File Ref.No.6218/GA - IV - J1/2012/CU

UNIVERSITY OF CALICUT

Abstract

General & Academic - Faculty of Science- Scheme & syllabus of Integrated Botany with Computational Biology programme in tune with Regulations for the Integrated Programmes under Choice Based Credit Semester System (CBCSS), w.e.f 2020 admision - Implemented subject to ratification by the Academic Council - Orders Issued.

G & A - IV - J

U.O.No. 8389/2021/Admn Dated, Calicut University.P.O, 25.08.2021

Read:-1. Item No: 1 in the Minutes of the meeting of BoS, Botany UG, held on 21.07.2021.
2. Remarks of the Dean, Faculty of Science, dated 04.08.2021.
3. Orders of the Vice Chancellor in the file of even no. dated 05.08.2021.

ORDER

1. The meeting of the Board of Studies in Botany (UG) held on 21.07.2021, approved the Scheme & syllabus of Integrated Botany with Computational Biology programme (upto 6 semester) in accordance with Regulations for the Integrated Programmes under Choice Based Credit Semester System (CBCSS) with effect from 2020 admission, vide paper read (1) above.
2. The Scheme & syllabus of Integrated Botany with Computational Biology programme (upto 6 semester) in accordance with Regulations for the Integrated Programmes under Choice Based Credit Semester System (CBCSS) with effect from 2020 admission, has been approved by the Dean, Faculty of Science, vide paper read (2) above, and by the Vice Chancellor, vide paper read (3) above, subject to ratification by the Academic Council.
3. Considering the urgency, the Vice Chancellor has accorded sanction to implement the Scheme & syllabus of Integrated Botany with Computational Biology programme in accordance with Regulations for the Integrated Programmes under Choice Based Credit Semester System (CBCSS) with effect from 2020 admissions, subject to ratification by the Academic Council.
4. Orders are issued accordingly. (Syllabus appended)

Arsad M

Assistant Registrar

To

1. The Principals of all Affiliated Colleges offering Integrated Botany with Computational Biology programme
2. The Director, Directorate of Admission

Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/CDC/JCE I/JCE IV/EX and EG Sections/GA I F/CHMK Library/Information Centres/SF/DF/FC

Forwarded / By Order

Section Officer

UNIVERSITY OF CALICUT

SYLLABUS

FOR

INTEGRATED BOTANY

WITH

COMPUTATIONAL BIOLOGY

Effective from 2020 admission

UNIVERSITY OF CALICUT
MEMBERS OF BOARD OF STUDIES IN BOTANY (UG)
(2020 -)

1. **Dr. Jyothi. P.V (Chairperson)** Associate Professor M E S Ponnani College Ponnani 9446339857, jyothipv2011@gmail.com

2. Dr. Vidya Varma P.K. Asst. Professor of Botany, Govt. Arts & Science College Calicut 9446540613, viva8077@gmail.com

3. Sri. Sojan Asst. Professor of Botany Govt. College Chittur, Palakkad 9447838608,sojanchakkalac kal@gma il.com

4. Dr.Vivek PJ Assistant Professor Dept of Botany, Govt. Sanskrit College Pattambi, Palakkad 9495242805 vivekpj@gmail.com

5. Dr. Swapna K.S. Asst. Professor of Botany, Govt. Arts & Science College Calicut 9947697733,kallumadathilswapna@gmail.com

6. Raga R. Asst. Professor of Botany, Govt. Women's College, Malappuram 9048889157,ragarmenon@gmail.com

7. Saratchandran A Divakaran Asst Professor,Botany,Sree Kerala Varma College, College Road P.O, Kanattukara, Thrissur PIN 680 011 94973 05131 saratcad@gmail.com

8. Dr.Delse P Sebastian Assistant Professor, Department of Botany, St. Joseph's College (Autonomous), Devagiri, Calicut 9447331351, delsbotany@gmail.com

9. Dr. Abhilash Assistant Professor, Department of Botany, SNG College, Chelannur, Kozhikode 9495413121, abhies@gmail.com

10. Dr. Zareena Viji Assistant Professor Dept of Botany, NSS College Nenmara,Palakkad reenaravi1@rediifmail 9447277885

Semester	Course	CREDIT
S-1	Common course: English1	4
	Common course: English II	3
	Common course: Additional Language	4
	Core course1: Plant Anatomy COURSE CODE**: IBC1B01T**	3
	Allied core course: Zoology	2
	Allied core course: Chemistry	2
S-2	Common course: English 1	4
	Common course: English II	3
	Common course: Additional Language	4
	Core course 2: Microbiology, Mycology& Plant Pathology COURSE CODE: **IBC2B02T**	3
	Allied core course: Chemistry	2
	Allied core course: Zoology	2
S-3	Core course 3: Phycology, Lichenology, Bryology& Pteridology COURSE CODE: **IBC3B03T**	4
	Core course 4: Methodology and Perspective in Science. COURSE CODE: **IBC3B04T**	4
	Core course 5: Gymnosperms, Palaeobotany, Phytogeography & Evolution COURSE CODE: **IBC3B05T**	3
	Allied core course: Chemistry	2
	Allied core course: Zoology	2
S-4	Core course 6: Biotechnology and Bioinformatics COURSE CODE: **IBC4B06T**	4
	Core course 7: Tissue Culture, Horticulture, Economic Botany & Ethnobotany COURSE CODE**: IBC4B07T**	3
	Core course 8: Basic mathematics in biological sciences COURSE CODE: **IBC4B08T**	4
	Core course 9: Practical of Semester 1-4 (Paper 1) COURSE CODE: **IBC4B09P**	4

	Allied core course: Chemistry	2
	Allied core course 10: Chemistry Practical	4
	Allied core course: Zoology	2
	Allied core course: Zoology Practical	4
S-5	Core course 10: Angiosperm Morphology and Systematics Part1 COURSE CODE: **IBC5B10T**	3
	Core course 11: Cell biology and Biochemistry COURSE CODE: **IBC5B11T**	3
	Core course 12: Genetics and Plant Breeding COURSE CODE: **IBC5B12T**	3
	Core Course13: Environmental Science COURSE CODE: **IBC5B13T**	3
	Open Course	2
s-6	Core course 14: Creativity, Research and Knowledge Management COURSE CODE**: IBC6B14T**	3
	Core course 15: Plant Physiology & Metabolism COURSE CODE: **IBC6B15T**	3
	Core course 16: Molecular Biology, Plant Morphogenesis & Embryology. COURSE CODE: **IBC6B16T**	3
	Core course 17: Genomics COURSE CODE: **IBC6B17T**	3
	Core Course 18: Elective: Genetics and Crop Improvement COURSE CODE**: IBC6B18T**	3
	Core course 19: practical of semester 5 (Paper II) COURSE CODE: **IBC6B19P**	5
	Core course 20: practical of semester 6 (Paper III) COURSE CODE**: IBC6B20P**	5
	Core course 21: Project COURSE CODE: **IBC6B21Pr**	2

SEMESTER-1

COURSE CODE: IBC1B01T

COURSE TITLE: PLANT ANATOMY

Theory 36 hrs.

Module – I: Plant Anatomy

1. Introduction: Significance of anatomy.
2. Plant cell- structure.
   A. Structure and composition of cell wall. Middle lamella Primary and Secondary wall thickening, Pits.
   B. Growth of cell wall – apposition, intussusception
   C. Extra cell wall materials – lignin, cutin, suberin, callose, wax.
3. Non-living inclusions: Reserve materials – carbohydrates (starch grains and sugars) proteins (aleurone grains) fats & oils, examples.

Excretory materials; Nitrogenous – alkaloids, Non-nitrogenous- gums, resins, tannins, organic acids, essential oils Mineral crystals- cystolyth, raphides, Druses.

4. Tissues: Definition and Types

A. Meristematic tissues – classification, Theories on apical organisation - apical cell theory, histogen theory, Tunica-Corpus theory.

B. Permanent tissues- definition, Classification- simple complex and secretory.

i. Simple tissues – parenchyma, collenchyma, sclerenchyma, - fibres and sclereids- structure, occurrence and function.

ii. Complex tissues - definition - xylem & phloem structure, function, origin, phylogeny.

iii. Secretory tissues – glands, glandular hairs, nectaries, hydathodes, schizogenous and lysigenous ducts, resin ducts and laticifers.

C. Structure of stomata, classification (Metcalfe & Chalk), cuticIe.

D. Vascular tissue system: vascular bundles - origin and types - conjoint, collateral bicollateral, radial, concentric – amphicribral and amphivasal, protoxylem, metaxylem,

protophloem, metaphloem, cambium, open and closed, endarch and exarch.

E. Primary growth of plant body; Dicot stem, Monocot stem, Dicot root, Monocot root, Dicot leaf and Monocot leaf.

F. Secondary body of the plant.

a. Normal secondary growth in dicot stem and dicot root. Formation of vascular cambial ring, Structure and activity of cambium - storied and non-storied, fusiform and ray initials.

Formation of secondary wood, annual rings, ring porous and diffuse porous wood, heart wood and sapwood, tyloses, secondary phloem, vascular rays.

Extra stelar secondary thickening in stem and root - periderm formation. Lenticels - structure & function.

b. Anomalous secondary growth in dicot stem (*Boerhaavia*. *Bignonia)* and monocot stem (*Dracaena*).

PRACTICAL

36 Hrs.

1. Study of primary plant structures – Dicot stem *Centella* and bi-collateral (*Cephalandra, Cucurbita*), - Monocot stem-(Bamboo)–Dicot root (aerial *Ficus, Tinospora, Pea*) -Monocot root (*Colocasia,* Musa)-Dicot leaf (*Ixora)* Monocot leaf (Grass)
2. Study of secondary plant structures (dicot stem –(*Vernonia, Polyalthia*) and Dicot root (*Tinospora*, Papaya) after secondary thickening)
3. Study of anomalous secondary thickening -*Boerhaavia*, *Bignonia*,*Dracaena*
4. Identification of different cell types - tissues, vascular bundles (all types).

REFERENCES

- Cutler, D. F., Botha, T., Stevenson, D. W. 2008. Plant anatomy: an applied approach. Blackwell.

- Cutter, E.G. 1969. Plant Anatomy - Part 1 Cells & Tissue. Edward Arnold.
- Cutter, E.G. 1971. Plant Anatomy, Part 2 Organs. Edward Arnold.
- Eames, A. J. & L H Mac Daniels. 1987. Introduction to Plant Anatomy.Tata-McGraw.
- Esau K. 1985. Plant Anatomy (2nd ed.). Wiley Eastern Ltd. NewDelhi.
- Fahn A.2000. Plant Anatomy. Pergamon Press.
- Pandey B.P. 2001. Plant Anatomy. S. Chand &Co.
- Srivastava, S. and Singh S.K. 2009. Anatomy of Angiosperms. Crescent Publishing Corporation.
- Tayal M.S. 2004. Plant Anatomy. Rastogi Publishers,Meerut.
- Vasishta P.C. 1974. Plant Anatomy, PradeepPublication.
- http://www.biologydiscussion.com/plant-anatomy/applications-plant-anatomy/top-7-applicationsof-plant-anatomy-botany/69516
- Beck C. B. 2010. An Introduction to Plant Structure and Development. Cambridge University Press.
- Dickison W. C. 2000. Integrative Plant Anatomy. AcademicPress.
- Pandey S.N. and A. Chadha 2015. Plant Anatomy and Embryology. Vikas PublishingHouse.
- Roy P. 2016. Plant Anatomy. New Central BookAgency.
- Rudall P. 2007. Anatomy of Flowering Plants. Edition 3, Cambridge UniversityPress.

SEMESTER:2

COURSE CODE: IBC2B02T

COURSE TITLE: MICROBIOLOGY, MYCOLOGY, & PLANT PATHOLOGY

Microbiology

1. Introduction to Microbiology (1hr)
2. Bacteria –Classification based on morphology and staining, ultra structure of bacteria; Bacterial growth, Nutrition, Reproduction. (5 hrs)
3. Viruses – Classification, architecture and multiplication; Bacteriophages, TMV, Retroviruses HIV, Viroids, Prions. (3 hrs)
4. Microbial ecology – Rhizosphere and Phyllosphere. (1 hr)
5. Industrial microbiology –alcohol, acids, milk products single cell proteins (1 hr)
6. Economic importance of bacteria, Vaccines: importance, mechanism. (1 hr)

PRACTICAL (MICROBIOLOGY)

1. Simple staining
2. Gram staining – Curd, root-nodules
3. Culture and isolation of bacteria using nutrient agar medium (demonstration only)

REFERENCES:

- Adams, M R & Moss, M.O. Food Microbiology. New Age International Publishing Ltd., NewDelhi.
- Brock, T. D. Biology of Microorganisms. PrenticeHall.
- Campbell, R. Microbiology. ELBS-Edward Arnold,London.
- Carpemter, P.L. Microbiology. W.B. Sunders &Company,Philadelphia.
- Dubey, R.C. & Maheswari, D.K. A text book of Microbiology. S.Chand.
- Desikachary. Cyanophyta-Monograph
- Goodfellow, M. et.al. The Biology of Actinomyçetes. Academicpress.
- Kumar, H.D. & Swati Kumar. Modern Concepts ofMicrobiology.
- Mathew, R.E.F. Plant Virology, Academicpress.
- Pelozar, M.J., Chan, E.C.S. & Krieg, N.R. Microbiology. Tata Mc GrawHill.
- Sharma, P.D. Microbiology & Plant Pathology. Rastogi Publishers,Meerut.

MYCOLOGY

1. General characters and phylogeny of the kingdom Fungi, the concept of anamorph and teleomorph. (2 hrs)
2. General characters, distribution, and biology of the following groups of fungi (8 hrs)

a) Mastigomycotina. Type: *Pythium*

b) Zygomycotina. Type: *Rhizopus*

c) Ascomycotina. Type:, *Xylaria, Aspergillus*

d) Basidiomycotina. Types: *Agaricus, Puccinia*

3. Economic importance of fungi: medicinal, industrial, agricultural. Fungi as model organisms for research. (1 hr)
4. Ecological importance of fungi: different modes of nutrition (pathogenic/parasitic, saprobic, symbiotic) (1 hr)

PRACTICAL (MYCOLOGY)

1. Micropreparation – Lactophenol cotton blue – Slides of the above mentioned types.

REFERENCES (MYCOLOGY)

- Alexopoulos C.J., Mims, C.W. and Blackwell, M. (1996) Introductory Mycology, 4th Edn. John Wiley and Sons, New York.
- Alexopoulos, C.J. and Mims C.W. (1979) Introductory Mycology, 3rd Edition, John Wiley and Sons, New York. 33 3. Jim Deacon (2007) Fungal Biology, 4th edition, Black
- Jim Deacon (2007) Fungal Biology, 4th edition, Blackwell publishing, Ane Books Pvt Ltd
- Mehrotra R.S. and Aneja K.R. (1990) An Introduction to Mycology, Wiley, Eastern Limited, New Delhi.
- Sethi, I.K. and Walia, S.K. (2011) Text book of Fungi and their Allies, Macmillan Publishers India Ltd.

Plant Pathology(12 hr)

1. Principles of Plant Pathology- Causal agents of plant diseases - Biotic causes (fungi, bacteria, virus, mycoplasma, nematodes, angiospermic parasites. Abiotic causes (nutrient and mineral deficiencies, effect of pollution). Koch's postulates. Latrogenic diseases. Seed pathology.
2. Details of different symptoms of plant diseases.
3. Process of infection- mechanical, physiological and enzymatic action. Penetration and entry of pathogens in to host tissue.
4. Host- parasite interaction. Enzymes and toxins in pathogenesis. Defense mechanisms in plants (structural and biochemical).
5. Details of different ways of spread and transmission of plant diseases- wind and water-mediated, seed borne and vector-borne.
6. Plant disease management- exclusion, eradication and protection. Different pesticides and fungicides and their application. Biocides in plant protection.
7. Study of the following diseases with reference to the symptoms, causal organisms, disease cycle and control measures:
8. Bunchy top of banana, Citrus canker, Blast disease of paddy, Mosaic disease of tapioca, Bacterial blight of paddy, Bud rot of coconut, Mahali of Arecanut, Powdery mildew of rubber, Abnormal leaf fall of rubber, tikka disease of Ground nut, Late blight of potato, Blister blight of tea, wheat rust, coffee rust, grey leaf spot of coconut, Quick wilt of pepper, rhizome rot of ginger and turmeric,

angiospermic parasites-*Viscum, Dendropthoe*.

PRACTICAL (PLANT PATHOLOGY)

Identification of the disease, pathogen, symptoms and control measures of the following:

(drawing not required)

a. Citrus canker
b. Mahali disease
c. Tapioca mosaic disease
d. Blast of Paddy
e. Quick wilt of pepper
f. Bunchy top of banana
g. Grey leaf spot of coconut

SUBMISSION (PLANT PATHOLOGY)

Students are expected to submit five properly identified Pathology specimens /herbarium during the practical examination of Paper-I held at the end of 4th semester. Diseases mentioned in the syllabus or any locally available common diseases of crop plants can be selected for submission.

REFERENCES

- Agrios, G.N. Plant pathology. 4th Ed., AcademicPress.
- Bilgrami, K.H. & Dube, H C. A Text Book of Modem Plant Pathology. Vikas Publishers, NewDelhi.
- Chaube, H.S. & Ramji Singh . |ntroductory Plant Pathology. lnternational BookDistributing Co.Lucknow.
- Gareth-Jones, D. Plant Pathology: Principles and Practice. Open UniversityPress.
- Horsfall J.G. & Cowling E. B. (Ed.). Plant Disease:An Advanced Treatise. AcademicPress.
- Lucas, J. A.. Plant Pathology and Plant pathogens.Blackwell.
- Manners, J.G. Principles of Plant Pathology. Cambridge UnivPress.
- Mehrotra, R.S. Plant Pathology. Tata Mc GrawHill.
- Pandey, B. P. Plant Pathology -pathogen and plant disease. S. Chand &Co.
- Pathak, V.N., Khatri, N.K. & Pathak, M. Fundamentals of Plant Pathology. Agro-biosIndia.
- Rangaswami, G. Diseases of Crop Plants of lndia. Prentice Halllndia.
- Tarr, S.A. J. The Principles of Plant Patholgy. WinchesterPress.
- Wheeler, H. Plant Pathogenesis. SpringerVerlag.
- Wood, R.K.S. Physiological Plant Pathology.Blackwell

SEMESTER 3

COURSE CODE: IBC3B03T

COURSE TITLE: PHYCOLOGY, LICHENOLOGY, BRYOLOGY& PTERIDOLOGY

1. Introduction, Range of thallus structure, pigments, reproduction (**1**hr.)
2. Life cycle, Classification of Algae proposed by FE Fritsch (1935). (**3**hr.)
3. General Features: Occurrence, thallus structure, reproduction, and life cycle of the types given below: (**18** hrs)

a. Chlorophyceae: *Chlorella*, *Volvox*, *Oedogonium*, *Chara*.
b. Xanthophyceae:*Vaucheria*.
c. Bacillariophyceae:*Pinnularia*.
d. Phaeophyceae:*Sargassum.*
e. Rhodophyceae:*Polysiphonia*.

4. Economic Importance: Algae as food, fodder, green manure, bio-fuels, pollution indicators, research tools, medicinal uses of algae, Commercial Products – carrageenin, agar-agar,alginates, diatomaceous earth. Harmful effects – water bloom, eutrophication, neurotoxins, parasitic algae. (**2** hr.)

PRACTICAL (PHYCOLOGY)

1. Identification of the vegetative and reproductive structures of the types studied.

REFERENCES (PHYCOLOGY)

- Anand, N. (1989) Culturing and cultivation of BGA. Handbook of Blue Green Algae. Bishen Sing Mahendra Pal Sing, Dehradun,Uttarakhand.
- Fritsch, F.E. (1935) The structure and reproduction of the algae. Vol. 1 and II, Cambridge UniversityPress.
- Kanika Sharma (2007) Manual of Microbiology. Tools and Techniques 2nd Edition. Ane BooksIndia.
- Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West Press,Delhi
- Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4thedition
- Mamatha Rao. (2009) Microbes and Non flowering plants: impact and application.Ane Books Pvt. Ltd., NewDelhi.
- Morris, I. (1967) An Introduction to the algae. Hutchinson and Co.London.
- Papenfuss, G.F. (1955) Classification ofAlgae.
- Prescott, L.M., Harley J.P., Klein D. A. (2005). Microbiology, McGraw Hill, India. 6th edition.
- Rober Edward Lee (2008) Phycology. Cambridge University Press India Pvt. Ltd. Ansari Road, NewDelhi
- Sahoo, D. (2000). Farming the ocean: seaweeds cultivation and utilization.Aravali International, NewDelhi.
- Van Den Hoek, D.G. Mann and H.M. JaHns (2009) Cambridge University Press India Pvt. Ltd. Ansari Road, NewDelhi.

LICHENOLOGY: (1 hr.)

General account and systematics of lichens, thallus structure, reproductive bodies, ecological significance (As Ecological indicators, Pollution indicators, Lichen in Soil formation and pioneers of Xerosere) and economic importance of lichens.

Type of Interaction between the components symbiosis – mutualism.

PRACTICAL (LICHENOLOGY)

1. Identification of different forms of Lichens.
2. *Usnea*: structure of thallus, fruiting body

BRYOLOGY

1. Introduction, general characters and classification by Stotler & Stotler (2008) (**2**hrs)
2. Study the distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (**6** hrs)

a. *Riccia*(Marchantiophyta)
b. *Anthoceros* (Anthocerotophyta)
c. *Funaria*(Bryophyta)

3. Economic importance of Bryophytes (½hr)
4. Fossil Bryophytes (½hr)

PRACTICAL (BRYOLOGY)

1. *Riccia* – Habit, Anatomy of thallus, V.S. of thallus through antheridium, archegonium and sporophyte.
2. *Anthoceros*- Habit, Anatomy of thallus. V.S. of thallus through antheridium, archegonium and sporophyte.
3. *Bryum* (due to non-availability of *Funaria* at lower altitudes) - Habit, structure of antheridial cluster, archegonial cluster, L.S. of sporophyte.

REFERENCES (BRYOLOGY)

- AlainVanderpoorten and Bernard Goffinet (2009) Introduction to Bryophytes.Cambridge

UniversityPress.
- Campbell H.D. (1940) The Evolution of land plants (Embryophyta), Univ. Press,Stanford.
- Chopra R.N. and P.K. Kumar, (1988) Biology of Bryophytes. Wiley Eastern Ltd.New Delhi.
- Crandall-Stotler, B. and R. E. Stotler. (2008) In A. J. Shaw and B. Goffinet,Bryophyte Biology, Cambridge University Press (Revisededition).
- Gangulee Das and Dutta. (2007) College Botany Vol.1, Central Book Dept.Kolkatta.
- Gangulee, H.C. and Kar A.K. College Botany Vol. II, New Central BookAgency.
- Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. CentralBook Depot.Allahabad.
- Shaw. J.A. and Goffinet B. (2000) Bryophyte Biology, Cambridge UniversityPress.
- Smith G.M. (1938) Cryptogamic Botany Vol.II. Bryophytes and pteridophytes.McGraw Hill Book Company,London.
- Sporne K.R. (1967) The Morphology of Bryophytes. Hutchinson University Library, London.
- Vasishta B.R. Bryophyta. Revised edition. (2011). S. Chand and Co. NewDelhi.
- Watson E.V. (1971) the structure and life of Bryophytes. Hutchinson UniversityLibrary, London.

PTERIDOLOGY

1. Introduction, general characters and classification (Smith *et al*., 2008 – brief outline only). (**2** hrs)

2. Study the distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (Developmental details are not required) (**12**hrs)

a. *Psilotum*(Psilotopsida)

b. *Selaginella* (Lycopsida).

c. *Equisetum*(Equisetopsida)

d. *Pteris*(Polypodiopsida)

3. Apogamy and apospory in Pteridophytes; Stelar evolution in Pteridophytes; Heterospory and seed habit; Affinities of Pteridophytes; Economic importance of Pteridophytes. (**6** hrs)

PRACTICAL(PTERIDOLOGY)

1. *Psilotum*- habit, T.S. of stem, C.S. of synangium (slides only)
2. *Selaginella* – habit, T.S. of stem, T.S. of rhizophore, L. S. of strobilus
3. *Equisetum* - habit, T.S. of stem, L.S. of strobilus
4. *Pteris* - habit, T.S. of stem, C.S. of sporophyll

REFERENCES (PTERIDOLOGY)

- Bower, F.O. (1935) Primitive Land Plants – Cambridge,London.
- Chandra S. & Srivastava M. (2003) Pteridology in New Millenium, KhuwerAcademic Publishers.
- Eames, A.J. (1979) Morphology of Vascular Plants, Lower Group. Wiley International edition, NewDelhi.
- Parihar, N.S. (1977) Biology and Morphology of Pteridophytes, Central BookDepot, Allhabad.
- Rashid, A. (1976) An Introduction to Pteridopyta, Vikas publ. Co. NewDelhi.
- Ranker, T.A. & Haufler, C.H. (eds.) (2008) Biology and Evolution of Ferns and Lycophytes.Cambridege UniversityPress.
- Mehltreter, K., Walker, L.R. & Sharpe, J.M. (eds.) (2010) Fern Ecology.Cambridge UniversityPress.
- Smith, A.R., Pryer, K.M., Schuttpelz, E. Korall, P., Schnelder, H. and Wolf, P.G. (2006) A

Classification for extant ferns. Taxon 53:705-731.

- Smith, A.R., Pryer, K.M., Schuettpelz, E. (2008) Fern classification.*In*:
- T.A. Ranker and C.H. Haufler (eds.). Biology and Evolution of Ferns and Lycophytes.Cambridge University press,U.K.
- Smith G.M. (1938) Cryptogamic Botany Vol. II. Bryophytes and Pteridophytes. McGraw Hill Book Company,London.
- Sporne, K.R. (1967) Morphology of Pteridophytes – Hutchinson University Library,London.
- Vasishta B.R. (1993) Pteridophyta – S. Chand and Co., NewDelhi.

COURSE CODE: **IBC3B04T**

COURSE TITLE: METHODOLOGY AND PERSPECTIVES IN SCIENCE.

Module I (15 h) - Scientific methods and patents

1. Steps in scientific methods (2 h)
2. Structure of Research report, Style of citation, Biological Journals, Impact Factor, Sources of reference: Google Scholar, Shodhganga, NCBI, Inflibnet, e-pathshala (5 h)
3. Latest methods of presentation. (2 h)
4. Patents (6 h)

PRACTICALS (SCIENTIFICMETHODS)

1. Bibliography searches using online tools

2. Familiarizing latest methods of ICT based presentations

Module II (15 h) – Micro technique

1. Principles of microscopy and parts of microscopes (1 h.)
2. Types of microscopes: Light microscope, Compound microscope, Phase contrast microscope, Fluorescent microscope, Electron microscope: Transmission Electron Microscopy (TEM) and Scanning Electron Microscopy (SEM) (6 h.)
3. Micrometry: Stage micrometer, Ocular micrometer, Calibration and working. (1 h)
4. Illustrations using digital camera and Photomicrography. (1 h)
5. General account of Killing and fixing, agents used for killing and fixing. Common fixatives – Formalin – Acetic – Alcohol, Carnoy's fluids I & II, Chromic acid – Acetic acid – Formation (CRAF) (1 h)
6. Dehydration and infiltration – general account of dehydration (Ethanol, Isopropyl alcohol, Acetone, Glycerine). Ethanol – Xylene series and Tertiary Butyl Alcohol Series. (1 h)
7. Infiltration: paraffin wax method, embedding. (1 h)
8. Free hand sectioning; Microtome (Rotary and sledge) serial sectioning and its significance. (1 h)
9. Staining – General account, Classification: natural dyes, coal-tar dyes. Double staining, Vital staining (1 h)
10. 6. Mounting, whole mounting, maceration and smears (1 h)

Module III (24 h) – Biophysical and biochemical techniques

1. pH and buffer solutions- hydrogen ion concentrations and pH, dissociation of acids and bases. Measurement of pH using organic indicator molecule and potentiometric method. Functions of buffers in a biological system. Use of buffers in biological and biochemical research. pH and life. Henderson and Hassel Balch equation.
2. Chromatography: Principles of chromatography. Types of chromatography.
3. Electrophoresis: Electrophoretic mobility, principles, PAGE, Agarose gel electrophoresis. Separation and detection of macromolecules by electrophoresis. Electrophoretic apparatus, technique and procedure.
4. Centrifugation - Theory of centrifugation. Centrifuge- Types, Methodology of centrifugation, applications.
5. Colorimetry and spectrophotometry: Beer-Lamberts law. Measurement of extinction. Calorimeters and spectrophotometers. Techniques and applications in biological and biochemical research. Comparison

between colorimetry and spectrophotometry.

6. Radiobiology: Autoradiography. Principles, types. Methods and applications in biological research.
7. Immunochemistry: immune response. Antigens- Antibodies. Histo-incompatibility antigens; Structure of IgG. Immunochemical assays-RIA, ELISA.
8. Cryobiology: Freeze drying (lyophilization)-application

REFERENCES

- P.G. Hewitt, J.A. Suchocki ISBN-10 0805 390385, Conceptual integrated science ISBN40139780805390384.
- R.G. Newton (1997) The truth of Science Physical theories and reality. Viva Books, New Delhi, II Edition.
- P.G. Hewitt, J.A. Suchocki ISBN-10 0805 390385, Conceptual integrated scienceISBN40
- 139780805390384.
- R.G. Newton (1997) The truth of Science Physical theories and reality. Viva Books, New Delhi, II Edition.
- Chandal S.R.S. A Handbook of Agricultural Statistics. Achal Prakashan Mandir, Kanpur,India.
- Das M.N. and N.C. Giri. Designs and Analysis of Experiments. Wiley EasternLtd.
- Elhance and Elhance. Fundamentals of Mathematical Statistics. Kithab Mahal, New Delhi,lndia.
- Gupta S.K and V.K. Kapoor. Fundamentals of Mathematical Statistics. Sultan Chand & Sons, New Delhi.
- Gupta C.B. An Introduction to Statistical Methods. Vikas Publishing House Pvt.Ltd.
- Kempthrone,O. An ntroduction to Genetic statistics. John Wiley and Sons lnc. NewYork.
- Mather K. and J.L. Links. Biometrical Genetics. Chapman and Hall,London.
- Panse, V.G and P.. Sukatme. Statistical Methods for Agricultural Workers. ICAR, NewDelhi.
- Rao C.A. Advanced Statistical Methods in Biometrical Research. Wiley and Sons, NewYork.
- Singh P. and S.S. Narayanan. Biometrical Techniques in Plant Breeding. Kalyani Publishers, New Delhi.
- Singh R.K. and Chaudhary B.D. Biometrical Methods in Quantitative Genetic Analysis.Kalyani Publishers,NewDelhi.
- Daniel W.W. Biostatistics- A foundation for Analysis in HealthSciences
- Hoppe, W. (Ed.). Biophysics. SpringerVerlag.
- Rogers,A.W. Techniques of Autoradiography.Elsevier.
- Roy, R.N. A Text Book of Biophysics. New Central Book Agency Pvt. Ltd,Calcutta.
- Sasidharan, A. Selected Topics of Biophysics. Frontier AreaPublishers.
- Slayter, E.M. Optical methods in Biology. WileyIntersciences.
- Wong, C.H. Radiation Tracer Methodology in Biophysical Sciences. PrenticeHall.
- Plummer, D. An introduction to Practical Biochemistry. Tata Mc Graw Hill, NewDelhi

COURSE CODE: **IBC3B05T**

COURSE TITLE: GYMNOSPERMS, PALAEOBOTANY, PHYTOGEOGRAPHY AND EVOLUTION

GYMNOSPERMS

1. Introduction, General characters and classification of Gymnosperms (Sporne, 1965) (**1**hr)
2. Distribution, morphology, anatomy, reproduction, life cycle and affinities of the following types (Developmental details not required): *Cycas, Pinus* and *Gnetum* (**6**hrs)
3. Evolutionary trends in Gymnosperms; Affinities of Gymnosperms with Pteridophytes

and Angiosperms (**1**hr.)

4. Economic importance of Gymnosperms. (**1**hr.)

PRACTICAL (GYMNOSPERMS)

1. *Cycas*- Habit, coralloid root, T.S. of coralloid root, T.S. of leaflet, T.S. of rachis, male cone and L.S. of male cone , microsporophyll, megasporophyll, T.S. of microsporophyll, L.S. of ovule and seed.

2. *Pinus*- branch of unlimited growth, spur shoot, T.S. of stem and needle, male cone and female cone, L.S. of male cone and female cone, seed.

3. *Gnetum*- Habit, stem T.S., leaf T.S., male and female cones, L.S. of ovule, seed.

REFERENCES (GYMNOSPERMS)

- Chamberlain C.J. (1935) Gymnosperms –Structure and Evolution, Chicago UniversityPress.
- Coutler J.M. and C.J. Chamberlain, (1958) Morphology of Gymnosperms. Central Book Depot,Allahabd.
- Sporne K.R. (1967) The Morphology of Gymnosperms, Hutchinson and Co. Ltd.London.
- Sreevastava H.N. (1980) A Text Book of Gymnosperms. S. Chand and Co. Ltd., NewDelhi.
- Vasishta P.C. (1980) Gymnosperms. S. Chand and Co., Ltd., NewDelhi.

PALAEOBOTANY

1. Introduction and objectives (½hr)
2. Fossil formation and types of fossils (**1**hr)
3. Geological time scale- sequence of plants in geological time (**2**hrs)
4. Fossil Pteridophytes- *Rhynia*, *Lepidodendron* and *Calamites* (**2**hrs)
5. Fossil gymnosperms- *Williamsonia* (**1**hr)
6. Important Indian Paleobotanical Institutes. (**1**hr)
7. Indian Palaeobotanists: Birbal Sahni and Savithri Sahni (**1**hr)
8. Applied aspects of Palaeobotany- exploration of fossil fuels (½hr)

PRACTICAL (PALAEOBOTANY)

1 Fossil Pteridophytes - *Rhynia* stem, *Lepidodendron* and *Calamites*

2 Fossil gymnosperms-*Williamsonia*

(Drawings may be replaced by photos with critical notes in the record)

REFERENCES (PALAEOBOTANY)

- Andrews H.N. (1961) Studies in Paleobotany. John Wiley and Sons Inc., NewYork.
- Arnold C.A. (1947) Introduction to Paleobotany, Tata McGraw Hill, NewDelhi.
- Shukla, A.C. & S.P. Misra, (1975) Essential of Palaeobotany, Vikas Publishing House, Pvt. Ltd., Delhi.
- Sreevastava H.N., (1998) Palaeobotany, Pradeep Publishing Company,Jalandhar.
- Taylor, T.N. Paleobotany. An Introduction to Fossil Plant Biology. Mc Graw Hill, NewYork.
- Steward A.C. (1935) Fossil Plants Vol. I to IV. Watson J. An introduction to study of fossil plants. Adams and Charles Black Ltd.London.

PHYTOGEOGRAPHY

1. Definition, concept, scope and significance of phytogeography. (**2**hrs.)

2. Patterns of plant distribution - continuous distribution and discontinuous distribution, vicarism, migration and extinction (**3**hrs.)

3. Continental drift -Evidences and impact. (**3**hrs.)

4. Glaciation: Causes and consequences. (**2**hrs)
5. Theory of land bridges. (**2**hrs)
6. Endemic distribution, theories on endemism, age and area hypothesis. (**3**hrs.)
7. Phytogeographical zones (phytochoria) of India. (**3**hrs.)

PRACTICAL (PHYTOGEOGRAPHY)

1 Mark the phytogeographic zones of India.

REFERENCES (PHYTOGEOGRAPHY)

1. Ronald Good, (1947) The Geography of Flowering Plants. Longmans, Green and Co,New York
2. Armen Takhtajan, (1986) Floristic Regions of the World. (translated by T.J. Crovello & A. Cronquist). University of California Press,Berkeley.
3. P. D. Sharma, (2009) Ecology and Environment, Rastogi Publications,Meerut

EVOLUTION

1. Theories on Origin of Universe, Earth and Origin of life. Condensation and Polymerization; Proteinoids and Prions – Oparin's concept; Miller's experiment. (**3**hrs)
2. Evolution of prokaryotic and eukaryotic cells, archaebacteria, early fossilized cells. (**2** hrs)
3. Theories on origin and evolution of species: Darwinism; Neo-Darwinism and its objection; Arguments and support for Darwinism, Modern concept of evolution. (**3**hrs.)
4. Evidences of organic evolution from Morphology, Anatomy, Embryology, Palynology, Genetics and Molecular Biology. (**3**hrs.)
5. Genetic Constancy and Creation of Variability: Cell divisions and genetic constancy; Genetic variability by recombination, Chromosomal variations, Gene mutations, Selection and genetic drift. (**4**hrs.)
6. Speciation: Isolating mechanism, Modes of speciation: sympatric and allopatric (**3**hrs.)

REFERENCES (EVOLUTION)

- Crick F. (1981) Life itself: Its origin and Nature. Simon and Schuster, NewYork.
- Drake J.W. (1970) The molecular basis of mutation. Holden – Day – SanFrancisco.
- Dott R.H. R.L. Batten, (1981) Evolution of the earth 3rd edn. McGraw Hill NewYork.
- Fox S.W. and Dose, K. (1972) Molecular evolution and the origin of life. W.H. Freeman & Co., San Francisco.
- Gould S.J. (1977) Ontogeny and Phylogeny. Harvard Univ. Press, Cambridge,Mass.
- Jardine N., D. Mc Kenzie (1972) Continental drift and the dispersal and evolutionof organisms. Nature, 234.20-24.
- Miller, S.L. (1953) A production of aminoacids under possible primitive earthconditions. Science, 117: 528-529.
- Strickberger, (1990) Evolution, Jones and Bastlett Publishers International,England.

SEMESTER-4

COURSE CODE: **IBC4B06T**

CORE COURSE: BIOTECHNOLOGY AND BIOINFORMATICS

BIOTECHNOLOGY Module –I (11hr.)

1. Introduction, concept, history of biotechnology
2. Plant gene structure and expression; Regulation of structure and expression,
3. Regulation of plant gene expression, Protein coding genes, Translational control, RNA

coding genes.

4. Gene Transfer to plants; Target plant cells for transformation, Transformation approaches, Agrobacterium-mediated genetic transformation of plants, Molecular mechanism of T-DNA transfer, Vector based the Ti plasmid, Protocol for Agrobacterium-mediated genetic transformation of plants.

5. Direct genetic transformation of DNA into protoplasts; Biolistic process (particle Bombardment mediated), Transformation of protoplast by electroporation, microinjection, macroinjection and microprojectiles; Virus vectors for gene transfer to plants)

Module II(8 hr.)

6. Crop improvement through gene transfer technology; Projectiles of transformed plants; Plant variety improvement: addition of useful trait; Genetic mapping and gene cloning.

7. Developing resistance in crops; Herbicide resistance, Insect resistance, Virus resistance, Fungal pathogen resistance, Bacteria resistance, Nematode resistance, Parasite resistance.

8. Engineering the plant cell factory for secondary metabolite production; Oligopeptides and proteins, sugar polymers, alkaloides and phenolics, degradable polymers-.

9. Uses and applications of transgenic plants; New products, Pharmaceuticals, human growth hormone and Forensics - DNA fingerprinting.

10. Plant quality and protection, Edible vaccines, Antiviral proteins(PAP), Antigens antibodies

11. Bio risks of producing transgenic plant; Bio-safety and product labeling, Trade secrecy and material transfer agreements patenting of plant varieties.

12. Environmental Biotechnology: Cleaner technologies- Fermentation, Paper and Plastic industries. Bioremediation. Bio flocculation. Biosensors. Biochips. Bio fertilizers significance. Biological Nitrogen Fixation-*nif* genes- structure, transfer prospects.

Nitrogenase biochemistry, function

13. Medicine - Production of human insulin, Forensics - DNA finger printing

14. Industry- Horticulture and Floriculture Industry, production of vitamins, amino acids and alcohol.

15. Agriculture -Genetically modified crops –Bt crops, Golden rice, Flavr Savr Tomato, Virus, herbicide resistant crops, Edible vaccines

PRACTICAL (BIOTECHNOLOGY)

1. Study of genetic engineering tools and techniques using photographs/diagram (Southern blotting, DNA finger printing, PCR).

BIOINFORMATICS

A. Computer application.(8hr.)

1. Computer in Science with special reference to biology, the scope and prospects.
Information super highway (internet)- Information net works: internet, World Wide Web. Web browsers, HTTP, HTML and URLs. Biological networks.

2. Online publications with special reference to biology, -electronic journals, books, downloading and uploading.)- Open Archive Initiative (www.openarchives.org), biomed central, PubMed central, freedom of scientific information access, e-access debate- concepts and implications, Free Software Movement, Free Software Foundation, GNU/Linux, etc. Online archives, databases, the Public Library of Science (www.publiclibraryofscience.org**).**

REFERENCES

- Online resources freely available at internet sites such as
- www. publiclibraryofscience.org
- www.openarchives.org
- www. pubmedcentral.gov
- www. biomedcentral.com

- www.nature.com/nature/debates/e-ccess/index.html

B. Bioinformatics

Module 1(8hr)

1. Introduction: importance and scope.

2. Biological Databases

a. Nucleic acid databases: EMBL, GenBank- structure of GenBank entries. Specialized genomic resources, UniGene.

b. Protein sequence databases: PIR, SWISS-PROT, TrEMBL

Composite protein databases: NRDB, OWL.

Secondary databases: PROSITE, PRINTS, BLOCKS, IDENTIFY.

Structure classification databases- SCOP, CATH.

Module II(10hr)

3. Database searching

a. Sequence database searching. EST searches. Different approaches to EST analysis. Merck/lMAGE, lncyte, TIGR. EST analytical tools. Sequence similarity, sequence assembly and sequence clustering.

b. Pair wise alignment technique: Comparison of sequences and sub-sequences. Identity and similarity. Substitution matrices, BLOSUM, DOTPLOT and BLAST.

c. Multiple alignment technique: Objective, Manual, simultaneous and progressive methods. Databases of multiple alignments. PSI-BLAST, CLUSTAL-W.

module III (9hr)

4. Protein structure Prediction:

a. Secondary structure prediction. Chou-Fasman, JPred.

b. Tertiary structure prediction: Comparative modelling -Modeller, RasMol.

5. Emerging areas of Bioinformatics: DNA Microarrays, functional genomics, comparative genomics, pharmacogenomics, chemo informatics, Medical informatics**.**

PRACTICALS

1. Acquisition of basic skills in Internet browsing
2. Use of web browsers and search engines.
3. Use of biological and bioinformatics websites Agris, Agricola, BIOSI S, CABWeb.
4. Visit to Bioinformatics websites: NCBI, SWISS PROT, PIR,PDB.

REFERENCES

- Attwood T.K. and D.J. Arry-smith. lntroduction to Bioinformatics. PearsonEducation.
- Sundararajan S. and R. Balaji, introduction to Bioinformatics. Himalaya PublishingHouse

COURSE CODE: **IBC4B07T**

COURSE TITLE: TISSUE CULTURE, HORTICULTURE, ECONOMIC BOTANY &ETHNOBOTANY

TISSUECULTURE

Module-1 (**12** hrs.)

1. Plant tissue culture – Principles and techniques; Cellular totipotency; *in vitro* differentiation – de differentiation and re-differentiation. (**2**hrs.)

2. Tissue culture medium – Basic components in tissue culture medium – Solid andliquid medium; Murashige and Skoog medium – composition and preparation. (**2**hrs.)

3. Aseptic techniques in *in vitro* culture – sterilization – different methods – sterilization of instruments and glassware, medium, explants; working principle of laminar air flow and autoclave. (**2**hrs)

4. Preparation of explants– surface sterilization, inoculation, incubation, sub culturing. (**2**hrs.)

5. Micro propagation - Different methods – apical, axillary bud proliferation, direct and indirect organogenesis and somatic embryogenesis. (**2**hrs.)

6. Different phases of micro propagation – multiple shoot induction, shoot elongation, *in vitro* and *in vivo* rooting hardening, transplantation and field evaluation; advantages and disadvantages of micro propagation, soma clonal variation. (**2**hrs.)

Module – II (8 hrs.)

1. Methods and Applications of tissue culture:

1. Shoot tip and meristem culture.
2. Somatic embryogenesis and synthetic seed production.
3. Embryo culture.
4. Protoplast isolation culture and regeneration: transformation and transgenics
5. Somatic cell hybridization, cybridization.
6. *In vitro* secondary metabolite production: cell immobilization, bioreactors
7. *In vitro* production of haploids – anther and pollen culture
8. *In vitro* preservation of germplasm

PRACTICAL (TISSUE CULTURE)

1. Preparation of nutrient medium – Murashige and Skoog medium using stock solutions.
2. Familiarize the technique of preparation of explants, surface sterilization, inoculation and subculturing.
3. Preparation of synthetic seeds.
4. Demonstration of anther culture.

REFERENCES (TISSUE CULTURE)

- Gamborg, O.L. & G.C. Philips (Eds.) (1995). Plant Cell, Tissue and Organ Culture: Fundamental Methods. Narosa Publishing House, New Delhi.
- Razdan MK (1995) Introduction to Plant Tissue Culture. Oxford & IBH publishing Co. Pvt.Ltd.
- Reinert & Bajaj. Plant Cell, Tissue and Organ Culture.
- Edwin F. George, Michael A. Hall and Geert-Jan De Klerk. (2008) Plant propagation by tissue culture Volume 1. The Background. Springer, P.O. Box 17, 3300 AA Dordrecht.
- Madhavi Adhav (2010) Practical book of Biotechnology and Plant Tissue culture, S Chand,
- New Delhi.
- Bhojwani, San Saran, Danu, Prem Kumar (2013) Tissue Culture : An Introductory Text. Springer.

HORTICULTURE

Module - I. (5 hrs)

1. Introduction, scope and significance; branches of horticulture. (**1**hr)
2. Soil- components of soil, types of soil. (**1**hr.)
3. Fertilizers – Chemical, organic, bio fertilizer, compost. (**1**hr.)
4. Pots & potting – earthen, fiber, polythene bags, potting mixture, potting, repotting, top dressing. (**1**hr.)
5. Irrigation – Surface, sprinkle, drip and gravity irrigation. (**1**hr.)

Module – II (7 hrs.)

1. Seed propagation –seed quality tests, seed treatment, essential condition for successful propagation: raising of seed beds, transplanting techniques. (**3**hrs.)

2. Vegetative propagation: (**4**hrs.)

1. Cutting (stem, roots)
2. Grafting (approach, cleft)

3. Budding (T-budding, patch)
4. Layering (simple, air).

Module - III.(6 hrs.)

1. Gardening – site selection; propagating structure: green house, poly house, moist chamber, net frame – Garden tools and implements. (**1**hr.)
2. Indoor gardening – selection of indoor plants, care and maintenance of indoor plants, Bonsai – Principle, creating the bonsai. (**1**hr.)
3. Outdoor gardening; landscaping- goals, types. (**1**hr.)
4. Cultivation and post-harvest management of vegetables and ornamental plants. (**1**hr.)
5. Protection of horticultural plants: Precautions to avoid pests and diseases, bio pesticides. (**1** hr.)
6. Mushroom cultivation – Oyster mushroom (**1**hr.)

PRACTICAL (HORTICULTURE)

1. Preparation of nursery bed and polybag filling.
2. Preparation of potting mixture – Potting, repotting.
3. Field work in cutting, grafting, budding, layering **(**drawing not required).
4. Familiarizing gardening tools and implements. (drawing not required)
5. Establishment of vegetable garden/ Visit to a horticulture station.
6. A brief report of item no. 5 may be recorded.

REFERENCES (HORTICULTURE)

- Andiance and Brison. (1971). Propagation HorticulturalPlants.
- Chanda, K.L. and Choudhury, B. Ornamental Horticulture inIndia.
- George Acquaah, (2005) Horticulture: Principles and Practices. Pearson Education, Delhi.
- Hudson, T. Hartmann, Dale K. Kester, Fred T. Davies, Robert L. Geneve,Plant Propagation, Principles andPractices.
- Katyal, S.C., Vegetable growing in India, Oxford, NewYork.
- Kolay, A.K. Basic Concepts of Soil Science. New Age International Publishers,Delhi.
- Naik, K.C., South Indian Fruits and theirCulture.
- Nishi Sinha: Gardening in India, Abhinav Publications, NewDelhi.
- Prakash, R and K. Raj Mohan, Jaivakrishi (Organic farming), State Institute of Languages, Thiruvananthapuram.
- Prasad, S., and U. Kumar. Green house Management for Horticultural Crops, Agrobios, Jodhpur.

ECONOMIC BOTANY

Study the different category of economically important plants their Binomial, Family and Morphology of useful part, products and uses: (**9** hr.)

1. Cereals and Millets – Rice, Wheat, Maize and Ragi
2. Pulses and legumes – Green gram, Bengal gram, Black gram
3. Sugar – Sugarcane
4. Fruits – Apple, Pine Apple, Papaya, Banana, Mango, Guava, Jack, Grapes, Sapota
5. Vegetables – Carrot, Beet Root, Corm, Potato, bitter gourd, Cucumber, Snake gourd, Ladies finger, Cabbage, *Amaranthus*
6. Ornamentals – Rose, *Anthurium*,Jasmine
7. Masticatories – Betel vine, Betel nut, Tobacco
8. Beverages – Coffee, Tea,Cocoa
9. Fibre – Coir, Cotton,Jute
10. Timber – Teak, Rose wood, Jack, *Ailanthus*.
11. Fats and oils – Coconut, Gingelly, Sunflower

12. Latex –Rubber

13. Gums and Resins – Dammar, Gum Arabic, Asafoetida

14. Spices – Pepper, Ginger, Cardamom, Clove, Nutmeg, Allspice, Cinnamon

15. Medicinal – *Adhatoda*, *Catharanthus*, *Phyllanthus*, *Rauvolfia*, *Aloe*

PRACTICAL (ECONOMIC BOTANY)

1. Students shall be able to identify plants or plant products (raw or processed) studied in theory and shall be able to write Botanical names, Family and morphology of useful parts of source plants.

Students need not make any illustrations but make a table in the record giving the details of the items mentioned in the theory syllabus.

REFERENCES (ECONOMIC BOTANY)

- Bendre Kumar 2000: Economic Botany' Rastogi Publications, Shivaji road, Meerut.
- Jain. S. K. 1981. Glimpses of Indian Economic Botany.Oxford.
- Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4thedition.

ETHNOBOTANY

1. Introduction, scope and significance (**1**hr.)

2. Major tribes of South India. Importance of Traditional Botanical Knowledge, TBGRI model of Benefit Sharing. (**2** hrs.)

3. Ethnobotanical significance of the following: (**6**hrs.)

1. Aegle marmelos

2. Ficus religiosa

3. Curcuma longa

4. Cynadon dactylon

5. Ocimum sanctum

6. Trichopus zeylanicus

PRACTICAL (ETHNOBOTANY)

Students are expected to identify the plants mentioned in the Ethnobotany syllabus and it must be given as a table showing Common name, Binomial, Family and Ethnobotanical significance in the record book. (Drawing not required)

REFERENCES (ETHNOBOTANY)

- Baker. H.G. (1970) Plant and Civilization.
- Jain. S. K. (1995). A Manual of Ethnobotany. Scientific Publishers,Jodhpur.
- Cotton, C.M. (1996) Ethnobotany – Principles and Applications. Wiley andSons

COURSE CODE: **IBC4B08T**

COURSE TITLE: BASIC MATHEMATICS IN BIOLOGICAL SCIENCES

Module I (9 h)

Introductory concepts and Scilab: Review of basic mathematics: Co-ordinate geometry, equations of line, circle and sphere; Trigonometric functions, graphs of functions, types of functions: linear functions, Inverse Functions, Exponentials and logs; Graphical solution of equations of the form f(x) = 0. Scilab, Basic environment, data types, variables, operators, programming, built-in function and user defined function.

Module II (9 h)

Vectors and Matrices: Vectors & Matrices: Scalars & Vectors, addition, subtraction, dot, cross & scalar triple products; Matrices: types, addition, subtraction, multiplication, transpose & inverse (general idea only), determinants, solutions of simultaneous equations using matrices.

Module III (9 h)
Set theory: permutation, combination: Set theory, sets, elements, set operation, finite &countable sets, counting, factorial, permutation, combination, binomial coefficients.

Module IV (18 h) - Biostatistics

- The science of statistics and its applications in biological research.
- Types and collection of data- Census; Sampling- theory and methods.
- Tabulation and presentation of data- diagrammatic and graphic presentation.
- Analysis of data- measures of central tendency: mean, median, mode, geometric mean, harmonic mean, and percentile.
- Measures of dispersion - Range, quartile deviation, mean deviation, standard deviation and standard error. Relative measures of dispersion - coefficient of variation.
- Probability and Statistics: Basic concepts; sample space & events, laws of probability, conditional probability: Baye's theorem, Random variables: probability distribution, binomial, Poisson, normal etc.; Sampling; Markov's processes.
- Tests of significance- formulation and testing of hypothesis- testing the probability of committing type 1 and type 2 errors. z test, t test, chi-square test and ANOVA

Module V (9 h) – Applied Statistics

- Scope of statistical methods
- Analysis of variance- one way classification and two way classification, F test, F value calculation, F table.
- Correlation and Regression analysis- coefficient of correlation- significance testing. Rank correlation.
- Experimental designs- designing an experiment- CRD, RBD, LSD. Factorial experiments.
- Statistical softwares- SPSS, SPAR, MINITAB

REFERENCES:

- Aitken, M., Broadhurst, B., & Hladky, S. (2008). Mathematics for biological scientists. New York [etc.]: Garland Science [etc.].
- Isaev, A. (2006). Introduction to mathematical methods in bioinformatics.Springer.
- Lipschutz, S., & Schiller, J. J. (1998). Schaum's Outline of Theory and Problems of Introduc-tion to probability and statistics.McGraw-Hill.
- Olive, J. (2000). Maths: A Self-study Guide. Cambridge UniversityPress.
- Ramachandran, H., Nair, A.S. (2012). (Scilab: Free Software to Matlab). S. ChandLimited.
- Russell, B. (1903). The principles of mathematics (Vol. 1, p. 173). Cambridge, UP:Cam-bridge.
- Stewart, J. (2008). Calculus Early Transcendentals, 6e. Bob Pirtle, Belmont, CA 94002USA,883-886.
- Sundar Rao, P. S. S., & Richard, J. (1996). An introduction to biostatistics. New Delhi. Prentice-Hall India, 19,135-52.

SEMESTER 5

COURSE CODE:IBC5B10T

COURSE TITLE:**ANGIOSPERM MORPHOLOGY AND**

SYSTEMATICS PART1

ANGIOSPEM MORPHOLOGY

1. Technical description of a flowering plant (brief) (**2**hr.)

2. Inflorescence: racemose, cymose and specialised (cyathium, hypanthodium, coenanthium, verticillaster, thyrsus) (**3**hr.)

3. Flower: Flower as a modified shoot, detailed structure of flowers, floral parts –their arrangement, relative position, cohesion and adhesion - symmetry of flowers. (**4**hr.)

4. Fruits– simple, aggregate and multiple with examples; Seed structure - dicot and monocot - albuminous and ex-albuminous, aril, caruncle; Dispersal of fruits and seeds - types and adaptations. (**5**hr.)

PRACTICAL (ANGIOSPEM MORPHOLOGY)

1. Identify the types of inflorescence and fruits mentioned in the syllabus.

2. All the types mentioned under inflorescence and fruits must be represented in the photo album.(All drawings in records are replaced by photo album submission).

REFERENCES (ANGIOSPEM MORPHOLOGY)

- Gangulee, H.C., J.S. Das & C. Dutta. (1982) College Botany (5th Ed.) New CentralBook
- Agency,Kolkata.
- George, H.M. Lawrence. (1951) Introduction to Plant Taxonomy. Mac Millan comp.Ltd.,
- NewYork.
- Simpson, M. G. (2006) Plant Systematics. Elsevier Academic Press,London
- Sporne, K.R. (1974) Morphology of Angiosperms. Hutchinson University Press,London.

SYSTEMATICS

Module-I (**7**hr.)

1. Components of systematics: identification, description nomenclature and classification; objectives and importance of systematics (**2**hr.)

2. Systems of classification: Artificial– Linnaeus; Natural– Bentham and Hooker; Phylogenetic – Hutchinson; Angiosperm Phylogeny Group system (**4**hr.)

Module – II (**12**hr.)

1. Detailed study (systematic position, distribution, common members, diagnostic features, description from habit to fruit and economic importance of the following families. Annonaceae, Malvaceae, Meliaceae, Fabaceae with sub families, Myrtaceae, Cucurbitaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Liliaceae, Orchidaceae and Poaceae.

Module- III (**9** hr.)

1. Taxonomic structure: Hierarchy; Concepts of taxa; Species: Biological, Phenetic and Phylogenetic; Genus; Family. (**2**hr.)

2. Taxonomic character – concept, primitive and advanced characters, sources, comparative morphology, vegetative, reproductive, macro and micromorphology; modern trends in taxonomy, cytotaxonomy, chemotaxonomy, numerical taxonomy, molecular taxonomy and phylogenetics. (**4** hr.)

3. Contributions of eminent Taxonomists viz Hendrik van Rheede, William Roxburgh, Robert Wight, J. S. Gamble and EK Janaki Ammal. (**2**hr.)

Module – IV (**12** hr.)

1. Plant Nomenclature – Limitations of common name, ICN **-** Principles (introduction only); Typification (holotype, isotype, syntype paratype and lectotype); Priority– merits and demerits; Effective and valid publication; Author citation. (**3**hr.)

2. Plant identification – Keys; indented and bracketed, construction and applications. (**2**hr.)

3. Taxonomic information resources – Herbarium preparation and maintenance, Herbarium types: International- Kew (K); National-Central national herbarium (CAL), MH Coimbatore,Virtual herbarium, Botanic Gardens: RBG, Kew; IGB, Kolkotta; JNTBGRI Thiruvananthapuram and MBGIPS, Kozhikode. (**4** hr.)

4. Taxonomic literature- Floras, e-Flora, Monographs, Revisions, Journals and online resources & Databases. (**3**hr.)

PRACTICAL (SYSEMATICS)

1. Students are expected to work out at least two members of each family mentioned in the syllabus and make suitable diagrams (floral diagram and floral formula not needed). Describe them in technical terms and identify up to species using the Flora. Orchidaceae may be excluded from practical examination scheme.
2. Students shall be able to prepare artificial key to segregate any five given plants. This must be recorded.
3. Familiarization of herbarium techniques (Demonstration only).
4. Mounting of a properly dried and pressed specimen of any common wild plant (rare, endangered or endemic plants should not be collected for the purpose) from any one of the families mentioned in the syllabus, with proper herbarium label (to be submitted in the record book).
5. Every student shall submit original images of plants, at least one from each family mentioned in the syllabus, duly certified by Head of the department, at the time of examination. The images of plants should be properly identified and they should carry details like systematic position, GPS location, date, name and reg. no. of the student etc. Habitat, Habit,

Inflorescence and single flower should be represented. Web sourced and outsourced images should not be used. The images can be submitted along with the photo album containing images of inflorescence and fruits mentioned under morphology. Individuality should be strictly maintained while preparing the photo album.

6. It is compulsory that every student has to undertake field study trips of 3-5 days to study vegetation of ecologically different areas, under the guidance of teachers. Visits to standard Herbaria, Organizations/ Institutes involved in exploring plant resources, Botanical museums etc. may be conducted as part of study tour. Local habitats like sacred groves, rice fields, wetlands, forests, grasslands etc. also can be selected for field trips. Avoid visit to tourist places with meager plant diversity and of having only entertainment value. Submit a field visit report countersigned by the Head of the department during the practical examination.
7. If a student fails to undergo the study tour he /she may not be permitted to attend the examination.

REFERENCES (SYSEMATICS)

- Bharati Bhattacharyya (2009) Systematic Botany, Narosa Publishing House Pvt. Ltd.,New Delhi.
- Burkill, I.H. (1965) Chapters on the History of Botany in India,Delhi.
- Clive A. Stace (1991) Plant Taxonomy and Biosystematics, Cambridge UniversityPress.
- Davis, P.H. & V.H. Heywood, (1963) Principles of Angiosperm Taxonomy. Oliver &Boyd Ltd., London.
- Gurucharan Singh (2012) Plant Systematics- Theory and Practice. Oxford & IBH, NewDelhi.
- Gurucharan Singh, (2019) Plant Systematics - An Integrated Approach, 4th edition. CRC Press.Florida.
- Jeffrey, C. (1968) An introduction to Plant Taxonomy, Cambridge University Press,London.
- Mondal A.K. (2009) Advanced Plant Taxonomy, New Central Book agency Pvt. Ltd. Kolkata.
- Nicholas J. Turland *e al*. (2018) International Code of Nomenclature for algae, fungi, and plants- Shenzhen Code (printed/ electronic version) Koeltz BotanicalBooks.
- Pandey, S.N. & S.P. Misra. (2008) Taxonomy of Angiosperms. Ane Books India,New Delhi.
- Radford, A.E. (1986) Fundamentals of Plant Systematics. Harper & Row Publishers, New York.
- Sambamurthy A.S.S. (2005) Taxonomy of Angiosperms, I.K. International Pvt. Ltd, New Delhi.
- Sharma, B.D. *et al*. (Eds.) (1996) Flora of India, Vol. I. Botanical Survey of India,Kolkata.
- Simpson, M.G. (2006) Plant Systematics. Elsevier Academic Press, London
- Sivarajan, V.V. (1991) Introduction to Principles of Plant Taxonomy. Oxford & IBH,New Delhi.
- Stuessy, T.F. (1990) Plant Taxonomy – The systematic evaluation of Comparativedata.

Columbia University Press, NewYork.

COURSE CODE: **IBC5B11T**

COURSE TITLE: CELL BIOLOGY& BIOCHEMISTRY

CELL BIOLOGY

Module I (7 hr.)

1. Architecture of cells. Prokaryotic and Eukaryotic cells.

2. Structure and function of the following: Cell membrane (fluid mosaic model), Endoplasmic reticulum, Golgi complex, mitochondria, chloroplast, Lysosomes Glyoxisomes Ribosomes Cytoskeleton Cytosol Vacuole

3.Interphase nucleus- Nuclear membrane; Nuclear pore complex; organization of interphase Nucleus; Euchromatin and heterochromatin; Nucleolus

4. Chromatin organization- nucleosomes scaffold. Organization of eukaryotic chromosome .Heterochromatin- constitutive, facultative and condensed. Euchromatin. Satellite DNA. Chromosome banding and its significance.

Special types of chromosomes–Polytene chromosomes, lamp-brush chromosomes. Chromosomal changes: structural aberrations: deletion, duplication, inversion, translocation - their meiotic consequences and significance.

Numerical aberration - Definition - Basic chromosome number (Genomic Number) Aneuploidy, Haploidy and Polyploidy - their meiotic behaviour and significance

5. Cell reproduction: Cell cycle-Mitosis, Specific events G1, S, G2 and M phases. Significance of G0. Control of cell cycle. Significance. Gene expression during cell cycle. Mitotic Inducers.

Module II(11hr)

5. Meiosis: types, synaptonemal complex, significance of meiosis. Genetic control and consequences of meiosis. Restriction points and check points. Cell cycle regulation of meiotic events- behaviour of sex chromosomes in meiosis- suppression of DNA replication between Meiosis I and II. Meiotic defects and human diseases.

Module III(9 hr.)

6. Programmed cell death- necessity, classes, signals. Genetic analysis of cell death. Proteins regulating apoptosis.

Pathways leading to cell death- significance. Aging- cellular and extracellular. Cell signaling.

7. Cell interactions-communication, recognition and adhesion. Application.

8.Cellular differentiation and specialization. General characteristics, intrinsic interactions- Nucleo- cytoplasmic. Extrinsic interactions. Molecular mechanisms of cellular differentiations.

Module – IV(7 hr.)

9. Cancer- carcinogenic agents. Phenotype of the transformed cell. Genetic basis of malignant transformation oncogenes.

Tumour suppressor genes. Cancer and cell cycle. Metastasis. Interaction of cancer cells with normal cells.

PRACTICAL

1. Study of Mitosis in root tip cells. Calculation of mitotic index

2. Pre-treatment of root típs with colchicine /hydroxy quinoline /paradichlorobenzene and study of chromosomes in Chlorophytum/ Zea mays/ Crotalaria/ Cyanotis.

3. Isolation of plastids and mitochondria.
4. Chromosome banding

REFERENCES:

1. Cooper Jeffrey M. The Cell- A Molecular Approach. ASM,Washington.
2. Karp Gerald. Cell Biology. JohnWiley andSons.
3. Derobertis. Cell and MolecularBiology.
4. Pollard T.D. and Earn Shaw W.C. Cell Biology.Saunders.

Biochemistry

module– I (3 hr.)

1. The molecular logic of life.

2. The chemical unity of diverse living organisms.

3. Weak interactions in aqueous systems and the fitness of the aqueous environment for living organisms.

Module I I (13hr.)

4. Biomolecules: a- Carbohydrates- Classification, structure and functions of simple sugars and compound carbohydrates. Sugar derivatives of biological importance.

b- Lipids. Classification- storage and structural lipids;
lipids in membranes; the supramolecular architecture of membranes.

c- Amino acids, peptides and proteins.

Amino acids: classification based on polarity; properties. Covalent structure of proteins. Three dimensional structure of proteins. Protein- tertiary and quaternary structures. Native conformation and biological functions of proteins, Denaturation and renaturation. Functions of protein.

d-Nucleotides and nucleic acids. Structure and function of nucleotides and nucleotide derivatives.

Module- I I I (4 hr.)

5. Secondary metabolites: Secondary metabolites, their physiological roles. Significance- ecological and phylogenetic importance

6. Enzymes Classification (IUB), Mechanism of enzyme action, optimization of weak interactions in the transition state. Co-enzymes, inhibition, regulation: allosteric enzymes, covalently modulated enzymes. Isoenzymes.

PRACTICALS

.Qualitative tests for monosaccharides, and reducing non reducing oligosaccharides, starch, amino acids and protein

- Molisch’s test for all carbohydrates
- Benedict’s test for reducing sugars
- Barfoed’s test for monosaccharides
- Seliwanoff’s test for ketoses
- Fearson’s test (methyl amine test) for reducing disaccharides
- Iodine test for starch
- Ninhydrin test for amino acids and protein
- Xanthoproteic test for amino acids with aromatic R-groups
- Millon’s test for tyrosine
- Hopkins- Cole test for tryptophan
- Biuret test for peptide linkage and proteins

Qualitative tests for lipids. Emulsification, saponification, acrolein test, Boundouin'stest.
Quantitative estimation of protein by Biuret / Branford's /Lowry et al method.
Quantitative estimation of DNA and RNA (colorimetric /spectrophotometric)
Quantitative estimation of total phenolics.

REFERENCES:

- Cooper Jeffrey M. The Cell- A Molecular Approach. ASM,Washington.
- Karp Gerald. Cell Biology. JohnWiley andSons.
- Derobertis. Cell and MolecularBiology.
- Pollard T.D. and Earn Shaw W.C. Cell Biology.Saunders.

COURSE CODE: **IBC5B12T**

COURSE TITLE: GENETICS & PLANT BREEDING

GENETICS

Module – I (**23** hrs.)

1. Introduction- Mendel's life history (brief), Mendelian experiments: Monohybrid cross and dihybrid cross, Mendelian ratios, Laws of inheritance; Back cross, test cross. (**5**hrs)
2. Modified Mendelian ratios:

a. Allelic interactions: dominant – recessive, Incomplete dominance – flower color in Mirabilis; Co dominance – Coat colour in cattle, Blood group in human beings; Lethal genes – Sickle cell anemia in Human beings. Modified dihybrid ratios by incomplete dominance of one pair of gene (3:6:3:1:2:1) and both pairs (1:2:1:2:4:2:1:2:1). (**6**hrs)

b. Interaction of genes: Non epistatic - Comb pattern inheritance in poultry (9:3:3:1): Epistasis: dominant - Fruit colour in summer squashes; Recessive epistasis - Coat color in mice; Complementary gene interaction- flower color in *Lathyrus*. (**6**hrs)

3. Multiple alleles- general account: ABO blood group in man, Self sterility in *Nicotiana*, Coat colour in Rabbits. (**3**hrs.)
4. Quantitative inheritance / polygenic inheritance / continuous variation- Skin color in human beings, Ear size in maize. (**3**hrs.)

Module –II (**13** hrs.)

1. Linkage and crossing over- importance of linkage, linkage and independent assortment. Complete and incomplete linkage. Crossing over general account, 2 point and 3 –point
2. crossing over, cytological evidence of genetic crossing over. Determination of gene sequences; interference and coincidence; mapping of chromosomes. (**7** hrs)
3. Extra nuclear inheritance- general account- maternal influence- plastid inheritance in *Mirabilis*, Shell coiling in snails. (**3** hrs)
4. Population genetics; Hardy –Weinberg law and equation (**3**hrs)

PRACTICAL (GENETICS)

1. Students are expected to work out problems related to the theory syllabus. One problem each from all the types mentioned should be recorded.

a. Monohybrid cross
b. Dihybrid cross
c. Test cross and backcross
d. Determination of genotypic and phenotypic ratios and genotype of parents
e. Non-epistasis
f. Complementary gene interaction
g. Epistasis: dominant and recessive
h. Polygenic interaction
i. Multiple allelism
j. Chromosome mapping
k. Calculation of Coincidence and interference

REFERENCE (GENETICS)

- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction toGenetic
- Analysis. W. H. Freeman and Co., U.S.A. 10thedition.
- Gunther, S. Spend & Richard Calender (1986) - Molecular Genetics CBS PublishersDelhi.
- Gupta, P.K. (2018 -19) Genetics. Revised edition. Rastogi Publications,Meerut
- John Ringo (2004) Fundamental Genetics Cambridge UniversityPress.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics.Benjamin
- Cummings. U.S.A. 9thedition.
- Lewin B. (2000) Genes VII Oxford UniversityPress.
- RastogiV.B. (2008) Fundamentals of Molecular Biology, Ane Books,India.
- Sinnot, W.L.C. Dunn & J. Dobzhansky (1996) Principles of Genetics. TataMc
- Graw Hill Publishing Company Ltd., NewDelhi.
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons Inc., U.S.A. 5th edition.
- Verma, P.S. & Agarwal (1999) Text book of Genetics. S. Chand & Co., NewDelhi.

PLANT BREEDING

Module-I (**4** hrs.)

1. Definition and objectives of Plant breeding – Organization of ICAR and its role inplant breeding. (**2**hrs.)
2. Plant Genetic Resources - Components of Plant Genetic Resources. (**2**hrs)

Module-II (**14** hrs.)

A. Breeding techniques (**12** hrs.)

1. Plant introduction: Procedure, quarantine regulations, acclimatization- agencies of plant introduction in India, major achievements.
2. Selection -mass selection, pure line selection and clonal selection, genetic basis of selection, significance and achievements.
3. Hybridization – procedure; intergeneric, interspecific and intervarietal hybridization with examples; composite and synthetic varieties.
4. Heterosis breeding - genetics of heterosis and inbreeding depression.
5. Mutation breeding – methods -achievements.
6. Polyploidy breeding
7. Breeding for disease and stress resistance

B. Modern tools for plant breeding: Genetic Engineering and products of genetically modified crops (brief mentioning only). (**2**hrs.)

PRACTICAL (PLANTBREEDING)

1. Techniques of emasculation and hybridization of any bisexual flower.
2. Floral biology of Paddy, any one Pulse and Coconut tree.
3. Visit to a plant breeding station and submission of its report.

REFERENCES (PLANT BREEDING)

- Allard. R.W. (1960). Principles of Plant breeding, John Wiley & Sons, Inc, NewYork.
- Chaudhari. H.K. Elementary Principles of Plant breeding, Oxford & IBHPublishers.
- Singh, B.D. (2005). Plant Breeding: Principles & methods, Kalyani Publishers, NewDelhi.
- Sinha U. & Sunitha Sinha (2000) Cytogenetics, Plant breeding & Evolution,Vikas PublishingHouse.
- 5. Swaminathan, Gupta & Sinha (1983) Cytogenetics of Crop plants Macmillan IndiaLtd.

COURSE CODE: **IBC5B13T**

COURSE TITLE: ENVIRONMENTAL SCIENCE

Module - I

1. Ecosystem: Definition, abiotic and biotic factors, trophic structure, Food chain and food web, Ecological pyramids, Energy flow, Productivity of ecosystems. (**4**hrs.)
2. Biogeochemical cycles (Carbon, Nitrogen, Phosphorous) (**3**hrs.)
3. Plant adaptations: Adaptations in Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites. (**3**hrs.)
4. Plant Succession: Definition – Primary and Secondary succession; Autogenic and allogenic succession; Mechanism of plant succession–Xerosere and Hydrosere (**4**hrs.)

Module-II

1 Biodiversity and Conservation: Definition; Biodiversity - Global and Indian Scenario; Megadiversity nations and hotspots: Biosphere reserves; Biodiversity centers in India. (**5** hrs.)

2 Threats to biodiversity; Endangered and endemic plant species, Red data book, Exotic and indigenous plant species, Keystone species, Flagship species, Umbrella species, Indicator species. (**4** hrs.)

3 Conservation strategies *ex situ* and *in situ* methods. Organizations– IUCN, UNEP & WWF; (NBPGR), Kerala state Biodiversity Board (KSBB). (**4**hrs.)

Module-III

1 Pollution: Sources and types of pollution – air, water, soil, thermal and noise ;biodegradableand non-biodegradable pollutants; bio magnification; BOD. (**4** hrs.)

2 Global environmental changes – climatic changes – global warming and greenhouse gases, acid rains, el-nino, efforts of world organizations in the regulation of greenhouse gases emission. (**5**hrs)

3 Management of environmental pollution – conventional and phyto technological approaches – solid wastes management including e-wastes- environmental legislations in India (Prevention and Control of Pollution act, 1981). (**5**hrs.)

Module- IV

1 Major ecosystems of the Biosphere; Sea; Estuarine ecosystem; Lentic ecosystem: lake, Pond; Lotic ecosystem: river; Desert; Forest; Grass land. (**5**hrs.)

2 Techniques in plant community studies – Quadrat and transect methods– species area curve– density, frequency, abundance, dominance of populations– importance value index – construction of phytographs. (**8**hrs.)

PRACTICAL

1. Construct a food web from the given set of data, (Representative of a natural ecosystem). (Drawing not required).
2. Construct ecological pyramids of number, biomass and energy from the given set of data (Representative of a natural ecosystem). (Drawing not required).
3. Study of plant communities: Determination of density, abundance, dominance, frequency by quadrat method.
4. Demonstration of determination of Dissolved Oxygen by Winkler's method.
5. Study of morphological and anatomical characteristics of plant groups: Hydrophytes, Xerophytes, halophytes, epiphytes, parasites. (Drawing not required).

REFERENCES

- Beeby A. & Brennan A.M. (2004) First Ecology. Ecological Principles and Environmental Issues. Oxford UniversityPress.
- Cunninghan W.P. and M.A. Cunningham (2003). Principles of EnvironmentalScience: Inquiry and Applications. Tata McGraw Hill Pub.N.D.
- Dash M.C. (1993). Fundamentals of Ecology. Tata McGraw Hill Publishing Company Ltd. NewDelhi.

- Dix J.H. (1989). Environmental Pollution. Atmosphere, Land, Water and Noise. Wiley Chichester.
- Khitoliya R.K. (2007). Environmental Pollution – Management and Control for Sustainable development S. Chand and Company Ltd., NewDelhi.
- Mishra D.D (2008). Fundamental Concepts in Environmental Studies. S. Chand&Co., New Delhi.
- Mishra S.P. & S.N. Pandey (2008). Essential Environmental Studies. Ane BooksPvt. Ltd.Thiruvananthapuram.
- Odum E.P. (1983). Basics of Ecology. Saunders International UNEdition.
- Shukla R.S. & P.S. Chandel (2005). A Text Book of Plant Ecology S. Chand & Co. Ltd. New Delhi.
- Wise, D.L.(2005) Global Environmental Biotechnology. Ane Books.Thiruvananhapuram.
- Bharucha E. (2005) Text Book of Environmental Studies for UG courses.University Press (India) Private Limited Hyderabad.
- Diamond, J., T.J. Case (1986). Community ecology. Harper & Row, NewYork.
- Futuyma P.J., Slatkin M. (1983) Co-evolution. Sinauer Associates, SunderlandMass.
- Krebs, C.J. (1985). Ecology 3rd edn. Harper & Row NewYork.
- Sharma, P.D. (2008-2009). Ecology and Environment. RastogiPublication.
- Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth SystemsApproach.Oxford University Press.U.S.A.

SEMESTER-6

COURSE CODE: IBC6B14T

COURSE TITLE: CREATIVITY, RESEARCH & KNOWLEDGE MANAGEMENT

Module I:(8 hr.)

Creativity & Thinking Skills: Various views on creativity; creativity & innovation, critical thinking; logical thinking – inductive & deductive logic – common logical fallacies

Module II(9hr.)

Research and it types : Various outlooks on research: pure versus applied, incremental versus innovative, qualitative versus quantitative; Philosophy of science; the scientific method, the research process –creative question – hypothesis – planning and designing of experiments – critical analysis – sources of errors and minimization.

Module III:(12hr.)

Research Report Writing: Format of a science research paper – the IMRAD format – objectives of each section reference citing styles; Proof reading & editing; Publishing Science: Authorship; Publication process - Peer review – single/double blind and open; fabrication, falsification and plagiarism – Turnitin; Open Access Publications and other emerging trends in scientific communication; case study of paper writing and peer review; popular journals in Computational Biology & Bioinformatics (brief overview of their scope).

Module IV:(11hr.)

Knowledge Management Skills: Advanced internet search skills – specialized academic search; Google scholar and Scopus; Bibliometrics and webometrics – impact factors –h, h-b and g indices pitfalls in interpreting impact; Reference management tools: diigo, zotero, endnote; Current awareness: RSS feeds, TOC alerts, DB alerts.

Module V: (7hr.)

IPR awareness: Copy lefts, copyrights and patents; IPR of software and life forms; Brief overview of IPR laws in India - Protection of traditional knowledge; Patent amendment of 2005 and its impact; Overview of International treatise – GATT, TRIPS; India as an emerging Knowledge power; Ethics – its role in scientific research and academics, conflict of interests; aca-demia-industry collaborations. Geographical Indication (GI) tag; Benefits of GI tag in agriculture

Module V(6 hrs.)

I (Flexi module)- *Only for Internal Assessment. Lecturers may expand and/ or interpret the syllabus to update it or suit the particular cohort in any way)*: Allied Topics: Profile of key Bioinformatics/CB/ pharmaceutical institutions and industries in India& abroad. Overview of Bioinformatics policy of Govt. of India; Job opportunities in CB/BI & skill profiles; Quality – basic concepts – popular certifications; Making effective multi-media and poster presentations; Professional Societies in the field – their role in research and knowledge dissemination.

REFERENCES:

- Day, R., Gastel, B. (2012). How to write and publish a scientific paper. Cambridge UniversityPress.
- Katz, M. J. (2009). From Research to Manuscript: A Guide to Scientific Writing.Springer.
- Lee, J. A. (2000). The scientific endeavor: A primer on scientific principles and practice. Ben-jamin Cummings.
- Lester, J.D.(2005).Research Paper Handbook: Your Complete Guide. Good YearBooks.
- Lowe, P. (1995). Creativity and problem solving.McGraw-Hill.
- Murray, R. (2010). How to Write a Thesis. McGraw-HillEducation.
- Rao, R.A., Rao, B.(2008). Intellectual Property Rights: A Primer. Eastern BookCompany.
- Ruxton, G., & Colegrave, N. (2011). Experimental design for the life sciences. Oxford Univer-sity Press.
- Trochim, P. D. W. M. (2003). Research methods. DreamtechPress.

COURSE CODE: **IBC6B15T**
COURSE TITLE: PLANT PHYSIOLOGY AND METABOLISM

Plant Physiology

Module – I(5hr.)

1. Water and plant cells: Properties of water, hydrogen bonding, polaritv, cohesion and adhesion. Diffusion, osmosis, imbibition, plant cell as an osmotic system, osmotic pressure, osmotic potential, turgor pressure, wall pressure, water potential and its components.
2. Water movements in cells and tissues. Soil-plant atmosphere continuum. Transpiration, stomatal movement, modern theories of stomatal mechanism. Why transpiration? Anti-transpirants.
3. Absorption of water by transpiration pull and cohesion of water molecules. Radial movement of water through root. Soil-plant-atmosphere continuum of water.
4. The ascent of xylem water and the uptake of water by roots. Transpiration pull and cohesion of water molecules. Merits and demerits of cohesion-tension theory.
5. .Absorption of mineral ions- solute absorption.

Module II (7 hr.)

6. Plants and nitrogen: The nitrogen cycle. Biological nitrogen fixation, symbiotic nitrogen fixation in leguminous plants. Biochemistry of nitrogen fixation. Export of fixed nitrogen from nodules. Genetics of nitrogen fixation. Nitrogen assimilation, assimilation of nitrate. Nitrogen nutrition -agricultural and ecological aspects.

Biosynthesis of amino acids- reductive amination and transamination. GDH and GS/ GOGAT pathway.

Module III (10 hr.)

7. Photosynthesis: Absorption and fate of light energy, absorption and action spectra. Photoreceptors-chlorophylls, carotenoids, phycobilins. Bio energetics and the light dependent reactions of photosynthesis. Photosynthetic electron transport and photophosphorylation. The two pigment systems ,Z-scheme, water oxidizing clock. The photosynthetic carbon reduction cycle, C3, C2,C4 and CAM metabolism and ecological significance.

8. Translocation and distribution of photo assimilates. Phloem transport, Sources and sinks, mechanism of translocation. Phloem loading and unloading, distribution of assimilates. Translocation of xenobiotic chemicals.

Module IV(8hr.)

9. Patterns in plant development: Growth, differentiation, and development . Genetic control and hormonal regulation of development. Seed germination- physiology of hormones in plant development- auxins, gibberellins, cytokinins, abscisic acid and ethylene. Role of vitamins and nutrients.

Plant movements- phototropism, gravitropism. nyctinastic and seismonastic movements.

10. Photomorphogenesis: Phytochrome: chemistry and physiological effects. Mechanism of phytochrome and gene action. Cryptochromes and blue light effect

11. Seed dormancy and germination.

12.Stress Physiology: Types of stress- water, temperature, salt, stresses caused by pests and pathogens and pollutants.

PRACTICALS

1. Determination of water potential by tissue weight change method.
2. Extraction of leaf pigments and preparation of absorption spectra of chlorophylls and carotenoids.
3. Demonstration of Hill reaction.
4. Separation of leaf pigments by paper chromatography and column chromatography.
5. Effects of light intensity on photosynthesis by Wilmot's bubbler.
6. Thistle funnel osmoscope
7. Ganong’s photometer
8. Ganong’s light screen
9. Ganong’s respirometer
10. Kunhe’s fermentation vessel
11. Mohle’s half leaf experiment
12. Absorbo-transpirometer
13. Determination of sugars and amino acids in germinating seed by TLC.
14. Extraction of seed proteins based on solubility.
15. Biochemical analyses of leakages from seeds during germination.
16. Analyses of proline in water stressed plants.
17. Testing of seed viability by NBTtest.
18. Changes in the reserve proteins during germination

REFERENCES

- William G. Hopkins. Introduction to Plant Physiology. John Wiley & SonsInc.
- Lincoln Taiz and Eduardo Zeiger. Benjamin/Cumming Publishing Company lnc. NewYork.

Metabolism

Module – I

(4 hr.)

1. Enzymes: General aspect, classification, Michaelis-Menton equation and its significance. Mechanism of enzyme action, co-enzymes, inhibition, regulation, allosteric enzymes, covalently modulated enzymes. Kinetics of enzyme catalysis. Isoenzymes.

Module II (9 hr.)

2. Intermediary metabolism: Anabolism, catabolism, amphibolic pathways and anapleurotic reactions. Link between primary metabolism and secondary metabolism. Bioenergetics and thermodynamics.

3. Catabolism of hexoses: Glycolysis- two phases, overall balance sheet, regulation; fate of pyruvate under aerobic and anaerobic conditions. Pentose phosphate pathway-multifunctional pathway (significance).

Module III (11 hr.)

Tricarboxylic acid cycle: Formation of acetate, reaction of citric acid cycle, anapleurotic reactions of citric acid cycle. Regulation of citric acid cycle. Glyoxylate cycle. Amphibolic nature of TCA cycle.

4. Oxidation of fatty acids. Activation and entry of fatty acids, Beta oxidation of saturated and unsaturated fatty acids. Regulation.

5. Oxidation of amino acids and entry to TCAcycle.

6. Oxidative phosphorylation: Electron transfer reactions in mitochondria. Electron carriers, multienzyme complexes, ATP synthesis. Regulation of oxidative phosphorylation. Shuttle systems- Alternate pathways- Thermogenesis.

7. Carbohydrate biosynthesis: Gluconeogenesis, biosynthesis of starch, glucose and other carbohydrates. Involvement of NDP- sugars. Regulation.

8. Lipid biosynthesis: Biosynthesis of fatty acids. Triacylglycerol's, phospholipids and isoprenoids. Regulation.

9. Biosynthesis of nucleotides: PRPP and its significance. Purine and pyrimidine biosynthesis. Precursors and regulation. Conversion of NMP to NTP. Biosynthesis of deoxyribonucleotides.

10. Secondary metabolism: Main pathways and their relation to primary-metabolism

.**PRACTICALS**

1. Extraction of enzyme: Any enzyme.
2. Effect of substrate on enzyme and determination of its Kmvalue.
3. pH dependent activity profile of enzymes.
4. Ammonium sulphate precipitation of enzymes.
5. Desalting of proteins by gel filtration using Sophadex G25/dialysis
6. Separation of isoenzymes by native PAGE.
7. Determination of enzyme / protein sub units by SDSPAGE.
8. Metabolism of germinating seeds - changes in metabolizable carbohydrates

REFERENCES

- Lehnìnger. Principles of Biochemistry, Macmillan,U.K.
- Geoffrey Zubay. Biochemistry. Macmillan Publishing Company, NewYork.
- Trevor Palmer. Enzymes- Biochemistry, Biotechnology and Clinical Chemistry.Norwood Publishing,Chichester.

COURSE CODE: **IBC6B16T**

COURSE TITLE: MOLECULAR BIOLOGY, PLANT MORPHOGENESIS & EMBYOLOLOGY

Molecular Biology(27 hr)

1. Nucleic acids: DNA– the genetic material; the discovery of DNA as the genetic material; bacterial transformation (Griffith's & Avery's experiments); Hershey and Chase experiment; Structure of DNA, Watson & Crick's Model, Types of DNA- (A,B,Z); Replication: semi conservative replication–Meselson and Stahl's experiment;,
2. Structure of DNA: Repetitive DNA; c-value paradox.
3. Replication of DNA: Enzymology of replication. Molecular mechanism of replication in prokaryotes and eukaryotes. Primosomes and replisomes. Telomerase and its function. RNA- structure, types and properties
4. Gene expression: regulation of gene expression- Operon concept- Gene regulation in prokaryotes and eukaryotes enhancers and silencers.
5. Protein synthesis: Transcription, post-transcriptional events. Introns and their significance. Translation.Post translational events. Role of chaperons.
6. Mutation: Spontaneous and induced. Physical and chemical mutagens. Molecular mechanism of mutation. Mutation and cancer. Mutator and antimutatór genes. DNA repairing mechanisms.
7. Molecular evolution: The origin of genomes. Evolution of new genes. Origin of eukaryotic genomes. Phylogenetics. Application of molecular phylogenetics.

REFERENCES

1. Lewin Benjamin. Genes. Oxford Universitypress.
2. Brown TA. Genomes. John Willey andSons.
3. Snustad, Simmons and Jenkins. Principles of Genetics. John Willey andSons.
4. Weaver and Hendrick. Genetics. Wm. C. BrownPublishers.
5. Hawkins J.D. Gene Structure and Expression. Cambridge UniversityPress.

PRACTICAL

Working out problems from molecular genetics.

1. isolation of nucleic acid and identification of histones bySDS-PAGE.
2. isolation of plant DNA and its quantification by spectrophotometric/ calorimetric method.
3. lmmunological techniques: ELISA and WesternBIot.

SUBMISSION

Visit a research station with Well equipped Biotechnology/ Molecular biology lab and submit a duly certified detailed report of the same during the practical examination.

Plant morphogenesis:(5 hr.)

Basic concepts of plant morphogenesis. Totipotency, symmetry, polarity, differentiation pattern formation. Factors influencing morphogenesis. Organisation of shoot and root apical meristem and the molecular basis of their development. Leaf development. Floral meristems and floral development in Arabidopsis and Antirrhinum

Embryology (22 hr)

1. Introduction to angiosperm embryology - structure of dithecous and monothecous anther.
2. Microsporogenesis: Structure and function of wall layers, role of tapetum in pollen development
3. Male gametophyte: Pollen mitosis, division of generative cells, heterospory.
4. Megasporogenesis: Megaspore triad, dyad, coenomegaspore.
5. Embryo sac - different types- ultra-structure of components- synergid and antipodal. Theories of the morphological nature of embryosac
6. Pollination -Artificial pollination - ultra-structural and dis-ultrastructural and histo-chemical sigma.

Significance of pollen - pistil interaction. Role of pollen wall proteins and stigma. In vitro pollination and

fertilization.

7. Fertilization: Role of synergids - filiform apparatus, heterospermy and triple fusion.
8. Structure and development of typical dicot and monocot embryos- structure and function of suspensor.
9. Endosperm: classification and type- ruminate endosperm- mosaic endosperm- endosperm haustoria – physiology and cytology of endosperm.
10. Polyembryony - classification – practical value.
11. Apomixis - general account, genetics of apomixis.
12. Parthenocarpy –seedless fruits
13. Experimental embryology-embryo culture, anther culture, ovule culture.
14. Embryology in relation to taxonomy

PRACTICALS

1. Study of anther development of *Datura*.
2. Preparation of dissected whole mounts of microsporangium.
3. Study of megaspore mother cell, megaspore and embryo sac.
4. .Study of the receptivity of stigma and in situ germination of pollen.
5. Dissection of stages in the development of embryo and endosperm.
6. Pollen germination using hanging drop technique.
7. Demonstration of intra-ovarian pollination

REFERENCES:

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- Wardlaw C.W. Embryogenesis in Plants. Methusen,London

COURSE CODE:**IBC6B17T**

C**OURSE TITLE: GENOMICS**

COURSE CONTENT (54 hr.)

Module I: String view of DNA: Composition of DNA-(Chargaff's Rule), Reading frames +1, +2, +3 and -1, - 2, -3, ORFs, Codon usage bias, tandem and inverted repeats, concepts of similarity - homologous, orthologous and paralogous sequences.

Module II: Basic file formats: FASTA, GCG, PIR, Phylip, Nexus file formats etc. Sequence Data Bases, detailed study of GenBank of NCBI- typical Gen Bank (DDBJ+EMBL) for DNA and RNA,

Module III: Sequence Representation & Analysis: Basic gene statistics–base counts, word (n- mer) frequencies, vector contamination analysis, use of Perl scripts in genomics, gene finding, splice site recognition, transcription factor binding site identification, SNPs, microsatellite, minisatellite, sequence profiles, sequence logos, sequence chromatograms.

Module IV: Sequence alignment: Pair-wise sequence alignment, Need of Scoring schemes- Penalizing gaps – Linear and Affine gap penalty; Effect of scoring schemes, Scoring matrices for amino acid sequence alignment, PAM Probability matrix- Log odds matrix(Brief account only); BLOSUM(Brief account only); Dot-plot visualization(Brief account only); Smith –Waterman algorithm for local alignment, Needleman-Wunsch algorithm, Statistics of Sequence alignment score: E-values, bit scores and sensitivity, specificity; BLAST and FASTA.

REFERENCES:

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- Zvelebil, M. J., & Baum, J. O. (2008). Understanding bioinformatics. GarlandScience.

COURSE CODE:**IBC6B18T**

COURSE TITLE: ELECTIVE GENETICS AND CROP IMPROVEMENT

Module -1.

Crop genetics - General account of origin, genetic variability, floral biology, breeding techniques and achievements in: Rice, Coconut, Rubber, Arecanut, Cashew and Pepper. (**11**hrs)

Module –II

1. Plant genetic resources- Definition; Classification of Plant Genetic resources. Activities– exploration, conservation, evaluation, documentation and utilization. (**2**hrs)

2. Agencies involved in plant genetic resources activities – NBPGR and IPGRI (**4**hrs)

3. International institutes for crop improvement – IRRI, ICRISAT, CIMMYT, IITA. Brief account on research activities and achievements of national institutes – IARI, CCMB, IISc, BARC, CPCRI, IISR, RRII, CTCRI, KFRI, JNTBGRI. (**4**hrs)

Module- III

1. Methods of crop Improvement (**4** hrs)

1.Plant introduction

2. Selection - Principles, Selection of segregating populations, achievements

3. Hybridization – Interspecific hybridization; intergeneric – achievements. Genetics of back crossing, Inbreeding, Inbreeding depression, Heterosis and Heterobeltiosis

Module -IV.

1 Heteroploidy in crop improvement – achievements and future prospects – Significance of haploids and polyploids (**2**hrs)

2 Mutations in crop improvement – achievements and future prospects (**2**hrs)

3 Genetics of nitrogen fixation – Use of biofertilizers in crop improvement (**2** hrs)

4 Genetics of photosynthesis (**1** hr)

Module- V.

1. Breeding for resistance to abiotic stresses – Introduction, importance of abiotic and biotic stresses and its characteristics. (**10** hrs)
2. Breeding for drought resistance: Genetics of drought resistance; Breeding methods and approaches; Difficulties in breeding for drought resistance.
3. Breeding for mineral stress resistance: Introduction, Salt affected soils, Management of salt affected soils: Salinity resistance –general account.
4. Breeding for resistance to biotic stresses. (**12** hrs)
5. Disease resistance – History of breeding for disease resistance; Genetics of pathogenicity – Vertical and horizontal resistance; Mechanism of disease resistance; Genetics of disease resistance – Oligogenic, polygenic and cytoplasmic inheritance – Sources of disease resistance – Methods of breeding for disease resistance.
6. Insect resistance – Introduction, Mechanism, Nature and genetics of insect resistance, Oligogenic, Polygenic and cytoplasmic resistance, sources of insect resistance, breeding methods for insect resistance, Problems in breeding for insect resistance, Achievements, Breeding for resistance to parasitic weeds.

PRACTICAL

1. Visit a leading breeding station in South India and a detailed report should be included in the practical record. The record duly certified by HoD should be submitted at the time of practical examination of core practical paper III.

2. Make illustrations on the floral biology of Rice, Cashew and *Solanum* spp.

3. Demonstration of hybridization in Rice, Cashew and *Solanum* and describe the procedure.

4. Study the variability under induced stress (salinity and moisture) of seedlings of rice and green gram and record

the observations.

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