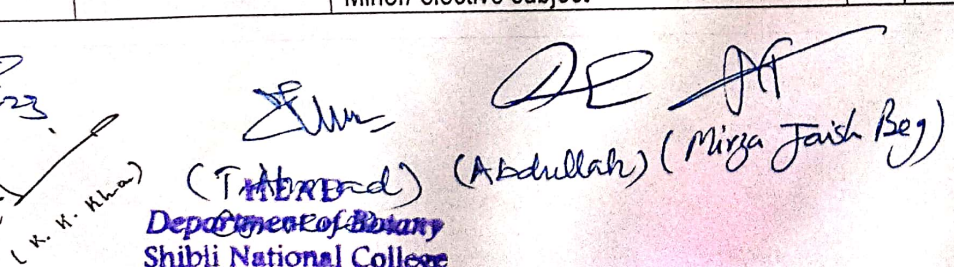


Revised Curriculum of M.Sc. Botany
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CHOICE BASED CREDIT SYSTEM (CBCS)

Semester	Paper Code	Papers	Type	Credit	Semester credits	
Sem-I	B040701T	Microbiology	Compulsory	04	20	
	B040702T	Phycology and Bryophytes	Compulsory	04		
	B040703T	Pteridophytes & Gymnosperms	Compulsory	04		
	B040704T	Cell Biology & Biomolecules	Compulsory	04		
	B040705P	Laboratory Exercises corresponding to the Theory courses.	Compulsory	04		
			Minor/ elective subject	Optional		04
			Major Research Project	Compulsory		04
Students have to select any one group from the given two optional groups						
Sem-II	B040801T	Plant Anatomy & Developmental Biology	Compulsory	04	20	
	B040802T	Taxonomy of Angiosperms	Compulsory	04		
	B040803T	Group A Plant Pathology	Genetics & Genomics	Optional		04
	B040804T		Optional	04		
	B040805T	Group B Paleobotany & Palynology	Mycology	Optional		04
	B040806T		Optional	04		
	B040807P	Laboratory Exercises corresponding to the Theory courses.	Compulsory	04		
			Minor/ elective subject	Optional		04
	B040807RP	Major Research Project	Compulsory	04		
Students have to select any one group from the given two optional groups						
Sem-III	B040901T	Plant Physiology and Biochemistry	Compulsory	04	20	
	B040902T	Plant Biotech & Biology	Compulsory	04		
	B040903T	Group A Soil Science & Phytogeography	Plant Resource Utilization & Conservation	Optional		04
	B040904T		Optional	04		
	B040905T	Group B Economic Botany	Microbial Biotechnology	Optional		04
	B040906T		Optional	04		
	B040907P	Laboratory Exercises corresponding to the Theory courses.	Compulsory	04		
			Minor/ elective subject	Optional		04
			Major Research Project	Compulsory		04
Students have to select any two group from the given three optional groups						
Sem-IV	B040101T	Group A Water Resource Management	Plant Ecology	Optional	04	20
	B040102T		Optional	04		
	B040103T	Group B Cyto genetics, Plant Breeding & Biostatistics	Environment Management & Technology	Optional	04	
	B040104T		Optional	04		
	B040105T	Group C Forest Ecology	Computer Application and Bioinformatics	Optional	04	
	B040106T		Optional	04		
	B040107P	Laboratory Exercises corresponding to the Theory courses.	Compulsory	04		
			Minor/ elective subject	Optional	04	



 (T. Akbar) (Abdullah) (Mirza Faish Beg)

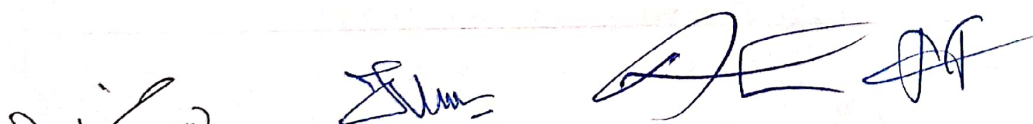
 Department of Botany

 Shibli National College

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B040108RP	Major Research Project	Compulsory	
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M.Sc. First Year (Semester-I)			
Credits=04	Compulsory	Paper-I (Theory)	
Maximum Marks:75		Minimum Marks:25	
Sem-I; 1.1. Microbiology	<p style="text-align: center;">Unit-I</p> <p>Basis of bacterial classification, Bacterial isolation: Serial dilution and enrichment culture techniques. Maintenance and preservation of Bacterial culture.</p> <p style="text-align: center;">Unit- II</p> <p>Genetic analysis of Bacteria; conjugation, transformation and transduction: Lytic and Lysogenic. Transposons; types of transposons. Nitrogen metabolism; ammonification, nitrogen fixation nitrification and denitrification, Commercial use of bacteria.</p> <p style="text-align: center;">Unit -III</p> <p>Classification of plant viruses, characteristics and ultrastructure of viruses; Isolation, purification and characterization of Viruses. Chemical nature, replication, transmission of viruses, economic importance.</p> <p style="text-align: center;">Unit-IV</p> <p>General symptoms of Viral infection, Phytoplasma General characteristics and its role in causing plant disease.</p>		
<p>Suggested Readings:</p> <ol style="list-style-type: none"> 1. Madigan MT, Martinko JM, Bender KS, Buckley DH, Stahl DA (2014) Brock Biology of Microorganisms, 14 th edition, Benjamin Cummings, New York. 2. Stanier RY, Ingraham JL, Wheelis ML, Painter PR (1987) General Microbiology, 5th edition, MacMillan, Press Ltd, New Jersey. 3. Talaro KP, Chess B (2011) Foundations in Microbiology, 8th edition, McGraw-Hill, New York. 4. Willey JM, Sherwood L, Woolverton CJ (2013) Prescott's Microbiology, 9th edition, McGraw-Hill, New York. 5. Pelczar M.J., Chan E.C.S. and Krieg N.R. (2003) Microbiology. 5th Edition, Tata 6. McGraw-Hill Publishing Company Limited, New Delhi. 			
Credits=04	Compulsory	Paper-II(Theory)	
Maximum Marks:75		Minimum Marks:25	
Sem-I; 1.2. Phycology & Bryophytes	<p style="text-align: center;">Unit – I</p> <p>Principle of important system of classification of algae upto the rank of Classes. Algal reproduction and Life Cycle General, Economic and environmental aspect of algae. Algal Pigmentation.</p> <p style="text-align: center;">Unit- II</p> <p>General characters, occurrence, habitat, Cellular Organization, reserve food material and reproduction in the following classes.</p> <ul style="list-style-type: none"> • Cyanophyceae; <i>Gleotrichia</i>, <i>Oscillatoria</i>, <i>Nostoc</i> and <i>Scytonema</i> • Chlorophyceae; <i>Chlorella</i>, <i>Hydrodictyon</i>, <i>Cladophora</i>, <i>Oedogonium</i> and <i>Chara</i>. • Phaeophyceae; <i>Ectocarpus</i>, <i>Dictyota</i> and <i>Laminaria</i>. • Rhodophyceae; <i>Batrachospermum</i>, <i>Polysiphonia</i> and <i>Gelidium</i>. • Xanthophyceae; <i>Botrydium</i> and <i>Vaucheria</i> • Bacillariophyceae; <i>Navicula</i>. <p style="text-align: center;">Unit – III</p> <p>Bryophytes: Origin and evolution of sporophytes, Classification, Geographical distribution, economic importance of bryophytes</p> <p style="text-align: center;">Unit-IV</p> <p>Comparative study of Morphology anatomy life history, Classification and phylogeny of Hepaticopsida; <i>Marchantia</i>, <i>Pellia</i>, <i>Porella</i>, <i>Plagiochasma</i> and <i>Takakia</i>, <i>Anthocerotopsida</i>; <i>Anthoceros</i> and <i>Notothylus</i> and Bryopsida; <i>Sphagnum</i> <i>Funaria</i>, <i>Polytrichum</i>, Fossil Bryophytes.</p>		

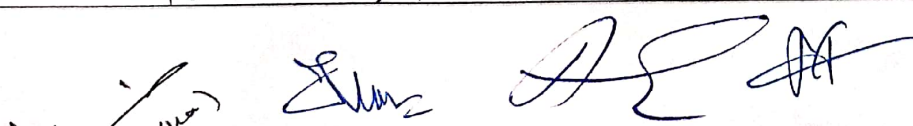

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Suggested Readings

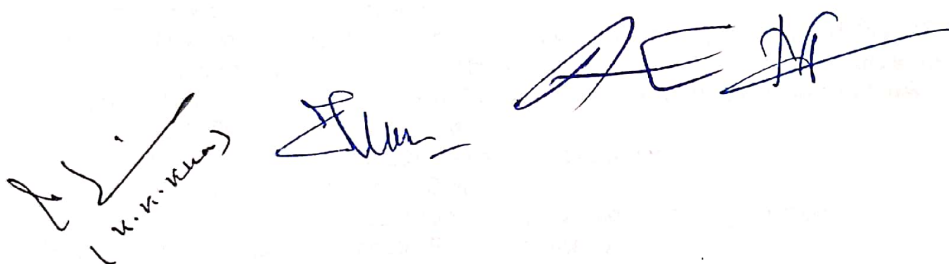
1. Puri P (1980). Bryophytes. Atma Ram & Sons, New Delhi.
2. Kumar HD (1988). Introductory Phycology. Affiliated East-West Press Ltd., New Delhi.
3. Morris J (1986). An Introduction to the Algae. Cambridge University Press, U.K.
4. Round FE (1986) The Biology of Algae. Cambridge University Press, U.K.
5. An Introduction To The Algae By Ian Morris
6. The Algae By V.J.DJ Chapman
7. The Structure And Reproduction Of Algae By F.E Fritsch
8. Phycology By Robert Edward Lee
9. Algae An Introduction to The Phycology By Hoek Christian Van Den
10. An Introduction To The Study Of Algae By V.J Chapman
11. Algae Anatomy Biochemistry, And Biotechnology By Laurabarsanti, Paologuallieri
12. Diversity Of Microbes And Cryptogams, Algae By O.P.Sharma
13. An Introduction to Phycology by G.R. South , A.Whittick.

Credits=04	Compulsory	Paper-III(Theory)
Maximum Marks:75		Minimum Marks:25
Sem-I; 1.3.	Unit-I	
	Classification and origin of Pteridophytes; The vegetative sporophytes; stellar theory: Telome theory: The fertile sporophytes: sporangia; position, ontogeny. Types, structure. Heterospory and Seed habit: Occurrence, cause and significance.	
	Unit-II	
Pteridophytes & Gymnosperms	The gametophytes: Germination of fern spores, development of fern prothallus; Comparative study of Psilophyta; (<i>Psilotum</i>), Lycopsida; (<i>Lycopodium</i>) and (<i>Selaginella</i>), Sphenopsida; (<i>Equisetum</i>), and Pteropsida; (<i>Nephrolepis</i>) and (<i>Marsilea</i>). Apospory and Apogamy.	
	Unit-III	
	Classification of Gymnosperms up to the rank of orders. General account of the Fossils of Medullosaceae (<i>Medullosa</i>), Pentoxylales (<i>Pentoxylon</i>), Corditales (<i>Cordaites</i> sp.)	
	Unit-IV	
	General account of the following groups with special reference to the genera indicated in brackets: Gingoales (<i>Ginkgo biloba</i>), general anatomy, cone organization, life history and distribution, Ephedrales (<i>Ephedra</i> sp.) Gnetales (<i>Gnetum</i> sp.) and Welwitschiales (<i>Welwitschia</i> sp.)	
Suggested Readings:		
<ol style="list-style-type: none"> 1. Bhatnagar SP, Moitra A (1996) Gymnosperms, New Age international Ltd Publication, New Delhi. 2. Parihar NS (1973) An Introduction to Embryophyta, Vol I (Bryophyta) and Vol II(Pteridophyta), Central Book Department, Allahabad. 3. Parihar NS (1996). The Biology and Morphology of Pteridophytes. Central Book Depot, Allahabad. 4. Rashid A (2011) An Introduction to Pteridophyta, 2 nd edition, Pub Vikas Publishing House Pvt Ltd, Noida. 5. Sambamurty AVSS (2005) A Textbook of Bryophytes, Pteridophyte 6. Sporne KR (1965). The Morphology of Gymnosperms. Hutchinson Univ. Library 7. Sporne KR (1967) Morphology of Gymnosperms, BI Publication, New Delhi. 8. Sporne KR 1991. The Morphology of Pteridophytes. B.I. Publ. Pvt. Ltd. 		
Credits=04	Compulsory	Paper-IV(Theory)
Maximum Marks:75		Minimum Marks:25
Sem-I; 1.4.	Unit-I	
Cell Biology &	Cytoskeleton: microtubules, Microfilaments and intermediate filaments. Interphase nucleus and nucleolus, Nuclear pore complex (NPC). Cell organelles: structure & functions, endomembrane system: Plasmodesmata.	
	Unit-II	
	Cell division: cell cycle, mitosis and meiosis; Control of cell division: cyclins, Cdks, cell cycle check points.	


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Biomolecules	spindle organization and chromosomal movement, uncontrolled cell division, tumor, cancer, apoptosis and programmed cell death in plants.		
	Unit-III		
	Cell signaling: cell surface receptors, G-protein, GPCRs, second messengers, membrane derived messengers, serine/threonine kinases and receptor tyrosine kinase (RTKs).		
	Unit-IV		
	Characteristic and nomenclature of carbohydrate protein and lipid.		
	Enzyme: Structure, mechanism, Apoenzyme, Allosteric enzyme and abzymes.		
Suggested Readings:			
1. Brown WV & Berke MB (1974). Text Book of Cytology, Blackstains Sons & Co.			
2. Brachet J & Mirsky AE (1959). The Cell, Academic Press, Vols. 16D			
3. De Robertis EDP & De Robertis EMF 8. (2001). Cell and Molecular Biology, Lippineott Williams & Wilkins, Bombay.			
4. Wolfe SL (1993). Molecular and Cellular Biology, Wordsworth Publ. Co., California, USA.			
5. Sharma AK & Sharma A (1980). Chromosome Techniques. Theory and Practice, Butterworth.			
6. Roy SC & Kumar KDC (1977). Cell Biology, New Central Book Agency, Calcutta.			
Credits=04			
Sem-I; 1.5.	Minor/Elective subject		
Credits=04	Compulsory	Paper-V(Practical-I)	
Maximum Marks:75		Minimum Marks:25	
Sem-I; 1.6.	Laboratory Exercises corresponding to the Theory courses.		



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M.Sc. First Year (Semester- II)		Paper-I(Theory)
Credits=04	Compulsory	Minimum Marks:25
Maximum Marks:75		
Sem-II; 2.1.	<p style="text-align: center;">Unit-I</p> <p>The cambium, vascular and cork cambium its derivative tissues, differentiation of secondary phloem and Xylem. Structure of woods in relation to its weight, strength, durability and taxonomic significance. Anomalous secondary growth in roots and stems (monocots & dicots).</p> <p style="text-align: center;">Unit-II</p> <p>Cork cambium and its derivatives, function of cork and its uses, abscission layers. Origin of Lateral and adventitious roots, root-stem transition. Anatomy in relation to taxonomy & embryology.</p> <p style="text-align: center;">Unit-III</p> <p>Male Gametophyte- Microsporogenesis, tapetum and its role, pollen development. Female Gametophyte- Ovule development, Megasporogenesis. Organization of embryo sac, types of embryo sacs. Pollination- Mechanism and vectors, pollen germination and pollen tube growth.</p> <p style="text-align: center;">Unit- IV</p> <p>Fertilization and its control with special reference to incompatibility in flowering plant. Endosperms & its abnormalities, Embryo developments. Apomixes Polyembryony and its induction.</p>	
Suggested Readings:		
<ol style="list-style-type: none"> 1. A Plant Anatomy by (Pande 1978) 2. A principle and practices in plant morphology by (Raghuvanshi & Joshi 1971) 3. A text book of botany by Julius Sachs 4. Anatomy of Seed Plant By(Katherine Esau 1960) 5. Anatomy of the Dicotyledons and Anatomy of the Monocotyledons by Metcalfe and Chalk 1979 6. Bhojwani S. S. & Bhatnagar SP (2000). Embryology of Angiosperms (4th Revised and enlarged edition). 7. Burgess J (1985). An Introduction to Plant Cell Development, Cambridge University Press, Oxford. 8. Esau, K. (1993). Plant Anatomy, Wiley Eastern Ltd. 9. Fahn A (1982). Plant Anatomy 3rd Edn, Pergamon Press, Oxford. 10. Integrated plant anatomy by William C, Dickisons 2000 11. Larson PR (1995). The Vascular Cambium, Springer Verlag, Heidelberg, Germany. 12. Iqbal M (1990). The Vascular Cambium, R.S.P., Taunton, UK. 13. Iqbal M (1995). The Cambial Derivatives, Gebruder Borntraeger, Stuttgart, Germany. 14. Mahswari P (1950). An Introduction to Embryology of Angiosperms. 		
Credits=04	Compulsory	Paper-II(Theory)
Maximum Marks:75		Minimum Marks:25
Sem-II; 2.2.	<p style="text-align: center;">Unit-I</p> <p>System of classification, History, outline of basic importance and shortcoming of following classifications.</p> <ul style="list-style-type: none"> • Bentham & Hooker • Takhtajan • Hutchinson • Engler & Prantl <p>(History and development of APG)</p> <p style="text-align: center;">Unit-II</p> <p>Rules of Botanical Nomenclature, ICBN, Fields and Herbarium techniques, Plants Identification, Taxonomic key, Typification, introduction to taxonomic evidences from cytology, photochemistry, molecular biology data.</p> <p style="text-align: center;">Unit-III</p> <p>General knowledge of distinguishing features of the following families with special reference of best flora</p>	
Taxonomy Of Angiosperms		



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Dicotyledons: Ranunculaceae, Magnoliaceae, Caryophyllaceae. Asteraceae, Rosaceae, Rutaceae, Anacardiaceae, Fabaceae, Myrtaceae and Combretaceae.

Unit-IV

Numerical Taxonomy ^{Taxonomy} in relation to Embryology Cytology and Anatomy, Chemotaxonomy. Identification and economic use of following families;

Dicotyledons: Oleaceae, Asclepiadaceae, Boraginaceae, Scrophulariaceae, Bignoniaceae, Pedaliaceae, Acanthaceae, Verbanaceae, Lamiaceae, Polygonaceae, Piperaceae, Euphorbiaceae and Moraceae.

Monocotyledons: Orchidaceae, Araceae, Zingiberaceae. Cyperaceae and Poaceae

- Suggested Readings:**
1. Lawrence, B.M. Taxonomy of vascular plants, IBH publication Tata Mc Grew Hill.
 2. Sharma, Trivedi B.S. Taxonomy, Kitab Mahal Prayagraj.
 3. Naik, V.N. (1984). Taxonomy of Angiosperms. Tata McGraw-Hill, New Delhi.
 4. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, New York.
 5. Singh, Gurcharan (2007). Plant Systematics. Oxford & IBH Publishing Co, New Delhi.

Credits=04	Optional	Paper-III(Theory)
		Minimum Marks:25

Maximum Marks:75
Sem-II; 2,3.

**Genetics
&
Genomics**

Unit-I

Mendelism and Basic Principle of Heredity, Genetic Terminologies and their concept Mendel Laws of inheritance: Dominance, Monohybrid cross, Dihybrid cross and Trihybrid cross (Forked-line Method or Branch Diagram Method) with their probability, Law of Segregation, Law of Independent assortment, Test cross, Backcross and Chi-square Test

Unit-II

Exception of Mendelism: Incomplete Dominance, Co-dominance, Multiple alleles, Pseudodominance, Over Dominance, Gene Interaction, Epistasis, Pleiotropy, Genomic Imprinting, Penetrance and Expressivity, Linkage and Recombination, Sex linked, influence Character, Inbreeding and outbreeding, heterosis and inbreeding depression.

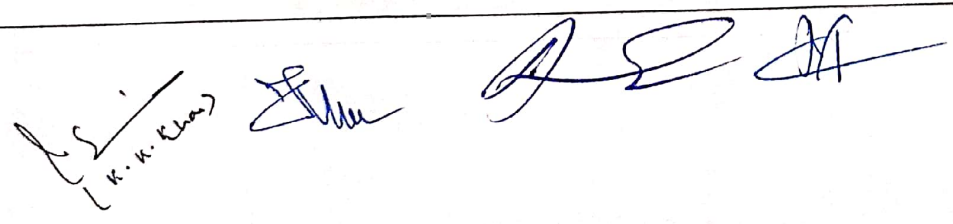
Unit-III

Morphology and type of chromosome Chromosomal Basis of Mendelism: Chromosome, Chromosome theory of Heredity, Sex linked Gene in Human, Sex determination in Human, Birds, Insect and other organism, Dosage compensation,

Unit-IV

Sex linked and sex influenced characters, introduction and overview: Structural Genomics: Genetic and Physical Map, Entire Genome sequencing, Copy number variations and Single Nucleotide Polymorphism, Meta-genomics and Synthetic Biology

- Suggested Readings:**
1. Strickburger M (1990). Genetics. MacMillan Publishing Company, New York.
 2. Gardner J (1991). Principle of Genetics. John Wiley & Sons, New York.
 3. Klug WS& Cummings MR (1997). Essential of Genetics. Prentice Hall Publishing Co., New Jersey.
 4. Brown T (1989). Genetics: A Molecular Approach. Chapman & Hall, London.
 5. Goodenough U (1984). Genetics. Sandir College Publishing, Philadelphia.
 6. Lewin, B. (2007). Genes Vol. 9. Oxford University Press.



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Credits=04	Group-A	Optional	Paper-IV(Theory)
Maximum Marks:75		Minimum Marks:25	
Sem-II; 2.4.	Unit-I		
Plant Pathology	Importance & concept of disease in plants, variability in plant pathogen, Mechanism by attack plant pathogen, effect of environment on disease development, plant disease forecasting. Koch's Postulates, Disease symptoms, pathogen & disease triangle.		
	Unit-II		
	Transmission of plant diseases, isolation and purification plant pathogens, Pathogenicity test, Principle and method of plant disease control.		
	Unit-III		
Rots diseases with special reference to fruit and stem end rot of papaya. Damping off of seedlings of crop plants. Downy mildews of cucurbits. Rust of wheat and Barley. Powdery mildew of pea. Smuts and Bunts: Covered smut of Barley; loose smut of wheat and Bunt of rice. Wilt of sugarcane. Leaf spots: leaf spot of turmeric; Leaf blight of wheat. Blast disease of rice and mango anthracnose. Galls and other abnormalities: stem gall of coriander leaf curl of Peach.			
Unit-IV			
Plant disease: Causal organism, symptoms and management			
<ul style="list-style-type: none"> • Bacterial diseases: Citrus canker and Tundu disease of wheat. • Viral diseases: Mosaics of tobacco, YVM of Okra, papaya, potato and tungro of rice. • Phytoplasmal diseases: Grassy shoot of sugarcane. • Nematode diseases: Ear cockle of wheat 			

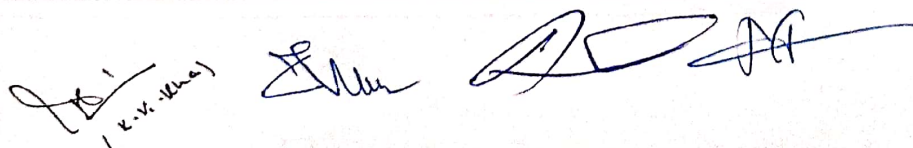
Suggested Readings

1. Agrios GN (2005) Plant Pathology, Academic Press, Burlington.
2. John AL (1998) Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press, Publication, Boca Raton, USA.
3. Dickinson CM (2003) Molecular Plant Pathology, Bios Scientific Publisher, Oxford.
4. Bridge PD, Clarkson JM (1998) Molecular Variability of Fungal Pathogens, CAB, International, Oxford shire.
5. Singh RS (2008) Plant Diseases, Oxford and IBH Publishing Co Pvt Ltd, New Delhi.
6. Singh RS (2008) Principles of Plant Pathology, Oxford and IBH Publishing Co Pvt. Ltd, New Delhi.
7. Dhingra OD, James B, Sinclair (1995) Basic Plant Pathology Methods, CRC
8. Concise Encyclopedia of Plant Pathology by P. Vidhyasekaran

Credits=04	Group-B	Optional	Paper-V(Theory)
Maximum Marks:75		Minimum Marks:25	
Sem-II; 2.5.	Unit-I		
Mycology	Outline classification as per Smith Ainsworth, Mims, Comparative account of Thallus structure and spore producing organs.		
	Unit-II		
	Interrelation life cycle pattern & Phylogeny of Myxomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.		
	Unit-III		
Mode of nutrition of fungi and their physical and chemical requirement for growth and reproduction.			
Unit-IV			
Heterokaryosis, parasexuality, heterothallism, variation in fungi, hormonal control of sexual reproduction. Economic importance of fungi			

Suggested Readings:

1. Alexopoulos CJ, Minus CW, Blackwell M (1996) Introductory Mycology, John Cambridge.
2. Carlile MJ, Watkinson SC, Booday GW (2001) The Fungi, Academic Press,
3. Deacon JW, Blackwell M (1997) Introduction to Modern Mycology, Oxford.



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	4. Maheshwari R (2012) Fungi: Experimental Methods in Biology, CRC Press, Boca Raton, Florida.		
	5. Webster J, Roland WS (2007) Introduction to Fungi, Cambridge University Press,		
	6. Webster John (1980) Introduction to fungi, Cambridge University Press, Wiley and Sons, Inc, New York.		
Credits=04	Group-B	Optional	Paper-VI (Theory)
Maximum Marks:75		Minimum Marks:25	
Sem-II; 2.6.	Unit-I		
Paleobotany & Palynology	Fossil history of Bryophytes, Pteridophytes and Gymnosperms: Principles of Paleobotany and geological time scale.		
	Unit-II		
	Process of fossilization and types of fossils; Method of study of fossils and carbon dating technique. General account of Bennettitales, Cordaitales, Glossopteridales, Ginkgoales.		
	Unit-III		
	Pollen Morphology and its germ pore, Caulpate condition in monocots and dicots		
	Unit-IV		
	Aeropalynology, Forensic Palynology and palaeopalynology and their role in taxonomic evidence, Pollen Allergy.		
Suggested Readings:			
1. Stewart Wilson N, Paleobotany and Evolution of Plants.			
2. S.R. Misha, Text Book Of Paleobotany.			
3. Peter George, Introduction to Paleobotany.			
4. G.Erdtman, Hand Book of Palynology: Morphology, taxonomy, ecology; an introduction to the study of Pollen grains & spores.			
5. K.Bhattacharya M.R. Majumdar & S.G. Bhattacharya, A text book of Palynology.			
P.K.K. Nair, Essential of Palynology.			
Credits=04	Minor/Elective subject		
Sem-II; 2.7.	Paper-VII (Practical-II)		
Credits=04	Compulsory		
MaximumMarks:75		Min Passing Marks:25	
Sem-II; 2.8.	Laboratory Exercises corresponding to the Theory courses.		

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M.Sc. Second Year (Semester-III)		Paper-I(Theory)
Credits=04	Compulsory	Minimum Marks:25
Sem-III; 3.1. Plant Physiology & Biochemistry	<p style="text-align: center;">Unit-I</p> <p>Water relation: Absorption and transportation and loss of water, Transpiration regulation of opening and closing in stomata. Criteria of essentiality of mineral nutrients, mineral metabolism essential and non-essential elements, deficiency and toxicity of elements. Absorption and translocation of minerals, biological nitrogen fixation and metabolism. Photoperiodism and vernalization, and plant movements.</p> <p style="text-align: center;">Unit-II</p> <p>Photosynthesis light harvesting complex of higher plants light reaction of photosynthesis, photosynthetic carbon reduction pathway, Hatch slack pathway and crassulacean acid metabolism (CAM). Respiration: Types of respiration, mechanism, glycolysis, Tricarboxylic acid cycle, Electron Transport System, Fermentation, respiration quotient and photorespiration. Plant growth regulators, Auxins, Gibberellins, cytokinins, Ethylene, ABA (abscissic acid), Brassinosteroids, Jasmonates, Salicylic acid.</p> <p style="text-align: center;">Unit-III</p> <p>Composition and structure function of carbohydrates, protein and lipids, Enzymes regulatory and active sites activation energy and isozymes. Enzyme kinetics Michaelis-Menten equation, classification of enzymes, prosthetic groups and cofactors.</p> <p style="text-align: center;">Unit-IV</p> <p>Bioenergetics: Laws of thermodynamics and its application biological system, concept of entropy, enthalpy and free energy, energy rich bonds and high energy compounds Biochemical techniques: Chromatography, electrophoresis, centrifugation, spectrophotometry and tracer techniques.</p>	
<p>Suggested Readings:</p> <ol style="list-style-type: none"> 1. Devlin RM & Witham FH (1986). Plant Physiology. CBS Pubs. and Distributors, New Delhi. 2. Hopkins WG (1995). Introduction to Plant Physiology, John Wiley & Sons. Inc., New York, USA. 3. Moore TC (1989). Biochemistry and Physiology of Plant Hormones. SpringerVerlag. New York, USA. 4. Singhal et al. (1999). Concepts in Photobiology. Photosynthesis and Phytomorphogenesis, NarosaPub. House, N. Delhi. 5. Taiz & Zeigler (2006). Plant Physiology 4th Edn. Sinauer Associates Inc., Publishers, Sunderland 6. Salisbury FB & Celon W (1986). Plant Physiology 3d Edn. CBS Publishers, New Delhi. 7. Voet & Voet (1995). Biochemistry 2nd Edn, John Wiley & Sons, Inc., New York, USA. 8. Nelson DL& Cox MM (2000). Lehninger Principles of Biochemistry. Macmillan Worth Publishers, Madison Av., New York 9. Lehninger AL (1993). Principle of Biochemistry. CBS Publishers, New Delhi. 10. Cooper, A (2004). Biophysical Chemistry. Royal Society of Chemistry, Cambridge Publication. 11. Hames, BD, Hooper NM & Houghton JD (1998). Instant Notes in Biochemistry. Viva Books, NewDelhi . 12. Wildon K& Walker J (2000). Practical Biochemistry: Principles and Techniques 5th Edn, Cambridge University Press. 13. Skoog, DA, Holler FJ & Timothy N (1998). Principles of Instrumental Analysis 5th Edn. Saunders College Publishing. 14. Wise DL (1991). Bioinstrumentation and Biosensors. Marcel Dekker, New York. 		
Credits=04	Compulsory	Paper-II(Theory)
Maximum Marks:75		Minimum Marks:25
Sem-III; 3.2.	<p style="text-align: center;">Unit-I</p> <p>Genetic Engineering of Plants: Objectives, strategies and approaches; transformation methods: Agrobacterium mediated biolistic approach, microinjection, electroporation and liposome mediated selection of transformants and their molecular characterization.</p> <p style="text-align: center;">Unit-II</p> <p>Application: Production of Transgenic plants viz herbicide resistant plants; engineering Plants for abiotic stress, senescence- tolerance and male sterility, environmental, social and legal implications. Production of</p>	

(H. N. Kumar)

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Plant Biotechnology & Molecular Biology	<p>genetically modified (GM) plants.</p> <p style="text-align: center;">Unit-III</p> <p>General Feature of Replication , DNA polymerase mechanism and their specialization, Mechanism of DNA Replication, initiation ,elongation and termination) in prokaryotes and eukaryotes ,</p> <p style="text-align: center;">Unit-IV</p> <p>Gene and chromosome, Chromatin , Histone and their variants Nucleosomes :Nucleosomes assembly and Histone modification, A ,B and Z DNA, Renaturation and Denaturation kinetics</p>
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Suggested Readings:

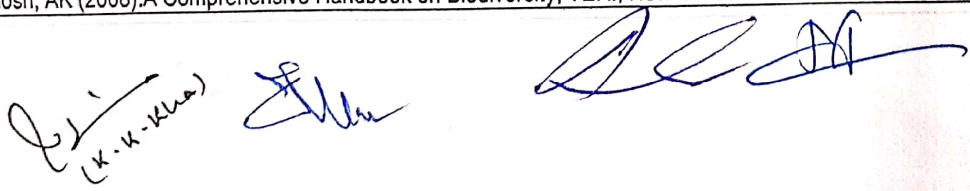
- Hill W E (2000). Genetic Engineering. Hardwood Academic Publishers, the Netherlands.
- Brown T (1995). Gene Cloning. Chapman & Hall, London.
- Ranjan R (1996). Transgenic Plant. Agro Botanica, Bikaner
- Sellor J (1999). Genetic Engineering. Plenum Press, New York.
- Tombs M (1990). Biotechnology and Genetic Engineering Reviews. Intercept, U.K.
- Old RW & Primrose SB (1985). Principle of Gene Manipulation: An Introduction to Genetic Engineering, Blackwell
- Alberts B, Bray D, Lewis J, Raf M, Roberts K & Watson JD (1989). Molecular Biology of the Cell, Garland Publishing inc., New York
- Alcamo IE (1994). Fundamentals of Microbiology, The Benjamin/Cummings Publishing Co., New York.
- Benjamin Lewin (2007). Genes IX, Prentice Hall.
- Brachet J & Mirsky AE (1959). The Cell, Academic Press, Vols.
- Brown WV & Berke MB (1974). Text Book of Cytology, Blackstains Sons & Co.
- De Robertis EDP & De Robertis EMF (2001). Cell and Molecular Biology, Lippincott Williams & Wilkins, Bombay.
- Evans DA Sharp WR & Amirato PY (1986). Handbook of Plant Tissue Culture. Macmillan Publishing Company, New York. .
- Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D & Darnell J (2000). Molecular Cell Biology. W.H. Freeman and Co., New York, USA.

Credits=04	Group- A	Optional	Paper-III(Theory) Minimum Marks:25
Maximum Marks:75			

Sem-III; 3.3	<p style="text-align: center;">Unit-I</p> <p>Plant Introduction, Domestication, importance history, botany, cultivation and processing of cereals (Wheat, Maize, Rice) legumes/Pulses (Pisum, Cicer, <i>Cajanus</i>), Fiber plants and their products Cotton (<i>Gossypium</i>), Jute (<i>Corchorus</i> sp), Sunhemp (<i>Crotolaria</i> sp)</p> <p style="text-align: center;">Unit-II</p> <p>Medicinal plants opium poppy (<i>Papaver somniferum</i>), sharpgandha (<i>Rauwolfia serpentina</i>) Tulsi (<i>Ocimum</i>), Giloy (<i>Tinospora cordifolia</i>), and narcotics. Fumitories & masticatories', Beverage yielding plants, important wood and timber yielding plants Sissoo (<i>Dalbergia Sissoo</i>), Sal (<i>Shorea robusta</i>), Teak (<i>Tectona grandis</i>), sugar and sugar yielding plants Sugar cane (<i>Saccharum officinarum</i>) Beet root (<i>Beta vulgaris</i>).</p> <p style="text-align: center;">Unit-III</p> <p>Principles of conservation; in-situ and ex-situ conservation principles and practices NSC, Botanic gardens, BSI, NBPGR, ICAR, CSIR, DST and DBT & gerpalsm conservation.</p> <p style="text-align: center;">Unit-IV</p> <p>Plant biodiversity (Type and measurement), Seed banks and cryobanks, Green revolution – benefits, Red Data Book, Sustainable development</p>
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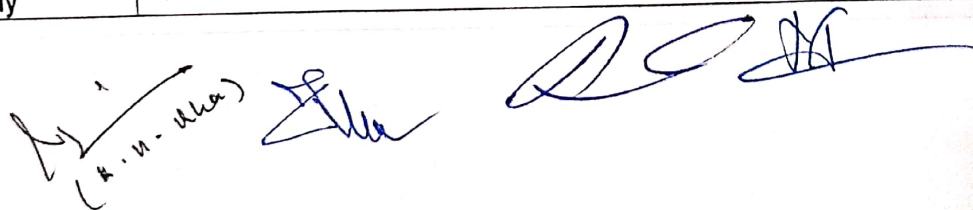
Suggested Readings:

- Jain SK, Sinha BK & Gupta RC (1991). Notable Plants in Ethnomedicine of India. Deep Publications, New Delhi.
- Chowdhery HJ & Murti SK (2000). Plant Biodiversity and Conservation in India: An Overview. Bishen Singh, Mahendraçal Singh, Dehradun.
- Jain SK (1991). Contribution of Indian Ethnobotany. Scientific Publishers, Jodhpur.
- Singh VK & Abrar MK (1990). Medicinal Plants and Folkories. Today & Tomorrows Printers&&Publishers, New Delhi.
- Ghosh, AK (2008). A Comprehensive Handbook on Biodiversity, TERI, New Delhi.



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Credits=04	Group-A	Optional	Paper-IV(Theory) Min Passing Marks:25
Maximum Marks:75			
Sem-III; 3.4	<p style="text-align: center;">Unit-I</p> <p>Soil: Its origin & development, process of soil formation and soil profile. Soil properties in relation to plant growth, Calcification, Podsolization and laterization.</p> <p style="text-align: center;">Unit-II</p> <p>Physical Properties of soil: Texture, Structure, Density, Porosity and Permeability of soil. Soil -water energy concept, soil water quantities & their measurement</p> <p style="text-align: center;">Unit-III</p> <p>Soil chemical properties: Chemical nature of soil, soil solution and nutrients, soil pH, Cation exchange phenomenon, Acidity, alkalinity and Salinity of soil Soil organisms: Process of humification and mineralization, microorganisms and their roles to higher plants, Soil erosion and conservation.</p> <p style="text-align: center;">Unit-IV</p> <p>Plant geography: Distribution Patterns, Barriers, endemic. Concept of hotspot, age area hypothesis, Vegetational & floristic region of India.</p>		
Suggested Readings:			
1. N.C. Brady & R.R. Weil "The Nature and Properties of Soils".			
Credits=04	Optional	Paper-V(Theory) Minimum Marks:25	
Maximum Marks:75			
Sem-III; 3.5.	<p style="text-align: center;">Unit-I</p> <p>Microbes in the production of alcohol, beer, wine and vinegar, Commercial production of antibiotics, therapeutics vaccines, biopesticide.</p> <p style="text-align: center;">Unit-II</p> <p>Soil Microbiology: Decomposition of organic matter in soil, cycling of essential elements in nature, biofertilisers, Microorganism in food processing, Cheese, butter, milk and bread.</p> <p style="text-align: center;">Unit-III</p> <p>Microorganisms in relation to biotechnology: Microbes and bioremediation, production of alcohol, beverages, organic acids, vitamins, antibiotics and enzymes.</p> <p style="text-align: center;">Unit-IV</p> <p>Role of Microorganism in sewage disposal and alternative source of energy, Microorganism and maintenance of environment.</p>		
Suggested Readings:			
1. Pelizar MJ, Chan ECS&Krig NR (1993). Microbiology, McGraw Hill Book Co., New York			
2. Purohit SS (1998). Microbiology: Fundamentals and Applications, Agrobotanica, Bikaner			
3. Razdan MK (1993). An Introduction of Plant Tissue Culture. Oxford & 1BH, New Delhi.			
4. Richard M, Twyman & Wisden W (1999). Advanced Molecular Biology, Viva Books Pvt. Ltd.			
5. Roy SC & Kumar KDC (1977). Cell Biology, New Central Book Agency, Calcutta.			
6. Sharma AK & Sharma A (1980). Chromosome Techniques. Theory and Practice, Butterworth.			
7. Thorpe TA (1995). In Vitro Embryogenesis in Plant. Kluwer Publishers, Dordrecht.			
8. Trever G, Faull J, Ketteridge S& Springham D (1995). Introductory Microbiology, Chapman & Hall, London			
Credits=04	Optional	Paper-VI(Theory) Minimum Marks:25	
Maximum Marks:75			
Sem-III; 3.6.	<p style="text-align: center;">Unit-I</p> <p>Origin of cultivated plants; various centre of origin criteria and various centre of origin. Origin and cultivation of wheat, rice, Maize, sugarcane, mustard and potato.</p> <p style="text-align: center;">Unit-II</p> <p>Spices and flavoring materials, vegetables, Gum and dye yielding plants, Latex yielding plants, Tea Coffee,</p>		
Economic Botany			



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rubber and insecticide yielding plants. Wood: Types, Porous and non-porous with special reference to Sal, Sheeshan, Teak and Pine wood and their distribution in India. Masticatories and Fumitories: Betel, Kaltha, Supari, Tobacco and Opium and its derivatives like Brown sugar and Hashish and Cannabis.	Unit-III Unit-IV		
Suggested Readings: 1. Encyclopedia of Plant and Crop Science by Robert M. Editor (Goodman)			
Credits=04	Compulsory	Minimum Marks:25	Paper-VII (Practical-II)
Maximum Marks:75			
Laboratory Exercises corresponding to the Theory courses.			
Sem-III: 3.7.	Compulsory	Minimum Marks: 35	Paper-VIII
Credits=04			
Maximum Marks:100			
Sem-III: 3.8.			
Major Research Project			

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CHOICE BASED CREDIT SYSTEM (CBCS)
M.Sc. Second Year (Semester-IV)**

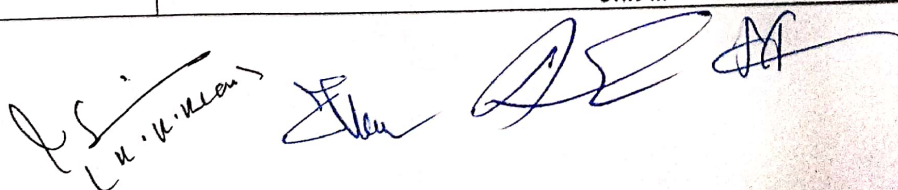
Credits=04		Group-A	Optional	Paper-I (Theory)	Minimum Marks:25
Maximum Marks:75		Unit-I			
Sem-IV; 4.1.					
Concept and Scope of Ecology: The environment interaction of factors and ecological niche, Plant communities' dynamics and development succession and climax, ecological adaptation and plant indicators.					
Unit-II					
Population ecology, natality, mortality, survivorship and growth curves, biotic potential, carrying capacity and environmental resistance, r & K selection.					
Unit-III					
Ecosystem: Concept of ecosystem, trophic structure, food chain, energy flow, productivity and energy subsidy, Biological diversity and mega diversity countries.					
Unit-IV					
Green house effect, Climate change and global warming, Ozone depletion and acid rain, Environmental pollution and its control (Water, Air and Noise)					
Plant Ecology					
Suggested Readings:					
1. Pierzynski GM, Sims JT & Vance GF (2005). Soils and Environmental Quality. CRC, London.					
2. Perk M (2006). Soil and Water Contamination from Molecular to Catchment Scale. Taylor & Francis. The Netherland.					
3. Coley D (2008). Energy & Climate Change. John Wiley & Sons. London.					
4. Tanez JG, Hernandez-Esparza M, Dorla-Serano C, Fregoso-Infante A & Singh MM (2007). Environmental Chemistry. Fundamentals. Springer.					
5. Suresh G (2007). Environmental Studies and Ethics. IK International New Delhi. Asia, Pvt. Ltd.					
6. Odum EP & Barrett GW (2005). Fundamentals of Ecology. V Edn, Thomson Cambridge University Press.					
7. Chapman JL & Reiss MJ (1995). Ecology Principles & Applications. Cambridge University Press.					
8. Brady, NC. The nature and properties of soils. Prentice, Hall of India Pvt. Ltd.					
Credits=04		Group-A	Optional	Paper-II (Theory)	Minimum Marks:25
Maximum Marks:75					
Sem-IV; 4.2.					
Unit-I					
Distribution of water resources, Lentic and Lotic Water bodies, Aquifers, Hydrological cycle, catchment infiltration, water shed management					
Unit-II					
Physico-chemical properties of fresh water, water quality Parameter and standards. Water pollution and its sources, ground water.					
Unit-III					
Water stress adaptation in plant, Role of plants in water management, Water borne diseases, water management strategies, management of ground water, rain water harvesting,					
Unit-IV					
Recharging of ground water, recycling of waste water.					
Water prevention and control of pollution, Treatment technologies, Treatment of drinking water (Ion exchange, Reverse osmosis and water disinfection), Treatment technology, Domestic waste water treatment.					
Water Resource Management					
Suggested Readings:					
1. Ghosh, AK (2008). Simplifying Climate Change. TERI, New Delhi.					
2. Sampson, Garey P (2005). The WTO and Sustainable Development, TERI, New Delhi.					
3. Somayaji & Somayaji G (2009). Environmental Concerns and Sustainable Development. TERI, New Delhi.					
4. Saikia, Ranjane (2009). Making Sense of Climate Change. TERI, New Delhi.					
5. Lovejoy TE & Hannah L (2005). Climate Change and Biodiversity. TERI, New Delhi.					

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Credits=04	Group-B	Optional	Paper-III(Theory) Minimum Marks:25
Environment management & Technology Sem-IV; 4.3. Maximum Marks:75	<p style="text-align: center;">Unit-I</p> Basics of Environmental Science: Origin of Earth, Biotic-abiotic interaction, Decline in Biodiversity and the consequences. Environmental Phenomenon and Episodes: Ozone layer depletion, Climatic change. Occupational Health Hazards: Silicosis, Asbestosis, Carcinogens, Mutagens, Teratogens and Toxicity of Heavy Metals.		
<p style="text-align: center;">Unit-II</p> Non-conventional Energy: Hydrogen, Alcohol, Bio-diesel, Wind and Solar energy Water Management Technologies: Hydrological cycle, Water quality standards, Major sources of water pollution, basics of ground and surface water, Analysis of selected Physico-chemical properties of water (DO, BOD, COD, Nitrate, Phosphate, Chloride, pH, Acidity, Alkalinity, Turbidity, Electrical Conductivity, Temperature), Eutrophication and Aquaculture.			
<p style="text-align: center;">Unit-III</p> Air Quality Monitoring and Management: Composition of air, Major sources of air pollution. Indoor air pollution, Monitoring of SO _x , NO _x and O ₃ Solid Waste Management Technologies: Sources of solid waste, Solid waste disposal, Vermicomposting, R3 Principle, Noise Pollution and Abatement: Sources of noise pollution, Noise standards, Biological and behavioral effects of noise pollution.			
<p style="text-align: center;">Unit-IV</p> International Agreements on Environment: Treaties and Protocols of United Nations Conference on Human Environment-UNCHE (Stockholm, 1972), United Nations. Conference on Environment and Development- UNCED (Rio de Janeiro, 1992), World Summit on Sustainable Development- WSSD (Johannesburg, 2002). Environmental Legislation: Powers and functions of Central and State Pollution Control Boards, Wildlife Protection Act 1972, The Water (Prevention and control of pollution) Act 1974, Prevention and Control of Air Pollution Act 1981.			
<p>Suggested Readings:</p> <ol style="list-style-type: none"> 1. Magill, PL., Holden, ER. & Ackley, C (1956). Air pollution Hand Book. MC Graw-Hill Book Co. 2. Coley, D. (2008). Energy & climate change, John Wiley & Sons. London. 3. Null, Air Pollution and plant life 4. Saxena, MM. Environmental analysis water soil and air 5. Fulekar, M. H. Environmental Biotechnology 6. Sawicki, E. Handbook of environmental genotoxicology 7. Lyons, J. J. Principles of air pollution meteorology 8. Mc Caul, J. Water Pollution 			
Credits=04	Group-B	Optional	Paper-IV(Theory) Minimum Marks:25
Cytogenetics Plant Breeding Sem-IV; 4.4. Maximum Marks:75	<p style="text-align: center;">Unit-I</p> Basic of Cytogenetics and their concepts: Cell Cycle and architecture of chromosomes in prokaryotes and eukaryotes, Chromonemata, chromosome matrix, chromomeres, centromere, telomere, artificial chromosome construction, Karyotyping, Chromosome banding and painting- In situ hybridisation and various application., Chromosomes variation and their implications, Ploidy.		
<p style="text-align: center;">Unit-II</p> Applications of Cytogenetics :Fertilization in crop plant and their barriers, Role of polyploids and aneuploids in crop breeding, Evolutionary and genetic problem in crops, Synthesis of new crops (Wheat, Paddy, Cotton, Brassica) and hybridisation between different species, Production of haploid and dihaploids and doubled haploids in crop breeding.			
<p style="text-align: center;">Unit-III</p>			



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Biostatistics	Measure of central tendency, Data analysis and Graphs, Binomial, Poisson and normal probability distribution, Chi-sq test and Null hypothesis, Parametric and Non-parametric statistics.
	Unit-IV
	T-test, Z-test, U-test and F-test, Regression and correlation and ANOVA, Standard deviation, Variance, Sampling distributions and Errors.

Suggested Readings:

1. Razdan MK (1993). An Introduction of Plant Tissue Culture. Oxford & 1BH, New Delhi.
2. Clark MS, Wall WJ (1996) Chromosomes: The Complex Code, Chapman & amp; Hall, London.
3. Sharma AK, Sharma A (1985) Advances in Chromosome and Cell Genetics, Oxford & IBH Publishing Co, Kolkata.
4. Krebs JE, Lewin B, Goldstein ES (2011) Genes X, Sudbury, Massachusetts.
5. Gupta PK (2007) Cytogenetics, Rastogi Publication, Meerut.
6. Gardner EJ, Simmons MJ, Snustad DP (2006) Principals of Genetics, 8th edition, John Wiley & amp; Sons, Wiley India Edition.
7. Alberts B, Bray D, Lewis J, Ralf M, Roberts K, Watson JD (1999) Molecular Biology of the Cell, Garland Publishing Inc, New York.
8. Allard RW (1999) Principles of Plant Breeding, 2nd edition, John Wiley and Sons, New York.
9. Hartl DL, Jones EW (2007) Genetics—Analysis of Genes and Genomes, 7th edition, Jones and Barlett publishers, Burlington.
10. David CA, et al., (2007) Epigenetic, 2nd edition, Cold Spring Harbor Laboratory Press, New York.
11. Spillane C, McKeown PC (2014) Plant Epigenetic and Epigenomics: Methods and Protocol, Springer Publisher, London.
12. Thorpe TA (1995). In Vitro Embryogenesis in Plant. Kluwer Publishers, Dordrecht.
13. Evans DA, Sharp WR & Amirato PY (1986). Handbook of Plant Tissue Culture Macmillan Publishing Company. New Yo.
14. Daniel W (1977). Biostatistics, John Wiley, New York.
16. Khan, IA & Khanum, A (1994). Fundamentals of Biostatistics. Ukaaz Publications, Hyderabad.

Credits=04	Group-C	Optional	Paper-V (Theory)
			Minimum Marks: 25

Maximum Marks:75

Sem-IV; 4.5.

Computer Application & Bioinformatics

Unit-I

Computer Fundamentals and programming Languages, Role of super computer in biology.

Unit-II

Historical background and scope of Bioinformatics, Transcriptomics and Proteomics, Metabolomics.

Unit-III

Data generation and data retrieval, generation of data, gene sequencing, Mass spectrometry, Microarray, Drug aided design, structure based and ligand based approaches, Molecular phylogeny, system biology and functional biology.

Unit-IV

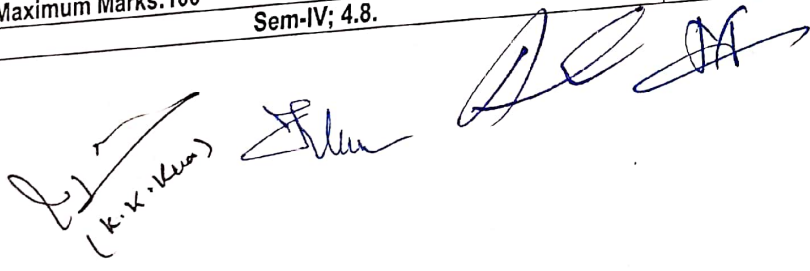
Primary nucleotide sequence databases- EMBL, Gene bank, DDBJ. Protein sequence data bases- Swissprot/TrEMBL, PIR, Sequence motif data bases- Pfam, PROSITE. Dynamic Programming BLAST and FASTA, Phylogenetic analysis.

Suggested Readings:

1. Computer Fundamental: B.Ram
2. Fundamental of Information Technology: Leon & Leon
3. MS Office: BPB Publication
4. A First course in Computers: sanjay Saxena
5. Computer Networks, Acme Learning: Anurajan Mishra
6. Gupta SP (1969). Statistical Methods, Sultan Chand & Sons, New Delhi.
7. Sundar Rao PSS & Richard J (1999). An Introduction to Biostatistics. A Manual for Students in Health Sciences, Prentice Hall of India Pvt. Ltd., New Delhi.

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8. Rao S.S (1999) Networking Scenario in India New Lib-world 100(4) 160-68			
9. Schena, M.2003. Microarray Analysis John Wiley Publication New York.			
10. Prevsner, J.2005. Bioinformatics & Functional Genomics John Wiley & sons new jersey.			
Credits=04	Group- C	Optional	Paper-VI(Theory) Minimum Marks:25
Maximum Marks:75	Unit-I		
Sem-IV; 4.6.	Human evolutionary dependence on forest: scope and relevance; forest types of India; Ecological morphology of rain forest flora		
Forest Ecology	Unit-II		
	Structure of forest ecosystem: Photosynthetic efficiency; leaf area and growth Nutrient cycling in tropical forest ecosystems.		
	Unit-III		
	Reproductive strategy of tropical trees; Natural and artificial regeneration; Factor destructive to forest ecosystems; causes and effects of deforestation systems; Role of trees in combating air pollution.		
Unit-IV			
Physico-chemical properties of forest soil; ecological significance of soil texture; soil biology and soil fertility, Comparison of forest and grassland. Accumulation and decomposition of forest litter; forest humus; the geochemical and biogeochemical cycling of nutrients.			
Suggested Readings:			
1. Odum EP & Barrett GW (2005). Fundamentals of Ecology. V Edn, Thomson Asia, Pvt. Ltd.			
2. Chapman JL & Reiss MJ (1995). Ecology Principles & Applications. Cambridge University Press.			
3. Brady, NC, The nature and properties of soils, Prentice, Hall of India Pvt. Ltd.			
Credits=04	Compulsory	Paper-VII (Practical-IV) Minimum Marks:25	
Maximum Marks:75	Laboratory Exercises corresponding to the Theory courses.		
Sem-IV; 4.7.	Compulsory		
Credits=04	Minimum Marks: 35		
Maximum Marks:100	Major Research Project		
	Sem-IV; 4.8.		



 (K.K. Sharma)

MINOR

Minor Syllabus For Botany
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Unit-I

- Cell: Cell Structure and functions
- Cell: The Unit of life.
- Biomolecules
- Cell Cycle and Cell Division

Unit-II

- Morphology of flowering plants
- Anatomy of flowering plants
- Floral Characters.
- The Inflorescence
- Types of leaves

1st Paper

Unit-III


- Photosynthesis in higher plants.
- Respiration in plants.
- Ecosystem: Biodiversity and Conservation.


2nd Paper


Unit-IV

- Plant growth and development
- Mineral Nutrition of its transport
- Biotechnology and its application

श्री विक्रम नन्द
16.08.23


(T. Ahmad)
HEAD
Department of Botany
Sri Sri National College
Azamgarh


(Mirza Faish Beg)


ABDULLA