Unit I (Part 1)

Pharmacognosy & Phytochemistry (BP-405)

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UNIT-I

Introduction to Pharmacognosy:

(a) Definition, history, scope and development of Pharmacognosy

(b) Sources of Drugs – Plants, Animals, Marine & Tissue culture

(c) Organized drugs, unorganized drugs (dried latex, dried juices, dried extracts, gums and mucilages, oleoresins and oleo- gum -resins).

Pharmacognosy

Pharmacognosy is a scientific discipline, which is primarily concerned with the study of crude drugs obtained from natural sources, such as plants, animals, and minerals. The term 'Pharmacognosy' was first coined and used by German Scientist **Seydler** in 1815 in a book he wrote on crude drugs, entitled "***Analecta Pharmacognostica***". It was derived from two *Greek* words: *pharmakon*, which means 'a drug', and *gnosis*, which means knowledge of' or *gignosco*, which means 'to acquire knowledge of'. Thus the literal meaning of pharmacognosy is: knowledge of drugs, or to acquire knowledge of drugs. Thus Pharmacognosy may be defined as the objective study of crude drugs and related substances of natural origin (Plants, Animals and minerals) to acquire knowledge about their nature and properties.

It may also be defined as an applied science which is concerned with acquiring knowledge of all aspects of crude drugs and other natural substances of pharmaceutical importance by the application of various scientific disciplines. In other words, it may be said that Pharmacognosy is an important branch of pharmacy, which deals with the scientific study of the structural, physical, chemical, biochemical and sensory characters of crude drugs and related substances of plant, animal and mineral origin. It also includes a study of their history, distribution, cultivation, collection, identification, preparation, evaluation, preservation, use and commerce.

Studies of some spices and condiments are included in the subject matters of Pharmacognosy, as they possess definite medicinal and pharmaceutical properties. Cinnamon bark, Cardamon fruit and various umbelliferous fruits (Fennel, Coriander, Cumin, Anise, etc.), Mustard seed, Clove flower-bud, and Ginger rhizome are some typical examples of such articles. In addition, pharmacognosy includes studies of a variety of commercial and medicinal products such as pesticides, enzymes, vitamins, antibiotics, allergens, and allergenic extracts.

Since Pharmacognosy has developed over the years through the traditional uses of medicinal plants and other natural products as remedies for ailments, the study of medicinal plants and traditional medicines of the past and present and their practice also fall under the purview of modern pharmacognosy.

History of Pharmacognosy

The history of Pharmacognosy is as old as civilization. Plants were used medicinally in

- China
- India
- Egypt
- Greece before beginning of the Christian era.

Ancient China

Chinese pharmacy, according to legend, stems from Shen Nung (about 2700 B.C.), emperor who sought out and investigated the medicinal value of several hundred herbs. He reputed to have tested many of them on himself, and to have written the first *Pen T-Sao*, or *Native Herbal*, recording 365 drugs. These were subdivided as

follows: 120 emperor herbs of high, food grade quality which are non-toxic and can be taken in large quantities to maintain health over a long period of time, 120 minister herbs, some mildly toxic and some not, having stronger therapeutic action to heal diseases and finally 125 servant herbs that having specific action to treat disease and eliminate stagnation. Most of those in the last group, being toxic, are not intended to be used daily over a prolonged period of weeks and months. **Shen Nung** conceivably examined many herbs, barks and roots brought in from the fields, swamps and woods that are still recognized in pharmacy (podophyllum, rhubarb, ginseng, stramonium, cinnamon bark and ephedra).

Ancient Egypt

The most complete medical documents existing are the *Ebers Papyrus* (1550 B.C.), a collection of 800 prescriptions, mentioning 700 drugs and the *Edwin Smith Papyrus* (1600 B.C.), which contains surgical instructions and formulas for cosmetics. The *Kahun Medical Papyrus* is the oldest it comes from 1900 B.C. and deals with the health of women, including birthing instructions.

However, it is believed that the Smith Papyrus was copied by a scribe from an older document that may have dated back as far as 3000 B.C.

Ancient India

In India knowledge of medicinal plants is very old, and medicinal properties of plants are described in *Rigveda* and in *Atharvaveda* (3500–1500 B.C.) from which *Ayurveda* has developed. The Ayurvedic writings can be divided in three main ones *(Charaka Samhita*, *Susruta Samhita*, *Astanga Hrdayam Samhita)* and three minor ones (*Sarngadhara Samhita, Bhava Prakasa Samhita, Madhava Nidanam Samhita).* Ayurveda is the term for the traditional medicine of ancient India. **Ayur** means life and **veda** means the study of which is the origin of the term. The oldest writing - *Charaka Samhita*—is believed to date back six to seven centuries before Christ. It is assumed to be the most important ancient authoritative

writing on Ayurveda. The *Susruta Samhita* is thought to have arisen about the same time period as the *Charaka Samhita*, but slightly after it *Astanga Hrdayam* and the *Astanga Sangraha* have been dated about the same time and are thought to date after the *Charaka* and *Susruta Samhitas*. Most of mentioned medicines origin from plants and animals, e.g. ricinus, pepper, lilly, valerian, etc.

Ancient Greece and Rome

Greek scientists contributed much to the knowledge of natural history. Hippocrates (460–370 B.C.) is referred to as father of medicine and is remembered for his famous oath which is even now administered to doctors. Aristotle (384–322 B.C.), a student of Plato was a philosopher and is known for his writing on animal kingdom which is considered authoritative even in twentieth century. Theophrastus (370–287 B.C.), a student of Aristotle, wrote about plant kingdom. Dioscorides, a physician who lived in the first century A.D., described medicinal plants, some of which like belladonna, ergot, opium, and colchicum are used even today. Pliny wrote 37 volumes of natural history and Galen (131 – A.D. 200) devised methods of preparations of plant and animal drugs, known as 'galenicals' in his honour.

SCOPE OF PHARMACOGNOSY

Pharmacognosy is critical in development of different disciplines of science.

- The knowledge of **plant taxonomy**, **plant breeding, and plant pathology and plant genetics** is helpful in the development of cultivation technology for medicinal and aromatic plants.
- Plant chemistry **(Phytochemistry)** has undergone significant development in recent years as a distinct discipline. It is concerned with the enormous variety of substances that are synthesized and accumulated by plants and the structural elucidation of these substances. **Extraction, isolation,**

purification and characterization of phytochemicals from natural sources are important for advancement of medicine system.

- The knowledge of **chemotaxonomy, biogenetic pathways** for formation of medicinally active primary and secondary metabolites, **plant tissue culture** and other related fields is essential for complete understanding of Pharmacognosy.
- One should have the basic knowledge of biochemistry and chemical engineering is essential for development of collection, processing and storage technology of crude drugs.
- Pharmacognosy is important branch of pharmacy which is playing key role in new drug discovery and development by using natural products. Pharmacognosy has given many leads for new drug discovery and development.
- It is an important link between modern medicine systems (allopathy) and traditional system of medicine. As part of integrative system of medicine, pharmacognosy can help to increase effectiveness of modern medicine system.
- It is acting as **bridge** between pharmacology, medicinal chemistry and pharmacotherapeutics and also pharmaceutics. It also bridges pharmaceutics with other pharmacy subjects.
- More than 60 percent of world population is still using natural product for their primary healthcare needs. Pharmacognosy can provide safe and effective drugs in combination with modern medicine system.
- Pharmacognosy includes knowledge about safe use of herbal drugs including toxicity, side effects, drug interaction thereby increasing effectiveness of modern medicine.

- Pharmacognosy is an important link between pharmacology and medicinal chemistry. As a result of rapid development of phytochemistry and pharmacological testing methods in recent years, new plant drugs are finding their way into medicine as purified phytochemicals, rather than in the form of traditional galenical preparations.
- Pharmacognosy is the base for development of novel medicines. Most of the compounds obtained from natural product serve as prototype or base for development of new drug which are more active and less toxic.
- 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.

Discovery of new medicines from plants: Nutraceutical use versus drug development

Little work was carried out by the pharmaceutical industry during 1950–1980s; however, during the 1980–1990s, massive growth has occurred. This has resulted in new developments in the area of combinatorial chemistry, new advances in the analysis and assaying of plant materials and a heightened awareness of the potential plant materials as drug leads by conservationists. New plant drug development programmes are traditionally undertaken by either random screening or an ethnobotanical approach, a method based on the historical medicinal/food use of the plant. One reason why there has been resurgence in this area is that

conservationists especially in the United States have argued that by finding new drug leads from the rainforest, the value of the rainforests to society is proven, and that this would prevent these areas being cut down for unsustainable timber use. However, tropical forests have produced only 47 major pharmaceutical drugs of world-wide importance. It is estimated that a lot more, say about 300 potential drugs of major importance may need to be discovered. These new drugs would be worth $147 billion. It is thought that 125,000 flowering plant species are of pharmacological relevance in the tropical forests. It takes 50,000 to 100,000 screening tests to discover one profitable drug. Even in developed countries there is a huge potential for the development of nutraceuticals and pharmaceuticals from herbal materials. For example the UK herbal materia medica contains around 300 species, whereas the Chinese herbal materia medica contains around 7,000 species. Even up to the beginning of twentieth century, pharmacognosy was more of a descriptive subject akin mainly to botanical science, and it consisted of identification of drugs both in entire and powdered conditions and concerned with their history, commerce, collection, preparation and storage.

The development of modern pharmacognosy took place later during the period 1934–1960 by simultaneous application of disciplines like organic chemistry, biochemistry, biosynthesis, pharmacology and modern methods and techniques of analytic chemistry, including paper, thin layer, and gas chromatography and spectrophotometry

The substances from the plants were isolated like

- Strychnine (1817)
- Quinine and caffeine (1820)
- Nicotine (1828)

- Atropine (1833)
- Cocaine (1855)

Their structures were elucidated and pharmacological active constituents studied.

The development was mainly due to the following four events:

1. Isolation of penicillin in 1928 by William Fleming and large-scale production in 1941 by Florey and Chain.
2. Isolation of resperpine from rauwolfia roots and con-firming its hypotensive and tranquilizing properties.
3. Isolation of vinca alkaloids, especially vincristine and vinblastine. Vincristine was found useful in the treatment of leukaemia. These alkaloids also have anticancer properties.
4. Steroid hormones like progesterone were isolated by partial synthesis from diosgenin and other steroid saponins by Marker's method. Cortisone and hydro-cortisone are obtained from progesterone by chemical and microbial reaction.

This period can also be termed antibiotic age, as besides penicillin, active antibiotics like streptomycin, chloramphenicol, tetracycline and several hundred antibiotics have been isolated and studied extensively.

Natural Sources of drugs

Plant Sources

A number of plants have medicinal qualities and have been used for centuries as drugs or drug sources. Although the earliest plant source for drugs was the leaf, other parts of plants (e.g., barks, fruits, roots, stem, wood, seeds, blossoms, bulb

etc.) were also later exploited for drug extraction. Where the product is used without further processing e.g., ground leaves or bark, boiled concoctions or powdered sap, the substance is called crude drug.

The table below shows some pharmacologically active principles or drugs derived from various parts of a plant.

Plant part	**Drugs**
Leaves	Digoxin, digitoxin (from *Digitalis purpurea*/foxglove plant); atropine (from *Atropa belladonna, Datura metel, Hyoscyamus niger*)
Flowers	Vincristine, vinblastine (from *Vinca rosea*)
Fruits	Physostigmine (from *Physostigma venenosum*/calabar bean)
Seeds	Strychnine (from *Nux vomica*)
Roots	Emetine (from *Cephaelis ipecacuanha*); reserpine (from *Rauwolfa serpentina*)
Bark	Quinine (from *Cinchona bark*); Conessine (Holarrhena antidysenterica)
Stem	Tubocurarine (from *Chondrodendron tomentosum*); Ephedrine (*Ephedra sinica and Ephedra equisetina*)

Animal Sources

Many important drugs are derived from animal source. In most instances, these medicinal substances are derived from the animal's body secretions, fluid or glands. Insulin, heparin, adrenaline, thyroxin, cod liver oil, musk, beeswax, enzymes, and antitoxins sera are some examples of drugs obtained from animal

sources. Like plant products, drugs from animal sources may be crude (unrefined) or refined material.

Animal	Drugs
Cod Liver oil	Cod liver oil is a dietary supplement derived from liver of cod fish (Gadidae). As with most fish oils, it contains the omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA). Cod liver oil also contains vitamin A and vitamin D. Historically; it was given to children because vitamin D had been shown to prevent rickets, a consequence of vitamin D deficiency.
Shark Liver oil	Shark liver oil is oil obtained from the livers of sharks. It has been used for centuries as a folk remedy to promote the healing of wounds and as a remedy for respiratory tract and digestive system problems. It is a rich source of Vitamin A.
Silkworm	The best-known silk is obtained from the cocoons of the larvae of the mulberry silkworm *Bombyx mori*
Honey bees	Beeswax is a natural wax produced by honey bees of the genus Apis. Honey

Microbial sources

Several life-saving drugs have been historically derived from microorganisms. Examples include penicillin produced by *Penicillium chrysogenum*, streptomycin from *Streptomyces griseus*, chloramphenicol from *Streptomyces venezuelae*, neomycin from *Streptomyces fradiae*.

Marine sources

Bioactive compounds from marine flora and fauna have extensive past and present use in the prevention, treatment or cure of many diseases. Coral, sponges, fish, and marine microorganisms produce biologically potent chemicals with interesting anti-inflammatory, anti-viral, and anticancer activity. For example curacin A from marine cyanobacterium *Lyngbya majuscule*, eleutherobin from coral *Eleutherobia*

sp., discodermolide from marine sponge *Discodermia dissoluta*, etc. show potent anti-tumour activity.

Mineral sources

Minerals (both metallic and non-metallic minerals) have been used as drugs since ancient times. Our body requires trace elements of minerals in order to maintain homeostasis. Patients lacking an adequate level of these materials may take specific mineral-based drugs to raise the level of minerals.

Examples include ferrous sulfate in iron deficiency anemia; magnesium sulfate as purgative; magnesium trisilicate, aluminum hydroxide and sodium bicarbonate as antacids for hyperacidity and peptic ulcer; zinc oxide ointment as skin protectant, in wounds and eczema; gold salts (solganal, auranofin) as anti-inflammatory and in rheumatoid arthritis; selenium as anti-dandruff.

Organized drugs

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.

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.

Seeds: Nuz-vomica, Isapghol, Castor

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

Plants and Herbs: Ergot, Ephedra, Bacopa, Andrographis,

Unorganized drugs

The drugs which are prepared 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 *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 Gua-iacum, 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.