



গৌড়বঙ্গ বিশ্ববিদ্যালয়

**UNIVERSITY OF GOUR BANGA**

(Established under West Bengal Act XXVI of 2007)

Recognised by UGC u/s 2f & 12B

N.H.-34 (Near Rabindra Bhawan), P.O.: Mokdumpur,

Dist.: Malda, West Bengal, Pin-732 103

**UG SYLLABUS OF BOTANY  
(SEMESTER SYSTEM)[NEP-2020]**

**BOTANY MAJOR (BOTMJ)**

**BOTANY MINOR (BOTMN)**

**DRAFT**

**w.e.f. Academic session 2023**

OUTLINE OF THE SYLLABUS

Syllabus for undergraduate programme in Botany [ NEP-2020]											
ACADEMIC YEAR	SEMESTER		MAJOR COURSE (MC)	MULTI DISCIPLINARY COURSE (MDC)	MINOR COURSE (MnC)	DISCIPLINE SPECIFIC ELECTIVE (DSE)	SKILL ENHANCEMENT COURSE (SEC)	ABILITY ENHANCEMENT COURSE (AEC)	INTERNSHIP / APPRENTICE-SHIP/ PROJECT/ COMMUNITY OUTREACH (IAPC)	VALUE ADDED COURSE (VAC)	
	1 <sup>ST</sup> YEAR	2 <sup>ND</sup> YEAR									
	SEM-I	SEM-II	CREDIT= 4 MARKS = 50 T+P= 3+1 [(25+15)+10] = 50	CREDIT= 3 MARKS = 50	CREDIT= 4 MARKS = 50 [(25+15)+10] = 50	CREDIT= 4 [3+1] MARKS = 50 [(25+15)+10] = 50	CREDIT= 3 MARKS = 50	MODERN INDIAN LANGUAGE (MIL) CREDIT= 2 MARKS= 25	CREDIT= 2 MARKS= 25	CREDIT= 2 MARKS= 25	
	MC-1-T MC-1-P MC-2-T MC-2-P	MC-3-T MC-3- P MC-4-T MC-4-P	MDC-1	MDC-2	MnC-1-T MnC-1-P	MnC-2-T MnC-2-P	SEC-1	MIL-1	IAPC Must for certificate Optional For diploma	ENV	22
	SEM-III		MC-5-T MC-5-P MC-6-T MC-6-P	MDC-3	MnC-3-T MnC-3-P		SEC-3	ENGLISH Lang-1			22 + 2 <sup>IAPC</sup>
											20
											<b>TOTAL CREDIT</b>

	SEM-IV	MC-7-T MC-7-P MC-8-T MC-8-P MC-9-T MC-9-P	MnC-4-T MnC-4-P				ENGLISH Lang-2	IAPC Must for Diploma & above stage	18 + 2 <sup>IAPC</sup>
3 <sup>RD</sup> YEAR	SEM-V	MC-10-T MC-10-P MC-11-T MC-11-P DSE-1A-T DSE-1A-P DSE-1B-T DSE-1B-P DSE-2A-T DSE-2A-P DSE-2B-T DSE-2B-P	MnC-5-T MnC-5-P					Choose ONE from pool	22
	SEM-VI	MC-12-T MC-12-P MC-13-T MC-13-P DSE-3A-T DSE-3A-P DSE-3B-T DSE-3B-P DSE-4A-T DSE-4A-P DSE-4B-T DSE-4B-P	MnC-6-T MnC-6-P						20
4 <sup>TH</sup> YEAR HONOURS + RESEARCH	SEM-VII	MC-14-T MC-14-P DSE-5A-T DSE-5A-P DSE-5B-T DSE-5B-P DSE-6A-T DSE-6A-P DSE-6B-T DSE-6B-P	MnC-7-T MnC-7-P					DM OR APE	20

<b>4<sup>TH</sup> YEAR HONOURS</b>	<b>SEM-VIII</b>	MC-15-T MC-15-P DSE-7A-T DSE-7A-P DSE-7B-T DSE-7B-P DSE-8A-T DSE-8A-P DSE-8B-T DSE-8B-P		<b>MnC-8-T MnC-8-P</b>				<b>DM &amp; APE</b>		<b>24</b>
	<b>SEM-VII</b>	MC-14-T MC-14-P DSE-5A-T DSE-5A-P DSE-5B-T DSE-5B-P DSE-6A-T DSE-6A-P DSE-6B-T DSE-6B-P DSE-7A-T DSE-7A-P DSE-7B-T DSE-7B-P		<b>MnC-7-T MnC-7-P</b>						<b>20</b>
	<b>SEM-VIII</b>	MC-15-T MC-15-P DSE-8A-T DSE-8A-P DSE-8B-T DSE-8B-P DSE-9A-T DSE-9A-P DSE-9B-T DSE-9B-P DSE-10A-T DSE-10A-P DSE-10B-T DSE-10B-P		<b>MnC-8-T MnC-8-P</b>				<b>DM OR APE</b>		<b>24</b>

NOTE:

MDC to be selected / opted from the common pool of courses offered by University of Gour  
Banga.

- IAPC = Internship / Apprentice-ship / Project / Community outreach

- DM = Dissertation on Major
- APE = Academic Project / Entrepreneurship
- Total credits at the end of 4<sup>th</sup> year = 170
- Students can exit after semester-II; for that, the student has to secure 44 credits + 2 credits = total 46 credits. For such case, student has to complete the IAPC course and will be awarded UNDER GRADUATE CERTIFICATE IN BOTANY.
- Students can exit after semester-IV; for that, the student has to secure 84 credits inclusive of one (01) IAPC course (either at semester-II or semester-IV). . For such case, student has to complete the IAPC course and will be awarded UNDER GRADUATE DIPLOMA IN BOTANY.
- Student can exit after semester-VI; for that the student has to secure 126 credits inclusive of one (01) IAPC course (either at semester-II or semester-IV). In such case the student will be awarded UNDER GRADUATE DEGREE IN BOTANY.
- The fourth year of study has two options for the students, in both options, student has to secure 170 credits. The students on successful completion will be awarded as follows:-
- ❖ **Either** BACHELOR OF BOTANY HONOURS WITH RESEARCH / HONOURS WITH RESEARCH IN DISCIPLINE-1 (MAJOR) WITH DISCIPLINE-2 (MINOR) DISCIPLINES.
- ❖ **Or** BACHELOR OF BOTANY HONOURS IN DISCIPLINE-1 (MAJOR) WITH DISCIPLINE-2 (MINOR)
  - A student willing to be awarded the degree with first option ( i.e. Honours with Research) has to complete EITHER two (02) Dissertations on Major discipline & one (01) Academic projects / Entrepreneurships OR one (01) Dissertation on Major discipline and two (02) Academic projects / Entrepreneurships during semester-VII and semester-VIII, each of four (04) credits.
  - A student willing to be awarded the degree with second option ( i.e. Honours) has to complete only one (01) Dissertation on Major discipline / Academic project / Entrepreneurship of four (04) credits. The student has to study one extra DSE course both in semester-VII and semester-VIII than the prior case.
- ✓ The four-year under graduate programme has to be completed in maximum seven years of duration.
- ✓ Common pool of MDC Courses & VAC-Courses will be offered as recommended by the UGB.

## COURSE NOMENCLATURE

CODE	CREDIT	NOMENCLATURE
<b>FIRST YEAR- FIRST SEMESTER</b>		
MC-1-T	3	ALGAE AND MICROBIOLOGY
MC-1-P	1	ALGAE AND MICROBIOLOGY
MC-2-T	3	FUNGI, LICHEN AND PLANT PATHOLOGY
MC-2-P	1	FUNGI, LICHEN AND PLANT PATHOLOGY
MnC-1-T	3	BIODIVERSITY
MnC-1-P	1	BIODIVERSITY
SEC-1	3	MEDICINAL BOTANY
<b>FIRST YEAR- SECOND SEMESTER</b>		
MC-3-T	3	BRYOPHYTA AND PTERIDOPHYTA
MC-3- P	1	BRYOPHYTA AND PTERIDOPHYTA
MC-4-T	3	PLANT MORPHOLOGY AND PLANT SYSTEMATICS
MC-4-P	1	PLANT MORPHOLOGY AND PLANT SYSTEMATICS
MnC-2-T	3	BIODIVERSITY
MnC-2-P	1	BIODIVERSITY
SEC-2	3	BASIC LABORATORY AND FIELD SKILL
<b>SECOND YEAR- THIRD SEMESTER</b>		
MC-5-T	3	GYMNOSPERM AND PALEOBOTANY
MC-5- P	1	GYMNOSPERM AND PALEOBOTANY
MC-6-T	3	PLANT ANATOMY AND PLANT ECOLOGY
MC-6-P	1	PLANT ANATOMY AND PLANT ECOLOGY
MnC-3-T	3	PLANT MORPHOLOGY AND SYSTEMATICS

MnC-3-P	1	PLANT MORPHOLOGY AND SYSTEMATICS
SEC-3	3	BIOFERTILIZER
<b>SECOND YEAR- FOURTH SEMESTER</b>		
MC-7-T	3	PLANT PHYSIOLOGY
MC-7- P	1	PLANT PHYSIOLOGY
MC-8-T	3	CELL BIOLOGY AND PLANT BREEDING
MC-8-P	1	CELL BIOLOGY AND PLANT BREEDING
MC-9-T	3	PALYNOLOGY AND REPRODUCTIVE BIOLOGY OF ANGIOSPERMS
MC-9-P	1	PALYNOLOGY AND REPRODUCTIVE BIOLOGY OF ANGIOSPERMS
MnC-4-T	3	PLANT MORPHOLOGY AND SYSTEMATICS
MnC-4-P	1	PLANT MORPHOLOGY AND SYSTEMATICS

## SEMESTER- I

### **Major Course -1 (MC-1) : Algae & Microbiology [ 04 Credits : F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MC-1-T** of marks 25
- Practical component paper of this course: **MC-1-P** of marks 15

### **Topic content of MC-1-T [03 Credits] (Lecture period = 60)**

#### **Algae & Microbiology**

##### **Algae**

[1] General characteristics; Ecology and distribution; range of thallus organization; Cell structure and components; cell wall, pigment system, reserve food, flagella; methods of reproduction and uses. (Cyanophyta, Chlorophyta, Charophyta, Bacillariophyta, Phaeophyta & Rhodophyta)

[2] Classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups)

[3] Cyanophyta: cell structure and function with special reference to heterocyst & akinete. Life history of – *Anabaena* sp.

[4] Chlorophyta: cell structure and function with special reference to chloroplast types. Life history of – *Oedogonium* sp.

[5] Charophyta: cell structure and function with special reference to corticated cells, globule and nucleole of *Chara* sp. Life history of *Chara* sp.

[6] Bacillariophyta (diatoms): cell structure and function, cell division, auxospore formation & classification with respect to cellular symmetry (pinnate & centric diatoms).

[7] Phaeophyta: cell structure and function. Life history of *Ectocarpus* sp.

[8] Rhodophyta: cell structure and function with reference to cell to cell connection and phycocolloids. Life history of – *Polysiphonia* sp.

##### **Microbiology**

[1] Introduction to microbial world: Discovery, general characteristics; Types-archaeobacteria, eubacteria, wall-less forms (mycoplasma and spheroplasts); Cell structure: Flagella (ultrastructure) & Pilli; Cell wall – chemical structure and differences between Gram +ve & Gram – ve bacteria; Bacterial genome and plasmid; Endospore - formation, structure and function.

[2] Bacterial reproduction: Vegetative and asexual; Genetic Recombination (a) Transformation – with special emphasis on Natural and Induced competence and DNA uptake, (b) Conjugation – F- factor, F+ x F–, Hfr x F–, concept of F', chromosome mobilization(c) Transduction– Generalised and specialized.

[3] Viruses: Discovery, physiochemical and biological characteristics; classification (Baltimore), general, structure with special reference to viroids and prions; replication (general account).

[5] DNA virus, (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics.



**Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]**

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

**Topic content of MC-1-P [01 credit]**

**Algae & Microbiology**

**Algae**

[1] Preparation of semi-permanent slide using lactophenol as mounting medium and cotton blue as stain of – *Anabaena* sp., *Oedogonium* sp., *Chara* sp., *Ectocarpus* sp. & *Polysiphonia* sp. and camera lucida drawing of selected portion of thallus mentioning proper magnification.

**Microbiology**

[1] Preparation of heat fixed and single-stained bacterial smear of bacteria from curd.

[2] Gram staining technique of bacteria using bacterial inoculum ( mixed or pure culture).

**NOTE:** Students will perform Gram staining procedure (differential staining) upto the Safranin step and comment on their observation based on supplied bacterial sample only.

Reference strain concept may be demonstrated but not mandatory for examination purpose.

**Question pattern for Practical Examination: [10+2+3 = 15]**

- Workout for algal specimen: ONE SLIDE slide preparation[02] + magnification[02] + drawing with camera lucida drawing prism and labeling[04] + comment[02] = 10
- Workout for microbiological sample: TWO SLIDES – one GRAM STAINING : slide preparation[03] + drawing with label[01] + comment[02] = 06 & one SIMPLE STAINING: slide preparation[02] + drawing with label[01] + comment[01] = 04
- Laboratory note book. [02]
- Viva-voce [03]

Any ONE workout- EITHER algal sample OR bacterial sample

**Suggested Readings**

1. Bold, H.C. & Wynne, M.J. ....Introduction to Algae: Structure & Reproduction [Prentice Hall]
2. Ganguly, H.C. & Kar, A.K.....College Botany Vol.-II [New Central Book Agency]
3. Hoek, C., Mann, D.G. & Jahns, H.M. 1995 .....Algae: an..... [Cambridge Univ. Press]
4. Kumar, H.D. & Singh, H.N. ....Introductory Phycology [East-West Press Pvt. Ltd]
5. Lee, R.E. Phycology [Cambridge Univ. Press]
6. Vashistha, B.R., Singh, A.K. & Singh, V.P.....Algae [S. Chand & Co. Pvt. Ltd.]
7. Atlas, R.M. Principles of Microbiology [McGraw Hill]

8. Banerjee, A.K. & Banerjee, N. ...Fundamentals of Microbiology and Immunology [New Central Book Agency]
9. Pelczar, M.J., Chan, P.C.S. & Krieg, N.R. ....Microbiology [Tata McGraw Hill]
10. Stanier, R.Y., Ingraham, J.L., Wheelis, M.L. & Painter, P.R. .General Microbiology [Macmillan Education Ltd.]
11. Tortora, G.J., Funke, B.R. & Case, C.L. .Microbiology - An Introduction [Dorling Kindersley India Pvt. Ltd. for Pearson Education]
12. Willey, M.J., Sherwood, L.M. & Woolverton, C.J.....Prescott, Harley and Klein's Microbiology [McGraw Hill]

## **Major Course -2 (MC-2) : Fungi, Lichens and Plant Pathology [ 04 Credit : F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MC-2-T** of marks 25
- Practical component paper of this course: **MC-2-P** of marks 15

### **Topic content of MC-2-T [03 credits] (Lecture period = 60)**

## **Fungi, Lichens and Plant Pathology**

### **Fungi & Lichen**

[1] Introduction to true fungi; General characteristics; Nutrition; Thallus organization; Cell wall composition; Teleomorphic and Anamorphic; Degeneration of sex in fungi; Life Cycle Patterns; Parasexuality.

[2] Classification (Ainsworth 1973) up to sub-division diagnostic characters with examples.

[3] Characteristic features; Ecology and significance; Thallus organisation; Reproduction; Life cycle with reference to *Rhizopus* sp., *Ascobolus* sp., *Agaricus* sp. and *Penicillium* sp.

[4] Symbiotic associations: Lichen – Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction and ecological role. Mycorrhiza- Ectomycorrhiza, Endomycorrhiza, Significance and role in Agriculture.

[5] Applied Mycology: Role of fungi in biotechnology; Application of fungi in food industry. Fungi as Biocontrol agents; Mycotoxins.

[6] Industrial production of Cheese, Ethanol, Baker's yeast, Amylase and Riboflavin.

### **Plant Pathology**

[1] Introduction to plant pathology; Plant pathology in India and Global prospective; Concept of Disease in Plants and Types of Diseases.

[2] Terms and definitions: Disease concept, Symptoms, Etiology, Inoculum and Infection, Pathogenesis, Disease triangle and Disease cycle, Epidemic and Endemic, Sporadic and Pandemic Disease. Koch's postulate.

[3] Mechanism of infection (Pre-penetration, Penetration and Post-Penetration), Plant defense responses with reference to Phytoalexins and PR proteins. Signal transduction leading to SAR and ISR.

[4] Concept of plant disease management:, Chemical, Biological and Quarantine. Concept of crop rotation. Integrated Pest Management (IPM).

[5] Symptoms, Causal organism, Disease cycle and control measures of: Bacterial diseases – Citrus canker, Viral diseases – Tobacco Mosaic Disease. Fungal diseases – Late blight of potato and Black stem rust of wheat.

**Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]**

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

**Topic content of MC-2-P [01 credit]**

**Fungi, Lichens and Plant Pathology**

**Fungi & Lichen**

[1] Study of asexual stage from temporary mounts, drawing and microscopic measurement: *Rhizopus* sp., *Ascobolous* sp. / *Peziza* sp. and *Agaricus* sp. / *Schizophyllum* sp.

[2] Study from permanent slides: Sexual stage in *Rhizopus* sp., Conidia of *Penicillium* sp., *Aspergillus* sp.

[3] Lichens: Study of growth forms of lichens from Herbarium/preserved specimens (crustose, foliose and fruticose) on different substrates through museum specimen.

**Plant Pathology**

[1] Study from temporary mounts (Histopathology): Late Blight of Potato, Stem rot of Jute, Leaf rust of *Justicia*.

[2] Study from permanent slides: Uredial, Telial, Pycnidial and Aecial stages of *Puccinia graminis*.

[3] Herbarium specimens of viral, bacterial, fungal and nematode diseases (maximum 20 herbarium sheets or vials with field reports).

**Question pattern for examination: [10+2+3 = 15]**

- Workout for fungal specimen: ONE SLIDE slide preparation[02] + drawing with microscopic measurements and labeling[04] + comment[02] = 08
- Workout for pathological sample: ONE SLIDE slide preparation[02] + drawing with labeling[03] + comment[02] +causal organism and name of the host 0.5+0.5=1)= 08
- Identification with reason: one specimen[02]
- Laboratory records and field submissions [02]
- Viva-voce [03]

Any ONE workout- EITHER fungal sample OR pathological sample

### Suggested Readings

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
2. Webster, J. and Weber, R. (2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
4. Kershaw, K.A. (1985), Physiological ecology of lichens, Cambridge University Press, Cambridge.
5. Negi, H.R.; Kareem, A., Lichens: The Unsung Heroes.
6. Negi, Hans Raj, Lichens: A valuable bioresource for environmental monitoring and sustainable development, Resonance. India, 2003,8(1), 51-58
7. Seaward, M.R.D. (1977) (Ed.), Lichen ecology, Academic Press, London.
8. Sharma, P.D. (2011). Plant Pathology, Rastogi Publication, Meerut, India.
9. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
10. Melhotra R.S and Aggarwal-Ed. Plant Pathology, Mc.Graw Hill Education

### **Minor Course -1 (MnC-1) : Biodiversity [ 04 Credit : F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MnC-1-T** of marks 25
- Practical component paper of this course: **MnC-1-P** of marks 15

#### **Topic content of Paper- MnC-1-T [03 Credits]**

### **Biodiversity**

**[1] Microbes:** Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and Lysogenic cycle, RNA virus (TMV); Economic importance. Bacteria – Discovery, General characteristics and cell structure; Cell wall – chemical structure and differences between Gram +ve & Gram –ve bacteria; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance with respect to uses of microbes as Biofertilizer, Bioplastic and Biopesticides.

**[2] Algae:** General characteristics; Ecology and distribution; Range of thallus organization and reproduction; classification of Lee (only upto groups) with characteristic features of each group; Morphology and life-cycles of the following: *Nostoc* sp., *Oedogonium* sp., and *Chara* sp. Economic importance of algae.

**[3] Fungi:** Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction. Classification according to Ainsworth 1973; True Fungi General characteristics, ecology and significance, life cycle of *Rhizopus* sp. (Zygomycota) *Ascobolus* sp. (Ascomycota), *Agaricus* sp. (Basidiomycota). Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

**[4] Introduction to Archegoniate:** Unifying features of archegoniates, Transition to land habit, Alternation of generations.

**[5] Bryophytes:** General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of

*Marchantia* sp., *Anthoceros* sp. and *Funaria* sp. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

**[6] Pteridophytes:** General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes. Morphology, anatomy and reproduction of *Selaginella* sp., *Equisetum* sp. and *Pteris* sp. (Developmental details not to be included).

**[7] Gymnosperms:** General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* sp. and *Pinus* sp. (Developmental details not to be included). Ecological and economical importance.

**Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]**

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

**Topic content of Paper- MnC-1-P [01 credit]**

**Biodiversity**

[1] Electron Micrographs/Models of viruses – T-Phage and TMV.

[2] Study of vegetative and reproductive structures of *Nostoc* sp., *Oedogonium* sp. (Macrandrous), and *Chara* sp. through permanent slides.

[3] Asexual stage from permanent slides of *Rhizopus* sp., *Ascobolous* sp. / *Peziza* sp. and *Agaricus* sp.

[4] Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)

[5] Type study using permanent mounts: *Marchantia* sp. (antheridial and archegonial heads); *Anthoceros* sp. (Sporophyte); *Funaria* sp. (Capsule)

[6] Type study using permanent slide: *Selaginella* sp.- morphology; Stem (T.S), Strobilus (L.S); *Equisetum*- morphology, strobilus (L.S). *Pteris*- morphology, sporophyll (L.S), Morphological studies of Megasporophyll and Microsporophyll.

[7] *Cycas* sp. - Morphology, Leaflet (T.S).

[8] *Pinus* sp. - Morphology, Needle (T.S), Morphological studies of Male and Female Cones.

**Question pattern for examination: [10+2+3 = 15]**

- Identification of five specimens as per syllabus, each of two marks [Reason-1.5 marks, identification-0.5 marks= 2marks]
- Laboratory note book. [02]
- Viva-voce [03]

**Suggested Readings**

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.

3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

## **Skill Enhancement Course (SEC-1): Medicinal Botany** **[Credit 3] Lectures: 30**

**Theory Paper: SEC-1 [03 credits] [F.M =50]**

### **Topic content of SEC-1**

**[1] History, Scope and Importance of Medicinal Plants.** Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridoshaconcepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

**[2] Conservation of endangered and endemic medicinal plants.** Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

**[3] Ethnobotany and Folk medicines.** Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. Folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.

### **Question pattern for examination: [(2+2+2+2+2) + (5+5+5+5) + 10 = 50]**

- Five (05) short answer-type questions each of two (02) marks to be attempted out of Eight (08) such questions framed. [2 x 5 = 10]
- Four (04) short notes each of Five (05) marks to be attempted out of Six (06) such questions framed. [5 x 4 = 20]
- One (01) descriptive / explanatory-type question of total Ten(10) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [10 x 1 = 10]

### **Suggested Readings**

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.

**End of semester-I**

## SEMESTER-II

### Major Course -3 (MC-3):BRYOPHYTA AND PTERIDOPHYTA [ 04 Credit:F.M.-50]

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MC-3-T** of marks 25
- Practical component paper of this course: **MC-3-P** of marks 15

### **Topic content of MC-3-T [03 Credits] (Lecture period = 60)**

#### **Bryophytes and Pteridophytes-**

1. Introduction: Transition to land habit, Evolution and complexity of sporophyte (telome theory); Alternation of generations.
2. **Bryophytes:** General characteristics; Adaptations to land habit; Classification (Proskauer, 1957) up to class. Range of thallus organization. Ecological and economic importance of bryophytes with special reference to *Sphagnum* sp.
3. Type Studies- Bryophytes: Morphology, anatomy and reproduction and sporophyte development and alternation of generation of *Marchantia* sp, *Anthoceros* sp., *Sphagnum* sp. and *Funaria* sp.
4. **Pteridophytes:** General characteristics; Classification up to class (Sporne, 1975); Concept of heterospory and origin of seed habit; Apogamy, and apospory; Stelar evolution. Ecological and economic importance of pteridophytes. Early land plants *Rhynia* sp .and *Lepidodendron* sp. (Reconstructed).
5. Type Studies- Pteridophytes: Morphology, anatomy and reproduction of *Psilotum*, *Lycopodium* sp., *Selaginella* sp., *Equisetum* sp. and *Pteris* sp. (Developmental details not to be included).

#### **Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]**

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

## Topic content of MC-3-P [01 Credit]

### Bryophytes and Pteridophytes-

#### 1. Bryophytes

- i. Morphology of thallus and permanent slide preparations of the following
- ii. *Marchantia* sp.: Work out of Antheridiophore, Archegoniophore.
- iii. *Anthoceros* sp.: - Dissection of sporophyte (to show stomata, spores, pseudoelaters, columella).
- iv. *Funaria* sp.: - Whole mount of leaf, rhizoids, operculum, peristome, annulus, spores and longitudinal section of capsule.

#### 2. Pteridophytes

- i. Morphology and permanent slide preparations of the following
- ii. *Selaginella* sp. and *Lycopodium* sp. :, Whole mount of strobilus, longitudinal section of strobilus.
- iii. *Equisetum* sp -Longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore.
- iv. *Pteris* sp - Transverse section of sporophyll, whole mount of sporangium.

#### **Question pattern for Practical Examination: [8+2+2+3 = 15]**

- Workout for Bryophyte specimen: ONE SLIDE slide preparation[02] drawing and labeling[04] + comment[02] = 8
- Workout for Pteridophyte specimen: ONE SLIDE slide preparation[02] drawing and labeling[04] + comment[02] = 8
- One specimen for identification either from bryophyte or pteridophyte using permanent slide or preserved specimen of **two marks** [Reason-1.5 marks, identification-0.5 marks= 2marks].

**List of specimens for identification**-Whole mount of rhizoids& scales, vertical section Gemma cup of *Marchantia* sp., Longitudinal Section of Capsule of *Sphagnum*, Transverse section of stem of *Selaginella* sp. and *Lycopodium* sp. Transverse section of internode of *Equisetum*, mount of spores of *Pteris* sp.

- Laboratory note book. [02]
- Viva-voce [03]

Any ONE workout- EITHER bryophyte OR pteridophyte specimens
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#### Suggested Readings

1. Smith, G.M. ....Cryptogamic Botany Vol. 1 [McGraw Hill]
2. Puri, P. ....Bryophyte [Atmaram& Sons]
3. Rashid, A. ....An Introduction to Bryophyta [Vikas Publishing House]
4. Vashishta, B.R. ....Bryophyta [S. Chand & Co.]
5. Vashishta, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.



6. Gifford, E.M. & Foster, A.S. ....Morphology and Evolution of Vascular Plants [Freeman & Co.]
7. Mukherjee, R.N. & Chakraborty, K. ....An Introduction to Vascular Cryptogams (Pteridophytes) [Kalyani Publishers]
8. Rashid, A. ....An Introduction to Pteridophyta [Vikas Publishing House]

## **Major Course -4 (MC-4-T) PLANT MORPHOLOGY AND PLANT SYSTEMATICS**

### **[ 04 Credit:F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MC-4-T** of marks 25
- Practical component paper of this course: **MC-4-P** of marks 15

### **Topic content of MC-4-T [03 Credits] (Lecture period = 60)**

## **Plant Morphology and Plant Systematics-**

### **Plant Morphology**

[1] Introduction to angiospermic morphology, Palynology and Anatomy, scope and applications in systematics, forensic and pharmacognosy.

[2] Leaf: Types, Margin, Base, Venation and Phyllotaxy, Petiole and modifications.

[3] Inflorescence: types with examples; Flower: Floral parts, Thalamus and insertion of floral parts, Calyx, Corolla, Aestivation, Perianth, floral diagram and floral formula. Stamen: Types and anther shape. Carpel : types, placentation-types, ovule structure and types; Fruit types with examples.

### **Plant Systematics-**

[1] Significance of Plant systematics: Introduction to systematics; Plant identification, Classification, Nomenclature. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access.

[2] Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary).

[3] Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

[4] Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Outline of classification systems of Linnaeus (1753), Bentham and Hooker (1862-1883) upto series and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

[5] Biometrics, numerical taxonomy and cladistics : Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms, cladograms (definitions and differences).

[6] Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).

[7] Diagnostic features of Families: **Dicotyledons**- Ranunculaceae, Brassicaceae, Malvaceae, Leguminosae (sensu lato), Apiaceae, Solanaceae, Lamiaceae, Cucurbitaceae, Rubiaceae, Euphorbiaceae, Asteraceae. **Monocotyledons**-Alismataceae, Poaceae, Zingiberaceae and Orchidaceae.

**Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]**

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

### **Topic content of MC-4-P [01 Credit]**

#### **Plant Morphology and Plant Systematics**

[1] Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

Ranunculaceae- *Ranunculus* sp, *Delphinium* sp.

Brassicaceae- *Brassica* sp, *Alyssum* sp / *Iberis* sp.

Malvaceae- *Eucalyptus* sp, *Callistemon* sp (bottle brush)

Apiaceae- *Coriandrum* sp / *Anethum* sp / *Foeniculum* sp.

Solanaceae- *Solanum* sp / *Physalis* sp / *Nicotiana* sp .

Lamiaceae- *Salvia* sp / *Ocimum* sp / *Leucas* sp / *Leonurus* sp.

Cucurbitaceae: *Cephalandra* sp./ *Nukia* sp.

Rubiaceae: *Dentella* sp. / *Spermacoce* sp.

Euphorbiaceae: *Jatropha* sp / *Croton* sp / *Acalypha* sp.

Asteraceae- *Sonchus* sp. / *Launaea* sp., *Vernonia* sp. / *Ageratum* sp. / *Tridax* sp.

Liliaceae – *Asphodelus* sp ./ *Lilium* sp ./ *Allium* sp.

Poaceae – *Triticum* sp. / *Hordeum* sp. / *Avena* sp.

[2] Mounting of a properly dried and pressed specimen of at least 10-15 collected Angiospermic plants with herbarium label and arranged according to Bentham and Hookers system of classification.

[3] Botanical excursion: Enlistment of plants observed in the field and submission of field note book with 10-25 photographs with ecological notes on the plants observed.

[4] Morphology: Morphological studies (No working out): Different types of phyllotaxy in plants; Types of special inflorescence; Aestivations, Anther types and Placentation; Different types of fruits.

**Question pattern for Practical Examination: [7+3+2+3 = 15]**

- **Workout of Plant Specimen:** Description with drawing and labeling-2, Floral formula-1, Floral diagram-1, family 1, Identification of genus using Bengal Plants 2 = Total-7
- Two specimens for identification from morphology as per syllabus using permanent slide/living specimen of total **three marks** [Reason-1 mark, identification-0.5 marks= 1.5marksx2=3].
- Herbarium, field records and Laboratory Note Book-2
- Viva-3

**Suggested Readings**

1. Eames, A.J. ....Morphology of Angiosperms [McGraw Hill]
2. Ganguly, H.C. & Kar, A.K. ....College Botany Vol. I [New Central Book Agency]
3. Lawrence, G.H.M. .... (Glossary) Taxonomy of Vascular Plants [Oxford & IBH]
4. Datta, S.C. ....Systematic Botany [Wiley Eastern]
5. 3. Mukherjee, S. ....College Botany Vol. III [New Central Book Agency]
6. 4. Mitra, D., Guha, J. & Chowdhury, S.K...Studies in Botany, Vol. I [Moulik Library]
7. 5. Naik, V.N. ....Taxonomy of Angiosperms [Tata McGraw Hill]
8. 6. Heywood, V.H. ....Flowering Plants of India [Oxford University Press]
9. 7. Stace, C.A. ....Plant Taxonomy and Biosystematics [Arnold Publishers]
10. 8. Prain, D. ....Bengal Plants Vol. I & II [Bishen Singh, Mahendra Pal Singh]
11. 9. Sivarajan, V.V. ....Introduction to Principles of Plant Taxonomy [Oxford & IBH]

**Minor Course -2 (MnC-2) : Biodiversity [ 04 Credit : F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MnC-2-T** of marks 25
- Practical component paper of this course: **MnC-2-P** of marks 15

**Topic content of Paper- MnC-2-T [03 Credits]**

**Biodiversity**

[1] **Microbes:** Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and Lysogenic cycle, RNA virus (TMV); Economic importance. Bacteria – Discovery, General characteristics and cell structure; Cell wall – chemical structure and differences between Gram +ve & Gram –ve bacteria; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance with respect to uses of microbes as Biofertilizer, Bioplastic and Biopesticides.

[2] **Algae:** General characteristics; Ecology and distribution; Range of thallus organization and reproduction; classification of Lee (only upto groups) with characteristic features of each group; Morphology and life-cycles of the following: *Nostoc* sp., *Oedogonium* sp., and *Chara* sp. Economic importance of algae.

[3] **Fungi:** Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction. Classification according to Ainsworth 1973; True Fungi General characteristics, ecology and significance, life cycle of *Rhizopus* sp. (Zygomycota) *Ascobolus* sp. (Ascomycota), *Agaricus* sp. (Basidiomycota). Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance.

[4] **Introduction to Archegoniate:** Unifying features of archegoniates, Transition to land habit, Alternation of generations.

[5] **Bryophytes:** General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* sp., *Anthoceros* sp. and *Funaria* sp. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum* sp.

[6] **Pteridophytes:** General characteristics, classification, Early land plants (Cooksonia and Rhynia). Classification (up to family), Heterospory and seed habit, stellar evolution. Ecological and economical importance of Pteridophytes. Morphology, anatomy and reproduction of *Selaginella* sp., *Equisetum* sp. and *Pteris* sp. (Developmental details not to be included).

[7] **Gymnosperms:** General characteristics; Classification (up to family), morphology, anatomy and reproduction of *Cycas* sp. and *Pinus* sp. (Developmental details not to be included). Ecological and economical importance.

**Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]**

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

**Topic content of Paper- MnC-1-P [01 credit]**

**Biodiversity**

[1] Electron Micrographs/Models of viruses – T-Phage and TMV.

[2] Study of vegetative and reproductive structures of *Nostoc* sp., *Oedogonium* sp. (Macrandrous), and *Chara* sp. through permanent slides.

[3] Asexual stage from permanent slides of *Rhizopus* sp., *Ascobolous* sp. / *Peziza* sp. and *Agaricus* sp.

[4] Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)

[5] Type study using permanent mounts: *Marchantia* sp. (antheridial and archegonial heads); *Anthoceros* sp. (Sporophyte); *Funaria* sp. (Capsule)

[6] Type study using permanent slide: *Selaginella* sp.- morphology; Stem (T.S), Strobilus (L.S); *Equisetum*- morphology, strobilus (L.S). Pteris- morphology, sporophyll (L.S), Morphological studies of Megasporophyll and Microsporophyll.

[7] *Cycas* sp. - Morphology, Leaflet (T.S).

[8] *Pinus* sp. - Morphology, Needle (T.S), Morphological studies of Male and Female Cones.

Question pattern for examination: [10+2+3 = 15]

- Identification of five specimens as per syllabus, each of two marks [Reason-1.5 marks, identification-0.5 marks= 2marks]
- Laboratory note book. [02]
- Viva-voce [03]

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.
7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

**Skill Enhancement Course (SEC-2): Basic Laboratory and Field Skills in Plant Biology**

**[Credit 3] Lectures: 30**  
**Theory Paper: SEC-2[F.M =50]**

**Topic content of SEC-2**

**1: Lab safety and good lab practices**-General laboratory safety, good laboratory practices, biosafety measures (first-aid practices to be followed in case of burn, acid spills and injury), safety symbols, lab safety equipments (fire extinguisher, fume hood, safety glasses), classes of laboratory chemicals, maintenance and handling of chemicals (Labels, Quality - LR/ AR/ Molecular biology grade/ HPLC grade; Expiry date; Precautions for use), Disinfectants, Biocontainment, Disposal of hazardous chemicals, radioactive and biological waste, Laboratorywastemanagement.

**2: Use and maintenance of Laboratory equipment**-Weighing balance (Top loading and Analytical), pH meter (calibration and use), magneticstirrer, pipettes and micropipettes, autoclave, laminar airflow, BOD incubator, incubator shaker, micrometer, haemocytometer, spectrophotometer, Agarose gel electrophoresis unit, SDS PAGE unit, centrifuge, distillation unit, conductivitymeter, Lux meter.

**3: Microscopy, sample and slide preparation** -Microscopes (Dissecting, Compound and Electron microscopes), Fixation and Preservation (for light and electron microscopy)

**4: Measurements and calculations**-Units of measurements and conversion from one unit to another, measurement of volumes of liquids, Weighing, calculations: scientific notations, powers, logarithm and fractions.

**5: Solutions and Buffers**-Molarity, Molality, Normality, percent solution, stock solution, standard solution, dilution, dilution series, pH, acids and bases, buffers - phosphate, Tris- acetate, Tris- Cl and Citrate buffer.

**6: Basic culturing techniques**-Basic culture media (LB, YEB, MS) - liquid and solid, Culture techniques: plating (streak, spread & pour), replica plating, serial dilution.

**Question pattern for examination: [(2+2+2+2+2) + (5+5+5+5) + 10 = 50]**

- Five (05) short answer-type questions each of two (02) marks to be attempted out of Eight (08) such questions framed. [2 x 5 = 10]
- Four (04) short notes each of Five (05) marks to be attempted out of Six (06) such questions framed. [5 x 4 = 20]
- One (01) descriptive / explanatory-type question of total Ten(10) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [10 x 1 = 10]

**Suggested readings:**

1. Evert, R. F., Eichhorn, S. E., Perry, J.B. (2012). Laboratory Topics in Botany. W.H.Freeman and Company.
2. Mesh, M.S., Kebede-Westhead, E. (2012). Essential Laboratory Skills for Biosciences. John Wiley & Sons, Ltd.
3. Mu, P., Plummer, D. T. (2001). Introduction to practical biochemistry. TataMcGraw-Hill Education.
4. Mann, S. P. (2016). Introductory Statistics, 9th edition. Hoboken, NJ, John WileyandSons Inc.
5. Danniell, W.W. (1987). Biostatistics. New York, NY: John Wiley Sons.
6. Jones, A.M., Reed, R., Weyers, J. (2016). Practical Skills in Biology, 6th Edition, Pearson
7. Bisen, P.S. (2014). Laboratory Protocols in Applied Life Sciences, 1st edition. CRC Press.
8. Zar, Z. H. (2010). Biostatistical Analysis, 5th edition, Pearson Prentice Hall, New Jersey, USA.

## SEMESTER- III

### Major Course -5 (MC-5) : Gymnosperm & Palaeobotany

#### [ 04 Credit : F.M.-50]

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MC-5-T** of marks 25
- Practical component paper of this course: **MC-5-P** of marks 15

#### **Topic content of MC-5-T [03 Credits] (Lecture period = 60)**

### **Gymnosperm and Palaeobotany**

#### **Gymnosperms**

- [1] General characters and classification by Stewart and Rothwell, 1993 (up to order)
- [2] Ecological and economic importance of Gymnosperms.
- [3] Vegetative morphology, anatomy and reproductive structures, development of gametophytes and embryogeny of *Cycas* sp., *Pinus* sp. and *Gnetum* sp.
- [4] Fossil gymnosperms: Structural features, geographical and geological distribution of reconstructed genera: *Lyginopteris* sp., *Williamsonia* sp. and *Cordaites* sp.

#### **Paleobotany**

- [1] Fossil: types and modes of preservation (Schopf, 1975), conditions of preservations, fossilization process.
- [2] Geological time scale and major events of plant life through geological ages.
- [3] Gondwana – an overview of Indian Gondwana flora.
- [4] Importance of study of fossil.

#### **Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]**

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

## Topic content of MC-5-P [01 Credit]

### Gymnosperm and Palaeobotany

#### Gymnosperms:

1. Anatomical study of leaflet of *Cycas* sp. and *Pinus* sp. needle.
2. Morphological studies of reproductive structure of the genera mentioned in the theoretical syllabus. *Cycas* sp. (Megasporophyll and Microsporophyll) *Pinus* sp.- (male and female cones), *Gnetum* sp. (male and female cones)

#### Paleobotany:

1. Morphological study: *Glossopteris* sp. leaf fossils, *Ptilophyllum* sp.
2. Study from permanent slides / micrograph: T.S. of stem of *Lepidodendron* sp., *Calamites* sp., *Lyginopteris* sp.

#### Marks distribution for Practical Examination (Total 15 marks):

1. Workout: 6 marks (Slide preparation:02; drawing and labelling: 02; comments:02)
2. Identification: 3 sample x 2 marks= 06 marks (Identification:01; Comment:01). Out of three identification, one specimen from Gymnosperms and two from Paleobotany.
3. Viva-voce: 02 marks
4. Submission: 01mark

#### Suggested Readings

9. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
10. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.
11. Vasishta, P.C. ....Gymnosperms [S. Chand & Co.]
12. Bhatnagar, S.P. & Moitra, A. ....Gymnosperms [New Age International]
13. Arnold, C.R. ....An Introduction to Paleobotany [Agrobios India]
14. Andrews, Jr. H.N. ....Studies in Paleobotany [John Wiley & Sons Inc.]
15. Agashe, S.N. ....Palaeobotany [Oxford & IBH]
16. Taylor, T.N. ....Paleobotany-An introduction to fossil plant biology [McGraw Hill]
17. Meyen, S.V. ....Fundamentals of Paleobotany [Chapman & Hall]



## **Major Course -6 (MC-6) : Plant Anatomy and Plant Ecology**

**[ 04 Credit : F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MC-6-T** of marks 25
- Practical component paper of this course: **MC-6-P** of marks 15

**Topic content of MC-6-T [03 Credits] (Lecture period = 60)**

### **Plant Anatomy and Plant Ecology**

#### **Plant Anatomy**

**[1] Introduction and scope of Plant Anatomy:** Applications in systematics, forensics and pharmacognosy.

**[2] Structure and Tissues system:** Classification of tissues; Simple and complex tissues (no phylogeny); cytodifferentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances. Hydathodes, cavities, lithocysts and laticifers.

**[3] Apical meristems:** Meristematic and permanent tissues: Organization of shoot apex (Tunica-carpus concept) and organization of root apex (Korper-Kappe concepts); Structure of dicot and monocot leaf, Kranz anatomy. Structure of Xylem and Phloem tissue; Types and evolution of stele; Vascular bundle -types and function. Root-Stem transition and its significance;

**[4] Vascular Cambium and Wood:** Basic concepts of cambium; Secondary growth in root and stem. Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Normal and Anomalous secondary growth (citing examples of *Dracaena* sp. stem, *Bignonia* sp. stem, *Tinospora* sp. root, Orchid root), different types of wood. Concept and application of Dendrochronology.

**[5] Adaptive and Protective Systems:** Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni- and multicellular, glandular and nonglandular, two examples of each), stomata (classification); Development and composition of periderm, rhytidome and lenticels. Adcrustation and incrustation; Anatomical adaptations of xerophytes and hydrophytes.

#### **Plant Ecology**

**[1] Introduction:** Basic concepts; Levels of organization. Inter-relationships between the living world and the environment.

**[2] Soil and Water:** Importance; Origin, Formation; Composition; Physical; Chemical and Biological components; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil (concept only); Water table.

- [3] Light, temperature, wind and fire:** Variations; adaptations of plants to their variation.
- [4] Biotic interactions:** Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; biomass, standing crop.
- [5] Population ecology:** Characteristics and Dynamics, Ecological Speciation
- [6] Plant communities:** Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts.
- [7] Ecosystems:** Structure; Processes; Food chains and Food webs; Ecological pyramids.
- [8] Functional aspects of ecosystem:** Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

**Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]**

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

**Topic content of MC-6-P [01 Credit]**

**Plant Anatomy and Plant Ecology**

**Plant Anatomy**

1. Study of anatomical details through permanent slides/temporary stain mounts/museum specimens/micrographs with the help of suitable examples: Apical meristem of root, shoot and vascular cambium. Xylem: Tracheary elements-tracheids, vessel elements; perforation plates; xylem fibres; Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
2. Epidermal system: cell types, stomata types; trichomes: non-glandular and glandular.
3. Root: monocot, dicot, secondary growth.
4. Stem: monocot, dicot - primary and secondary growth; periderm; lenticels.
5. Anomalous growth (*Dracaena* sp. stem, *Bignonia* sp. stem, *Tinospora* sp. root, Orchid root).
6. Secretory tissues: cavities, lithocysts and laticifers.

**Plant Ecology**

1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper)
2. Study of morpho-anatomical adaptations of hydrophytes and xerophytes.
  - a. Hydrophyte: *Eichhornia* sp., *Nymphaea* sp., *Hydrilla* sp..
  - b. Xerophyte: *Nerium* sp., *Casuarina* sp., *Opuntia* sp., *Euphorbia tirucauli*.

3. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
4. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.
5. Botanical excursion: Field visit to familiarize students with ecology of different sites.

**Marks distribution for Practical Examination(Total 15 marks):**

1. Anatomy: 04marks (workout slide: 01; drawing and labelling:02; comment;01)
2. Ecology: 06marks (Quadrat; Requisition:01Principle:01 observation, calculation and result:03; comment: 01)
3. Identification (as per Syllabus): 1 x 02marks= 02 marks (Reason:01, identification:01)
4. Viva-Voce: 02 marks
5. Submission:01 mark

**Suggested Readings**

6. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.
7. Fahh, A. (1974). Plant Anatomy. Pergmon Press, USA.
8. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
9. Evert, R.F. (2006) Esau's Plant Anatomy: Meristems, Cells, and Tissues of the Plant Body: Their Structure, Function and Development. John Wiley and Sons, Inc.
10. Odum, E.P. ....Fundamentals of Ecology [Saunders]
11. Ambasht, R.S and Ambasht, N.K .....A Text book of plant Ecology [CBS Publ.]
12. Sukla, R.S. & Chandal, P.S. ....Plant Ecology [S. Chand & Co.]
13. Verma, P.S. & Agarwal, V.K. ....Concept of Ecology [S. Chand & Co.]
14. Kumar, H.D. ....Modern Concept of Ecology [Vikas Pub House]
15. Dhaliwal, G.S., Sangha, G.S. and Ralhan, P.K. ....Fundamentals of EnvironmentalSciences [Kalyani Pub.]
16. Asthana, D.K. and Asthana M. ....Environmental Problems and Solutions[S. Chand & Co.]
17. Cox, C.B.& Moore, P.D. ....Biogeography –An Ecological and EvolutionaryApproach [Blackwell Scientific Publ.]
18. Mani, M.S. ....Biogeography of India [Springer-Verlag]
19. Mitra, D., Guha, J. & Chowdhury, S.K.....Studies in Botany Vol. II[Mouluk Library]
20. Sharma, P.D. ....Elements of Ecology [Rastogi Publ.]

## **Minor Course -3(MnC-3) : PLANT MORPHOLOGY AND PLANT TAXONOMY [ 04 Credit : F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MnC-3-T** of marks 25
- Practical component paper of this course: **MnC-3-P** of marks 15

### **Topics of MnC-3-P [03 credits] (Lecture period = 60)**

## **Morphology and Plant Taxonomy**

### **Plant Morphology**

1. Introduction to angiospermic morphology, Palynology and Anatomy, scope and applications in systematics, forensic and pharmacognosy.
2. Leaf: Types, Margin, Base, Venation and Phyllotaxy, Petiole and modifications.
3. Inflorescence: types with examples; Flower: Floral parts, Thalamus and insertion of floral parts, Calyx, Corolla, aestivation, Perianth, floral diagram and floral formula. Stamen: Types and anther shape. Carpel : types, placentation-types, ovule structure and types; Fruit types with examples.

### **Plant Systematics**

- 1. Introduction to plant taxonomy:** Identification, Classification, Nomenclature.
- 2. Identification:** Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access
- 3. Taxonomic hierarchy:** Ranks, categories and taxonomic groups
- 4. Botanical nomenclature:** Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.
- 5. Classification:** Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

**6. Diagnostic features of Families: Dicotyledons:** Brassicaceae, Malvaceae,, Solanaceae, Lamiaceae, Asteraceae; **Monocotyledons-** Poaceae and Orchidaceae.

Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

### **Topics of MnC-3-P [01 credit]**

#### **Morphology and Plant Taxonomy**

[1] Morphology: Morphological studies (No working out): Different types of phyllotaxy in plants; Types of special inflorescence; Aestivations, Anther types and Placentation; Different types of fruits.

[2] Identification of plant specimen: ( Family name and Scientific name to be mentioned only)

Brassicaceae- *Brassica* sp., *Alyssum* sp. / *Iberis* sp.

Malvaceae- *Sida* sp./ *Abutilon* sp.

Solanaceae- *Solanum* sp. / *Physalis* sp./ *Nicotiana* sp.

Lamiaceae- *Salvia* sp./ *Ocimum* sp./ *Leucas* sp./ *Leonurus* sp.

Asteraceae- *Sonchus* sp./ *Launaea* sp., *Vernonia* sp./ *Ageratum* sp./ *Tridax* sp.

[3] Herbarium sheet of Angiosperms (minimum 10 properly mounted and labeled)

#### **Marks distribution [ (2 x5 =10) +1+1+3=15]**

[1] Three spot identification of angiospermic plants (two dicotyledonous and Monocotyledonous- Family and Scientific name to be mentioned only) and two identification from plant morphology each having 02 marks, 2 x 5 =10

[2] Laboratory note book (01 mark)

[3] Submission of Herbarium sheet of Angiosperms (minimum 10 properly mounted and labeled) [01 mark]

[3] Viva-voce (03 marks)

### Suggested Readings

1. Odum, E.P. ....Fundamentals of Ecology [Saunders]
2. Ambasht, R.S and Ambasht, N.K .....A Text book of plant Ecology [CBS Publ.]
3. Kumar, H.D. ....Modern Concept of Ecology [Vikas Pub House]
4. Mukherjee, S. ....College Botany Vol. III [New Central Book Agency]
5. Mitra, D., Guha, J. & Chowdhury, S.K...Studies in Botany, Vol. I [Moulik Library]
6. Heywood, V.H. ....Flowering Plants of India [Oxford University Press]
7. Stace, C.A. ....Plant Taxonomy and Biosystematics [Arnold Publishers]
8. Prain, D. ....Bengal Plants Vol. I & II [Bishen Singh, Mahendra Pal Singh]
9. Sivarajan, V.V. ....Introduction to Principles of Plant Taxonomy [Oxford & IBH]

### Skill Enhancement Course

#### Biofertilizers

(Credits: 3)

Lectures: 30

1. General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.
2. *Azospirillum* sp.: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacter* sp: classification, characteristics – crop response to *Azotobacter* sp inoculum, maintenance and mass multiplication.
3. Cyanobacteria (blue green algae), *Azolla* sp and *Anabaena azollae* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* sp. in rice cultivation.
4. Plant Growth Promoting Rhizobacteria (PGPR) and Plant Growth Promoting Fungi (PGPF): Characterization, mode of action and effect on plant growth and disease suppression. Induction of resistance in host against plant pathogens-mechanism and pathway involved.
5. Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.
6. Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application.

### **Suggested Readings**

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay \_Publication, NewDelhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New \_Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic \_Farming AktaPrakashan, Nadiad
- 7.

End of semester-III

### **SEMESTER-IV**

#### **Major Course -7 (MC-7) : Plant Physiology**

**[ 04 Credit : F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MC-7-T** of marks 25
- Practical component paper of this course: **MC-7-P** of marks 15

**Topic content of MC-7-T [03 Credits] (Lecture period = 60)**

#### **Plant Physiology**

**[1] Plant-water relations:** Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, transmembrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration; Cavitation and embolism.

**[2] Mineral nutrition:** Essential and beneficial elements, macro and micronutrients.

**[3] Nutrient Uptake:** Transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption. proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.

[4] **Carbon assimilation:** photosynthetic pigments and their role (chlorophylls and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, CO<sub>2</sub> reduction, photorespiration, C<sub>4</sub> pathways; CAM and its ecological significance. Factors affecting CO<sub>2</sub> reduction.

[5] **Carbon Oxidation:** Glycolysis and its significance, fate of pyruvate, oxidative pentose phosphate pathway, TCA cycle, mitochondrial electron transport, oxidative phosphorylation, factors affecting respiration.

[6] **Translocation in the phloem:** Phloem loading and unloading; Source–sink relationship.

[7] **Transpiration: Stomata** – Transpiration, factors affecting transpiration, antitranspirants, mechanism of stomatal movement. Role and significance of CO<sub>2</sub>, K<sup>+</sup> - ion, blue light & abscisic acid in stomatal movement; Anti-transpirant.

[8] **Plant growth regulators:** Introduction to Plant growth hormones/regulators. Types of plant growth regulators (natural and synthetic). Physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroids and Jasmonic acid. Commercial Plant Growth Hormones examples and uses.

[9] **Physiology of flowering:** Photoperiodism, flowering stimulus, florigen concept, vernalization.

[10] **Phytochrome, cryptochromes and phototropins:** Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR)

[11] **Seed Dormancy:** Types, causes and methods of breaking seed dormancy.

Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

## **Topic content of MC-7-P [01 Credits]**

### **Plant Physiology**

#### **MC-7-P (01): Plant Physiology (Practical, Credit 01) Full Marks 15**

1. Determination of stomatal frequency and rate of transpiration per stomata per hour.
2. Comparison of imbibition of water by starchy, proteinaceous and fatty seeds.
3. Rate of photosynthesis under varying HCO<sub>3</sub><sup>-</sup> concentration (using bicarbonate) in aquatic plants.
4. Measurement of oxygen uptake by respiring tissue (per gram / hr.) by germinating seeds.



5. Determination of water potential/Osmotic pressure of given tissue (potato tuber) by weight method.
6. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA Bioassay).

**Marks distribution for Practical Examination(Total 15 marks):**

1. Experimental any one from the list (12)  
(Requirement-2, Principle 2, Experimental setup: 01; Result and calculation:5, comment=12)
2. Viva-Voce: 02 marks
3. Laboratory records submission: 01 mark

**Suggested Readings**

1. Jain, V.K. ....Fundamentals of Plant Physiology [S. Chand & Co.]
2. Lehninger, A.L., Nelson, D.L. & Cox, M.M. ....Principles of Biochemistry [CBS]
3. Mukherji, S. & Ghosh, A. ....Plant physiology [New central Book Agency]
4. Pandey, S.N & Sinha, B.K. ....Plant Physiology [Vikas Publ. House]
5. Salisbury, F.B. & Ross, C.W. ....Plant Physiology [Wordsworth Publ. Co.]
6. Sinha, R.K. ....Modern Plant Physiology [Narosa Publishing House]
7. Taiz, L & Zeiger, E. ....Plant Physiology [Sinauser Associates Inc. Publishers]
8. Verma, S.K ....A Text book of Plant Physiology & Biochemistry [S. Chand & Co.]
9. Voet, D. & Voet, J.G. ....Biochemistry [John Wiley]
10. Wilkins, M.B. ....Advanced Plant Physiology [ELBS, Longman]

**Major Course -8 (MC-8) : Cell Biology and Plant Breeding**

**[ 04 Credit : F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MC-8-T** of marks 25
- Practical component paper of this course: **MC-8-P** of marks 15

**Topic content of MC-8-T [03 Credits] (Lecture period = 60)**

**Cell Biology and Plant Breeding**

**Cell biology**

[1] **The cell:** Cell as a unit of structure and function, Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endosymbiotic theory).

[2] **Cell wall and membrane:** Plant cell wall, plasma membrane, models of membrane structure (fluid mosaic model), endocytosis and exocytosis.

[3] **Cell organelles (structure and function):** Nucleus, chloroplast, mitochondria, Endomembrane system, peroxisome, Lysosome.

[4] **Cytoskeleton:** microtubules, microfilaments and intermediary filament.

[5] **Cell division:** Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle-checkpoints, role of protein kinases.

### **Plant Breeding**

[1] Basic concept of plant breeding, significance and role in crop improvement.

[2] Origin of Cultivated Plants: Concept of Centers of Origin, their importance with reference to N.I. Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of new crops/varieties, importance of germplasm diversity.

[3] Green Revolution (History, Basic concepts and significance).

[4] Selection methods in plant breeding: Mass Selection, Pure-line Selection, Pedigree Selection, Bulk Selection and hybridization.

[5] Outline idea about Male sterility, Heterosis, Hybrid Vigor.

[6] Seed bank, Gene Bank, Germplasm- Importance and role in plant breeding.

Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

### **Topic content of MC-8-P [01 credit]**

#### **Cell Biology and Plant Breeding**

1. Study of plant cell structure with the help of epidermal peel mount of *Allium/Rhoeo/Crinum*
2. Chromosome preparation: Pre-treatment, Fixation, Staining, Squash and Smear preparation, Preparation of permanent slides. Study of Mitotic Chromosomes: Metaphase chromosome preparation, free hand drawing, determination of 2n number and comment on chromosome morphology of *Allium cepa*.
3. Determination of mitotic index in pre-fixed root tips of *Allium cepa*.
4. Identification of cell organelles with the help of electron micrographs (Chloroplast, ER, Golgi Apparatus); Stages of cell division from permanent slide or electron micrographs.
5. Demonstration of Emasculation and hybridization techniques in self and cross-pollinated crops.

## Marks distribution for practical examination (Total 15 marks)

1. Workout
  - a. Determination of 2n: 05 marks (Slide preparation: 02; drawing and labelling:02; comment 1= 05)
  - or
  - b. Mitotic index: 05 marks (Slide preparation: 02; observation and calculation:02 comment 01 =05)
2. Demonstration of Emasculation 03 marks (Requisition:01; Demonstration:02)
3. Identification 03 marks (1.5x2marks) (One Specimen from cell organelle; One Specimen from mitosis stage) [Reason = 1 + Identification statement= 0.5 Total = 1.5]
4. Laboratory records :01 mark
5. Submission of Permanent Slides: 01 mark
6. Viva-Voce: 02 marks

### Suggested readings

1. Cooper, G.M. ....The Cell - A Molecular Approach [ASM Press]
2. De Robertis, E.D.P. & De Robertis, E.M.M. ....Cell and molecular Biology [Waverly Pvt. Ltd. for Lea & Fabiger]
3. Karp, G. ....Cell and Molecular Biology: Concepts and Experiments [John Wiley & Sons. Inc]
4. Powar, C.B. ....Cell Biology [Himalaya Publishing House]
5. Verma, P.S. & Agarwal, V.K. ....Concept of Cell Biology [S. Chand & Co.]
6. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell, Pearson Education Inc. U.S.A. 8th edition.
7. Allard, R.W. ....Principles of Plant Breeding [John Wiley]
8. Chawdhuri, H.K. ....Elementary Principles of Plant Breeding [Oxford & IBH]
9. Poehlman, J.M. & Barthakur, D. ....Plant Breeding [Oxford & IBH]
10. Singh, B.D. ....Plant Breeding: Principles and Methods [Kalyani Publishers]

## **Major Course -9 (MC-9) : Palynology and Reproductive Biology of Angiosperms**

**[ 04 Credit : F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MC-9-T** of marks 25
- Practical component paper of this course: **MC-9-P** of marks 15

## Topic content of MC-9-T [03 Credits] (Lecture period = 60)

### Palynology and Reproductive Biology of Angiosperms

#### Palynology

[1] **Palynology and scope:** a brief account

[2] **Pollen morphology:** Pollen morphology, units, polarity, symmetry, shape, size, aperture; NPC system for numerical expression of apertural details; evolution of aperture types.

[3] **Pollen Viability and Storage:** Pollen Viability and Storage: Estimation; variations; responsible factors; short- and long-term storage; significance.

[4] **Branches of Palynology & Application:** Branches of palynology & application: Branches of palynology; palynology in taxonomic & phylogenetic deductions; palynology in academic & applied aspects including melissopalynology, medical palynology, forensic palynology, entomopalynology & copropalynology.

#### Reproductive Biology of Angiosperms

[1] **Reproductive development:** Induction of flowering; flower as a modified determinate shoot. Flower development: genetic and molecular aspects.

[2] **Anther and pollen biology:** Anther wall: Structure and functions, microsporogenesis, callose deposition and its significance. microgametogenesis, male germ unit

[3] **Ovule:** Structure; Types; Special structures—endothelium, obturator, aril, caruncle and hypostase; Female gametophyte— megasporogenesis (monosporic, bisporic, tetrasporic) and megagametogenesis (details of *Polygonum* type); Organization and ultrastructure of mature embryo sac.

[4] **Pollination and fertilization:** Pollination types, agents and adaptations; pollen germination; path of pollen tube in pistil; double fertilization.

[5] **Embryo, Endosperm and Seed:** Structure and types; General pattern of development of dicot and monocot embryo and endosperm; Suspensor: structure and functions; Embryo-endosperm relationship; Nutrition of embryo; Unusual features; Embryo development in *Paeonia*. Seed structure.

Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

## Topic content of MC-9-P [01 credit]

### Palynology and Reproductive Biology of Angiosperms

1. Slides/Micrographs of Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages and Male Germ Unit.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material), ultrastructure of pollen wall (micrograph).
3. Pollen fertility and Pollen germination: Fertility, Germination: Calculation of percentage germination in different media using hanging drop method.
4. Ovule: Types-anatropous, orthotropous, amphitropous/campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (Permanent slides/specimens/photographs, Micrographs).
5. Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.
6. Intra-ovarian pollination; Test tube pollination through photographs.
7. Endosperm: Dissections of developing seeds for endosperm with free-nuclear haustoria.
8. Embryogenesis: Study of development of dicot embryo through permanent slides; Dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

#### **Marks distribution for practical examination (Total 15 marks)**

1. Workout: pollen fertility and germination 05 marks (Principle: 01; observation and calculation: 03 comment:01)
2. Workout: Endosperm dissection 03 marks (Slide preparation:01; drawing and labelling: 01; comment:01)
3. Identification 4 marks (4 sample x 1 marks): palynology (02 samples) reproductive biology (02 samples) [Identification with reason :01]
4. Viva:02 marks
5. Laboratory Note Book:01 mark

#### **Suggested Readings**

1. Bhojwani, S.S. and Bhatnagar, S.P. .... The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
2. Shivanna, K.R. .... Pollen Biology and Biotechnology. Oxford and IBH Publishing Co. Pvt. Ltd. Delhi.
3. Raghavan, V.....Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M. I ..... Embryology of Angiosperms, Springer-Verlag, Netherlands.

5. Mehra, P.N. ....Evolution of spore through the ages [Palynological Society of India, National Botanic Garden, Lucknow]
6. Nair, P.K.K. ....Pollen Morphology of Angiosperms [Scholar Publication]
7. Erdtman, G. ....Pollen Morphology and Plant Taxonomy [Ielden: E.G. Brill]
8. Faegri, K. & Iverson, J. ....Text Book of Pollen Analysis [Oxford: Blackwell Scientific Publication]

### **Minor Course -4(MnC-4) : PLANT MORPHOLOGY AND PLANT TAXONOMY [ 04 Credit : F.M.-50]**

This course is composed of two components – Theory & Practical, these two components will be treated as two separate papers under this course.

Internal assessment @ 20% of F.M. = 20% of 50 = 10

- Theory component paper of this course: **MnC-4-T** of marks 25
- Practical component paper of this course: **MnC-4-P** of marks 15

### **Topics of MnC-4-P [03 credits] (Lecture period = 60)**

#### **Morphology and Plant Taxonomy**

##### **Plant Morphology**

4. Introduction to angiospermic morphology, Palynology and Anatomy, scope and applications in systematics, forensic and pharmacognosy.
5. Leaf: Types, Margin, Base, Venation and Phyllotaxy, Petiole and modifications.
6. Inflorescence: types with examples; Flower: Floral parts, Thalamus and insertion of floral parts, Calyx, Corolla, aestivation, Perianth, floral diagram and floral formula. Stamen: Types and anther shape. Carpel : types, placentation-types, ovule structure and types; Fruit types with examples.

##### **Plant Systematics**

1. **Introduction to plant taxonomy:** Identification, Classification, Nomenclature.

2. **Identification:** Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access
3. **Taxonomic hierarchy:** Ranks, categories and taxonomic groups
4. **Botanical nomenclature:** Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.
5. **Classification:** Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).
6. **Diagnostic features of Families: Dicotyledons:** Brassicaceae, Malvaceae,, Solanaceae, Lamiaceae, Asteraceae; **Monocotyledons-** Poaceae and Orchidaceae.

Question pattern for examination: [(1+1+1+1) + (3+3+3+3) + 9 = 25]

- Four (04) very short answer-type questions each of One (01) mark to be attempted out of Six (06) such questions framed. [1 x 4 = 4]
- Four (04) short notes each of Three (03) marks to be attempted out of Five (05) such questions framed. [3 x 4 = 12]
- One (01) descriptive / explanatory-type question of total Nine (09) marks in which two or three parts will be asked in such a manner that, no part corresponds to more than Four (04) marks will have to be answered. Two (02) such descriptive / explanatory-type questions to be framed. [9 x 1 = 9]

### **Topics of MnC-3-P [01 credit]**

#### **Morphology and Plant Taxonomy**

[1] Morphology: Morphological studies (No working out): Different types of phyllotaxy in plants; Types of special inflorescence; Aestivations, Anther types and Placentation; Different types of fruits.

[2] Identification of plant specimen: ( Family name and Scientific name to be mentioned only)

Brassicaceae- *Brassica* sp., *Alyssum* sp. / *Iberis* sp.

Malvaceae- *Sida* sp./ *Abutilon* sp.

Solanaceae- *Solanum* sp. / *Physalis* sp./ *Nicotiana* sp.

Lamiaceae- *Salvia* sp./ *Ocimum* sp./ *Leucas* sp./ *Leonurus* sp.

Asteraceae- *Sonchus* sp./ *Launaea* sp., *Vernonia* sp./ *Ageratum* sp./ *Tridax* sp.

[3] Herbarium sheet of Angiosperms (minimum 10 properly mounted and labeled)

### **Marks distribution [(2 x5 =10) +1+1+3=15]**

- [1] Three spot identification of angiospermic plants (two dicotyledonous and Monocotyledonous- Family and Scientific name to be mentioned only) and two identification from plant morphology each having 02 marks, 2 x 5 =10
- [2] Laboratory note book (01 mark)
- [3] Submission of Herbarium sheet of Angiosperms (minimum 10 properly mounted and labeled) [01 mark]
- [3] Viva-voce (03 marks)

### **Suggested Readings**

- 10. Odum, E.P. ....Fundamentals of Ecology [Saunders]
- 11. Ambasht, R.S and Ambasht, N.K .....A Text book of plant Ecology [CBS Publ.]
- 12. Kumar, H.D. ....Modern Concept of Ecology [Vikas Pub House]
- 13. Mukherjee, S. ....College Botany Vol. III [New Central Book Agency]
- 14. Mitra, D., Guha, J. & Chowdhury, S.K...Studies in Botany, Vol. I [Moulik Library]
- 15. Heywood, V.H. ....Flowering Plants of India [Oxford University Press]
- 16. Stace, C.A. ....Plant Taxonomy and Biosystematics [Arnold Publishers]
- 17. Prain, D. ....Bengal Plants Vol. I & II [Bishen Singh, Mahendra Pal Singh]
- 18. Sivarajan, V.V. ....Introduction to Principles of Plant Taxonomy [Oxford & IBH]

End of semester-IV