UNIVERSITY OF RAJASTHAN
JAIPUR

SYLLABUS

M.Sc. Botany

Semester Scheme

I[st] Semester Exam December 2016

Dy. Registrar (Acad.)
University of Rajasthan
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M. Sc. Botany Semester Scheme 2016-18

Scheme of Examination

- *M. Sc. (Botany) semester scheme will be spread over two academic years consisting of four semesters. The course of first semester shall be of 42 credits.*
- *In theory, 15 hrs of theory teaching will be equivalent to one credit. In practical, 45 hrs of laboratory work will be equivalent to 2 credits.*
- *Each semester will have continuous assessment which will include internal assessment in theory and practical by internal examination (70 marks) and overall performance assessed by seminar/ oral examination- viva voce/* Attendance /Classroom Participation/Quiz/Home Assignment *etc. (30 marks) and the maximum marks will be 100.*
- *Each theory paper shall carry 100 marks and will be of 3 hrs duration. The theory question paper will be divided into two parts A and B. Part A of question paper shall be compulsory and contain 10 (ten) very short answer type questions covering entire syllabus. Each carrying 2 (two) marks, with a total of 20 marks.*
- *Part B of question paper will have 4 questions having 100% internal choice. Each question will carry 20 marks, with a total of 80 marks.*
- *Each Practical examination will be of four/six hour duration and involve laboratory experiments/ exercises, and viva- voce examination and record in the ratio of 75: 25 (i.e. 15% for record and 10% for viva). Syllabi tour shall be compulsory. Students are required to submit 10 herbarium sheets of plant collection/Plant Material. These will carry 10 marks to be allotted out of 15marks assigned for records.*

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FIRST- SEMESTER

S. No.	SUBJECT CODE	Course Title	Course Category	Credit	Contact hours per week			EoSE duration (Hrs.)	
					L	T	P	Theory	P
1.	BOT 701	Algae, Fungi and Bryophyta	CCC	4	4	0	0	3	0
2.	BOT 702	Cell Biology and Evolution	CCC	4	4	0	0	3	0
3.	BOT 703	Plant Ecology	CCC	4	4	0	0	3	0
4.	BOT 711	Practical- General (Based on BOT 701, BOT 702 & BOT 703)	CCC	6	0	0	9	0	6
5.	BOT A01	Plant Pathology- Principles and Diseases	ECC	4	4	0	0	3	0
6.	BOT B01	Seed Science & Technology	ECC	4	4	0	0	3	0
7.	BOT C01	Morphology & Morphogenesis	ECC	4	4	0	0	3	0
8.	BOT D 01	Plant Biosystematics	ECC	4	4	0	0	3	0
9.	BOT A11	Practical-Elective* Plant Pathology- Principles and Diseases	ECC	2	0	0	2	3	4
10.	BOT B11	Practical-Elective* Seed Science & Technology	ECC	2	0	0	2	3	4
11.	BOT C11	Practical-Elective* Plant Morphology & Morphogenesis	ECC	2	0	0	2	3	4
12.	BOT D11	Practical-Elective* Plant Biosystematics	ECC	2	0	0	2	3	4

*** Elective lab can be opted only if the respective Elective theory has been opted by the student**

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BOT 701: ALGAE, FUNGI AND BRYOPHYTA

ALGAE (20 Hours)

- Algae in diversified habitats (terrestrial, freshwater and marine), thallus organization, cell ultra-structure, reproduction (vegetative asexual and sexual) classification of algae: based on pigments, cell wall composition, reserved food material and flagellation . Salient features of cyanopyta, chlorophyta, bacillariophyta, xanthophyta, pyrrhophyta, phaeophyta and rhodophyta with special reference to *Spirulina, Scytonema , Dunaliella, Pinnularia,Gonyaulax, Laminaria, Gelidium* and *Batrachospermum: Acetabularia*

(15 Hours)

- Economic importance of algae specially in industries, food, fodder, biofertilizers, Biofuels and algal bloom, isolation and culture of algae. **(5 Hours)**

FUNGI (20 Hours)

- General characters, substrate relationship, cell ultra-structure, thallus organization,cell wall composition, nutrition (saprobic, biotropic and symbiotic), reproduction (asexual and sexual).

(5 Hours)

- Heterothallism, heterokaryosis, Brachymeosis, parasexuality, sex harmones and recent trends in classification of fungi, phylogeny of fungi. **(5 Hours)**
- General account of mastigomycotina , zygomycotina, ascomycotina, basidiomycotina and deuteromycotina with special reference to *Rhizopus*, *Peronospora Neurospora*, *Polyporus*, *Drechslera* and *Colletotrichum.* **(6 Hours)**
- Economic importance of fungi in industries, medicines and as food, fungi as biocontrol agents, poisonous fungi, mycorhizae. **(4 Hours)**

BRYOPHYTA (20 Hours)

- Distribution, Classification of Morphology, structure, reproduction and bryophytes. **(4 Hours)**
- General account of marchantiales, jungermanniales, anthocerotales, sphagnales, funariales and polytrichales with special reference to *Plagiochasma, Notothylus, Sphagnum. Physcomitrella patens* and*Polytrichum.* **(6hours)**
- Fossil Bryophytes, evolutionary trends in Bryophytes. **(3 Hours)**
- Economic importance of Bryophyta **(3 Hours)**
- Role of Bryophytes in plant succession. **(4 Hours)**

Suggested Laboratory Exercises:

Morphological study of representative members of algae, fungi and bryophytes present in your locality in their natural habitat with special reference to:

- **Algae:** *Microcystis, Spirullina, Scytonema, Rivularia, Dunaliella, Aulosira, Spirogyra, Pediastrum, Hydrodictyon, Ulva, Pithophora, Stigeoclonium, Gelidium* and *Batrachospermum*: Isolation and culture of algae.

- **Fungi:** *Stemonites, Peronospora, Pythium, Albugo, Rhizopus, Pilobolus,* Yeast, *Emericell a, Chaetomium,Pleospora, Morchella, Melamsora, Phallus, Polyporus, Drechslera, Curvularia, Phoma, Penicillium.Aspergillus, Colletotricum, Fusarium* and *Alternaria*.
- Isolation and culture of fungi using moistened blotters, PDA and Sabouraud's Dextrose Agar media.
- **Bryophyta :** *Plagiochasma , Pogonatum, Pellia, Notothylus, Andreaea* and *polytrichum*

Suggested Readings:

1. Alexopoulus, C.J., Mims, C.W. and Blackwel,M. (1996) Introductory Mycology, John Wiley & Sons ind.

2. Anderson, R.A. (2005) Algal Culturing Techniques. Physiological Society of America. Elsevier Academic Press, USA.

3. Fritsch, F.E. (1993, 1945). The structure and Reproduction of Algae Vol. I, II. Cambridge University Press, Cambridge, UK.

4. Kashyap, S.R. (1932) Liverworts of Western Himalayas and Punjab Plains (VII. I & II) Reserchco Publications , New Delhi,.

5. Richardson, D.H.S. Biology of Mosses. (1981). Blackwell Scientific Publications, Oxford, ,

6. Bold, H. C., Alexopoulus, C.J. and Delevoryas. T. (1980) : Morphology of plant and fungi (4th Ed.) Harper & Foul Co., New Work.

9. Ghemawat, M.S., Kapoor J.N., and Narayana, H.S. (1976) : A text book of Algae. Ramesh Book Depot, Jaipur.

10. Gilbert, M Smith. Cryptogamic Botany, Vol. I & II (2nd Ed.)(1985). Tata McGraw Hill. Publishing Co. Ltd., New Delhi.

11. Puri, V. Bryophytes. (1985). Atmaram & sons. Delhi, Lucknow.

12 .Sharma, P.D.(1996). Introduction to Bryophytes. Ramesh Book Depot, Jaipur.

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BOT 702: Cell Biology and Evolution

Credits: 4 **60 hours**

A) Structural organization and function of organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, structure & function of cytoskeleton and its role in motility). 5

B) Membrane structure and function :Structure of model membrane, lipid bilayer and membrane protein) (diffusion, osmosis, ion channels, active transport and membrane pumps. 5

C) Intracellular compartments and transport: mechanism of protein sorting in peroxisomes, nucleus, chloroplast , mitochondria & ER and regulation of intracellular transport. 8

D) Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle). 7

E) Cell signaling Hormones and their receptors, cell surface receptor, second messengers, signaling through G-protein coupled receptors, signal transduction pathways (Cyclic AMP,phospholipaseC,Ca^{+2}-Cadmodulin & Receptor Tyrosine Kinase pathway), regulation of signaling pathways 8

F) Cellular communication: general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins. 5

G) Apoptosis: Apoptosis (Programmed cell death): Mechanism of apoptosis, Apoptosis triggered by internal & external pathways, Apoptosis inducing factors, cancer, oncogenesis . 5

H) Emergence of evolutionary thoughts Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations. 4

I)Origin of cells and unicellular evolution: Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes. 4

J) Paleontology and Evolutionary History: The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms; Major groups of plants and animals. 4

K). Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution. 5

Suggested Laboratory Exercises

1 EM study of cell organelles
2 Fluorescence staining with FDA for cell viability
3 Cell wall staining with calcifluor white 6

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4 Study of stages in cell cycle
5 Mitosis and Meiosis
6 Histochemical localization of protein, carbohydrate, fats, starch, lignin, nucleic acids
7 Isolation of mitochondria and the activity of its marker enzyme, succinate dehydrogenase (SDH).
8 Isolation of chloroplast and study of its percentage intactness
9 Isolation of chloroplast and study of light reaction system.
10. Demonstration of SEM and TEM.
11. Hardy-Weinberg numerical
12. Any other practical based on theory syllabus.

Suggested readings:

1 Krishnamurthy, K.V. (2000). Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.
2. Reeve, ECR. (2001). Encyclopedia of Genetics, F. D. Publication, Chicago, USA
3. De, DN. (2000). Plant Cell Vacuoles: An Introduction. CSIRO Publication, Collingwood, Australia.
4 De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. (VIII Edition). Lippincott Williams and Wilkins, Philadelphia.
5 Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. (V Edition).. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
6. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. (VII Edition). Pearson Benjamin Cummings Publishing, San Francisco.
7 Kleinsmith, L.J. and Kish, V.M. (1995). Principles of Cell and Molecular Biology (2nd Edition). Harper Collins College Publishers, New York, USA.
8. Harris, N. and Oparka, K.J. (1994). Plant Cell Biology: A Practical Approach. IRL Press, at Oxford University Press, Oxford, U.K
9 Gunning, B.E.S. and Steer, M.W. (19960. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers. Boston, Massachusetts.
10 Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition John Wiley & Sons. Inc.
11 Griffiths, A J F. et. al.(2000). An introduction to genetic analysis, W. H. Freeman and Company, New York, USA.
12. Hall, J.L. and Moore, A.L. (1983). Isolation of Membranes and Organelles from Plant Cells. Academic Press, London, UK.
13. Roy, S.C. and De, KK. (1999). Cell Biology. New Central Book Agency (P) Ltd., Calcutta.
14. Hartl, D. L. (1994). Genetics. Jones and Bartlett Publishers International, USA

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BOT-703 Plant Ecology

Science of Ecology: Introduction to ecology, evolutionary ecology, ecological models; **Population**: Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure, population growth. Competition and coexistence, intra-specific interactions, interspecific interactions, scramble and contest competition model, mutualism, commensalism and allelopathy, prey-predator interactions.

15 hours

Vegetation organization: Concepts of community and continuum, community coefficients, interspecific associations, ordination, species diversity and pattern diversity in community, concept of habitat and ecotone, ecological niche.

Vegetation development: Temporal changes (cyclic and non-cyclic), mechanism of ecological succession (relay floristic and initial floristic composition), succession models (facilitation, tolerance and inhibition models), Changes in ecosystem properties during succession, concept of climax.

15 hours

Ecosystems: Nature and size of ecosystem, components of an ecosystem (producers, consumers and decomposers), Grazing (grassland) and Detritus food chain in freshwater ecosystems, food webs, Ecological energetic: Solar radiation and energy intakes at the earth's surface, energy flow models, Productivity of various ecosystems of the world and global biogeochemical cycles of carbon and nitrogen, Ecosystem Management: Homeostasis and cybernetics of ecosystem, Resilience of ecosystem, Restoration of degraded ecosystems, ecology of plant invasion. Ecosystem services, **15 hours**

Biomes, Biodiversity & Conservation: Major biomes of the world and Impact of changing climate on biomes, Biodiversity assessment (local, national and global), loss of diversity, conservation (ex-situ and in situ) and management, International Conservational organizations, biodiversity act of India and related international conventions. Diversity indices, sustainable development, natural resource management in changing environment, molecular ecology, genetic analysis of single and multiple population, molecular approach to behavioural ecology, conservation genetics. **15 hours**

Suggested Readings

1. Smith, R.L. 1996. Ecology and Field Biology, Harper Collins, New York.
2. Muller-Dombois, D. and Ellenberg, H., 1974. Aims and Methods of Vegetation Ecology, Wiley, New York.
3. Begon, M. Harper, J.L. and Townsend, C.R. 1996. Ecology, Blackwell Science, Cambridge, U.S.A.
4. Ludwig, J. and Reynolds, J.F. 1988. Statistical Ecology. John Wiley & Sons.
5. Odum, E.P. 2005. Fundamentals of Ecology, Saunders, Philadelphia.
6. Odum, E.P. 2005. Basic Ecology, Saunders, Philadelphia.
7. Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology, Benjamin/Cummings Publication Company, California.
8. Kormondy, E.J., 1996. Concepts of ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.
9. Chapman, J.L. and Reiss, M.J. 1988. Ecology, Principles and Applications. Cambridge University Press, Cambridge, U.K.
10. Molan, B. and Billharz, S. 1997. Sustainability Indicators, John Wily Sons, New York.

11. Heywood, V.H. and Watson, R.T. 1985. Global Biodiversity Assessment Cambridge University Press.
12. N.S. Subrahmanyam and A.V. S.S. Sambamurty 2000. Ecology. Narosa Publishing House, Delhi
13. S.K. Maiti. 2004. Handbook of Methods in Environmental Studies Vol. I &2. ABD Publisher, Jaipur.
14. J. L. Chapman and M. J. Reiss. 1995. Ecology principles and applications. Cambridge University Press.
15. C. Faurie, C. Ferra, P. Medori and J. Devaux. 2001. Ecology Science & Practice. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
16. G.T. Miller Jr. 2005. Essentials of Ecology. III Edition, Thomson, Brooks/Cole

Suggested Laboratory Exercises

1. To determine minimum size and number of quadrat required for reliable estimate of biomass in grasslands.
2. To compare protected and unprotected grassland stands using community coefficients (similarity indices).
3. To estimate IVI of the species in a grassland/woodland using quadrat method.
4. To determine gross and net phytoplankton productivity by light and dark bottle method.
5. To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.
6. To determine the Water holding capacity of soils collected from different locations.
7. To determine percent organic carbon and organic matter in the soils of cropland, grassland and forest.
8. To estimate the dissolved oxygen content in eutrophic and oligotrophic water samples by azide modification of Wrinkler's method.
9. To estimate chlorophyll content in SO_2 fumigated and unfumigated plants leaves.
10. To estimate rate of carbon dioxide evolution from different soils using soda lime or alkali absorption method.
11. To study environmental impact of a given developmental activity using checklist as a EIA method.

BOT A01 Plant Pathology
Principles and Diseases

Plant Pathology: History & Scope : Parasitism and disease development, Host-Parasite interaction , Pathogenicity, **(5 Hrs)**

Dispersal of plant pathogens –Direct ,Indirect and Biological Transmission **(5 Hrs)**

Host Factors in Disease Development: Inoculum Potential, Protective and defense mechanisms in plants, Phytoalexins ,Genetics of plant disease ,Phenomenon of resistance and susceptibility. Gene for gene hypothesis. **(10 Hrs)**

Alteration in plant physiological method due to plant pathologen interaction. (5 Hrs)

Symptomology, Identification and Control of following plant diseases (35 Hrs)

Fungal Diseases:

Crucifers –*Alternaria* blight

Paddy – Paddy blast

Leaf rot and Foot rot of Pan (*Piper beetle)*

Red rot of Sugarcane, Flax rust,

Bacterial diseases

Brown rot of Potato,

Blight of Rice,

Crown Gall disease of stone fruits

Angular leaf spot of Cotton.

Phytoplasma Disease:

Little leaf of Brinjal,

Sesame Phyllody,

Plant Galls: Classification, developmental anatomy, host- parasite interaction and physiology of Insect induced plant galls of Rajasthan. Economic significance of galls

Plant Galls : Galls of *Pongamia*, *Cordia*, *Prosopis* and *Salvodora*

Nematology: General account of nematode disease, Symptoms caused by nematodes.Methods used in Nematology. Control of plant parasitic nematodes, Inter relationship between nematode and other Plant pathogens

Nematode Disease: Molya disease of Wheat and Barley, Soybean Cyst nematode

Suggested practical :-

Histopathology of nematode infected roots

Study of following disease

- Red rot of Sugarcane
- Paddy Blast
- Flax rust,
- Crown Gall disease of stone fruits
- Angular leaf spot of Cotton.
- Little leaf of Brinjal,
- Sesame Phyllody,
- Galls of Pongamia , *Cordia* , *Prosopis*, *Salvadora*
- Molya disease of wheat and Barley
- Soyabean cyst nematodes

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Suggested Readings:

1. Agrios, G.N. 2005. Plant Pathology, 5th edition. Academic Press, New York, USA.
2. Alexopoulos, C.J., C.W. Mims and M. Blackwell. 1996. Introductory Mycology. 4th edition, John Wiley and Sons, Inc., New York, USA
3. Khan, J.A. and J. Dijkstra. 2002. Plant Virus as Molecular Pathogens. The Haworth Press Inc. USA.
4. Mehrotra, R.S. and A. Agarwal. 2003. Plant Pathology. 2ndEdition. TATA McGraw Hill. Pub. Company Ltd. New Delhi.
5. Singh, R.S. 1982. Plant Pathogens: The Fungi. Oxford and IBH Publishing Company, New Delhi, India
6. Singh, R.S. 1989. Plant Pathogens: The Prokaryotes. Oxford and IBH Publ. Company, New Delhi, India.
7. Trigiano, R.N., M.T. Windham and A.S. Windham. 2008. Plant Pathology: Concepts and Laboratory Exercises. 2nd edition. CRC Press.
8. Vidhyasekram, P. 2004. Concise Encyclopedia of Plant Pathology. Food product Press and Haworth Press Inc. Binghamton,

BOT B01: Seed Science & Technology

History of seed testing and its importance to agriculture. Aims of seed testing, Seed- definition and its types. Sampling of seeds, purity analysis (physical and genetical), seed moisture content, germination test, rapid test of viability and evaluation, seedling evaluation, various methods of seed separation, cleaning, drying and Seed processing plant and its process. **12 Hrs**

Gross architecture of seed structure of angiosperms, identification and structure of seeds of important crop plants with special reference to Rajasthan (wheat, pearl millet, mustard, gram, pea, spices). Identification of designated objectionable weeds at seed level. **12 Hrs**

Principles of seed production, seed production in self and cross pollinated crops; hybrid seed production. Production of foundation and certified seeds; synthethetic seed, terminator seed technology, Physiology of seed germination; seed and seedling vigour. **12 Hrs**

Seed storage methods, principles for safe seed storage, effects of storage, mycotoxins, Deterioration of seeds in storage by micro-organisms, insects and rodents; detoxification, control of seed deterioration, Seed Bank **12 Hrs**

Seed certification standards and quarantine regulations. International cooperations, International Seed Testing Association - Rules and recommendations, Certificates, other seed certificates; Indian Seeds Act and recent amendments, National and Regional Seed Corporations of India - their organisation, aims and functions. National and International Co-operation in Seed Pathology. Sanitary and phytosanitary (SPS) agreements of WTO. **12 Hrs**

List of suggested Practical exercises:

1. Structure of seeds of some crop plants (wheat, pearl millet, mustard, gram, and pea).

Dy. Registrar (Acad.)
University of Rajasthan
JAIPUR

2. Preparation of inventory of designated objectionable weeds at seed level and identification.
3. Identification of seed coat cracking.
4. Study of physical purity of seed sample.
5. Study of seed germination, seedling abnormality and seedling index.
6. Determination of moisture content of seeds.
7. TZ test for seed viability
8. Assay of enzymes in crop seeds.
9. Preparation of synthetic seeds.
10. Localization of starch, protein, lipids, tannins, phenols and lignin in seed sections.
11. Isolaton and identification of storage fungi.
12. Preparation of phytosanitary certificate etc. of seed lot.

Suggested Readings:

1. Agarwal, V.K. and Sinclair, J.B. (1987).Principles of Seed-pathology, II edition CRC Lewis Publishers, Boca Raton, New York, London.
2. Agrawal, R.L. 1980. Seed Technology. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
3. Anonymous (1985, 2014). International rules for seed testing. International Seed Testing Association (ISTA). http://www.seedtest.org/en/home.html; http://www.seedtest.org/en/international-rules-_content---1--1083.html
4. Bewley, J.D. and Black, M. 1983. Physiology and Biochemistry of Seeds in Relation to Germination. Volume I & II. Springer-Verlag, Berlin, Heidelberg, New York.
5. Copeland, L.O. 1976. Principles of Seed Sci. and Technology Minnesota, USA.
6. Khare, D. and Bhale, M.S. (2014). Seed Technology. Scientific Publishers (India), Jodhpur. Revised 2nd Ed.
7. Kulkarni, G.N. 2002. Principles of Seed Technology. Kalyani Publishers, New Delhi.
8. Neergaard, P. 1986. Seed- A horse of hunger or a source of life. Revised print of Danish Government Institute of Seed Pathology for Developing Countries. Hellerup, Denmark.
9. Winton, A. L. and Winton, K. B. (1932-1939): The structure and composition of foods. Vol I and II: John Wiley and Sons, Inc., New York.

BOT C01: Morphology & Mophogenesis

Floral anatomy and its role in explaining the morphology of the Stamen and Carpel, seed and pericarp and their taxonomic significance. 10

Anther-organizational relationship of anther tissues , ultrastructure aspects of microsporogenesis, pollen-sporoderm pattern. pollen analysis, pollen fertility and sterility, allergy due to pollen. Viability, storage and germination of pollen. 12

Embryo sac - basic types and their inter-relationships, ultrastructural aspects of embryosac development. Pollen pistil interaction, morphology of style and stigma, ultrastructural studies on pollen tube growth in the pistil, fertilization. 13

Endosperm - Major types of endosperms, endosperm haustoria cytology and role in embryo development. 5

Embryo-, Embryogenic laws, Major types of embryogenesis, , Apomixis – types, agri-horticultural importance. 10

Embryological features of the following families : Santalaceae, Loranthaceae, Podostemaceae, Onagraceae, Cyperaceae, Exocarpaceae, Boraginaceae, Campanulaceae and Tropeolaceae.10

Suggested Readings

1. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms (4th revised and enlarged edition). Vikas Publishing House, New Delhi.
2. Fahn, A. 1982. Plant Anatomy. (3rd edition). Pergamon Press, Oxford. New York.
3. Leins, P., TucKer, S.C. and Endress, P.K. 1988. Aspects of Floral Development, J. Cramer, Germany.
4. Proctor, M and Yeo, P. 1973. The Pollination of Flowers. William Collins Sons, London
5. Raghavan, V 1997. Molecular Embryology of Flowering Plants. Cambridge University Press, Cambridge.
6. Shivanna, K.R. and Sawhney, VK. (eds.) 1997. Pollen Biotechnology for Crop Production and Improvement. Cambridge University Press, Cambridge.
7. Shivanna, K.R. and Rangaswamy, N.S. 1992. Pollen Biology : A Laboratory Mannual, Springer-Verlag, Berlin-Heidelberg (and references therein).

- ***Suggested practical/Field exercises;***
- 1. Study of floral anatomy by cutting serial transverse sections.
- 2. Study different types of placentation.
- 3. Transverse sections of different stages of developing anthers to see development of wall layers and sporogenesis.
- 4.Spermoderm patterns of pollen grains
- 5. Make acetolysis preparations of pollen grains to study wall structure.
- 6. Pollen viability tests using different salt and sugar concentrations.
- 7. Endosperm haustoria
- 8. Stages in embryo development in plants like *Raphanus* and Legumes etc.

BOT D 01 Plant Biosystematics

Aims, components, and principles of taxonomy; Alpha and omega taxonomy, documentation and scope. **(4 Hours)**

Evolutionary taxonomic classifications with their merits and demerits; system of Hutchinson, Takhtajan, Cronquist, Dahlgren,Thorne and APG. **(8 Hours)**

Internationational and national botanical gardens, plant geography, Indian plant geographical regions. **(6 Hours)**

Taxonomic literature: Herbarium, flora, monograph, icons, index, library, manuals, taxonomic keys for plant identification. **(6 Hours)**

ICBN: Principles, rules and recommendation, Nomenclature of hybrids and cultivars, concept of biocode. **(10 Hours)**

Biosystemic procedures: serum diagnosis, Cytology- chromosomes morphology and number, polyploidy, aneuploidy, chromosome bands, G-C Bands.
Histochemistry - lipids, starch, ascorbic acid, tannins, phenols, proteins, Molecular systematics (RAPD, RFLP analysis). **(12 Hours)**

Biosystematic tools: palynology – pollen characters in detail related to taxonomy; embryology - embryological characters of taxonomic importance. **(8 Hours)**

Numerical Taxonomy- Principles, concepts, operational taxonomic units (OTU), data processing and taxonomic studies, taximetric methods for study of population variation and similarity - coding, cluster analysis, cladistics and cladogram. **(6 Hours)**

Suggested Readings:

1. Cole, A.J. Numerical Taxonomy, Academic Press, London
2. Davis, P.H. and Heywood, V.H. 1973, Principles of Angiosperms Taxonomy, Robert E. Kreiger Pub. Co., New York.
3. Grant, V. 1971, Plant Specimen, Columbia University Press London.
4. Grant, W.E. 1984, Plant Biosystematics. Academic Press London.
5. Harrison, H.J. 1971. New Concepts in Flowering Plant Taxonomy. Rieman Educational Book Ltd. U.K.
6. Heslop- Harrison, J. 1967. Plant Taxonomy, English Language Book Soc. & Edward Arnold Pub. Ltd. U.K.
7. Heywood, V.H. And Moore, D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.
8. Jones, A.D. and Wilbins, A.D. 1971. Variations and Adaptations in Plant Species. Hiemand & Co., New York.
9. Jones, S.B. Jr. and Luchsinger, A.E. 1986. Plant Systematic (2nd Edition). Mc.Graw-Hill Book Co., New York.
10. Nordenstam, B., El Gazaly, G. and Kassas, M. 2000 Plant Systematic For 21st Century. Portlend Press Ltd., London
11. Porter C.L. Taxonomy of Flowering Plants, Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper & Row Pub., USA.

12. Solbrig, O.T. And Solbrig, D.J. 1979. Population Biology and Evolution, Addison-Weslley Publicating Co. Ind USA.
13. Solbrig, O.T. 1970. Principles and Methods of Plant Biosystematics. The Macmillan Cocollier- Macmillan Ltd., London.
14. Stabbings, G.L. 1974. Flowering Plant- Evolution above Species Level. Edward Arnold Ltd. London.
15. Stace, C.A. 1989. Plant Taxonomy and Biosystematics (2nd Edition) Edward Arnold Ltd. London,
16. Takhtajan, A.L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, New York.
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Suggested Laboratory Exercises:

1. Description of a specimen from representative, locally available families.

List of Locally Available Families

(1)Ranunculaceae, (2) Capparidaceae, (3) Portulacaceae, (4) Caryophyllaceae, (5) Malvaceae, (6) Tiliaceae, (7) Sterculiaceae, (8) Zygophyllaceae, (9) Rhamnaceae, (10) Sapindaceae, (11) Leguminosae (12) Combretaceae, (13) Myrtaceae, (14) Cucurbitaceae, (15) Umbelliferae - Apiaceae, (16) Rubiaceae, (17)Asteraceae, (18) Primulaceae, (19) Plumbaginaceae, (20) Asclepiadaceae, (21) Convulvulaceae, (22)Solanaceae, (23) Boraginaceae, (24) Polemoniaceae, (25) Acanthaceae, (26) Pedaliaceae, (27) Martyniaceae, (28) Bignoniaceae, (29) Labiatae, (30) Nyctaginaceae, (31) Polygonaceae, (32) Chenopodiaceae, (33) Amaranthaceae, (34) Aizoaceae, (35) Molluginaceae, (36) Euphorbiaceae, (37) Commelinaceae and (38) Cyperaceae (39) Poaceae

2. Description of a species based on various specimens to study intraspecific variation: a collective exercise.
3. Description of various species of a genus, location of key characters and preparation of keys at generic level.
4. Location of key characters and use of keys at family level.
5. Field trips within and around the campus, compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant.
6. Training in using floras and herbaria for identification of specimens described in the class.
7. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
8. Comparison of different species of a genus and different genera of a family to calculate similarity coeffecients and preparation of dendrograms.
9. Molecular taxonomy