Proposed Curriculum For B. Sc. (Honours) Botany and B. Sc. Program with Botany

Submitted to
COOCH BEHAR PANCHANAN BARMA UNIVERSITY

Under

Choice Based Credit System
(For Session 2017-2018)

Syllabus for Botany Honours Cooch Behar Panchanan Barma University, Cooch Behar Semester – 1

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week			Credit
				L	T	P	
1	Phycology Lichenology	Core Course-I	HBOT-CCT-101	4			4
2	Phycology Lichenology (Practical)	Core Course-I (Practical)	HBOT-CCP-101			4	2
3	Mycology Phytopathology	Core Course-II	HBOT-CCT-102	4			4
4	Mycology Phytopathology (Practical)	Core Course-II (Practical)	HBOT-CCP-102			4	2
5	GE-I	GE					4
6	GE-I (Practical)	GE					2
7	Eng/EVS	AECC					2
				Total Credit			20

Semester – II

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week			Credit
				L	T	P	
1	Bryology Palaeobotany and Palynology	Core Course-III	HBOT-CCT-203	4			4
2	Bryology Palaeobotany and Palynology (Practical)	Core Course-III (Practical)	HBOT-CCP-203			4	2
3	Pteridology and Gymnosperms	Core Course-IV	HBOT-CCT-204	4	0	0	4
4	Pteridology and Gymnosperms (Practical)	Core Course-IV (Practical)	HBOT-CCP-204	0	0	4	2
5	GE-II	GE					4
6	GE-II (Practical)	GE					2
7	Eng/EVS	AECC					2
							20

Semester – III

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week L	T	P	Credit
1	Plant Systematics	Core Course-V	HBOT-CCT-305	4			4
2	Plant Systematics (Practical)	Core Course-V	HBOT-CCP-305			4	2
3	Phytogeography and Economic Botany&	Core Course-VI	HBOT-CCT-306	4	0	0	4
4	Ethnomedicine Phytogeography and Economic Botany& Ethnomedicine(Practical)	Core Course-VI (Practical)	HBOT-CCP-306			4	2
5	Morphology and Plant Anatomy	Core Course- VII	HBOT-CCT-307	4			4
6	Morphology and Plant Anatomy(Practical)	Core Course-VII (Practical)	HBOT-CCP-307			4	2
7	GE-III	GE					4
8	GE-III (Practical)	GE					2
9	SEC-I	AEEC-I					2
							26

Semester – IV

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week L	T	P	Credit
1	Biochemistry and Plant Metabolism	Core Course-VIII	HBOT-CCT-408	4			4
2	Biochemistry and Plant Metabolism (Practical)	Core Course-VIII (Practical)	HBOT-CCP-408			4	2
3	Ecology and Pharmacognosy	Core Course- IX	HBOT-CCT-409	4			4
4	Ecology and Pharmacognosy (Practical)	Core Course- IX (Practical)	HBOT-CCP-409			4	2
5	Plant physiology	Core Course X	HBOT-CCT-410	4			4
6	Plant Physiology (Practical)	Core Course X (Practical)	HBOT-CCP-410			4	2

7	GE-IV	GE					4
8	GE-IV (Practical)	GE					2
9	SEC-II	AEEC-II					2
							26

Semester – V

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week			Credit
				L	T	P	
1	Microbiology	Core Course- XI	HBOT-CCT-511	4			4
2	Microbiology (Practicals)	Core Course-XI (Practical)	HBOT-CCP-511			4	2
3	Cell Biology and Genetics	Core Course- XII	HBOT-CCT-512	4			4
4	Cell Biology and Genetics (Practical)	Core Course- XII (Practical)	HBOT-CCP-512			4	2
5	DSE-I	DSE-I					4
6	DSE-I (Practical)	DSE-I					2
7	DSE-II	DSE-II					4
8	DSE-II (Practical)	DSE-II					2
				Total Credit			24

Semester – VI

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week			Credit
				L	T	P	
1	Molecular Biology and Biostatistics	Core Course-XIII	HBOT-CCT-613	4			4
2	Molecular Biology and Biostatistics (Practicals)	Core Course- XIII (Practical)	HBOT-CCP-613			4	2
3	Plant Biotechnology and Tissue culture	Core Course-XIV	HBOT-CCT-614	4			4
4	Plant Biotechnology and Tissue culture (Practicals)	Core Course-XIV (Practical)	HBOT-CCP-614			4	2

5	DSE-III	DSE-III					4
6	DSE-III (Practical)	DSE-III					2
7	DSE-IV	DSE-IV					4
8	DSE-IV (Practical)	DSE-IV					2
				Total Credit			24

Total Credit = 140

Core Course: Botany Honours

Semester	Papers	Name of the subject	Teaching Scheme In hours per week			Credit
			L	T	P	
I	1	Phycology and Lichenology	4		2	6
I	2	Mycology and Phytopathology	4		2	6
III	3	Bryology, Palaeobotany and Palynology	4		2	6
IV	4	Pteridology and Gymnosperms	4		2	6
V	5	Plant systematics	4		2	6
VI	6	Phytogeography and Economic Botany	4		2	6
VII	7	Morphology and Plant Anatomy	4		2	6
VIII	8	Biochemistry and Plant Metabolism	4		2	6
IX	9	Ecology and Pharmacognosy	4		2	6
X	10	Microbiology	4		2	6
XI	11	Plant Physiology	4		2	6
XII	12	Cell Biology and Genetics	4		2	6
XIII	13	Molecular Biology	4		2	6
XIV	14	Plant Biotechnology and Tissue culture	4		2	6
			Total Credit			84

AECC – Ability Enhancement Compulsory Courses: English/ Modern Indian Language/EVS

AEEC – Ability Enhancement Elective Course
[i.e. Skill Enhancement Course (SEC)]

[Two papers are to be taken and each paper will have 2 credit]: 1.Vermicomposting and organic farming

2. Mushroom cultivation
3. Cultivation of medicinal Plants
4. Laboratory skills

Discipline Specific Elective Courses (DSE):

(Four papers are to be taken each carrying 6 credit)

DSE- I : Stress Physiology/Ethnobotany
DSE-II: Plant Breeding/ Horticultural Practices
DSE III: Bioinformatics/Research Methodology
DSEIV: Biostatistics/ Cryopreservation

Interdisciplinary/Generic Elective (GE) from other Department:

[Four papers are to be taken and each paper will be of 6 credit]:
(Papers are to be taken from any of the following disciplines. (At least two papers are to be taken from chemistry)

1. Chemistry, 2. Zoology, 3. Botany, 4. Physiology, 5. Microbiology.

General Elective: Botany

Semester.	Papers	Name of the subject	Teaching Scheme In hours per week			Credit
			L	T	P	
I	1	Algae, Fungi and Bryophyta	4		2	6
II	2	Pteridophyta,Gymnosperms&Paleobotany	4		2	6
III	3	Plant Taxonomy and Plant Anatomy	4		2	6
IV	4	Plant Physiology and Cytogemnetics	4		2	6
V	5	Economic Botany/Pharmacognosy	4		2	6
VI	6	Plant Biotechnology/Tissue culture	4		2	6
VII	7	Microbiology/Plant Pathology	4		2	6
VIII	8	Plant Breeding/ Horticultural Practices	4		2	6

IX	9	Bioinformatics/Research Methodology	4		2	6
X	10	Biostatistics/ Cryopreservation	4		2	6
			Total Credit			60

DETAILED SYLLABUS FOR BOTANY HONOURS ACCORDING TO CBCS-UGC

COOCH BEHAR PANCHANAN BARMA UNIVERSITY

COOCH BEHAR

SEMESTER - I

Theory – Marks 50
Core Course – I (Theory) (Marks 25)
HBOT-CCT-101
Phycology (15) –

1. Introduction; Habitat and distribution; thallus organization; origin and evolution of sex in algae; Life cycle patterns.
2. Broad outline of classifcation of Lee (2008) up to class and divisions respectively.

3. Cyanophyceae: Salient features, ultrastructure of cell, structure and function of heterocyst; reproduction.
4. Chlorophyceae: Salient features; life history of *Chlamydomonas, Oedogonium* and *Trentepohlia.*

5. Charophyceae: Salient features; life history of *Coleochate* and *Chara*.
6. Xanthophyceae: Salient features; life history of *Vaucheria.*
7. Bacillariophyceae: *S*alient features, cell structure and reproduction.
8. Phaeophyceae: *S*alient features; life history of *Ectocarpus*.
9. Rhodophycee: Salient features; life history of *Polysiphonia*.
10. Economic importance – Benefcial: food. phycocolloids (agar, algin and carrageenan), diatomaceous earth; Harmful: algal as pathogen in plants and algal toxins.

Lichenology(10) -

Lichen: Classifcation, thallus structures, reproduction; ecological and economic signifcance.

Internal Assessment - 10

Core Course – II (Theory) (Marks 25)
HBOT-CCT-102
Mycology (15) –

1. Status of fungi in living system.
2. Introduction, Salient features - fungal tissue organization, modifcation of hyphae, structure of fungal cell, fagella, habit, septum, homothallism and heterothallism, parasexuality, cell division.

3. Broad outline Classifcation of Ainsworth and Bisby (1983).
4. Phycomycetes: Salient features, life histories of *Synchytrium, Rhizopus.*
5. Ascomycetes: Salient features, Ascus development, types of ascocarps; life histories of *Saccharomyces* and *Ascobolus*.
6. Basidiomycetes: Salient features (dikaryotization, clamp connection); development of Basidium (holobasidium and phragmobasidium), fruit body types, life histories of *Puccinia, Ustilago* and *Polyporus.*
7. Deuteromycetes: Salient features with special reference to conidial fruit body types.
8. Economic importance of fungi – As food (Mushroom – types; procedure of spawn production and cultivation of Oyster and Button mushroom); Mycorhizae (importance in agriculture and forestry).

Phytopathology (10) -

1. Diseases: Defnition; concepts of parasitism and saprophytism, Koch's postulate.
2. Classifcation of plant diseases based on symptoms.
3. Pathotoxins (HV toxin and Wild-fre toxin).
4. Structural and biochemical defense mechanism of plants.
5. Control of Plant diseases: Physical, chemical and biological methods.
6. Symptoms, disease cycles and control measures of White rust of crucifer, Brown spot of rice, Late blight of potato, Rust of wheat.

Internal Assessment - 10

Practicals – Marks 30
Core Course – I (Practical) (Marks 15)
HBOT-CCP-101- (15)
Algae/Phycology -

1. Study of the following genera: *Oscillatoria, Oedogonium, Chara, Vaucheria* and *Ectocarpus.*

2. Identifcation of all the genera included in the theoretical syllabus by their vegetative and reproductive structures.

Core Course – II (Practical) (Marks 15)

HBOT-CCP-102 (15)

Fungi/ Mycology -

1. Study of the following genera: *Rhizopus, Ascobolus, Agaricus* (gill) and *Polyporus.*
2. Identifcation of all the macroscopic and microscopic genera included in the theoretical syllabus. (It should also include *Alternaria* and *Fusarium* of Deuteromycetes).

Phytopathology -

1. Study of the following diseases: White rust, Rust of wheat/*Justicia*, smut of wheat (or any member of Poaceae)
2. Demonstration on isolation and subculturing of pathogen.

[NB. Practicals will also include feld study with specimen collection, preservation and their submission with proper documentation. It also includes temporary and where ever necessary permanent slide submission.]

Bibliography for Semester I –

1. College Botany Vol. –II. - Gangulee and Kar, New Central Book Agency, Kolkata.
2. Studies in Botany, Vol. I. - Mitra, Mitra, Choudhury. Moulik Library, Kolkata.
3. Text Book of Botany, Voli-1 and 2, By Hait, Ghosh and Bhattacharya, New Central Book Agency.
4. Botany – A. C. Datta, Oxford Univ. Press.
5. The structure and reproduction of algae, Fritsch, F. E. Vol. I (1935), Vol. II. Cambridge University Press
6. Introduction to the algae: structure and reproduction. 3rd Edition (1985). Bold, H. C. and Wynne, M. J. Wall. Prentice Hall of India Private Limited.
7. Phycology. 4th edition. Lee, R. E. (2009) Cambridge University Press.
8. An Introduction to Phycology. Van der Hock, D. G. Mann and Johns, H. M. 1995. Cambridge University Press.
9. Text Book of Algae, Sharma O.P. Tata McGraw Hill Publishing Co. Latyest edn.
10. Botany for degree students. Algae. B. R. Vashistha, A. K. Sinha. V. R. Singha (Latest edition).
11. Introduction to Fungi. Webster, J. Cambridge University Press.
12. Introduction to Fungi, Dubey, H. C. Vikas Publishing House.
13. Introduction to Mycology. Alexopoulas, C. J., Mims, C. W. and Blackwell Wiley. Bastern Limited, New Delhi.
14. Introductory Mycology. R. S. Mehrotra and Aneja, K. R. New Age International
15. Text Book of Fungi, Sharma, O. P. Tata Mc Graw Hill Publishing Co. Latest edn.
16. Botany for degree students. Fungi. B. R. Vashistha, A. K. Sinha. V. R. Singha (Latest edition). S. Chand
17. Plant Pathology. Agrios R. N. academic Press
18. Plant Pathology, Mehrotra, R. S. Tata Mc Graw Hill Publishing Company. New Delhi
19. Diseases of Crop Plants in India. Rangaswamy, G. Prentice Hall India Pvt. Ltd. New Delhi
20. Plant Diseases. Singh, R. S. Oxford & IBH, New Delhi.
21. Pathogen and Plant Diseases. Pandey, B. P., S. Chand & Company Ltd. Rangaswamy, G. New Delhi.

SEMESTER – II

Theory – Marks 50
Core Course – III (Theory) (Marks 25)
HBOT-CCT-203
Bryology (15) –

1. Origin and evolution of Bryophytes.
2. Introduction, General habit and distribution, Broad outline of Classifcation according to Crandell Stotler and Stotler (2008); Comparative study of Hepaticopsida, Anthocerotpoida and Bryopsida.
3. Life histories of *Marchantia, Pellia, Porella, Anthoceros, Sphagnum* and *Funaria*.
4. Evolutionary trends in the gametophyte and sporophytes of bryophytes.

Palaeobotany and Palynology (10) -

1. Contributions of Birbal Sahni in Indian Palaeobotany.
2. Introduction, importance of Paleobotany.
3. Defnition of fossil, process of fossilization, types of fossils on the basis of their preservation; concept of Form Genus, conditions for fossilization.
4. Origin of life, Geologic Time Scale, major events of plant life through geologic time.
5. Spore/pollen morphology with reference to polarity, size, shape, symmetry, aperture and sculpture.
6. Importance of Palynology; Melittopalynology.

Internal Assessment – 10

Core Course – IV (Theory) (Marks 25)
HBOT-CCT-204

Pteridology(15)-

1.General characteristics; Classifcation; Early land plants (*Rhynia*).
2.Classifcation (up to family), morphology, anatomy and reproduction of *Psilotum*, *Lycopodium*, *Selaginella*, *Equisetum* and *Pteris* ; apogamy and apospory; heterospory and seed habit, telome theory, stelar evolution; Ecological and economic importance.

Gymnosperms(10)-

1.General characteristics, classifcation (up to family), morphology, anatomy and reproduction of *Cycas*, *Pinus* and *Gnetum*, Ecological and economic importance.

Internal Assessment-10

Practicals – Marks 30
Core Course – III (Practical) (Marks 15)

HBOT-CCP-203-(15)

Bryophyta-

1. Study of the gametophytic and sporophytic structures of the following genera: *Marchantia, Anthoceros and Funaria.*
2. Spot identifcation of genera that are included in the theoretical syllabus.

Palaeobotany and Palynology –

1. Study (including mode of preservation) of the following: *Lepidodendron* (stem in T. S.), *Calamites* (stem in T. S.), *Lepidodendron* (seed, specimen), *Glossopteris* (leaf, specimen), *Lyginopteris*

(stem in T. S.), *Vertebraria* (root, specimen).

Core Course – IV(Practical) (Marks 15)
HBOT-CCP-204-(15)

Pteridology-

Study of morphology, anatomy and reproductive structures in *Lycopodium, Selaginella, Equisetum, Marsilea,and Pteris.*

Gymnosperms-

Study of morphology, anatomy and reproductive structures in *Cycas, Pinus ,and Gnetum*.

Bibliography for Semester II

1. Biology of Bryophytes, 2005, Chopra, R. N. & P. K. Kumra, New Age International, New Delhi.

2. Bryophyte Biology (2nd Edition), 2009, Gofnet, B. & A. J. Shaw, Cambridge University Press

3.Parihar, N.S. (1991). An introduction to Embryophyta: Vol. I. Bryophyta. Central Book Depot.Allahabad.

4.Vashistha, P.C., Sinha, A.K., Kumar, A. (2010). Pteridophyta. S. Chand. Delhi, India.

5. Bhatnagar, S.P. & Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers,New Delhi, India. 6. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R. (2005). Biology. Tata McGraw Hill, Delhi.

7. . Morphology of Vascular Plants – Lower Groups. 1936. Eames, A. J. Tata McGraw Hill, New Delhi

8. Morphology and Evolution of Vascular Plants. 1989. Giford E.M and Foster A.S W H Freeman

and Company, New York.

9. Paleobotany and the Evolution of Plants. 1993. Stewart, W.N. and Rathwell, G.W. Cambridge
University Press.

10. Palaeobotany-The Biology and Evolution of Fossil Plants. 2009. Taylor Thomas N., Taylor Edith L.

and Krings Michael. Academic Press, Elsevier.

Semester-III

Core Course – V (Theory) (Marks 25)
HBOT-CCT-305
Plant Systemetics(25)

1.Introduction to systematics; Plant identifcation, Classifcation, Nomenclature. Evidences from

palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Documentation: Flora, Monographs, Keys:Single access and Multi-access.

2.Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept

(taxonomic, biological, evolutionary).

3.Principles and rules (ICN); Ranks and names; Typifcation, author citation, valid publication,
rejection of names, principle of priority and its limitations; Names of hybrids.

4.Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classifcation systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series); Brief reference of Angiosperm Phylogeny Group (APG IV, 2016) classifcation.

5.Characters; Variations; OTUs, character weighting and coding; Cluster analysis; Phenograms,
cladograms (defnitions and diferences).

6.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. Study of the following families: Ranunculaceae, Malvaceae, Euphorbiaceae, fabaceae, Solanaceae, Acanthaceae, Lamiaceae, Rubiaceae, Cucurbitaceae, Asteraceae, Alismataceae, Zingiberaceae, Poaceae and Orchidaceae

Internal Assessment-10 Marks

Core Course – VI (Theory) (Marks 25)
HBOT-CCT-306
Phytogeography and Economic Botany& Ethnomedicine

Phytogeography-

Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local Vegetation.

Economic Botany-

1. Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity; evolution of newcrops/varieties, importance of germplasm diversity.

2. Cereals : Wheat and Rice (origin, morphology, processing & uses); Brief account of millets.

3. Legumes: Origin, morphology and uses of Chick pea, Pigeon pea and fodder legumes.

Importance to man and ecosystem.

4. Sources of sugars and starches:

Morphology and processing of sugarcane, products and by-products of sugarcane industry.
Potato – morphology, propagation & uses.

5. Spices:
Listing of important spices, their family and part used. Economic importance with special reference to fennel, large cardamom, clove and black pepper.
6. Beverages:
Tea, Cofee (morphology, processing & uses)
7. Sources of oils and fats:
General description, classifcation, extraction, their uses and health implications groundnut, coconut, soybean, mustard (Botanical name, family & uses). Essential Oils:
General account, extraction methods, comparison with fatty oils & their uses.
8. Natural Rubber:
Para-rubber: tapping, processing and uses.
9. Drug-yielding plants:
Therapeutic and habit-forming drugs with special reference to C*inchona, Digitalis, Papaver* and

Cannabis; Tobacco (Morphology, processing, uses and health hazards).
10. Timber plants:
General account with special reference to teak and pine.

Ethnomedicine-

1.Ethnomedicine- defnition
2.Ethnomedicine in India
5.Plants used by tribes of North Bengal *:Eclipta prostrata; Sesbania grandifora;Glycomis arboroea; Vitex negundo; Coccinia grandis(=indica); Allostonia scholaris, Artimisia vulgaris.*

Internal Assessment-10 Marks

Core Course – VII (Theory) (Marks 25)

HBOT-CCT-307

Morphology and Plant Anatomy Morphology

of Angiosperms-

1. Leaves: Types, phyllotaxy, modifcations of leaves, stipules.
2. Inforescence: Types with examples.
3. Flower – General characteristics, as a modifed shoot; aestivation; placentation and its evolution; foral formulae, foral diagram; adhesion and cohesion of foral parts.

4. Fruits: Defnition and types.
5. Dispersal of fruits and seeds.
6. Organization of orthotropous ovule, types of ovules; megasprogenesis.
7. Development of male and female gametophytes (*Polygonum* type)
8. Pollination: Types and contrivances.
9. Fertilization.
10. Development of typical dicot embryo (Crucifer - type).
11. Endosperm: Types, development of free nuclear type.

Plant Anatomy –

1. Cell wall: Structure, growth and thickenings.
2. Tissue: Defnition, organization of shoot and root apices, mechanical tissue and their distribution in plant bodies.
3. Tissue system – Epidermal (multiple epidermis, bulliform cells, stomatal types, trichoblasts, glandular hairs), vascular (leaf gap, branch gap, types of vascular bundles) and ground tissue system (Genral features of cortex, pith and medullary rays); Stele types.

2. Root-stem transition.
3. Secondary growth: normal secondary growth in dicot shoot and root, concept of growth ring, ring and difused porus wood, heart wood and sap wood, Periderm, Lenticel, commercial cork, bark, polyderm and rhytidome.
4. Anomalous secondary growth in stems of *Bignonia, Boerhaavia, Strychnos* and *Dracaena* (*Cordyline*), signifcance.

Internal Assessment- 10 Marks

Practicals – Marks 30

Core Course – V (Practical) (Marks 15)

HBOT-CCP-305-(15)

Plant Systemetics-

Study of morphology of locally available plants of following families including floral formula floral diagram and their identifcation up to genus by following published keys (eg. Bengal Plants by David Prain ,1903):Malvaceae, Fabaceae, Euphorbiaceae, Apiaceae, Apocyanaceae, Solanaceae,

Schrophulariaceae, Acanthaceae, Lamiaceae, Rubiaceae, Cucurbitaceae and Commelinaceae.
Spot identifcation up to species mentioning families of all locally available plants included under the theoretical syllabus.

Core Course – VI (Practical)
HBOT-CCP-306 (Marks 15)
Phytogeography and Economic Botany& Ethnobotany-

PLANT GEOGRAPHY-

1. To prepare map showing vegetation of West Bengal and to comment on it.
2. To prepare map of India with respect to – Major Climatic Zones, Biogeographical regions of India and to comment on it.

ECONOMIC BOTANY-

1. **Cereals**: Wheat (habit sketch,) ,Rice(habit sketch, study of paddy and grain, starch grains)

2. **Legumes**: Soybean, Groundnut, (habit, fruit, seed structure).
3. **Sources of sugars and starches**: Sugarcane (habit sketch; cane juice), Potato(habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains).
4. **Spices:** Black pepper, Fennel and Clove (habit).
5. **Beverages**: Tea (plant specimen, tea leaves), Cofee (plant specimen, beans).
6. **Sources of oils and fats**: Mustard–plant specimen, seeds.
9. **Drug-yielding plants**: Specimens of *Digitalis, Papaver* and *Cannabis.*
10. **Tobacco**: specimen and products of Tobacco.
11. Woods: *Tectona, Pinus*: Specimen, Section of young stem.
12. **Fiber-yielding plants**:Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fber).

Ethnomedicine-

Study of various specimens as prescribed in theory syllabus

Core Course – VII (Practical)
HBOT-CCP-307 (Marks 15)
Morphology –

1. Morphological study of the plant organs included in the theoretical syllabus (No Submission is required)

Plant Anatomy -

1. Study of the anomalous structures of stems of the following genera: *Bignonia, Dracaena, Boerhaavia and Strychnos.*
2. Microscopic identifcation of the followings: Primary structure of Sunfower and maize stem and gram and *Canna* root, Bulliform cells, stomatal types, lenticels, raphides (acicular and sphaeraphides), Cystolith.
3. Maceration of wood elements of *Cucurbita* and *Pinus* stem and their microscopic examination.

[NB. Practicals will also include feld study with specimen collection, preservation and their submission with proper documentation. It also includes temporary and where ever necessary permanent slide submission.

Bibliography for Semester-III

1. Singh, (2012). *Plant Systematics:* Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
2. Jefrey, C. (1982). An Introduction to *Plant Taxonomy.* Cambridge University Press, Cambridge.
3. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963). *Flora* of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of *Plant Systematics*. Harper and Row, New York.
6. Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
7. Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers,
The Netherlands.
8. Chrispeels, M.J. and Sadava, D.E. 1994 Plants, Genes and Agriculture. Jones & Bartlett _Publishers. 1. Dickison, W.C. (2000). Integrative Plant Anatomy. Harcourt Academic Press, USA.

9. Fahn, A. (1974). Plant Anatomy. Pergmon Press, USA.
10. Mauseth, J.D. (1988). Plant Anatomy. The Benjammin/Cummings Publisher, USA.
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Structure, Function and Development. John Wiley and Sons, Inc.

Semester-IV

Core Course – VIII (Theory) (Marks 25)
HBOT-CCT-408
Biochemistry-12 Marks

1. Biomolecules:
Types and signifcance of chemical bonds; Structure and properties of water; pH and bufers.
Carbohydrates: Nomenclature and classifcation; Monosaccharides ; Disaccharides; Oligosaccharides and polysaccharides.
Lipids: Defnition and major classes of storage and structural lipids; Fatty acids structure and

functions; Essential fatty acids; Triacyl glycerol's structure, functions and properties; Phosphoglycerides.
Proteins: Structure of amino acids; Levels of protein structure-primary, secondary, tertiary and

quarternary; Protein denaturation and biological roles of proteins.
Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of

nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

2. Bioenergenetics:
Laws of thermodynamics, concept of free energy, endergonic and exergonic reactions, coupled

reactions, redox reactions. ATP: structure, its role as a energy currency molecule.

3. Enzymes:
Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classifcation of enzymes; Features of active site, substrate specifcity, mechanism of action (activation energy, lock and key hypothesis, induced - ft theroy), Michaelis – Menten equation,

enzyme inhibition and factors afecting enzyme activity.

Plant Metabolism-13 Marks

1. Concept of metabolism:
Introduction, anabolic and catabolic pathways, regulation of metabolism, role of regulatory enzymes (allosteric ,covalent modulation and Isozymes).
2. Carbon assimilation:
Historical background, photosynthetic pigments, role of photosynthetic pigments (chlorophylls
and accessory pigments), antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle, CO_2 reduction, photorespiration, C4pathways; Crassulacean acid metabolism; Factors afecting CO_2 reduction.
3. Carbohydrate metabolism:
Synthesis and catabolism of sucrose and starch.
4. Carbon Oxidation:
Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle,amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide-resistant respiration, factors afecting respiration.

5. ATP-Synthesis:
Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism

(oxidative and photophosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

6. Lipid metabolism:

Synthesis and breakdown of triglycerides, β-oxidation, glyoxylate cycle, gluconeogenesis and its

role in mobilisation of lipids during seed germination, α oxidation.

7. Nitrogen metabolism:

Nitrate assimilation, biological nitrogen fxation (examples of legumes and non-legumes); Physiology and biochemistry of nitrogen fxation; Ammonia assimilation and transamination.

8. Mechanisms of signal transduction:

Receptor-ligand interactions; Second messenger concept, Calcium calmodulin, MAP kinase cascade.

Internal Marks-10

Core Course – IX (Theory) (Marks 25)
HBOT-CCT-409
Ecology and Pharmacognosy-

Ecology-15 Marks

1. Introduction:

Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.

2. Soil:

Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profle; Role of climate in soil development.

3. Water:

Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain,

fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

4. Light, temperature, wind and fre:

Variations; adaptations of plants to their variation.

5. Biotic interactions:

Trophic organization, basic source of energy, autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop.

6. Population ecology :

Characteristics and Dynamics .Ecological Speciation **7.**

Plant communities:

Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic;
Ecotone and edge efect; Dynamics: succession – processes, types; climax concepts.

8. Ecosystems:

Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

9. Functional aspects of ecosystem:

Principles and models of energy fow; Production and productivity; Ecological efciencies;

Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

Pharmacognosy-

1. Pharmacognosy: Defnition and scope.
2. Pharmacopoeias: Defnition and examples.

3. Classifcation of plant drugs: Morphological and chemical (brief knowledge of diferent categories

of drug plants producing carbohydrates, alkaloids, essential oils, resins and glycosides).
4. Concise account of macro - micro morphological features, constituents, adulterants, allied drugs

and uses of the following plants - *Digitalis* (leaf drug); *Cinchona* (bark drug); *Cephaelis* (root and

rhizome drugs); *Rauvolfa* (root and rhizome drugs); *Strychnos* (seed drug); *Syzygium* (fower

drug) and *Coriandrum* (fruit drug).
5. Secondary metabolites : Defnition of secondary metabolites and diference with primary metabolites ,Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis (outlines only),
Major types–terpenoids, phenolics, favonoids, alkaloids and their protective action against pathogenic

microbes and herbivores.).

Internal Assessment-10 Marks

Core Course-X(Theory) Marks-25
HBOT-CCT-410
Plant physiology-25 Marks

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 and factors affecting transpiration, anti-transpirants, mechanism of stomatal movement.
2: Mineral nutrition-
Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents
3: Nutrient Uptake-
Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.
4: Translocation in the phloem-
Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source–sink relationship.
5: Plant growth regulators-
Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene, Brassinosteroid and Jasmonic acid. 39

6: Physiology of flowering-

Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy.
7: Phytochrome, cryptochromes and phototropin-
Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high

irradiance responses (HIR), mode of action.

Internal assessment- 10 Marks

Practicals – Marks 45
Core Course – VIII (Practical) (Marks 15)
HBOT-CCP-408
Biochemistry and Plant Metabolism-

1.Qualitative detection of carbohydartes(non-reducing and reducing);protiens; and organic acids(oxalic, citric, tartaric,& malic) in laboratory sample.
2.Quantative estimation of (a) protiens by Folin Phenol reagent(colorimetric estimation)
(b) glucose by Benedict's quantitative reagent
(c) catalase and urase activity in plant sample.
3. Experimental demonstration of Hill's reaction.
4. To study the efect of light intensity on the rate of photosynthesis.
5. Efect of carbon dioxide on the rate of photosynthesis.
6. To compare the rate of respiration in diferent parts of a plant.
7. To demonstrate activity of Nitrate reductase in germinating leaves of diferent plant sources.

Core Course – IX (Practical) (Marks 15)
HBOT-CCP-409
Ecology -

1. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.

2. (a). Study of morphological adaptations of hydrophytes and xerophytes (four each).
(b). Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*) Epiphytes.
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. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus.

6. Field visit to familiarise students with ecology of diferent sites.

Pharmacognosy-

1**.** Organoleptic and microscopic evaluation of the following drug plants:
a. *Datura /Adhatoda /Azadirachta* (Leaf drug)
b. *Zingiber / Cephaelis* (Rhizome & Root drug)
c. *Coriandrum/Trachyspermum/ Foeniculum/Cuminum* (Fruit drug)
d. *Strychnos* (Seed drug)

Core Course – X (Practical) (Marks 15)
HBOT-CCP-410

Plant Physiology (Practical)-

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/leaf.

4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a

mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the effect of different concentrations of IAA on *Avena* coleoptile elongation (IAA Bioassay).

8. To study the induction of amylase activity in germinating wheat/ barley grains.

Demonstration experiments

1. To demonstrate suction due to transpiration.
2. Fruit ripening/Rooting from cuttings (Demonstration).

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Anamaya Publications, New Delhi, India.
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Semester-V

Core Course – XI(Theory) (Marks 25)
HBOT-CCT-511
Microbiology-25 Marks

Biology & Diversity of Virus:
1. Nature and origin of virion.
2. Nomenclature and classification, distinctive properties of viruses, morphology (symmetry) and a general account on different kinds of viruses. Viral genome.
3. Structure, chemistry of viruses- capsid and their arrangements, types of envelops and their composition, Molecular organization of virion with special reference to TMV and HIV.
4. Isolation, purification and identification of viruses based on physical, chemical and immunological techniques.
5. Transmission of plant viruses, genetic basis of cell to cell movement of plant viruses.
6. Management of plant viruses following classical and modern technique. Satellite virus.
7. Viral replication: Lytic and Lysogenic cycles - Lytic cycle in T even phages, lysogeny in lambda phage.
8. Sub viral particles - prions, viroid's, virusoid.

Biology & Diversity of Bacteria:
1. Scope of microbiology, Microbial taxonomy and phylogeny, major groups of Bacteria.
2. Bacterial morphology, ultra-structure of Gram positive and Gram-negative bacteria.
3. Bacterial motility, bacterial sporulation.
4. Bacterial Growth: Kinetics, growth curve, factors affecting growth.
5. Nutritional types: Photolithotrophs, chemolithotrophs, photo organotrophs & chemoorganotrophs.
6. Bacterial Genetics: Organization and replication of genetic material in bacteria – bacterial chromosome, plasmid. Recombination in bacteria - conjugation, transformation and transduction.
7. Microbial ecology: Concept of microbial ecology with reference to air, water and soil.
8. Food microbiology: Food borne infections and intoxications; preservation of food.

9. Immunology: Cells and organs of immune system, types, antigen (chemical nature and types),

immunoglobulins (structure and types), brief idea about hypersensitivity and vaccine.
10. Medical Microbiology: Air, water, food and soil borne diseases - causal organisms, symptoms,
control.
11. Industrial microbiology: Industrial production of ethanol, penicillin and vitamin B12. **General account on Mycoplasmas and Actinomycetes.**

Internal Assessment-10 Marks

Core Course – XII(Theory) (Marks 25)

HBOT-CCT-512

Cell Biology and Genetics-

Cell Biology-

1: The cell

Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin ofeukaryotic cell (Endosymbiotic theory).

2: Cell wall and plasma membrane

Chemistry, structure and function of Plant cell wall. Overview of membrane function; fuid mosaic model; Chemical composition of membranes; Membrane transport – Passive, active and

facilitated transport, endocytosis and exocytosis.

3: Cell organelles

Nucleus: Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

Cytoskeleton: Role and structure of microtubules, microflaments and intermediary flament.

Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semiautonomous nature of mitochondria and chloroplast.

Endomembrane system: Endoplasmic Reticulum – Structure, targeting and insertion of proteins

in the ER, protein folding, processing; Smooth ER and lipid synthesis, export of proteins and lipids; Golgi Apparatus – organization, protein glycosylation, protein sorting and export from Golgi Apparatus; Lysosomes

4: Cell division

Phases of eukaryotic cell cycle, mitosis and meiosis; Regulation of cell cycle- checkpoints, role

of protein kinases.

Genetics-

1: Mendelian genetics and its extension

Mendelism: History; Principles of inheritance; Chromosome theory of inheritance; Autosomes and sex chromosomes; Probability and pedigree analysis; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Recessive and Dominant traits, Penetrance and Expressivity, Numericals; Polygenic inheritance.

2: Extrachromosomal Inheritance

Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast;Maternal efects-shell coiling in snail; Infective heredity- Kappa particles in *Paramecium.*

3: Linkage, crossing over and chromosome mapping

Linkage and crossing over-Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage.

4: Variation in chromosome number and structure

Deletion, Duplication, Inversion, Translocation, Position efect, Euploidy and Aneuploidy

5: Gene mutations

Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: ClB

method.Role of Transposons in mutation.DNA repair mechanisms.

6: Fine structure of gene

Classical vs molecular concepts of gene; Cis-Trans complementation test for functional allelism;

Structure of Phage T4, rII Locus.

6. Population and Evolutionary Genetics

Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

Practicals – Marks 30

Core Course – (XI) (Marks 15)

HBOT-CCP-511

Microbiology-

1. Study of symptoms of diseases of economically important plants caused by virus.
2. Study of inclusion bodies in virus infected plants, its distribution and orientation.
3. Field record of herbarium sheets of virus infected plants must be submitted
4. Preparation of bacterial media-
   a) Nutrient agar and nutrient broth
   b) Preparation of slants and Stab and pouring in Petri-plates.
5. Sub-culturing of bacterial culture.
6. Simple and Gram staining
7. microscopic examination of bacteria from curd by simple staining.

Core Course – (XII) (Marks 15)

HBOT-CCP-512

Cell Biology -

1. Study of plant cell structure with the help of epidermal peel mount of Onion/*Rhoeo/Crinum* .
2. Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.
3. Measurement of cell size by the technique of micrometry.
4. Counting the cells per unit volume with the help of haemocytometer. (Yeast/pollen grains).

5. Cytochemical staining of : DNA- Feulgen and cell wall in the epidermal peel of onion using Periodic Schif's (PAS) staining technique.
6. Study the phenomenon of plasmolysis and deplasmolysis.
7. Study the efect of organic solvent and temperature on membrane permeability.
8. Study diferent stages of mitosis, karyotype and mitotic index of *Allium cepa* by aceto-orcein squash technique.
9. Study of meiosis of *Allium cepa* and *Rhoeo* by aceto-carmine smear technique.

Genetics-

1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
2. Chromosome mapping using point test cross data.
3. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1,
9:3:4).

5. Blood Typing: ABO groups & Rh factor.
6. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes.
7. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.

8. Study of human genetic traits: Sickle cell anemia, Xeroderma Pigmentosum, Albinism, red-green

Colour blindness, Widow's peak, Rolling of tongue and Attached ear lobe.

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Bartlett Publication.
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Inc. U.S.A. 8th edition.
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Semester-VI

Core Course – XIII(Theory) (Marks 25)
HBOT-CCT-613
Molecular Biology and Biostatistics

Molecular Biology-

1. Nucleic acids : Carriers of genetic information

Historical perspective; DNA as the carrier of genetic information (Grifth's, Hershey & Chase, Avery, McLeod & McCarty, Fraenkel-Conrat's experiment.

2. The Structures of DNA and RNA / Genetic Material

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves; Organization of DNA- Prokaryotes, Viruses, Eukaryotes.RNA Structure_Organelle DNA -- mitochondria and chloroplast DNA.The Nucleosome_Chromatin

structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

3.The replication of DNA

Chemistry of DNA synthesis (Kornberg's discovery); General principles – bidirectional, semiconservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5'end of linear chromosome; Enzymes involved in DNA replication.

4. Central dogma and genetic code

Key experiments establishing-The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features**)**

5. Transcription

Transcription in prokaryotes and eukaryotes. Principles of transcriptional regulation; Prokaryotes: Regulation of lactose metabolism and tryptophan synthesis in *E.coli.* Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing.

6. Processing and modifcation of RNA

Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing pathways, group I and group II intron splicing, alternative splicing eukaryotic mRNA processing(5' cap, 3' polyA tail); Ribozymes; RNA editing and mRNA transport.

7. Translation

Ribosome structure and assembly, mRNA; Charging of tRNA, aminoacyl tRNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post-translational modifcations of proteins.

Biostatistics-

1.Biostatistics

Defnition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.

2.Collection of data primary and secondary

Types and methods of data collection procedures - merits and demerits. Classifcation - tabulation and presentation of data - sampling methods.

3.Measures of central tendency

Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Co- efcient of variations.

4.Correlation

Types and methods of correlation, regression, simple regression equation, ftting prediction, similarities and dissimilarities of correlation and regression

5.Statistical inference

Hypothesis - simple hypothesis - student 't' test - chi square test.

Core Course – XIV(Theory) (Marks 25)
HBOT-CCT-614
Plant Biotechnology and Tissue Culture

Plant Biotechnology-25 Marks

1.Recombinant DNA technology

Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

2.Gene Cloning
Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCRmediated
gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR
3.**Methods of gene transfer**
Agrobacterium -mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes

(Luciferase, GUS, GFP).
4.Applications of Biotechnology
Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops

with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Tissue culture-

Plant Tissue Culture
Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Practicals – Marks 30
Core Course – (XIII) (Marks 15)
HBOT-CCP-613
Molecular Biology and Biostatistics

Molecular Biology-

1. Preparation of LB medium and raising *E.Coli.*
2. Isolation of genomic DNA from *E.Coli.*
3. DNA isolation from caulifower head.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication

and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through

photographs.
7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al,

Grifth's, Hershey & Chase's and Fraenkel & Conrat's experiments)
8. Study of the following through photographs: Assembly of Spliceosome machinery; Splicing mechanism in group I & group II introns; Ribozyme and Alternative splicing.

Biostatistics-

1) Calculation of mean, standard deviation and standard error
2) Calculation of correlation coefcient values and fnding out the probability
3) Calculation of 'F' value and fnding out the probability value for the F value.

Core Course – (XIV) (Marks 15)
HBOT-CCP-614
Plant Biotechnology and Tissue Culture-

1. (a) Preparation of MS medium.
   (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura*, *Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artifcial seeds through photographs.
3. Isolation of protoplasts through photograph.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: *Agrobacterium* -mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Isolation of plasmid DNA through photograph.
8. Restriction digestion and gel electrophoresis of plasmid DNA through photograph and diagram.

Bibliography for Semester VI-

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12. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of

recombinant DNA. ASM Press, Washington.
13. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication
House Pvt. Ltd., New Delhi. 5th edition.
14. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
15. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and
Applications. John Wiley & Sons Inc. U.S.A.

Discipline Specifc Elective Courses (DSE):

(Four papers are to be taken each carrying 6 credit)

DSE- I :	Stress Physiology/Ethnobotany
DSE-II:	Plant Breeding/ Horticultural Practices
DSE III:	Bioinformatics/Research Methodology
DSEIV:	Biostatistics/ Cryopreservation

Discipline Specifc Elective-I
Stress Physiology
(Credits: Theory 4, Practical 2)

Theory: Marks 25

1: Defning plant stress

Acclimation and adaptation.

2: Environmental factors

Water stress; Salinity stress, High light stress; Temperature stress; Hypersensitive reaction; Pathogenesis– related (PR) proteins; Systemic acquired resistance; Mediation of insect and disease resistance by jasmonates.

3: Stress sensing mechanisms in plants

Calcium modulation, Phospholipid signaling

4: Developmental and physiological mechanisms that protect plants against environmental stress

Adaptation in plants; Changes in root: shoot ratio; Aerenchyna development; Osmotic adjustment; Compatible solute production.

5: Reactive oxygen species–Production and scavenging mechanisms

Practical-15 Marks

1. Quantitative estimation of peroxidase activity in the seedlings in the absence and presence of salt stress.
2. Superoxide activity in seedlings in the absence and presence of salt stress.
3. Zymographic analysis of peroxidase.
4. Zymographic analysis of superoxide dismutase activity.
5. Quantitative estimation and zymographic analysis of catalase.
6. Quantitative estimation and zymographic analysis of glutathione reductase.
7. Estimation of superoxide anions.

Suggested Readings

1. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.

Ethnobotany
(Credits: Theory 4,Practical 2)
Theory- 25 Marks

1: Ethnobotany

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science.The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

2: Methodology of Ethnobotanical studies

a) Field work b) Herbarium c) Ancient Literature d) Archaeological fndings e) temples and sacred places.

3: Role of ethnobotany in modern Medicine

Medico- ethnobotanical sources in India;Signifcance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum*

c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfa sepentina, Trichopus zeylanicus, Artemisia,Withania*.

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

4: Ethnobotany and legal aspects

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

5.Ethnobotany in the Eastern Himalaya and North Bengal.

Practical-15 Marks

1. Identification of drug yielding plants
2. Organoleptic studies of locally available ethnomedicinal plants
3. A visit to local ethnic community to record ethnobotanical information.

Suggested Readings

1) S.K. Jain, Manual of Ethnobotany, Scientifc Publishers, Jodhpur, 1995.
2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
3) Lone et al,. Palaeoethnobotany
4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, _Lucknow, India.
5) S.K. Jain, 1990. Contributions of Indian ethnobotny.Scientifc publishers, Jodhpur.
6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – _Chichester
7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India.Botanical Survey of India. Howrah. _8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996_9) Faulks, P.J. 1958.An introduction to Ethnobotany, Moredale pub. Ltd.

Discipline Specifc Elective-II

Plant Breeding

(Credits: Theory-4, Practical-2)
THEORY- 25 Marks
1: Plant Breeding
Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important

achievements and undesirable consequences of plant breeding.
2: Methods of crop improvement
Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure,

advantages and limitations.
3: Quantitative inheritance
Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human

beings.Monogenic vs polygenic Inheritance.
4: Inbreeding depression and heterosis
History, genetic basis of inbreeding depression and heterosis; Applications.
5: Crop improvement and breeding
Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Practical-15 Marks

1. Hybridization techniques

Suggested Readings
1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.

2. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH.
2nd edition.
3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.

Discipline Specifc Elective-II

Horticultural Practices

(Credits: Theory-4, Practical-2)
THEORY- 25 Marks
1: Introduction
Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.
2: Ornamental plants
Types, classifcation (annuals, perennials, climbers and trees); Identifcation and salient features

of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental fowering trees

(Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fshtail and areca palms, semul, coraltree).

3: Fruit and vegetable crops
Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identifcation of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).
4: Horticultural techniques
Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.
5: Landscaping and garden design
Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.
6: Floriculture
Cut fowers, bonsai, commerce (market demand and supply); Importance of fower shows and

exhibitions.

7: Disease control and management

Field and post-harvest diseases; Identifcation of defciency symptoms; remedial measures and

nutritional management practices; Crop sanitation; IPM strategies (genetic, biological andchemical methods for pest control); Quarantine practices; Identifcation of common diseases

andpests of ornamentals, fruits and vegetable crops.

8: Horticultural crops - conservation and management

Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

9: Field trip

Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural felds at

IARI or other suitable locations.

Practical-15 Marks

1.Horticultural techniques for propagation (Grafting, budding, Layering)

2.Fruit quality analysis (TSS, Acidity)

3.Viability test- Seed/Pollen

Suggested Readings

1. Singh, D. & Manivannan, S. (2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.

5. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

Discipline Specifc Elective-III

Bioinformatics

(Credits: Theory-4, Practical-2)

THEORY-25 Marks

1. Introduction to Bioinformatics

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

2. Databases in Bioinformatics

Introduction, Biological Databases, Classifcation format of Biological Databases, Biological Database Retrieval System.

3. Biological Sequence Databases

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database
Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.
EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.
DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.
Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR.
Swiss-Prot: Introduction and Salient Features.

4. Sequence Alignments

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

5. Molecular Phylogeny

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

6. Applications of Bioinformatics
Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR)

techniques in Drug Design, Microbial genome applications, Crop improvement
Practical- 15 marks
1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.
Suggested Readings
1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and

Bioinformatics. _II Edition. Benjamin Cummings.

Discipline Specifc Elective-III
Research Methodology
Credit: Theory 4; Practical 2
Theory- 25 Marks
1: Basic concepts of research
Research-defnition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs emperical).Research methods vs methodology.Literature-review and its consolidation; Library research; feld research; laboratory

research.
2: General laboratory practices
Common calculations in botany laboratories. Understanding the details on the label of reagent

bottles. Molarity and normality of common acids and bases.Preparation of solutions.
Dilutions.
Percentage solutions. Molar, molal and normal solutions.Technique of handling micropipettes;
Knowledge about common toxic chemicals and safety measures in their handling.
3: Data collection and documentation of observations
Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of feld photography.
4: Overview of Biological Problems
History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

5: **Methods to study plant cell/tissue structure**
Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue

preparation: living vs fxed, physical vs chemical fxation, coagulating fxatives, non-coagulant

fxatives; tissue dehydration using graded solvent series; Parafn and plastic infltration; Preparation of thin and ultrathin sections.
6: Plant microtechniques
Staining procedures, classifcation and chemistry of stains. Staining equipment. Reactive dyes

and fuorochromes (including genetically engineered protein labeling with GFP and other tags).

Cytogenetic techniques with squashed plant materials.

7: The art of scientifc writing and its presentation
Numbers, units, abbreviations and nomenclature used in scientifc writing. Writing references.

Powerpoint presentation. Poster presentation. Scientifc writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Practical- 15 Marks

1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and feld photography.
4. Poster presentation on defned topics.
5. Technical writing on topics assigned.

Suggested Readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientifc writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

Discipline Specifc Elective-IV
Biostatistics-Theory (25 Marks)

1.Biostatistics
Defnition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.

2.Collection of data primary and secondary
Types and methods of data collection procedures - merits and demerits. Classifcation - tabulation and presentation of data - sampling methods.

3.Measures of central tendency
Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Coefficient of variations.

4.Correlation
Types and methods of correlation, regression, simple regression equation, ftting prediction, similarities and dissimilarities of correlation and regression

5.Statistical inference
Hypothesis - simple hypothesis - student 't' test, chi square test.

Biostatistics-Practical (15 Marks)

1) Calculation of mean, standard deviation and standard error
2) Calculation of correlation coefcient values and fnding out the probability
3) Calculation of 'F' value and fnding out the probability value for the F value.

Discipline Specific Elective-IV
Cryopreservation-Theory (25 Marks)

AEEC – Ability Enhancement Elective Course

[i.e. Skill Enhancment Course (SEC)]

[Two papers are to be taken and each paper will have 2 credit]: The course should be project based and dissertation should be submitted.

1.Vermicomposting and organic farming

2. Mushroom cultivation
3. Cultivation of medicinal plants

4. Laboratory skills

Skill Enhancment Course (SEC)

1. Vermicomposting and organic farming (15 Marks)

1.vermicomposting: Defnition and scope
2.Aims and objective of vermicomposting
3.Difference between vermiculture and vermicomposting
4.Vermicomposting technology:An overview
5.Concepts and development of organic farming
6.Types of organic farming, Biodynamic farming, Benefts of organic farming.
7.Conventional farming v/s organic farming
8.Plant protection- botanical pesticides I,Plant protection- botanical pesticides II,Plant protection- botanical pesticides III.
9.Policies and incentives of organic production, Farm inspection and certifcation

2.Mushroom Cultivation (15 Marks)

1:Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.
2:Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors afecting the mushroom bed preparation

- Low cost technology, Composting technology in mushroom production.
3:Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in saltsolutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fbre content - Vitamins.
4:Food Preparation_:Types of foods prepared from mushroom.Research Centres - National level and Regional level._Cost beneft ratio - Marketing in India and abroad, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications,

Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

Skill Enhancement Course
3.Cultivation of Medicinal Plants
(15 marks)

1:History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Defnitionand Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, 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. Defnition: 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 classifcation, 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. Defnition; 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.

Suggested Readings

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

Skill Enhancement Course
4.Laboratory Skills
(15 Marks)

1.Fundamentals of laboratory work *(*safety, weights & measures, bufers, using a pH meter*).*
2.General idea on laboratory equipments-a) Light Microscope
b) Burette and pipette
c)Centrifuges: Standard, high speed
d) Incubators
e)Volumetric glasswares
f) Laminar Air Flow(LAF) Chamber
g) Autoclave
h) Water Bath
i) Colorimeter
j)Spectrophotometer
3.Preliminary idea on the following laboratory techniques:
a) Various methods of sectioning/cutting of samples
b) Procedures for proper staining like Gram Staining, single and double staining c) Filtration and Titration
d) Sterilization
e) Media preparation(Bacteriological)
f) Innoculation and pour plates

g) Separation by various chromatographic technique like Column ,Paper and Thin Layer
h) determination of RNA, Protein and Nucleic Acids concentrations by UV-VISIBLE

Spectroscopy

Suggested Readings:

1. Principles and Techniques of Biochemistry & Molecular Biology by Keith Wilson and John Walker.

2. Biochemical Calculations by Irwin H. Segel.

Proposed Curriculum

For

B. Sc. Program with Botany

Submitted to
COOCH BEHAR PANCHANAN BARMA UNIVERSITY

Under

Choice Based Credit System
(For Session 2017-2018)

Syllabus for B.Sc. Program with Botany
Cooch Behar Panchanan Barma University, Coochbehar

Semester – 1

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week			Credit
				L	T	P	
1	Algae, Fungi, Bryophyta	Core Course-I		4			4
		Core Course-I (Practical)				4	2
	DSC 2A [other Discipline]	Core Course-II					6
	DSC 3A [other Discipline]	Core Course-III					6
	EVS	AECC					2
	Total Credit						20

Semester – II

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week			Credit
				L	T	P	
1	Pteridophytes, Gymnosperms and Palaeobotany	Core Course-IV		4			4
		Core Course-IV (Practical)				4	2
	DSC 2B [other Discipline]	Core Course-V					6
	DSC 3B [other Discipline]	Core Course-VI					6
	English	AECC					2
	Total Credit						20

Semester – III

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week			Credit
				L	T	P	
1	Plant Taxonomy and Plant Anatomy	Core Course-VII		4			4
		Core Course-VII (Practical)				4	2
	DSC 2C [other Discipline]	Core Course-VIII					6
	DSC 3C [other Discipline]	Core Course-IX					6
	Skill Enhancement Course	SEC-1					2
	Total Credit						20

Semester – IV

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week	Credit

				L	T	P	
1	Plant Physiology and Cytogenetics	Core Course-X		4			4
		Core Course-X (Practical)				4	2
2	DSC 2D [other Discipline]	Core Course-XI					6
	DSC 3D [other Discipline]	Core Course-XII					6
	Skill Enhancement Course	SEC-2					2
	Total Credit						20

Semester – V

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week			Credit
				L	T	P	
1	Skill Enhancement Course	SEC-3					2
2	Discipline Specific Elective (Theory)	DSE-1A		4			4
3	Practical	DSE-1A (Practical)				4	2
4	Discipline Specific Elective (Theory)	DSE-2A		4			4
6	(Practical)	DSE-2A (Practical)				4	2
7	Discipline Specific Elective (Theory)	DSE-3A		4			4
8	(Practical)	DSE-3A (Practical)				4	2
	Total Credit						20

Semester – VI

Sr. No.	Name of the subject	Nature	Code	Teaching Scheme In hours per week			Credit
				L	T	P	
1	Skill Enhancement Course	SEC-4					2
2	Discipline Specific Elective (Theory)	DSE-1B		4			4
3	Practical	DSE-1B (Practical)				4	2
4	Discipline Specific Elective (Theory)	DSE-2B		4			4
6	(Practical)	DSE-2B (Practical)				4	2
7	Discipline Specific Elective (Theory)	DSE-3B		4			4
8	(Practical)	DSE-3B (Practical)				4	2
	Total Credit						20

Total Credit = 120

Core Course: Botany (Program)

Semester.	Papers	Name of the subject	Teaching Scheme In hours per week	Credit

			L	T	P	
I	1	Algae, Fungi and Bryophyts	4		4	6
II	2	Pteridophyta, Gymnosperms and Palaeobotany	4		4	6
III	3	Plant Taxonomy and Plant Anatomy	4		4	6
IV	4	Plant Physiology and Cytogemnetics	4		4	6
		Total Credit				24

AECC – Ability Enhancement Compulsory Courses: English/ Modern Indian Language/EVS

AEEC – Ability Enhancement Elective Course:
[i.e. Skill Enhancment Course (SEC)]

[Four papers are to be taken and each paper will have 2 credit]: 1.Vermicomposting and organic farming

2. Mushroom cultivation
3. Ethnobotany
4. Laboratory skills

Discipline Specifc Elective Courses (DSE):
(Six papers will have be taken each carries 6 credit)

DSE- 1A : Economic Botany/Pharmacognosy
DSE-2A: Plant Biotechnology/Tissue culture
DSE-3A: Microbiology/Plant Pathology
DSE-1B: Plant Breeding/ Horticultural Practices
DSE-2B: Bioinformatics/Research Methodology
DSE-3B: Biostatistics/Cryopreservation

Other Disciplines of Choice:
[One must be chemistry]
1. Zoology, 2. Physiology, 3. Microbiology, 4. Physics, 5. Computer Science etc

Detailed syllabus for B.Sc. (Program)
Subject - Botany

SEMESTER – I

Theory –
Core Course: I (Marks 25)
(Algae, Fungi and Bryophyta)
Algae -

General characteristics; Ecology and distribution;
Range of thallus organization and reproduction;
Classifcation of algae (Lee – 2008);
Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Zygnema*, *Vaucheria*, *Fucus*.

Economic importance of algae

Fungi -

Introduction- General characteristics, cell wall composition , nutrition, reproduction and classifcation (Ainsworth and Bisby-1t83)
General characteristics and life cycle of *Mucor* (Zygomycota), *Penicillium* (Ascomycota), *Agaricus* (Basidiomycota) and Deuteromycetes;
Lichens: General account, reproduction and signifcance;
Mycorrhiza: ectomycorrhiza and endomycorrhiza and their signifcance

Bryophytes -

General characteristics, Classifcation (Proskauer, 1t57),
Morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included).
Ecological and Economic importance of bryophytes.

Internal assessment – (10)

Practical's –15 Marks
Core Course: I (Practical) (Marks 15/2 credit)
(Algae, Fungi and Bryophyta)

Study of following genera: *Oscillatoria, Oedogonium, Mucor, Agaricus; Marchantia, and Funaria***.**

Identifcation of all the genera included in the theoretical syllabus.
Wet specimen collection and preservation.

SEMESTER - II

Theory –
Core Course: IV (Marks 25)
(Pteridophyta, Gymnosperms and Palaeobotany)
Pteridophytes -

General characteristics, classifcation (Sporne, 1t75);Early land plants (*Rhynia*). Morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included).

Heterospory and seed habit, stelar evolution. Economical importance of Pteridophytes.

Gymnosperms -

General characteristics,

Classifcation (Stewart and Rothwell, 1t83),

Morphology, anatomy and reproduction of *Cycas* and *Gnetum*. (Developmental details not to be included).

Economical importance.

Palaeobotany –

Terminologies (Palaeobotany, Palynology, Palaeoforistics, Palaeoecology, fossils, subfossil) and their defnition.

Types of fossils on the basis of mode of preservation.

Internal assessment - 10

Practicals –

Core Course – IV(Practical) (Marks – 15)

Pteridophytes – Study of stem anatomy and reproductive structure of *Selaginella*, *Equisetum* and *Pteris*

Gymnosperms - Morphoanatomical studies of *Cycas* (leafet, rachis, microsporophyll), *Pinus* (Stem, needle, male cone)

Identifcation includes all other genera included in the theoretic operation

SEMESTER – III

Theory –

Core Course: VII (Marks 25)

Plant Taxonomy and Plant Anatomy

Plant Taxonomy- Marks15

1. Introduction to plant taxonomy

Identifcation, Classifcation, Nomenclature.

2. Identifcation

Functions of Herbarium, important herbaria and botanical gardens of the world and India;
Documentation: Flora, Keys: single access and multi-access

3.Taxonomic evidences from palynology, cytology, phytochemistry and molecular data

4.Taxonomic hierarchy

Ranks, categories and taxonomic groups

5. Botanical nomenclature

Principles and rules (ICN); ranks and names; binominal system, typifcation, author citation, valid publication, rejection of names, principle of priority and its limitations.

6. Classifcation

Types of classifcation-artifcial, natural and phylogenetic. Bentham and Hooker (upto

series).

7. Biometrics, numerical taxonomy and cladistics

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definition and differences).

8. Study of the following families: Ranunculaceae, Brassicaceae, Solanaceae, Lamiaceae, Cucurbitaceae, Asteraceae, Alismataceae, Poaceae and Orchidaceae

Plant Anatomy- Marks10

1: Meristematic and permanent tissues

Root and shoot apical meristems; Simple and complex tissues.

2: Organs

Structure of dicot and monocot root stem and leaf.

3: Secondary Growth

Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).

4: Adaptive and protective systems

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Internal assessment – (10)

Practicals –

Core Course: VII (Practical) (Marks 15)

Plant Taxonomy-

1. Study of vegetative and foral characters of the following families (Description, V.S. fower, section of ovary, foral diagram/s, foral formula/s and systematic position according to Bentham & Hooker's system of classifcation):Brassicaceae -*Brassica, Alyssum / Iberis;* Asteraceae - *Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax;* Solanaceae -*Solanum sp, Withania;* Lamiaceae -*Salvia, Ocimum*; Liliaceae - *Asphodelus / Lilium / Allium.*

2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Plant Anatomy-

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).

Bibliography for Semester III

1. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA, U.S.A.

2. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., NewDelhi. 3rd edition

3. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
4. Mauseth, J.D. (1t88). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

SEMESTER –IV

Theory –

Core Course: X (Marks 25)

Plant Physiology and Cytogenetics

Plant Physiology- 13 Marks

1: Plant-water relations

Importance of water, water potential and its components; Transpiration and its signifcance; Factors afecting transpiration; Root pressure and guttation.

2: Mineral nutrition

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements

3: Translocation in phloem

Composition of phloem sap, girdling experiment; Pressure fow model; Phloem loading and unloading.

4: Photosynthesis

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fxation; Photorespiration.

5: Respiration

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

6: Enzymes

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

7: Nitrogen metabolism

Biological nitrogen fxation; Nitrate and ammonia assimilation.

8: Plant growth regulators

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

9: Plant response to light and temperature

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

Cytogenetics- 12Marks

1**:** Cell as a unit of Life

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

2**:** Cell Organelles

Mitochondria- Structure, composition; Semiautonomous nature;mitochondrial DNA

Chloroplast- Structure, composition; semiautonomous nature, chloroplastDNA. ER, Golgi body & Lysosomes: _Structures and roles.

Peroxisomes and Glyoxisomes:_Structures, composition, functions in animals and plants

Nucleus:_Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief). _

3: Cell Membrane and Cell Wall

The functions of membranes; Models of membrane structure; The fuidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall. _

4: Cell Cycle

Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

5: Genetic material

DNA: Miescher to Watson and Crick- historic perspective, DNA structure, types of DNA, types of genetic material.

DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi–conservative,

semi discontinuous
6: Transcription (Prokaryotes and Eukaryotes)
Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types;

Translation (Prokaryotes and eukaryotes), genetic code.

Internal Assessment-10Marks

Practical

Core Course (Practical) (Marks 15)

Plant Physiology-

1. To study the efect of two environmental factors (light and wind) on transpiration by excised twig.

2. Calculation of stomatal index and stomatal frequency.
3. Demonstration of Hill reaction.
4. Demonstrate the activity of catalase and study the efect of pH and enzyme concentration.
5. To study the efect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
6. The rate of respiration in any two parts of a plant.
7. Separation of amino acids by paper chromatography(through photograph).

Cytogenetics-

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. Study of mitosis and meiosis (temporary mounts and permanent slides).
5. Measure the cell size (either length or breadth/diameter) by micrometry.
6. Study the structure of nuclear pore complex by photograph (from Gerald Karp)Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
7. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

Bibliography for Semester IV

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.

2. Hopkins, W.G., Huner, N.P., (200t). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1ttt). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
4. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
5. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
6. Cooper, G.M. and Hausman, R.E. 200t. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
7. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 200t. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco

Discipline Specifc Elective Courses (DSE):

(Two papers are to be taken each carrying 6 credit)

DSE- 1A : Economic Botany/Pharmacognosy
DSE-2A: Plant Biotechnology/Tissue culture
DSE-3A: Microbiology/Plant Pathology
DSE-1B: Plant Breeding/ Horticultural Practices
DSE-2B: Bioinformatics/Research Methodology
DSE-3B: Biostatistics/Cryopreservation

Discipline Specifc Elective Courses (DSE):

DSE- 1A: Economic Botany/Pharmacognosy

Economic Botany (Theory) marks-25

1: Origin of Cultivated Plants
Concept of centres of origin, their importance with reference to Vavilov's work
2: Cereals
Wheat -Origin, morphology, uses
3: Legumes
General account with special reference to Gram and soybean
4: Spices
General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)
5: Beverages
Tea (morphology, processing, uses)
6: Oils and Fats
General description with special reference to groundnut
7: Fibre Yielding Plants
General description with special reference to Cotton (Botanical name, family, part used,

morphology and uses).

Practical (15 Marks)

1. Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove Tea,

Cotton, Groundnut through specimens, sections and microchemical tests

Suggested Readings

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd.,

New Delhi. 4th edition.

Pharmacognosy (25 Marks)

1. Pharmacognosy: Defnition and scope.
2. Pharmacopoeias: Defnition and examples.
3. Classifcation of plant drugs: Morphological and chemical (brief knowledge of diferent categories

of drug plants producing carbohydrates, alkaloids, essential oils, resins and glycosides).
4. Concise account of macro - micro morphological features, constituents, adulterants, allied drugs

and uses of the following plants - *Digitalis* (leaf drug); *Cinchona* (bark drug); *Cephaelis* (root and

rhizome drugs); *Rauvolfa* (root and rhizome drugs); *Strychnos* (seed drug); *Syzygium* (fower

drug) and *Coriandrum* (fruit drug).
5. Secondary metabolites: Definition of secondary metabolites and diference with primary metabolites ,Interrelationship of basic metabolic pathways with secondary metabolite biosynthesis (outlines only),
Major types–terpenoids, phenolics, favonoids, alkaloids and their protective action against pathogenic microbes and herbivores.).

Pharmacognosy (Practical) Marks-15

1**.** Organoleptic and microscopic evaluation of the following drug plants:
a. *Datura /Adhatoda /Azadirachta* (Leaf drug)
b. *Zingiber / Cephaelis* (Rhizome & Root drug)
c. *Syzygium* (Flower drug)
d. *Coriandrum/Trachyspermum/ Foeniculum/Cuminum* (Fruit drug)
e. *Strychnos* (Seed drug)

Suggested Reading-

1.Trease and Evans Pharmacognosy 6th Edition by William Charles Evans
2.Text Book of Pharmacognosy and Phytochemistry byBiren Shah 2nd Edn

DSE-2A:Plant Biotechnology/Tissue culture

Plant Biotechnology (Theory) Marks-25

1.Recombinant DNA technology
Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC1t, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC).

2.Gene Cloning
Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCRmediated
gene cloning; Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; PCR
3.**Methods of gene transfer**
Agrobacterium -mediated, Direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment; Selection of transgenics– selectable marker and reporter genes

(Luciferase, GUS, GFP).

4.Applications of Biotechnology
Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops

with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Gentically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Plant Biotechnology (Practical) Marks-15

1. Construction of restriction map of circular and linear DNA from the data provided.
2. Study of methods of gene transfer through photographs: *Agrobacterium* -mediated, direct gene

   transfer by electroporation, microinjection, microprojectile bombardment.
3. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato

   through photographs.
4. Isolation of plasmid DNA.
5. Restriction digestion and gel electrophoresis of plasmid DNA.

Tissue Culture (Theory) Marks-25

Historical perspective; Composition of media; Nutrient and hormone requirements (role of vitamins and hormones); Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Tissue Culture (Practical) marks-15

1. (a) Preparation of MS medium.
   (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of

   tobacco, *Datura*, *Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis &
   artifcial seeds through photographs.
3. Isolation of protoplasts.

Suggested Reading-

1. Bhojwani, S.S. and Razdan, M.K., (1tt6). Plant Tissue Culture: Theory and Practice. Elsevier

   Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms. Vikas Publication
   House Pvt. Ltd., New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N. Jr. (2008). Plant Biotechnology & Genetics: Principles, Techniques and

   Applications. John Wiley & Sons Inc. U.S.A.

DSE- 3A Microbiology/Plant Pathology

Microbiology (Theory) marks-25

Biology & Diversity of Virus

1. Nature and origin of virion.
2. Nomenclature and classifcation, distinctive properties of viruses, morphology (symmetry) and a general account on diferent kinds of viruses, Viral genome,Satellite virus.
3. Viral replication: Lytic and Lysogenic cycles - Lytic cycle in T even phages, lysogeny in lambda phage.
4. Sub viral particles - prions, viroids, virusoid.

Biology & Diversity of Bacteria

1. Scope of microbiology, Microbial taxonomy and phylogeny, major groups of Bacteria.
2. Bacterial morphology, ultra structure of Gram positive and Gram negative bacteria.
3. Bacterial motility, bacterial sporulation.
4. Bacterial Growth: Kinetics, growth curve, factors afecting growth.
5. Nutritional types: Photolithotrophs, chemolithotrophs, photoorganotrophs & chemoorganotrophs.
6. Bacterial Genetics: Organization and replication of genetic material in bacteria – bacterial chromosome, plasmid. Recombination in bacteria - conjugation, transformation and transduction.

7. Microbial ecology: Concept of microbial ecology with reference to air, water and soil.
8. Food microbiology: Food borne infections and intoxications; preservation of food.

t. Immunology: Cells and organs of immune system, types, antigen (chemical nature and types), immunoglobulins (structure and types), brief idea about hypersensitivity and vaccine.

General account on Mycoplasmas and Actinomycetes.

Microbiology (Practical) Marks-15

1. Study of symptoms of diseases of economically important plants caused by virus.
2. Field record of herbarium sheets of virus infected plants must be submitted
3. Preparation of bacterial media-
   a) Nutrient agar and nutrient broth
   b) Preparation of slants and Stab and pouring in Petri-plates.
4. Sub-culturing of bacterial culture.
5. Simple and Gram staining
6. microscopic examination of bacteria from curd by simple staining.

Plant Pathology (Theory) Marks-25

1. Diseases: Defnition; concepts of parasitism and saprophytism, Koch's postulate.
2. Classifcation of plant diseases based on symptoms.
3. Pathotoxins (HV toxin and Wild-fre toxin).
4. Structural and biochemical defense mechanism of plants.
5. Control of Plant diseases: Physical, chemical and biological methods.
6. Symptoms, disease cycles and control measures of White rust of crucifer, Brown spot of rice, Late blight of potato, Rust of wheat.

Plant Pathology (Practical) Marks-15

1.Study of the following diseases: White rust, Rust of wheat/*Justicia*, smut of wheat (or any member of Poaceae)
2.Demonstration on isolation and subculturing of pathogen.

Suggested Reading-

1. Environmental Microbiology, (1st edn), 2006, R M Maier, I L Pepper, C P Gerba. Academic Press.

2. Microbial Ecology: Fundamentals and applications. (1tt2). 3rd Edition, Atlas, RN and Bartha R,

Redwood city, Benjamin/Cummings.
3. Prescott'sMicrobiology , 2013, J.Willey, L. Sherwood, C.Woolverton., McGraw Hill.
4. Brock Biology of Microorganisms (13th edn), 2010, M.T. Madigan, J.M. Martinko, D. Stahl, D.P.Clark., Benjamin Cummings
5. Principles of Microbiology (2nd Edn), 1tt5, R. M. Atlas, W. C. Brown Publications
6. Alcamo's Fundamental of Microbiology ((tth Edn), 2010, Jefrey C. Pommerville, Jones and Bartlett Publication.
7. Foundations in Microbiology: Basic Principles (8th edn), 2011, K.P.Talaro, B. Chess, McGraw Hill.
8. Microbiology: An Introduction (11th edn), 2012, G.J.Tortora, B.R.Funke, C.L.Case, Benjamin Cummings
t.Plant Pathology. Agrios R. N. academic Press
10.Plant Pathology, Mehrotra, R. S. Tata Mc Graw Hill Publishing Company. New Delhi
11.Diseases of Crop Plants in India. Rangaswamy, G. Prentice Hall India Pvt. Ltd. New Delhi
12.Plant Diseases. Singh, R. S. Oxford & IBH, New Delhi.
13.Pathogen and Plant Diseases. Pandey, B. P., S. Chand & Company Ltd. Rangaswamy, G. New Delhi.

DSE-1B: Plant Breeding/ Horticultural Practices

Plant Breeding (Theory) Marks-25

1: Plant Breeding
Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.
2: Methods of crop improvement
Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: for self-pollinated, cross-pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.
3: Inbreeding depression and heterosis
History, genetic basis of inbreeding depression and heterosis; Applications.
4: Crop improvement and breeding
Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Practical-15 Marks

1. Hybridization techniques

Suggested Readings

1. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.

2. Chaudhari, H.K. (1t84). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.

3. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing Gr.

Horticultural Practices (Theory) marks-25

THEORY

1: Introduction

Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.

2: Ornamental plants

Types, classifcation (annuals, perennials, climbers and trees); Identifcation and salient features

of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (opuntia, agave and spurges)] Ornamental fowering trees

(Indian laburnum, gulmohar, Jacaranda, Lagerstroemia, fshtail and areca palms, semul, coraltree).

3: Fruit and vegetable crops

Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops; Identifcation of some fruits and vegetable varieties (citrus, banana, mango, chillies and cucurbits).

4: Horticultural techniques

Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.

5: Landscaping and garden design

Planning and layout (parks and avenues); gardening traditions - Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry; policies and practices.

6: Floriculture

Cut fowers, bonsai, commerce (market demand and supply); Importance of fower shows and

exhibitions.

7: Disease control and management

Field and post-harvest diseases; Identifcation of defciency symptoms; remedial measures and

nutritional management practices; Crop sanitation; IPM strategies (genetic, biological andchemical methods for pest control); Quarantine practices; Identifcation of common diseases

andpests of ornamentals, fruits and vegetable crops.

8: Horticultural crops - conservation and management

Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

9: Field trip

Field visits to gardens, standing crop sites, nurseries, vegetable gardens and horticultural felds at

IARI or other suitable locations.

Practical-15 Marks

1.Horticultural techniques for propagation (Grafting, budding, Layering)

2.Fruit quality analysis (TSS, Acidity)

3.Viability test- Seed/Pollen

Suggested Readings

1. Singh, D. & Manivannan, S. (200t). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post-Harvest Technology of Horticultural Crops. UCANR Publications, USA.

5. Capon, B. (2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.

DSE -2B Bioinformatics/Research Methodology

Bioinformatics (Theory) Marks-25

(Credits: Theory-4, Practical-2)
THEORY
1. Introduction to Bioinformatics
Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.
2. Databases in Bioinformatics
Introduction, Biological Databases, Classifcation format of Biological Databases, Biological Database Retrieval System.
3. Biological Sequence Databases
National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database
Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.
EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.
DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.
Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR.
Swiss-Prot: Introduction and Salient Features.
4. Sequence Alignments
Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).
5. Molecular Phylogeny
Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.
6. Applications of Bioinformatics
Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR)

techniques in Drug Design, Microbial genome applications, Crop improvement

Practical- 15 Marks

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (200t) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and

Bioinformatics. _II Edition. Benjamin Cummin

Research Methodology

Theory: Marks-25
1: Basic concepts of research
Research-defnition and types of research (Descriptive vs analytical; applied vs fundamental;

quantitative vs qualitative; conceptual vs empirical) Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory

research.

2: General laboratory practices

Common calculations in botany laboratories. Understanding the details on the label of reagent

bottles. Molarity and normality of common acids and bases.Preparation of solutions. Dilutions.

Percentage solutions. Molar, molal and normal solutions.Technique of handling micropipettes;

Knowledge about common toxic chemicals and safety measures in their handling.

3: Data collection and documentation of observations

Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of feld photography.

4: Overview of Biological Problems

History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

5: **Methods to study plant cell/tissue structure**

Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue

preparation: living vs fxed, physical vs chemical fxation, coagulating fxatives, non-coagulant

fxatives; tissue dehydration using graded solvent series; Parafn and plastic infltration; Preparation of thin and ultrathin sections.

6: Plant microtechniques

Staining procedures, classifcation and chemistry of stains. Staining equipment. Reactive dyes

and fuorochromes (including genetically engineered protein labeling with GFP and other tags).

Cytogenetic techniques with squashed plant materials.

7: The art of scientifc writing and its presentation

Numbers, units, abbreviations and nomenclature used in scientifc writing. Writing references.

Powerpoint presentation. Poster presentation. Scientifc writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Practical-15Marks

1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and feld photography.
4. Poster presentation on defned topics.
5. Technical writing on topics assigned.

Suggested Readings

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1tt5). Scientifc writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1ttt). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

Discipline Specific Elective-3B
Biostatistics-Theory (25 Marks)

1.Biostatistics
Defnition - statistical methods - basic principles. Variables - measurements, functions, limitations and uses of statistics.
2.Collection of data primary and secondary
Types and methods of data collection procedures - merits and demerits. Classifcation - tabulation and presentation of data - sampling methods.
3.Measures of central tendency
Mean, median, mode, geometric mean - merits & demerits. Measures of dispersion - range, standard deviation, mean deviation, quartile deviation - merits and demerits; Coefficient of variations.

4.Correlation
Types and methods of correlation, regression, simple regression equation, ftting prediction, similarities and dissimilarities of correlation and regression
5.Statistical inference
Hypothesis - simple hypothesis - student 't' test, chi-square test.

Biostatistics-Practical (15 Marks)
1) Calculation of mean, standard deviation and standard error
2) Calculation of correlation coefcient values and fnding out the probability
3) Calculation of 'F' value and fnding out the probability value for the F value.

AEEC – Ability Enhancement Elective Course [i.e. Skill Enhancment Course (SEC)]: The course should be project based and dissertation should be submitted

[Four papers are to be taken and each paper will have 2 credit]:
1.Vermicomposting and organic farming
2. Mushroom cultivation
3. Cultivation of medicinal plants
4. Laboratory skills

Skill Enhancment Course (SEC)
1. Vermicomposting and organic farming (15 marks)
1.vermicomposting: Definition and scope
2.Aims and objective of vermicomposting
3.Difference between vermiculture and vermicomposting
4.Vermicomposting technology: An overview
5.Concepts and development of organic farming
6.Types of organic farming, Biodynamic farming, Benefts of organic farming.
7.Conventional farming v/s organic farming
8.Plant protection- botanical pesticides I,Plant protection- botanical pesticides II,Plant protection- botanical pesticides III.
9.Policies and incentives of organic production, Farm inspection and certifcation

2.Mushroom Cultivation (15 Marks)
1:Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms.Types of edible mushrooms available in India - *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.

2:Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors afecting the mushroom bed preparation

Low cost technology, Composting technology in mushroom production.
3:Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in saltsolutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fbre content - Vitamins.
4:Food Preparation_:Types of foods prepared from mushroom.Research Centres - National level and Regional level._Cost beneft ratio - Marketing in India and abroad, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1tt1) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1tt0) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1t88). Mushroom cultivation, Mittal Publications, Delhi.

4. Nita Bahl (1t84-1t88) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

Skill Enhancement Course
3.Cultivation of Medicinal Plants
(15 marks)

1:History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Defnitionand Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, 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. Defnition: 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 classifcation, 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. Defnition; 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.

Suggested Readings

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

Skill Enhancement Course
4.Laboratory Skills
(15 Marks)

1.Fundamentals of laboratory work *(*safety, weights & measures, bufers, using a pH meter*).*
2.General idea on laboratory equipments-a) Light Microscope
b) Burette and pipette
c)Centrifuges: Standard, high speed
d) Incubators
e)Volumetric glasswares
f) Laminar Air Flow(LAF) Chamber
g) Autoclave
h) Water Bath
i) Colorimeter
j)Spectrophotometer
3.Preliminary idea on the following laboratory techniques:
a) Various methods of sectioning/cutting of samples
b) Procedures for proper staining like Gram Staining, single and double staining c) Filtration and Titration
d) Sterilization
e) Media preparation(Bacteriological)
f) Innoculation and pour plates
g) Separation by various chromatographic technique like Column ,Paper and Thin Layer h) determination of RNA, Protein and Nucleic Acids concentrations by UV-VISIBLE Spectroscopy

Suggested Readings:

1**.**Principles and Techniques of Biochemistry & Molecular Biology by Keith Wilson and John Walker.

2.Biochemical Calculations by Irwin H. Segel.