Semester-I

Undergraduate Certificate in Botany

GENERIC ELECTIVE (GE)- Plant Cell Biology

No. of Hours- 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Plant Cell Biology	**4**	**4**	**0**	**0**	**Passed Class** XII	**Nil**

UNDERGRADUATE CERTIFICATE IN BOTANY		
Programme : ***Undergraduate Certificate in Botany***	**Year: I**	**Semester: I**
Subject: Botany		
Course: BOT GE 1	**Plant Cell Biology**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the plant cell structure and its function.
2. Understand the various cell components and the general principles in cell communication and interaction.
3. Study the structure and genome organization of chloroplast and mitochondria.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Principles of microscopy, cell theory, structural organization of the plant cell and its chemical composition, Cell wall structure and function.	**15**
2	Plasmamembrane, models, structures and functions, Cytoskeleton, organization and role of microtubules and microfilaments.	**15**
3	Structure and functions of nucleus, endoplasmic reticulum, golgi apparatus, ribosomes, lysosomes and glyoxysomes, chloroplast and mitochondria.	**20**
4	Demonstration of types of cells and different cell organelles through slides/photographs .	**10**

Suggested Readings

- Alberts, B., Hopkin, K., Johnson, A., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2019). Essential cell biology (5th ed.). W. W. Norton & Company, Inc.
- Rastogi, V. B. Cell Biology. Medtech Science Press: A Division of Scientific International.
- Verma, P.S. and Agrawal, V. K.. Cell Biology. (2016) S. Chand and Company, New Delhi.

Semester-II

Undergraduate Certificate in Botany

GENERIC ELECTIVE (GE)- Plant Science – I

No. of Hours- 60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Plant Science – I	**4**	**4**	**0**	**0**	**Passed Class**	**Nil**

UNDERGRADUATE CERTIFICATE IN BOTANY		
Programme : ***Undergraduate Certificate in Botany***	**Year: I**	**Semester: II**
Subject: Botany		
Course: BOT GE 2	**Plant Science – I**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Develop understanding about the classification and diversity of different microbes (viruses, Algae, Fungi & Lichens) and their economic and ecological importance.
2. Understand the structure and reproduction of certain selected bacteria, algae, fungi and lichens.
3. Develop critical understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms.
4. Understand the basic concepts of plant taxonomy.
5. Understand plant morphology, anatomy and embryology.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Microbes: General characteristics, economic and ecological importance of bacteria andviruses. Algae: General characteristics; range of thallus, reproduction and economic importance Fungi: General characteristics, reproduction, ecology and significance.	**15**
2	Bryophytes: General characteristics, reproduction and economic importance. Pteridophytes: General characteristics, ecological and economic importance. Gymnosperms: General characteristics, ecological and economic importance. Introduction to Plant taxonomy, ICN, Herbarium and botanical garden.	**20**
3	Plant Embryology: Embryo, types of ovules and embryo sacs; endosperm; types of endosperm; dicot and monocot embryo, pollination, fertilization. Plant Anatomy: Types of tissues, root and shoot apical meristems, simple, complex and secretary tissues, structure of dicot and monocot root, stem and leaf.	**15**
4	Demonstration of representative specimens of each group. Demonstration of types of embryo, ovules and cells through slides/photographs.	**10**

Suggested Readings

- Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, 4th edition. Singapore, John Wiley and Sons (Asia).
- Kumar, H.D. (1999). Introductory Phycology, 2nd edition. Delhi, Delhi: Affiliated East-West. Press Pvt. Ltd.
- Bhatnagar, S.P., Moitra, A. (1996). Gymnosperms. New Delhi, Delhi: New Age International (P) Ltd Publishers.
- Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Prayagraj: U.P.: Central Book Depot.

- Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. San Francisco, U.S.A: Pearson Benjamin Cummings.
- Raven, P.H., Evert, RF., Eichhorn, S.E. (1999). Biology of Plants. New York, NY: W.H.Freeman and Company Worth Publishers.
- Singh, G. (2012). Plant Systematics: Theory and Practice, 3rd edition. Oxford and IBH Pvt.Ltd. New Delhi.

Semester-III

Undergraduate Diploma in Botany

No. of Hours- 60

Generic Elective: Plant Science – II

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Plant Science – II	**4**	**4**	**0**	**0**	**Passed Class**	**Nil**

UNDERGRADUATE DIPLOMA IN BOTANY		
Programme : ***Undergraduate Diploma in Botany***	**Year: II**	**Semester: III**
Subject: Botany		
Course: BOT GE 3	**Plant Science – II**	

Course Outcomes:

After the completion of the course the students will be able to

1. Understand the basic biochemical and physiological process in plants.
2. Understand the fundamentals of plant tissue culture techniques used in molecular biology.
3. Understand the concept of biodiversity and its conservation.
4. Understand the concepts of plant breeding methods and crop evolution.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Plant Physiology and Biochemistry: Photosynthesis, respiration, nitrogen fixation, carbohydrates, proteins, lipids and secondary metabolites.	**15**
2	Plant Biotechnology: Plant tissue culture, recombinant DNA technology and techniques used in molecular biology. Plant breeding methods and evolution of major crop plants, economics and utilization of plant resources.	**15**
3	Biodiversity and Conservation: Species, population, ecosystem, ecological succession, environmental pollution, biodiversity, In situ and ex situ conservation, International Union for Conservation of Nature (IUCN), Climate change and its consequence.	**15**
4	To test the presence of protein, carbohydrate and lipids in given sample. Preparation of MS medium for tissue culture. Visit to some in-situ and ex-situ conservation sites.	**15**

Suggested Readings

- Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. NarosaPublishing House, New Delhi.
- Frankel O.H, Brown A.D.H. and Burdon J.J. (1995). The Conservation by Plant Diversity Technical guidelines for the site movement of Germplasm (1989) by FAO IBPGR.
- Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley andSons, U.S.A. 4th Edition.
- Kochhar S.L. (2016). Economic Botany. Cambridge University Press, London.
- Pandey, B.P. (1999). Economic Botany. S. Chand, New Delhi.
- Paroda R.S. and Arora R.K. (1991). Plant genetic resources Conservation and Management. International Board for Plant Genetic

Resources, (IBPGR), Rome, (Italy)

- Shantharam, S. and Montogmery, J.F. (1999). Biotechnology, Biosafety and Biodiversity. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
- Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
- Taiz, L., Zeiger, E., (2014). Plant Physiology. Sinauer Associates Inc., U.S.A. 6th Edition.
- Vasil, I.K. and Thorpe, T.A (1994). Plant Cell and Tissue Culture. Kluwer Academic Publishers, Netherlands.

Semester-IV

Undergraduate Diploma in Botany

Generic Elective: Inheritance in Plant Biology

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Inheritance in Plant Biology	**4**	**4**	**0**	**0**	**Passed class**	**Nil**

UNDERGRADUATE DIPLOMA IN BOTANY		
Programme : ***Undergraduate Diploma in Botany***	**Year: II**	**Semester: IV**
Subject: Botany		
Course: BOT GE 4	**Inheritance in Plant Biology**	

Course Outcomes:

After the completion of the course the students will be able to

1. Understand the concepts and principles of inheritance and sex determination.
2. Students will get familiarized with causal agents of genetic changes (mutations).
3. Learn how genetic information is used to detect diseases and also to establish unique identity of an individual.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Chromosomal Inheritance: Principles of Mendelian inheritance, Incomplete dominance and co- dominance; Multiple allelism; lethal alleles; Linkage and crossing over. Extra-chromosomal Inheritance: Chloroplast Inheritance, Cytoplasmic inheritance.	**15**
2	Chromosome structure and alternations in chromosome: Structural alterations in chromosome: duplication, deficiency, inversion and translocation Numerical alterations in chromosome: Euploidy, Aneuploidy and Polyploidy.	**20**
3	Mutation: spontaneous and induced mutation; physical and chemical mutagens; Consequences of mutation.	**15**
4	Demonstration of different stuructures of chromosomes and changes in chromosome structure	**10**

Suggested Readings

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, 8th edition. New Delhi, Delhi: John Wiley & sons.

- Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2020). Introduction to Genetic Analysis, 12th edition. New York, NY: W.H. Freeman and Co.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2020). Concepts of Genetics, 12th edition. San Francisco, California: Benjamin Cummings.
- Campbell, N.A., Urry,L.A., Cain, M.L., Wasserman,S.A., Minorsky, P.V., Reece, J.B. (2020). Biology, 12th Edition. Harlow,England : Pearson

Semester-V

Bachelor of Science in Botany

Generic Elective: Medicinal Plants of Uttarakhand

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Medicinal Plants of Uttarakhand	**4**	**4**	**0**	**0**	**Passed Class**	**Nil**

BACHELOR OF SCIENCE IN BOTANY			
Programme : ***Bachelor of Science in Botany***		**Year: III**	**Semester: V**
Subject: Botany			
Course: BOT GE 5	**Medicinal Plants of Uttarakhand**		

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the diversity and distribution of medicinal plants in Uttarakhand
2. Study the techniques/methods for the sustainable utilization of the medicinal plants.
3. Understand the economic importance of medicinal plants of Uttarakhand.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	General idea of Indian systems of medicine (Ayurveda, Siddha, Unani, Tibetan, Yoga and Naturopathy) and the traditional medicinal system of Uttarakhand. Brief history, prospects and uses of important medicinal plants of Uttarakhand Himalaya, scope and importance of medicinal plants, challenges in medicinal plant sector.	**20**
2	Diversity, distribution, assessment and indigenous uses of threatened medicinal plants of Uttarakhand. Collection and processing of medicinal plants; methods for documentation of traditional medicine knowledge.	**15**
3	Promotion of medicinal plant sector at national level: National Medicinal Plant Board and State Medicinal Plant Boards - objectives and functions. Other organizational initiatives for promotion of MAPs at National and International levels. Demand and supply of medicinal plants. Conservation, threats, IUCN Red list criteria and management of threatened medicinal plants of Uttarakhand.	**15**

4	Demonstration and identification of some important medicinal plants	**10**

Suggested Readings

- Anonymous. (2014). Herbal Wealth of Uttarakhand Vol. I & II. Central Council for Research in Ayurvedic Sciences, New Delhi.
- Arber, A. (1999). Herbal plants and Drugs. Mangal Deep Publications.
- Arya, D., Joshi, G.C. and Tewari, L.M. 2018. Crude drugs plants of Uttarakhand. Indu Book Services Pvt. Ltd. (Publishers & Distributors) New Delhi.
- Bhatt, D., Joshi, G.C., Tewari, L.M. and Pandey, N.C. (2020). Traditional Medicinal Systems and Threatened Medicinal Plants of Kumaun, Western Himalaya, India. Indu Book Services Pvt. Ltd. (Publishers & Distributors) New Delhi.
- Chhetri, D.R. (2015). Medicinal Plants of the Himalaya: Production Technology and Utilization. Agrobios (India).
- Chopra, R.N., Nayar S.L. and Chopra, I.C. (1956). Glossary of Indian Medicinal Plants, C.S.I.R, New Delhi.
- Kala, C.P. (2010). Medicinal Plants of Uttarakhand: Diversity, Livelihood and Conservation, Biotech Books.
- Pandey, P.C., Tewari, L. and Pande, H.C. (2006). Folk Medicine and Aromatic Plants Of Uttaranchal, Bishen Singh Mahendra Pal Singh, Dehradun.
- Sah, R. (2004). Nature's Medicinal plants of Uttarakhand: Herbs, Grasses and Ferns. Vol. II. Gyandodaya Prakashan, Nainital.
- Sah, R. (2004). Nature's Medicinal plants of Uttarakhand: Tree, shrubs and Climbers. Vol. I. Gyandodaya Prakashan, Nainital.
- Tewari, L.M., Singh, N., Upreti, K. and Pangtey, Y.P.S. (2008). Medicinal Plants of Ranikhet Consul Book Depot, Nainital.

Semester-VI

Bachelor of Science in Botany

GENERIC ELECTIVE (GE): Global Climate Change

No. OF Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Global Climate Change	**4**	**4**	**0**	**0**	**Passed Class**	**Nil**

BACHELOR OF SCIENCE IN BOTANY		
Programme : ***Bachelor of Science in Botany***	**Year: III**	**Semester: VI**
Subject: Botany		
Course: BOT GE 6	**Global Climate Change**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the global climate changes and global warming.
2. Learn about the measures being taken for the mitigation of climate changes.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	General concept of Global climate change, Impact of global warming and climate change, Greenhouse effect, Greenhouse gases, Carbon foot print, Carbon trading, Carbon sequestration.	**15**
2	Introduction to climate change adaptation, Mitigation strategies for global warming, International initiative for mitigating global climate changes; Inter governmental panel on climate change (IPCC); United Nation Framework convention on Climate change (UNFCCC).	**15**
3	Climate change policy and international solutions, Conference of Parties (COP), Kyoto protocol; Montreal protocol; Paris Pact; India's initiatives for mitigating climate change.	**15**
4	To assess the carbon foot print and carbon sequestration potential opf different forest types.	**15**

Suggested Readings

- Singh, S., Singh, P., Rangabhashiyam, S. and Srivastava, K. K. (2021). Global Climate Change, Elsevier.
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Company Pvt. Ltd., New Delhi.
- Mathez, E. A. and Smerdon, J. (2009). Climate Change- The Science of Global Warming and Our Energy Future, Columbia University Press.

Semester VII

GENERIC ELECTIVE (GE)- MOLECULAR BIOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Molecular Biology	**4**	**4**	**0**	**0**	**Bachelor of Science in Botany**	**Nil**

BACHELOR IN BOTANY WITH HONOURS		
Programme : ***Master of Science in Botany***	**Year: IV**	**Semester: VII**
Subject: Botany		
Course: BOT GE7	**Course Title: Molecular Biology**	

Course outcomes:

After the completion of the course the students will be able to

1. Learn the structure and function of nucleic acids at molecular level.
2. Understand the concept of central dogma and genetic code.
3. Learn molecular details of DNA replication and its types.
4. Understand transcription and translation including post-transcriptional and post-translational modifications of transcripts and polypeptides/proteins

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Nucleic acids as carriers of genetic information : Experiments that established nucleic acids (DNA & RNA) as the carrier of genetic information: Griffith's, Hershey & Chase, Avery, McLeod & McCarty and Fraenkel-Conrat's experiment. Structure and organization of the genetic material : DNA double helix structure (Watson and Crick model); salient features of DNA double helix. Types of DNA: A, B & Z conformations, denaturation and renaturation (only melting profile- Tm), types of RNA (mRNA and rRNA, tRNA).	**12**
2	Central Dogma and Genetic Code : The Central Dogma, Genetic code and its salient features, Experiments for deciphering Genetic code (Experiments by Nirenberg & Metthaei and Har Gobind Khorana). Replication of DNA : Mechanism - initiation, elongation and termination; Enzymes and other proteins involved in DNA replication; General principles – bidirectional, semiconservative and semi discontinuous replication (Replisome), RNA priming (Primase & Primosome); Various modes of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA. Replication of the 5'end of linear chromosome (end replication problem & Telomerase).	**20**
3	Mechanism of Transcription : Transcription process in prokaryotes (Initiation, Elongation and Termination); structure and function of RNA polymerase enzyme; concept of promoters and transcription factors; major differences between prokaryotic and eukaryotic transcription; concept of post	**20**

	transcriptional modifications (eukaryotic mRNA processing: 5' capping; 3' tailing). Mechanism of Translation : Translation in prokaryotes: Initiation, Elongation and Termination; concept of charging of tRNA and role of aminoacyl synthetases; ribosome structure and assembly (in prokaryotes and eukaryotes); major differences between prokaryotic and eukaryotic translation; post-translational modifications (concept of phosphorylation, glycosylation-briefly).	
4	Demonstration of double helical structure of DNA, replication, transcription and translation with 3-D structure through power point presentation	**8**

Suggested Readings

- Lodish, H., Berk, A., Zipursky, S.L. Maztsudaira, P., Baltimore, Dand Darnell, l. (2016). Molecular Cell Biology (8th Edition). W.H. Freeman and Co., New York, USA.
- Alberts, B., Bray,D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. (2014). Molecular Biology of the Cell. Garland Publishing Inc., New York.6th edition.
- Watson, J.D. (2013). Molecular Biology of the Genes, Banjamin.7th Edition.
- Wolfe, S.L. (1993).Molecular and Cellular Biology. Wadsworth Publishing Co.California.
- Stent, G.S. (1986).Molecular genetics. Bishen Singh Mahendra Pal Singh, Dehradun.
- Barry, J.M. and Barry. B.M. (1973). Molecular Biology, Prentice Hall of India. New Delhi.

Semester VII

GENERIC ELECTIVE (GE)- FUNDAMENTALS OF BIOCHEMISTRY

No. of Hours- 60

CREDITDISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Fundamentals of Biochemistry	**4**	4	0	0	**Bachelor of Science in Botany**	**Nil**

BACHELOR IN BOTANY WITH HONOURS		
Programme : ***Bachelor in Botany With Honours***	**Year: IV**	**Semester: VII**
Subject: Botany		
Course: BOT GE 8	**Course Title: Fundamentals of Biochemistry**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the structure, classification and functions of biochemical compounds.
2. Understand the structure, functions and biochemical pathway of secondary metabolites.
3. Understand the catalytic mechanism of enzymes, their inhibitors and regulation.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Carbohydrates: structure and function of monosaccharides oligosaccharides, polysaccharides, Glycolysis, Feeder pathway Lipids: Fat metabolism (simple lipids, compound lipids, derived lipids), fat metabolism, β-oxidation of fats.	**15**
2	Proteins: Amino acids, structure of primary, secondary, tertiary, quaternary proteins, Ramachandran plot, protein Sequencing. Secondary metabolites: Alkaloids, flavanoid, terpenoid and their biosynthetic pathway.	**15**
3	Enzymology: General aspects, allosteric mechanism ,regulatory and active sites, isozymes, kinetics of enzymatic analysis, Michaelis- Menten equation and its significance, enzyme inhibition (competitive, uncompetitive and non-competitive).	**20**
4	To test the presence of different substrates in given samples. To estimate R.Q. of different substrates.	**10**

Suggested readings

- Nelson, D. L. and Cox, M. M. (2021). Lehninzer. Principles of Biotechnology. Macmillan, 8th Edition.
- Srivastava,H.S.(2003).Elements of Biochemistry. Rastogi Publications, Meerut.
- Cooper, T.G.(1977).Tools in Biochemistry. Wiley New York.
- Bosch,C.(1972).Mechanism of Protein Synthesis and its Regulation. Elsevier Pub. Comp. N. York.
- Ribonsen,T.(1968).The biochemistry of Alkaloides Springer Verlog, Berlin
- Meister,A.(1965).Biochemistry of the Amino acids. 2vols. Academic Press, New York

Semester VIII

GENERIC ELECTIVE (GE) – METHODS IN PLANT BIOLOGY AND THEIR APPLICATIONS

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Methods in Plant Biology and their Applications	**4**	**4**	**0**	**0**	**Bachelor of Science in Botany**	**Nil**

BACHELOR IN BOTANY WITH HONOURS		
Programme : ***Bachelor in Botany with Honours***	**Year: IV**	**Semester: VIII**
Subject: Botany		
Course: BOT GE 9	**Course Title: Methods in Plant Biology and their Applications**	

Course outcomes: After the completion of the course the students will be able to:

1. Gain the knowledge of various techniques and instruments used for the study of plant biology.
2. Understand the principles and use of light, confocal and electron microscopy, Principles of centrifugation, spectrophotometry, chromatography, x-ray diffraction technique and chromatography techniques.

Credits: 4	**Generic Elective**
Max. Marks:	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Plants and Intelligence Introduction to plant Intelligence and memory - Historical perspective, Sensory Biology, Cell to cell communication, Self-recognition, Recognition of neighbors and relatives.	**15**
2	Principles of Microscopy Dissection and light and compound microscope, electron microscope (SEM and TEM), importance of sample preparation for microscopy, staining techniques, micrometry. Histo-chemical and Immuno techniques Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.	**20**
3	Biophysical Method Molecular analysis using UV/visible and fluorescence, spectrophotometer, circular dichroism, NMR and ESR spectroscopy, Molecular structure determination using X-ray diffraction and NMR, molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.	**15**
4	Demonstration of different instruments used in plant biology	**10**

Suggested Readings

- Trewavas A. (2017). The foundations of plant intelligence. Interface Focus 7: 20160098. http://dx.doi.org/10.1098/rsfs.2016.0098
- Wilson, K., Walker, J. (2018). Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
- Koller, D. (2011). The Restless Plant. Edited by Elizabeth Van Volkenburgh, Haward University Press, Cambridge, Massachusetts, and London, England.

Semester VIII

GENERIC ELECTIVE (GE) – TRADITIONAL KNOWLEDGE SYSTEM

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Traditional Knowledge System	**4**	**4**	**0**	**0**	**Bachelor of Science in Botany**	**Nil**

BACHELOR IN BOTANY WITH HONOURS		
Programme : ***Bachelor in Botany with Honours***	**Year: IV**	**Semester: VIII**
Subject: Botany		
Course: BOT GE 10	**Course Title: Traditional Knowledge System**	

Course outcomes: After the completion of the course the students will be able to:

1. Understand the concept, scope and importance of traditional knowledge.
2. Study the traditional knowledge systems of major tribal communities of Uttarakhand.
3. Explain the need for and importance of protecting traditional knowledge.
4. Interpret the concepts of Intellectual property in order to protect the traditional knowledge.

Credits: 4	**Generic Elective**
Max. Marks:	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Traditional knowledge: Introduction, nature and characteristics, scope and importance, Kinds of traditional knowledge (Unani/Siddha/Ayurveda), Indigenous Knowledge (IK), characteristics, traditional knowledge *vis-a-vis* indigenous knowledge, traditional knowledge of Uttarakhand. Protection of traditional knowledge: The need for protecting traditional knowledge Significance of TK Protection, value of TK in global economy, Role of Government to harness TK.	**20**
2	Traditional knowledge and intellectual property: Systems for protection of traditional knowledge, Legal concepts for the protection of traditional knowledge, Patents and traditional knowledge, Strategies to increase protection of traditional knowledge, Geographical Indications (GI).	**15**
3	Aspects of Biodiversity and Indian Traditions: Traditional knowledge of Uttarakhand: With special reference to food, agriculture and medicine. Tribal communities (Raji, Bhotia, Tharu and Boxa) of Uttarakhand: their culture and traditional knowledge on the uutilization of plants. Traditional Knowledge and it implication in modern society, Traditional Knowledge Digital Library (TKDL).	**15**
4	Methods of documenting uses of plants in traditional practices	**10**

Suggested readings

- Jha, A. (2009). Traditional Knowledge System in India,
- Kappor, K. (). Knowledge Traditions and Practices of India.
- Pande, P.C. Madhya Himalayi Sanskriti mein Gyan, Vigyan evam Paravigyan.
- Ram Reddy,S. Surekha ,M. and Krishna Reddy,V (2016). Biodiversity Traditional Knowledge Intellectual Property Rights .Scientific Publishers.
- Unnikrishna,P and Suneetha, M. (2012). Biodiversity, traditional knowledge and community health: strengthening linkages. Institute for Advanced Studies, United Nations University ,Tokyo.
- TKDL (www.tkdl.res.in) online resources.

Semester IX

GENERIC ELECTIVE (GE) – FOREST ECOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisiteof the course(if any)
		Lecture	Tutorial	Practical/Practice		
Forest Ecology	**4**	**4**	**0**	**0**	**Honours Degree in Botany**	**Nil**

MASTER OF SCIENCE IN BOTANY		
Programme : ***Master of Science in Botany***	**Year: V**	**Semester: IX**
Subject: Botany		
Course: BOT GE 11	**Course Title: Forest Ecology**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the structure and function of forest ecosystem.
2. Understand methods for studying vegetation, community pattern and processes, ecosystem function, biodiversity, carbon stock and carbon sequestration.
3. Understand the students to understand the linkage between humans and forests.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	General Aspects of Forests: Forest ecology and forest ecosystems, Importance of forests in environmental conservation Primary Productivity and Detritus Pool; Formulations of Primary Productivity: Photosynthetic pathways and their significance; Allocation of Net primary production and biomass accumulation; Measurement of biomass and primary productivity in forest ecosystems of the world; Plant biomass and turnover; Human Use of productivity.	15
2	Litter fall in Forest Ecosystems; determining litter fall, factors affecting it; Forest litter: type of litter; Coarse Woody debris; forest floor litter mass. Detritus Pathway of Energy Flow and Decomposition Processes: Decomposer organisms and their trophic interactions; decomposition processes; Measurements of Litter decomposition; decomposition rate. Nutrient cycling in forest ecosystems: nutrient cycle models in forest ecosystem. Nutrient supply and uptake , Role of mycorrhizae in nutrient cycling; Nutrient concentration and storage in vegetation.	15
3	Succession: Overview on forest succession with focus on Himalayan forest ecosystem; Attributes of species of different successional stages Major forest types of forest India: Forest classification of India; Forest of Himalaya with particular reference to Sal, Pine and Oak forests.	20

	Global climate changes and forests. Man and forest: Commercial exploitation of forest, shifting agriculture; settled agriculture; structure and functioning of Central Himalayan Agroecosystem. Regeneration status of major forest trees with respect to acute vs. chronic human disturbance; Shifting cultivation practices.	
4	Assessment of forest biomass, carbon sequestration, primary productivity and regeneration pattern of different forests.	10

Suggested readings

- Bir, S.S. and Chatha, G.S. (1988). Forest Vegetation Characteristics of Indian Hills. Today and Tomorrow's Printers & Publ., New Delhi.
- Misra, R. (1968). Ecology Work Book. Oxford & IBH Publishing Co. New Delhi.
- Puri, G.S., Meher-Homji V.M., Gupta R.K. and Puri R.K. (1960). Forest Ecology. Oxford and IBH Pub.Co. Pvt. New Delhi.
- Singh, J.S. and. Singh, S.P. (2014). Forest of Himalaya: structure, Function and Impact of Man. Gyanodaya Prakashan, Nainital, India.
- Singh, J.S. Singh S.P. and Gupta, S.R. (2014). Ecology, Environment and Resource Conservation. S. Chand and Compony Pvt. Ltd., New Delhi.
- Waring, R.H. and Schlesinger, W.H. (1985). Forest Ecosystems: Concepts and Management. Academic Press, New York.

Semester IX

GENERIC ELECTIVE (GE) – HERBARIUM TECHNIQUES

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITYAND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the Course (if any)
		Lecture	Tutorial	Practical/Practice		
Herbarium Techniques	**4**	**4**	**0**	**0**	**Honours Degree in Botany**	**Nil**

MASTER OF SCIENCE IN BOTANY		
Programme : ***Master of Science in Botany***	**Year: V**	**Semester: IX**
Subject: Botany		
Course: BOT GE 12	**Course Title: Introduction of Herbarium And Its Significance**	

Course outcomes: After the completion of the course the students will be able to

1. Understand the processing and importance of Herbarium.
2. Learn about the preparation of Flora.
3. Learn the basic techniques of classification.
4. Understand the collection and identification of plants.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Herbarium: History, Introduction, Methods of Collection of Specimens, Tools and Equipment, Botanical Gardens. Herbarium Preparation (a. Poisoning, b. Pressing, c. Drying, d. Mounting, e. Documentation, f. Arrangement, g. Maintenance h. Cataloging)	**20**
2	Types of herbaria (International, National, Regional and University, Medicinal plant, Economically important plant, Agricultural herbaria), Important herbaria of the World, Major Herbaria in India, Acronym.	**15**
3	Role of Herbarium in Teaching and Research, Function of Herbarium and Conservation, Digitization, Virtual Herbarium.	**15**
4	Visit to herbarium; demonstration and preparation of herbarium from local flora	**10**

Suggested readings

- Saxena, N.B. and Saxena, S. (2012). Plant Taxonomy. Pragati Prakashan.
- Jain, S.K. and Rao, R.R. (1976). A Hand book of Field and Herbarium Methods.
- Sambamurty A.V.S.S. (2010). Taxonomy of Angiosperms. I.K. International Pvt. Ltd.
- Singh, G. (2010). Plant Systematics. CBS PUB & DIST PVT Limited INDIA.
- Sharma,O.P. (2009). Plant Taxonomy. Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Gaur R.D. (1999). Flora of District Garhwal, N.W. Himalaya Transmedia, Srinagar Garhwal.

Semester X

GENERIC ELECTIVE (GE): LICHENOLOGY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Lichenology	**4**	**4**	**0**	**0**	**Botany in Honours Degree**	**Nil**

MASTER OF SCIENCE IN BOTANY		
Programme : ***Master of Science in Botany***	**Year: V**	**Semester: X**
Subject: Botany		
Course: BOT GE 13	**Course Title: Lichenology**	

Course Outcomes:

After the completion of the course the students will be able to:

1. Understand the general characters, structure, types, reproduction and various habitats of lichens.
2. Develop conceptual skill about identifying fungi and lichens.
3. Understand the physiology and biochemistry of lichens.
4. Study the ecological and economic importance of lichens.
5. Gain knowledge about the major lichen families and their representative genera.

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Introduction, General characteristics of lichens, history of Lichenology, collection and preservation of lichens, habitat and growth form of lichens. Classification of lichens. Morphology and anatomy of lichens, Reproduction in lichens.	**20**
2	Physiology and chemistry of lichens, ecological and economic importance of lichens, Overview of some common lichens of Uttarakhand Himalaya.	**15**
3	Salient features of Parmeliaceae, Lecanoraceae, Teloschistaceae, Ramalinaceae, Physciaceae, Collemataceace, Candelariaceae, Peltigeraceae and Usneaceae.	**15**
4	Methods to identify different lichens. Demonstration of different lichen specimens	**10**

Suggested readings

- Arya, V., Kumar, B. and Arya, P. (2019). Lichen Wealth of Uttarakhand Himalaya. Lap Lambert Academic Publishing.
- Awasthi, D.D. (2000). Hand book of lichens, Bishen Singh Mahendrapal Singh: Dehradun India.
- Awasthi, D.D. (2007). A compendium of the macrolichens of India, Nepal and Srilanka. Dehradun Bishen Singh Mahendra pal Singh: Dehradun India.
- Sati, S.C. and Pant, P. (2023). A test Book on Lichens: The Endolichenic Fungi. Elite Publishing House, New Delhi.
- Webster, J. (1985). Introduction to Fungi. Cambridge University Press. New York.

Semester X

GENERIC ELECTIVE (GE): PALAEOBOTANY

No. of Hours-60

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course Title	Credits	Credit distribution of the Course			Eligibility criteria	Pre-requisite of the course(if any)
		Lecture	Tutorial	Practical/Practice		
Paleobotany	**4**	**4**	**0**	**0**	**Honours Degree in Botany**	**Nil**

MASTER OF SCIENCE IN BOTANY		
Programme : ***Master of Science in Botany***	**Year: V**	**Semester: X**
Subject: Botany		
Course: BOT GE 14	**Course Title: Paleobotany**	
Course Outcomes: After the completion of the course the students will be able to: 1. To understand the importance of paleobotany in plant science. 2. To understand the process of fossilization and factors affecting the process of fossilization.		

Credits: 4	**Generic Elective**
Max. Marks: As per Univ. rules	**Min. Passing Marks: Asper Univ. rules**

Unit	Topic	No. of Hours (60)
1	Definition and importance of Paleobotany, Principles of Paleobotany Geological time scale Fossil; Definition, types and mode of preservation Fossilization: Theories and factors affecting the process of fossilization Nomenclature and reconstruction of fossil plants Methods of study of fossils and carbon dating technique	20
2	Origin and evolution of life: Overview of the earliest environment on Earth, Basic concepts and theories about origin of life. Applied Paleobotany: Fundamentals of paleo-floristics, paleogeography, paleoecology and paleoclimatology	15
3	Colonization of land: Emergence of seed plants, appearance of angiosperms, basic concept of continental drift, Paleobotany in India, Gondwana flora	15
4	Demonstration of different types of fossils through preserved specimens	10

Suggested readings

- C.A. Arnold. (1947). An introduction to Paleobotany
- J. Walton. (1940). An introduction to the study of fossil plants