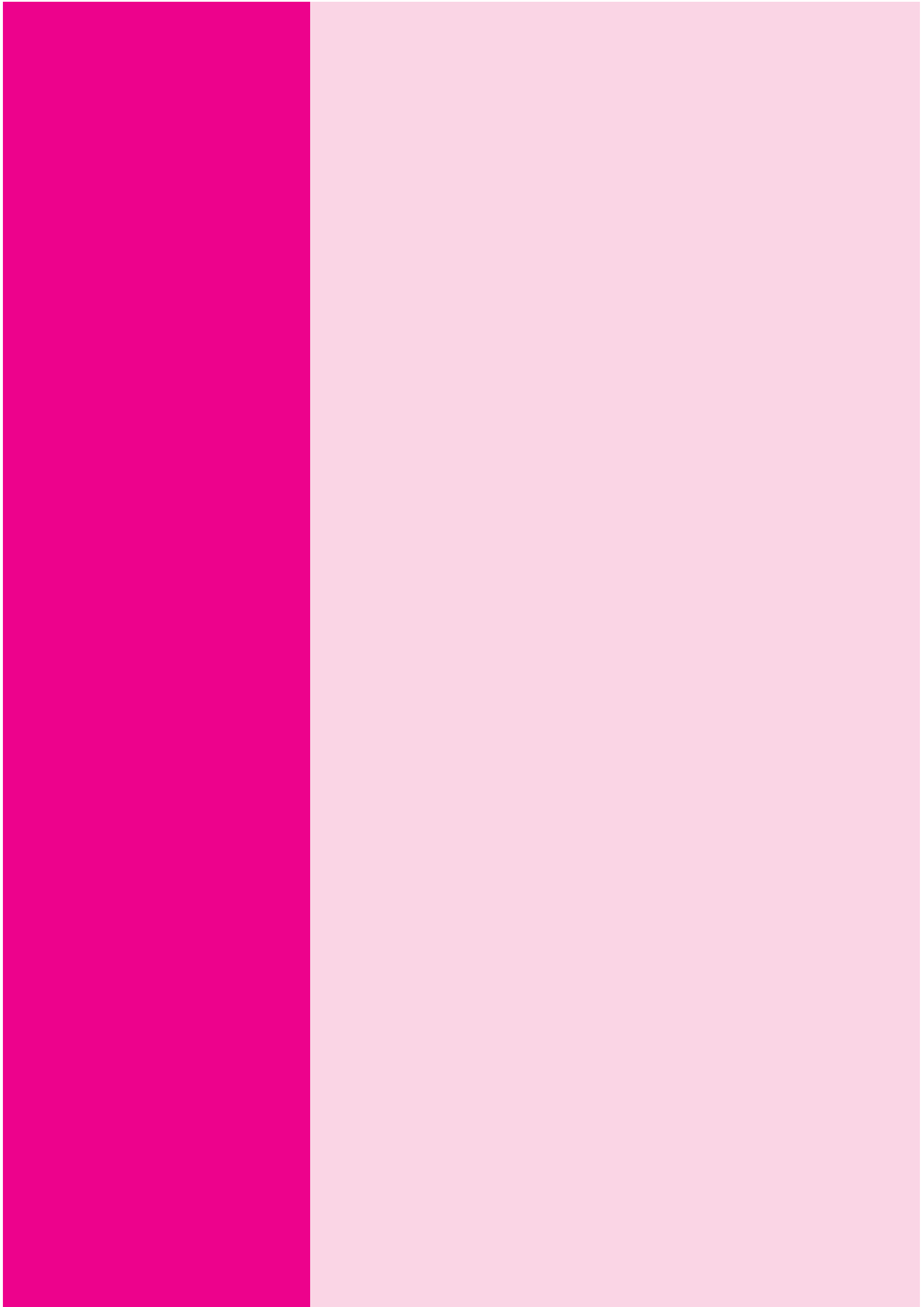


# **PART - I PHARMACOGNOSY**

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# CHAPTER 1

## Pharmacognosy: Scope and History

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## Introduction

The term 'pharmacognosy' (combination of two Greek words i.e., *pharmakon* means drug and *gnosis* means knowledge) means acquiring knowledge of drugs was coined in 1815 by C. A. Seydler, German medical student in his thesis title "*Analytica Pharmacognostica*". Pharmacognosy is defined as scientific and systematic study of structural, physical, chemical and biological characters of crude drugs along with history, method of cultivation, collection and preparation for the market. The American Society of Pharmacognosy defines pharmacognosy as "the study of the physical, chemical, biochemical and biological properties of drugs, drug substances or potential drugs or drug substances of natural origin as well as the search for new drugs from natural sources. It is also called as study of crude drugs.

Thus pharmacognostical studies of plant drugs involves study of synonyms, vernacular names, biological sources, distribution, morphology, histology, chemistry, qualitative test, various physicochemical tests, pharmacological actions along with commercial varieties, substitutes, adulterants and any other quality control parameters of the drugs.

## Scope

- The pharmacognosy has played an important role in the development of various departments of the science. Pharmacognosy gives a sound knowledge of the vegetable drugs under botany and animal drugs under zoology. It also includes plant taxonomy, plant breeding, plant pathology, plant genetics and by this knowledge one can improve the cultivation methods for both medicinal and aromatic plants. Now-a-days phytochemistry (plant chemistry) has undergone the significant improvement. This includes a variety of substances that are accumulated by plants and synthesized by plants.
- Pharmacognosy explains thorough knowledge of the history, cultivation, collection, quality control, transport, storage and even economic impact of crude drugs.
- World Health Organization (WHO) has estimated that the 80% of the world population uses the herbal medicines in primary health care. Some of the very famous crude drugs are senna as a purgative, digitalis as a cardiotonic and rauwolfia as an antihypertensive drug.
- The knowledge of extraction of medicinal constituents from various parts of plants and its utilization has revolutionized the health sciences.
- Novel techniques like bioassay guided fractionation helps in the isolation of phytochemicals on the basis of potency of their therapeutic effects.
- Recently started studies on natural drug-drug, drug-food interactions is avoiding the untoward effects of severe interactions and hence helps in obtaining the optimal therapeutic outcomes especially for classes like Blood thinners, protease inhibitors, cardiac glycosides, immunosuppressant.
- In the pharmaceutical industry, various drugs of botanical origin are used in drug manufacture process. Knowledge of pharmacognosy will surely help as a research tools in new drug development.
- Recent guidelines for quality control of crude drugs is to assure the identity, purity, consistency of drug substances, efficacy to determine the therapeutic responses, indications, clinical aspects and pharmacological effects, safety to avoid untoward toxic reactions, interactions and contraindications.

- Pharmacognosy has a vital contribution to the advancement of natural and physical science due to advances in technologies of cultivation, purification, identification, characterization of natural drugs.
- Pharmacognosy is vital link between pharmacology and medicinal chemistry because it enables isolation of purified natural drugs, converts into medicine and evaluates its therapeutic effects.
- Pharmacognosy links pharmaceuticals and basic science as well as ayurvedic and allopathic system of medicines to each other.
- However, this subject is as old as pharmacy and mankind evolution; recently it is evolved as a multi-disciplinary subject focusing many modern disciplines like ethonobotany, ethonopharmacology, phytotherapy, phytochemistry, chemo-taxonomy, biotechnology, clinical trials, herbal drug interaction and even novel drug delivery systems like phytosomes rather only botanical and taxonomical descriptions. Recent advances in extraction methods, analytical hyphenated techniques, screening methods continues to hasten major changes in this subject. Modernization of conventional and/or traditional dosage forms is opening doors to industrial pharmacognosy.
- Due to most recent technologies and innovative chemical concepts, many new drugs or drug candidates still originated from natural products or derivatives thereof. Even in this era of nanotechnology, natural drugs are important part of primary health care which is giving pharmacognosy professionals new possibilities to exploit the huge diversity designed and generated by nature.
- There is a shortage of established scientists engaged in pharmacognosy research, which tends to involve subject matter beyond the conventional scientist's knowledge base. Hence, actual secret of opportunities in pharmacognosy research is that only the tip of the iceberg seems to have been discovered yet.
- Due to rapid growth in demand and popularity of natural products, research is directed towards patentable drug discovery and development in the field of pharmacognosy.

## History

History of pharmacognosy is as old as mankind. Human being came to know medicines from nature itself. Table 1.1 is explaining various historical developments which together contributed to development of pharmacognosy. Various traditional systems of medicines are also part of historical development of pharmacognosy.

**Table 1.1** Scientists and their work in the development of Pharmacognosy

Name	Profession	Work	Period
Hippocrates <i>Father of Medicine</i>	Greek scientist	Studied human anatomy and Physiology	460-360 B.C
Aristotle <i>Father of Biology</i>	Greek Philosopher	Animal kingdom	384-322 B.C.
Theophrastus <i>Father of Botany</i>	Greek Philosopher	Plant kingdom	370-287 B.C.

Table 1.1 Contd...

Name	Profession	Work	Period
Pedanius Dioscorides	Greek physician	<i>De Materia Medica</i> book is compilation of several plants	78 A.D.
Gaius Plinius Secundus or Pliny the Elder	Roman naturalist	Encyclopedic work entitled <i>Naturalis Historia</i>	25-70 A.D.
Aelius Galenus or Claudius Galenus or Galen	Greek pharmacist	Galenical Pharmacy	131-200 A.D.
Carl Linnaeus <i>Father of Taxonomy</i>	Swedish botanist	Binomial classification	1753
C A Seydler	German scientist	Coined word <i>Pharmacognosy</i>	1815
Sir Joseph D. Hooker	British botanist	Plant nomenclature	1817-1911
George Bentham	English botanist	Plant nomenclature	1800-1884
Charles Darwin	English naturalist	Evolutionary theory	1809-1882
Friedrich Sertürner	German chemist	Isolated first alkaloid morphine from opium	1804
Mikhail Tsvet	Russian scientist	Separation of plant pigments by chromatography	1900

## Alternative Systems of Medicine

### Ayurveda System

It is about 5000 year old system of medicine native to India. It is holistic system of medicine which considers whole body while treating disease and not just a diseased part of body. Ayurveda has thousands year's evidence based history so it can be just complete system rather alternative system or complementary system. Ayurveda is a Sanskrit word which means (Ayur-life and veda - to gain knowledge or science) science of life. Ayurveda deals with different types of plants, minerals and animal products. Charak samhita by Charak includes the principle components or theory of Ayurveda. Sushrut samhita edited by Sushrut is about the surgical treatments in Ayurveda.

**Theory and principles:** Ayurveda involves fundamental principles of **tridosha** (kapha-

lubrication, vata respiration and pitta-metabolism), **panchshil** (rasa: therapeutically active substances, guna: quality, virya: active principle and potency, vipaka: the end product of digestion, prabhava: actual effect of drug on body), **panch mahabhuta** (earth, water, sky, fire and air), **saptadhatu** [rasa (plasma), raktam (blood), mamsa (muscles), meda (fat), asthi (bone), majja (bone marrow and nerves), shukra (reproductive fluid or semen)] and triguna i.e., *satva* (good), *raja* (aggressive), *toma* (dullness)

**Diagnosis:** When non-equilibrium between any of above principles causes to person suffers from diseases. Ayurveda cures the cause of disease by considering to mental, physical, social and spiritual welfare of human beings. Observation of body color, tongue, nail, eyes, pulse and investigation of blood, urine and fecal matter is criteria of diagnosing actual cause of disease.

**Treatment:** Panchkarma is an important treatment in Ayurveda which includes snehan (massage), swedan (steam), vaman (vomit), virechan (expulsion) and basti (medicated enemas). The medicines are given in the form of powder (churna, bhasma), liquid (asava, arishta and taila), semisolid (leha or paka) and tablets (gutika, vati). Treatment of ayurveda involves use of drugs obtained from plant, animal and mineral sources. Dosage forms of ayurveda are powders (churna), bhasma (oxides of metals), quath (extracts), gutika (pills), lep (ointment), asava and arishtha (alcohol containing liquids) or taila (medicated oils). There are eight branches of Ayurveda:

1. Kayachikitsa (internal medicine)
2. Kumarbhritya (pediatrics)
3. Trachchikitsa (psychology medicine)
4. Shalaky Tantra (ear, nose and throat)
5. Shalya Tantra (surgery)
6. Agada Tantra (toxicology)
7. Rasayana Tantra (geriatrics)
8. Vajikaran Tantra (gynecology)

### Siddha System

Siddha system of medicine is one of the oldest medical systems known to mankind even before ayurvedic system which was flourished in Vedic culture, Dravidian culture and Indus Valley Civilization. This system of medicine originated from tamil traditional medicine. The most of literature of this system is given in Tamil Language. 18 "Siddhas" (spiritual persons) developed this system so it is called as Siddha. Sage agathiyar is considered the guru of all Siddhas. It is believed that it was first described by lord Shiva to his wife Parvathy and then to their son lord Muruga.

**Theory and principles:** Generally the basic principles of the siddha medicine are almost similar to ayurveda. Siddha deals with thousands of herbs, animal, mineral and

metals. Like in ayurveda, in siddha medicine also, the physiological components of the human beings are classified as vata (air), pitta (fire) and kapha (earth and water).

**Diagnosis:** It involves observation of pulse, skin color, tongue, eyes, nail and if required blood, urine and fecal matter.

Guna	Personalities	Complications
Vata	Stout, black, cold and inactive healthy	Increased Vata shows arrogant behaviour, paralysis, heart attack.
Pitta	Lean, whitish complexion and perfectionist	Increased Pitta shows graying of hair, anemia and instability.
Kapha	Well built, good complexion and well behaved	graying of hair, causes jaundice, heart attack.

**Treatment:** Treatment in this system involves the preparation of fresh medicine. It is then prepared and administered with some Pathya (some restriction). E.g., Day time sleeping is not allowed or some food material is restricted like chicken, mango, coconut, mustard, groundnut, almond, tobacco etc. Medicine can be kashayam (extract), churnam (powder), tailams (medicated oil), gulligai (pills), chenduram (metal), bhasmam (calcination product) and or ghritam (medicated ghee).

### Unani System

This system is also called as unani-tibb or yunani medicine which was developed by arab and persian physicians such as Rhazes (al-Razil), Avicenna (ibn sena), Al-zahrawi, and Ibn nafis.

**Theory and principles:** Unani medicine involves concept of the four humours (akhlat) i.e., Phlegm (balgham), blood (dam), yellow bile (safrâ') and black bile (saudâ'). Abnormality in humor leads to disease condition in body.



**Diagnosis:** In diagnosis unani physician (hakim) asks patient a lot of questions to know history and decides treatment.

**Treatment:** After diagnosing the disease, treatment involves either to eliminate cause (Izala-e sabab), normalize humors (tadeele akhlat) or to normalize tissues or organs (tadeele aza). Method of treatment involves modification of essential pre-requisites of health (Ilaj-bil-tadbeer) or panchkarma like in Ayurveda (Ilaj-bil-tadbeer) or pharmacotherapy (Ilaj-bil-advia) or surgery (Ilaj-bil-yad). As far as possible unani medicine therapy attempts to use simple physical means to cure a disease. Some of the techniques used in Ilaj-bil-tadbeer (regimental therapy) include hijamah (cupping), fasd (venesection), tareeq (sweating), idrar-e-baul (diuresis), hamam (turkish bath), dalak (massage), kai (cauterization), ishal (purgings), qai (vomiting), riyazat (exercise) and taleeq (leeching) particular consistency. The bases are generally purified by adding aab leemun (lemon juice), sat leemun (lemon extract) or shibb-e-yamani (alum) etc., before making the qiwam. Afterwards, the ingredient drugs are mixed in qiwam to prepare majun, itrifal, laboob, tiryaaqat or mufarreah. For making majun or any of its preparations, the consistency of qiwam for majun is three Tars. The consistency of qiwam for laooq is two tars.

Word Majun is derived from Ajn, which means to mix. In this preparation powder of drugs is mixed well in qiwam (basic solution of particular consistency) of sugar or asl (honey). Their names are given on the name of inventor, chief ingredients or action. Like majun sheikhurrais is named on inventor. majun mullein is named due to its laxative action. Majun azaraqi, as azaraqi is chief ingredient. So itrifal (triphala), jawarish (digestive tonic), yaqooti (ruby containing),

bershasha are all majun but according to composition use ingredient preparation method, and other properties, their names are different.

### Homeopathy System

Homeo means 'similar' and Pathos means 'suffering' so homeopathy is the "system of similar suffering". German physician Samuel Hahnemann first stated the basic principle of homeopathy in 1796, known as the "law of similars" (let like be cured by like").

**Theory and principle:** Homeopathy emphasises the root cause of the disease and the nature's law of its cure that is 'like cures like'. Thus, homeopathy deals with the following seven principles which are outlined below:

- **Individualisation:** No two individuals in the world are alike, i.e., the disease affecting two individuals cannot be similar though they may share common symptoms. Therefore, the medicines used to cure the same disease in different individuals are different.
- **Principle of similar:** Use of the medicine will produce similar symptoms of disease in a healthy individual. For example, an onion is a substance, which makes your eyes water and your nose burn. If you are having an attack of hay fever with watering eyes and a burning nose, a homeopathic remedy made from onion can relieve it.
- **Principle of simplex:** Only one single simple medicine at one time and no combination is allowed.
- **Minimum dose:** Minimum medicine at a time.
- **Law of proving:** Medicine should have the capacity to produce disease state in a healthy individual.

- **Law of dynamisation:** Medicine should preserve the normal state of healthy body.
- **Vital force:** Medicine should have the capacity to arouse sufficient energy to maintain a healthy body.

**Diagnosis:** It involves knowing of complete hereditary history as well as observation of moods, habits, skin, eyes, tongue, blood, urine etc., of patients.

**Treatment:** When the symptoms picture matches with the drug picture, the physician always attempts to identify a single medicine. In producing remedies for diseases, homeopaths use a process called “dynamisation” or “potentisation”, whereby a substance is diluted with alcohol or distilled water and then vigorously shaken in a process called “succussion”. Three logarithmic potency scales are in regular use in homeopathy for dilution. Hahnemann created the “centesimal” or “C scale”, diluting a substance by a factor of 100 at each stage. Homeopathic pills are made from an inert substance (often sugars, typically lactose), upon which a drop of liquid homeopathic preparation is placed. Hahnemann began to test what effects substances produced in humans, a procedure that would later become known as “homeopathic proving”.

### Chinese System

Traditional Chinese Medicine (TCM) is older than 2,000 years have been developed in China. Historical physicians in TCM include Zhang Zhongjing, Hua Tuo, Sun Simiao, Tao Hongjing, Zhang Jiegu, and Li Shizhen.

**Theory and principles:** Chinese medicine involves concept of Yin and Yang. Yin means negative, dark, water, moon, female, inside, cold or moist. Yang means positive, bright, sun, fire, male, outside, hot or dry. Yin dominating body shows inactivity, cold or lethargy while yang dominating body shows

fever, hyper-activity. Five element theory of TCM (wood-germination, water-decay, fire-growth, earth-ripening and metal-nourishment) relates to five body organs (wood-liver, fire-heart, water-kidney, earth-spleen and metal-lung) and symbolises man and nature relationship. TCM believes that *qi* means energy, blood and water are three essential substances for body’s normal health.

**Diagnosis:** TCM diagnosis consists in tracing symptoms to an underlying disharmony pattern, mainly by palpating the pulse and inspecting the tongue.

**Treatment:** Treatment includes use of herbal medicines or massage and acupuncture therapy.

### Kampo System

Kampo medicine is an ancient traditional system that developed in Japan between the 7<sup>th</sup> and 9<sup>th</sup> centuries after adapting traditional Chinese system. Shunki Tashiro, Dosan Manase, Nagoya and Todo Yoshimasu are few people who played important role in development of Kampo system. Regulations, and likewise safety precautions, are much stronger and tighter for Japanese kampo than Chinese traditional medicine due to strict enforcement of laws and standardization. It was not as famous but merits of natural medicines have been recognized today and hence it is estimated that 80% of Japanese physicians integrate kampo prescriptions into their practice. In Japan, kampo is integrated into the national health care system and it follows strict regulations of the standardization, purity, and stability of kampo ingredients. In treatment kampo medicine is patient-centered.

**Theory and principles:** Generally the basic principles of the kampo medicine are almost similar to TCM except abdominal diagnosis which very important in kampo than TCM.

**Diagnosis:** In kampo system, the focus is not on the disease, but rather on treating patients and promoting well-being, assessing the proper fit between a pattern of symptoms and a kampo prescription.

**Treatment:** Now a day, it is very popular system in treating chronic diseases. Till date about 400 herbs has been explored and standardized in kampo system.

### Aromatherapy

Aromatherapy is a form of alternative medicine that uses essential oils in the treatment or prevention of certain diseases especially related to pain, anxiety, hair or skin. Evidence for the efficacy of aromatherapy in treating medical conditions remains poor, with a particular lack of studies employing rigorous methodology, but some evidence exists that essential oils may have therapeutic potential. Many such oils are described by dioscorides, along with beliefs of the time regarding their healing properties, in his *De Materia Medica*, written in the first century. The modes of application of aromatherapy include aerial diffusion, direct inhalation, topical applications. Aromatherapy is alone does not cure

conditions but in combination with other techniques show positive effects and helps the body to find a natural way to cure itself and improve immune response.

### Naturopathy

The term Naturopathy was coined in 1895 by John Scheel. Naturopathy is a system of prevention rather treatment. Prevention through stress reduction and a healthy nutritious diet and lifestyle is emphasized, and drugs and surgery are generally minimized. It focuses on natural healing power of body thus art of living. This system uses soil and water in treatment of diseases in the form of mudpacks and steam baths respectively. Fasting is also part of naturopathy treatment.

### Yoga

Yoga consists of exercises (physical postures) and meditation (mental concentration). It believes that exercise improves blood circulation in the body and meditation improves mental health. Thus Yoga improves physical, mental as well as social health along with personal behavior of the person.

**Table 1.2** Eight limbs included in yoga

Yama	Five abstentions	Ahimsa (non-violence), satya (truth), asteya (non-covetousness), brahmacharya (celibacy) and aparigraha (non-possessiveness).
Niyama	Five observances	Shaucha (purity), santosha (contentment), tapas (austerity), svadhyaya (study of the vedic scriptures to know about god and the soul) and ishvara-pranidhana (surrender to god).
Asana	Seat	Seated position used for meditation
Pranayama	Suspending breath	To restrain or stop and thus control of the life force.
Pratyahara	Abstraction	Withdrawal of the sense organs from external objects
Dharana	Concentration	Fixing the attention on a single object
Dhyana	Meditation	Intense contemplation of the nature of the object of meditation
Samadhi	Liberation	Merging consciousness with the object of meditation

## Crude Drugs

Crude drugs are the drugs, which are obtained from natural sources like plant, animals or minerals and used as such as they occur in nature without any processing except, collection, drying and size reduction. It also defined as the drugs that have not been advanced in value or improved in condition by shredding, grinding, chipping, crushing, distilling, evaporating, extracting, artificial mixing with other substances or any other process beyond that which is essential to its proper packing and to prevention of decay or deterioration during manufacturing. Crude drugs and their constituents are commonly used as therapeutic agents. Major sources of crude drugs are plant (senna, opium, digitalis and clove), animal (musk, honey, shark liver oil) and mineral (shilajit, talc, bentonite).

### Classification of Crude Drug

In Pharma-cognosy crude drugs are classified in the following category.

**Alphabetical Classification:** In this classification drugs are classified in alphabetical order using either their Greek name or Latin name. Though pharmacopoeias, formulary, encyclopedias of various countries follow this classification, but due to lack of scientific value now-a-days this classification is not preferred. Example: Acacia, bael, cinchona, dill, ergot, fennel, ginger, henbane, ipecac, jalap, kurchi, licorice, myrrh, nux-vomica, opium, podophyllum, quassia, rauwolfia, senna, tea, urgenia, vasaka, wool fat, yam, zedoary etc. Major advantage of this method is that it provides quick reference.

**Morphological Classification:** This is most simple classification method where crude drugs are grouped into two major classes: organized (having specific parts of plant like root, rhizome, flower, leaf, fruit, bark, seed,

wood etc.) and unorganized drugs (dried lattice, juice, gum, wax, oil etc.). But many crude drugs are very similar morphologically and hence difficult to distinguish. Many times crude drug available in powder form that time morphological classification is not so suitable and acceptable.

Part	Example
Leaves	Senna, digitalis, vasaka, eucalyptus
Barks	Cinchona, kurchi, cinnamom
Woods	Quassia, sandalwood
Roots	Rauwolfia, ipecacuanha, aconite
Rhizomes	Turmeric, ginger, valerian, podophyllum
Seeds	Nux-vomica, strophanthus
Flowers	Clove, saffron
Fruits	Coriander, colocynth, fennel
Entire plant	Vinca, belladonna
Resins	Balsam of tolu, myrrh, asafoetida, benzoin
Gums and Mucilages	Acacia, tragacanth, guar gum
Dried lattices	Opium
Dried juices	Aloes, kino

**Taxonomic Classification:** In this classification crude drugs are arranged according to taxonomic order i.e., phylum, division, class, sub-class, orders, families, genus and species (See chapter 2 for more details). Precise and orderly arrangement of drugs has no ambiguity in this classification. But again this type of classification lacks scientific value and unorganized crude drugs are difficult to classify.

Phylum - Spermatophyta  
 Division - Angiospermae  
 Class - Dicotyledons  
 Sub-class - Sympetalae  
 Order - Tubiflorae  
 Family - Solanaceae  
 Genus - *Atropa*  
 Species - *belladonna*

**Biological or Pharmacological Classification:** In this classification, crude drugs having similar therapeutic effects or pharmacological activity are grouped together but drugs having more than one therapeutic effect are difficult to classify. It also doesn't give any idea about chemistry or taxonomy.

Pharmacological Action	Drug
Carminatives	Fennel, coriander, clove.
Purgatives	Cascara, aloe, senna, rhubarb.
Cardio tonics	Digitalis, squill, strophanthus
Anti- cancer	Taxaol, vinca, podophyllum
CNS stimulant	Nux-vomica
Expectorant	Vasaka, liquorice
Bitter tonic	Gentian, chirata

**Chemical Classification:** This classification is purely based on chemistry of constituents. Different crude drugs are classified according to the presence of major active

constituents. This is most preferred method of classification.

Chemical class	Drugs
Alkaloid	Cinchona, rauwolfia, datura
Volatile oil	Clove, fennel oil, coriander
Glycoside	Senna, digitalis, licorice
Resin	Jalap, ginger, tolu balsam
Carbohydrates	Acacia, honey, starch, isapgol
Tannins	Arjuna, ashoka
Lipid	Castor oil, peanut oil, mustard
Proteins	Casein, gelatin
Enzymes	Papain, trypsin

**Chemotaxonomic Classification:** Chemo-taxonomy is a technique which establishes relation between chemistry and taxonomy. It is also called as chemosystematics. Morphological characters and chemical constituents are interrelated and have a lot significant for the plant taxonomy. E.g., In case of eucalyptus, feather-veined leaves have high pinene content in their essential oil,

**Table 1.3** Parameters involved in pharmacognostic study of crude drug

Parameters	Description
Common names	Names in various languages
Biological source	Genus, species and family
Geographical source	Location of sources
History	Discovery of crude drug
Cultivation , collection and preparation for market	Time and method of cultivation, irrigation, climate, fertilizers, collection time, processing etc.
Morphological description	Color, odor, taste, size, shape, extra features
Microscopical description	Cell, tissue type and arrangement, cell inclusions, special characters etc
Chemical constituents	Major and minor chemical constituents present
Chemical tests	To identify crude drug and its chemistry
Uses and pharmacological actions	Various therapeutic applications
Adulterants and commercial varieties	Useful for quality control
Formulations available in Market	To understand market potential
Quality control and standardization	To establish qualitative and quantitative standards with the help of sophisticated instruments.

while intermediate veined leaves contain both pinene and cineole. Chemotaxonomic study starts with exact choice of group, then sound sampling, analysis of chemical

content, interpretation, comparison and finally classification. More details on this topic can be read in chapter 7.

## Sources of Crude Drug

<b>Plant</b>	Plant source is the oldest source of natural drugs. About 25% of the drugs prescribed worldwide came from plants, most of such active compounds being in current use. Many more crude drugs are considered as basic and essential for primary health care by the World Health Organisation (WHO). Additionally significant numbers of synthetic drugs are also obtained from natural precursors. Thus plants provide a large bank of rich, complex and highly varied structures of phytochemicals which are unlikely to be created in just laboratories. For example: digoxin from <i>Digitalis</i> spp., quinine and quinidine from <i>Cinchona</i> spp., vincristine and vinblastine from <i>Catharanthus roseus</i> , atropine from <i>Atropa belladonna</i> and morphine and codeine from <i>Papaverum somniferum</i> .
<b>Animal</b>	Animal source is one of very interesting source for various drugs. Example: Honey from honeybee, beeswax from bees, cod liver oil from shark, bufalin from toad, insulin from animal pancreas, musk oil from musk, spermaceti wax from sperm whale, woolfat from sheep, carminic acid from colchineal, venoms from snake.
<b>Mineral</b>	A mineral is a naturally occurring substance that is solid and stable at room temperature, can be representable by a chemical formula, usually a biogenic, and has an ordered atomic structure. Most naturally occurring mineral substances are used in medicine in a highly purified form. Example: sulfur is a key ingredient in certain bacteriostatic formulations, shilajit is used as tonic, calamine is used as anti-itching agent.
<b>Marine</b>	Bioactive compounds from marine flora and fauna have extensive past and present use in the treatment of many diseases and serve as compounds of interest both in their natural form and as templates for synthetic modification. Several molecules isolated from various marine organisms (microorganisms, algae, fungi, invertebrates, and vertebrates) are currently under study. So far, more than 10,000 compounds have been isolated from marine organisms. Only 10% of over 25,000 plants have been investigated for biological activity. Example: Agar -agar is a gelatinous substance derived by boiling a polysaccharide fraction from red algae, carrageenans or carrageenins are a family of linear sulfated polysaccharides that are extracted from red seaweeds.
<b>Plant tissue culture</b>	Plant tissue culture refers to growing and multiplication of cells, tissues and organs on defined solid or liquid media under aseptic and controlled environment. Plant cell and tissue cultures hold great promise for controlled production of myriad of useful secondary metabolites on demand. Example: antihypertensive ajmalicine from callus culture of <i>Catharanthus roseus</i> , anti-inflammatory berberine from suspension culture of <i>Thalictrum minus</i> , antiparkinson L-DOPA from callus culture of <i>Stizolobium hassjo</i> , immune modulatory ginsenoside from callus culture of <i>Ginseng</i> spp.