# Introduction to Pharmacognosy

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# Pharmacognosy

- **Pharmacognosy is derived from two Greek words,** *Pharmakon* **&** *Gnosis*

- **Pharmakon** – means **'drug'.**
- **Gnosis** – means **'knowledge'.**
- In brief, Pharmacognosy means **'knowledge of drugs'.**
- ➢ It is a study of drugs that originate in the **plant & animal kingdoms.**

**Pharmacognosy is a branch of pharmacy which deals with the basic resources of medicines from nature (plant & animal) and their uses as medicaments from ancient time to present day.**

# Pharmacognosy

**Pharmacognosy** may be defined as an important branch of Pharmacy which deals with the study of structural, physical, chemical, biochemical and sensory characters of natural drugs of plant and animal origin. It also includes a study of their history, distribution, cultivation, collection, identification, preparation, evaluation, preservation, use and commerce.

• At present pharmacognosy involves not only the crude drugs but also their natural derivatives (pure compounds or constituents).

• Digitalis leaf and its isolated glycoside, digitoxin; Rauwolfia root and its purified alkaloid, reserpine; and thyroid gland with its extracted hormone, thyroxine, are all part of the subject matter of pharmacognosy.

# Pharmacognosy - History

History of pharmacognosy is actually the history of medicine that is medicinal plants.

## Pre-history:

- The first or beginning of pre-history on use of medicinal plants or herbs or animals, and the place where and how used were not well known, and those information were unwritten for a long time. As a result, the pre-history on herbs was almost lost.

- However, some information was recorded by oral transmission from generation to generation.

# Pharmacognosy - History

## Written History:

- The written history has originated which was based on region, religion and culture etc.

The written history was divided into the following:

1. The western medicine
2. The Unani (Islam)
3. The Ayurveda (Indian)
4. The orient
5. The Greek History
6. The African System

## 1. The western medicine:

✓ This is originated in **Mesopotamia and Egypt**. **Mesopotamia** is considered as the **first origin of human civilization**. The Sumerians (peoples of ancient Mesopotamia) developed cuneiform tablet of herbal medicines. Those tablets is preserved in British museum.

✓ **In Egypt,** information had written on paper – *Papyrus ebers* (1600BC). It consisted of 800 prescriptions, mentioning 700 drugs.

✓ The first pharmacopoeia named London Pharmacopoeia was published in 1618 and then British Pharmacopoeia was published in 1864.

## 2. The Unani (Islam)

- This herbal system was developed by Arabian Muslim Ibn Sina (980 – 1037 AD). He was a prince and ruler. He was a very brilliant pharmacist and physician who wrote a book – "Kitab-Al-Shifa", means 'Book of Healing'.

- The book was written on Arabic language. This is a great contribution of Ibn Sina on medical and pharmaceutical sciences.

# 3. The Ayurveda (Indian, 2500-600 BC):

Ayurveda is the term for traditional medicine of ancient India.

The word "Ayur" means 'Life' and "veda" means 'The study of' that is "Study of Life".

The Ayurvedic writings were divided into three systems:

1) Charaka Samhita, 2) Sushruta Samhita and 3) Astanga samhita.

The oldest writing was Charaka Samhita (six to seven century before Christ).

The book describes uses of many metallic drugs eg., iron, mercury, sulphur, cupper etc with

## 4. The orient (2700 BC):

> This is originated from **Chinese, Japanese** and **Tibet** etc. The orient herbalism was very old (142 – 220 BC) and called "Kampo". The written documents were made by the King 'Shen Nung' (2700 BC) and Shang (1766 – 1122 BC) etc.

> **Shen Nung** investigated medicinal value of several herbs and written a book – **"Pen T-Sao"** or native herbal.

# 5. The Greek History:

Some of the early naturalists, scientists and physicians who contributed enormously to the development of human knowledge about medicinal plants include following:

➤ **Hippocrates (Father of Medicine, 460-370 BC):**

He was the first natural doctor who utilized simple remedies such as vinegar, honey, herbs etc in healing. He is also known to have collected and identified a number of medicinal plants.

➤ **Aristotle (384-322 BC):**

He gave the philosophy of medicine. He listed more than 500 plants of medicinal importance.

➤ **Theophrastus (340 BC):**

gave scientific basis of use of plants as medicine.

➤ **Galen (131-200 AD):**

a Greek pharmacist-physician. He developed the methods of preparing and compounding medicines by mechanical means. He was the originator of the formulae for a cold cream.

## 6. The African System (Tropical Africa, North and South America):

> They keep information in their groups or tribes. The information transmitted from one generation to another.

> These regions are richest sources of medicinal plants and needs to explore for new drug discovery.

# Scope of Pharmacognosy

Pharmacognosy deals primarily with information on the sources and constituents of natural drugs.

1. Primary source of medicines (from ancient time to present day), for example – hyoscine, morphine, ergotamine, ouabain etc.

2. Providing Template/guide for the discovery of new drugs, for example – Pathidine (analgesic drug) designed from morphine.

# Terms &

# Phrase used in

# Pharmacognosy

# Drug

Standard dictionaries define drug as "an original, simple medicinal substance, organic or inorganic, used by itself or as an ingredient in medicine".

According to WHO's definition – "any substance used in a pharmaceutical product that is intended to modify or explore physiological systems or pathological states for the benefit of the recipient".

Pharmaceutical product/Medicine means "a dosage form (tablet/capsule/syrup/IV/IM) containing one or more drugs along with other substances included during the manufacturing process".

# Application of Drug

- **Prevention of a disease :** for example, vaccine.

- **Fight against an infection:** for example, antibiotics.

- **Temporary blocking of a normal function:** for example, general & local anesthetics

- **Detoxification of the body:** for example, antidotes.

- **Diagnostic agents:** for example, radioisotopes.

- **Correction of dysfunction:** for example, cardiotonics (eg, digoxin) for the treatment of congestive heart failure.

- **Correction of hyperfuntion:** for example, Rauwolfia root (eg., reserpine) for the treatment of hypertension.

## Crude Drug:

The term "Crude", as used in relation to natural products. A crude drug is a natural drug of plant or animal origin which has undergone no treatment other than collection and drying, that is, the quality or appearance of the drug has not been advanced in value or improved in condition by any physical or chemical treatment.

*For example:* Digitalis leaf, Rauwolfia root etc.

# Indigenous vs Naturalized

## Indigenous :

Plants growing in their native countries are said to be indigenous to those regions.

For example: Aconite (*Aconitum napellus*) in the mountainous region of Europe. It is highly poisonous used as diuretic in Homeopathy preparation

## Naturalized:

Plants are said to be naturalized when they grow in a foreign land or in a locality other than their native homes.

For example: Datura (*Datura stramonium)* which was introduced into the USA from Europe.

# Official Books

It provides guideline for the manufacturing, quality control, packaging, storage, dose regimen, indication, contraindication etc of different pharmaceutical products/medicine for the treatment of diseases.

- **USP** – United States Pharmacopoeia
- **BP** – British Pharmacopoeia
- **NF** – National Formulary
- **BNF** – British National Formulary
- **BDNF** – Bangladesh National Formulary
- **BPC** – British Pharmaceutical Codex
- **Martin Dale Extra Pharmacopoeia**
- **Materia Medica**
- **Physician's Index**
- **Goodman's & Gilmann's:** The Pharmacological Basis of Therapeutics.

# Official vs Unofficial vs Nonofficial drug

## Official drug:

Any drug (crude or prepared) which is included in pharmacopoea or in national formulary or in recognized books is called an 'official drug'.

For example: quinine, morphine, codeine, paracetamol are included in BP, USP, NF and so on.

## Unofficial drug:

A drug which has been recognized earlier in the pharmacopoeia or in national formulary or in recognized books but not found in the current issue is designated as an 'unofficial drug'. Those substances were excluded from the recognized books due to their severe toxic effects on humans. For example: Sucralfate (hyperacidity), mercurial compounds (diuretics), benzoic acid (preservative) etc.

## Official vs Unofficial vs Nonofficial drug

## Nonofficial drug

Substance that has never been appeared in either of the official books may be called nonoffical. Such types of compounds may be published in current journals having proven clinical value, but we do not know about their side effects.

For example - Curcumine (sinusitis), etc.

# Extractive

The **crude mixtures of chemical constituents** that are removed from plants or animals by **various extraction processes** are called extractives or derivatives.

# Secondery metabolites

These are substances synthesized or produced as **by-products by plants** during their **metabolic activities**. Apparently they are of no primary use of plants.

They are therefore also regarded as 'waste products of metabolism, which are usually accumulated in some parts of the plant and are physiologically active on living organisms.

# **Monograph**

The descriptive material pertaining to any drug, therapeutic agent included in the pharmacopoeia is known as the monogram.

The monogram of a drug includes the following information on the drug:

official title, synonyms, definition, description, collection or preparation, identity tests, tests for adulterants, method of assay, storage, uses and doses.

# Monogram of
## *Trigonella foenum-graecum (Family: Papilionacacae)*

**Common name:** Fenugreek (Eng.), Methi (Bengali)

**Cultivation:** It is cultivated in different area of Bangladesh, India, Pakistan, Middle East, Africa.

**Description:** The Latin species name *foenum-graecum* means 'Greek hay', which is a dried plant's (leaves or seeds) and has a strong hay-like scent. It has a strong, pleasant and a peculiar odor and grows best in well-drained soils with a low rainfall into brownish- yellow rhombic shape seeds.

Parts used: Ripe, dried seeds

**Chemical constituents:** Seeds are rich in mucilage (maily galactomannans), fixed oil, fatty acids and protein. They also contain alkaloids, saponine, glycosides etc.

**Uses:** Seeds are diuretics, astringent. They are popularly used in the treatment of loss of appetite, weight loss, menstrual disorder. Also used in hypertension, diabetes, sexual problem etc. It lowers TG, cholesterol, LDL. **Dose:** Daily dose, 18 g.

# Pharmacognosy & Modern Medicine

❑ Simultaneous advancement in the field of chemistry, biochemistry, biosynthesis and pharmacology has developed pharmacognosy.

❑ Various active compounds have been isolated from plants which are used in modern medicine.

❑ With the advancement of synthetic organic chemistry most of the active constituents of plants have been synthesized.

❑ More than 100 plants are used in modern medicine in various parts of the word.

# Important active constituents of plants used in medicine

| Active constituents | Plants | Pharmacological activity |
|---|---|---|
| Morphine, Codeine, Papaverine | *Papaver somniferum* L. | Sedative, smooth muscle relaxant |
| Quinine, Quinidine | *Cinchona* sp. | Antimalarial, antiarrthythmic |
| Hyoscine, Atropine | *Datura* sp., | Parasympatholytic |
| Digitoxin, Digoxin | *Digitalis lanata* | Cardiotonic |
| Reserpine, Rescinamine | *Rauwolfia* sp. | Hypotensive, vasodialator |
| Vincristine, Vinblastin | *Catharanthus roseus* | Anticancer |

# Important active constituents of plants used in medicine

| Active constituents | Plants | Pharmacological activity |
|---|---|---|
| Caffeine | *Camellia sinenssis* | CNS stimulant |
| Cocaine | *Erythroxylum coca* | Anaesthetic |
| Ephedrine | *Ephedra* sp. | Sympathomimetic |
| Pilocarpine | *Pilocarpus jaborandi* | Parasympathomimetic |
| Ergometrine Ergotamine Ergotoxine | *Claviceps purpurea* | Oxytocic Vasoconstrictor Vasodialator |

## Important active constituents of plants used in medicine

| Active constituents | Plants | Pharmacological activity |
|---|---|---|
| Psyllium mucilage | *Plantago ovata* | Laxative |
| Sennosides | *Cassia angustifolia* | Laxative |
| Theophylline | *Caffea arabica* | CNS stimulant Diuretic |
| Steroid hormones | *Solanum* sp. | Anti-inflammatory, antiarthriytic |

# Application of Pharmacognosy

- Plants always provide novel molecular structure, which played important role for the molecular design and development of novel potent, less toxic or nontoxic drugs e.g. natural morphine has got analgesic & narcotic effect but meperidine a synthetic drug originates from morphine basic skeleton is non-narcotic.

- Plant & animal products give potential biological effect without any undesirable effects.

- Plant & animal products can be taken with very

# Limitation of Pharmacognosy

Drugs obtained from natural sources have a variety of limitations. The majors are;

•A natural compound may be highly active but usually this is associated with high toxicity problem, **ex-** the toxic and therapeutic dose of digitalis are very close which create serious problem to use this medicine by the patient alone.

•Some compounds are found in natures that give beneficial pharmacological actions but their potencies are too low to be employed therapeutically.

•The yield of active natural products may be very low and thus the production cost of those drugs will be very high

•The source of a natural drug may be very limited with respect to geography, season and climate etc.

# Sources of Medicaments

- At present the prime sources of modern or allopathic medicines are synthesized in the laboratory by organic chemist.

- Only a few of compounds are isolated from plants, which are cannot be replaced by synthetic method.

- For example: morphine isolated from *Papaver somniferum*;

vincristin & vinblastin (anticancer drug) from *Vinca rosea*,

the most potent anticancer drug taxol from *Texus brevifolia*;

the constituents of digitalis cannot be properly replaced by any synthetic drug like quinidine which is used for the treatment of arrhythmia.

# Classification of Drugs

In pharmacognosy, drugs may be classified according to -

1. Their morphology
2. The taxonomy of the plants and animals from which they are obtained
3. Their therapeutic application
4. Their chemical constituents or active principles.

Each of these methods of classification has advantages and disadvantages.

# 1. Morphological classification

- In this system, the drugs are grouped according to the part of the plants, such as roots, leaves, stems, barks, flowers, seeds etc.

- The drugs obtained from the direct parts of the plants are called as **organized drugs**. They are made up of whole plants or any parts derived from them.

eg., **Root** – Rauwolfia, aconite, ginger; **Bark** – Cinnamon, Cinchona **Fruit** – Amla, Bahera, Capsicum, **Leaf** – Digitalis, Senna, Tulsi, coca; **Wood** – Sandal wood.

- The drugs which are prepared from plants by some intermediate physical process such as incision, drying or extraction with a solvent are called **unorganized drugs**, eg., Dried juice (Aloe juice), Dried extract (agar), Dried latex (Opium latex), Honey, Beewax etc.

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

## 2. Taxonomical classification

- In this system crude drugs are arranged according to the natural groups (e.g. Families) of their source.

- For example: all the drugs obtained from Solanaceae are grouped together as Solanaceous drugs.

- Tropane alkaloids are the main constituents of Solanaceous drugs.

| Family | Drugs |
|--------|-------|
| Solanaceae | Solanaceous drugs. eg. Tropane alkaloids |
| Umbelliferae | Umbelliferous drugs. eg., volatile oils |

# 3. Pharmacological classification

- In pharmacological classification the drugs are grouped according to their therapeutic use.

- For example cardiotonic drug include digitalis, purgative drugs include castrol oil.

| Pharmacological action | Drugs |
|---|---|
| Anticancer | Vinca |
| Analgesic | Opium, cannabis |
| Purgatives | Senna, Aloe, Castrol oil, Plantago husk |
| Cardiotonic | Digitalis, strophanthus |
| Tranquillizer | Rauwolfia root |
| Anti-inflammatory | Tumeric, colchicum |

The main drawback of this classification is that a drug can be placed in various classes according to its therapeutic use. For example: Cinchona (quinine) can be grouped in antimalarial and antiarrhythmic catagories.

**4. Chemical classification**

- The biological activity of a drug is due to the presence of certain chemical constituents in the drug.

- Plants and animals synthesize chemical compounds such as carbohydrates, protein, fat, volatile oils, alkaloids, resin etc.

  •The chemical classification of drugs is dependent upon the grouping of drugs with identical chemical constituents.

# Chemical classification of drugs

| Chemical constituents | Drugs |
|---|---|
| **1.     Carbohydrates**<br>     a) Monosaccharidase<br>     b) Disaccharide<br>     c) Polysaccharide  Gum<br>            Mucilages  Cellulose | - Dextrose, fructose, galactose<br>-Sucrose, Lactose, Maltose<br>-Starch<br>-Acacia, Tragacanth<br>-Plantago seed<br>-Cotton |
| **2. Glycosides**<br>     a) Cardiac<br>     b) Anthraquinone<br>     c) Saponins<br>     d) Cyanophore | -Digitalis, strophanthus<br>-Aloe, Cascara, senna<br>-Arjuna<br>-Wild cherry bark |
| **3. Tanins** | Amla, Bohera, Ashoka bark |
| **4. Volatile oil** | Clove oil, rose oil, peppermint oil, tulsi etc |
| **5. Lipids**<br>     a) Fixed oils & fats<br>     b) Waxes | -Olive oil, castor oil, coconut oil etc<br>-Bees wax |

# Chemical classification of drugs

| Chemical constituents | Drugs |
|---|---|
| 6. Resins | ginger, capsicum etc. |
| 7. Alkaloids<br>  a) Pyridine & piperidien<br>  b) Tropane<br>  c) Quinoline<br>  d) Isoquinoline<br>  e) Indole<br>  f) Steroidal<br>  g) Purine | <br>a) Nicotiana, areca nut<br>b) Coca, Belladonna, Datura<br>c) Cinchona<br>d) Opium, Ipecac<br>e) Ergot, Nuxvomica, Rauwolfia, catharanthus, Physostigma<br>f) Kurchi<br>g) Tea, Coffee |
| 8. Protein | Gelatin, gluten etc |
| 9. Vitamins | Thiamine (B1), Riboflavin (B2), Ascorbic acid etc |
| 10. Antibiotics | Penicillin, streptomycin, tetracycline etc |
| 11. Hormones | Adrenaline, thyroxine etc |

# Evaluation of Drugs

- A natural substance is considered as food if it fills stomach in every day life without any harmful effect.

- A substance become drug if it change a pathological or disease state of human/animal to normal physiological condition having no undesirable effect in specific dose.

- A long-term studies (chemical, biological and physical etc) are required to establish whether a substance will be considered as drug or food or eliminate for consumption. Those studies are referred as evaluation.

**Evaluation of drug means –**
- Identification
- Determination of quality
- Determination of purity

# Identification

✓ The identification can be established by <span style="color:red">careful observational study</span> of the collected drug, and then <span style="color:pink">compared with authentic specimen</span> by the collector.

✓ Therefore, for proper identification of a drug from plant or animal sources, a collector must be educated about plant taxonomy and very much experienced with his/her job.

✓ **Therefore, drugs from plants/animals are identified by –**

    o    **A qualified, specialized & experienced personnel**

    o    **Comparison with the authentic sample specimen.**

✓ In every country, there is a <span style="color:lavender">national herbarium</span> where most of plants specimen are preserved. A number of specialists are working on plant identification there.

# Quality

- The word "quality" refers to the intrinsic value of the drug, i.e., the amount of medicinal principles or active constituents present. These principles are classified as carbohydrate, alkaloid, glycoside, volatile oil, lipid, antibiotics and steroids etc.

- A high grade of quality in a drug is of primary importance. An effort should be made to obtain and maintain high quality.

- To maintain high quality products one should do the following:
1. Select proper source (wild or cultivated)
2. Appropriate time of collection
3. Collection of required parts of plants (bark, leaf, stem, rhizome, root)
4. Preparation of the collected drug by proper cleaning, drying.
5. Proper preservation to avoid contamination by microorganisms and moisture, heat, air and light.

# **<u>Purity</u>**

- **The purity of drug can be achieved by –**

1. **Proper identification**

2. **Quality assurance.**

# Evaluation Method

- The evaluation of a drug involves a number of methods, which may be classified as follows:

1. Organoleptic

2. Microscopic

3. Biological

4. Chemical

5. Physical

# 1. <u>Organoleptic evaluation of drug</u>

- Organoleptic evaluation means the study of a drug with the help of organs of sense.

- It includes any drug's macroscopic or external appearance, color, odor, taste & sounds of its fracture etc.

- The macroscopic or external characteristic of a drug may be divided into 7 headings -

1. Shape
2. Size
3. Color
4. Fracture & internal color
5. Odor
6. Taste

# 2. Microscopic evaluation of drug

Microscopic evaluation of drug can be done in the laboratory by the use of microscopes and utilizes various microscopic characters of the drugs, such as types and arrangement of various cells and tissues.

# 3. <u>Chemical evaluation of drug</u>

- Chemical evaluation of drugs involves both qualitative and quantitative determination of their active principles.

•In this method characteristic qualitative chemical tests are employed to identify crude drugs and their constituents.

# 4. <u>Biological evaluation of drug</u>

- The biological evaluation of crude drugs is very useful in determining the **pharmacological activity** of the drug.

- Since **living organism or their isolated living tissues** are used, this method is also called the biological method or **bioassay**.

- Many drugs, particularly the **antibiotics, toxins and toxoids and also vitamines** are assayed by this method.

## 5. <u>Physical evaluation of drug</u>

The physical evaluation of crude drugs is accomplished by the determination of various physical characteristics using various physico-chemical techniques, for example, specific gravity (of fats and volatile oils), melting points (of alkaloids), optical rotation (of alkaloid and volatile oils), etc.