St. Xavier's College (Autonomous),

Mumbai

Syllabus of the courses offered by the Department of Botany

(2019-20)

DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester I Syllabus (2019-20)

Course Code	Course Title
SBOT0701	CRYPTOGAMS

LEARNING OBJECTIVES:

The students will be able to understand:

- The morphology, structure and importance of the organisms.
- Classification and interrelationships between various groups and reasons behind the same.
- Applications of Algae and Bryophytes in different fields.
- The range of structural variation in Algae and Bryophytes.

Unit I: Algae: (15 Lectures)

Classification of Algae up to orders (G. M. Smith), diversification of habitat, general distribution, thallus organization, origin and evolution, fossil algae. Life cycle study of *Scytonema, Volvox, Ulothrix, Gracillaria, Padina*.

Unit II: Applied Phycology: (15 Lectures)

Algal collection and preservation, techniques of culturing Algae, Concept of photo-bioreactor, Algae as biofuel, Algae causing biological hazards.

Unit III: Bryophyta I: (15 Lectures)

Classification up to order as per the system proposed by G. M. Smith, ecological and economic importance of Bryophytes. Life cycle study of *Targionia, Porella, Notothallus,* and *Polytrichium.*

Unit IV: Bryophyta II: (15 Lectures)

Origin and evolution of Bryophyta with reference to habitat and form. Evolution of the Sporophyte in Bryophyta.

CIA- multiple choice questions / assignments / presentation / field report / test.

Practicals: SBOTPR0701

1) Study of the following types: *Scytonema, Lyngbya, Anabaena, Volvox, Scenedesmus, Ulothrix, Enteromorpha, Pithophora, Closterium, Nitella, Padina,* and *Gracillaria*.
2) Study of the following types: *Riccia*, *Targionia, Marchantia, Plagiochasma, Fimbraria, Pellia, Porella, Notothallus, Sphagnum*, *Polytrichium,* and *Funaria.*
3) Estimation of biomass from suitable algal culture. Study of growth curve of algae.

References:

1. Smith, Gilbert M; Cryptogamic Botany Algae & Fungi Volume 1; 2nd edition; McGraw-hill book Comp. Tokyo, 1955.
2. Vasishtha B. R. And A. K. Sinha- Botany for degree students Part 1 ALGAE; S. Chand & Company Ltd, 1st edition, revised 2005.
3. Smith, Gilbert M; Cryptogamic Botany Bryophyta & Pteridophyta Volume 2; 2nd edition; McGraw-hill book Comp. Tokyo, 1955.
4. Parihar, N. S.; Pteridophytes: An introduction to embryophyta, vol.II; Central Book Depot , 1962.
5. Kar, Ashok Kumar; Gangulee, Hirendra Chandra; College botany: Volume II; 2nd edition; Kolkata: New Central Book Agency (P) Ltd, 1989, 2006.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester I Syllabus (2019-20)

Course Code	Course Title
SBOT0702	PLANT TAXONOMY

LEARNING OBJECTIVES

The students will be able to understand:

- Various classification systems of angiosperms and the basis of their classification.
- Evolution and study of various taxonomic characters,
- The distinguishing characters of plants belonging to different families and the economic importance of these families.

Unit I: Concept of characters: (15 Lectures)

Evolution, variation and speciation, concept of species, biosystematics categories, biotypes and ecotypes. Concept of characters: introduction, type, function. values of taxonomic characters – numerical taxonomy, chemotaxonomy, molecular systematic.

Unit II: Principles of taxonomy: (15 Lectures)

Origin and evolution of angiosperms; Principles of taxonomy and phylogeny of angiosperms for assessment of relationships, delimitation of taxa and attribution of rank: a) criteria, b) guidelines, c) practical considerations, d) use of categories.

Unit III: Classification systems: (15 Lectures)

Evolution of classification systems, ancient, modern and current systems of classification (excluding the systems covered at UG level).

Unit IV: Families: (15 Lectures)

Study of families and their economic importance: Menispermaceae, Portulacaceae, Guttiferae, Passifloraceae, Rhamnaceae, Sapindaceae, Lythraceae, Chenopodiaceae, Cyperaceae, Polygonaceae.

CIA- multiple choice questions / assignments / presentation / field trips and report / test.

Practicals: SBOTPR0702

1) Study of families: Menispermaceae, Portulacaceae, Guttiferae, Passifloraceae, Rhamnaceae, Sapindaceae, Lythraceae, Chenopodiaceae, Cyperaceae, Polygonaceae,.
2) Identification of genus and species with the help of flora volumes.
3) Field excursion.

References:

1. Simpson M. G. Plant Systematics 2nd ed., Academic Press, 2010.
2. Sivarajan, V.V. Introduction to the principles of plant taxonomy, Cambridge Univ. Press. 1995.
3. Phillippe Lemey, Macro Salemi, Anne-Mieke Vandamme, Phylogenetic Handbook - A practical approach to phylogenetic analysis and hypothesis testing.
4. Singh Gurucharan, Plant Systematics – Theory and Practice 3rd edition 2010.
5. Subrahmanyam, N.S.; Modern plant taxonomy; New Delhi: 1st edition; Vikas Publishing House Pvt. Ltd., 1995.
6. Lawrence, George H.M.; Taxonomy of Vascular Plants; 1st edition; New Delhi: Oxford &Ibh Publishing Co., 1967.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester I Syllabus (2019-20)

Course Code	**Course Title**
SBOT0703	**PLANT METABOLISM**

LEARNING OBJECTIVES

The students will be able to understand:

- Where and how energy is produced, Requirements for energy production.
- How energy production is regulated, Regulation of energy usage, sources of these requirements.
- How secondary metabolites are produced from light energy.

Unit I: Photosynthesis: (15 Lectures)

Organization of photosynthetic apparatus, light absorbing pigments, organization of light antenna systems, mechanism of electron transport, proton transport and ATP synthesis in chloroplast. Repair and regulation of photosynthetic machinery, role of carotenoids.

Unit II: Assimilation of Nutrients in Plants: (15 Lectures)

Phosphorus, Sulphur, cations and molecular oxygen assimilation in plants. Chemical fertilizers in crop production, foliar nutrition, responses of mineral toxicity, heterotrophic nutrition in higher plants (insectivorous plants)

Unit III: Regulation of metabolism in Plants: (15 Lectures)

Regulation of glycolysis, regulation of C3, C4 and CAM pathways.

Unit IV: Secondary Metabolites: (15 Lectures)

Cutins, waxes and suberin; Secondary metabolites: classes, role, biosynthesis of terpenes, phenolics and alkaloids and other compounds. Major pathways of secondary-metabolite biosynthesis and their inter-relationship with primary metabolism.

CIA - multiple choice questions / assignments / presentation / field report / test.

Practicals: SBOTPR0703

1) Enzyme kinetics: Determination of Km and Vmax of the enzyme amylase.
2) Solvent extraction of chlorophyll a/b, xanthophylls and study of absorption pattern.
3) Study of Hill Reaction.
4) Detection of tannins, saponins, alkaloids, flavonoids, steroids and triterpenoids, wax, cutin, etc.
5) Estimation of flavonoid content in the given plant sample.
6) A study of the enzyme polyphenol oxidase from potato peels.
7) Study of ratio of chl.a and chl.b in C3 and C4 plants.

Quantitative study of diurnal fluctuation in titratable acid number (TAN) in CAM plant.

References:

1. Salisbury, Frank B.; Ross, Cleon W.; Plant physiology; 3rd edition, Reprint; New Delhi: CBS Publishers & Distributors, 1986 (2001).
2. Kochhar, P. L.; A textbook of Plant Physiology; 7th edition; Delhi: Atma Ram & Sons, 1964.
3. Verma S. K. Textbook of Plant physiology and Biochemistry; 4th edition; S. Chand & Company Ltd, 2003.
4. Sinha, R. K.; Modern plant physiology; 2nd edition; New Delhi: Narosa Publishing House, 2004.
5. S. Mukherjee, Ashim Kumar Ghosh. Plant Physiology. New Central Book Agency; 3rd Revised edition 2009.
6. Hans-Walter Heldt, Birgit Piechulla. Plant Biochemistry. Academic Press; 3rd edition 2004.
7. Lincoln Taiz, Eduardo Zeiger. Plant physiology. Plants Physiology. Oxford University Press Inc.; 3rd Revised edition edition 2002.
8. Bob B. Buchanan, Wilhelm Gruissem, and Russell L. Jones. Plant biochemistry and molecular biochemistry. Wiley; 1st edition 2002.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester I Syllabus (2019-20)

Course Code	Course Title
SBOT0704	MOLECULAR BIOLOGY

LEARNING OBJECTIVES

The students will be able to understand:

- The genetic regulation in cells of living organism.
- How the higher plant organism changes over time and what are the molecular mechanisms underlying these changes.
- Identify the basic methods and approaches used in molecular biology.
- Explain the role played by the molecular components of the genetic machinery.

Unit I: Gene Regulation I **(15 Lectures)**

Control of gene expression in eukaryotes: Chromatin remodeling, transcriptional control, mRNA processing control, mRNA translocation control, mRNA degradation control, Protein degradation control.

Unit II: Gene Regulation II **(15 Lectures)**

Genetic control of development in plants: Cell differentiation, function of gene regulation, genes regulated by developmental program, environmental cues, homeobox and homeobox proteins.

Unit III: Plant biotechnology **(15 Lectures)**

Identification of Molecular markers - RFLP, RAPD, AFLP, STS, ISSR, Microsatellites. Use of YAC, BAC and viral vectors in plants. Viral vectors: General information on SV-40, Vaccinia, Baculovirus and retroviruses. Strategies to create: Transgenic plants with herbicide resistance. Methods of modifying the Diazotrophs (N_2 fixing bacteria)

Unit IV: Applications of plant biotechnology **(15 Lectures)**

Resistance to stress: insect resistance, virus resistance, herbicide, fungi and bacteria, salt and drought. Improvement of nutritional content and quality: Amino acid, lysine, vitamin content, iron, gluten, starch, fruit ripening, Food plant appearance and Plant yield: altering lignin content, increasing oxygen content. Plants as Bioreactors: Plantibodies, vaccines, biopolymers and vitamins.

CIA- multiple choice questions / assignments / presentation / field report / test.

Practicals: SBOTPR0704

1) Isolation of plasmid. Quantification of DNA.
2) Agarose gel electrophoresis separation for plasmid DNA.
3) Isolation of Plant DNA by CTAB method.
4) Restriction enzyme digestion and separation of fragments.

Reference books:

1. Amon,A., Ploegh,H., Bretscher,A. Martin,K.2016. Molecular Cell Biology. Macmillan Learning.
2. Buchanan, B., Gruissem, W. Jones, R. 2015. Biochemistry and Molecular Biology of Plant Biochemistry and molecular biology of plants. Wiley.
3. Glick, B., Pasternak, J. Patten, C. 2010. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
4. Karp, G. 2009. Cell and Molecular Biology: Concepts and Experiments Cell and molecular biology: Concepts and experiments. John Wiley & Sons.
5. Krebs J, Lewin B, Goldstein E, Kilpatrick S. 2014. Lewin's GENES XI. Jones & Bartlett Learning.
6. Russell, P. 2011. IGenetics: A Molecular Approach. Benjamin-Cummings Publishing Company.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester II Syllabus (2019-20)

Course Code	Course Title
SBOT0801	ARCHEGONIATES

LEARNING OBJECTIVES

The students will be able to understand-

- Classification and interrelationships between order of gymnosperms.
- The significance of bryophytes as pioneer plants on land and their role in the origin of pteridophytes.
- The role of pteridophytes in the origin of seed plants, and their economic importance.

Unit I: Pteridophyta I **(15 Lectures)**

Classification of pteridophyta up to orders, study of life cycles of *Osmunda, Marsilea, Ophioglossum,* and *Azolla*.

Unit II: Pteridophyta II **(15 Lectures)**

Heterospory, apospory and apogamy, economic importance of pteridophytes, cultivation and maintenance of ornamental ferns.

Unit III: Gymnosperms **(15 Lectures)**

Classification of gymnosperms up to orders; general characters, affinities and interrelationships of Cycadofilicales, Cycadales, Bennettitales, Cordaitales, Coniferales, Ginkgoales and Gnetales. Life cycle of *Araucaria* and *Podocarpus*.

Unit IV: Paleobotany **(15 Lectures)**

Fossilization Process, early non-vascular plants, ancient lycopods, Pteridospermales, conifers and flowering plants. Study of fossil form genera– *Rhynia, Calamites*, *Cordaites, Lyginopteris*, *Glossopteris*.

CIA- moodle / project / assignment / presentation / field report / test.

Practicals: SBOTPR0801

1) Gymnosperms: Study of following types - *Araucaria, Cupressus, Podocarpus*.
2) Study of types- *Psilotum, Lycopodium, Isoetes, Osmunda, Marsilea, Ophioglossum, Angiopteris, Lygodium, Salvinia, Azolla.* Study of sori of ferns.
3) Study of fossil genera– *Rhynia, Calamites*, *Sigillaria, Lepidodendron, Cordaites, Stigmaria, Sphenophyllum, Pentoxylon.*

References:

1. Smith, Gilbert M; Cryptogamic Botany Bryophyta & Pteridophyta Volume 2; 2nd edition; McGraw-hill book Comp. Tokyo, 1955.
2. Kar, Ashok Kumar; Gangulee, Hirendra Chandra; College botany : Volume II; 2nd edition; Kolkata : New Central Book Agency (P) Ltd , 1989, 2006.
3. Chamberlain, Charles Joseph; Coulter, John Merle; Morphology of Gymnosperms; 2nd edition; Allahabad : Central Book Depot, 1964.
4. Chamberlain, Charles Joseph; Gymnosperms : structure and evolution; 2nd edition; New York : Dover Publications, Inc. , 1966.
5. Introduction to paleobotany by Chester A. Arnold.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester II Syllabus (2019-20)

Course Code	Course Title
SBOT0802	ANATOMY AND MEDICINAL BOTANY

LEARNING OBJECTIVES

The students will be able to-

- Differentiate between the different meristems, learn about their locations, functions, and their division; learn the properties, features, protection and treatment of timber wood.
- Know the sources, geographical distribution and phytoconstituents of medicinal plants.
- Learn the methods to determine the quality of crudes.

Unit I: Anatomy (15 Lectures)

Meristems: Definition, type of meristems; apical cell, histogen, and tunica corpus theory. Tactile sense organs, gravitational and optical sense organs.

Unit II: Wood Anatomy (15 Lectures)

Types of wood elements; macroscopical and microscopical features of wood; physical and mechanical properties of wood; protection and treatment of wood.

Unit III: Medicinal Plants (15 Lectures)

Medicinal plants: sources and geographical distribution. Plant constituents in Vasaka, Cinchona, Digitalis, *Glycirrhiza glabra, Dioscorea sps, Artemisia*, *Terminalia bellerica, Terminalia chebula, Citronella*, fennel, and lemon grass.

Unit IV: Quality control of crude drugs (15 Lectures)

Exomorphic, endomorphic characters, and chemical tests. Standardization parameters- moisture content, solvent extraction value, bitter value, foaming index, heavy metals detection.

CIA- moodle/ project / assignment / presentation / field report / test.

Practicals: SBOTPR0802

1) Study of (a) wood elements in *Annona, Michelia, Sterculia* and *Thuja*, using the maceration technique,(b) leaf surface characters in *Pistia, Ficus, Avicennia* and *Peperomia;* (c) photosynthetic system in *Pinus*, *Cyperus, Ficus* and *Oxalis*. (d) Pollen morphology- (excluding those covered in UG).
2) Double staining of sections and making permanent slides (5 different materials)
3) Estimation of vitamin C, vitamin E in plant sample.
4) Analyze the nutritional value of honey- detection of sugars by chromatography.
5) Identification of exomorphic and endomorphic features of plants studied in theory.
6) Determine solvent extractive value, and moisture content of the given plant sample.

References:

1. Eames, Arthur J.; Mac Daniels, Laurence H.; An introduction to plant anatomy; 2nd edition. Reprint; New Delhi : Tata Mcgraw-Hill Publishing Company Limited, (1978, 2004)
2. Esau, Katherine; Anatomy of seed plants; 2nd edition; New York : John Wiley & Sons, 1977.
3. Fahn, A; Plant anatomy; 4th edition. Indian reprint; New Delhi : Aditya Books (P) Ltd., 1997.
4. Kokate, C.K.;Purohit, A.P.;Gokhale, S.B.; Pharmacognosy; 39th edition; Pune : Nirali Prakashan.
5. Trease George Edward; A text book of Pharmacognosy; Edn, Bailliere, Tindall & Cox, London, 1957.
6. Qadry, J.S.; Pharmacognosy; 16th edition; N.A. : Author , 2010.
7. Trease, George Edward;Evans, William Charles; Pharmacognosy; 11th edition; London : Cassell& Company Ltd., 1978.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester II Syllabus (2019-20)

Course Code	**Course Title**
SBOT0803	**ECOLOGY**

LEARNING OBJECTIVES

The students will be able to understand-

- The importance of ecosystem in recycling of nutrients and its benefits. Effects of climate change on vegetation. Factors which limit distribution and diversity of plants.
- Population characteristics and its estimation methods, landscape and restoration ecology.

Unit I: Ecosystem and Nutrient Cycling, and Elevated CO_2 levels (15 Lectures)

Ecosystem importance in recycling of nutrients, nutrient limitation in temperate *vs* tropical management practices on nutrient recycling (wood logging etc), Positive feedbacks between species composition and nutrient recycling. Global Change: Elevated CO_2 levels on climatic changes and its effect on vegetation, atmospheric N_2 deposition on plant communities, effect on vegetation and community structure.

Unit II: Distribution and diversity (15 Lectures)

Limiting factors (Abiotic /biotic): distribution, seed dormancy, dispersal, post dispersal, pollination and its factors. Germination: physical and environmental factors, various hypotheses on biogeography including island biogeography, Niche and theory of niche (Grinnelian and Hutchinsons models)

Unit III: Population Ecology (15 Lectures)

Life history strategies (r-K *vs* R-C-S), population growth, life history, meta-populations, genetic populations, open-closed populations, various methods to estimate populations and population size, Lotka-Volterra equation, population growth equation, life strategies and their equations.

Unit IV: Methods to estimate diversity, and Landscape ecology (15 Lectures)

Estimating diversity- alpha, beta, gamma (local and regional), density estimation, various estimators. Diversity- stability relationship; measuring biodiversity- species richness, evenness, rarefaction curve, asymptotic estimators. Landscape and Restoration ecology: Concept of scale, models in landscape ecology, cause of landscape patterns, quantifying landscape patterns for planning and conservation- direct, indirect, intermediate.

CIA- assignment / presentation / field report / test.

Practicals: SBOTPR0803

1) To record limiting factors for the coastal (brackish water) to prepare a restoration plan for the area. To determine the diversity and density using sampling techniques suitable for the forest ecosystem. To study the plant community structure by using appropriate methods (quadrat / transect) and quantifying species indicators for the ecosystem. To study the population structure of woodland ecosystem using appropriate sampling techniques.
2) To compare the biomass and net primary production; Measurement of water quality based on hardness, total alkalinity, total solids and total dissolved solids in water samples.
3) Problems on Population growth and diversity estimation.

References:

1. R.S. Ambasht - A text book of plant ecology.
2. Fundamental of Ecology (1971): E P Odum; WB Saunders Company.
3. Jogdand, SN 1995. Environmental Biotechnology. Himalaya Publishing House, Mumbai.
4. Ecology and environment; PD Sharma, Rastogi publications, Meerut. 7th ed – 2004.
5. Ecology- N.S. Subrahmanyam and A.V.S.S. Sambamurty, Narosa Publishing House, 2000;
6. Environmental Science; by-Santra SC; Central Publ. New Delhi.

DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester II Syllabus (2019-20)

Course Code	Course Title
SBOT0804	PLANT DEVELOPMENT

LEARNING OBJECTIVES

The students will be able to understand-

- The gene regulating mechanisms in the development of various floral organs.
- The process of senescence and the metabolic changes taking place in plant cell during senescence.

Unit I: Meristem Development (15 Lectures)

Organization of root apical meristems; Root development, leaf development and phyllotaxy. Transition of flowering; Floral meristems and floral development in *Arabidopsis* and *Antirrhinum*.

Unit II: Control of flowering (15 Lectures)

Floral organs, genes regulating the floral development –floral organ identity genes - MADS box genes, a model for floral evocation; SDP and LDP and florigen.

Unit III: Pollen Development (15 Lectures)

Pollen development and gene expression, male sterility, sperm dimorphism and hybrid seed production; pollen storage; pollen embryos. Types of embryo sacs. Pollen-pistil interaction and fertilization, sporophytic and gametophytic self-incompatibility. Seed development, fruit growth, embryo culture.

Unit IV: Senescence and Programmed Cell Death (15 Lectures)

Programmed cell death (PCD) an overview. Overview of senescence- pigment metabolism, protein metabolism, regulation of metabolic activity during senescence, endogenous PGRs and senescence.

CIA- MCQs / short questions / assignment / presentation / test.

Practicals: SBOTPR0804

1) Estimation of carotenoids in the young, mature and senescent leaves.
2) Study of morphology of the pollens
3) Study of pollen viability.
4) Study of meiosis in *Tradescantia* buds.
5) Study of meristems through permanent slides and photographs.
6) Determination of total proteins in plant tissue extracts (control and GA3 treated grains).

References:

1. Bob B. Buchanan (Editor), Wilhelm Gruissem (Editor), Russell L. Jones (Editor), Biochemistry and Molecular Biology of Plants, 2nd Edn. Wiley Blackwell.
2. Lincoln Taiz, Eduardo Zeiger, Ian Max Meller, Angus Murphy, Plant Physiology and Development, 6th Edn, Sinauer Associates Publications.
3. Agatha Wilson (Editor), Plant Molecular Biology,
4. R. F. Lyndon, Plant Development- The Cellular Basis.
5. Ottoline Leyser, Stephen Day, Mechanisms in Plant Development, John Wiley & Sons.
6. Donald E. Fosket, Plant Growth and Development: A Molecular Approach, Charles B. Beck,
7. An Introduction to Plant Structure and Development- Plant Anatomy for the Twenty-First Centaury, 2nd Edn. Cambridge University Press.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester III Syllabus (2019-20)

Course Code	Course Title
SBOT0901	BIOSTATISTICS

LEARNING OBJECTIVES

On completion of the course, the student shall be able to-

- Understand the basic concepts of statistics and apply them.
- Understand concepts to analyze multivariate data
- Use open source computer programs like R or PSPP for statistical analysis of sampled data.

Unit I: Understanding data structure: (15 Lectures)

Designing studies: experimentation, natural experiments, temporal dependence, replication-randomization, independence,. Variables: categorical vs continuous, dependent vs independent; classes of experiment design, probability theory.

Unit II: Descriptive Statistics: (15 Lectures)

Measures of central tendency, location and spread of data, types of distribution, parametric and non-Parametric test. Hypothesis testing: Type I and type II errors, null hypothesis, test of significance, correlation and its assumptions; students-t test and its assumptions, chi square test and its assumption.

Unit III: Data Analysis: (15 Lectures)

Regression and its assumption: linear vs non-linear models, variance estimation, model selection (AIC), ANOVA and its assumption, ANOCOVA, MANOVA, comparing means, median analysis, variance analyzing, 2-way contingency tables.

Unit IV: Multivariate Statistics: (15 Lectures)

Comparing means of 2 or more variables, multivariate normality measurement of distance ordination-PCA, FA, NMDS, advantages vs disadvantages of cluster, discriminant analysis, multiple regression.

CIA- moodle/ project / assignment / presentation / field report / test.

Practicals: SBOTPR0901

1) Using the software that provides a basic set of capabilities: frequencies, cross tabs comparison of means (t-tests and one way ANOVA); linear regression, logistic regression and re-ordering data, non-parametric tests, factor analysis, cluster analysis, principal component analysis, chi-square analysis.
2) Analyze the data for Hypothesis testing, Normal deviate test, chi-square test, correlation and regression, test of significance of means, paired and unpaired t-test, application of analysis of variance (ANOVA)
3) Basics of R software.

References:

1. Bailey, N.T.J. 1994. Statistical methods in Biology. Cambridge University Press, UK.
2. Chainy, G.B.N., Mishra, G. and Mohanty, P.K. 2005. Biostatistics. Oscar Publications India, Ltd.
3. Forthofer, R. N., Lee, E. S. and Hernandez, M. 2006. Biostatistics: A guide to design, analysis and discovery. Academic Press, London.
4. Glantz, S.A. 2005. Primer of Biostatistics, McGraw-Hill Inc., London.
5. Miller Jr, R.G., Efron, B., Brown Jr, B.W. and Mosses L.E. 1980. Biostatistics
6. Casebook. Wiley-Interscience Publishers, New York.
7. Prasad S. 2000. Fundamentals of Biostatistics. Emkey publications, Delhi.
8. Rosner, B. 2005. Fundamentals of Biostatistics. Duxbury Press.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester III Syllabus (2019-20)

Course Code	**Course Title**
SBOT0902	**PLANT PATHOLOGY**

LEARNING OBJECTIVES

The students will be able to-

- Distinguish the various symptoms of plant diseases and understand host pathogen relationship.
- Analyze the preventive and control measures and the defense strategies used by plant host.
- Learn the method of studying plant diseases and recognize the factors responsible for causing the plant diseases.
- Understand the whole process of disease cycle in some economically important plants.

Unit I: Fungi and Lichens: (15 Lectures)

Classification of fungi (C. J. Alexopoulos & C.W. Mims, 1979); various spore bearing organs, their arrangements, spore release and dispersal. Study of *Penicillium, Claviceps, Stemonitis,* and *Trichoderma.* Lichen: Thallus, morphology and reproduction in *Parmelia* and *Usnea*.

Unit II: Plant pathogens, Symptoms and Classification of plant diseases: (15 Lectures)

Plant pathogens, host pathogen relationship, dissemination of pathogens, epidemiology; disease forecasting. Classification of plant diseases. Symptoms: necrotic, atrophic, hypertrophic. host defense mechanism.

Unit III: Plant diseases: (15 Lectures)

Study of following diseases: wart disease of potato, white rust of crucifers, red rot of sugarcane, downy mildew of pea / grape, tikka disease of ground nut, powdery mildew of cereals / grasses, looser smut of wheat, brown spot of rice. citrus canker, bacterial brown rot of potato, tobacco mosaic, leaf curl of potato, root knot disease of potato / sugarcane.

Unit IV: Prevention and Control of Plant diseases: (15 Lectures)

Prevention, control, prophylaxis, therapy and immunization. Post-harvest diseases, protection of stored products. Microbes responsible for spoilage in storage: Diseases of post-harvest durables and perishables, factors affecting spoilage, management of storage fungi and decay of perishables.

CIA- moodle/ project / assignment / presentation / field report / test.

Practicals: SBOTPR0902

1) Type Study of *Penicillium*, *Stemonitis, Saprolegnia, Phytophthora, Xylaria, Peziza, Daedalea, Claviceps* and *Trichoderma.*
2) Study the symptoms and causal organism of the plant diseases mentioned in theory (three from group 1 and one each from the rest); To identify the various symptoms of plant diseases.
3) Field trip to any Agricultural Institute / University.

References

1. Smith, Gilbert M; Cryptogamic Botany Algae & Fungi Volume 1; McGraw-hill book Comp, 1955.
2. Vasishtha B.R. And A. K. Sinha- Botany for degree students Part 2 FUNGI; S. Chand & Company Ltd.
3. Alexopoulos, Constantine J.; Mims, Charles W; Introductory mycology; 3rd edition; New Delhi : Wiley Eastern Limited , 1983.
4. Kar, Ashok Kumar;Gangulee, Hirendra Chandra; College botany : Volume II; 2nd edition; Kolkata : New Central Book Agency (P) Ltd , 1989, 2006.
5. Srivastava, J.P.; An introduction to fungi; 2nd edition; Allahabad : Central Book Depot, 1962.
6. Chopra, G.L.; A classbook of fungi; 7th edition; Jullundur : S. Nagin & Co., 1964.
7. Sharma, O.P.; Textbook of algae, New Delhi: Tata Mcgraw-Hill Publishing Company Limited, 1986

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester III Syllabus (2019-20)

Course Code	Course Title
SBOT0903	APPLIED BOTANY

LEARNING OBJECTIVES:

On completion of the course, the student shall be able to understand-

- The organization of biological data, green synthesis of nanoparticles.
- Basics of plant tissue culture and its application if plant breeding
- Microbial and phytoremedial methods used in cleaning environment.

Unit I: Bioinformatics: **(15 Lectures)**

Organization of biological data; querying in databases; gene finding, motif finding and multiple sequence alignment; protein sequence analysis (theory and algorithms); exploration of databases, retrieval of desired data.

Unit II: Nanotechnology: **(15 Lectures)**

Introduction, synthesis of nanomaterials- various methods for green synthesis of nanomaterial- polysaccharide, tollens, irradiation, biological and polyoxometalates methods. Biosynthesis of nanoparticles using biological agents like bacteria, fungi, actinomycetes, yeast, algae and plants.

Unit III: Tissue culture and plant breeding: **(15 Lectures)**

Plant tissue culture: concepts of cell differentiation, pathways for in-vitro regeneration; Applications: micropropagation, meristem culture, embryo rescue, synseed production, and cryopreservation. Plant Breeding methods: selection, hybridization, polyploidy, induced mutation, in-vitro cultivation of plant cells, somatic hybrid plants, gene transfer.

Unit IV: Microbiology and phytoremediation: **(15 Lectures)**

Microbiology: Biocontrol of plant diseases, microbes and quality of environment; biodegradation of pesticides, toxic chemicals and agricultural residues. Phytoremediation: process, phytotechnologies for cleanup of pollutants in the environment, biodiversity prospecting for phytotechnologies.

CIA- open book test / assignment / presentation / field report / test/ MCQ.

Practicals: SBOTPR0903

1) Motif finding, BLAST, MSA, phylogenetic tree, DNA barcoding; Synthesis of nanoparticles, its characterization and antimicrobial activity. Induction of polyploidy using chemical agents; Preparation of explants, surface sterilization and initiation of culture.
2) Demonstrating phytoabsorption of contaminants by hydroponics. Effect of effluents containing heavy metals on germination of suitable seed material. In-vivo allelopathic studies. Study of any four bio-pesticides and their market products.

References:

1. Baxevanis, A. D. and Ouellate, B. F. F. 2009 Bioinformatics: A Practical Guide to the analysis of genes and proteins. John-Wiley and Sons Publications, New York.
2. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
3. Acquaah G, 2007. Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. USA.
4. Dubey, R. C. 2014 Advanced Biotechnology. S. Chand & Co. Pvt. Ltd., New Delhi.
5. Agarwal, K.C. 2001, Environmental Biology, Nidi Pubi. Ltd., Bikaner
6. Callow, J. A., Ford-Lloyed, B. V. and Newbury, H. J. 1997. Biotechnology and Plant Genetic Resources: Conservation and Use, CAB International, Oxon UK.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester III Syllabus (2019-20)

Course Code	Course Title
SBOT0904	**ANGIOSPERMS- I (PHYLOGENY & NOMENCLATURE)**

LEARNING OBJECTIVES

The students will be able to-

- Strengthen the fundamentals learnt in under graduate program and will learn new approaches for application of botanical knowledge in human welfare.
- Apply technological tools in unraveling the mystery of evolution, understand phylogeny, identification and understand diversity, using the knowledge in biodiversity, bioprospecting, green belt planning, and IPR.

Unit I: Evolution: (15 Lectures)

Plesiomorphic and apomorphic characters, character weighing, the effects of evolutionary theory on systematic, monographic, and floristic development. Primitive versus advanced, homology and analogy, parallelism and convergence.

Unit II: Phylogeny, Phylogenetic Techniques: (15 Lectures)

Use of cladistic in classification; understanding phylogeny, constructing phylogeny, monophyly, paraphyly and polyphyly; patterns of variation and phylogenetic trees. Building trees- rooting technique, distance methods, maximum likelyhood methods, bootstrapping using trees, phyllocode.

Unit III: Nomenclature: (15 Lectures)

ICBN 1830-Paris Code to 2018-Shenzhen code; major adaptations considered in these International Botanical Congress; important rules of ICBN, typification, type concept and types of type, basionym, homonym, tautonym, taxonomic and nomenclature synonyms.

Unit IV: Keys and GB: (15 Lectures)

Types of keys- single access and multi access keys, preparation of keys for Taxon, keys based on exomorphic characters. Green-belt planning- concept and recommendations; utility of GBP; list of plants, ornamental, flowering, shady; importance of Green Belt in the current environmental conditions in India.

CIA- MCQ / assignment / presentation / field trips and report / test/ review of research paper.

Practicals: SBOTPR0904

1) Preparation of Dichotomous Key of Five Families (min 5 genera / species from each family). Use of keys for identification of family, genus and species. Writing of species description using taxonomic terminology. Cluster analysis of any family using Cladistics techniques based on morphological characters. (practical will continue the whole semester).
2) Preparation of Herbarium specimens. 10 specimens to be prepared and submitted during practical examination. Study of published Floras, Revision and Monograph; identification, listing and analysis of their components. Field excursion.

References:

1. Amati, Marco. Urban Green Belts in the Twenty-First Century (Urban Planning and Environment) Ashgate Publishing House. 2008.
2. Gurucharan Singh, Plant Systematics - An Integrated approach 3rd edition. 2010.
3. Naik, V.N., Taxonomy of Angiosperms, Tata McGraw Hill Publishing Company. 1984.
4. Pullaiah T., Text Book of Biosystematics – Theory and Practice. Regency Publications. 2013
5. Turland, N., The Code Decoded. A User's guide to the International Code of Nomenclature for Algae, Fungi and Plants. Koeltz Scientific Books. Berlin. Germany. 2013

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester IV Syllabus (2019-20)

Course Code	Course Title
SBOT1001	INSTRUMENTATION

LEARNING OBJECTIVES

The students will be able to-

- Understand the basic concepts of microscopy, aseptic techniques, centrifugation, spectroscopy, chromatography and tracer techniques.
- Understand the applications of techniques mentioned above in biology.
- Learn the method of scientific writing.

Microscopy and Aseptic techniques: (15 Lectures)

Construction, working and applications of fluorescent and electron microscope; Using laminar air flow and autoclave; isolation, inoculation, transfer and maintenance of culture; pure culture and subculturing techniques.

Unit II: Centrifugation and Spectroscopy: (15 Lectures)

Working and applications of differential, rate-zonal, isopycnic, and density gradient centrifugation; principle, working and applications of UV-visible, IR, NMR, and atomic absorption spectroscopy.

Unit III: Chromatography and Tracer techniques: (15 Lectures)

HPLC and GC- principle, working and applications. Ion exchange, exclusion and affinity Chromatography- principle, practical procedure and applications. Tracer techniques: Principle, applications; radioisotopes and autoradiography. geiger muller counter, liquid scintillation counter.

Unit IV: Scientific writing: (15 Lectures)

Scientific writing- literature survey, journals, topic selection, hypothesis; aims, objective/s, introduction, method, results and discussion; Citing of references- analyzing journal articles, major errors, citing and using sources. Executive summaries; formatting documents; revising your paper-typesetting punctuation, summarizing.

CIA- moodle/ project / assignment / presentation / field report / test.

Practicals of MSBOTPR1001 are allotted as a project work

References:

1. S.E. Ruzin, Plant Microtechnique and Microscopy, Oxford University Press, (New York) 1999
2. Upadhyay, Upadhyay and Nath, Biophysical Chemistry: Principles and Techniques, 2014, Mumbai, Himalaya Publishing House
3. D.T Plummer, An Introduction to Practical Biochemistry,. 3 rd Ed. Tata McGraw-Hill Publishing Co. Ltd. (New Delhi). 1996
4. Freifelder, D. (1982) Physical Biochemistry 2nd edition, W.H. Freeman and Co., N.Y. USA.
5. Centrifugation : a practical approach, edited by D. Rickwood,1984, Oxford
6. John A.Adam ,Chromatographic Analysis of Pharmaceuticals 2nd ed ,Marcel Dekker Inc
7. Daniel G. Riordan, Steven E. Pauley, Biztantra: Technical Report Writing Today, 8th Edition (2004)
8. M. Frank. Writing as thinking: A guided process approach, Englewood Cliffs, Prentice Hall Reagents

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester IV Syllabus (2019-20)

Course Code	Course Title
SBOT1002	ANGIOSPERMS-II (CHARACTERS & ETHNOBOTANY)

LEARNING OBJECTIVES

The students will be able to-

- Learn the diversity, present status and interrelationships among different families apart from their characteristic features and economic importance.
- Know the importance of different anatomical, embryological and palynological features.
- To understand the use of IPR, patents, copyrights in protecting our traditional knowledge.

Unit I: Families II: (15 Lectures)

Study of the following families: Nympheaceae, Onagraceae, Vitaceae, Nyctaginaceae, Balsaminaceae, Boraginaceae, Gentianaceae, Cyperaceae, Lentibulariaceae and Commelinaceae. A detailed study of the present status, affinities, phylogeny and interrelationships of these families.

Unit II: Anatomical characters (15 Lectures)

Leaf Anatomy, types and functions of trichomes and stomata; petiole and nodal anatomy; leaf architecture – principle and methodology. Floral and wood anatomy;

Unit III: Embryological and Palynological characters (15 Lectures)

Families with embryological features– Podostemaceae, Cyperaceae and Onagraceae. Interpreting taxonomic affinities – *Trapa*, *Paeonia*, *Exocarpos*, Loranthaceae. Pollen structure; pollen aperture types and their evolution. Pollinia in Orchidaceae and Asclepiadaceae. Eurypalynous and stenopalynous taxa.

Unit IV: Ethnobotany: (15 Lectures)

Ethnobotany- Introduction, history, scope, interdisciplinary approaches. Ethnobotanical work by tribes of Maharashtra. Methods in ethnobotanical research, ethics and guidelines. Folk taxonomy of plants, bioprospecting, commercial use of traditional knowledge, equitable benefit sharing models.

CIA – MCQ, Assignments, Research paper analysis, Field excursion, Herbarium work

Practicals MSBOTPR1002 are allotted as a project work

References:

1. Bhattacharya B., Systematic Botany. 2nd Ed., Narosa Publishing House. 2009
2. Bhojwani, S.S. & Bhatnagar, S.P.: The embryology of angiosperms. (Rev. ed.) Delhi. Vikas Publishing House Pvt. Ltd., 1996.--(583.0433BHO)
3. Fahn, A.: Plant anatomy. (4th ed. Indian reprint) New Delhi. Aditya Books (P) Ltd., 1990(1997). 81-85353-41-7--(581.4FAH)
4. Foster, Adriance S.: Practical plant anatomy. (2nd ed. Indian reprint) New Delhi. Affiliated East-West Press Pvt. Ltd., 1965.--(581.4FOS)
5. Johansen, Donald Alexander: Plant embryology : Embryogeny of the Spermatophyta. Waltham. Chronica Botanica Company, 1950.--(581.33JOH)
6. Khader Ali Feroz, The Law of Patents – With special Focus on Pharmaceuticals in India(Student Ed. 2009), ISBN 9788180381508
7. Mandal F.B. and Nandi N.C., Biodiversity – Concept, Conservation and Biofuture. 2nd ed. Asian Books Pvt. Ltd., 2013.
8. Narayan P., (2006) Patent Law. ISBN 8171771785 4th Ed.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester IV Syllabus (2019-20

Course Code	**Course Title**
SBOT1003	**ANGIOSPERMS-III (TAXONOMIC AIDS)**

LEARNING OBJECTIVES

The students will be able to-

- To understand the importance and application of numerical taxonomy, various taxonomic databases and the usefulness of internet in taxonomic studies.
- To understand the use of libraries, literature, herbarium and botanical gardens.

Unit I: Numerical Taxonomy: (15 Lectures)

Principles of numerical taxonomy, OTU, taxonomic characters, coding of characters, measuring resemblance, simple matching coefficient, taxonomic distance, cluster analysis.

Unit II: Progressive taxonomy: (15 Lectures)

Progressive taxonomy- Internet, taxonomic databases (Kew, IPNI, the plantlist, tropicos, efloraindia, etc). Present status and future scope of taxonomy in India-vegetation survey, floristics, revisionary and monographic studies, ethnobiological studies, job opportunities and role of taxonomists.

Unit III: Tools in taxonomy: (15 Lectures)

Library- Literature: definition, origin, history, evolution and classification of taxonomic literature. **Herbarium**- definition, utility, development and maintenance; herbaria in India, role of BSI in herbaria, private herbaria, KEW herbarium. **Garden-** Origin, history, types, role in taxonomic studies; development of gardens in India; KEW garden; Germplasm storage techniques and its importance.

Unit IV: Applied Taxonomy (15 Lectures)

GIS: Raster, vector, projection, corrections, geo-rectification; **Remote Sensing-** Principles, types, advantages and limitations, applications in vegetation classification and forest resource management; remote sensing of soil and water. **Plant quarantine-** Purpose, history, plant protection organizations; exclusive, regular and domestic quarantine; certification of plant materials.

CIA – MCQ, Assignments, Research paper analysis, Field excursion, Herbarium work

Practicals: SBOTPR1003

1) Study of Angiosperm families as **mentioned in course 1002** for theory.
2) Study of (a) published floras (International, National, regional and local), revision, monograph and check list. Nomenclature Exercises. (b) Review of Taxonomic databases- theplantlist.org, IPNI, TROPICOS, eFloraindia. (c) Interpretation of remote sensing images. (d) Review of research paper (from any taxonomy related scientific journal)
3) Visit to plant quarantine Lab- report to be entered in journal. Preparation of diversity map for a given organism for a given area using QGIS software (or Google earth).

References:

1. Apte, T. 2006. Intellectual Property Rights, Biodiversity and Traditional Knowledge. Kalpavriksh, Grain & IIED, Pune / New Delhi.
2. Balick, M. & P. A. Cox. 1996. Plants, People, and Culture: The Science of Ethnobotany. Scientific American Library, New York.
3. Cunningham, A.B. 1993. Ethics, Ethnobiological Research, and Biodiversity. WWF. International Publication. Switzerland.
4. Duthfield, G. 2004. Intellectual Property, Biogenetic Resources and Traditional Knowledge.
5. Jain, S.K. & V. Mudgal. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh.
6. Laird, S.A. 2002. Biodiversity and Traditional knowledge Equitable partnerships in Practice. Earthscan Publications Ltd., London.
7. Singh Gurucharan, Plant Systematics – Theory and Practice 3rd edition 2010.

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DEPARTMENT OF BOTANY, ST. XAVIER'S COLLEGE (AUTONOMOUS), MUMBAI.
MSc Botany Semester IV Syllabus (2019-20)

Course Code	Course Title
SBOT1004	**ANGIOSPERMS- IV (GEOGRAPHY AND IPR)**

LEARNING OBJECTIVES

The students will be able to-

- Learn the application of technological tools used in unraveling the mystery of evolution, phylogeny, identification and diversity.
- Using the knowledge in plant geography and ethnobotany along with angiosperm taxonomy.

Unit I: Families III: (15 Lectures)

Study the following families: Oleaceae, Plumbaginaceae, Sapotaceae, Bignoniaceae, Caryophyllaceae, Loranthaceae, Urticaceae, Araceae and Orchidaceae. A detailed study of their present status, affinities, phylogeny and interrelationships.

Unit II: Cytological evidence: (15 Lectures)

Taxonomic evidences in relation with cytology**;** chromosome morphology, chromosome behavior, heterochromatin, use of cytological data at family, genus and species level.

Unit III: Plant Geography: (15 Lectures)

Historical development, physical geography of earth, theories of plant distribution, major biomes of the world; minor biomes; Phytogeographical regions of India; Endemism- role of Indian endemic flora in plant based discoveries. Descriptive and dynamic phytogeography.

Intellectual Property Rights: (15 Lectures)

IPR- Definition, types, legislation, types of patent applications, patentable and non-patentable inventions , case study of patent filing, role of patent in small and medium enterprises. Trademarks, industrial designs, and geographical indications and their benefits.

CIA – MCQs, Assignments, Research paper analysis, Field excursion, Herbarium work.

Practicals: SBOTPR1004

1) Study of Angiosperm families as **mentioned in course 1004** for theory.
2) Study of (a) Calyx in Family Lamiaceae, androecium in Leguminosae, and pollinia in Asclepiadaceae and Orchidaceae. (b) Embryo mounting – Dicot , Monocot and Polyembryony. (c) Study of leaf epidermal characters – trichomes, stomata etc. (d) Study of leaf architecture, preparation of slides and documentation of the same.
3) Morphological description of the entire plant. Preparation of synoptic keys to the families, genus and species. Study of Karyotypes of *Allium cepa* and *Aloe vera*.
4) Field excursion. Case study of patent filing.

References:

1. Alexiades, M., ed. 1996. Selected guidelines for ethnobotanical research: A field manual. New York: New York Botanical Garden.
2. Balee W. L. 2003. Footprints of the Forests. Bishen Singh Mahendar Pal Singh, India.
3. Cotton, C. M. 1997. Ethnobotany – Principles and Applications. John Wiley and Sons Limited.
4. Cunningham, A.B. 2001. Applied Ethnobotany. Earthscan Publications Ltd.
5. Jain, S.K. & V. Mudgal. 1999. A Handbook of Ethnobotany.
6. Nordentam, B., El Gazaly, G. and kassas, M. 2000.Plant systematic for 21stcentury.Portland press. Ltd, London.
7. Takhtajan, A. L. 1997. Diversity and classification of Flowering Plants. New York.
8. Sharma Arunkumar and ArchanaSharm. 1980. Chromosome Technique: Theory and Practices.

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