UNIT 10 PHARMACOGNOSY AND PHYTOPHARMACEUTICALS

Structure

10.1 INTRODUCTION

The present chapter deals with the term "Pharmacognosy", its origin and history. It also covers the study of phytoconstitutents, different aspects of classification of phytoconstitutents, their extraction, isolation and characterization by using different physical, chemical and spectroscopic techniques. Pharmacognosy is concerned with the knowledge of crude drugs obtained from natural origin. Pharmacognosy has a long history i.e. 3500 B.C. Most of the world's population relies upon natural plants for cure of ailments. Phytoconstituents present in the medicinal plants are responsible for the pharmacological activity. These phytoconstituents can be classified on the basis of their chemical moiety.

The phytoconstituents are extracted through maceration, decoction, percolation and continuous hot extraction method, isolated and purified by physical techniques like fractional liberation, fractional crystallization and using different chromatographic techniques. The isolated compounds are identified and characterized by the application of various spectroscopic techniques like UV, IR, NMR spectroscopy and Mass spectrometry.

Objectives

After studying this unit, you should be able to:

- understand the importance of pharmacognosy;

- classify the phytoconstituents present in the plants;
- explain various techniques of extraction, isolation and purification of crude drugs; and
- explain the various chemical and spectroscopic methods for characterization of phytoconstituents isolated from plants.

10.2 PHARMACOGNOSY

The word Pharmacognosy is derived from two Greek words "Pharmakon" means *drug* and "Gignosco" means to *acquire knowledge of.*

Hippocrats (460-360 B.C.)	Father of medicines
Aristottle (384-322 B.C.)	Study of Animal Kingdom
Theophrastus (372-287 B.C.)	Study on Plant Kingdom
Pliny Elder (23-70 A.D.)	Compiled 37 volumes of natural history.
Galen (131 - 200 A.D.)	Introduced Galenical Pharmacy
Seydler (1815)	Discovered the term 'Pharma-cognosy'.
William Withering (1785)	Published medicinal properties of fox glove.
Sertuerner (1806)	First isolated morphine from opium.
Stars and Otto (1852)	Gave a number of extraction procedures.
Newmann (1860)	Isolated cocaine.
Nagai (1887)	Isolated ephedrine.

The term *Pharmacognosy* was introduced by C.A. Seydler, a medical student in Halle Salle, Germany in the year 1815.

A number of definitions for the term Pharmacognosy are used which are as follows:

i) Pharmacognosy is defined as scientific and systematic study of structural, physical, chemical and biological characters of crude drugs along with their history, method of cultivation and collection and preparation for market.

ii) Pharmacognosy may be defined as an applied science that deals with the biological, biochemical and economic features of natural drugs and their constituents.

iii) Pharmacognosy is the study of drugs that originate from the plants and animal kingdom.

Pharmacognosy serves as a link between the following:

a) Pharmacognosy and medicinal chemistry
b) Pharmaceuticals and Basic Sciences
c) Ayurvedic and Allopathic Systems of Medicine.

10.2.1 History of Pharmacognosy

The history of herbal medicines is as old as human civilization. Indian history of medicinal plants is taken back from 3500 B.C. A large portion of Indian population depends upon Indian system of medicine i.e. Ayurveda which have well known treatise in *Charaka Samhita* and *Sushrutha Samhita.*

10.2.2 Scope of Pharmacognosy

Pharmacognosy as an applied science which played a crucial role in the development of different disciplines of science. The knowledge of plant taxonomy, breeding, pathology and plant genetics is helpful in the development of different disciplines of science. The technology involving extraction, purification, and characterization of pharmaceuticals from natural resources has signified contribution to the advancement of natural and physical sciences. Pharmacognosy is the infrastructure on which depends evolution of noble medicines. Further, crude drugs also provide essential intermediates for final

synthesis of active compounds. India is the richest source of medicinal plants which are distributed in almost all parts of the country. To cope up with the demand of constant supply for the phytochemical industries, the domestication and cultivation of some of the important plants are necessary. There are many drugs which are imported to India like Balsam of Tolu, Benzoin, Asafoetida etc. If the cultivation is carried out in India, sufficient amount of foreign exchange can be saved. There are number of diseases for which modern medicine have no cure like stress, genetic diseases, arthritic diseases, liver disorder, cancer and AIDS etc. In such cases, only symptoms are treated to provide relief to the patients. But plant drugs from pharmacognosy have answers to such questions i.e. by use of plant drugs, we can treat incurable diseases.

In this way, pharmacognosy has a wide scope in different areas to save mankind.

SAQ 1

Fill in the blanks:

a) The term Pharmacognosy was introduced by……..in year …..….

b) Pharmacognosy word is ived from two Greek words "……..." means ……. and "……..." means …….. .

c) Morphine was first isolated by ……..

d) Father of Medicines is ……

10.3 CLASSIFICATION OF PHYTOCONSTITUENTS

The medicinal potential of a crude drug is determined by nature of constituents present in it. The plant drugs chemically consist of mixture of organic and inorganic constituents known s phytoconstituents. They are formed in plants through the activity of their individual cells. Pharmaceutically important groups are the organic constituents. The process by which plants convert the simple chemical substances into complex organic compounds with the help of enzymes is known as biosynthesis. The phytoconstituents of therapeutic importance can be classified into the following main groups:

i) Carbohydrates
ii) Glycosides
iii) Tannins and Phenolic Compounds
iv) Proteins and Amino Acids
v) Colouring Matter
vi) Lipids – Fixed Oils, Fats and Waxes
vii) Volatile Oils
viii) Alkaloids
ix) Resins and Resin Combinations
x) Carotenoids

i) **Carbohydrates**

Carbohydrates are defined as plant products which consist of carbon, hydrogen and oxygen, the ratio of hydrogen to the oxygen is two to one.

Carbohydrates are of wide occurrence in nature and provide means of storage and transport of energy and also the building blocks of the cell wall. Crude drugs mostly consist of either simple or complex type of carbohydrates. The simple ones are hexoses, pentoses and methyl pentoses, slightly more complex are di- and tri- saccharides, more complex carbohydrates are cellulose, starch, gums, mucilages etc. Pharmaceutically important carbohydrates are polysaccharides and polyuronides.

ii) **Glycosides**

Glycosides are the substances which on hydrolysis yield one or more sugars (glycon) along with non-sugar (aglycon) compounds. They occur in various parts of plants like leaves, bark, fruits, and seeds. They are further classified into different groups of pharmaceutically importance like saponins and anthracin derivatives.

iii) **Tannins and Phenolic Compounds**

Tannins are complex phenolic compounds which are soluble in water and have an astringent and bitter taste. Tannins are classified into two groups on the basis of their ability to be hydrolysed. First group is referred to as *hydrolysable tannins* as these can be readily hydrolysed. Second group is known as *non-hydrolysable* or *condensed tannins*. These are resistant to cleavage. The tannins are used in treatment of burns as they precipitate proteins of exposed tissues to form a protective coating. They are used in tanning industries for converting animal hides to leather. Simple phenolic compounds occur in many plants and have different pharmaceutical uses. Vanillin is the aglycon of the glycosides of vanilla pods and is used in confectionary and in perfumery. Similarly, eugenol (clove), salicin and arbutin are simple phenolic compounds.

iv) **Proteins and Amino Acids**

This constituents a major class of natural products of different categories including albumin, globulin, conjugated proteins etc.

v) **Colouring Matter**

They are widely distributed in natural products. The majority consist of chlorophyll, anthoxanthins, anthocyanins etc.

vi) **Lipids – Fixed Oils, Fats and Waxes**

The term *lipid* is used for fixed oils, fats and waxes. Fixed oils are liquid at normal temperature while fats are solids or semi-solids at this temperature. Chemically, they are esters of glycerol with long chain fatty acids. These esters are termed as *glycerides*.

Fixed oils and *fats* are non volatile. They are insoluble in water and are lighter than it and form a permanent stain on paper. They are sparingly soluble in cold alcohol (except castor oil), but soluble in other organic solvents like petroleum ether, diethyl ether, chloroform etc.

Waxes are esters of higher alcohols (e.g. cetyl alcohol) with higher fatty acids. They are insoluble in water but are soluble in many organic solvents and can be saponified by alcoholic alkali.

vii) **Volatile Oils**

Volatile oils are the odorous constituents found in various parts of plants, they evaporate on exposure to air at ordinary temperature. As volatile oils are responsible for the essence or odour of the plants, they are also known as *essential oils*. They are present in entire plant or in any part of the plant like inflorescence (coriander), flowers (lavender), fruits (fennel), leaves (eucalyptus), bark (cinnamon), peel (oranges), hairs modified parenchyma cells, in tubes called such as glandular hairs, modified parenchyma cells, in tubes called vittae or in lysigenous or schizogenous cavities.

Chemically, volatile oils are the mixtures of monoterpenes and sesquiterpenes; they may be simple hydrocarbons, alcohols, ketones, aldehydes, phenols, ethers, oxides, esters, acids, aromatic or aliphatic compounds. Volatile oils are used as flavouring agents or as perfumes in various pharmaceutical preparations and some of them are used for their therapeutic actions as antibacterial, antifungal, antispasmodic and antiseptic. In plants, they may serve as insect attractants helping in cross-pollination of flowers or in some cases as insect repellents, thus preventing their destruction.

viii) **Alkaloids**

They constitute a major class of chemical groups present in plant drugs. Originally alkaloids meant 'alkali like' which was applied indiscriminately to all the organic bases. With course of time, the term alkaloid has altered in significance and presently, it includes mainly the cyclic nitrogenous bases, which occur in plant. Thus, alkaloids are the *naturally occurring organic substances having a cyclic nitrogenous nucleus exhibiting basic properties and a pronounced physiological action.* Alkaloids are found distributed in various parts of the mature plants as in seeds (strychnos), in fruits (piper), in leaves (belladonna), in roots (rauwolfia), in rhizomes and roots (ipecac), in corms (colchicum) and in bark (cinchona).

ix) **Resins and Resin Combinations**

Resins are solid or semisolid amorphous products of complex chemical nature. These are usually obtained as exudates from plants, and are considered as end products of metabolism. Resins and related resinous

products are produced in plants during normal growth or secreted as results of injury to the plants. They usually occur in schizogenous or schizolysigenous cavities or ducts. Resins often occur in homogenous combination with other plant products. These are collectively called *resin combinations.* The resin combinations of pharmaceutical importance are oleoresins, oleo-gum-resins, and balsams.

x) **Carotenoids**

Carotenoids are responsible for many of red orange and yellow pigments observed in the plant and animal kingdoms. They are generally tetra-terpenoid derivatives (containing about 40 carbon atoms) and can be divided into hydrocarbons and oxygenated forms known as *xanthophylls*. The former groups are less polar and can be extracted into petroleum ether. Xanthophylls are more polar as they contain alcoholic, ketonic, aldehydic, carboxyl or epoxide groups, and can therefore be extracted into ethanol or mixtures of ethanol and less polar solvents such as chloroform.

SAQ 2

Fill in the blanks:

a) Chemically, volatile oils are the mixtures of …….. and …….

b) Carbohydrates are defined as plant products which consist of carbon, hydrogen and oxygen, the ratio of hydrogen to the oxygen is ……..

c) Glycosides on hydrolysis yields ……. and …… compounds.

d) Name the classes of tannins on the basis of their ability to be hydrolysed.

e) Name the group of phytoconstituents which form a permanent stain on paper.

f) The word ‘alkaloid’ means…….. .

10.4 EXTRACTION, ISOLATION AND CHARACTERIZATION OF PHYTOPHARMACEUTICALS

The crude drug contains the *active constituents* which can be isolated from these drugs by various methods of extraction and separation.

10.4.1 Phytochemical Investigation

Phytochemical investigation or **screening** is the extraction, isolation, purification and characterization or identification of therapeutically or pharmacologically active plant constituents by using different physical, chemical, chromatographic and spectroscopic techniques. The first and foremost step in this is the *selection*, *identification*, *collection* and *extraction* of the plant material.

10.4.2 Extraction

Extraction is the commonly employed technique for separation of active substances from crude drugs. It involves the use of different solvents. The dried powdered plant material is commonly used for extraction. The fresh plant part when used is homogenized or macerated with a solvent such as alcohol which is a general solvent for many potential constituents. Water immiscible solvents, such as light petroleum is used for the extraction of fixed and essential oils, steroids and aglycones. Chloroform and ether are used for separation of alkaloids and quinones.

10.4.3 Extraction Methods

Extraction of crude drugs can be done by various processes depending on the physical nature of drug and chemical properties of constituents present in it. Various methods used for extraction of drugs include infusion, decoction, digestion, maceration and percolation.

The processes like infusion, decoction and digestion are now obsolete, hence rarely used with few exceptions for extraction of drugs. Only the maceration and percolation processes are of particular importance and most pharmacopoeias refer to these processes for the extraction of crude drugs.

i) **Maceration:** Maceration process involves the immersion of the crude drug material in bulk of solvent for a period of at least three to seven days with frequent shaking.

ii) **Percolation:** In percolation process, solvent is continuously flown through the bed of the crude drug material and the extract is obtained. It is carried out in a percolator which is a 'V' shaped vessel.

iii) **Decoction:** Decoction is the process in which the crude plant material is extracted with warm solvent for a specified period of time. It is then filtered, marc pressed and the filtrate is concentrated.

10.4.4 Isolation and Purification of Constituents

The isolation and purification of constituents present in the extract depends upon the physical and chemical characteristics of the compound to be separated. The physical techniques employed for this purpose are:

i) Fractional Crystallization
ii) Fractional Distillation
iii) Fractional Liberation
iv) Paper Chromatography
v) Thin Layer Chromatography
vi) Column Chromatography
vii) High Performance Thin Layer Chromatography (HPTLC)
viii) High Performance Liquid Chromatography (HPLC)

i) **Fractional Crystallization**

Phytopharmaceuticals crystallize out at the point of supersaturation in the solvent in which they are soluble. Slow concentration, slow evaporation, refrigeration are the processes that are involved in the crystallization of products.

ii) **Fractional Distillation**

Fractional distillation is useful for the separation of volatile oils and hydrocyanic acid from plant materials. The components like citral, citronellal and eucalyptol are separated by fractional distillation.

iii) **Fractional Liberation**

Some groups of compounds having the tendency of precipitation and comes out the solvent. For example, a mixture of alkaloids gets liberated when they treated with excess of alkali.

iv) **Paper Chromatography**

It is based on principle of the *partition chromatography* in which the components of the extract get distributed between two liquid phases. One phase is stationary liquid which is usually water held in the fibres of Whatman filter paper and other is a mobile phase. It is used for the study of flavonoids, glycosides, alkaloids, carbohydrates, amino acids and proteins.

v) **Thin Layer Chromatography**

It is used for qualitative screening of different plant extracts. The stationary phase is generally silica gel G supported over glass or aluminium plates and mobile phase is different solvents or mixture of solvents. This technique is used for isolation of compounds on small scale in the laboratories.

vi) **Column Chromatography**

It comprises of the open column in which stationary phase is packed in the column and different solvents with different polarity are used for the separators of mixture of components. This is useful for the purification of natural products, biochemicals, vitamins, hormones etc.

vii) **High Performance Thin Layer Chromatography (HPTLC)**

This is the advanced technique of TLC. In HPTLC, samples to be chromatographed are applied to the self coated plates in the form of a band without damage to the layer. HPTLC is highly used in the study of natural products, herbal cosmetics, and it is also effective in the analysis of pesticides, and used in biochemical research.

viii) **High Performance Liquid Chromatography (HPLC)**

This technique is mainly applicable in the microanalysis of chemical constituents. This is basically a form of column chromatography where

packing material is of uniform particle size and regular shape. The columns are finely packed and pressure up to 5000 lb in^{-1} can be employed to achieve acceptable flow rates.

10.4.5 Methods of Identification of Constituents

The class of the compounds can be determined by their response to colour tests with chemical reagents. The various chemical tests are used for the detection of the following classes of compounds:

i) Alkaloids
ii) Carbohydrates and Glycosides
iii) Phytosterols
iv) Fixed Oils and Fats
v) Saponins
vi) Phenolic Compounds and Tannins
vii) Gums and Mucilages

Let us now study them in detail.

i) **Detection of Alkaloids**

The small portions of solvents free chloroform, alcohol and water extracts are stirred separately with a few drops of hydrochloric acid and filtered. The filtrate is tested carefully with various alkaloidal reagents such as Mayer's Reagent (cream precipitate), Dragendroff's reagent (orange brown ppt.), Hager's Reagent (yellow ppt.) and Wagner's Reagent (reddish brown ppt.).

ii) **Detection of Carbohydrates and Glycosides**

a) Small quantities of alcoholic and aqueous extracts are dissolved separately in 5 mL of distilled water and filtered. The filtrate may be subjected to Molisch's test to detect the presence of carbohydrates.

b) Another small portion of extract is hydrolysed with dil. hydrochloric acid for few hours in water bath and is subjected to Libermann Burchard's, Legal's and Borntrager's tests to detect the presence of different glycosides.

iii) **Detection of Phytosterols**

The petroleum ether, acetone and alcoholic extracts are refluxed separately with a solution of alcoholic potassium hydroxide till complete saponification takes place. The saponification mixture is diluted with distilled water and extracted with ether. The ethereal extract is evaporated and the residue (unsaponificable matter) is subjected to Liebermann and Burchard's tests.

iv) **Detection of Fixed Oils and Fats**

A small quantity of petroleum ether and benzene extract is passed separately between two filter papers, oil strains on the paper indicates the presence of fixed oils.

v) **Detection of Saponins**

About 1 mL of alcoholic and aqueous extracts are diluted separately with distilled water to 20 mL and shaken in a graduated cylinder for 15 minutes. One cm layer of foam indicates the presence of saponins. The test solution may be subjected to test haemolysis.

vi) **Detection of Phenolic Compounds and Tannins**

Small quantities of alcoholic and aqueous extracts in water are tested for the presence of phenolic compounds and tannins with dil. ferric chloride solution (5%), 1% solution of gelatin containing 10% sodium chloride, 10% lead acetate and aqueous bormine solution.

vii) **Detection of Gums and Mucilages**

About 10 mL of aqueous extract is added to 25 mL of absolute alcohol with constant stirring. The precipitates are dried in air and examined for its swelling properties and for the presence of carbohydrates.

Detection of Volatile Oil: About 50 g of powdered material is taken in a volatile oil estimation apparatus and subjected to hydro distillation. The distillate is collected in the graduated tube of the assembly in which the aqueous portion is automatically separated from the volatile oil if it is present in the drug.

10.4.6 Spectrophotometry

i) Ultraviolet (UV) and Visible Spectroscopy
ii) Infrared (IR) Spectroscopy
iii) Mass Spectrometry (MS)
iv) Nuclear Magnetic Resonance Spectroscopy (NMR)

i) **Ultraviolet (UV) and Visible Spectroscopy**

The absorption spectra of plant constituents can be measured in very dilute solution against a blank solvent by using automatic recording spectrophotometer. The colourless compounds absorb in the range of 200 to 400 nm i.e. UV range and the coloured compounds absorbs in the range of 400 to 700 nm i.e. the visible region. Different natural products are analysed by this technique eg. reserpine (268 nm), morphine (286 nm) and colchicine (360 nm).

ii) **Infrared (IR) Spectroscopy**

IR spectroscopy is the valuable tool for the characterization of plant constituents. It is the study of the reflected, absorbed or transmitted radiant energy in region of electromagnetic spectrum wavelength ranging from 0.8 to 500 nm. IR is a function of wave number. It can be near IR region (1250 to 4000 cm^{-1}), mid I.R. (4000-400 cm^{-1}) and far IR (400-20 cm^{-1}). The alkaloidal components can be identified by the application of IR spectroscopy.

iii) **Mass Spectrometry (MS)**

Mass spectrometry mainly deals with electron ionisation, subsequent fragmentation of molecules, determination of the mass to charge ratio (m/z) and the relative abundance of ions that are produced. The possible structure of original molecules can be designed by knowing the fragmentation patterns.

iv) **Nuclear Magnetic Resonance Spectroscopy (NMR)**

NMR spectroscopy involves the absorption of radio frequency radiation by the substances which are kept in magnetic field. Absorption is due to interaction of radiation with magnetic moment of nuclei in the sample and these occur at different frequencies for nuclei with chemically different environment within a molecule. Deuterated analogues of water, chloroform, acetone etc. are used as solvent for this purpose.

It can be proton NMR i.e. ^{1}H-NMR or ^{13}C-NMR. ^{1}H-NMR is used for determining the structure of an organic compound by measuring the chemical shift values of different types protons present in it. The ^{13}C-NMR spectroscopy gives direct information on the nature of the carbon skeleton of the molecule.

SAQ 3

Fill in the blanks:

a) ……. solvents are used for the extraction of fixed and essential oils, steroids and aglycones.

b) Maceration process involves the immersion of the crude drug material in bulk of solvent for a period of at least …….with frequent shaking.

c) Fractional Distillation technique is mainly useful for the separation of …… from plant materials.

d) In Paper Chromatography, components of the extracts get distributed between two liquid phases- one phase is …… and other is ……...

e) In Thin Layer Chromatography, the stationary phase is generally ……. supported over glass or aluminium plates.

f) In UV- Visible spectroscopy, the colourless compounds absorb in the UV range of …… and the coloured compounds absorb in the range of …… .

g) NMR spectroscopy involves the absorption of ……radiation by the substances which are kept in magnetic field.

10.5 SUMMARY

Now we summarize, what all has been discussed about pharmacognosy and phytopharmaceuticals in this unit. *Pharmacognosy* is related to better understanding and utilization of medicinal plants and is concerned with drugs of natural origin. *Pharmacognosy* has a long history and has a wide scope in fields of alternative systems of medicine, botany, phytochemistry, herbal formulations, biotechnology etc.

The phytoconstituents present in plants are main components responsible for medicinal value of herbs and these can be classified is various groups of carbohydrates, glycosides, tannins and phenolic compounds, proteins and amino acids, colouring matter, lipids, volatile oils, alkaloids, resin and resin combinations and carotenoids on the basis of their chemical moiety.

Phytochemical investigation of crude drugs start with extraction by various techniques like maceration, percolation and decoction, followed by isolation and purification by crystallization, fractional distillation, fractional liberation, paper chromatography, thin layer chromatography, column chromatography, HPLC, HPTLC and finally these isolated phytoconstituents are characterized by various chemical and spectroscopical methods like IR, UV, NMR spectroscopy and Mass spectrometry.

10.6 TERMINAL QUESTIONS

1. Define Pharmacognosy. Also explain the scope of Pharmacognosy.
2. Name various groups of phytoconstituents of medicinal importance.
3. Name various methods used for extraction of crude drugs.
4. Name different physical techniques used for the isolation and purification of phytoconstituents.
5. Give the chemical tests for the detection of alkaloids and saponins.
6. Name different techniques of spectrophotometery and explain the Infrared (IR) spectroscopy in brief.

10.7 ANSWERS

Self Assessment Questions

1. a) C. A. Seydler, 1815
   b) ‘Pharmakon’, drug, ‘Gignosco’, to acquire knowledge of.
   c) Hippocrats
   d) Sertuerner
2. a) Monoterpenes and Sesquiterpenes
   b) Two to one
   c) Glycon, Aglycon
   d) Hydrolysable Tannins, Non-hydrolysable
   e) Fixed oils and Fats
   f) Alkali like
3. a) Water immiscible solvents, such as light petroleum
   b) Three to seven days
   c) Volatile oils and hydrocyanic acid
   d) Stationary Phase, Mobile Phase
   e) Silica gel G

f) 200 to 400 nm, 400 to 700 nm
g) Radio frequency

Terminal Questions

1. The term Pharmacognosy was introduced by C.A. Seydler, in the year 1815. The term is derived from two Greek words “Pharmakon” means drug and “Gignosco” means to acquire knowledge of.

   A number of definitions for the term Pharmacognosy are used as:

   Pharmacognosy is defined as scientific and systematic study of structural, physical, chemical and biological characters of crude drugs along with their history, method of cultivation and collection and preparation for market.

   Pharmacognosy may also be defined as an applied science that deals with the biological, biochemical and economic feature of natural drugs and their constituents.

   Scope of Pharmacognosy: Pharmacognosy as an applied science played a crucial role in the development of different disciplines of science. The knowledge of plant taxonomy, breeding, pathology and plant genetics is helpful in the development of different disciplines of science. The technology involving extraction, purification, and characterization of pharmaceuticals from natural resources is signified contributions to the advancement of natural and physical science.

   Pharmacognosy is the infrastructure on which depends evolution of noble medicines. Further crude drugs also provide essential intermediates for final synthesis of active compounds. India is the richest source of medicinal plants which are distributed in almost all parts of the country. To cope up the demand of constant supply for the phytochemical industries domestication and cultivation of some of the important plants are necessary. There are many drugs which are imported to India like Balsam of Tolu, Benzoin, Asafoetida etc. If the cultivation is carried out in India, sufficient amount of foreign exchange can be saved. There are number of diseases for which modern medicine have no cure like stress, genetic diseases, arthritic diseases, liver disorder, cancer and AIDS etc. In such cases, only symptoms are treated to provide relief to the patients. But plant drugs from pharmacognosy have answers to such questions i.e. by use of plant drugs, we can treat incurable diseases.

   In this way, pharmacognosy has a wide scope in different areas to save mankind.

2. The main groups of phytoconstituents of therapeutic importance are as follows:

   a) Carbohydrates
   b) Glycosides
   c) Tannins and Phenolic Compounds
   d) Protein and Amino Acids
   e) Colouring Matter

f) Lipids – Fixed oils, Fats and Waxes
g) Volatile oils
h) Alkaloids
i) Resins and Resin Combinations
j) Carotenoids

3. Various methods used for extraction of Crude drugs are:

   Infusion, Decoction, Digestion, Maceration and Percolation.

4. Physical techniques used for the isolation and purification of phytoconstituents are:

   a) Fractional Cystallization
   b) Fractional Distillation
   c) Fractional Liberation
   d) Paper Chromatography
   e) Thin Layer Chromatography
   f) Column Chromatography
   g) High Performance Thin Layer Chromatography
   h) High Performance Liquid Chromatography

5. Give the chemical tests for the detection of alkaloids and saponins.

   a) **Detection of Alkaloids:** The small portions of solvents free chloroform, alcohol and water extracts are stirred separately with a few drops of hydrochloric acid and filtered. The filterate is tested carefully with various alkaloidal reagents such as Mayer's Reagent (cream precipitate), Dragendroff's reagent (orange brown ppt.), Hager's Reagent (yellow ppt.) and Wagner's Reagent (reddish brown ppt.).

   b) **Detection of Saponins:** About 1 mL of alcoholic and aqueous extracts are diluted separately with distilled water to 20 ml and shaken in a graduated cylinder for 15 minutes. One cm layer of floam indicates the presence of saponins. The test solution may be subjected to test haemolysis.

6. Various techniques of spectrophotometery are:

   a) Ultraviolet and Visible Spectroscopy
   b) Infrared (IR) Spectroscopy
   c) Mass Spectrometry (MS)
   d) Nuclear Magnetic Resonance Spectroscopy (NMR)

Infrared (IR) Spectroscopy

IR spectroscopy is the valuable tool for the characterization of plant constituents. It is the study of the reflected, absorbed or transmitted radiant energy in region of electromagnetic spectrum wavelength ranging from 0.8 to 500 nm. IR is a function of wave number. It can be near IR region (1250 to 4000 cm^{-1}), mid I.R. (4000-400 cm^{-1}) and far IR (400-20 cm^{-1}). The alkaloidal components can be identified by the application of IR spectroscopy.