THE COURSE: POPULATION & EVOLUTIONARY GENETICS
COURSE OUTCOMES (CO)

CO1: Gain knowledge on the gene frequency, changes in gene frequency and their consequences in the genetics of populations using Hardy Weinberg law.
CO2: Analyze the factors affecting the gene frequencies in populations and their impacts
CO3: Explain the process of species evolution and molecular conceptsCO4 : Identify factors affecting gene frequencies
CO5: Analyze the importance of population gene frequencies in driving theprocess of evolution.
CO6: Explain the increased incidence of lethal hereditary diseases inconsanguineous populations.

COURSE CONTENT

MODULE I: Population Genetics-Definition, Historical account and Terminology, Genetic Constitution of Mendelian Populations, Concept of Gene and genotype frequencies, Genetic transmission in Populations; Genetic polymorphisms.

MODULE II: Hardy-Weinberg principle, Equilibrium conditions, Assumptions, predictions and derivation of Hardy-Weinberg Equation; Systems of Mating, Random mating, Non – random mating; Calculating gene and genotype frequencies for – codominant alleles, dominant-recessive alleles, autosomal loci with multiple alleles and blood types; sex-linked alleles – X-linked codominant and dominant-recessive alleles; sex-influenced traits; Attainment of Genetic equilibrium for autosomal alleles and sex-linked alleles; Major and minor properties of Hardy-Weinberg Principle.

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 allelism
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.

LEARNING RESOURCES:

REFERENCES

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Online resource table

Resource	Link	Description
National Center for Biotechnology Information (NCBI)	https://www.ncbi.nlm.nih.gov/guide/genetics-molecular-biology/	Provides databases, tools, and resources for genetic research, including population genetics studies.

Model question paper

UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY
Fourth Semester M.Sc. (CSS 4) Degree Examination
Branch: Genetics and Plant Breeding
BOT-CC – 541 POPULATION & EVOLUTIONARY GENETICS

Time: 3 hrs **Maximum 60 marks**

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

1. Name one factor that can disrupt Hardy-Weinberg equilibrium.
2. What is chi- square test?
3. How is degrees of freedom‘calculated?
4. Define the term species
5. What is positive nonrandom mating?
6. A student is confused with the term peripatric speciation. Can you help him?
7. Give two examples of convergent evolution.
8. Define consanguinity.
9. When studying a species' genetic diversity, what term describes the number of individuals whose genetic makeup reflects that of the entire population?
10. Name the type of mutation that occurs only once in the lineage and does not reappear in future generations.

(10X1=10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 words

11. Explain mutation selection balance
12. What genetic concept is used to measure the probability of genetic diseases being expressed in offspring from consanguineous marriages?
13. Provide an example of a sex-influenced trait and describe how it manifests differently in males and females.
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 forcodominant and dominant recessive autosomal loci
17. How does recurrent mutation affect gene frequency in a random mating population?

(5X3=15 marks)

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

18. How does migration change gene frequency in a random mating population, ifthe migration is recurrent? What will be the difference in gene frequency betweena donor and a recipient population after sixth generation of migration whencompared to first generation?
19. Describe the different modes of speciation
20. Describe the consequence of gene erosion and its remedies
21. Define inbreeding coefficient. What are the major genetic effects of inbreeding?
22. Write an account on origin and evolution of humans.
23. The molecular clock has become an essential tool in many areas of evolutionary biology, including systematics, molecular ecology, and conservation genetics. Discuss

the role of molecular clocks in estimating species divergence.

24. Describe how the founder effect differs from genetic drift and give an example of each.

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. Explain the role of Hardy-Weinberg equilibrium in studying human genetic variation and evolutionary relationships.
26. Describe gametic selection and zygotic selection and their effects in populations

(1X10=10marks)

SEMESTER IV	Course Code: BOT- CC- 542	Credits: 3

NAME OF THE COURSE: DEVELOPMENTAL GENETICS

COURSE OUTCOMES (CO)

CO1: Gain knowledge on genetic and molecular basis of cell differentiation and development in model organisms.
CO2: Recognize significance of cell signaling mechanism and its importance in immunological response
CO3: Analyze various theories of ageing and identification of factors accelerating ageing
CO4: List out the reasons, and discuss molecular and genetic factors in tumour development and progression
CO5: Identify various types of carcinogens and its action

COURSE CONTENT

MODULE I: Cell differentiation, growth and development- Basic concepts ofdevelopment- 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, Types of Cell surface receptors, G protein coupled receptors, Signal transduction pathways- ras/map kinase pathway, phosphoinositide pathway, receptor serine kinases, secondary signal molecules, second messengers, calcium signaling, two component regulatory systems, bacterial chemotaxis, quorum sensing and quorum sensingdisruptors. Immunology- Structure and function of different classes of immuno- globulins, Monoclonal antibodies, 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 – *Synecchococcus, 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, Telomease, Wear and tear theories. Differencebetween necrosis and apoptosis-Processes, pathways and proteins involved in apoptosis regulation- Factors and signals inducing cell death.

MODULE V: Regulation of Cancer-Tumourogenesis in plants- Characteristics of CrownGall 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, Chromosomes in malignant diseases in man. altered metabolism in cancer. 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. Molecular Tools for screening and diagnosis of human diseases – Prenatal Diagnosis of Genetic Disorders and Congenital Defects, Somatic Chromosome mutation, environmental carcinogenesis.

MODULE VI: Mutation detection systems: Specific locus test, Ames test, *ClB* 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. Gene and environmental interactions, Environmental influences in gene expression. Human mutations- Understanding of mutations in Humans, ABO blood types, Muscular Dystrophy, Fragile X syndrome, Huntington's disease, Xeroderma pigmentosum. Knock out mutations and transgenes, *cre*/*lox* system for targeted deletion of gene. Environmental genomics, Epigenetics and Environment.

LEARNING RESOURCES:

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ONLINE RESOURCES:

- http://evolution.berkeley.edu
- www.benbest.com
- http://labs.biology.ucsd.edu
- www.mdpi.com
- http://advances.sciencemag.org
- http://mcb.asm.org
- www.dnalc.org
- https://swayam.gov.in
- https://epgp.inflibnet.ac.in/

Online Resource Table

Resource	Link	Description
National Institute of General Medical Sciences (NIGMS):	https://www.nigms.nih.gov/	Offers research funding and resources on developmental genetics and biology.

Model question paper

UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY
Fourth Semester M.Sc. (CSS 4) Degree Examination
Branch: Genetics and Plant Breeding
BOT-CC-542 DEVELOPMENTAL GENETICS

Time: Three hours **Maximum marks: 60**

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

1. How might a scientist investigate if a species undergoes senescence?
2. How does the Zeitgeber light influence the sleep-wake cycle.
3. Explain the term free-running period
4. Which biological rhythm governs the timing of seasonal behaviors in animals?
5. Define E-box
6. What are NIH3T3 and He La cell lines?
7. _____ is an example of a growth factor, while _____ is an example of a receptor for that growth factor.
8. Give the role of SOD in aging
9. Provide an example of natural immunity.
10. Mention the primary function of MHC molecules in the immune system.

(10X1= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 words

11. Define tumour suppressor gene. What are the important activities if p53? Explain
12. Give an example of DNA tumour virus. Describe its structure, genomicorganization and involvement in tumour formation
13. Write role of g*ap* gene in development
14. Give the relation between the rhythmic bioluminescence in *Gonyaulax* to light signals
15. What are the effects of maternal genes in the development of *Drosophila*?
16. Identify the theory of aging that involves genetic programming and give a brief explanation.
17. Compare necrosis and apoptosis in terms of their causes and cellular outcomes.

(5X3= 15 marks)

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

18. Why *Sxl* gene considered to be the master-switch in the sex determination of *Drosophila mealnogaster*
19. Discuss the genetic impact in *Caenorrhabditis elegans* sex determination
20. Explain the genetics of circadian clock mechanism in insects
21. How do mutations in the ABC genes affect flower development? Provide an example of a mutation's effect.
22. The immune system is considered to be most appropriate model system forstudying the cellular and molecular mechanism of aging. Explain
23. Explain types, disease syndrome and cytogenetics of xeroderma pigmentosum
24. With the help of schematic representation explain nuclear excision repair mechanism

(5X5= 25 marks)

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

25. 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
26. Explain the mechanisms of signal transduction pathways and their role in cellular communication**.**

(1X10= 10marks)

SEMESTER IV	Course Code: BOT- CC- 543	Credits: 3

NAME OF THE COURSE: ECOLOGY AND CONSERVATION BIOLOGY

COURSE OUTCOMES (CO)

CO1: Gain knowledge on ecological concepts such as population dynamics, community interactions, and ecosystem functions.

CO2: Analyze the distribution of climates and ecosystems.

CO3: Recognize the value of biodiversity.

CO4: Evaluate strategies for biodiversity conservation.

CO5: Recognize the importance of international conventions and treaties on nature and conservation.

MODULE I: Introduction to Ecology: Definitions, Principles of Ecology- Levels of organization and habitat- interaction between environment and biota. Application of Law of thermodynamics, food chain, food web, trophic levels, ecological pyramids and recycling - energy flow and transaction. Productivity and Biogeochemical cycles. Ecosystem Ecology: Ecosystem structure; ecosystem function; ecosystem services; energy flow and mineral cycling (C, N, P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

MODULE II: Population Ecology: Characteristics of a population- population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations. Concept of carrying capacity, Population fluctuation and regulation. Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edge effect and ecotone. Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. Ecological interactions - interspecific competition, herbivory, carnivory, Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predatism, competition – intra-specific and inter- specific; Ecological and environmental significance of interactions.

MODULE III: Study of climate- their distribution and adaptation to the environment. Deserts (dry and cold) Tundra, Grassland, Savannah, Temperate forests, Tropical rain forests, Mangrove Ecological concepts of species: Autecological level (genecology), Synecological level. Ecads (Ecophenes), Ecotypes, Ecospecies. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax.

MODULE IV: Applied Ecology Environmental pollution; global environmental change; biodiversity: major drivers of biodiversity change; status, monitoring, and documentation; biodiversity management approaches. Current environmental issues in India, Environmental education and awareness. Green Protocol. Disaster management, Global environmental problem, ozone depletion, greenhouse effect, global warming, acid rain, nuclear hazards – Climate change, Eutrophication.

MODULE V: Biodiversity: Definition, types of biodiversity - Genetic diversity, Species diversity, Ecosystem diversity, SDG's in biodiversity conservation. Value of Biodiversity- Intrinsic, consumptive, productive use, social, ethical, aesthetic and option values. Utilitarian values of biodiversity- goods, services and information. Threats to biodiversity. Concept of Biodiversity Hotspots, Biodiversity hot spots of India. Concept of endemism and endemic species. ICUN plant categories with special reference to Kerala/ Western Ghats. Genetic resources for food and agriculture, status and trends of agrobiodiversity, agrobiodiversity and livelihoods, traditional knowledge and agrobiodiversity, agrobiodiversity and in situ conservation in ethnic minority communities, environmental services, sustainable management ofagrobiodiversity, agrobiodiversity conservation and economic development.

MODULE VI: Conservation of Biodiversity: Strategies for conservation: In-situ and ex-situ conservation- protected areas-biosphere reserves, national parks, Wildlife sanctuaries, Conservation Reserves, Community reserves, Sacred Groves. Single species / single habitat-based conservation programmes (e.g. Project tiger, Valley of flowers). Ex situ conservation-Managed ecosystems, biological resources and gene banks, botanical gardens, bio-parks, simulated ex situ conservation strategies, ecotourism. Top-down and bottom- up protocols for conservation. Strategies for ex situ conservation – Botanical Gardens, Seed banks, Field gene banks, Test tube gene banks, pollen banks, DNA bank, in vitro conservation. Conservation Practices in India and World- Important international conventions & treaties on nature & conservation. Ecosystem Restoration and Management. Biodiversity register.

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Online Resource Table

Resource	Link	Description
National mission on education through ICT (NME- ICT)	https://youtu.be/RgaGSx6WEOE	- Ecosystem concept
	https://youtu.be/s6D2Kwn-bEM	Global Environmental Change
	https://youtu.be/MUFxwB4Ziuo	Habitat and niche
	https://youtu.be/PzyEIxLKmG0	Metapopulation
	https://youtu.be/erCNyR06vCg	Project tiger
	https://youtu.be/GfgMmPUngH4	Species interaction
	https://youtu.be/IBKixBQFOaY	Species interaction

Model Question Paper

DEPARTMENT OF BOTANY

UNIVERSITY OF KERALA

Fourth Semester M.Sc. (CSS4) Degree Examination

Branch: Genetics and Plant Breeding

BOT-CC- 543 ECOLOGY AND CONSERVATION BIOLOGY

Time: Three hour **Maximum marks: 60**

I. Answer all questions in one word or sentence

1. Mention importance of green protocol
2. Name the national park famous for one-horned rhinoceros
3. Which day is celebrated as „World environment day"?
4. What is antibiosis?
5. Give the year in which Project Tiger launched
6. Define greenhouse effect
7. What is eutrophication?
8. Define ecotone
9. Explain K selection
10. List out causes of acid rain

(1X10= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Enumerate and explain characteristic features of Tundra
12. Differentiate autecology and synecology
13. Explain interspecific competition
14. Why do we need to protect biodiversity?
15. Write a note on population growth curve
16. Differentiate rare and exotic species?
17. What is co-extinction? Give suitable examples.

(5X3= 15 marks)

III. Answer any *four* of the following. Each answer not exceeding 250 words

18. "Organisms are highly adapted for their life in desert ecosystem". Substantiate
19. Give an account of biogeographical zones of India
20. How does species diversity differ from ecological diversity?
21. Explain different types of ecological interactions
22. What do you mean by hot spots of biodiversity? What are the criteria for identifying hot spots and name the biodiversity hotspots located in India
23. Enlist major threats to biodiversity and suggest suitable preventive measures
24. Describe the different IUCN red list categories of species according to the basis of degree of threat.

(5X5= 25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. In situ and ex situ conservation strategies can be effectively utilized for conservation of RET enlisted plants" Substantiate with examples
26. What is pollution? Give an account of environmental pollution leads to global warming. Mention the importance of environmental education in preventing global warming.

(1X10= 10 marks)

SEMESTER IV	Course Code: BOT- CC- 544	Credits: 3

NAME OF THE COURSE: PRACTICAL IV

MODULE I:

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

MODULE II:

1. Study of various developmental stages and polytene chromosomes of *Drosophila*
2. Preparation of sex chromatin from cheek cells
3. ABC model flower development
4. Problems: nuclear cytoplasmic interactions with particular reference to *Acetabularia*

MODULE III:

1. Angiosperm embryo development using bean/ *Tridax*/ *Vinca* seeds
2. Early plant development – Pollen tube formation
3. Study of plant tumours – galls
4. Study of human cancers using permanent slides

MODULE IV:

1. Analysis of vegetation - Quadrat /line transects to find frequency and interpret the vegetation in terms of Raunkier's frequency formula.
2. To find out the dissolved oxygen content in the given water sample (pond, lake, well etc).
3. To find out the primary production in the given water sample using light and dark bottle method.
4. Estimation of carbonate and bicarbonate content in water samples.
5. Estimation of total organic carbon content in the given soil sample

MODULE V:

1. Visit to a local area to document environmental assets river/ forest/ grassland/ hill/ mountain
2. Visit to a local polluted site-Urban/Rural/Industrial/Agricultural. Report of the two should be included in the record.

MODULE VI:

Germplasm collection of major agricultural crops (minimum two from each category)

a) **Cereals**: Rice, Wheat
b) **Pulses**: Green gram, Black gram, Horse gram, Sword bean
c) **Vegetables**: Capsicum, Ladies finger
d) **Underutilized crops**: wild edible fruits, vegetables
e) **Oil seeds**: Sesame, Sunflower, Castor

SEMESTER IV	Course Code: BOT-D- 545	Credits: 6

NAME OF THE COURSE: DISSERTATION

COURSE OUTCOMES (CO)

CO1: Develop the skill for identification of research problems and design suitable experiments

CO2: Gain the capability to observe, analyze and interpret the results obtainedand conclude.

CO3: Discuss the methodologies to be adopted for scientific research and publication

SEMESTER I-IV	Course Code: BOT- GC- 501	Credits: 2

NAME OF THE COURSE: PLANT TISSUE CULTURE

COURSE OUTCOMES (CO)

CO1: To develop deep knowledge on the technique of plant tissue culture and its application.

CO2: Develop skill in various tissue culture techniques

CO3: Apply tissue culture techniques for crop improvement

CO4: Gain knowledge in the production of artificial seeds, conservation ofgermplasm

COURSE CONTENT

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

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, components of media, growth regulators, undefined supplements, surface sterilization of explants, inoculation, subculturing etc.

MODULE III: Different types of cultures**, c**allus culture- characteristic features, Cytodifferentiation, 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 somaclonal 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, cryprotection, 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
M.Sc (CSS) Degree Examination
BOT-GC-501 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. Differentiate cybrid and hybrid
8. Expand DMSO
9. Name two surface sterilizing agents
10. Define gynogenic haploid

(10x1= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Write short notes on shoot tip culture
12. Give an account of plant growth regulators
13. Enlist steps for synthetic seed preparation
14. List out the application of cryopreservation. Point out thedisadvantages
15. Describe different types of sterilization techniques.
16. What is somaclonal variation? Mention the significance
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 250 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? Mention the difficulties inculturing the protoplast
22. Explain the scope of plant tissue culture.
23. What are the constituents of a tissue culture medium? Mention the role of each
24. How do you set a tissue culture laboratory?

(5x5= 25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

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

(1X10= 10 marks)

SEMESTER I-IV	Course Code: BOT- GC- 502	Credits: 2

NAME OF THE COURSE: MICROBIAL TECHNOLOGY

COURSE OUTCOMES (CO)

CO1: Get deep knowledge on the microbial techniques and its application.
CO2: Develop skill in microbiology practices, and apply bioprocess technology.
CO3: Analyze phylogeny of microbial isolates.

COURSE CONTENT

MODULE I: Introduction**,** Historical development and significance: History of development of Microbiology; Development of fields of Microbiology in 20th century, Ecological, clinical and industrial importance.

MODULE II: Basic techniques and principles of Microbiology, General laboratory requirements for Microbiology: Laboratory rules and safety regulations, first aid, Preparation of glassware - washing - sterilization techniques, laminar flow chambertypes, safety levels. Microscopy: Types of microscope, slide preparation. Preparation of culture media, nutritional needs of microbes, pure culture techniques, preparation of slants, sub-culturing, Microbial growth measurements, cell count, turbidity measurement, Optical Density, serial dilution, standard plate count, types of dyes, staining techniques - simple – Grams staining.

MODULE III: Different groups of Microorganisms: Viruses, Bacteria, Fungi, Actinomycetes; Classification, Isolation and cultivation**.** Structure of common bacteria(*E. coli, Bacillus*), actinomycetes (*Streptomyces)* and fungi (*Aspergillus, Penicillium, Trichoderma, Agaricus*), Phylogenetics – morphological, biochemical and molecular phylogenetics.

MODULE IV: Analysis of cultivable and non cultivable microorganisms, Long term and short term preservation of Microbes, Culture collections and Mycological herbarium - Importance, Examples of Indian and International culture collections.

MODULE V: Microbial Genetics: Prokaryotes and Eukaryotes, Isolation of genomic DNA, Plasmid isolation, agarose gel electrophoresis, PCR amplification, Restriction digestion, Competent cell preparation and transformation, Cloning and expression.

MODULE VI: Microbes as cell factories: Production of antibiotics & enzymes, Antimicrobial screening, MIC and MBC, antibiotic sensitivity testing, Submerged and solid state fermentation, Optimization, Production of industrial enzymes using microbes (alpha amylase and protease). Plant-Microbe interactions - mutualism, symbiosis, commensalisms, predation, parasitism, competition, biofilms. Phylloplane, endophytic and rhizosphere microbes, Lichens, Mycorrhiza: ecto-, endo-, ectendo-, VAM. Use of microbes in agriculture, Nitrogen fixation (symbiotic and asymbiotic associations), Phosphate solubilization, antagonism, plant growth promoting rhizobacteria (PGPR).

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Model question paper
DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA
M.Sc (CSS) Degree Examination
BOT-GC-502 MICROBIAL TECHNOLOGY

Time: Three hours **Maximum marks: 60**

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

1. Define an VAM
2. Expand MTCC
3. What are Ray-fungi?
4. Define MIC
5. What is probiotic? Name a probiotic drink.
6. What is actinorrizha?
7. Give an example of Phosphate solubilizing bacterium
8. What is bioleaching ?
9. Name two symbiotic Nitrogen fixing organisms
10. Define contamination

(10X1= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Write a note on the different microbial groups producing antibiotics.
12. Discuss PGPR and its applications.
13. Give a brief account of slime molds.
14. Give general characters of bacteriophages
15. What is bacterial growth curve?
16. Explain the steps in bacterial biofilm formation.
17. Differentiate phylloplane and rhizosphere fungi.

(5X3= 15 marks)

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

18. Write about the microbial groups producing antibiotics with example.
19. Write the contributions of Louie Pasteur and SA Waksman
20. Write a commonly used method for isolation of pure culture of bacterium.
21. Explain briefly the structure and functions of bacterial cell wall
22. Briefly explain the morphological features of Aspergillus
23. What are the constituents of a microbial culture medium? Point out the role of each.
24. Microbial growth can be measured by many methods. Explain different methods.

(5X5= 25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. Give five examples of microbial products and write short notes on theprocesses relating to modern biotechnology
26. Explain the importance microbial culture collections and types ofculture collections.

(1X10= 10 marks)

SEMESTER I-IV	Course Code: BOT- GC- 503	Credits: 2

NAME OF THE COURSE: PLANT CELL CULTURE TECHNOLOGY

COURSE OUTCOMES (CO)

CO1 : Gain knowledge in new advances in the field of cell culture technologies
CO2 : Apply this knowledge for the enhanced production of useful and novel compounds for the benefit of mankind.

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- Bioreactros (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, lysergicacid, taxol, Terpenoids-menthol, camphor, caroteniod, pigments, Polyterpenes- rubber, Phenyl propanoids-anthocyanin, coumarins, flavanoids, isoflavniods, stilbenes, tannins, Quinones-anthraquinones, benzoquinones, naphthoquinones, Steroids-diosgenin, sterols, ferruginol.

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

LEARNING RESOURCES:
REFERENCES

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ONLINE RESOURCES:

- http://vlab.amrita.edu
- http://www.nature.com/nbt/journal/v22/n11/full/nbt1027.html?foxtrotcallback=true
- https://www.acsedu.co.uk/Courses/General-Horticulture/TISSUE-CULTURE-BHT306- 118.aspx
- https://www.wiziq.com/tutorials/plant-tissue-culture
- www.ncbiotech.org/educational-resources
- www.nptel.ac.in/courses/102103016 (National Programme on Technology Enhanced Learning (NPTEL) - Phase II- Course Name: Plant Biotechnology, Indian Institute of Technology Guwahati, Guwahati)

Model Question Paper
DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA
M Sc (CSS) Degree Examination
BOT-GC- 503- 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. Which instrument you will suggest to large scale cultivation of plant cells
10. Write expansion and use of EMS

(10X1=10 marks)

II. Answer any *five* questions. Each answer not exceeding 150 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 inmetabolic 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 250 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 fromcultured plant cells
24. Explain sterilization techniques used in cell culture laboratory

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

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

(1X10=10 marks)

EMESTER I-IV	Course Code: BOT- GC- 504	Credits: 2

NAME OF THE COURSE: PRINCIPLES OF GARDENING

COURSE OUTCOMES (CO)

CO1: Recognize the scope and significance of horticulture and floriculture

CO2: Gain knowledge on the various types of plants and propagation techniques

CO3: Design and lay out a vegetable/ ornamental/ 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.

LEARING RESOURCES:

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ADDITIONAL REFERENCES

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- Journal of Applied horticulture

Model Question Paper
DEPARTMENT OF BOTANY
UNIVERSITY OF KERALA
M. Sc. (CSS) Degree Examination
BOT-GC-504- 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 bymechanical method
10. What do you mean by monoecious plant?

(10X1=10 marks)

II. Answer any *five* questions. Each answer should not exceed 150 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. Suggest any three measures to prevent the spread of viral disease in ornamentals

(5X3=15 marks)

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

18. Briefly describe the role of national agencies involved in thepromotion 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. Micropropagation is a means to produce large number of plants. Discuss thestatement based on its applications
23. Briefly explain the types of specialized structures used for the propagation of plants.

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

24. Evaluate the merits and demerits of artificial vegetative propagation in comparison with sexual reproduction
25. Explain the various management practices used for the cultivation of horticultural crops

(1X10=10 marks)

SEMESTERI- IV	Course Code: BOT- GC- 505	Credits: 2

NAME OF THE COURSE: TRANSGENIC PLANTSCOURSE OUTCOMES (CO)

CO1: Understand the basic concepts of genetic engineering in plants
CO2: Acquainted with genetic transformation techniques in plants
CO3: Understand the applications of transgenic plants and Biosafety regulations

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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- www.nrcpb.res.in
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Model question paper

DEPARTMENT OF BOTANY

UNIVERSITY OF KERALA

M.Sc (CSS) Degree Examination

BOT-GC-505: 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 150 words

11. Write a note on a transgenic crop with improved pest resistance
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 250 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. Marker genes are important in production of transgenic plants. Discuss.
24. Explain how a recombinant DNA can be constructed.

(5X5= 25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

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

(1X10= 10marks)

SEMESTER I-IV	Course Code: BOT- GC- 506	Credits: 2

NAME OF THE COURSE: ETHNOBOTANY

COURSE OUTCOMES (CO)

CO1 : Get knowledge about Indian ethnobotanists and ethnic communities of Kerala
CO2 : Identify and classify ethnobotanical plant resources for documentation
CO3 : Apply uses of ethnomedicinal plants in day today life

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 ethnobiology 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

LEARNING RESOURCES:

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Model question paper

DEPARTMENT OF BOTANY

UNIVERSITY OF KERALA

M.Sc (CSS) Degree Examination

BOT-GC-506 ETHNOBOTANY

Time: Three hours **Maximum marks: 60**

I. Answer all questions in one word or sentences

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 Emblica officinalis

(10X1=10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 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 250 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 500 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)

SEMESTER I-IV	Course Code: BOT- GC- 507	Credits: 2

NAME OF THE COURSE: HERBAL COSMETICS

COURSE OUTCOMES (CO)

CO 1: Understand the natural ingredients used in cosmetic formulations.
CO2: Study the properties and benefits of herbs in skincare and cosmetic products.
CO3: Develop practical skills in formulating herbal cosmetics.
CO4: Understand the safety and regulatory compliance of herbal cosmetics.

COURSE CONTENT

MODULE I: Introduction to herbal cosmetics: Definition and significance of herbal cosmetics, Types of herbal cosmetics, Study of common drugs used in cosmetics. Brief history of herbal cosmetics, Indian cosmetic industry and scope of herbal cosmetics in market. Challenges in formulating herbal cosmetics.

MODULE II: From Raw Materials to Products: Raw materials, machinery and equipments used in preparation of herbal cosmetics. Types of raw materials used in cosmetics: i) Water, ii) preservatives, iii) humectants, iv) surfactant, v) oil, fat and waxes, vi) perfumes, vii) colours.

MODULE III: Facial cosmetics: cleansing creams, Emollients, Moisturizers (cold cream, moisturizing cream, and night cream), Bleaches, Sunscreen and anti-sunburn preparations, Processes used in the manufacture of herbal cosmetics.

MODULE IV: Herbal Remedies and Formulations: Herbs used as antioxidants, free-radical scavenger, antiseptic, antibacterial, anti-wrinkle, anti-fungal, Plants commonly used in herbal cosmetics - For skin, hair & face, Common name, Parts used, products that can be prepared with them, method of preparation.

MODULE V: Herbal excipients-significance of substances of natural origin as excipients-colorants, sweetners, binders, diluents, viscosity builders, disintegrants, flavors and perfumes. Herbal formulations: Conventional herbal formulations like syrups, mixtures and tablets and novel dosage forms like phytosomes.

MODULE VI: Quality assurance in Herbal Drug Industry: Concept of TQM, GLP, ISO-9000, Quality audit, Suppliers' audits and approval, Auditing of Storage area, Weighing areas, Production area. Regulatory guidelines: Compliance of Drug & Cosmetic Act 1940 with reference to provisions for packaging and labelling (Rule 150 A, schedule S), permitted colors, flavors etc. BIS guidelines for cosmetic products and raw materials.

LEARNING RESOURCES:

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Model question paper
UNIVERSITY OF KERALA
DEPARTMENT OF BOTANY
M.Sc. (CSS) Degree Examination
BOT-GC- 507 HERBAL COSMETICS (Generic Course)

Time: Three hours **Maximum marks: 60**

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

1. Define phytosomes
2. List any two plants with skin whitening properties.
3. What are humectants?
4. Name the chemical constituent in Henna which is used as colouring agent.
5. ……produces crimson colour with turmeric
6. Which part of *Santalum album* is used as drug?
7. Define herbal cosmetics
8. Define the term 'androgenic haploid'.
9. Expand TQM
10. State the method used for extracting delicate perfumes

(10X1= 10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Describe the machinery and equipments used in the preparation of herbal cosmetics.
12. Differentiate between conventional and novel formulations
13. Give an account of the significance of herbal cosmetics
14. Explain the BIS guidelines for cosmetic products and raw materials.
15. Explain about the quality assurance in herbal industry.
16. Briefly explain the history of herbal cosmetics.
17. Give an account of herbal remedies and formulations.

(5X3= 15 marks)

III. Answer any *four* of the following Each answer not exceeding 250 words

18. Explain the regulatory guidelines in herbal drug industry.
19. Discuss the different types of herbal cosmetics
20. Give an account of the challenges in formulating herbal cosmetics.
21. Describe the process used in manufacture of herbal cosmetics.
22. Briefly explain about Indian cosmetic industry and the scope of herbal cosmetics in market.
23. Discuss about the commonly used plants in herbal cosmetics for hair and method of preparation.
24. Describe the significance of herbal excipients.

(5X5= 25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. Describe various types of raw materials used in cosmetics.
26. Give an account on facial cosmetics.

(1X10= 10 marks)

SEMESTER I-IV	Course Code: BOT- SE- 501	Credits: 2

NAME OF THE COURSE: PLANT PROPAGATION AND NURSERY MANAGEMENT

COURSE OUTCOMES (CO)

CO1: Gain knowledge on various aspects of nursery development, management andmarketing of products
CO2: Demonstrate the propagation, growth, and maintenance of plants in nursery conditions.

CO3: Utilize the plant tissue culture techniques in the propagation of crops, medicinal plants and ornamentals.
CO4: Apply plant propagation and nursery operation skills and knowledge to explore career opportunities in horticulture industry

COURSE CONTENT

MODULE I: Development of Nursery: nursery site, potting and transplanting, selecting and managing nursery stock, introduction to plant breeding, pest and disease management,growing media, specialized structures for propagation and maintenance -mist chamber, agro-net shade-house, glass house, hardening chamber; nursery materials and equipment, irrigation, nursery management and marketing.

MODULE II: Composting, organic fertilizers, green manures-*Azolla* cultivation, vermicompost, production of biofertilizers, biofungicides, biopesticides, integrated pest management. Soil-less production of horticultural crops–hydroponics, sand culture, gravel culture, aquaponics, terrarium. Modern devices in nursery operations and automations.

MODULE III: Plant propagation- conventional tools: Seed propagation techniques-dormancy breaking treatments; vegetative propagation- cutting- softwood and hardwood cuttings, layering, grafting and budding. Specialized parts of propagation - (bulbs, tubers, offsets, runners, suckers, slip, corms). Development of clonal plantations. Clonal propagation technology of important crops and commercial trees (Rubber, *Eucalyptus*, *Casuarina* etc.).

MODULE IV: Plant propagation –Biotechnological tools: Plant tissue culture- 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, basics of aseptic techniques, sterilization techniques, preparation of stock solutions and culture media, inoculation, tissue culture stages, multiplication by shoot tip, nodal culture and callus culture subculture, rooting – *in vitro* and *ex vitro* rooting and hardening. Micropropagation technology of crops, medicinal plants and ornamentals

MODULE V: Skill acquisition in conventional propagation- production of 2 week old, ready to transplant seedlings of any three of the following vegetable crops through seed germination; brinjal, tomato, okra (bhindi), cow pea, bitter gourd, snake gourd, ash gourd. Propagation through cuttings any one of the following: rose, henna, Croton, Air layering: any one of the following; Croton, *Callinadra* sp. Development of grafted plants: any one of the following; Croton, Rose, *Solanum.*

MODULE VI: Skill acquisition in plant tissue culture: Preparation of stock solutions and media, autoclaving, surface sterilization, inoculation. Establishment of *in vitro* culture forany of the following; *Dianthus, Oldenlandia, Bacopa, Plumbago sp. etc.* Potting and maintenance of micropropagated plants in the hardening chamber

LEARNING RESOURCES

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Model question paper

UNIVERSITY OF KERALA

DEPARTMENT OF BOTANY

M.Sc (CSS) Degree Examination

BOT-SE-501 PLANT PROPAGATION AND NURSERY MANAGEMENT

Time: Three hours **Maximum marks: 60**

I. Answer all questions in one word or sentence

1. Write a note on importance of shade net in a nursery
2. Name two plants which can be propagated with air layering
3. What is Fumigation?
4. Mention importance of hardening of plants
5. Write about a biopesticide
6. Explain the importance of autoclaving
7. What is the use of agar agar in a medium
8. Name an organic insecticide
9. Mention the need for transplantation of seedlings in tomato
10. Write about a propagation technique of rose

(10X1=10 marks)

II. Answer any *five* questions. Each answers not exceeding 150 words.

11. Write about conventional propagation technique of brinjal
12. Enlist specialized parts for propagation
13. Write about importance organic farming
14. Differentiate *In vitro* and *ex vitro* rooting
15. Write about aquaponics
16. Differentiate callus culture and shoot culture
17. How an explant can be inoculated in a culture tube

(5X3=15 marks)

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

18. Explain how a microporpagated plants can be established in field
19. Write about modern devices for nursery automation
20. Write about mist chamber and glass house
21. Write an account on surface sterilization techniques
22. Illustrate and explain grafting and budding
23. Explain basic technique for *in vitro* propagation
24. If you want to develop a nursery, explain how you can do it?

(5X5=25 marks)

IV. Answer any *one* of the following, not exceeding 500 words

25. Briefly describe how *in vitro* culture can be established for Dianthus
26. Write about techniques for soil less propagation and maintenance of plants

(1X10=10 marks)