Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Major 16
Course Name: *Plant Breeding, Genomics and Bioinformatics*
Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no	**Unit content**	**No. of classes**	**Marks**
Unit 1	Principles of plant breeding, hybridization and selection; concepts in improvement of major crop species; polyploidy inheritance, self-incompatibility.	6	8
Unit 2	QTL mapping using molecular marker, population statistics; heritability, Hardy-Weinberg law of equilibrium, Novel plant breeding tools (TALEN's, CRISPR-Cas9, Base editing).	7	10
Unit 3	Chromosome variation in higher plants; haploid production system, breeding application of haploids; aneuploidy, trisomic, tetrasomic, nullisomic and their significance in genetic studies; parthenogenesis and apogamy, action of physical and chemical mutagens; mutation in crop improvement.	8	10
Unit 4	Intellectual Property Rights -- Intellectual property rights (IPR); Patents, trade secrets, copyright, trademarks; Geographical Indicators (GI); Registration, subject matter and ownership of IPRs. Plant genetic resources; GATT & TRIPPS; Patenting of biological material; Plant breeders rights (PBRs) and farmers rights.	8	10
Unit 5	Genomics: Organization of nuclear and organellar genomes, Sequencing Genomes, Comparative genomics, Functional genomics	6	10
Unit 6	Bioinformatics: Introduction to bioinformatics, biological databases, data mining and retrieval, scope and application of bioinformatics, nucleic acid and protein sequence analysis, sequence alignment, local and global alignment, database search for homologous sequences-BLAST and	10	12

	FASTA, protein structure analysis, Ramachandran plot, computer-aided drug discovery.		
PRACTICAL [Credit: 01]			
1. Principle, techniques and procedure of emasculation. 2. Sequence (protein/DNA) downloading from databases, alignment and homologous sequence search 3. Sequence BLAST, annotation and gene prediction with the help of bioinformatical tools. 4. Protein modelling, structure prediction and Ramachandran plot analysis 5. Chromosome analysis, study of chromosome behaviour in mitosis and meiosis, chromosome anomalies in plant cells. 6. Comparative genomics of bacteria		30	40

Reading list:

1. Acquaah, G. (2012). Principles of Plant Genetics & Breeding. 2nd edition. Hoboken, NJ, Wiley.
2. Allard, R.W. (1999). Principles of Plant Breeding. John Wiley, New York.
3. Singh, B.D. (2022). Plant Breeding: Principles and Methods, 12th edition. New Delhi, Delhi: Kalyani Publishers.
4. Frey, K. J. (1982). Plant Breeding II. Kalyani Publishers, New Delhi.
5. Chopra, V.L. (2023). Plant Breeding: Theory and Practice 2nd Restructured Edition, New India Publishing Agency, New Delhi.
6. Poehlman J. M. and Sleper D. A. (1995). Breeding Field Crops, 4th Ed. Panima Publishing Corporation, New Delhi.
7. Welsh, J. R. (1981). Fundamentals of Plant Genetics and Breeding. John Wiley and Sons, New York.
8. Ahuja, V.K. (2007) Laws related to IPR. LexisNexis, India.
9. Snustad DP, Simmons MJ (2010) Principles of Genetics, John Wiley & Sons Inc., India. 5thedition
10. Pierce BA (2016) Genetics-A conceptual approach, W.H. Freeman and Co. USA, Sixth edition.
11. Primerose SB and Twyman RM (2014), Principles of Gene manipulation and genomics. Wiley Blackwell. Seventh Edition.

Graduate Attributes

Course Objective:

This course will give an insight on various plant breeding approaches for crop improvement and related IPR related issues. It will provide a basic understanding on various tools available genomics and bioinformatics.

Course outcomes:

On successful completion of the course, students will be able to:

1. Explain the principles of plant breeding, hybridization, and selection, as well as the concepts in the improvement of major crop species, polyploidy inheritance, self-incompatibility, and the Hardy-Weinberg law of equilibrium.
2. Apply novel plant breeding tools such as TALEN's, CRISPR-Cas9, and base editing in practical scenarios to improve crop species.
3. Analyze chromosome variations in higher plants, including haploid production systems and the breeding application of haploids, as well as the significance of aneuploidy, trisomic, tetrasomic, and nullisomic conditions in genetic studies.
4. Evaluate the significance of intellectual property rights in plant breeding and assess the use of bioinformatics tools in genomics and functional genomics.
5. Design and conduct practical experiments in plant breeding and bioinformatics, including emasculation techniques, sequence analysis, gene prediction, protein modeling, chromosome analysis, and comparative genomics of bacteria.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme

Subject: Botany

Semester: Seventh

Major-17

Course Name: *Conservation Ecology and Biodiversity Assessment*

Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit No	**Unit Content**	**No. of classes**	**Marks**
Unit 1	**Conservation Ecology**- Concept, principles, postulates and ethics, genetic variation and its loss, variation in natural populations, Species and habitat conservation- prioritizing species and habitat, protected area networks; major approaches to their management, Indian case studies on conservation/management strategy.	8	10
Unit 2	**Conservation strategies**- In-situ, Ex-situ and hybrid approaches, conservation: facilities, the establishment of new populations, captive breeding, reintroduction, advantages and disadvantages, Metapopulation- concept, types, and conservation importance	7	8
Unit 3	**Biodiversity:** Concept, levels, types and Importance, Methods for biodiversity monitoring, Indicators for biodiversity, megadiversity zones and hot spots; hottest hot spots, mega diversity countries, centres of plant diversity and endemism biodiversity and ecosystem services	6	8
Unit 4	**Threats to biodiversity:** Causes of biodiversity loss, species extinction, vulnerability of species to extinction, IUCN threat categories, Red data book; Biodiversity Act and biodiversity action plan; IPRs, national and international programs for biodiversity conservation, wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, TRAFFIC.	10	12
Unit 5	**Biodiversity Assessment:** Concept and Importance, methodology of assessment and analysis of different species groups, monitoring of different species groups; importance of documentation and use of information technology in biodiversity study, sustainable use of biodiversity; biodiversity loss and its consequences.	7	10

Unit 6	**Protected Area Network:** Concept, History, Indian Scenario: Biospheres, National Parks and Wildlife Sanctuaries, Wildlife conservation projects, Conservation population, design and management of protected areas; problems of protected areas in India, connectivity and corridors; population biology of endangered species. Population viability analysis, Wildlife conservation in NE India- Case Studies	7	12
PRACTICAL [Credit: 01]			
1. Ecological data analysis in Microsoft Excel: Data entering in Excel worksheet; Statistical interpretation in Excel; Data analysis tool, Pak: Basic graphical tools; T-test; Chi-Square test for independence of attributes; Spearman's rank correlation test. 2. Introduction to MS-Access: Creation of databases, tool bars, menu bars, opening of a data bar, entry format, entry of data, saving and formatting of data, queries of data, sorting of data and others. 3. Demonstration of biodiversity assessment methods in the University campus; 4. Qualitative and Quantitative analysis of vegetation. 5. Field visit to the forest nearby or protected area to study the biodiversity and understand the conservation strategies employing the protected area.		30	40

Reading list:

1. Anna A. Sher, Richard B. Primack · (2019) an Introduction to Conservation Biology. Oxford University Press
2. Anne E. Magurran, Brian J. McGill (2011) Biological Diversity: Frontiers in Measurement and Assessment. Oxford University Press.
3. Fred Van Dyke, Rachel L. Lamb (2020). Conservation Biology: Foundations, Concepts, Applications. Springer International Publishing 6
4. Jase Fitzgerald (2017). Biodiversity: An Introduction. Larsen and Keller Education.
5. Kelsey Malone (2020) Ecology: Evolution, Biodiversity and Conservation CALLISTO REFERENCE.
6. Krishnamurthy KV (2018) an Advanced Textbook on Biodiversity – Principles and Practice, Oxford and IBH Publishing, New Delhi.
7. Lisa Idzikowski (2019). Biodiversity and Conservation. Greenhaven Publishing LLC
8. Malcolm L. Hunter, Jr., James P. Gibbs, Viorel D. Popescu. (2021). Fundamentals of Conservation biology (4th edition). Wiley
9. Michael O'Neal Campbell. 2021. Critical Research Techniques in Animal and Habitat Ecology. Nova Science Publishers.
10. Peter Stiling (2015). Ecology: Global Insights & Investigations 2nd Edition. McGraw-Hill international edition Reference books

11. PetrosGanatsas (2021). Forest Biodiversity, Conservation and Sustainability. Mdpi AG
12. Singh JS, Singh SP and Gupta SR (2014) Ecology, Environmental Science and Conservation. 4th Edition. S. Chand & Company Pvt. Ltd.

Graduate Attributes

Course Objective:

This course will provide an understanding on importance of conservation ecology, status of the planet's biological diversity, value of biodiversity and drivers of its loss, basic concepts and scientific principles of conservation and global patterns in biodiversity, practical issues and challenges with wildlife conservation.

Course outcomes:

On successful completion of the course, students will:

1. Understand the concept and importance of biodiversity
2. Understand biodiversity changes and factors associated with the changes
3. Understand the biodiversity assessment methods
4. Understand the ecological, social, and economic impacts of biodiversity loss, and
5. Learn the management principles and tools that are used to conserve diversity at various levels.

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme

Subject: Botany

Semester: Seventh

Major 18

Course Name: ***Plant diseases, diagnostic and management***

Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	Introduction to Plant Diseases: Koch's postulate and germ theory of diseases, biotic and abiotic causes of plant diseases, symptoms and signs of plant diseases caused by fungi, bacteria, virus, and nematode.	6	6
Unit 2	Dissemination of plant pathogens; disease cycle; physiological changes due to disease in plants; Genetics of plant diseases	8	10
Unit 3	Diagnosis of Plant Diseases: Visual identification of common plant diseases, Laboratory techniques (microscopy, culturing, and serological tests); molecular methods (PCR, DNA sequencing, and ELISA)	8	12
Unit 4	Epidemiology of plant diseases; Disease mapping, forecasting and surveillance techniques	8	8
Unit 5	Concept of plant disease control; Cultural, Chemical, and biological control of plant diseases; Integrated pest management (IPM); Management of soil borne plant pathogens; Management of seed borne pathogens	8	12
Unit 6	Resistant gene identification and development of disease resistant plant (Traditional and biotechnological approach), GMO (bt-cotton, bt-brinjal, bt-chickpea)	7	12
PRACTICAL [Credit: 01]			
8. Study of plant disease symptoms and their causal organisms 9. Isolation and identification of pathogen from diseased plant materials 10. Isolation of soil borne fungal pathogens and their control 11. Proving of Koch's postulate at least one disease		30	40

Reading list:

1. Agrios, G. N. (2005). Plant pathology (5th ed.). Academic Press.
2. Lucas, J. A. (2015). Plant pathology and plant pathogens (4th ed.). Wiley-Blackwell.

3. Schumann, G. L., & D'Arcy, C. J. (2010). Essential plant pathology. American Phytopathological Society Press.
4. Maloy, O. C., & Murray, T. D. (Eds.). (1993). Encyclopedia of plant pathology (Vol. 1-2). Wiley-Interscience.
5. Madden, L. V., Hughes, G., & van den Bosch, F. (2007). The study of plant disease epidemics. American Phytopathological Society Press.
6. Hammond, B. G., & Lemaux, P. G. (2008). Genetically modified crops: Promises, perceptions, and realities. Advances in Agronomy, 98, 1-41.
7. Staskawicz, B. J., & Jones, J. D. (2000). Molecular plant pathology since 2000. Molecular Plant Pathology, 1(1), 9-20.

Graduate Attributes

Course Objective:

This paper will focus on the comprehensive understanding of plant diseases, their diagnosis, and effective management strategies.

Course outcomes:

On completion of the course, students will-

8. Comprehend the fundamental concepts of plant diseases, including Koch's postulates, the germ theory of diseases, and the distinction between biotic and abiotic causes of plant diseases.
9. Analyze the dissemination of plant pathogens, understand the disease cycle, and evaluate the physiological changes induced by diseases in plants, with a focus on the genetic aspects of plant pathogens.
10. Apply various diagnostic techniques for plant diseases, including visual identification, laboratory methods such as microscopy and culturing, and advanced molecular methods like PCR, DNA sequencing, and ELISA.
11. Evaluate the epidemiology of plant diseases, including disease mapping, forecasting, and surveillance techniques, to understand the spread and control of plant pathogens in different environments.
12. Propose and assess various methods for plant disease control, including cultural, chemical, and biological approaches, as well as integrated pest management strategies tailored to manage soil-borne and seed-borne plant pathogens, while also considering the identification and development of disease-resistant plants, including biotechnological approaches such as GMOs.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Major-19
Course Name: *Environmental Microbiology*
Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	Microbiology of soil, water and air (common soil microflora, microbes in soil health improvement, common water microflora, microbial water quality analysis, common air microflora)	6	6
Unit 2	Culture-dependent microbial study (Growth media, culture techniques, CFU count and enumeration, characterization of isolates and species identification)	8	10
Unit 3	Culture-independent microbial study (direct microscopic methods, meta-genomics, transcriptomics, proteomics and metabolomics)	8	12
Unit 4	Microbial interactions (symbiosis, antagonism, parasitism, commensalism, amensalism, cooperation, quorum and anti-quorum sensing)	8	8
Unit 5	Biogeochemical cycling (Role of microbes in biogeochemical cycling, carbon cycle, nitrogen cycle, sulfur cycle, phosphorus cycle)	8	12
Unit 6	Scope of microbiology in environmental engineering (reclamation of degraded soil, purification of polluted water, biodegradable waste management)	7	12
PRACTICAL [Credit: 01]			
1. Enumeration and identification of common soil microbes 2. Enumeration and identification of common water microbes 3. Use of differential media/specific media to identify a particular group of microbes 4. Catalase/Phosphatase test for bacteria 5. MPN test for water quality 6. Methylene blue reductase test for milk quality		30	40

Reading list:

1. Sylvia DM, Fuhrmann JJ, Hartel PG, Zuberer DA (2005) Principles and Applications of Soil Microbiology, Pearson, USA.
2. Pepper IL, Gerba CP, Gentry TJ (2014) Environmental Microbiology, Academic Press, USA.
3. Atlas RM (2010) Handbook of Microbiological Media, CRC Press, USA.
4. Madigan MT, Martinko JM, Bender K, Buckley D, Stahl D (2018) Brock Biology of Microorganisms, Pearson, USA.
5. Riesenfeld CS, Schloss PD, Handelsman J (2004) Metagenomics: Genomic Analysis of Microbial Communities, Kluwer Academic Publishers, USA.
6. Hugenholtz P, Tyson GW (2008) Metagenomics, Springer, USA.
7. Falkowski PG, Fenchel T, Delong EF (2008) The Microbial Engines That Drive Earth's Biogeochemical Cycles, Science, USA.
8. Fuqua C, Greenberg EP (2002) Signaling in Bacteria: New Insights into Microbial Ecology and Evolution, ASM Press, USA.
9. Schlesinger WH, Bernhardt ES (2013) Biogeochemistry: An Analysis of Global Change, Academic Press, USA.
10. Paul EA (2014) Soil Microbiology, Ecology, and Biochemistry, Academic Press, USA.
11. Bitton G (2011) Wastewater Microbiology, Wiley-Blackwell, USA.
12. Thakur IS (2006) Environmental Biotechnology: Basic Concepts and Applications, I.K. International Publishing House, India.
13. Cappuccino JG, Welsh CT (2016) Microbiology: A Laboratory Manual, Pearson, USA.
14. Benson HJ (2012) Microbiological Applications: Laboratory Manual in General Microbiology, McGraw-Hill, USA.

Graduate Attributes

Course Objective:

The objective of this course is to provide a comprehensive understanding of environmental microbiology, emphasizing microbial communities in soil, water, and air, and their roles in soil health, water purification, and biogeochemical cycles. Students will learn both culture-dependent and culture-independent techniques for studying microbes, including growth media preparation, CFU counting, and advanced genomic methods. The course covers microbial interactions and their ecological significance, and includes practical skills in microbial enumeration, identification, and biochemical testing. It also highlights the application of microbiology in environmental engineering, preparing students for advanced studies or careers in the field.

Course outcomes:

On completion of the course, students will be able to-

1. List common soil microbes and explain their role in the nitrogen cycle.
2. Understand the concept of symbiosis and provide examples of how this interaction benefits soil health.
3. Perform CFU counting and use meta-genomics data to analyze microbial diversity in a soil sample.

4. Analyze results from the methylene blue reductase test to determine milk quality and identify the presence of specific microbial contaminants.
5. Evaluate different microbial bioremediation strategies for purifying polluted water and recommend the most effective method based on scientific evidence.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14

Four-year Undergraduate Programme
Subject: Botany
Semester: Seventh
Research component-(RC-1)
Course Name: *Research Methodology*
Course Level: 400-499, and subsequent level as per NEP structure

THEORY [Total marks: 60] Credit: 03; Total No. of classes: 45			
Unit no.	**Unit content**	**No. of classes**	**Marks**
Unit 1	Research methodology: Research concept, Identification of research gap, Understanding the scientific question(s), Novelty of research in support of existing literatures, setting hypothesis and objectives, writing research proposal/synopsis.	6	6
Unit 2	Experimental designs: Formulation of research problem, sampling technique, methods selection, experimental set up, data generation/acquiring, Coding/decoding and reproducibility of data.	8	10
Unit 3	Statistical analysis and data representation: SD, SE, Correlation and Regression, Test of significance, ANOVA, DMRT, data validation, biological significance of data, impact of small sampling size in data analysis, utility of computer/software (MS office, excel, power point, graphics, sigma plot, SPSS etc.) in data analysis and presentation	8	12
Unit 4	Scientific writings: Forms of scientific writing i.e. research articles, notes, reports, review, monograph, dissertation/thesis, popular article, etc. Components of research article, Writing strategy for a research article. Research ethics and Plagiarism	8	8
Unit 5	Field Techniques: Collection and preservation techniques of specimens (Algae, Fungi, Higher Plants), Instrumentation and safety measures in laboratory and field, sampling methods/strategy, Principle and application of GIS, GPS, Remote sensing Unit	8	12
Unit 6	Basic knowledge on analytical (Principle and application of UV-Vis, IR, FTIR and NMR Spectroscopy), Basic knowledge on separation techniques (Principal and application of Chromatography techniques, Gel filtration, Ion exchange, GC, HPLC), Centrifugation, Microscopy (Principle and application of Phase	7	12

	contrast, DIC, Fluorescence, Confocal, SEM, TEM) and molecular techniques.		
PRACTICAL [Credit: 01]			
1. A local field visits for collection and preservation of specimens like algae, fungi, and higher plants. 2. To perform statistical analysis using the software tool like Excel. 3. To work out standard deviation (SD), standard error (SE), correlation and regression, and test of significance. 4. Demonstrations on HPLC and gel filtration. 5. Detection of plagiarism using any plagiarism detection tool.		30	40

Suggested Readings:

1. Kumar R (2014) Research Methodology: A Step-by-Step Guide for Beginners. Sage Publications, UK.
2. Booth WC, Colomb GG, Williams JM (2016) The Craft of Research. University of Chicago Press, US.
3. Quinn GP, Keough MJ (2002) Experimental Design and Data Analysis for Biologists. Cambridge University Press, UK.
4. Montgomery DC (2019) Design and Analysis of Experiments. Wiley, United States.
5. Box GEP, Hunter JS, Hunter WG (2005) Statistics for Experimenters: Design, Innovation, and Discovery. Wiley-Interscience, US.
6. Zar JH (2010) Biostatistical Analysis. Pearson, US.
7. Schimel J (2012) Writing Science: How to Write Papers That Get Cited and Proposals That Get Funded. Oxford University Press, US.
8. Hofmann AH (2019) Scientific Writing and Communication: Papers, Proposals, and Presentations. Oxford University Press, US.
9. Brower JE, Zar JH, von Ende CN (1998) Field and Laboratory Methods for General Ecology. McGraw-Hill, US.
10. Wegmann M, Leutner B, Dech S (2016) Remote Sensing and GIS for Ecologists: Using Open Source Software. Pelagic Publishing, UK.
11. Skoog DA, Holler FJ, Crouch SR (2017) Principles of Instrumental Analysis. Cengage Learning, US.
12. Upadhyay A, Upadhyay K, Nath N (2014) Biophysical Chemistry: Principles and Techniques. Himalaya Publishing House, India.
13. Kirkup L (2002) Data Analysis with Excel®: An Introduction for Physical Scientists. Cambridge University Press, UK.
14. Leech NL, Barrett KC, Morgan GA (2011) SPSS for Intermediate Statistics: Use and Interpretation. Routledge, US.

Graduate Attributes

Course Objective:

The course aims to equip students with a comprehensive understanding of research methodology, covering key aspects such as identifying research gaps, formulating hypotheses, and designing reproducible experiments. Students will learn statistical analysis and data representation using software tools like MS Office, SPSS, and SigmaPlot. Additionally, they will receive training in scientific writing and ethical considerations, as well as field techniques including specimen collection and safety protocols. Basic knowledge of analytical techniques such as spectroscopy and microscopy will also be provided to support research endeavors.

Course outcomes:

On successful completion of the course, students will be able to:

1. Comprehend fundamental research concepts, critically analyze literature to identify gaps, and articulate scientific questions, setting clear hypotheses and objectives within the context of existing studies.
2. Apply experimental design principles to formulate research problems, select sampling techniques, design experimental setups, and ensure reproducibility through proper data coding and decoding.
3. Apply statistical methods and use software tools for data analysis and presentation, understanding the impact of sample size on data validity.
4. Create diverse forms of scientific writing, understand research article components, develop writing strategies, and evaluate ethical considerations and plagiarism.
5. Understand and implement collection and preservation techniques for various specimens (Algae, Fungi, Higher Plants), apply GIS, GPS, and remote sensing, and become proficient in various analytical techniques and microscopy methods while adhering to safety measures.

Theory Credit: 03
Practical Credit: 01
No. of Required Classes: 75 (Theory: 45; Practical: 30)
No. of Contact Classes: 75 (Theory: 45; Practical: 30)
No. of Non-Contact Classes: Nil

Particulars of Course Designer (Name, Institution, email id):

CCS, Department of Botany
Gauhati University, Guwahati-14