Name of Unit	**Fundamentals of Pharmacognosy**
Subject Name	**Introduction to Pharmacognosy**
Course/Subject Code	**BP105T**
Class: B. Pharm. Semester	**Ist**
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LEARNING OUTCOME OF MODULE 01

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

NO.	**CO**
BP105.1	Describe the historical development, classification, and scope of Pharmacognosy.
BP105.2	Explain cultivation, processing, and conservation techniques for medicinal plants.
BP105.3	Apply quality evaluation methods to crude drugs using organoleptic, microscopic, and chemical parameters.
BP105.4	Identify primary and secondary metabolites with their therapeutic relevance
BP105.5	Recognize traditional systems of medicine and commonly used phyto-therapeutic agents

LO	Particular	Course Outcome Code
LO 1	Students will learn the definition, history, scope, and significance of Pharmacognosy.	**BP105.1**
LO 2	Students will learn the classification and sources of natural drugs and their applications.	**BP105.1**
LO 3	Students will learn the discovery and therapeutic importance of major natural drugs.	**BP105.4**
LO 4	Students will learn important herbal and traditional pharmacopoeias and their uses.	**BP105.5**
LO 5	Students will learn different classifications of crude drugs and distinguish official/non-official and codified/non-codified drugs.	**BP105.1 BP105.3**

CONTENT TABLE

Topic
Fundamentals of Pharmacognosy (a) Definition, history, present status, scope and development of pharmacognosy. (b) **Sources of drugs:** Plants, animals, microbial, marine, mineral and plant tissue culture. (c) **Historical milestones in drug discovery:** Morphine, quinine, aspirin, warfarin, penicillin, cephalosporin, taxol and artemisinin. (d) **Introduction to different herbal / traditional pharmacopoeias:** Indian Pharmacopoeia, British Herbal Pharmacopoeia, United States Pharmacopeia – Herbal Medicines and Dietary Supplements, Ayurvedic Pharmacopoeia of India, Unani Pharmacopoeia of India and American Herbal Pharmacopoeia. (e) **Official and non-official; codified and non-codified drugs.** Classification of crude drugs: alphabetical, morphological, taxonomical, chemical, pharmacological and chemotaxonomic classification along with their merits and limitations

1.1 DEFINITION, HISTORY, PRESENT STATUS, SCOPE AND DEVELOPMENT OF PHARMACOGNOSY

DEFINITION

Pharmacognosy is a fundamental branch of pharmaceutical sciences that deals with the scientific study of drugs obtained from natural sources, including plants, animals, minerals, and microorganisms. It encompasses the description, identification, authentication, evaluation, extraction, isolation, characterization, and standardization of crude drugs and their bioactive constituents. Unlike synthetic drug chemistry, pharmacognosy focuses on naturally occurring substances, which are chemically complex and biologically diverse.

Pharmacognosy, known initially as materia medica, may be defined as the study of crude drugs obtained from plants, animals and mineral kingdom and their constituents. A German Scientist C. A. Seydler entitled Analectica Pharmacognostica. to describe the study of medicinal plants and their properties. The word pharmacog-nosy is derived from two Latin words **pharmakon, 'a drug,'** and **gignoso, 'to acquire knowledge of'**. It means 'knowledge or science of drugs'.

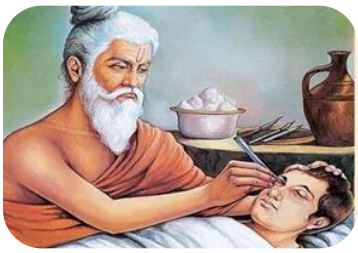
Initially, pharmacognosy was restricted to the descriptive study of medicinal plants, including their morphological and anatomical features. However, with the advancement of science and technology, it has evolved into a multidisciplinary and integrative science, combining principles of botany, taxonomy, phytochemistry, biochemistry, molecular biology, biotechnology, pharmacology, and analytical chemistry.

HISTORY OF PHARMACOGNOSY

Primitive Era

During the primitive era, early humans used natural substances such as leaves, roots, bark, fruits, animal parts, and minerals for treatment of diseases. The knowledge of medicinal plants developed mainly through observation, experience, trial-and-error methods, and observation of animal behavior. Natural substances were used for pain relief, wound healing, fever, digestive disorders, and poisonous bites. Although no written records existed during this period, the primitive era laid the basic foundation for the development of herbal medicine and pharmacognosy.

Maharishi Charaka

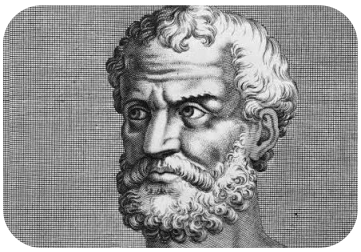


Maharishi Sushrutha

Shen-Nong

Aristotle

Hippocrates



Theophrastus

Dioscoroides

Galen

Carl Linnaeus

Friedrich Sertürner

C.A. Seydler

paracelsus

Fig 1.1 The great contributors in field of Natural Drugs

Ancient Egyptian Civilization

Ancient Egyptian civilization made one of the earliest documented contributions to pharmacognosy through the famous Ebers Papyrus written around 1550 BC. This scripture described more than 700 medicinal substances and formulations including aloe, garlic, castor oil, senna, and opium. Egyptian physicians developed methods for preparation, storage, and therapeutic use of herbal medicines and contributed significantly to early pharmaceutical knowledge.

Ancient Indian Civilization

Charaka

Charaka, known as the "Father of Indian Medicine," wrote the famous Charaka Samhita. He systematically described medicinal plants, herbal formulations, disease classification, and therapeutic applications of natural drugs used in Ayurveda. His work established the scientific foundation of Ayurvedic medicine and pharmacology.

Sushruta

Sushruta is regarded as the "Father of Surgery." In his classical text Sushruta Samhita, he described medicinal plants, surgical procedures, toxicology, wound healing methods, and pharmaceutical preparations. His work greatly advanced ancient medical and pharmaceutical sciences.

Ancient Chinese Civilization

Shennong, known as the "Divine Farmer" and regarded as the "Father of Chinese Medicine," compiled the ancient Chinese text Pen Tsao. This work documented hundreds of medicinal plants and natural drugs such as ginseng, ephedra, cinnamon, and rhubarb. It formed the foundation of Traditional Chinese Medicine and herbal therapeutics.

Ancient Greek Civilization

Hippocrates

Hippocrates is known as the "Father of Medicine." He introduced scientific observation and rational therapy in medicine and emphasized the use of medicinal plants for treatment of diseases. His work replaced supernatural beliefs with logical medical practices and strongly influenced future medical sciences.

Theophrastus

Theophrastus is regarded as the "Father of Botany." In his book Historia Plantarum, he described plant morphology, classification, cultivation, and medicinal properties. His contributions laid the

foundation for botanical classification and scientific study of medicinal plants.

Dioscorides

Dioscorides wrote the famous De Materia Medica, which described approximately 600 medicinal plants and natural drugs. He explained methods of collection, identification, storage, preparation, and therapeutic uses of crude drugs. His work remained a standard pharmacological reference for nearly 1500 years.

Ancient Roman Civilization

Galen is regarded as the "Father of Pharmacy." He developed methods for preparation of herbal extracts and pharmaceutical formulations known as "Galenicals." His contributions significantly advanced pharmaceutical compounding and drug preparation techniques.

Arab-Persian Civilization

Avicenna, known as the "Prince of Physicians," wrote the famous The Canon of Medicine. He described medicinal plants, pharmacological actions, disease treatments, and preparation of medicines. His work greatly influenced medicine and pharmacy in Asia and Europe for centuries.

Modern Era

Renaissance Period

Paracelsus is known as the "Father of Toxicology." He introduced chemical medicines and emphasized the importance of dose in therapy. His famous statement, "The dose makes the poison," became a fundamental principle in pharmacology and toxicology.

Carl Linnaeus

Carl Linnaeus is regarded as the "Father of Taxonomy." He developed the modern system of plant classification and binomial nomenclature, which greatly improved scientific identification and classification of medicinal plants used in pharmacognosy.

Friedrich Sertürner

Friedrich Sertürner was the first scientist to isolate Morphine from opium in pure form in 1805. His discovery initiated alkaloid chemistry and marked the beginning of modern phytochemical and pharmacognostic research.

C.A. Seydler

C.A. Seydler first used the term "Pharmacognosy" in his work Analecta Pharmacognostica published in 1815. His contribution formally established pharmacognosy as a scientific discipline dealing with natural drugs.

Contemporary Modern Era

In the contemporary era, Pharmacognosy has evolved into a highly advanced interdisciplinary science integrating phytochemistry, pharmacology, biotechnology, molecular biology, genomics, metabolomics, and bioinformatics. Modern pharmacognosy now includes herbal drug standardization, marine pharmacognosy, molecular pharmacognosy, tissue culture, biotechnology-based drug discovery, and evidence-based validation of traditional medicines.

SCOPE OF PHARMACOGNOSY

Pharmacognosy is critical in development of different disciplines of science. The knowledge of plant taxonomy, plant breeding, plant pathology and plant genetics is helpful in the development of cultivation technology for medicinal and aromatic plants.

Pharmacognosy is important branch of pharmacy which is playing key role in new drug discovery and development by using natural products. It is an important link between pharmacology and medicinal chemistry.

By means of Pharmacognosy, natural products can be dispensed, formulated and manufactured in dosage forms acceptable to modern system of medicine. Development of Pharmacognosy also leads to development of botany, taxonomy, plant biotechnology, plant genetics, plant Pathology, Pharmaceutics, Pharmacology, Phytochemistry and other branches of science.

Pharmacognosy is a branch of pharmaceutical science that deals with the study of drugs obtained from natural sources such as plants, animals, minerals, and microorganisms. Its scope is very broad and includes the identification, cultivation, extraction, evaluation, standardization, and therapeutic use of natural drugs. It also combines traditional knowledge with modern scientific techniques for the discovery and development of medicines.

Source, Collection and Identification

Pharmacognosy deals with the identification, authentication, collection, cultivation, processing, and storage of crude drugs obtained from natural sources such as plants, animals, minerals, and marine organisms. Proper handling and preservation methods are important to maintain the quality and medicinal value of crude drugs.

Macroscopic and Microscopic Study

This area includes the study of the external and internal characteristics of crude drugs. Macroscopic evaluation involves observing size, shape, color, odor, and texture, while microscopic evaluation studies cellular structures, tissues, and histological features for accurate identification and detection of adulteration.

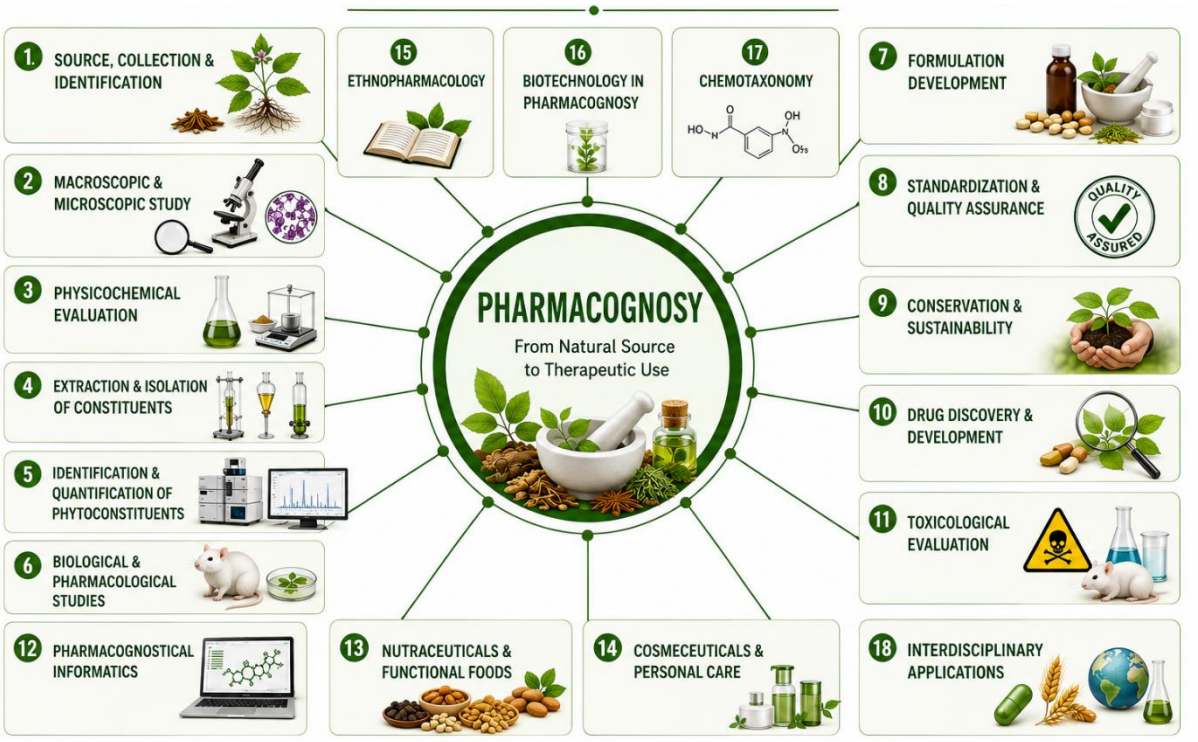


Fig 1.2. The Scope of Pharmacognosy

Physicochemical Evaluation

Pharmacognosy involves the determination of physicochemical parameters such as ash value, extractive value, moisture content, volatile oil content, and foreign matter. These parameters help in quality control, purity testing, and standardization of herbal drugs.

Extraction and Isolation of Constituents

This branch focuses on the extraction, isolation, purification, and characterization of bioactive compounds from natural sources. Various extraction techniques are used to isolate alkaloids, glycosides, flavonoids, tannins, terpenoids, steroids, and volatile oils.

Identification and Quantification of Phytoconstituents

Modern analytical methods such as Thin Layer Chromatography (TLC), High Performance Liquid Chromatography (HPLC), Gas Chromatography-Mass Spectroscopy (GC-MS), UV spectroscopy, IR spectroscopy, and NMR spectroscopy are used for qualitative and quantitative analysis of phytochemicals.

Biological and Pharmacological Studies

Pharmacognosy evaluates the biological activities of medicinal plants and natural products, including antimicrobial, antioxidant, anti-inflammatory, antidiabetic, anticancer,

hepatoprotective, and cardioprotective activities. It also studies toxicity, mechanism of action, and safety profiles.

Formulation Development

The subject contributes to the development of herbal formulations such as tablets, capsules, syrups, ointments, gels, tinctures, and creams. It also includes dosage form design, optimization, and stability studies of herbal medicines.

Standardization and Quality Assurance

Pharmacognosy ensures the quality, purity, safety, and efficacy of herbal products by establishing standards and specifications. It also involves Good Manufacturing Practices (GMP), regulatory compliance, and quality assurance of raw materials and finished products.

Conservation and Sustainability

The field promotes conservation of medicinal plants and biodiversity through sustainable harvesting, cultivation practices, in vitro conservation, and ex situ conservation methods to prevent extinction of valuable medicinal species.

Drug Discovery and Development

Natural products are important sources of new drug molecules. Pharmacognosy helps in screening natural products for pharmacological activity and developing novel therapeutic agents from plants and microorganisms.

Toxicological Evaluation

This area deals with the assessment of acute, sub-acute, and chronic toxicity of herbal drugs and natural products. Safety evaluation is necessary to ensure safe therapeutic use and avoid adverse effects.

Pharmacognostical Informatics

Pharmacognosy uses databases, bioinformatics, chemoinformatics, and computational tools for drug discovery, phytochemical analysis, medicinal plant documentation, and research studies.

Nutraceuticals and Functional Foods

The subject includes the study and development of nutraceuticals, dietary supplements, and functional foods derived from natural sources that provide health benefits beyond basic nutrition.

Cosmeceuticals and Personal Care

Natural products are widely used in cosmetics and personal care formulations such as herbal creams, shampoos, lotions, anti-aging products, and skincare preparations due to their therapeutic and protective effects.

Ethnopharmacology

Ethnopharmacology studies traditional systems of medicine and indigenous knowledge regarding the medicinal use of plants and natural substances by different cultures and communities.

Biotechnology in Pharmacognosy

Biotechnology techniques such as plant tissue culture, hairy root culture, genetic engineering, and metabolic engineering are used for large-scale production and enhancement of medicinal compounds.

Chemotaxonomy

Chemotaxonomy involves the classification and identification of plants based on their chemical constituents. It helps in understanding plant relationships and discovering new medicinal species.

Interdisciplinary Applications

Pharmacognosy has applications in pharmacy, medicine, agriculture, food industry, veterinary science, biotechnology, environmental science, and cosmetic industries. It integrates traditional knowledge with modern scientific research for healthcare advancement.

PRESENT STATUS OF PHARMACOGNOSY

At present, Pharmacognosy has evolved into one of the most dynamic, research-oriented, and globally significant branches of pharmaceutical sciences. What once began as the simple study of crude drugs from natural sources has now transformed into a highly advanced interdisciplinary science integrating phytochemistry, biotechnology, molecular biology, pharmacology, analytical chemistry, genomics, metabolomics, and bioinformatics. With the increasing worldwide demand for herbal medicines, natural therapeutics, nutraceuticals, and plant-based healthcare products, pharmacognosy has gained tremendous importance in modern medicine and pharmaceutical industries.

In the present era, natural products continue to remain one of the richest sources of novel therapeutic agents. Several life-saving drugs used today, including anticancer, antimalarial, analgesic, antimicrobial, and cardiovascular drugs, have originated directly or indirectly from

natural sources. Pharmacognosy therefore plays a central role in modern drug discovery and development. The growing problem of antimicrobial resistance, adverse effects associated with synthetic drugs, and increasing preference for safer and eco-friendly medicines have further strengthened the importance of pharmacognostic research worldwide.

Modern pharmacognosy is no longer confined only to identification of medicinal plants; it now encompasses advanced scientific approaches for isolation, characterization, standardization, and quality evaluation of bioactive compounds. Sophisticated analytical techniques such as HPLC, HPTLC, GC-MS, LC-MS/MS, DNA fingerprinting, metabolomic profiling, and tissue culture technology are extensively used for authentication and quality assurance of herbal drugs and phytopharmaceuticals. In addition, pharmacognosy has become an essential component in the development of standardized herbal formulations, functional foods, cosmeceuticals, and nutraceutical products.

The subject also contributes significantly to conservation of medicinal plants, sustainable utilization of natural resources, and validation of traditional systems of medicine such as Ayurveda, Unani, Siddha, and Traditional Chinese Medicine. Emerging areas like marine pharmacognosy, nano-pharmacognosy, ethnopharmacology, and molecular pharmacognosy have further expanded its scope and research potential.

Thus, the present status of pharmacognosy reflects its remarkable transformation from a traditional descriptive discipline into a modern, innovative, and indispensable scientific field that serves as a bridge between nature and modern medicine. It continues to play a crucial role in global healthcare, pharmaceutical innovation, and the discovery of safer and more effective therapeutic agents for the future.

1.2. SOURCES OF NATURAL DRUGS

Natural drugs are obtained from a wide variety of sources, including plants, animals, microorganisms, marine organisms, minerals, and biotechnological products. Among these, plants constitute the most significant source and provide drugs such as digitalis, senna, cinchona, and aloe. Animal-derived drugs include honey, cod liver oil, heparin, and insulin. Microorganisms serve as sources of antibiotics, enzymes, and vitamins, while marine organisms yield valuable compounds with anticancer, antiviral, and anti-inflammatory activities. Certain mineral substances such as kaolin and talc are also used therapeutically. Recent advances in biotechnology have further expanded the sources of natural drugs through tissue culture, genetic engineering, and microbial fermentation.

Table 1.1. Natural Sources of Drugs

Source	Description	Examples of Crude Drugs / Products
Plants	Plants are the major source of crude drugs. Different plant parts such as leaves, roots, bark, flowers, fruits, seeds, and rhizomes are used medicinally.	Senna (leaves), Cinchona (bark), Clove (flower), Ginger (rhizome), Digitalis
Animals	Drugs obtained from animals or animal products are used directly or after processing.	Honey, Gelatin, Cod liver oil, Pearl, Snake venom, Cantharides
Microbial Sources	Microorganisms such as bacteria, fungi, and actinomycetes produce important antibiotics, enzymes, and bioactive compounds.	Penicillin, Streptomycin, Bacitracin, Erythromycin, Cephalosporin
Marine Sources	Marine plants and animals provide biologically active compounds with therapeutic importance.	Agar, Algin, Heparin, Cytarabine, Omega-3 fatty acids
Mineral Sources	Drugs obtained from minerals and inorganic substances are used after purification and processing.	Kaolin, Talc, Sulphur, Iron compounds, Magnesium sulphate
Plant Tissue Culture	In vitro culture techniques are used to grow plant cells, tissues, or organs under sterile conditions for production of secondary metabolites and conservation.	Taxol, Shikonin, Ginseng cultures, Dioscorea cultures

Plant Sources

Plant source is the oldest source of drugs. Most of the drugs in ancient times were derived from plants. Almost all parts of the plants are used i.e. leaves, stem, bark, fruits and roots.

The number of species of flowering plants is estimated to be 2 to 2.5 lakhs falling in about 300 families and 10000 genera. Only a small percentage of the total species have been studied scientifically for the presence of any therapeutic activity and isolation of the responsible bioactive compound isolated.

Majority of the natural drugs from plant sources are derived from Spermatophytes (seed bearing plants). Thy phyla Angiosperme is the dominant one while the phyla Gymnospermae yields few useful drugs such as Turpentine oil, Colophony, ephedrine etc. Male Fern from Pteridophyta provides Taenicidal (tape worm killing) agents

In Angiospermae, Dicotyledon plants provide more drugs than the Monocotyledon plants which yield limited drugs such as Squill, Lemon grass oil, Aloes etc.

Examples of drugs obtained from plants include Quinine, Atropine, Cocaine, Morphine, Codeine, Ergotamine, Reserpine, Caffeine, Sennosides, Glycyrrhizin, volatile oils, fixed oils etc.

Animal Sources:

Gelatin is obtained from ox and sheep, Wool fat from sheep, Beeswax from honeycomb,

Cochineal from insects are some examples of drugs obtained from land animals. Spermaceti, Shark liver oil, Cod liver oil, halibut liver oil are some of the drugs obtained from marine animals.

Microbial Sources:

Well-known antibiotics produced by a group of microorganisms known as actinomycetes yielding antibiotics such as actinomycin, amphotericin, chloramphenicol, erythromycin, kanamycin, neomycin, gentamicin, streptomycin and tetracycline.

Aspergillate group of fungi produce antibiotics such as penicillin, griseofulvin and cephalosporin. Among the bacteria, genus Bacillusproduces antibiotics such as polymyxin B and bacitracin. Ergot alkaloids also are obtained from a resting stage of a fungus.

Algae are source of limited number of drugs such as Agar and Alginate

Mineral Sources:

Several silicates such as Kaolin, Bentonite, Diatomite and compounds of Na, K, Al, Ca, Mg etc. are obtained from Mineral sources including Sulphur and Iodine.

Plant Tissue Culture:

It is in-vitro cultivation of plant cell or tissue under aseptic and controlled environmental conditions, in liquid or on semisolid well- defined nutrient medium for the production of primary and secondary metabolites or to regenerate plant. This technique affords alternative solution to problems arising due to current rate of extinction and decimation of flora and ecosystem. Applications are Production of Phytopharmaceuticals, Biochemical Conversions Clonal Propagation (Micro-propagation), Production of Immobilized Plant Cell and Sources of drugs of naturalorigin.

Marine Sources:

The greater part of the earth surface is covered by seas and ocean, which contains about 5,00,000 species of marine organisms. Many of these compounds have shown pronounced biological activity. In the western medicine agar, alginic acid, carrageenan, protamine sulphate, spermaceti & cod and halibut liver oils are the established marine medicinal products. Macroalgae or seaweeds have been used as crude drugs in the treatment of iodine deficiency states such as goiter, etc. Various examples are-

Anticancer drug- Bryostatins, Dolastatins,Ara-C

Anti-inflammatory drugs- Pseudoterosins, bi-indole, Manoalide

Cardio-vascular drugs- Anthopleurins, Laminine,Saxitoxin

Anthelmintic drugs- Kainic acid, Domoic acid

Antimicrobial drugs- Cephalosporin, Istamycin, Nitenin

1.3 HISTORICAL DEVELOPMENTS IN DRUG DISCOVERY

Phytochemicals are naturally occurring chemical compounds produced by plants, many of which possess important medicinal, nutritional, and therapeutic properties. The historical development of phytochemicals began with the ancient use of medicinal plants in traditional systems of medicine such as Ayurveda, Traditional Chinese Medicine, Egyptian medicine, and Greek medicine. Early civilizations used crude plant materials for treatment of diseases without knowing the exact active constituents responsible for their effects.

The scientific study of phytochemicals started during the 18th and 19th centuries with the development of extraction and isolation techniques. In 1805, Friedrich Sertürner successfully isolated morphine from opium, marking the beginning of alkaloid chemistry and modern phytochemical research. This discovery encouraged scientists to isolate and identify other active plant constituents such as quinine, caffeine, atropine, nicotine, and glycosides.

During the late 19th and early 20th centuries, advancements in organic chemistry, chromatography, and spectroscopy greatly improved the identification and structural elucidation of phytochemicals

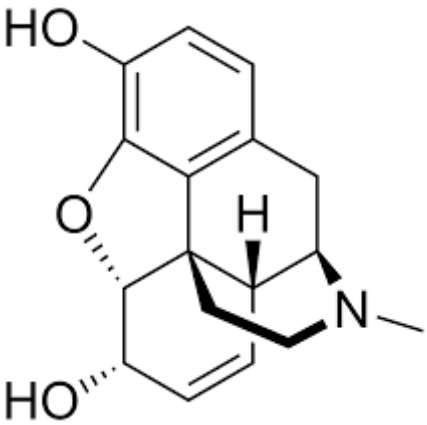
In modern times, phytochemicals play a major role in drug discovery, nutraceuticals, cosmetics, and pharmaceutical research. Advanced analytical techniques such as HPLC, GC-MS, IR, NMR, and mass spectrometry are widely used for the isolation, characterization, and standardization of plant constituents. Today, phytochemical research continues to contribute significantly to the development of new medicines and healthcare products derived from natural sources.

Table 1.2. Historical Development in Drug Discovery

Drug	**Natural Source**	**Chemical Class**	**Discovery Year**	**Scientist**	**Use**
Morphine	Papaver somniferum	Alkaloid	1803–1805	Friedrich Sertürner	Analgesic
Quinine	Cinchona officinalis	Alkaloid	1820	Pelletier & Caventou	Antimalarial
Aspirin	Willow bark	Salicylate	1897	Felix Hoffmann	Analgesic, antipyretic
Warfarin	Sweet clover derivative	Coumarin derivative	1940	Karl Paul Link	Anticoagulant
Penicillin	Penicillium mold	Beta-lactam antibiotic	1928	Alexander Fleming	Antibiotic
Cephalosporin	Cephalosporium fungus	Beta-lactam antibiotic	1945	Giuseppe Brotzu	Antibiotic
Paclitaxel	Taxus brevifolia	Diterpenoid	1967	Wall & Wani	Anticancer
Artemisinin	Artemisia annua	Sesquiterpene lactone	1972	Tu Youyou	Antimalarial

MORPHINE

Morphine is one of the most important alkaloids discovered in the history of medicine and pharmacognosy. It was the first alkaloid isolated in pure form from a natural source and marked the beginning of modern alkaloid chemistry and scientific drug discovery. Morphine is obtained from the latex of Papaver somniferum and possesses powerful analgesic properties. It remains the gold standard opioid analgesic for severe pain management.



1.3 a. Structure of Morphine ***b. Opium flowers and Capsules***

Historical Development

- Ancient civilizations such as Egyptians, Greeks, Indians, Chinese, and Romans used opium for pain relief and sedation.
- During the Middle Ages, opium preparations became widely used medicinally and recreationally.
- In 1805, German apothecary Friedrich Sertürner isolated morphine as a pure crystalline alkaloid.
- Sertürner named the compound “Morphium” after Morpheus, the Greek god of dreams.
- In 1817, Joseph Louis Gay-Lussac helped publish Sertürner’s findings and modified the name to “Morphine.”

- Commercial production of morphine began in Europe during the 1820s.
- In the 1850s, the hypodermic syringe enabled injectable morphine therapy.
- In 1819, Meissner classified morphine as an alkaloid.
- Robert Robinson later elucidated the morphinan ring structure of morphine.
- In 1952, Marshall D. Gates Jr. achieved the first total synthesis of morphine.

Uses

Severe pain management

Cancer pain

Postoperative analgesia

Trauma and palliative care

Myocardial infarction pain relief

QUININE

Quinine is one of the earliest and most important plant-derived antimalarial drugs. It is obtained from the bark of Cinchona officinalis and played a revolutionary role in malaria treatment and tropical medicine. Quinine became one of the earliest successful examples of pure alkaloid isolation from medicinal plants.

Fig 1.4. a. Structure of Quinine b. Cinchona bark

Historical Development

- Indigenous South Americans traditionally used cinchona bark to treat fever.
- Jesuit missionaries introduced cinchona bark into Europe during the seventeenth century.
- Cinchona bark became known as “Jesuit’s bark” or “Peruvian bark.”
- Around 1630, the Countess of Chinchón reportedly recovered from malaria using cinchona bark.
- In 1820, Pelletier and Caventou isolated quinine from cinchona bark.

- Standardized quinine therapy significantly improved malaria treatment.
- Cinchona plantations were established in India, Java, and Sri Lanka.
- In 1944, Woodward and Doering reported formal total synthesis of quinine.
- During World War II, quinine shortages stimulated synthetic antimalarial research.

Uses

- Treatment of severe malaria
- Drug-resistant malaria
- Antipyretic action
- Flavoring agent in tonic water
- Research in antimalarial pharmacology

ASPIRIN

Aspirin is one of the most widely used drugs in medicine and is known for its analgesic, antipyretic, anti-inflammatory, and antiplatelet properties. It originated from willow bark obtained from the willow tree, Salix alba, which had been used in traditional medicine for centuries. Aspirin became a landmark in synthetic medicinal chemistry and modern therapeutics.

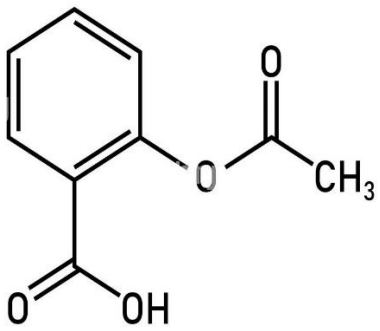


Fig. 1.5. a. Structure of Aspirin ***b. Willow bark***

Historical Development

- Ancient Egyptians, Greeks, and Romans used willow bark for pain and fever relief.
- Hippocrates recommended willow bark for pain and fever.
- In 1828, Johann Buchner isolated salicin from willow bark.
- Henri Leroux improved extraction of salicin.
- In 1838, Raffaele Piria converted salicin into salicylic acid.
- Salicylic acid showed strong analgesic and antipyretic activity but caused gastric irritation.
- In 1853, Charles Frédéric Gerhardt synthesized acetylsalicylic acid.

- In 1897, Felix Hoffmann synthesized stable aspirin at Bayer.
- In 1899, Bayer marketed aspirin commercially.
- In 1971, John Robert Vane discovered inhibition of prostaglandin synthesis by aspirin.

Uses

- Analgesic
- Antipyretic
- Anti-inflammatory drug
- Prevention of heart attacks
- Prevention of stroke
- Antiplatelet therapy

WARFARIN

Warfarin is one of the most important oral anticoagulants in cardiovascular medicine. Its discovery originated from cattle bleeding disease caused by spoiled sweet clover. Warfarin revolutionized anticoagulant therapy and became widely used for prevention and treatment of thromboembolic disorders.

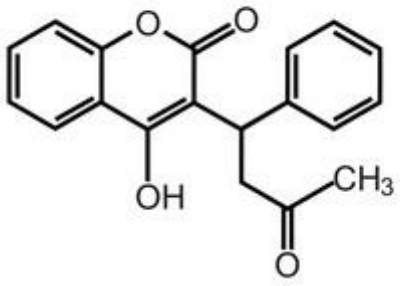


Fig. 1.6. a. Structure of Warfarin ***b. Sweet Clover***

Historical Development

- During the 1920s, cattle consuming spoiled sweet clover developed severe bleeding disorders.
- The condition became known as sweet clover disease.
- In the 1930s, Karl Paul Link investigated the cause of the disease.
- In 1940, dicoumarol was isolated from spoiled sweet clover.
- Dicoumarol was identified as a potent anticoagulant.
- Link's research team synthesized related anticoagulant compounds.
- Warfarin emerged as the most effective derivative.

- In 1948, warfarin was marketed as a rodenticide.
- In 1954, warfarin was approved for human therapeutic use.
- Later studies established its vitamin K antagonistic mechanism.

Uses

- Prevention of thrombosis
- Deep vein thrombosis
- Pulmonary embolism
- Atrial fibrillation
- Stroke prevention
- Prosthetic heart valve anticoagulation

PENICILLIN

Penicillin is regarded as one of the greatest discoveries in medical history. It was the first true antibiotic and revolutionized the treatment of bacterial infections. The discovery of penicillin marked the beginning of the antibiotic era and transformed modern therapeutics and microbiology.

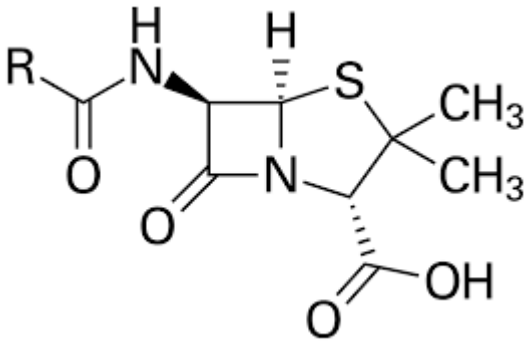


Fig. 1.7. Structure of Penicillin ***b. Penicillium chrysogenum***

Historical Development

- Ancient civilizations used moldy materials to treat wounds.
- Louis Pasteur and Robert Koch established microbial causes of infectious diseases.
- In 1928, Alexander Fleming discovered penicillin accidentally from Penicillium mold (*Penicillium chrysogenum*) contamination.
- Fleming observed inhibition of bacterial growth around the mold colony.
- Penicillin showed strong activity against Gram-positive bacteria.
- In the late 1930s and early 1940s, Florey, Chain, and Heatley purified penicillin.

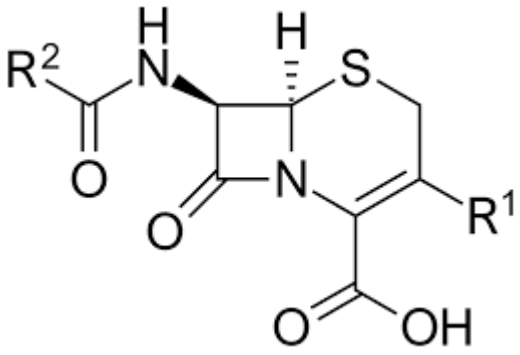
- In 1941, penicillin was first used clinically.
- During World War II, large-scale fermentation production was developed.
- Dorothy Hodgkin elucidated the β-lactam ring structure.
- In 1945, Fleming, Florey, and Chain received the Nobel Prize.

Uses

- Respiratory tract infections
- Skin infections
- Syphilis
- Streptococcal infections
- Pneumonia
- Septicemia
- Surgical infections

CEPHALOSPORIN

Cephalosporins are important β-lactam antibiotics widely used against bacterial infections because of their broad-spectrum activity and low toxicity. Their discovery represented a major advancement in overcoming penicillin resistance.



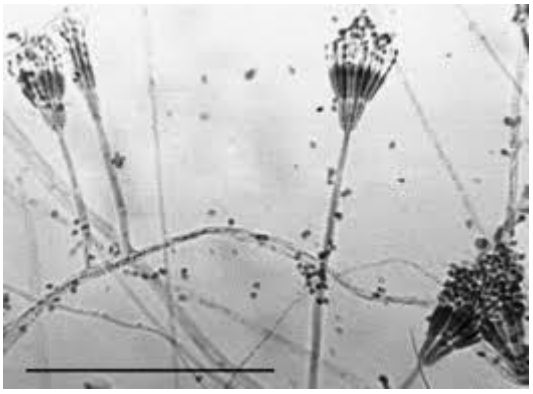


Fig.1.8. a. Structure of Cephalosporin ***b. Cephalosporium acremonium***

Historical Development

- Penicillin resistance stimulated search for newer antibiotics.
- In 1945, Giuseppe Brotzu discovered antibacterial activity in seawater near Sardinia.
- Brotzu isolated *Cephalosporium acremoniu*m fungus.
- Oxford researchers Edward Abraham and Guy Newton isolated cephalosporin C.
- Cephalosporin C showed resistance to penicillinase enzymes.
- Scientists identified the 7-aminocephalosporanic acid nucleus.

- Semisynthetic cephalosporins with improved properties were developed.
- First-generation cephalosporins were introduced during the 1960s.
- Later generations expanded antibacterial spectrum and β-lactamase resistance.

Uses

- Respiratory tract infections
- Urinary tract infections
- Meningitis
- Septicemia
- Surgical prophylaxis
- Hospital-acquired infections

PACLITAXEL

Paclitaxel, originally marketed as Taxol, is one of the most important plant-derived anticancer drugs. It was isolated from *Taxus brevifolia* and revolutionized cancer chemotherapy because of its unique mechanism of action on microtubules.

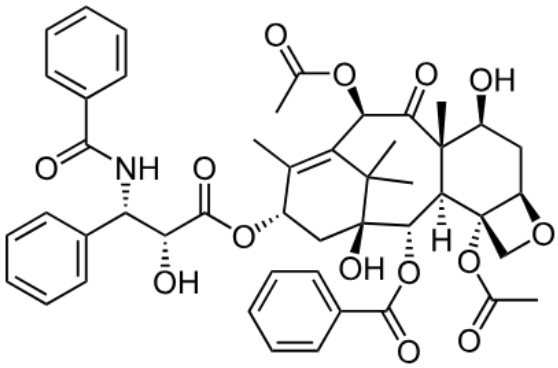


Fig. 1.9 a. Structure of Paclitaxel ***b. Taxus brevifolia***

Historical Development

- The National Cancer Institute initiated screening of plants for anticancer activity.
- In 1962, bark samples of Taxus brevifolia were collected.
- In 1967, Monroe Wall and Mansukh Wani isolated Taxol.
- In 1971, researchers elucidated its complex diterpenoid structure.
- Scientists discovered its unique microtubule-stabilizing mechanism.
- Supply problems arose because bark harvesting destroyed yew trees.
- Semisynthetic production using precursors from yew needles solved supply issues.

- Clinical trials during the 1980s demonstrated strong anticancer activity.
- In 1992, FDA approved paclitaxel for ovarian cancer.
- In 1994, Holton and Nicolaou achieved total synthesis of Taxol.

Uses

- Ovarian cancer
- Breast cancer
- Lung cancer
- Kaposi's sarcoma
- Cervical cancer
- Combination chemotherapy regimens

ARTEMISININ

Artemisinin is one of the most important modern antimalarial drugs. It is obtained from Artemisia annua and revolutionized malaria treatment, especially against drug-resistant *Plasmodium falciparum* malari

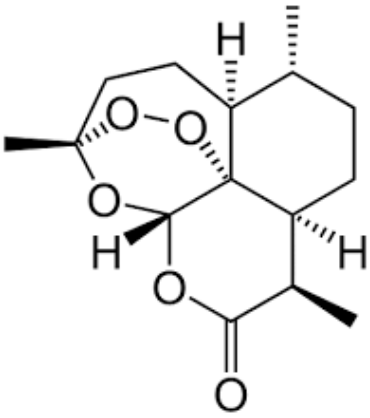


Fig. 1.10. a. Structure of Artemisinin ***b. Artemisia annua***

Historical Development

- *Artemisia annua* was used in traditional Chinese medicine for fever treatment.
- Ancient Chinese text by Ge Hong described Qinghao therapy.
- Chloroquine resistance created a global malaria crisis during the 1960s.
- In 1967, China launched Project 523 for antimalarial research.
- Tu Youyou screened herbal medicines for antimalarial activity.
- In 1972, low-temperature extraction successfully isolated artemisinin.

- Artemisinin was identified as a sesquiterpene lactone with an endoperoxide bridge.
- Semisynthetic derivatives such as artesunate and artemether were developed.
- Artemisinin Combination Therapy (ACT) became global standard malaria therapy.
- In 2015, Tu Youyou received the Nobel Prize.

Uses

- Treatment of malaria
- Drug-resistant Plasmodium falciparum malaria
- Artemisinin Combination Therapy (ACT)
- Rapid parasite clearance
- Global malaria control programs

1.4. INTRODUCTION TO DIFFERENT HERBAL AND TRADITIONAL PHARMACOPOEIAS

Pharmacopoeias are official and authoritative publications that provide standards for drugs, medicinal substances, pharmaceutical preparations, herbal medicines, and healthcare products. They serve as scientific and legal reference books for ensuring the identity, purity, quality, strength, and safety of medicines used in healthcare systems. In the field of herbal medicine and traditional systems of medicine, pharmacopoeias are especially important because natural products often show considerable variation due to differences in geographical source, cultivation practices, harvesting conditions, processing techniques, and storage methods. Herbal and traditional pharmacopoeias therefore provide standardized methods for authentication, quality control, analytical testing, and safe therapeutic use of medicinal plants and herbal formulations.

Different countries and traditional medical systems have developed their own pharmacopoeias according to their medicinal heritage and healthcare requirements. Some pharmacopoeias mainly focus on modern pharmaceutical products, while others specifically emphasize herbal medicines and traditional formulations. Important pharmacopoeias related to herbal and traditional medicines include the Indian Pharmacopoeia, British Herbal Pharmacopoeia, United States Pharmacopeia – Herbal Medicines and Dietary Supplements, Ayurvedic Pharmacopoeia of India, Unani Pharmacopoeia of India, and American Herbal Pharmacopoeia. These pharmacopoeias play a major role in herbal medicine standardization, pharmaceutical manufacturing, research, education, regulation, and global healthcare.

Fig.1.11. Various Pharmacopoeias used through out the World

INDIAN PHARMACOPOEIA (IP)

The Indian Pharmacopoeia is the official pharmacopoeia of India and serves as the legal and scientific standard for drugs manufactured, marketed, and used in the country. It establishes official specifications for pharmaceutical substances, dosage forms, biological products, herbal medicines, vaccines, blood products, radiopharmaceuticals, and medical devices. The Indian Pharmacopoeia is published by the Indian Pharmacopoeia Commission under the Ministry of Health and Family Welfare, Government of India. It acts as an authoritative reference for pharmaceutical industries, regulatory agencies, pharmacists, researchers, and quality control laboratories.

Origin and Development

Before independence, India mainly followed the British Pharmacopoeia for pharmaceutical standards. However, after independence, the need for an indigenous pharmacopoeia suitable for Indian healthcare requirements became essential. In 1948, the Government of India constituted the Indian Pharmacopoeia Committee under the chairmanship of R. N. Chopra. The committee was assigned the responsibility of preparing a national pharmacopoeia containing standards for

drugs commonly used in India.

The first edition of the Indian Pharmacopoeia was published in 1955. Subsequent editions were published periodically to incorporate new drugs, updated analytical methods, biological products, and modern pharmaceutical technologies. Over time, the pharmacopoeia expanded significantly with advances in analytical chemistry, biotechnology, microbiology, and herbal medicine research. The latest edition of the Indian Pharmacopoeia is the tenth edition published in 2026.

Contents and Coverage

The Indian Pharmacopoeia contains monographs for pharmaceutical substances, formulations, antibiotics, vaccines, biological products, blood products, herbal medicines, and excipients. The monographs provide detailed standards regarding identification tests, purity requirements, assay methods, impurity profiling, storage conditions, labeling requirements, and packaging specifications. Modern analytical techniques such as HPLC, HPTLC, GC, spectroscopy, dissolution testing, and microbiological assays are extensively incorporated into the pharmacopoeia.

Applications and Importance

The Indian Pharmacopoeia plays a central role in pharmaceutical manufacturing, drug regulation, quality assurance, and pharmacy education. Pharmaceutical industries use IP standards during raw material testing, manufacturing, in-process quality control, and finished product evaluation. Regulatory authorities use it for drug licensing, inspections, and market surveillance. It also supports research and development activities in pharmaceutical sciences and herbal medicine standardization. The pharmacopoeia helps ensure safe, effective, and high-quality medicines for public healthcare.

BRITISH HERBAL PHARMACOPOEIA (BHP)

The British Herbal Pharmacopoeia is an important scientific reference dedicated specifically to medicinal plants and herbal medicines used in the United Kingdom. It provides standards and monographs for herbal drugs and formulations commonly used in herbal medicine practice. The British Herbal Pharmacopoeia serves as an authoritative guide for herbal practitioners, pharmacists, researchers, and herbal pharmaceutical industries.

Origin and Development

The British Herbal Pharmacopoeia was developed by the British Herbal Medicine Association with the aim of scientifically standardizing herbal medicines and promoting safe herbal healthcare

practices. The first edition was published in 1971. As interest in herbal medicine increased, revised editions were introduced with expanded monographs, updated analytical standards, and improved pharmacological information. The pharmacopoeia gradually evolved into an important scientific document for herbal medicine standardization in Britain.

Contents and Coverage

The British Herbal Pharmacopoeia contains detailed monographs on medicinal plants and herbal preparations. Each monograph generally includes botanical descriptions, identification characteristics, active constituents, therapeutic uses, dosage recommendations, pharmacological activities, contraindications, safety information, and methods of preparation. The pharmacopoeia also includes analytical standards and quality control procedures for herbal medicines.

Applications and Importance

The British Herbal Pharmacopoeia is extensively used in herbal medicine practice, herbal drug standardization, pharmaceutical manufacturing, and pharmacognostic research. It provides scientific support for herbal medicines and promotes evidence-based herbal healthcare. The pharmacopoeia also contributes to quality assurance and prevention of adulteration in herbal products.

UNITED STATES PHARMACOPEIA (USP) – HERBAL MEDICINES AND DIETARY SUPPLEMENTS

The United States Pharmacopeia is one of the most influential pharmacopoeias in the world. It establishes standards for drugs, excipients, biological products, dietary supplements, nutraceuticals, and herbal medicines used in the United States. The USP is published by the United States Pharmacopeial Convention and serves as a legally recognized reference for pharmaceutical quality standards.

Origin and Development

The first USP was published in 1820 following a convention of physicians held in Washington, D.C. The National Formulary was later introduced in 1888 and eventually combined with USP to form USP–NF. With increasing popularity of herbal medicines and dietary supplements during the late twentieth century, USP expanded its scope to include detailed standards for botanical drugs, herbal extracts, vitamins, minerals, and nutraceuticals.

Herbal Medicines and Dietary Supplements

The USP contains extensive monographs for herbal medicines and dietary supplements. These

monographs provide scientific standards for botanical identity, chemical composition, assay methods, chromatographic fingerprinting, contaminant testing, microbial limits, and stability evaluation. The pharmacopoeia incorporates advanced analytical techniques such as HPLC, HPTLC, LC-MS, GC-MS, and DNA-based identification methods for authentication and quality control of herbal products.

Applications and Importance

USP standards are widely used by pharmaceutical industries, nutraceutical manufacturers, quality control laboratories, pharmacists, and regulatory agencies. The pharmacopoeia ensures safety, quality, consistency, and efficacy of herbal medicines and dietary supplements. It also promotes international harmonization of pharmaceutical and herbal standards.

AYURVEDIC PHARMACOPOEIA OF INDIA (API)

The Ayurvedic Pharmacopoeia of India establishes official standards for Ayurvedic drugs and formulations used in India. It is published by the Ministry of AYUSH, Government of India, and serves as an authoritative scientific reference for quality assurance and standardization of Ayurvedic medicines.

Origin and Development

Ayurveda is one of the oldest systems of medicine and is based on classical texts such as Charaka Samhita and Sushruta Samhita. Traditionally, Ayurvedic medicines were prepared according to formulations described in these classical texts. However, increasing industrial production and commercialization of Ayurvedic medicines created the need for scientific standardization and regulatory control.

To fulfill this need, the Government of India initiated development of the Ayurvedic Pharmacopoeia of India. The first volume was published in 1989. Since then, several additional volumes covering single drugs and compound formulations have been released. Modern editions increasingly incorporate advanced analytical techniques and quality standards.

Contents and Coverage

The API contains monographs for herbal drugs, mineral preparations, metallic formulations, animal-origin substances, and compound Ayurvedic formulations. The monographs include botanical identity, microscopic characteristics, physicochemical parameters, assay methods, chromatographic profiles, purity standards, and storage conditions. The pharmacopoeia also includes safety standards for heavy metals, pesticide residues, microbial contamination, and

aflatoxins.

Applications and Importance

The Ayurvedic Pharmacopoeia of India plays a major role in standardization, quality control, pharmaceutical manufacturing, regulatory compliance, research, and pharmacy education. It supports scientific validation of Ayurvedic medicines and promotes global acceptance of Ayurveda as a traditional healthcare system.

UNANI PHARMACOPOEIA OF INDIA (UPI)

The Unani Pharmacopoeia of India establishes official standards for medicines used in the Unani system of medicine in India. It is published under the Ministry of AYUSH, Government of India, and serves as a scientific and regulatory reference for standardization and quality assurance of Unani medicines.

Origin and Development

The Unani system originated from Greco-Arabic medicine and developed through contributions from Greek, Arab, and Persian scholars such as Hippocrates, Galen, and Avicenna. Unani medicine was introduced into India during the medieval period and gradually became an important traditional healthcare system.

The first volume of the Unani Pharmacopoeia of India was published in 1986. Since then, several additional volumes have been released covering herbal drugs, mineral preparations, animal-origin substances, and compound formulations. Modern analytical and quality control methods have increasingly been incorporated into the pharmacopoeia.

Contents and Coverage

The UPI contains monographs for herbal medicines, mineral drugs, metallic preparations, animal-origin drugs, and compound Unani formulations such as Majoon, Sharbat, Jawarish, Roghan, and Kushta preparations. The monographs provide standards for identification, physicochemical testing, assay procedures, chromatographic analysis, purity evaluation, and storage conditions.

Applications and Importance

The UPI supports quality control, standardization, pharmaceutical manufacturing, research, education, and regulatory control of Unani medicines. It helps preserve traditional Unani knowledge while integrating it with modern scientific standards and analytical techniques.

AMERICAN HERBAL PHARMACOPOEIA (AHP)

The American Herbal Pharmacopoeia is a highly respected scientific reference dedicated specifically to herbal medicine standardization. It provides comprehensive monographs for medicinal plants, botanical extracts, and herbal products used in herbal medicine practice and pharmaceutical industries.

Origin and Development

The American Herbal Pharmacopoeia was founded in 1995 by Roy Upton. It was developed with the aim of creating scientifically validated standards for herbal medicines and integrating traditional herbal knowledge with modern scientific research. Over time, the AHP expanded significantly and incorporated modern analytical techniques, pharmacological studies, toxicological evaluations, and clinical research findings.

Contents and Coverage

The AHP contains detailed monographs on medicinal plants, herbal extracts, essential oils, dietary supplements, and phytopharmaceutical products. Each monograph includes botanical descriptions, microscopic features, active constituents, analytical standards, chromatographic profiles, therapeutic uses, dosage recommendations, contraindications, toxicity data, and safety information. Advanced analytical methods such as HPLC, HPTLC, LC-MS, DNA fingerprinting, and metabolomic profiling are extensively incorporated.

Applications and Importance

The American Herbal Pharmacopoeia is widely used in pharmacognosy, herbal medicine research, pharmaceutical manufacturing, herbal product standardization, and quality control laboratories. It plays a major role in preventing adulteration, ensuring product authenticity, and promoting evidence-based herbal medicine. The pharmacopoeia also contributes significantly to international harmonization and scientific acceptance of herbal medicines.

Table 1.3. Publication details of various Pharmacopoeias

Pharmacopoeia	**First Publication**	**Important Revised Editions / Years**	**Latest Edition Status**	**Main Focus**	**Governing Authority**
Indian Pharmacopoeia (IP)	1955	1966, 1985, 1996, 2007, 2010, 2014, 2018, 2022	10th Edition, 2026	Modern pharmaceuticals and herbal drugs	Indian Pharmacopoeia Commission
British Pharmacopoeia (BP)	1864	Revised annually	BP 2025	Pharmaceutical standards	British Pharmacopoeia Commission

United States Pharmacopeia (USP)	1820	Revised annually with USP–NF updates	USP–NF 2025	Drugs, biologics, dietary supplements	USP Convention
American Herbal Pharmacopoeia (AHP)	1994/1995	Periodically updated monographs	Latest updates 2025	Herbal medicine standardization	American Herbal Pharmacopoeia Organization
Ayurvedic Pharmacopoeia of India (API)	1989	Multiple revised volumes published periodically	Ongoing revised volumes	Ayurvedic medicines	Ministry of AYUSH
Unani Pharmacopoeia of India (UPI)	1986	Multiple revised volumes published periodically	Ongoing revised volumes	Unani medicines	Ministry of AYUSH

1.5. CLASSIFICATION OF CRUDE DRUGS

OFFICIAL AND NON-OFFICIAL

Official drugs are those medicines that are included in recognized pharmacopoeias or official compendia such as the Indian Pharmacopoeia and possess legally accepted standards for identity, purity, quality, strength, and storage. These drugs are scientifically standardized, legally recognized, and widely accepted for therapeutic use. Examples include aspirin, paracetamol, morphine, and senna. In contrast, non-official drugs are not included in any official pharmacopoeia and therefore lack officially established standards. They are often used in traditional medicine, folk medicine, or experimental therapies and may require further scientific validation before gaining official recognition.

CODIFIED AND NON-CODIFIED DRUGS.

Codified drugs are drugs described in classical authoritative texts of traditional systems of medicine such as Ayurveda, Unani, Siddha, and Homeopathy. Their uses, preparation methods, and therapeutic applications are systematically recorded in traditional literature like the Charaka Samhita and Sushruta Samhita. Examples include Withania somnifera and Tinospora cordifolia. Non-codified drugs, on the other hand, are not mentioned in recognized classical texts and are mainly associated with folk and tribal medicine. Their knowledge is usually passed orally from generation to generation and they often require scientific study and standardization. These classifications are important in pharmacognosy because they help determine the legal status,

quality control, therapeutic acceptance, and research importance of medicinal substances.

Table 1.4. Difference between Official and Non-official drugs

Official Drugs	**Non-Official Drugs**
Included in official pharmacopoeias	Not included in official pharmacopoeias
Legally recognized	Not legally recognized
Possess established standards	Lack official standards
Scientifically standardized	May not be scientifically standardized
Subject to regulatory control	Limited regulatory control
Accepted widely in healthcare	Often limited to local or traditional use

Table 1.5. Difference between Codified and Non-codified drugs

Codified Drugs	**Non-Codified Drugs**
Mentioned in classical authoritative texts	Not mentioned in classical texts
Belong to recognized traditional systems	Usually associated with folk medicine
Have documented therapeutic use	Therapeutic use based on oral tradition
More standardized	Less standardized
Scientifically studied more extensively	Require further scientific validation
Recognized by traditional pharmacopoeias	Often not officially recognized

CLASSIFICATION OF DRUGS

The most important natural sources of drugs are higher plant, microbes and animals and marine organisms. Some useful products are obtained from minerals that are both organic and inorganic in nature. In order to pursue (or to follow) the study of the individual drugs, one must adopt some particular sequence of arrangement, and this is referred to a system of classification of drugs. A method of classification should be simple, easy to use, and free from confusion and ambiguities. Because of their wide distribution, each arrangement of classification has its own merits and demerits, but for the purpose of study the drugs are classified in the following different ways:

1.Alphabetical classification

2.Taxonomical classification

3.Morphological classification

4.Pharmacological classification

5.Chemical classification

6.Chemotaxonomical classification

ALPHABETICAL CLASSIFICATION

Alphabetical classification is the simplest way of classifica-tion of any disconnected items. Crude drugs are arranged in alphabetical order of their Latin and English names (common names) or sometimes local language names (ver-nacular names). Some of the pharmacopoeias, dictionaries and reference books which classify crude drugs according to this system are as follows:

Indian Pharmacopoeia

British Pharmacopoeia

British Herbal Pharmacopoeia

United States Pharmacopoeia and National Formu-lary

British Pharmaceutical Codex

European Pharmacopoeia

In European Pharmacopoeia these are arranged according to their names in Latin where in United States Pharmaco-poeia (U.S.P.) and British Pharmaceutical Codex (B.P.C.), these are arranged in English.

Merits

·It is easy and quick to use.

·There is no repetition of entries and is devoid of confusion.

·In this system location, tracing and addition of drug entries is easy.

Demerits

There is no relationship between previous and successive drug entries.

Examples: Acacia, Benzoin, Cinchona, Dill, Ergot,Fennel, Gentian, Hyoscyamus, Ipecacuanha, Jalap, Kurchi, Liquorice, Mints, Nux vomica, Opium, Podophyllum, Quassia, Rauwolfia, Senna, Vasaka, Wool fat, Yellow bees wax, Zeodary.

TAXONOMICAL CLASSIFICATION

All the plants possess different characters of morphologi-cal, microscopical, chemical, embryological, serological and genetics. In this classification the crude drugs are classified according to kingdom, subkingdom, division, class, order, family, genus and species as follows.

Class: Angiospermae (Angiosperms) are plants that produceflowers and Gymnospermae (Gymnosperms) which don't produce flowers.

Subclass: Dicotyledonae (Dicotyledons, Dicots) are plantswith two seed leaves; Monocotyledonae (Monocotyledons, Monocots) with one seed leaf.

Superorder: A group of related plant families, classified in theorder in which they are thought to have developed their dif-ferences from a common ancestor. There are six superorders in the Dicotyledonae (Magnoliidae, Hamamelidae, Caryophyl-lidae, Dilleniidae, Rosidae, Asteridae), and four superorders in the Monocotyledonae (Alismatidae, Commelinidae, Arecidae, and Liliidae). The names of the superorders end in –idae.

Order: Each superorder is further divided into several orders. The names of the orders end in –ales.

Family: Each order is divided into families. These are plantswith many botanical features in common, and are the highest classification normally used. At this level, the similarity between plants is often easily recognizable by the layman. Modern botanical classification assigns a type plant to each family, which has the particular characteristics that separate this group of plants from others, and names the family after this plant.

The number of plant families varies according to the botanist whose classification you follow. Some botanists recognize only 150 or so families, preferring to classify other similar plants as subfamilies, while others recognize nearly 500 plant families. A widely accepted system is that devised by Cronquist in 1968, which is only slightly revised today. The names of the families end in –aceae.

Subfamily: The family may be further divided into a numberof subfamilies, which group together plants within the family that have some significant botanical differences. The names of the subfamilies end in –oideae.

Tribe: A further division of plants within a family, based onsmaller botanical differences, bin still usually comprising many different plants. The names of the tribes end in –eae.

Subtribe: A further division based on even smaller botanicaldifferences, often only recognizable to botanists. The names of the subtribes end in –inae.

Genus: This is the part of the plant name that is most famil-iar; the normal name that you give a plant—Papaver (Poppy), Aquilegia (Columbine), and so on. The plants in a genus are often easily recognizable as belonging to the same group.

Species: This is the level that defines an individual plant. Often, the name will describe some aspect of the plant— the colour of the flowers, size or shape of the leaves, or it may be named after the place where it was found. Together, the genus and species name refer to only one plant, and they are used to identify that particular plant. Sometimes, the species is further divided into subspecies that contain plants not quite so distinct that they are classified as variet-ies. The name, of the species should be written after the genus name, in small letters, with no capital letter.

Variety: A variety is a plant that is only slightly differentfrom the species plant, but the

differences

are not so insig-nificant as the differences in a form. The Latin is varietas, which is usually abbreviated to var. The name follows the genus and species name, with var. before the individual variety name.

Form: A form is a plant within a species that has minorbotanical differences, such as the colour of flower or shape of the leaves. The name follows the genus and species name, with form (or f.) before the individual variety name.

Cultivar: A cultivar is a cultivated variety—a particularplant that has arisen either naturally or through deliberate hybridization, and can be reproduced (vegetatively or by seed) to produce more of the same plant.

The name follows the genus and species name. It is written in the language of the person who described it, and should not be translated. It is either written in single quotation marks or has cv. written in front of the name.

Table 1.6. Taxonomical Classification of crude drugs

Classification	***Cassia alata***	***Euphorbia hirta***
Kingdom	Plantae	Plantae
Subkingdom	Tracheobionta	Tracheobionta
Division	Magnoliophyta	Magnoliophyta
Class	Magnoliopsida	Magnoliopsida
Subclass	Rosidae	Rosidae
Order	Fabales	Euphorbiales
Family	Fabaceae	Euphorbiaceae
Genus	*Senna* Mill	*Euphorbia* L.

Merits

Taxonomical classification is helpful for studying evolution-ary developments.

Demerits

This system also does not correlate in between the chemical constituents and biological activity of the drugs.

MORPHOLOGICAL CLASSIFICATION

In this system, the drugs are arranged according to the morphological or external characters of the plant parts or animal parts, i.e. which part of the plant is used as a drug, e.g. leaves, roots,

stem, etc. The drugs obtained from the direct parts of the plants and containing cellular tissues are called as organized drugs, e.g. rhizomes, barks, leaves, fruits, entire plants, hairs and fibres. The drugs which are pre-pared from plants by some intermediate physical processes such as incision, drying or extraction with a solvent and not containing any cellular plant tissues are called unorga-nized drugs. Aloe juice, opium latex, agar, gambir, gelatin, tragacanth, benzoin, honey, beeswax, lemon grass oil, etc., are examples of unorganized drugs.

Fig. 1.12. Morphological Classification of Crude drugs

Organized drugs

Woods: Quassia, Sandalwood and Red Sandalwood.

Leaves: Digitalis, Eucalyptus, Gymnema, Mint, Senna,Spearmint, Squill, Tulsi, Vasaka, Coca, Buchu, Hamamelis, Hyoscyamus, Belladonna, Tea.

Barks: Arjuna, Ashoka, Cascara, Cassia, Cinchona, Cinnamon, Kurchi, Quillia, Wild cherry.

Flowering parts: Clove, Pyrethrum, Saffron, Santonica, Chamomile.

Fruits: Amla, Anise, Bael, Bahera, Bitter Orange peel,Capsicum, Caraway, Cardamom, Colocynth, Coriander, Cumin, Dill, Fennel, Gokhru, Hirda, Lemon peel, Senna pod, Star anise, Tamarind, Vidang.

Seeds: Bitter almond, Black Mustard, Cardamom, Colchi-cum, Ispaghula, Kaladana, Linseed, Nutmeg, Nux vomica, Physostigma, Psyllium, Strophanthus, White mustard.

Roots and Rhizomes: Aconite, Ashwagandha, Calamus, Calumba, Colchicum corm, Dioscorea, Galanga, Garlic, Gention, Ginger, Ginseng, Glycyrrhiza, Podophyllum, Ipecac, Ipomoea, Jalap, Jatamansi, Rauwolfia, Rhubarb, Sassurea, Senega, Shatavari, Turmeric, Valerian, Squill.

Plants and Herbs: Ergot, Ephedra, Bacopa, Andrographis, Kalmegh, Yeast, Vinca, Datura, Centella.

Hair and Fibres: Cotton, Hemp, Jute, Silk, Flax.

Unorganized drugs

Dried latex: Opium, Papain

Dried Juice: Aloe, Kino

Dried extracts: Agar, Alginate, Black catechu, Pale catechu,Pectin

Waxes: Beeswax, Spermaceti, Carnauba wax

Gums: Acacia, Guar Gum, Indian Gum, Sterculia, Tra-gacenth

Resins: Asafoetida, Benzoin, Colophony, copaiba Guaiacum, Guggul, Mastic, Coal tar, Tar, Tolu balsam, Storax, Sandarac.

Volatile oil: Turpentine, Anise, Coriander, Peppermint, Rosemary, Sandalwood, Cinnamon, Lemon, Caraway, Dill, Clove, Eucalyptus, Nutmeg, Camphor.

Fixed oils and Fats: Arachis, Castor, Chalmoogra, Coconut,Cotton seed, Linseed, Olive, Sesame, Almond, Theobroma, Cod-liver, Halibut liver, Kokum butter.

Animal Products: Bees wax, Cantharides, Cod-liver oil,Gelatin, Halibut liver oil, Honey, Shark liver oil, shellac, Spermaceti wax, wool fat, musk, Lactose.

Fossil organism and Minerals: Bentonite, Kaolin, Kiess-lguhr, Talc.

Table 1.7. Morphological Classification of crude drugs

Morphological Group	Description	Examples of Crude Drugs
Leaves	Drugs obtained from leaves	Senna, Digitalis
Roots	Drugs obtained from roots	Rauwolfia, Liquorice
Bark	Drugs obtained from bark	Cinnamon, Cinchona
Rhizomes	Underground stems	Ginger, Turmeric
Flowers	Drugs obtained from flowers	Clove, Saffron
Fruits	Drugs obtained from fruits	Fennel, Coriander
Seeds	Drugs obtained from seeds	Nux vomica, Castor
Whole Herb	Entire plant used as drug	Ephedra, Centella
Unorganized Drugs	Drugs without cellular structure	Honey, Aloe gel

Merits

Morphological classification is more helpful to identify and detect adulteration. This system of classification is more convenient for practical study especially when the chemical nature of the drug is not clearly understood.

Demerits

The main drawback of morphological classification is that there is no corelation of chemical constituents with the therapeutic actions.

Repetition of drugs or plants occurs.

PHARMACOLOGICAL CLASSIFICATION

Grouping of drug according to their pharmacological action or of most important constituent or their therapeutic use is termed as pharmacological or therapeutic classification of drug. This classification is more relevant and is mostly a followed method. Drugs like digitalis, squill and strophan-thus having cardiotonic action are grouped irrespective of their parts used or phylogenetic relationship or the nature of phytoconstituents they contain

Table 1.8. Pharmacological Classification of crude drugs

Pharmacological Action	**Description**	**Examples of Crude Drugs**
Laxatives	Promote bowel movement	Senna, Castor oil
Carminatives	Relieve flatulence	Fennel, Coriander
Expectorants	Help remove mucus from respiratory trac	Vasaka, Liquorice
Antihypertensives	Lower blood pressure	Rauwolfia
Analgesics	Relieve pain	Opium
Antimalarials	Treat malaria	Cinchona
Anticancer Agents	Used against cancer	Vinca
Antiseptics	Prevent microbial growth	Clove, Eucalyptus
Cardiotonics	Increase cardiac efficiency	Digitalis

Merits

This system of classification can be used for suggesting substitutes of drugs, if they are not available at a particular place or point of time.

Demerits

Drugs having different action on the body get classified separately in more than one group that causes ambiguity and confusion. Cinchona is antimalarial drug because of presence of quinine but can be put under the group of drug affecting heart because of antiarrhythmic action of quinidine.

CHEMICAL CLASSIFICATION

Depending upon the active constituents, the crude drugs are classified. The plants contain various

constituents in them like alkaloids, glycosides, tannins, carbohydrates, saponins, etc. Irrespective of the morphological or taxonomical char-acters, the drugs with similar chemical constituents are grouped into the same group. The examples are shown in this table.

Table 1.9. Chemical Classification of crude drugs

Class of Constituents	**Description**	**Examples of Crude Drugs**
Alkaloids	Nitrogen-containing basic compounds	Opium, Belladonna, Rauwolfia
Glycosides	Compounds yielding sugars on hydrolysis	Digitalis, Senna, Aloe
Volatile Oils	Aromatic oils obtained by distillation	Clove, Peppermint, Fennel
Tannins	Polyphenolic astringent compounds	Catechu, Nutgall
Flavonoids	Phenolic pigments with antioxidant activity	Citrus peel, Tea
Resins	Amorphous solid or semi-solid substances	Colophony, Cannabis
Saponins	Glycosides producing foam in water	Liquorice, Ginseng
Carbohydrates	Sugars and polysaccharides	Acacia, Starch
Proteins and Enzymes	Nitrogenous biomolecules	Papain, Diastase

Merits

It is a popular approach for phytochemical studies.

Demerits

Ambiguities arise when particular drugs possess a number of compounds belonging to different groups of compounds.

CHEMOTAXONOMICAL CLASSIFICATION

This system of classification relies on the chemical similarity of a taxon, i.e. it is based on the existence of relationship between constituents in various plants. There are certain types of chemical constituents that characterize certain classes of plants. This gives birth to entirely a new concept of chemotaxonomy that utilizes chemical facts/characters for understanding the taxonomical status, relationships and the evolution of the plants.

For example, tropane alkaloids generally occur among the members of Solanaceae, thereby, serving as a chemot-axonomic marker. Similarly, other secondary plant metabo-lites can serve as the basis of classification of crude drugs. The berberine alkaloid in Berberis and Argemone, Rutin in Rutaceae members, Ranunculaceae alkaloids among its members, etc., are other examples.

It is the latest system of classification that gives more scope for understanding the relationship between chemical constituents, their biosynthesis and their possible action.

Table 1.10. Chemotaxonomical Classification of crude drugs

Chemical Constituents	**Taxonomic Group**	**Examples**
Tropane Alkaloids	Family Solanaceae	Belladonna, Datura
Volatile Oils	Family Apiaceae	Fennel, Coriander
Cardiac Glycosides	Family Apocynaceae	Strophanthus, Vinca
Anthraquinone Glycosides	Family Fabaceae	Senna
Curcuminoids	Family Zingiberaceae	Turmeric
Quinoline Alkaloids	Family Rubiaceae	Cinchona
Essential Oils	Family Lamiaceae	Peppermint, Tulsi

Merits

Helps in identification and classification of plants based on chemical constituents.

Establishes relationship between taxonomy and phytochemistry.

Useful in discovering new medicinal plants with similar chemical constituents.

Demerits

Chemical constituents may vary due to climate, soil, season, and geographical conditions.

Closely related plants may not always contain similar chemical constituents.

Requires advanced analytical and phytochemical techniques.

MULTIPLE CHOICE QUESTIONS (MCQS)

FUNDAMENTALS OF PHARMACOGNOSY

1. The term Pharmacognosy is derived from:
A. Latin words
B. Greek words
C. French words
D. German words
Answer: B
2. “Pharmakon” means:
A. Plant
B. Knowledge
C. Drug
D. Disease
Answer: C
3. The term “Pharmacognosy” was first used by:
A. Galen
B. Hippocrates
C. C.A. Seydler
D. Dioscorides

Answer: C
4. Pharmacognosy mainly deals with:
A. Synthetic drugs
B. Natural drugs
C. Radiopharmaceuticals
D. Biotechnology products
Answer: B
5. Which of the following is known as the father of medicine?
A. Galen
B. Hippocrates
C. Avicenna
D. Dioscorides
Answer: B
6. “De Materia Medica” was written by:
A. Hippocrates
B. Galen
C. Dioscorides
D. Avicenna
Answer: C
7. “The Canon of Medicine” was written by:
A. Galen
B. Dioscorides
C. Avicenna
D. Charaka
Answer: C
8. Which ancient Indian text is related to Ayurveda?
A. Pen Tsao
B. Ebers Papyrus
C. Charaka Samhita
D. Canon of Medicine
Answer: C
9. Ebers Papyrus belongs to:
A. India
B. China
C. Egypt
D. Greece
Answer: C
10. Which branch of science deals with medicinal plants and crude drugs?
A. Pharmacology
B. Pharmacognosy
C. Toxicology
D. Microbiology
Answer: B
11. Which of the following is a plant source drug?
A. Honey
B. Penicillin
C. Digitalis
D. Cod liver oil
Answer: C
12. Insulin was originally obtained from:
A. Plants
B. Animals
C. Minerals
D. Marine organisms
Answer: B

13. Penicillin is obtained from:
A. Plant
B. Animal
C. Fungus
D. Mineral
Answer: C
14. Agar is obtained from:
A. Marine source
B. Animal source
C. Mineral source
D. Plant source
Answer: A
15. Kaolin is an example of:
A. Animal drug
B. Marine drug
C. Mineral drug
D. Plant drug
Answer: C
16. Plant tissue culture is mainly used for:
A. Synthetic drug production
B. Secondary metabolite production
C. Vaccine production
D. Mineral extraction
Answer: B
17. Morphine is obtained from
A. Cinchona
B. Opium poppy
C. Willow bark
D. Yew tree
Answer: B
18. Morphine belongs to which chemical class?
A. Glycoside
B. Flavonoid
C. Alkaloid
D. Tannin
Answer: C
19. Quinine is obtained from:
A. Digitalis
B. Cinchona bark
C. Willow bark
D. Rauwolfia
Answer: B
20. Quinine is mainly used as:
A. Analgesic
B. Antimalarial
C. Antibiotic
D. Anticancer
Answer: B
21. Aspirin originated from:
A. Neem
B. Cinchona
C. Willow bark
D. Ephedra
Answer: C
22. Aspirin belongs to which class?

A. Alkaloid
B. Terpenoid
C. Salicylate
D. Glycoside
Answer: C
23. Warfarin acts as:
A. Anticancer drug
B. Anticoagulant
C. Antibiotic
D. Antimalarial
Answer: B
24. Penicillin was discovered by:
A. Alexander Fleming
B. Florey
C. Chain
D. Pasteur
Answer: A
25. Penicillin is produced by:
A. Aspergillus
B. Penicillium
C. Rhizopus
D. Saccharomyces
Answer: B
26. Cephalosporin was discovered from:
A. Marine fungus
B. Plant root
C. Algae
D. Animal source
Answer: A
27. Taxol is obtained from:
A. Cinchona
B. Papaver
C. Taxus brevifolia
D. Artemisia annua
Answer: C
28. Taxol is mainly used as:
A. Antimalarial
B. Anticancer
C. Antibiotic
D. Antipyretic
Answer: B
29. Artemisinin is obtained from:
A. Artemisia annua
B. Cinchona officinalis
C. Taxus brevifolia
D. Papaver somniferum
Answer: A
30. Artemisinin is mainly used for treatment of:
A. Tuberculosis
B. Diabetes
C. Malaria
D. Hypertension
Answer: C
31. Indian Pharmacopoeia is published by:
A. WHO

B. IPC
C. FDA
D. BP Commission
Answer: B
32. The first edition of Indian Pharmacopoeia was published in:
A. 1948
B. 1950
C. 1955
D. 1960
Answer: C
33. British Pharmacopoeia was first published in:
A. 1820
B. 1864
C. 1901
D. 1955
Answer: B
34. USP stands for:
A. United States Pharmacology
B. United States Pharmacopeia
C. Universal Standard Pharmacopoeia
D. United States Pharmaceutical Practice
Answer: B
35. American Herbal Pharmacopoeia was founded by:
A. Roy Upton
B. Alexander Fleming
C. Seydler
D. Avicenna
Answer: A
36. Ayurvedic Pharmacopoeia of India was first published in:
A. 1955
B. 1966
C. 1989
D. 1999
Answer: C
37. Unani Pharmacopoeia of India was first published in:
A. 1986
B. 1990
C. 1995
D. 2001
Answer: A
38. Official drugs are:
A. Mentioned in folklore only
B. Included in pharmacopoeias
C. Experimental drugs
D. Marine products
Answer: B
39. Non-official drugs are:
A. Included in official compendia
B. Approved by WHO
C. Not included in pharmacopoeias
D. Only synthetic drugs
Answer: C
40. Codified drugs are:
A. Mentioned in classical literature

B. Synthetic drugs
C. Radioactive drugs
D. Marine drugs
Answer: A
41. Non-codified drugs are mainly associated with:
A. Pharmacopoeias
B. Folk medicine
C. Biotechnology
D. Synthetic chemistry
Answer: B
42. Alphabetical classification of crude drugs is based on:
A. Chemical constituents
B. Therapeutic action
C. Alphabetical order
D. Taxonomy
Answer: C
43. Morphological classification is based on:
A. Pharmacological action
B. External morphology
C. Chemical composition
D. Taxonomy
Answer: B
44. Taxonomical classification is based on:
A. Therapeutic use
B. Chemical constituents
C. Botanical relationships
D. Morphology only
Answer: C
45. Chemical classification is based on:
A. Habitat
B. Morphology
C. Active constituents
D. Taxonomy
Answer: C
46. Drugs classified according to therapeutic effect belong to:
A. Morphological classification
B. Taxonomical classification
C. Pharmacological classification
D. Alphabetical classification
Answer: C
47. Chemotaxonomy combines:
A. Morphology and geography
B. Taxonomy and chemistry
C. Pharmacology and morphology
D. Geography and pharmacology
Answer: B
48. One limitation of alphabetical classification is:
A. Difficult arrangement
B. No scientific relationship shown
C. Requires microscopy
D. Requires chromatography
Answer: B
49. Which classification is most useful for identifying adulteration?
A. Alphabetical
B. Morphological

C. Pharmacological
D. Taxonomical
Answer: B
50. Which classification is most useful for studying evolutionary relationships?
A. Chemical classification
B. Pharmacological classification
C. Taxonomical classification
D. Alphabetical classification
Answer: C

QUESTION BANK

Section A: 2 Marks Questions

Q. No.	Question	Cognitive Domain
1	Define Pharmacognosy.	Remembering
2	What are crude drugs?	Remembering
3	Define official drugs.	Remembering
4	What is chemotaxonomy?	Remembering
5	Write any two applications of plant tissue culture in Pharmacognosy.	Understanding
6	A crude drug is listed in the Indian Pharmacopoeia. Explain how you would classify it as an official or unofficial drug.	Applying
7	Analyze the importance of plant tissue culture in the conservation and large-scale production of medicinal plants.	Analyzing
8	Compare plant-derived and animal-derived drugs with respect to their sources and pharmaceutical importance.	Analyzing
9	A pharmaceutical company wants to develop a new herbal drug from a medicinal plant. Evaluate the importance of Pharmacognosy in ensuring the authenticity, quality, and safety of the drug.	Evaluating
10	Design a strategy for authenticating a newly discovered medicinal plant before its commercial utilization using suitable Pharmacognostic approaches.	Creating

Section B: 5 Marks Questions

1.

Q. No.	Question	Cognitive domain
1	Explain the definition and scope of pharmacognosy.	Understanding
2	Describe the historical development of pharmacognosy.	Understanding
3	Explain various natural sources of drugs with suitable examples.	Understanding
4	Write a short note on microbial sources of drugs.	Remembering
5	Explain alphabetical and morphological classification of crude drugs.	Understanding
6	Apply the principles of crude drug classification to classify medicinal drugs using appropriate systems with suitable examples.	Applying
7	Analyze the advantages and limitations of chemical classification of crude drugs over other methods of classification.	Analyzing
8	Analyze the significance of the indian pharmacopoeia in ensuring the	Analyzing

	quality, identity, and standardization of crude drugs.	
9	Evaluate the impact of the discovery of morphine and penicillin on the development of modern pharmacotherapy.	Evaluating
10	Design a suitable classification strategy for a newly discovered medicinal plant and justify the selection of the most appropriate classification system.	Creating

Section C: 10 Marks Questions

Q. No.	Question	Cognitive Domain
1	Define Pharmacognosy and discuss its history, development, present status, and scope in detail.	Understanding
2	Describe different natural sources of drugs including plants, animals, microorganisms, marine organisms, minerals, and plant tissue culture with examples.	Understanding
3	Discuss the historical milestones in the discovery and development of Morphine, Quinine, and Aspirin.	Understanding
4	Explain the discovery, development, and therapeutic importance of Penicillin, Cephalosporin, and Artemisinin.	Understanding
5	Explain the origin, development, and significance of the Indian Pharmacopoeia, Ayurvedic Pharmacopoeia of India, and Unani Pharmacopoeia of India.	Understanding
6	Apply different methods of crude drug classification to classify medicinal drugs and justify the selection of the most appropriate classification system with suitable examples.	Applying
7	Analyze the merits and limitations of alphabetical, morphological, taxonomical, chemical, pharmacological, and chemotaxonomical classification systems used for crude drugs.	Analyzing
8	Analyze the differences between official and non-official drugs, and codified and non-codified drugs, highlighting their significance in Pharmacognosy.	Analyzing
9	Evaluate the role of various pharmacopoeias in ensuring the quality, safety, and standardization of herbal drugs in pharmaceutical practice.	Evaluating
10	Design a comprehensive strategy for the authentication, classification, and standardization of a newly discovered medicinal plant intended for inclusion in an official pharmacopoeia.	Creating

CASE-BASED LEARNING (CBL) QUESTIONS

True / False (5)

1. Pharmacognosy mainly deals with drugs obtained from natural sources.
2. Morphine was first isolated from cinchona bark.
3. Marine organisms are important sources of bioactive compounds.
4. Official drugs are included in recognized pharmacopoeias.
5. Chemical classification groups crude drugs according to therapeutic action.

Answers:

1. True
2. False
3. True

4. True
5. False

Fill in the Blanks (5)

1. _____ is known as the Father of Pharmacognosy.
2. Quinine is obtained from _____ bark.
3. Penicillin was discovered from the fungus _____.
4. Drugs included in pharmacopoeias are called _____ drugs.
5. Classification based on plant parts is called _____ classification.

Answers:

1. Pedanius Dioscorides
2. Cinchona
3. *Penicillium notatum*
4. Official
5. Morphological

Match the Following (5)

Column A	Column B
Morphine	Marine source
Artemisinin	Opium
Agar	Taxonomical classification
Fabaceae	Sweet wormwood
Senna leaves	Morphological classification

Answers:

1 – b
2 – d
3 – a
4 – c
5 – e

PROBLEM-BASED LEARNING (PBL) QUESTIONS

True / False (5)

1. Plant tissue culture can be used for production of secondary metabolites.
2. Aspirin was originally developed from willow bark constituents.
3. Non-codified drugs are described in official pharmacopoeias.
4. Pharmacological classification is based on chemical constituents.
5. Cephalosporin is obtained from microbial sources.

Answers:

1. True
2. True
3. False
4. False
5. True

Fill in the Blanks (5)

1. Warfarin was discovered from spoiled _____.
2. The Ayurvedic Pharmacopoeia of India deals with _____ medicines.
3. Drugs obtained from animals include honey and _____ oil.
4. The term Pharmacognosy was first used by _____.
5. Classification based on chemical constituents is called _____ classification.

Answers:

1. Sweet clover
2. Ayurvedic
3. Cod liver
4. C.A. Seydler
5. Chemical

Match the Following (5)

Column A	Column B
Taxol	British Herbal Pharmacopoeia

Column A	Column B
Penicillin	Plant tissue culture
BHP	Microbial source
Rauwolfia	Pharmacological classification
Antihypertensive drugs	Root drug

Answers:

1 – b
2 – c
3 – a
4 – e
5 – d