Bachelor of Science (BOTANY)
B. Sc. (BOTANY)
Semester: VI

Course Code	US06MABOT01(T)	Title of the Course	PLANT ECOLOGY AND PHYTOGEOGRAPHY
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. To understand the basic concepts of ecology and its interactions. 2. To study the local and geographical distribution, structural adaptations of organisms in particular environmental factors.

Course Content		
Unit	Description	Weightage* (%)
1.	**Plant Ecology:** Introduction, Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis. Soil: Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.	25%
2.	**Water:** Importance; States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table. Light, temperature, wind and fire. Variations; adaptations of plants to their variation.	25%
3.	**Biotic interactions:** Trophic organization, basic autotrophy, heterotrophy; symbiosis, commensalism, parasitism; food chains and webs; ecological pyramids; biomass, standing crop. Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts. Ecosystems: Structure; Processes; Trophic organization; Food chains and Food webs; Ecological pyramids. Biogeochemical cycles: Carbon, Nitrogen and Phosphorus.	25%
4.	**Phytogeography:** Principles; Continental drift; Theory of tolerance; Endemism; Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India	25%

Teaching-Learning Methodology	Classroom interaction, Power point presentation, Charts, quiz, assignments, seminars, online content from internet.

Evaluation Pattern		
Sr. No.	Details of the Evaluation –NEP 2020, KCG and CCE (Continuous and Comprehensive Evalution.	Weightage
1.	Internal Examination Evalution includes Class Test (At least one)-15(30%), Quiz (At least one)-15(30%), Active learning-05(10%), Home Assignment-05(10%), Class Assignment-05(10%), Attendence-05(10%) This makes total 50 Marks.	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand ecological concepts, with significance of its interrelationships.
2.	Do analysis of various components of ecosystems.
3.	Learn the concepts of phytogeography at large scale.

Suggested References:

Sr. No.	References
1.	Odum, E. P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5th edition.
2.	Singh, J. S., Singh, S. P., Gupta, S. (2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India
3	Sharma, P. D. Ecology and Environment. Rastogi Publications, Meerut, India. 13th edition.
4	Wilkinson, D. M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
5	Kormondy, E. J. (1996). Concepts of ecology. PHI Learning Pvt. Ltd., Delhi, India. 4th edition.

On-line resources to be used if available as reference material

Bachelor of Science (BOTANY)
B. Sc. (BOTANY)
Semester: VI

Course Code	US06MABOT02(T)	Title of the Course	ANGIOSPERM PLANT SYSTEMATICS
Total Credits of the Course	4	Hours per Week	4

Course Objectives:	1. To study the concepts and importance of Plant systematic. 2. To learn the importance of herbarium preparation. 3.To learn describing plant, its classification and identification with classical as well as advanced methods.

Course Content		
Unit	Description	Weightage* (%)
1.	**Significance of Plant systematics:** Introduction to systematics; Plant identification, Evidences from palynology, cytology, phytochemistry and molecular data. Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora. Documentation: Flora, Monographs, Journals; Identification Keys: Single access and Multi-access.	25%
2.	**Taxonomic hierarchy:** Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Botanical nomenclature: Principles and rules (ICBN); Ranks and names; typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.	25%
3.	**Systems of classification:** Plant classification approach (cladistics, phenetics, phyletics). Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist. Classification systems of Bentham and Hooker (upto series) and Engler and Prantl (upto series).	25%
4.	**Phylogeny of Angiosperms:** Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly and clades). Origin and evolution of angiosperms; Co-evolution of angiosperms and animals; Methods of illustrating evolutionary relationship (phylogenetic tree, cladogram).	25%

Teaching-Learning Methodology	Classroom interaction, Power point presentation, Charts, quiz, Herbaria, Preserved specimens, seminars, online content from internet.

Evaluation Pattern		
Sr. No.	Details of the Evaluation –NEP 2020, KCG and CCE (Continuous and Comprehensive Evalution.	Weightage
1.	Internal Examination Evalution includes Class Test (At least one)-15(30%), Quiz (At least one)-15(30%), Active learning-05(10%), Home Assignment-05(10%), Class Assignment-05(10%), Attendence-05(10%) This makes total 50 Marks.	50%
2.	University Examination	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Understand the significance of angiosperm plant Systematics with their taxonomic hierarchy.
2.	Learn nomenclature, systems of classification and phylogeny of angiosperm plants.
3.	Understand classical and modern taxonomical studies.

Suggested References:	
Sr. No.	References
1	Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition
2	Jeffrey, C. (1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
3	Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F. (2002). Plant Systematics-A Phylogenetic Approach. Sinauer Associates Inc., U.S.A. 2nd edition.
4	Shah G. L. (1978); Flora of Gujarat State.Part I & II. Pub. By Sardar Patel University, Gujarat.
5	Singh, Pandey and Jain: A Text Book of Botany-Angiosperms.
6	B. P. Pandey, A text book of botany-Angiosperms.
7	Heywood (ed.) Modern Methods in Plant Taxonomy..
8	Jeffery, C. An Introduction to Plant Taxonomy
9	Jones, S.B., Luchsinger, A.L.1987. Plant Systematics
10	Judd, W.S; Campbell, C.S., Kellogg, E.A; Stevens, P.F. 1999. Plant Systematics: A Phylogenetic approach
11	Lawrence, G.H.M. Vascular Plant Systematics.
12	Gurucharn Singh, (1999), Plant Systematics; Oxford & IBH pub. New Delhi

On-line resources to be used if available as reference material

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Bachelor of Science (BOTANY)
B. Sc. (BOTANY)
Semester: VI

Course Code	US06MABOT03(P)	Title of the Course	BOTANY PRACTICAL
Total Credits of the Course	4	Hours per Week	8

Course Objectives:	1. To understand the basic concepts of ecology and its interactions. 2. To study the local and geographical distribution, structural adaptations of organisms in particular environmental factors. 3. To study the concepts and importance of Plant systematic. 4. To learn the importance of herbarium preparation. 5. To learn describing plant, its classification and identification with classical as well as advanced methods.

Course Content		
Part	Description	Weightage* (%)
1.	**Ecology** 1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter. 2. Determination of pH of various soil and water samples (pH meter, universal indicator and pH meter) 3. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency from two soil samples by rapid field tests. 4. Determination of organic matter of different soil samples by Walkley & Black rapid titration method. 5. Comparison of bulk density, porosity and rate of infiltration of water in soils of three habitats. 6. Determination of dissolved oxygen of water samples from polluted and unpolluted sources. 7. Study of morphological adaptations of hydrophytes and xerophytes (four each). 8. Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobanche*); Epiphytes, Predation (Insectivorous plants). 9. Determination of minimal quadrate size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed). 10. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law. 11. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus. 12. Field visit to familiarize students with ecology of different sites.	50%

2	**Plant systematics** 1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):Ranunculaceae, Brassicaceae , Myrtaceae, Umbelliferae , Asteraceae , Solanaceae , Lamiaceae, Euphorbiaceae ,Liliaceae ,Poaceae . 2. Learn the how to identify taxa using local/regional Flora as reference. 3. Field visit, plant collection and herbarium preparation and submission. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).	50%

Teaching-Learning Methodology	Field visits, Charts, Permanent slides, Herbaria, Preserved specimens, Photographs, online content from internet.

Evaluation Pattern		
Sr. No.	Details of the Evaluation –NEP 2020, KCG and CCE (Continuous and Comprehensive Evalution.	Weightage
1.	Internal Examination Evalution includes Lab Work Assignment-20(40%),Viva voice/Lab Quiz-20(40%),Attendence-10(20%)Which makes total 50 Marks.	50%
2.	Semester End Examination Evalution includes Lab Work Assignment-40(80%), Viva voice/Lab Quiz-10(20%) This makes total 50 Marks.	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	Abiotic and biotic factors that affect, the distribution, dispersal, and behavior of organisms, how ecological systems work at different spatial and temporal scales.
2.	Biodiversity and evolution of organisms from single cell structures.
3.	Understand how to describe and identify family.
4.	Prepare herbarium.

Suggested References:	
Sr. No.	References
1	Sharma, P. D. Ecology and Environment. Rastogi Publications, Meerut, India. 13th edition
2	Wilkinson, D. M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
3	Lawrence, G.H.M. Vascular Plant Systematics.
4	Gurucharn Singh, (1999), Plant Systematics; Oxford & IBH pub. New Delhi
5	Singh, (2012). Plant Systematics: Theory and Practice Oxford & IBH Pvt. Ltd., New Delhi. 3rdedition.
6	Shah G. L. (1978); Flora of Gujarat State.Part I & II. Pub. By Sardar Patel University, Gujarat.
7	Singh, Pandey and Jain: A Text Book of Botany-Angiosperms.
8	B. P. Pandey, A text book of botany-Angiosperms
9	Kumar, H. D. (1999). Introductory Phycology. Affiliated East-West Press, Delhi

On-line resources to be used if available as reference material

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Bachelor of Science (BOTANY)
B. Sc. (BOTANY)
Semester: VI

Course Code	US06MIBOT01(T)	Title of the Course	INFORMATICS AND STATISTICS FOR BOTANY
Total Credits of the Course	2	Hours per Week	2

Course Objectives:	1. Understand the scope and applications of bioinformatics in fields like genomics, proteomics, and drug discovery. 2. Learn to navigate key biological databases such as NCBI, UniProt, and KEGG for data retrieval and analysis. 3. Grasp the basics of descriptive and inferential statistics in the context of biological data. 4. Apply statistical methods like mean, median, standard deviation, and range to analyze and interpret biological data.

Course Content		
Unit	Description	Weightage* (%)
1.	**Introduction to Bioinformatics** Historical background, Aims and scope, bioinformatics in Genomics, Transcriptomics, Proteomics, Metabolomics, Systems biology and drug discovery, Applications and Limitations in bioinformatics. **Biological databases** Introduction to biological databases - Primary, secondary and composite databases. Study of following databases: NCBI (Genbank, PubChem, Pub Med and its tools (BLAST)), introduction to EMBL, DDBJ, Uni Prot, PDB,EXPASY and KEGG	50%
2.	**Introduction to Biostatistics** – Definition, statistical methods, biological measurement, kinds of biological data, functions of statistics and limitation of statistics. **Data types and presentation** Collection of data, sampling and sampling design, classification and tabulation, types of representations, graphic – bar diagrams, pie diagrams and curves **Descriptive Statistics** Measures of central tendency - mean, median, and mode; Measures of dispersion - range, standard deviation, and standard error.	50%

Teaching-Learning Methodology	Classroom interaction, Power point presentation, Charts, quiz, assignments, seminars, online content from internet.

Evaluation Pattern		
Sr. No.	Details of the Evaluation –NEP 2020, KCG and CCE (Continuous and Comprehensive Evalution.	Weightage
1.	Internal Examination Evalution includes Class Test (At least one)-10(40%), Quiz (At least one)-05(20%), Home Assignment-05(20%), Attendence-05(10%) This makes total 25 Marks.	50%
2.	Semester End Examination(25 Marks)	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	The student will understand • the basics of bioinformatics and develop awareness of the interdisciplinary nature of this field. • learn about biological databases, sequence retrieval, alignment, and phylogenetic analysis using various tools. • understand the basic concept of sampling methods, data classification, presentation and statistical analysis.

Suggested References:	
Sr. No.	References
1.	Ghosh, Z., Mallick, B. (2008). *Bioinformatics – Principles and Applications*, 1st edition. New Delhi, Delhi: Oxford University Press.
2.	Baxevanis, A.D., Ouellette, B.F., John (2005). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
3	Roy, D. (2009). *Bioinformatics*, 1st edition. New Delhi, Delhi: Narosa Publishing House
4	Andreas, D., Baxevanis, B.F., Francis, Ouellette. (2004). *Bioinformatics: A practical guide to the analysis of genes and proteins*, 3rd edition. New Jersey, U.S.: John Wiley and Sons.
5	Khan, I.A., Khanum, A. (2004). Fundamentals of Biostatistics, 5th edition. Hyderabad: Ukaaz publications
6	Campbell, R.C. (1998). Statistics for Biologists. Cambridge, U.S.A.: Cambridge University Press

On-line resources to be used if available as reference material

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Bachelor of Science (BOTANY)
B. Sc. (BOTANY)
Semester: VI

Course Code	US06MIBOT02(P)	Title of the Course	BOTANY PRACTICAL
Total Credits of the Course	2	Hours per Week	4

Course Objectives:	To build an understanding in silico/computational approaches in various aspects of understanding biology and biological research.

Course Content		
Part	Description	Weightage* (%)
1	1.Biological databases (NCBI, EMBL, UniProt, PDB) 2. ExPasy-Enzyme nomenclature database 3. Sequence retrieval (protein and gene) from NCBI (formats - FASTA, GenBank) 4.Protein Structure retrieval from PDB (in pdb format) and visualization by viewing tools (Ras Mol/ J mol/Mol*/Swiss 3D Viewer/Pymol) 5. Multiple sequence alignment (MEGA/Clustal omega) 6. Construction of phylogenetic tree (PHYLIP/ MEGA/ Clustal omega). 7. Making of Bar diagrams, Pie chart, Histogram, Frequency polygon, Cumulative frequency curve (any four) in the given data set using Microsoft Excel 8. Calculation of mean, mode, median, standard deviation and standard error (through manual calculation and using manual and Microsoft Excel) (use only ungrouped data) 9. Student's t-test (using Microsoft Excel only), chi square test (Manual and using Microsoft Excel) 10. Submission.	100%

Teaching-Learning Methodology	Online content from internet, Chalk and duster, Charts.

Evaluation Pattern		
Sr. No.	Details of the Evaluation –NEP 2020, KCG and CCE (Continuous and Comprehensive Evalution.	Weightage
1.	Internal Examination Evalution includes Lab Work Assignment-10(40%), Viva voice/Lab Quiz-10(40%),Attendence-05(20%)Which makes total 25 Marks.	50%
2.	Semester End Examination Evalution includes Lab Work Assignment-20(80%), Viva voice/Lab Quiz-05(20%), Which makes total 25 Marks.	50%

Course Outcomes: Having completed this course, the learner will be able to	
1.	The student will understand • the basics of bioinformatics and develop awareness of the interdisciplinary nature of this field. • learn about biological databases, sequence retrieval, alignment, and phylogenetic analysis using various tools. • understand the basic concept of sampling methods, data classification, presentation and statistical analysis.

Suggested References:	
Sr. No.	References
1	Ghosh, Z., Mallick, B. (2008). *Bioinformatics – Principles and Applications*, 1st edition. New Delhi, Delhi: Oxford University Press.
2	Baxevanis, A.D., Ouellette, B.F., John (2005). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins*, 3rd edition. New Jersey, U.S.: Wiley & Sons, Inc.
3	Roy, D. (2009). *Bioinformatics*, 1st edition. New Delhi, Delhi: Narosa Publishing House
4	Andreas, D., Baxevanis, B.F., Francis, Ouellette. (2004). *Bioinformatics: A practical guide to the analysis of genes and proteins*, 3rd edition. New Jersey, U.S.: John Wiley and Sons.
5	Khan, I.A., Khanum, A. (2004). Fundamentals of Biostatistics, 5th edition. Hyderabad: Ukaaz publications
6	Campbell, R.C. (1998). Statistics for Biologists. Cambridge, U.S.A.: Cambridge University Press

On-line resources to be used if available as reference material

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Bachelor of Science
(Minor Botany)
Semester: VI

Course Code	US06MIBOT03	Title of the Course	Economic Botany
Total Credits of the Course	2	Hours per Week	2

Course Objectives:	1. To introduce students to economically important plants and their botanical details. 2. To understand the morphology, processing and uses of cereals, spices, sugars, fibers, oils and beverages. 3. To study the sources of natural products such as rubber, essential oils and fatty oils. 4. To gain knowledge about the propagation, extraction and commercial importance of major economic plants.

Course Content		
Unit	Description	Weightage* (%)
1.	Introduction with their botanical name, family, geographical distribution, important constituents, varieties and uses of a. Cereals: Wheat, Maize, Rice, Bajra, b. Spices: Black Pepper, Clove, Turmeric, Ginger, c. Sources of Sugars: Sugarcane (Morphology and Processing of sugarcane) d. Sources of Starches: Potato: Morphology. Propagation, and Uses. e. Natural Rubber: Para Rubber (Tapping, Processing, and Uses)	50%
2.	Introduction with their botanical name, family, geographical distribution, important constituents, varieties and uses of a. Beverages: Tea, and Coffee. (Morphology, and Processing) b. Classification based on the origin of fibers, Fibers: Cotton, Jute.	50%

	c. Essential Oils: General account, Extraction methods, Comparison with fatty oils, and their Uses. d. Fatty Oils and Fats: Classification of vegetable oils and Extraction methods. e. Sources of Oils and Fats: Groundnut oil, Coconut oil, Linseed oil, Mustard oil.	

Teaching-Learning Methodology	Classroom interaction, Power point presentation, Charts, quiz, assignments, seminars, online content from internet.

Evaluation Pattern		
Sr. No.	Details of the Evaluation –NEP 2020, KCG and CCE (Continuous and Comprehensive Evaluation.	Weightage
1.	Internal Examination Evaluation includes Class Test (At least one)-10 (40%), Quiz (At least one)-05 (20%), Home Assignment-05 (20%), Attendence-05(10%) This makes total 25 Marks.	50%
2.	Semester End Examination (25 Marks)	50%

Course Outcomes: Having completed this course, the learner will be able to
1. Identify economically important plants and their botanical details. 2. Understand the morphology, processing and uses of major economic crops. 3. Learn extraction and processing methods of oils, fibers and rubber. 4. Apply knowledge of economic plants in agriculture, industry and daily life

Suggested References:	
1.	Sing V., Pande, P. C. and Jain D. K. (2018), Economic botany for UG students, Rastogi Publiction, Meerut
2.	Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
3.	Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
On-line resources to be used if available as reference material (open source)	

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Bachelor of Science
B. Sc. (Minor Botany Practical)
Semester: VI

Course Code	US06MIBOT04	Title of the Course	Practical Economic Botany
Total Credits of the Course	2	Hours per Week	4

Course Objectives:	1. Perform micro-chemical tests to identify plant constituents. 2. Identify economically important plants based on botanical features. 3. Detect presence of starch, protein, sugars, oils and cellulose in plant materials. 4. Understand rubber tapping and recognize rubber products. 5. Prepare and submit a scientific project related to Economic Botany.

Course Content: Practical Aim	Weightage* (%)
1. To study the economically important Cereals: Wheat, Maize, Rice, Bajra. (botanical name, family, distribution, morphology, variety and uses) 2. To study the economically important Spices: Black Pepper, Clove, Turmeric, Ginger. (botanical name, family, distribution, morphology, variety and uses) 3. To study the economically important Sources of Sugars, and Starch: Sugarcane, Potato. (botanical name, family, distribution, morphology, and uses) 4. To study the economically important Rubber: (botanical name, family, distribution, morphology, tapping and uses through Samples of rubber products or Specimen, or Photograph/model) 5. To study the economically important Beverages: Tea, coffee. (botanical name, family, distribution, morphology, and uses) 6. To study the economically important oil yielding plants: Groundnut oil, Coconut oil, Linseed oil, Mustard oil. (botanical name, family, distribution, morphology, and uses) 7. Micro-chemical test for starch. 8. Micro-chemical test for protein. 9. To test for the reducing and non-reducing sugar. 10. To detect the presence of mucilage. 11. To detect the presence of cellulose. 12. To test for the presence of fats and oil. 13. Project submission.	100%

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Teaching-Learning Methodology	Laboratory work, Chalk and duster, Charts, Models, Online content from internet open source, collection from field visit etc.

Evaluation Pattern		
Sr. No.	Details of the Evaluation –NEP 2020, KCG and CCE (Continuous and Comprehensive evaluation.	Weightage
1.	Internal Examination evaluation includes Lab Work -10 (40%), Viva voice/Lab Quiz-10 (40%), Attendence-05 (20%) Which makes total 25 Marks.	50%
2.	Semester End Examination evaluation includes Lab Work -20(80%), Viva voice/Lab Quiz-05(20%), Which makes total 25 Marks.	50%

Course Outcomes: Having completed this course, the learner will be able to

1. Identify economically important plants based on botanical features.
2. Perform micro-chemical tests to identify plant constituents.
3. Detect presence of starch, protein, sugars, oils and cellulose in plant materials.
4. Understand rubber tapping and recognize rubber products.
5. Prepare and submit a scientific project related to Economic Botany.

Suggested References:

1.	Sing V., Pande, P. C. and Jain D. K. (2018), Economic botany for UG students, Rastogi Publiction, Meerut
2.	Kochhar, S.L. (2012). Economic Botany in Tropics, MacMillan & Co. New Delhi, India.
3.	Wickens, G.E. (2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.

On-line resources to be used if available as reference material

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