

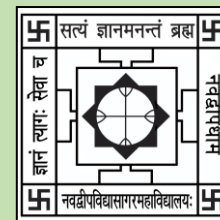


Nabadwip Vidyasagar College

Department of Botany

Under Graduate Programme

Programme Outcome (PO) and Course Outcome (CO)



Programme Outcome (PO):

- ✓ To provide detailed knowledge about different groups of plant from primitive to newly evolved one.
- ✓ To make the students familiar with the plants and its utilization in the industrial sectors.
- ✓ To prepare the students with the knowledge related to field and laboratory based studies.
- ✓ To provide knowledge to the students about the potential of these studies to become an entrepreneur.
- ✓ To provide the knowledge about the sustainable uses and conservation of plant species.
- ✓ To shape the foundation for higher studies (Mic., M.Tech., M.Phil., Ph.D.) in Botany and its allied field.
- ✓ Help the students to build the successful career in Botany.
- ✓ To enable the graduate prepare for subject/ discipline specific national as well as international competitive examinations.

Semester	Course Code	Course Content	Course Outcome (CO)
I	CC-T-01	Unit 1 Biomolecules	CO 1. Study about different biomolecules like water, sugar, protein, fat, DNA, RNA. CO 2. Information on pH and its relevance in daily life. CO 3. Structure of different biomolecules and their role.
		Unit 2 Bioenergetics	CO 4. Laws of thermodynamics CO 5. Implications of thermodynamics in daily life. CO 6. Concept of free energy, structure of ATP and its role in cellular regulation.
		Unit 3 Enzymes	CO7. Enzyme and its role in cellular activity. CO8. Structure of enzymes. CO9. Mechanism of action of enzymes.

	CC-T-01	• Unit 4 The Cell	CO10. Concept of cell. Its different part. CO11.Prokaryotes and eukaryotic cell structure. CO12.Origin of cell; endosymbiotic theory.
		• Unit 5 Cell wall and plasma membrane	CO13.Basic structure of cell wall, function of cell wall. CO14.Structure of plasma membrane, function of plasma membrane. CO15.Chrmical composition of cell wall and plasma membrane
		• Unit 6 Cell organelles	CO15.Basic information on cellular organelles. CO16.Structure of cellular organelles and their function. CO17.Basic cellular function involved with organelles.
		• Unit 7 Cell division	CO18.Basic idea of cell division. CO19.Types of cell division CO20.Regulation of cell division and implications of cell division.
	CC-T-02	• Unit 1 Morphology of leaves	CO21.Basics of leaf structure. Idea of phyllotaxy. CO22.Modification of leaves. CO23.Modification of stipules.
		• Unit 2 Morphology of inflorescence	CO24. Idea of inflorescence. CO25. Types of inflorescence. CO26. Evolution.
		• Unit 3 Morphology of flower	CO27.Basics of flower anatomy. CO28.Flower as modified shoot: idea. CO29.Adhesion, cohesion and floral formula & diagram.
		• Unit 4 Morphology of fruits and seeds	CO30.Basic idea of fruits and seeds. CO31.Fruits types and dispersal mechanism. CO32.Seed dispersal mechanism.
		• Unit 5 Cell wall	CO33.Idea of cell wall. CO34.Structure and function of cell wall. CO35.Growth, idea of apoplast sand symplast.
		• Unit 6 Tissue	CO36. Concept of tissue CO37. Classification of tissue with their distinct function.

			CO38. Understanding of pits, plasmodesmata etc.
		• Unit 7 Apical Meristem	CO39. Concept of shoot apex and root apex. CO40. Histogen theory, apical cell theory.
		• Unit 8 Primary plant body	CO41. Plant body structure concept, leaf gap CO42. Stele concept; stellar evolution.
		• Unit 9 Secondary plant body	CO43. Concept of secondary growth. CO44. Some special issues on secondary plant growth in <i>Dracaena sp.</i> , <i>Bignonia sp.</i> Etc. CO45. Concept of wood.
		• Unit 10 Adaptive and Protective systems	CO46. Concept of adaption in plants with example of cuticle, epidermis, waxes, trichome etc.
		• Unit 11 Scope of plant anatomy	CO47. Application in systematics, forensics and pharmacognosy.
II	CC-T-03	• Unit 1 Introduction to microbial world, microbial nutrition, growth and metabolism.	CO48. Basic introduction of microbial world and their characteristics features.
		• Unit 2 Viruses	CO49. Concept of virus, virion, viroids, prion, special notes on TMV, Bacteriophage and their reproduction.
		• Unit 3 Bacteria	CO50. Concept of bacteria with special notes on their reproduction, growth, nutrition.
		• Unit 4 Introduction to Algae	CO51. Concept of algae and their evolution from bacteria, general characteristics, classification, range of thallus. CO52. Role of algae in human welfare.

		• Unit 5 -7 Cyanophyta and Prochlorophyta; Rhodophyta, Chlorophyta and Charophyta; Xanthophyta and Phaeophyta	CO53. Ecology and occurrence; Range of thallus organization; Cell structure; Pigments; Nitrogen fixation; Reproduction; Morphology and life-cycle of Nostoc. Evolutionary significance of Prochloron. CO54. General characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of Chlamydomonas, Oedogonium, Coleochaete, Chara and Polysiphonia. CO55. Characteristics; Occurrence; Range of thallus organization; Cell structure; Reproduction. Morphology and life-cycles of Vaucheria, Ectocarpus and Fucus.
	CC-T-04	• Unit 1 Introduction to true fungi	CO56. Concept of fungi with special notes on their reproduction, growth, nutrition. CO57. Classification. CO58. Role in human welfare.
		• Unit 2 Chytridiomycota and Zygomycota	CO59. Characteristic features; Thallus organisation; Reproduction; Life cycle of <i>Synchytrium</i>, and <i>Rhizopus</i>.
		• Unit 3 Ascomycota	CO60. General characteristics, Sexual reproduction, development of ascus and ascospores, types of ascocarps; Heterokaryosis and parasexuality in asexual members CO61. Life cycle of <i>Saccharomyces</i>, <i>Talaromyces (Penicillium)</i>, <i>Neurospora</i> and <i>Ascobolus</i>.
		• Unit 4 Basidiomycota	CO62. General characteristics; development of basidia and basidiospores and basidiocarp. CO63. Life cycle of <i>Puccinia</i> emphasizing physiological specialization and <i>Agaricus</i>; Bioluminescence, Fairy Rings and Mushroom Cultivation.
		• Unit 5 Allied Fungi	CO64. General characteristics; Status of Slime molds, Occurrence; Types of plasmodia.
		• Unit 6 Oomycota	CO65. General characteristics; Life cycle of <i>Phytophthora</i> and <i>Albugo</i>.
		• Unit 7 Symbiotic associations	CO66. Concept of lichen and mycorrhiza, their structure. CO67. Role in human welfare.
		• Unit 8 Applied Mycology	CO68. Role of fungi in biotechnology; Application of fungi in food industry.

		• Unit 9 Plant Pathology	CO69. Basics of plant pathology, terms and concept. CO70. Concept of some plant pathogen and their diseases.
III	CC-T-05	• Unit 1-5 Bryophytes	CO71. General characteristics; Adaptations to land habit; Habitats; Range of thallus organization. Classification. CO72. Origin of bryophytes; Origin of alternation of generation (Homologous and Antithetic theories); Evolution of sporophyte (Progressive and Regressive concepts). CO73. Ecological and economic importance of bryophytes with special reference to <i>Sphagnum</i>. CO74. Lifecycle of some selected genus like <i>Riccia</i>, <i>Marchantia</i>, <i>Funaria</i>, <i>Anthoceros</i>.
		• Unit 6-10 Pteridophytes	CO75. General characteristics; Basic concepts of life cycle patterns of homosporous and heterosporous pteridophytes; Apospory and Apogamy; Habitat diversity. Classification. CO76. Origin of pteridophytes; Telome concept in land plant evolution; Structural features, geological and geographical distributions and evolutionary trends in early land plants <i>Cooksonia</i>, <i>Rhynia</i>, <i>Lepidodendron</i> and <i>Calamites</i>. CO77. Ecological and economic importance of pteridophytes. CO78. Systematic position, morphology, anatomy and reproduction of <i>Psilotum</i>, <i>Lycopodium</i>, <i>Selaginella</i>, <i>Equisetum</i>, <i>Ophioglossum</i>, <i>Pteris</i> and <i>Marsilea</i>.
	CC-T-06	• Unit 1 Progymnosperms and General account of Gymnosperms	CO79. Development of Progymnosperm concept; Diagnostic features of Progymnospermophyta; General characteristics of Gymnosperms.
		• Unit 2-5 Gymnosperms	CO80. Classification of vascular plants by Gifford and Foster (1989) with diagnostic features and examples (from division Pteridospermophyta to Gnetophyta). CO81. Systematic position, vegetative and reproductive morphology of sporophyte, wood anatomy, development of gametophyte, and embryogeny of <i>Cycas</i>, <i>Pinus</i>, <i>Ginkgo</i>, <i>Ephedra</i>, <i>Gnetum</i>; Indian distribution of each taxa. CO82. Origin and evolution of seed habit; Structural features, geological and geographical distribution, evolutionary trends in reconstructed genera <i>Lyginopteris</i>, <i>Williamsonia</i>, <i>Cordaitea</i>. CO83. Ecological and economic importance of gymnosperms.
		• Unit 6-10	CO84. Basic concept of fossils, geological era with special references to mass extinction.

		Palaeobotany	CO85. Gondwana land and plant fossils.
	CC-T-07	• Unit 1-7 Reproductive Biology of Plants	CO86. Introduction, concept of flower; flower as a modified shoot. CO87. Anther and pollen biology, ovule types. Pollen structure and concept on pollen biology. CO88. Pollination, fertilization details with references to self incompatibility. CO89. Types of embryo, endosperms, concept of apomixes, apospory, apogamy.
	SEC-T-01 B. Plant Diversity and Human Welfare	• Unit 1 Plant diversity and its scope	CO90. Concept of Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. CO91. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes.
		• Unit 2 Loss and Management of Biodiversity	CO92. Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management- Methodology for execution- IUCN, UNEP, UNESCO, WWF, NBPGR. CO94. Biodiversity legislation and conservations, Biodiversity information management and communication.
		• Unit 3 Conservation of Biodiversity	CO95. Conservation of genetic diversity, species diversity and ecosystem diversity, In situ and ex situ conservation. CO96. Social approaches to conservation, Biodiversity awareness programmes, Sustainable development.
		• Unit 4 Role of plants in relation to Human Welfare	CO97. a) Importance of forestry their utilization and commercial aspects, b) Avenue trees, c) Ornamental plants of India, d) Alcoholic beverages through ages. CO98. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses.
	CC-T-08	• Unit 1-7 Taxonomy of Angiosperms and Plant Systematics	CO99. Introduction to systematics; Plant identification, Classification (Artificial, Natural, Phylogenetic and Modern systems), Nomenclature. Taxonomy and its phases (Pioneer, Consolidation, Biosystematic and Encyclopaedic; alpha- and omega-taxonomy. CO100. Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). CO101. Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Outline of classification systems of Bentham and Hooker (1862-1883) (up to series) and Cronquist (1988); Brief
IV			

			reference of Angiosperm Phylogeny Group (APG III) classification. Description on some selected families. CO102. Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, paraphyly, polyphyly and clades). Origin and evolution of angiosperms.
	CC-T-09	• Unit 1 Introduction	CO103. Basic concepts; Levels of organization. Inter-relationships between the living world and the environment, the components and dynamism, homeostasis.
		• Unit 2 Soil	CO104. Importance; Origin; Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.
		• Unit 3 Water	CO105. Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.
		• Unit 4 Light, temperature, wind and fire	CO106. Variations; adaptations of plants to their variation.
		• Unit 5-9 Plant eco-system	CO107. Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession – processes, types; climax concepts. CO108. Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids CO109. Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.
		• Unit 10 Phytogeography	CO110. Principles; Continental drift; Theory of tolerance; Endemism. CO111. Brief description of major terrestrial biomes (one each from tropical, temperate & tundra); Phytogeographical division of India; Local vegetation.
	CC-T-10	• Unit 1-13 Economic Botany and Pharmacognosy	CO112. Concept of centres of origin, their importance with reference to Vavilov's work. Examples of major plant introductions; Crop domestication and loss of genetic diversity. CO113. General description, classification, extraction, their uses and health implications safflower, linseed, soybean, mustard and coconut (botanical name, family and uses).

			Essential Oils: General account, extraction methods, comparison with fatty oils and their uses. CO114. Introduction (Definition; Drug – Crude and commercial); Preparation of drugs; Organoleptic study of drugs; Physical and chemical evaluation of drugs; Classification of drug plants; Individual drugs; drug adulteration; constituents. CO115. Study of some drug plants (Botanical name with family, source, short description, histology, constituents, uses, adulterants).
	SEC-T-02 B. Mushroom Culture	• Unit 1-4	CO116. History, concept of mushroom culture. CO117. Process of some special mushroom culture with details. CO118. Role of mushroom, marketing, economy etc.
V	CC-T-11	• Unit 1 Plant-water relations	CO119. Water in plant life, diffusion, osmosis, imbibitions, water potential and its components; Water absorption by roots, aquaporins, pathways of water movement. CO120. Symplast, apoplast, transmembrane pathways, root pressure; Ascent of sap-cohesion-tension theory. CO121. Transpiration, factors affecting transpiration, antitranspirants, mechanism of stomatal movement, Guttation.
		• Unit 2 Mineral nutrition	CO122. Essential and beneficial elements, macro and micronutrients; Techniques used in nutritional studies and use of nutrient solutions. CO123. Criteria of essentiality, Roles of essential elements; Mineral deficiency symptoms.
		• Unit 3 Nutrient Uptake	CO124. Soil as a nutrient reservoir; Transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption. CO125. Role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, antiport.
		• Unit 4 Translocation in the phloem	CO126. Pathways of translocation, experimental evidence, Phloem sap, P-protein; Mass flow and Pressure-Flow Model; Phloem loading and unloading; Source-sink relationship.
		• Unit 5	CO127. Basic concept of plant hormone, role of hormone, mechanism of action of hormone : auxin, gibberellins, cytokinin, ethylene, ABA.

		Plant growth regulators	
		• Unit 6 Physiology of flowering	CO128. Classification of plants based on photoperiod responses, critical day length, concept of night length monitoring; Perception of flowering stimulus. CO129. Florigen concept; role of Flowering Locus T; Vernalization- Role of cold temperature in flowering.
		• Unit 7 Phytochrome, cryptochromes and phototropins	CO130. Discovery, chemical nature, role in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.
		• Unit 8 Seed dormancy	CO131. Types, factors causing dormancy, breaking down and significance of seed dormancy.
	CC-T-12	• Unit 1 Concept of metabolism	CO132. Introduction, anabolic and catabolic pathways; Regulation of metabolism; Role of regulatory enzymes (allosteric, covalent modulation and Isozymes).
		• Unit 2 Carbon assimilation	CO133. Historical background; Photosynthetic pigments, role of photosynthetic pigments (chlorophylls and accessory pigments). CO134. antenna molecules and reaction centres; Photochemical reactions, photosynthetic electron transport, PSI, PSII, Q cycle. CO135. CO₂ reduction: Calvin cycle, photorespiration, C₄ pathways; Crassulacean acid metabolism; Factors affecting CO₂ reduction.
	CC-T-12	• Unit 3 Carbohydrate metabolism	CO136. Synthesis and catabolism of sucrose and starch.
		• Unit 4 Carbon Oxidation	CO137. Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate pathway, oxidative decarboxylation of pyruvate; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle. CO138. Mitochondrial electron transport, oxidative phosphorylation; Cyanide-resistant respiration; Factors affecting respiration.

		• Unit 5 ATP-Synthesis	CO139. Mechanism of ATP synthesis; Substrate level phosphorylation: chemiosmotic mechanism (oxidative and photophosphorylation); ATP synthase, Boyers conformational model, Racker's experiment; Role of uncouplers.
		• Unit 6 Lipid metabolism	CO140. Synthesis and breakdown of triglycerides; β-oxidation of fatty acids; Glyoxylate cycle; Gluconeogenesis.
		• Unit 7 Nitrogen metabolism	CO141. Nitrate assimilation, biological nitrogen fixation (examples of legumes and non-legumes); CO142. Physiology and biochemistry of nitrogen fixation; Ammonia assimilation and transamination.
		• Unit 8 Mechanisms of signal transduction	CO143. Receptor-ligand interactions; Second messenger concept, Role of Calcium calmodulin.
	DSE-T-01 B. Industrial and Environmental Microbiology	• Unit 1 Scope of microbes in industry and environment	CO144. General concepts of industrial and environmental microbiology, principles of exploration of microorganisms of their products. CO145. Microbes in different habitats with special reference to extremophiles.
		• Unit 2 Bioreactors/ Fermenters and fermentation processes.	CO146. Concept of bioreactors, types, working principles. CO147. Uses of bioreactors.
		• Unit 3 Microbial production of industrial products.	CO148. Microorganisms involved, Media, fermentation conditions, downstream processing and uses. CO149. Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; Hands on microbial fermentations for the production and estimation (qualitative and quantitative) of different enzymes.
		• Unit 4	CO150. Microorganisms for industrial applications and hands on screening microorganisms for casein hydrolysis; starch hydrolysis; Cellulose hydrolysis.

		Microbial enzymes of industrial interest and enzyme immobilization	CO151. Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes (glucose isomerase and penicillin acylase).
		• Unit 5 Microbes and quality of environment	CO152. Distribution of microbes in air: Isolation of microorganisms from soil, air and water.
		• Unit 6 Microbial flora of water.	CO153. Concept of BOD, COD, TDS, TCS. CO154. Concept of coliform and their role in water quality. CO155. How to measure water quality.
		• Unit 7 Microbes in agriculture and remediation of contaminated soils.	CO156. Biological fixation: Bioremediation of contaminated soils. Isolation of root nodulating bacteria. CO157. Mycorrhizae with special reference to arbuscular mycorrhizal colonization in plant roots.
	DSE-T-02 B. Plant Breeding and Biometry	• Unit 1 Plant breeding	CO158. Concept, types, role in agriculture.
		• Unit 2 Methods of crop improvement	CO159. Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization. CO160. Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.
		• Unit 3 Quantitative inheritance	CO161. Concept, mechanism, examples of inheritance of Kernel colour in wheat, Skin colour in human beings. Monogenic vs polygenic inheritance.
		• Unit 4	CO162. History, genetic basis of inbreeding depression and heterosis; Applications.

		Inbreeding depression and heterosis	
		• Unit 5 Crop improvement and breeding	CO163. Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.
		• Unit 6 Biometry	CO164. Terms and Definition– sample and population, quantitative and qualitative variables, random sampling, frequency distribution, arithmetic mean, mode and median. CO165. Measurement of dispersion –standard deviation, coefficient of variation and standard error; Test of significance – Null Hypothesis, X2-test of goodness of fit, probability; Measurement of gene frequency (Hardy Weinberg hypothesis).
VI	CC-T-13	• Unit 1-11 Genetics	CO166. Concept of genetics, history, role of genetics in human welfare. CO167. Mendelian inheritance, linkage, mathematical calculation of gene distance. CO168. Mutation and its role. CO169. Central dogma and its regulation in cell. CO170. Population genetics.
		• Unit 1-6 Plant Molecular Biology and Biotechnology	CO171. Concept of plant tissue culture, history, types: micropropagation, somatic cell hybrid, artificial seeds, role in human welfare. CO172. Basic concept of recombinant DNA technology. Concept of vector. CO173. Concept of gene cloning, methods of gene transfer and gene cloning. CO174. Application of biotechnology in agriculture, human welfare. Role of transgenics in bioremediation (Superbug); edible vaccines.
	DSE-T-03 A. Biodiversity and	• Unit 1 Natural resources	CO175. Definition, types and distribution.
		• Unit 2 Land	CO176. Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation, restoration, conservation and management.
		• Unit 3	CO177. Concept, approaches (economic, ecological and socio-cultural).

	Conservation	Sustainable utilization	
		• Unit 4 Water	CO178. Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies.
		• Unit 5 Biological Resources	CO179. Concept, types, uses, conservation.
		• Unit 6 Forests	CO180. Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.
		• Unit 7 Energy	CO181. Renewable and non-renewable sources of energy
		• Unit 8 Contemporary practices in resource management	CO182. Environmental Impact Assessment (EIA), Geographical Information System (GIS). CO183. Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint; Resource Accounting; Waste management.
		• Unit 9 National and international efforts in resource management and conservation	CO184. National legislations: The Biological Diversity Act, 2002. CO185. Forest Conservation Act, 1980; Case studies relevant to resource management and conservation (eg. World Heritage Sites (Natural)/ Sacred Groves/ Biodiversity Heritage Sites/ Protection of Plant Varieties .
	DSE-T-03 A. Research Methodology	• Unit 1 Basic concepts of research	CO186. Concept, definition, types of fresearch.
		• Unit 2 General laboratory practices	CO187. Common calculation done in laboratory: percentage solution, molar solution, molal solution etc.

		• Unit 3 Data collection and documentation of observations	CO188. Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of Tissue specimens and application of scale bars. The art of field photography.
		• Unit 4 Overview of Biological Problems	CO189. History; Key biology research areas, Model organisms in biology (A Brief overview).
		• Unit 5 Methods to study plant cell/ tissue structure	CO190. Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, noncoagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.
		• Unit 6 Plant microtechniques	CO191. Staining procedures, classification and chemistry of stains. Staining equipment.
		• Unit 7 The art of scientific writing and its presentation	CO192. Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/ plagiarism.