Programme/Class: ***Bachelor of Science***	Year: **III**	Semester: **VI** **Paper-I**
Subject: **Botany**		
Course Code: B040601T	Course Title: **Cytogenetics, Plant Breeding & Nanotechnology**	

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

1. Acquire knowledge on cell ultrastructure.
2. Understand the structure and chemical composition of chromatin and concept of cell division.
3. Interpret the Mendel's principles, acquire knowledge on cytoplasmic inheritance and sex-linked inheritance.
4. Understand the concept of 'one gene one enzyme hypothesis' along with the molecular mechanism of mutation.

Credits: **4**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**

Unit	Topic	No. of Lectures (60hrs)
I	**Cell biology** Structure and function of cell wall, plasma membrane, ribosomes, Endoplasmic reticulum, golgi apparatus, mitochondria, chloroplast, lysosomes, peroxisomes and cell inclusions - Organization of nucleus: nuclear envelope, nucleoplasm and nucleolus. Chromosomal nomenclature- chromatids, centromere, telomere, satellite, secondary constriction.Organization of chromosomes- Nucleic acid and histones- types and classification. Lampbrush chromosomes and polytene chromosomes- Karyotype and idiogram.Cell cycle: G0, G1, S and G2 phases – mitosis: open and closed mitosis – amitosis - meiosis. Variation in Chromosome number (Numerical aberrations)- anueploidy and Euploidy-haploidy, polyploidy- significance (Structural aberrations) - deletion, duplication, inversion and translocation.	**8**
II	**Genetics** Chromosome theory of inheritance, crossing over and linkage; Incomplete dominance and codominance; Interaction of Genes; Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Polygenic inheritance; Extra-nuclear Inheritance, Linkage, crossing over, Concept of sex determination and Sex chromosomes; Patterns of Sex determination in plants	7
III	**Plant breeding** Plant introduction. Agencies of plant introduction in India, Procedure of introduction - Acclimatization – Achievements, Selection - mass selection, pure line selection and clonal selection. Genetic basis of selection methods, Hybridization: Procedure of hybridization, inter generic, inter specific, inter varietal hybridization with examples. Composite and synthetic varieties, Male sterility, Heterosis and its exploitation in plant breeding, Mutation, Molecular Breeding (use of DNA markers in plant breeding), achievements in India, Breeding for pest, pathogenic diseases and stress resistance.	8
IV	**Biostatistics:** Definition, statistical methods, basic principles, variables- measurements, functions, limitations and uses of statistics. Biometry: Data, Sample, Population, random sampling, Frequency distribution- definition only, Central tendency– Arithmetic Mean, Mode and Median; Measurement of dispersion–Coefficient of variation, Standard Deviation, Standard error of Mean; Test of significance: chi- square test for goodness of fit. Computer application in biostatistics - MS Excel and SPSS	7
V	**Plant tissue culture**	8

	Principles, components and techniques of *in vitro* plant cultures, Callus cultures, Cell culture, cell suspension cultures, Embryogenesis and organogenesis, Protoplast isolation and culturing of protoplast- principle and application, regeneration of protoplasts, protoplast fusion and somatic hybridization- selection of hybrid cells, Somaclonal variation, Plant secondary metabolites production.	
VI	**Nanotechnology** Fundamentals of nanoscale self-assembly process involved in important functional biomolecules such as Nucleic acid (DNA and RNA), Proteins, Enzymes. Cell structure and organelles, nanoscale assembly of cellular components (cell membrane and liposomes). Nanoscale assembly of microorganisms (virus). Nano-particles synthesis, Biological synthesis of Nanoparticles, Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials. Biomineralization, Magnetosomes, nano-pesticides, nano-fertilizers, nano-sensors.	**7**
VII	**Artificial Intelligence in Plant Sciences** Big Data Analytics, Blockchain Technology, 3-D Printing, Machine learning, Algorithms of Machine Learning, Expert systems and Fuzzy logic , Artificial Neural Networks and Genetic algorithms, Predictive Analytics, Agents and Robotics, IoT Sensors, Object Image capture & analysis ; Applications of Artificial Neural Networks in Plant Science.	**8**
VIII	**Introduction to use of Digital technologies – AI, IoT & ICT in Botany** Educational software- INFLIBNET, NICNET, BRNET, internet as a knowledge repository-google scholar, science direct. resource management, weather forecasting. IoT Database management, IoT platforms, IoT Graphical user interface • IoT application development for Android Mobile phones, ICT Applications for different crops and horticulture	**7**

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. □□□□□□ □□□□□□□ □□□□□□□□□□ ,□□□□□ □□□ □□□□□□□□□□□ □□□□ :□□□□ □□□□□□ □□□□□□□ :□□□□□□□ □□□□□□□ □□□□
2. □□□□□□ □□□□□□ , □□□□□□□□□, □□□ □□□□□□□□□□ **Sharma and Trivedi by RBD Publisher**
3. **Cell Biology And Genetics (Hindi) 2/e PB....Gupta P K (Hindi) rastogi Publications**
4. **PLANT BIOTECHNOLOGY (HINDI) October 2019 Publisher: Kindle Direct PublishingISBN: ISBN: 9781698665283 Authors:H. R. Dagla Jai Narain Vyas University**
5. **Biotechnology: Fundamentals And Application (hindi) (hb) ISBN : 9788177544732Edition : 03Year : 2018Author : Dr. Purohit SS , Mathur S**
6. **Biotechnology (Hindi) (Hindi, Paperback, B.D.Singh) Hindi Publisher: Kalyani Pubishers ISBN: 9789327246070, 9327246071**
7. **Cytogenetics, Plant Breeding, Evolution and Biostatistics ISBN #: 978-81-301-0066-1Sunil D Purohit & Gotam K Kukda, Apex Publishing House**
8. **Genetics and Biotechnology Sunil D Purohit, K. Ahmed & Gotam K Kukda Apex Publishing House**
9. **Padap Prajanan (Hindi) Hardcover – 1 January 2016 by Chandra Prakash Shukl (Author) Pointer Publishers, Jaipur**
10. **PLANT BREEDING : PRINCIPLE AND METHODS B D SINGH - IN HINDI**
11. □□□□□□ □□□ □□□□□□□□□ □□□□-□□□□□□ **Commission for Scientific and Technical Terminology (CSTT)**
12. □□□□ □□□□□□□□□ □□□□□□□ □□□ **Commission for Scientific and Technical Terminology (CSTT)**

1. G.M. Cooper. (2015). The cell: A Molecular Approach. 7th Edition. Sinauer Associates.
2. Alberts, B., Johnson, A.D., Lewis, J., Morgan, D., Raff, M., Roberts, K., Walter, P. (2014). Molecular Biology of Cell. 6th Edition. WW. Norton & Co.
3. Campbell, M.K. (2012) Biochemistry, 7th ed., Published by Cengage Learning.
4. Campbell, P.N. and Smith, A.D. (2011). Biochemistry Illustrated, 4th ed., Published by Churchill Livingstone
5. Tymoczko, J.L., Berg, J.M. and Stryer, L. (2012). Biochemistry: A short course, 2nd ed., W.H.Freeman.
6. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2011) Biochemistry, W.H.Freeman and Company

7. Nelson, D.L. and Cox, M.M. (2008). Lehninger Principles of Biochemistry, 5th Ed., W.H. Freeman and Company.
8. Karp, G. (2010). Cell Biology, John Wiley & Sons, U.S.A. 6th edition.
9. Hardin, J., Becker, G., Skliensmith, L.J. (2012). Becker's World of the Cell. 8th edition.Pearson Education Inc. U.S.A.)
10. Gardner, E.J., Simmons, M.J., Snustad, D.P. (1991). Principles of Genetics, John Wiley & sons, India. 8th e
11. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India.5th edition.
12. Klug, W.S., Cummings, M.R., Spencer, C.A. (2009). Concepts of Genetics. Benjamin Cummings, U.S.A..
13. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
14. M K Raxdan An Introduction to Plant Tissue Culture –; Oxfird & IBH Publishing Co.Pvt. Ltd.,New Delhi
15. Aggarwal SK (2009) Foundation Course in Biology, 2nd Edition, Ane Books Pvt. Ltd
16. Allard RW (1960) Principles of Plant Breeding. John willey and Sons. Inc. New York
17. BD Singh (2003) Plant Breeding. Kalyani Publishers
18. Cohn, N.S. (1964) Elements of Cytology. Brace and World Inc, New Delhi
19. Darnel, J.Lodish, Hand Baltimore, D. (1991) Cell and molecular biology. Lea and Fibiger, Washington.
20. De Robertis, E.D.P and Robertis, E.M.P (1991) Cell and molecular biology Scientific American books.
21. Dobzhansky, B (1961) Genetic and origin of species, Columbia university Press New York
22. Durbin (2007) Biological Sequence Analysis. Cambridge University Press India Pvt. Ltd
23. Gerald Karp (1985) Cell biology, Mc Graw Hill company..
24. Lewin, B, (1994) Genes, Oxford University Press, New York.
25. Lewis, W.H (1980) Polyploidy. Plenum Press, New York.
26. Nicholl T (2007) An Introduction to Genetic Engineering, Cambridge University Press India Pvt. Ltd
27. Roy S.C. and Kalayan kumar De (1997) Cell biology. New central Boos Calcutta
28. Sandhya Mitra,(1998) Elements of molecular biology. Macmillan, India Ltd.
29. Sharma JR (1994) Principles and Practices of Plant Breeding. Tata McGraw-Hill Pub. Co. New Delhi
30. Sharma, A.K and Sharma A (1980) Chromosome technique Theory and practice, Aditya Books, New York
31. Swanson, C.P (1957) Cytology and Genetics. Englewood cliffs, NewYork.
32. Taylor (2008) Biological Sciences. Cambridge University Press India Pvt. Ltd
33. Twymann, R.M. (1998) Advanced molecular biology Viva books New Delhi.
34. Veer Bala Rastogi (2008), Fundamentals of Molecular Biology Ane Books Pvt. Ltd
35. A. J. Nair . Basics of Biotechnology- Laxmi Publications, New Delhi.
36. S S Purohit and S K Mathur; Biotechnology-Fundamentals and Application- Agrobotanica, India.
37. A. J. Nair Introduction to Genetic Engineering & Biotechnology.Jones & Bartlett Publishers, Boston,USA.
38. H S Chawla Introduction to Plant Biotechnology-; Oxford & IBH publishing Co.Pvt.Ltd., New Delhi.
39. H D Kumar Modern concept of Biotechnology, Vikas Publishing House, Pvt. Ltd., New Delhi.
40. P C Trivedi ,Plant biotechnology, Recent Advances Panima Publishing Corporation, New Delhi.
41. Du, C., and S. A. Jackson. 2019. Machine learning and complex biological data. Genome Biology 20: 76. https://doi.org/10.1186/s13059- 019- 1689- 0
42. Alexis and Mathew Leon.,Fundamentals of Information Technology Leon Vikas
43. Plant R. E., Stone N. D. (1991). Knowledge-based systems in agriculture. McGraw-Hill, Inc. 1221 Avenue of the Americas, New York, NY 10020.
44. Han S., Steward B.L., Tang L. (2016). Intelligent agricultural machinery and field robots. In Zhang Q. Precision agriculture technology for crop farming (pp.133-176). CRC Press, Taylor&Francis Group, New York.
45. Lucci S., Kopec D. (2013). Artificial intelligence in the 21st century. 22841 Quicksilver Drive Dulles, VA 20166.
46. V.Rajaraman Introduction to Information Technology,., Prentice Hll.
47. Ramesh Bangia Learning Computer Fundamentals., Khanna Book Publishers
48. Bass, Joel,E and et. al., Allyn & Bacon, 2009 .Methods for Teaching Science as Inquiry, The truth of science, Newton R.G.,
49. R. Rangaswami (2009) A Text book of Agriculture Statistics .New Age International (P) Limited, Hyderabad.
50. Nageshwar Rao G.(2007)Statistics for Agriculture Sciences BS Publications. New Delhi
51. NigamA.K. andGupta,V.K.(1979)Hand book on Analysis of Agricultural Experiments.. IASRI Publication, New Delhi.

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58. Yubing Xie. 2012. Nanotechnology. CRC Press.The Nanobiotechnology Handbook. CRC Press.
59. Sulabha K. Kulkarni. 2014 Nanotechnology : Principles and Practices. CP publishing, New Delhi.
60. B S Murty, P Shankar, Baldev Raj, B B Rath, James Murday. 2012. Textbook of Nanoscience and Nanotechnology. Springer
61. K. K. Chattopadhyay and A. N. Banarjee. 2009. Introduction to Nanoscience and Nanotechnology. PHI Publication.
62. Sharma A.K. 2005. Text Book Of Biostatistics I, Discovery Publishing House.
63. Annadurai, B. 2007. Text Book of Biostatistics. New Age International.
64. Gurumani, N. 2010. An Introduction to Biostatistics (2nd Edn). MJP Publishers.
65. David S. Goodshell. 2004. Bionanotechnology-Lessons from nature. John Wiley Publications.
66. R. Stephen Crespi, Tibtech, Patenting in Biotechnology - Part I, Vol. 9, 117-122, 1991.
67. Pattnaik, P.K., Kumar, R., Pal, S., Panda, S.N. (Eds.)IoT and Analytics for Agriculture,2020
68. https://www.springer.com/gp/book/9789811391767
69. https://www.springer.com/gp/book/9789811550720
70. Petersen Roger G. (1994) Agricultural Field Experiments Design and Analysis by Marcel Dekker, NewYork.

This course can be opted as an elective by the students of following subjects:
Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science, B.A. (Curators), B.A. Geology.
Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	**5**
Quiz	**5**
Seminar	**7**
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	**8**
	25

Course pre-requisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Math/Statistics/Chemistry/ Computer Science)
Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:
https://www.cytology-iac.org/educational-resources/virtual-slide-library
https://www.asct.com/ASCTWeb/Content/Cytopreparation_Online_Course.aspx
https://www.mooc-list.com/tags/genetics
https://www.coursera.org/learn/genetics-evolution
https://www.my-mooc.com/en/mooc/introduction-to-genetics-and-evolution/

Further Suggestions:
Access to Statistics, Chemistry, Math and Biotechnology resources will be required

Programme/Class: ***Bachelor of Science***	Year: **III**	Semester: **VI** **Paper-II**
Subject: **Botany**		
Course Code: B040602T	Course Title: **Ecology & Environment**	

Course outcomes:

1. acquaint the students with complex interrelationship between organisms and environment;
2. make them understand methods for studying vegetation, community patterns and processes, ecosystem functions, and principles of phytogeography.
3. This knowledge is critical in evolving strategies for sustainable natural resource management and biodiversity conservation.

Credits: **4**	**Core Compulsory/Elective**
Max. Marks: **25+75**	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): **4-0-0**

Unit	Topic	No. of Lectures (60 hrs)
I	**Natural resources & Sustainable utilization**: Land Utilization, Soil degradation and management strategies; Restoration of degraded lands. Water , Wetlands; Threats and management strategies, Ramsar sites ,Forests: Major and minor forest products; Depletion, Biological Invasion, Energy: Renewable and non-renewable sources of energy , Contemporary practices in resource management : EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting.	**7**
II	**Ecology & Ecosystem** Definition of Ecology, Ecological Factors, Positive and negative interactions. Ecosystem – Concept of an ecosystem-structure and function of an ecosystem. Abiotic and biotic com-Energy flow in an ecosystem Ecological Succession-Definition & types. Processes and types (autogenic, allogenic, autotrophic, heterotrophic, primary & secondary), Hydrosere and Xerosere. Food chains and food webs, Ecological pyramids, production and productivity; And components. Types of ecosystems: Forest Ecosystem, Grassland, Crop land, aquatic Ecosystems Ecological Adaptations – Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites.	**8**
III	**Soil Formation, Properties & Conservation** Soil: Origin, Formation, composition, Soil types, Soil Profile, Soil Microorganisms, soil processes, Soil Erosion, Biogeochemical cycles, Soil Conservation: Biological– Contour farming, Mulching, Strip cropping, Terracing and Crop rotation. Mechanical–Basin Listing, Construction of dams, Watershed Management, Soil reclamation	**7**
IV	**Biodiversity and its conservation:** Definition -genetic, species, and ecosystem diversity. Value of biodiversity: social, ethical, aesthetic and option values; hotspots of Biodiversity threats to biodiversity, Biotic communities and populations, their characteristics and dynamics. Endemic and endangered species of plants in India. Ecological niche, ecotypes, ecological indicators. *Conservation of Biodiversity:* Ex-situ and in-situ conservation, Red data book, botanical gardens, National park, Sanctuaries, hot & hottest spots and Bioreserves. Role of Seed Bank and Gene Bank Valuing plant resources, ecotourism, Role of NBPGR, FAO, BSI.	**7**

V	**Phytogeography:** Biogeographic regions of India & world, Agroecological & Floristic zones of India. Natural vegetation of India, static and dynamic plant geography, basic principles governing geographical distribution of plants, Phytogeographical regions of India, Vegetational types in Uttar Pradesh.	**7**
VI	**Environmental audit & Sustainability** Concept of environmental audit; Guidelines of environmental audit; Methodologies adopted along with some industrial case studies; Environmental standards: ISO 14000 series; Scheme of labelling of environment friendly products (Ecomark); Life cycle analysis; Concept of energy and green audit, Strategies and debates on sustainable development; Concept of Sustainable Agriculture; India's environment action programme: issues, approaches and initiatives towards Sustainability; Sustainable development in practice.	**8**
VII	**Pollution, Waste management & Circular Economy** Environmental pollution, Environmental protection laws, Bioremediation, Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor, neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Yamuna Action Plan; implementation of CNG ;Waste- Types , collection and disposal, Recycling of solid wastes (hazardous & non-hazardous) - classification, collection and segregation , Incineration, Pyrolysis and gasification , Sanitary landfilling ; composting, Biogas production ,Circular Economy & sustainability.	**8**
VIII	**Environmental ethics, Carbon Credits & Role of GIS** Carbon credit: concept, exchange of carbon credits. Carbon sequestration, importance, meaning and ways. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Clean development mechanism. Geographical Information Systems: definitions and components; spatial and non-spatial data; GIS software packages; GPS survey, data import, processing, and mapping. Applications and case studies of remote sensing and GIS in land use planning, forest resources & agriculture studies.	**8**

Suggested Readings:

Course Books published in Hindi may be prescribed by the Universities.

1. Environmental Studies (Hindi)ISBN 81-301-0004-5B. L. Chaudhary & Jitendra Pandey Edition: 2013Pages: 340 + XII Apex Publishing House
2. Soil and Water Conservation ISBN #: 978-81-301-0071-5S. C. Mahnot & P. K. Singh Apex Publishing
3. House
4. Ecology And Environmental Biology (□□□□□□□□□□□□□ □□□ □□□□□□□□ □□□□□□) by RBD Publisher Author: Bhatia - Jain - Kohli - Shrivastava - Singh – Verma
5. □□□□□□□□□□ □□□□□□□ □□□ □□□□ □□□□□□□□ □□□□ :□□ □□ □□ □□□□□ □□□□□□□: □□□□□□□ □□□□□□□ □□□□
6. Paryavaran Evam Paristhitiki 5e (Hindi) Paperback – 20 February 2020 Majid Husain
7. Environmental Biology and Phytogeography ISBN #: 978-81-301-0064-7B. L. Chaudhary, Gotam K Kukda & Jitendra Kumar Joshi
8. Ugc Unified: Environmental Sciences (hindi) (pb) ISBN: 9788177545814 Edition : 01Year : 2015Author : Dr. Purohit SS , Dr. Deo PP , Dr. Agrawal Ashok KPublisher : Agrobios (India)

1. Chapman and Riss. Ecology: Principles and Applications, Latest Ed., Cambridge University Press
2. Shukla, R.S. & Chandel, P.S. Plant Ecology, Latest Ed., S. Chandel and Co.
3. Kumar, H.D. Modern Concept of Ecology, Latest Ed. Vikas Publishing House
4. Begon, M., Herper, J.L. and Townsend, C.R. Ecology- Individuals, Populations and Communities (3rd ed.), Oxford Blackwell Science
5. Verma, P.S. & Agarwal, U.K. Concept of Ecology, Latest Ed., S. Chand & Company

6. Odum, F.P. Fundamentals of Ecology, Latest Ed., Saunders
7. Sharma, P.D. Elements of Ecology, Latest Ed., Rastogi Publications
8. Ambasht, R.S. & Ambasht, N.K. A Text Book of Plant Ecology, Latest Ed., CBS Publication & Distributors
9. Mani, M.S. Bio-Geography of India, Latest Ed., Springer-Verlag.
10. Mackenzie et al. Ecology, Latest Ed., Viva Books.
11. Gurevitch, J. (et al.)., The Ecology of plants, 2002, Sinauer Associates.
12. Kimar, U. & Asija, M.J. Bio-diversity: Principles & Conservation, 2005, Student Edition, Agrobios (India)
13. Krishnamurthy, K.V. An Advanced Text Book on Biodiversity, 2003, Oxford & IBH Publishing Co. Ltd.
14. Mitra, D., Guha, J.K., Chowdhury, S.K. Studies in Botany, Vol. II (7th ed.) Moulik Library.
15. Primack, R.B. Essentials of Conservation Biology, 1993, Sinauer Associates.
16. Lo, C.P. & Yeung, A.K.W. Concepts and Techniques of Geographic Information Systems, 2002, Printice-Hall of India.
17. Cain, Bowman, Hacker. Ecology. 2014. 3rd Ed. Sinauer Associates
18. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
19. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.
20. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.
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28. George, T., Hilary, T. and Samuel, A. V. (1993). Integrated solid Waste Management, Engineering Principles and Management Issues, Mc Graw Hills.
29. George, T. and Frank, K. (2002). Handbook of solid waste management: (Second edition). Mc Graw Hills.
30. Kanthi, L. S. (2000). Basics of Solids and hazardous waste management Technologies. Prentice Hall.
31. Anonymous. 1997. National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New York.
32. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries
33. with Policy and Science Considerations. Martinus Nijhoff Publishers.
34. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
35. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
36. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
37. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
38. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future.Columbia University Press.
39. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
40. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition).Sage Publications.
41. . Demers, M.N. 2005. Fundamentals of Geographic Information System. Wiley & Sons.
42. Richards, J. A. & Jia, X. 1999. Remote Sensing and Digital Image Processing. Springer.
43. Sabins, F. F. 1996. Remote Sensing: Principles an Interpretation. W. H. Freeman.
44. Gaston, K J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London,
45. Singh, J. S. & Singh, S. P. 1987. Forest vegetation of the Himalaya. The Botanical Review 53:80-192.
46. Sodhi, N.S. & Ehrlich, P.R. (Eds). 2010. Conservation Biology for All. Oxford University Press.
47. Sodhi, N.S., Gibson, L. & Raven, P.H. 2013. Conservation Biology: Voices from the Tropics. Wiley-Blackwell, Oxford, UK.

This course can be opted as an elective by the students of following subjects: Open to all but special for B.Sc. Biotech, B.Sc. Microbiology, B.Sc. Agriculture, B.A. (Curators), B.A. Archaeology, B.A. Geology

Suggested Continuous Evaluation Methods:

Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	**5**
Quiz	**5**
Seminar	**7**
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	**8**
	25

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science.
Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts

Suggested equivalent online courses:
https://community.plantae.org/tags/mooc
uturelearn.com/courses/teaching-biology-inspiring-students-with-plants-in-science
https://www.coursera.org/courses?query=plants
http://egyankosh.ac.in/handle/123456789/53530

Programme/Class: *Bachelor of Science*	Year: **III**	Semester: **VI** **Paper-III**
Subject: **Botany**		
Course Code: B040603P	Course Title: **Lab on Cytogenetics, Conservation & Environment management**	

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

1. To perform all experiments related to the semester-i.e. Plant tissue cultured plants, conducting breeding on field, conserving and depolluting the environment.
2. Can be employed in environment impact assessment companies & start his own venture

Credits: **2**	**Core Compulsory**
Max. Marks: **25+75**	Min. Passing Marks:

Total No. of Lectures-Tutorials-Practical (in hours per week): 0**-0-2**

Unit	Topic	No. of Lectures(60hrs)
I	**Cell biology** 1. Study of plant cell structure with the help of epidermal peal mount of Onion/Rhoeo/Crinum 2. Measurement of cell size by the technique of micrometry. 3. Counting cells per unit volume with the help of haemocytometer (Yeast/pollen grains) 4. Determination of mitotic index and frequency of different mitotic stages in pre-fixed root tips of Allium cepa.	7

II	**Genetics** 1. Monohybrid cross (Dominance and incomplete dominance) 2. Dihybrid cross (Dominance and incomplete dominance) 3. Gene interactions (All types of gene interactions mentioned in the syllabus) a. Recessive epistasis 9: 3: 1. b. Dominant epistasis 12: 3: I c. Complementary genes 9: 7 d. Duplicate genes with cumulative effect 9: 6: 1 e. Inhibitory genes 13: 3 4. Observe the genetic variations among inter and intra specific plants. 5. Demonstration of Breeding techniques-Hybridization, case studies of mutation, polyploidy, emasculation experiment.	**8**
III	**Biostatistics:** 1.Univariate analysis of statistical data: Statistical tables, mean, mode, median, standard deviation and standard error (using seedling population / leaflet size). 2.Calculation of correlation coefficient values and finding out the probability. 3.Determination of goodness of fit in Mendellian and modified mono-and dihybrid ratios (3:1, 1:1, 9:3:3:1, 1:1:1:1, 9:7, 13:3, 15:1) by Chi-square analysis and comment on the nature of inheritance. 3. Computer application in biostatistics - MS Excel and SPSS	**7**
IV	**Plant tissue culture** 1.Familiarization of instruments and special equipments used in the plant tissue culture experiments 2.Preparation of plant tissue culture medium, and sterilization, Preparation of stock solutions of nutrients for MS Media. 3.Surface sterilization of plant materials for inoculation (implantation in the medium) 4.Micropropagation of potato/tomato/ - Demonstration 5.Protoplast isolation and culturing – Demonstration	**8**
V	**Ecology & Environment** 1. Ecological Adaptations: Hydrophytes, Xerophytes, Halophytes, Epiphytes and Parasites 2. Study of morphological adaptations of hydrophytes and xerophytes (four each). 3. Study of biotic interactions of: Stem parasite (Cuscuta), Root parasite (Orobanche) Epiphytes, Predation (Insectivorous plants). 4. Observation and study of different ecosystems mentioned in the syllabus. 5. Field visit to familiarize students with ecology of different sites	**8**
VI	**Soil Formation, Properties & Conservation** 1. Determination of pH of various soil and water samples (pH meter, universal indicator/Lovibond comparator and pH paper) 2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 3. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 4. Soil Profile study 5. Soil types of India-Map	**8**
VII	**Biodiversity and Phytogeography:** 1. Study of community structure by quadrat method and determination of (i) Minimal size of the quadrat, (ii) Frequency, density and abundance of components (to be done during excursion/field visit). 2. Marking of vegetation types of India, World & Uttar Pradesh on maps	**7**

	3. Phytogeographical areas of India	
VIII	Pollution &Waste management 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter 2. Estimation of chloride and dissolved oxygen content in water sample 3. Comparative anatomical studies of leaves form polluted and less polluted areas. 4. Measurement of dissolved O2 by azide modification of Winkler's method. 5. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 6. Microbiological assessment of drinking water using MPN technique- water from well, river, water supply department and packaged drinking water 7. Making kitchen waste from compost/vermicompost by Enzymes/Bio decomposer/ Whey with dung. **Climate Change, Carbon Credits & Role of GIS** 1. Conducting Waste Audit of your Institution -Demo 2. Green auditing of the College/University -Demo	**7**

Suggested Readings: as in papers above:

Course Books published in Hindi may be prescribed by the Universities.

1. Practical Botany (Part III) Author: Sunil D Purohit, Anamika Singhvi & Kiran Tak 2013 Apex Publishing House,Raj.
2. Practical Botany (Part II) Author: N. C. Aery, Sunil D Purohit & Gotam K Kukda 2013 Apex Publishing House,Raj.
3. □□□□□□□□□□□□ □□□□□□□ □□□□□□□ □□□ 3 □□□□ □□□□ □□□□□□□ □□□ □□□□ □□□□□ □□□□□□□ □□□□□□□ □□□□□□□ □□□□
4. A Handbook Of Soil, Fertilizer And Manure (2nd Ed.) (pb) ISBN : 9788177544152Edition : 02Year : 2017Author : Gupta PKPublisher : Agrobios (India)
5. Green Technology: An Approach For Sustainable Environment ISBN : 9788177543438Edition : 01Year : 2021Author : Dr. Purohit SSPublisher : Agrobios (India)
6. Laboratory Manual Of Chemical And Bacterial Analysis Of Water And SewageISBN : 9788177540802Edition : 01Year : 2011Author : Theroux FR , Eldridge EF , Mallmann WLPublisher : Agrobios (India)
7. Methods In Environmental Analysis: Water Soil And Air (2nd Ed.) ISBN : 9788177543087Edition : 02Year : 2021Author : Gupta PKPublisher : Agrobios (India)
8. Water Treatment And Purification Technology ISBN : 9788177540024Edition : 01Year : 2009Author : Ryan WJPublisher : Agrobios (India

http://vidyamitra.inflibnet.ac.in/index.php/home/subjects?domain=Life+Science&subdomain=Botany
http://heecontent.upsdc.gov.in/Home.aspx
(http://epathshala.nic.in/, http://epathshala.gov.in/)

This course can be opted as an elective by the students of following subjects:
Open to all but special for B.Sc. Biotech, B.Sc. Forestry, B.Sc. Agriculture, B. Pharma, B.Sc. Food Science, B.A. (Curators), B.A. Geology.

Suggested Continuous Evaluation Methods: Continuous Internal Evaluation shall be based on allotted Assignment and Class Tests. The marks shall be as follows:

Internal Assessment	Marks
Class Interaction	**5**
Quiz	**5**
Seminar	**7**
Assignment (Charts/ Flora/ Rural Service/ Technology Dissemination)	**8**
	25

Course pre-requisites:

Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Forestry/ Biotech/ Math/Statistics/Chemistry/ Computer Science)
Facilities: Smart and Interactive Class
Other Requisites: Video collection, Books, CDs, Access to On-line resources, Display Charts
Lab requisites: Biotech instruments, environmental lab instruments.

Suggested equivalent online courses:
https://www.cytology-iac.org/educational-resources/virtual-slide-library
https://www.asct.com/ASCTWeb/Content/Cytopreparation_Online_Course.aspx
https://www.mooc-list.com/tags/genetics
https://www.coursera.org/learn/genetics-evolution
https://www.my-mooc.com/en/mooc/introduction-to-genetics-and-evolution/

Further Suggestions: Access to Statistics, Chemistry, Math and Biotechnology resources will be required

Programme/Class: **Bachelor of Science**	Year: **III**	Semester: **VI /Project-II/ Paper-IV**
Subject: **BOTANY**		
Course Code: - B040604R	Course Title: **Project in Botany for Graduation**	

Course outcomes:
After completing this course a student will have:

- Project work will supplement field experimental learning and deviations from classroom and laboratory transactions.
- project work will enhance the capability to apply gained knowledge and understanding for selecting, solving and decision-making processes
- It will promote creativity and the spirit of enquiry in learners.
- They will learn to consult Scientists, libraries, laboratories and herbariums and learn importance of discussions, Botanical & field trips, print and electronic media, internet etc. along with data documentation, compilation, analysis & representation in form of dissertation writing
- It will enhance their abilities, enthusiasm, and interest.

Credits: **03**	Core: **Compulsory**
Max. Marks: **25+75**	Min. Passing Marks: **……**
Total No. of Lectures-Tutorials-Practical (in hours per week): **0-0-3**.	

	SUGGESTIVE LIST OF PROJECTS

Prepare beds for growing nursery for herbs, shrubs and trees.
Develop Green house facility in college and grow plants
Develop hydroponics facility in college and grow plants.
Develop botanical garden in the college with labelling
Vertical gardens, roof gardens.
Culture & art of making bonsai.
Computer Aided Designing (CAD) for outdoor and indoor scaping Exposure to CAD (Computer Aided Designing)
Phytochemical Analysis of Medicinal plants
Bio composting and Vermicomposting.
Performing Aromatherapy by essential Oils

Refer: libraries, journals, Memoirs, encyclopaedias, herbaria, Museums, etc.

This course can be opted as an elective by the students of following subjects:
This course can be opted as an elective by the students of following subjects: Open to all

Suggested Continuous Evaluation Methods:

Internal Assessment	Marks
Class Interaction	**5**
Seminar	**10**
Thesis/dissertation	**10**
	25

Course prerequisites:
Qualification: To study this course, a student must have qualified 10+2 with Biology/ NSQF level 3 from Sector Skill Councils / Diploma holder from ITI in (Biology/ Agriculture/ Biotech/ Forestry/ Microbiology/Gardening /biomedical Science.
Facilities: Smart and Interactive Class
Other Requisites: All listed under all papers of the course.

Suggested equivalent online courses:
https://ndl.iitkgp.ac.in/
http://heecontent.upsdc.gov.in/Home.aspx
(http://epathshala.nic.in/, http://epathshala.gov.in/)
nptel.iitm.ac.in
https://asiafoundation.org/what-we-do/books-for-asia?gclid=CjwKCAiA7939BRBMEiwA-hX5J-QhBITSyPnvj3r8yeio-L9f5uTy1a6oEoALCLa9Ebu0pyz858yQZxoC5wkQAvD_BwE
http://www.dli.ernet.in/, http://www.ulib.org/
http://www.tkdl.res.in/, http://www.vigyanprasar.gov.in/digilib
Directory of Open Access Repositories (DOAR)http://www.opendoar.org
Registry of Open Access Repositories (ROAR)http://roar.eprints.org/
http://www.iscnagpur.ac.in/knowledge_learning_files/5.7_General_Open_Access_e-Resources.pdf