

PREFACE

In a bid to standardise higher education in the country, the University Grants Commission (UGC) has introduced Choice Based Credit System (CBCS) based on five types of courses viz. *core, discipline specific, generic elective, ability and skill enhancement* for graduate students of all programmes at Honours level. This brings in the semester pattern, which finds efficacy in sync with credit system, credit transfer, comprehensive continuous assessments and a graded pattern of evaluation. The objective is to offer learners ample flexibility to choose from a wide gamut of courses, as also to provide them lateral mobility between various educational institutions in the country where they can carry acquired credits. I am happy to note that the University has been accredited by NAAC with grade 'A'.

UGC (Open and Distance Learning Programmes and Online Learning Programmes) Regulations, 2020 have mandated compliance with CBCS for U.G. programmes for all the HEIs in this mode. Welcoming this paradigm shift in higher education, Netaji Subhas Open University (NSOU) has resolved to adopt CBCS from the academic session 2021-22 at the Under Graduate Degree Programme level. The present syllabus, framed in the spirit of syllabi recommended by UGC, lays due stress on all aspects envisaged in the curricular framework of the apex body on higher education. It will be imparted to learners over the *six* semesters of the Programme.

Self Learning Materials (SLMs) are the mainstay of Student Support Services (SSS) of an Open University. From a logistic point of view, NSOU has embarked upon CBCS presently with SLMs in English / Bengali. Eventually, the English version SLMs will be translated into Bengali too, for the benefit of learners. As always, all of our teaching faculties contributed in this process. In addition to this we have also requisitioned the services of best academics in each domain in preparation of the new SLMs. I am sure they will be of commendable academic support. We look forward to proactive feedback from all stakeholders who will participate in the teaching-learning based on these study materials. It has been a very challenging task well executed, and I congratulate all concerned in the preparation of these SLMs.

I wish the venture a grand success.

Professor (Dr.) Subha Sankar Sarkar
Vice-Chancellor

Netaji Subhas Open University

Under Graduate Degree Programme

Choice Based Credit System (CBCS)

Subject: Honours in Botany (HBT)

Course: Medicinal Botany

Course Code: SE-BT-11

First Edition : May, 2022

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Dr. Subhasis Panda

Principal

Government General Degree College

: Course Writer :

Dr. Manishinath Das

Retd. Research Scientist

Dept. of Botany, University of Calcutta

: Course Editor :

Prof. Nanda Dulal Paria

Retd. Professor of Botany

NSOU

: Format Editor :

Mr. Sandip Das, NSOU

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**Netaji Subhas
Open University**

**UG : Botany
(HBT)**

**Medicinal Botany
SE-BT-11**

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Unit 1 □ History, Scope and Importance of Medicinal Plants

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1.0 Objective

- In this unit you will get an overview of different systems of indigenous medicinal sciences in India.
 - You will become acquainted with several plants used in Ayurveda, Siddha and Unani medicinal system.
-

1.1 Introduction

The history of medicine in India can be traced to the remote past. The earliest mention of the medicinal use of plants is found in the Rig Veda, perhaps the oldest repository of human knowledge, written between 4500 and 1600 B.C. Uses of 67 medicinal plants have been found in the Rig Veda. But in the Atharva Veda (2000 B.C. - 1500 B.C.) mention has been made about 290 plants for curing the diseases. Charaka (1000 B.C.) and Sushruta (800 B.C.), the two eminent physicians in India mentioned in their Samhitas about 700 plant species as therapeutic agents.

Later in the literature of Buddhist period (550 BC-470 BC) mention of many medicinal plants was made. In other old civilizations of the world viz. Mesopotomian, Sumerian (3000 B.C.-1970B.C.), Babylonian and Assyrian (1970 B.C.-539 B.C.), plants were used as medicine and amulet or Kabaj. In India, before independence, Dr. U.C. Dutta (1877) in his 'Materia Medica of the Hindus' mentioned the uses of many medicinal plants. Chopra (1933) described about 225 medicinal plants and their products sold in the markets. Kirtikar and Basu (1935) described about 604 plant species for the treatment of various ailments. Later Chopra et al. (1956, 1969) included about 1800 plant species in the Glossary of Indian Medicinal plants'.

1.2 Scope and Importance

All traditional ethnic societies depend, by and large, for healthcare and treatment of diverse ailments and diseases primarily on plant materials growing in their vicinity. The list of different plants used for medicinal purposes by the ethnic communities of India is quite

large. A gross survey has revealed that nearly 7500 wild plant species are used for the purpose, of these about 950 species appear to modern people, as new claims and worthy of scientific scrutiny. Chemical investigation and biological screening of about 300 wild plant species have already been carried out. These have enabled scientists to isolate many known and unknown compounds with potential biological activities. In this way new drug may be developed.

Most of the drugs obtained from plant sources show little or no side effects. The safety and efficacy of the drugs may be proved through pharmacological studies. A large number of drugs examined in this way has been shown to possess significant activity. Another important feature of medicinal plants is Market Scenario. This can be stated as -

(i) Domestic Scenario : Medicinal plant market in the country is today unorganized due to many problems. Medicinal plants are a living resource, exhaustible if overused and sustainable if used with care and wisdom. At present 95% collection of medicinal plants is from the wild sources. There is a vast, secretive and largely unregularized trade in medicinal plants, mainly from the wild. Confusion also exists in the identification of plant materials. Adulteration is also common in such cases.

(ii) Global scenario : According to the report of World Health Organisation (WHO), a large population of the world relies on the traditional systems of medicines, largely plant based to meet their primary health care. India at present (2000) exports herbal materials and medicines to the tune of Rs. 446 crores only while it has been estimated that this was raised to Rs. 3000 crores till 2005. The Chinese export based on plants including raw drugs, therapeutics and other estimated to be around Rs. 18000-22,000 crores. So the medicinal plants area can become a huge export opportunity after fulfilling domestic needs. The principal herbal drugs that have been finding a good market in foreign countries are Aconite, Acorus, Aloe, Belladonna, Cassia (Senna) Cinchona, Digitalis, Dioscoria, Ephedra, Plantago (Isabgol), etc.

1.3 Indigenous Medicinal Sciences

We can assume that in the distant past, humans suffered from diseases, deformities and disabilities. To overcome these, they would have discovered the ways of remedies known to them at that time following the proverb-‘necessity is the mother of invention’. Different ethnic communities have their own medicines for almost all diseases afflicting the human body. The tribes living in diverse ecological regions, use different medicinal plants for the same disease. It is obvious that tribal people accumulated the required data through experiential trial and error exercises and then transmitted the findings orally through

generations. It is presumed that ethnic peoples discovered herbal drugs for some ailments by keenly observing the reactions of some animals like the dog, mongoose, common lizard and monkey when they were afflicted by wounds caused by snakes, scorpions or other animals. In this way the medical sciences of ethnic communities or the indigenous medicinal sciences have been developed (the word 'indigenous' means born or produced naturally in a region).

Different indigenous medicinal sciences were developed in different countries, viz. Ayurveda, Siddha, Unani, Yoga and Naturopathy in India, There are also Chinese systems of medicine including Acupuncture, Japanese and Korean systems of medicine, Tibetan Medicine, etc.

1.4 Ayurveda

1.4.1 Definition

The term 'Ayurveda' is a combination of two components - Ayu and Veda. Ayu stands for life (age and longevity) and Veda means to know (or knowledge). Ayurveda then is the knowledge by which a healthy human life in all its aspects - physical, mental, intellectual and spiritual lives to the fullest. Ayurveda is concerned mainly with prolongation of healthy life and prevention of disease and senility and only secondarily with curing of disease (R. C. Majumdar - A concise history of science in India : Medicine Section).

1.4.2 Scope

The Ayurvedic system of medicine is prevalent in India since the vedic period and as early as the dawn of human civilization. Though this Indian system of medicine has undergone many changes in the course of its long history, it still remains the mainstay of medical relief to a large section of population of the nation.

Ayurveda being a science put into professional practice, with a lot of occasions to try newer drugs locally available, led to the successful use of several other drugs with therapeutic values similar to those of the classical drugs. Ayurveda had never been static. Its practitioners had been innovative and dynamic in the therapeutic practice and carried on clinical trials out of local flora and discovered newer medicine with same therapeutic values as the classical drugs. These newer drugs have been accepted by the then practising profession as substitutes. In fact on study of Ayurvedic literature, one comes across several references of permitting the use of a substitute drug when the classical drug is not available. This is based on its therapeutic equivalence and clinical efficacy.

Standardization of Ayurvedic drugs is also necessary for the identity, purity and strength of single drugs and compound formulations. Having regard to all these considerations, the Central Council of Ayurvedic Research recommended the constitution of Ayurvedic Pharmacopoeia Committee consisting of experts on Ayurveda and other sciences. A number of volumes of the Ayurvedic Pharmacopoeia and also the formulary for compound formulations have been published.

1.4.3 History and Origin

There are several versions about the origin of Ayurveda. One story seems to run through all of them. Lord Brahma, the creator of this world observing the suffering of humans, handed down Ayurveda (the knowledge of life) to the sun-god, Surya. Surya passed it on to his twin-sons, the Ashwini Kumar. They taught it to Indra, the rain-god. Indra finally passed it on to the sage Bharadwaja, a human being and thus the knowledge reached mankind.

The story is, perhaps, symbolic. The sun is the source of energy and therefore may be regarded as the original source of all medical knowledge. The Ashwini Kumars, or the rays of the sun, transmitted this knowledge to Indra, the rain-god. Rains facilitate the growing of food on earth and food nourished the human body and mind. Bharadwaja transmitted the science of Ayurveda to his two distinguished pupils, Punarvasu Atreya and Dhanwantari. Atreya established the school of medicine, Dhanwantari, the school of Surgery, in India.

Atreya had six distinguished pupils - Agnivesha, Bhela, Jatukarna, Parashara, Harita and Ksharapani - all of whom wrote treatises on medicines. None of these works have survived, we know about them from references of later works. The followers of the Dhanvantari school whose works have also been lost are - Vriddha-Susruta, Aupadhenava, Aurabhra, Pauskalavata, Gopuraraksita, Vaitarana and Bhoja. The Charaka Samhita of the school of medicine and the Susruta Samhita of the school of surgery have survived.

In brief, it may be said that the origins of the system of medicine known as Ayurveda predates the Vedas (Pre 5000 BC). In the Vedas we can find the philosophical and practical ideas that went to build the system.

In this connection, we may now discuss about the two famous Ayurvedic physicians.

1. Charaka : Charaka is the foremost among the physicians of Ayurveda. We have no firm dates about the time he lived. According to some authors he lived around 800 BC, a few hundred years later than Punarvasu Atreya and his pupils. Others, taking instance

from a Buddhist text, the Tripitaka, which mentions Charaka as the royal physician to the Kushan King, Kanishka (127-151 CE) have put Charaka to have lived in 1st-2nd century CE.

Charaka revised and edited the earlier work of Agnivesha, a direct disciple of Punarvasu Atreya, to make it concise and focused. Charaka's well-known book is known as Charaka Samhita. It comprising over 8000 verses is composed in Sanskrit in poetic metre. The Charaka samhita has eight Sthana or sections, totalling 120 chapters. These are-

- (i) Sutrasthana or, general principles (30 chapter)
- (ii) Nidanasthana or, pathology (8 chapters)
- (iii) Vimanasthana or specific determination (8 chapters)
- (iv) Sarirasthana or Anatomy (8 chapters)
- (v) Indriyasthana or Sensorial prognosis (12 chapters)
- (vi) Chikitsasthana or Therapeutics (30 chapters)
- (vii) Kalpasthana or Pharmaceutics and toxicology (12 chapters)
- (viii) Siddhisthana or Success in treatment (12 chapters) -the last chapter includes general principles of Panchakarma.

The Charaka Samita is scientific in content and reason based of Yukti-Vyapasraya. This monumental work has held away for almost two millennia and over the centuries has referred to and translated into many languages including Persian, Arabic, Tibetan, Chinese, English and the Indian Vernaculars.

2. Sushruta : As Charaka, the time of Sushruta has not been determined with certainty. There are a number of opinions. One of them puts him before Panini in the 8th Century BCE, there is a reference to the great surgeon Sushruta in his writings. Sushruta also finds mention in the Bower's Manuscript dated 4th of 5th century CE, where he is listed as one of the ten sages residing in the Himalayas. In some later Ayurvedic literature, he is described as a son of Vishvamitra or a descendant of Dhanwantari, the physician of the gods in Hindu mythology. According to one source, he lived in Varanasi and was a pupil of Divodasa, a king of Kashi, who was a great physician and teacher.

Sushruta is famous as the father of surgery, definitely in India and perhaps, worldwide. His great classic on the science of surgery is the Sushruta Samhita, portions of which may have been composed by a person with the same name several centuries later. We also come to know that one Nagarjuna, probably the famous Buddhist scholar who taught at

Nalanda University in the 3rd Century CE.

The treatise is composed in Sanskrit and divided into two parts -

The Purva tantra and the Uttara tantra

Purva-tantra : It has 5 sthana or sections and 120 chapter. these are

- (i) Sutrasthana - 46 chapters
- (ii) Nidanasthana - 16 chapters
- (iii) Sarirasthana - 10 chapters
- (iv) Kalpasthana - 8 chapters
- (v) Chikitsasthana - 40 chapters

Uttara tantra : It has 4 sections and 66 chapters.

- (i) Salakya
- (ii) Kayachikitsa
- (iii) Kumarabhritya
- (iv) Bhutavidya

Sushruta classified surgery into eight types and presented 300 surgical procedures in the Samhita. The Samhita also gives descriptions of 125 surgical instruments for performing ophthalmic, obstetrics and other operations. Sushruta's biggest contribution is the area of reconstructive surgery. He is recognized as the worlds first plastic surgeon for having given the procedure to reconstruct the human nose. The Sushruta Samhita was also translated into most of the foreign languages where Indian influence has spread.

Other well known Ayurvedic physicians are Jivaka, Nagarjuna, Vagbhatta, Madhava-Kara, Sarngadhara and Bhava Misra.

1.4.4 Pancha Mahabhutas

According to Ayurveda, the universe is created from five basic elements or Panchamahabhuta and their accompanying principles. Everything in this universe including human body and mind complex is composed of these five basic elements. The macrocosm (Universe) and the microcosm (man and other living creatures) are composed of the same ingredients. The mahabhutas are :

1. Akasha : It is defined with space and gives us sound and hearing; it also manifests as pores, cavities and channels in the human body.

2. Vayu : It is the basic gaseous element and identified with air. It gives tactile sense or sense of touch and manifests as all forms of movement-physical and physiological including neural. It has the characteristic of lightness.

3. Agni : It is the basic thermal element and identified with fire. It gives visibility of shapes and colours, the visual sense and digestion.

4. Ap : It is the basic aqueous element and identified with water and liquids. It gives sense of taste and is characterized by malleability, fluidity, viscosity and coldness.

5. Prithvi : It is the basic gross element and identified with earth. It gives the sense of smell and manifests as mass, density, opacity and inertia.

1.4.5 Saptadhatu

According to Ayurveda there are seven (7) fundamental elements or tissues in the human body that support its structure. They are created from the processing of the food, water and air we intake. These seven elements are called Saptadhatus. These are - Rasa, Rakta, Mansa, Meda, Asthi, Majja and Sukra.

(i) Rasa : The word ‘Rasa’ denotes sap or juice. In the human body it denotes plasma, lymph and such nutritional fluids.

(ii) Rakta : The word ‘Rakta’ means red. In human body it denotes blood and is the carrier of fire or energy that invigorates the mind and body.

(iii) Mamsa : The word ‘Mamsa’ literally means flesh. In the human body, it refers to muscle tissue that gives physical strength to the body and courage to the mind.

(iv) Meda : The word ‘Meda’ means fat. In human body it stands for adipose tissue.

(v) Asthi : The word ‘Asthi’ means bone. In human body it forms the skeletal system.

(vi) Majja : The word ‘Majja’ means marrow. In our body it stands for bone-marrow and nerve tissues.

(vii) Sukra : The word ‘Sukra’ stands for semen and reproductive fluids.

1.4.6 Tridosha

Ayurveda explains all bodily functions with the movements in the universe. The three main forces of the external world that we experience are the sun, moon and wind. The corresponding three forces in the human body are Pitta (bile), Kapha (phlegm) and Vata (wind). These are collectively known as tridoshas. The five basic elementary principles or Panchamahabhutas come together to give rise to these three energies or governing forces. Tridoshas are three humours in our body e.g. bile, phlegm and wind. The interrelationship

of tridosha, panchamahabhuta and the principle are stated in the following table :

Dosha	Mahabhuta	Principle
Pitta (Sun)	Agni-Fire	Transformational force
Kapha (Moon)	Ap (water) and Prithvi (Earth)	Force of lubrication, cohesion and preservation
Vata (Wind)	Akash (Space) and Vayu (Air)	Force of transportation and movement

Pitta comes from Agni, the fire principle and governs all transformative functions with body and mind. It controls digestion, metabolism, assimilation, nutrition etc. and at a more delicate level, intelligence and understanding. There are five types of pitta -

- (i) **Pachak pitta** : Responsible for release of digestive enzymes
- (ii) **Ranjak pitta** : It implies colour, it governs digestion in the liver leading to the formation of blood.
- (iii) **Sadhak pitta** : It governs perception and works through the nervous system.
- (iv) **Bhrajak pitta** : It resides in the skin and controls its temperature and complexion, it also regulates absorption of sunlight, oils and ointments through the skin.
- (v) **Alochak pitta** : It regulates the conversion of sensory stimuli, especially the creation of images on the retina.

Pitta is hot, light, pungent, sharp and acidic in nature. Persons with a predominance of pitta are physically of medium height and weight, with excellent power of digestion and with sharp intellect.

Vata is derived from Akasha and Vayu (the 'space' and 'air' principles) and governs movement within the body and mind.

There are five types of vata :

- (i) **Prana** : It is the life-force and moves from outside to the inside and upwards (intake of breath). Prana is responsible for receiving air, food, water and sensory impressions. It moves from the head to the body.
- (ii) **Udana** : It moves from the inside to the outside, it moves from the centre of the

body to the head and is based in the region of the throat. Udana governs exhalation and speech. It also regulates memory, motivation, enthusiasm and will-power.

(iii) Vyana : It moves from the centre to the outer peripheries, it is the centrifugal force in the body, it is centered in the heart and governs cardiac functions as well circulation of blood and sweat.

(iv) Samana : It moves from the periphery to the centre. It is the centripetal force in the body. It regulates the movement of intestine that leads to digestion of food. Samana Vayu maintains the equilibrium in the body.

(v) Apana : It governs downward motions, hence regulates the functions of rectum and urino-genital system. It is responsible for the discharge of urine, faeces, flatus (wind in or from stomach or bowels), menstrual fluids, semen and foetus.

Vata is cold, light, dry and changeful by nature. Persons with a predominance of vata are physically thin light and agile. Emotionally, they are energetic, flexible and adventurous.

Kapha : It is derived from Ap (water) and Prithvi (Earth) and regulates structure and lubrication in the body and mind. It controls body weight, lubrication in joints and other body parts, and the formation of body tissues.

There are five types of 'Kapha' that perform different functions as follows—

(i) Bodhak : This type of Kapha is present in the mouth and helps the taste of food items and their acceptability.

(ii) Kledak : It lines the inside of the stomach and protects it from the hot and penetrating effects of pachak pitta.

(iii) Tarpak : It resides in the brain and spinal column in the form of a protective fluid. It gives us the feeling of peace and contentment.

(iv) Shleshak : This type of kapha lubricates the bones and joint movements within the body.

(v) Avalambak : It is present in the thorax and pelvic region and lubricates the vital organs in this region — the lungs, the upper intestines and the heart.

Kapha is cold, heavy, slow, steady, soft and oily in nature. Persons with predominance of Kapha are physically well built, with good stamina, radiant skin, expressive eyes and a head full of hair. Emotionally, they are calm, thoughtful, steady and predictable.

When the three doshas are in balance, the body-mind complex is said to be in a state

of equilibrium and good health prevails. The problem arises when there is an imbalance with one or more of the entities going into deficiency or excess. Harmony is vitiated and manifestation of diseases takes place. Thus the literal meaning of the sanskrit word 'dosha' meaning fault becomes relevant.

1.4.7 Rasayana

Definition : The word 'Rasayana' means the path or way (ayana) of essence (rasa). In early Ayurvedic medicine it means the science of lengthening life span, and in later period (post 8th century) it refers to Indian alchemy. The science of Indian alchemy or proto-chemistry, is more generally known as 'the science of mercury' or 'Rasasastra'. Early Indian alchemical texts discuss the use of prepared forms of mercury or cinnabar (red mercuric sulphide).

Rasayana arrests physical and mental decay. It deals with therapies that rejuvenate and revitalize our energies to live a long life without senility or feebleness of old age.

Types of Rasayana : There are two types of Rasayana—

1. Kamyas Rasayanas : These are promoters of normal health. These boost body energy levels, immunity and general health, there are three types of kamyas Rasayanas.

(i) **Pranakamyas :** promoter of vitality and longevity

(ii) **Medhakamyas :** promoter of intelligence

(iii) **Srikamyas :** promoter of complexion

2. Naimittika Rasayanas : These help to fight specific diseases.

Chyawanaprasha is one of the traditional rasayanas. Specific adaptogenic herbs are also included in Rasayanas. These are Haritaki (*Terminalia chebula* Retz.) Amlaki (*Emblica officinalis* Gaertn), Shilajit (a type of exudate obtained from rocks), Ashwagandha (*Withania somnifera* Dunal), Tulasi or holy basil (*Ocimum sanctum* Linn.) Guduchi (*Tinospora cordifolia* (Willd) Miers) and Shatavari (*Asparagus racemosus* Willd).

All the plant drugs were found to be safe in both acute and sub-acute toxicity studies. Studies on the mechanisms of action of the plants including Shilajit revealed that they all produced immunostimulation. *Emblica officinalis* strengthened the defence mechanisms against free radical damage induced during stress. *Tinospora cordifolia* offered protection against stress induced gastric mucosal damage. Recent data obtained *Tinospora cordifolia* have led research workers to suggest that it may induce genotypic adaptation.

Rasayana formulations :

Puri (2003) has given detailed account of classical formulations of Rasayana, e.g. Amrit Rasayana, Mukta Panchamrit Rasayana, Brahmi Rasayana, Kamdugdha Ras, Laxmi Vilas Ras, Makaradhwaja Vati, Madanoday Modak, Laxman vilas Ras, Navajeevan Ras, Smritisagar Ras, Vasant Kusumakar Ras, Suvarna Basant Malati, Visha Rasayana etc.

These classical Rasayana formulae contain a large number of ingredients including minerals, pearls, coral and gems including a specially processed (samskara) mercury (the word Rasa indicates Parada or mercury as an ingredient).

The mineral Materia Medica of Ayurveda is classified under six categories and called Rasasastra. The drugs are called Rasausadhis, comprising of minerals, ashed materials or vasma and organometallic compounds; gems and pearls are also used as medicaments. The six categories are as follows :

- (i) Rasa - mainly 'Parada' or mercury
- (ii) Maharasa - precious minerals like mica, bitumen, copper sulphate etc.
- (iii) Uparasa - secondary minerals, viz. alum, sulphur etc.
- (iv) Sadharana Rasa - or ordinary minerals like arsenic, ammonium chloride etc.
- (v) Loha or metals including iron, gold, copper, silver, lead, tin, brass and bronze.
- (vi) Ratna - or gems including pearls, diamonds, lapis lazuli (a bright blue stone) etc.

The word 'Rasa' means also the taste. Rasas or the six tastes are Amla (sour), Madhura (sweet), Tikta (bitter), Katu (pungent or hot), Kashaya (astringent) and Lavana (salty).

In the Astanga-Ayurveda, there are eight separate branches. These are :

- (i) Kayachikitsa or therapeutics
- (ii) Salyatantra or surgery
- (iii) Salakyatantra or diseases of ear, nose and throat (ENT) and also tongue and oral cavity.
- (iv) Kumarbhritya or mother and child care (pre-natal & post natal)
- (v) Bhutavidya or knowledge of mental diseases, e.g. unmada (insanity), Apasmara (epilepsy), Abasada (depression), etc.

- (vi) Agadatantra : Knowledge of toxicology including snake bites and toxins arising from food items and their antidotes.
- (vii) Rasayanatantra : the knowledge of tonics for improving physical and mental health.
- (viii) Vajikaran - it deals with therapies in the area of virility or enhancement of sexual power in men and also the vitality rejuvenation.

So Rasayanatantra is one of the above-cited Astanga Ayurveda.

1.4.8 Plants used in Ayurvedic treatments

Different Ayurvedic medicines are mainly prepared from plant materials. In some cases minerals, organometallic compounds, organs, tissues and excreta of animals are also used to prepare medicines. Ayurvedic medicines may be (i) **Monoherbal**, i.e. prepared from single drug, e.g. Aswagandhachurna (powder of root of *Withania somnifera* Dunal) (ii) **Polyherbal**, i.e. prepared from several drugs, e.g. **Triphala** Kvatha Churna (powder of fruits of Haritaki: *Terminalia chebula* Retz, Bibhitaka : *Terminalia belerica* Roxb. and Amalaki : *Embllica officinalis* Gaertn.) (iii) **Herbomineral**, i.e. prepared from plant material and minerals e.g. Dhatrilouha (prepared from fruit of Amalaki and *Louhavasma*-ashed iron).

Some of the plants used in the preparation of Ayurvedic medicines for treatment of different diseases are listed below :

Sl No.	Name of the plant	Part(s) used	Ayurvedic name	used in/as
1.	<i>Acorus calamus</i> Linn. (Family Araceae)	Rhizome.	Vacha.	Dyspepsia, colic, bronchitis, fever, as nerve tonic, dysentery etc.
2.	<i>Abrus precatorius</i> Linn. (Fam. Fabaceae)	Root & seed.	Gunja, Kunch.	Roots as emetic and alexiteric (antidote) seeds - purgative, emetic, aphrodisiac, used in nervous disorder.

Sl No.	Name of the plant	Part(s) used	Ayurvedic name	used in/as
3.	<i>Asparagus racemosus</i> Willd. (Fam. Liliaceae)	Root.	Shatamuli, Shatavari.	Refrigerant, demulcent, diuretic, aphrodisiac, antispasmodic, anti dysenteric, galactagogue.
4.	<i>Bacopa monnieri</i> (Linn.) Wettst. (Fam. Scrophulariaceae) (Fig. 1c)	Whole plant, stem & leaf.	Brahmi, Nira-brahmi.	As nerve tonic, in asthma, epilepsy, insanity, loss of memory, as diuretic and also in snake bite.
5.	<i>Boerhaavia diffusa</i> Linn. (Fam. Nyctaginaceae)	Root.	Punarnava, Rakta punarnava.	Diuretic, laxative, expectorant, in asthma, antidote to snake venom.
6.	<i>Centella asiatica</i> (Linn.) Urban (Fam. Apiaceae)	Whole plant Leaves.	Mandukaparni, Brahmi.	Skin disease, leprosy, nervous disorder and as blood purifier. Leaves - improving memory, skin disease, insomnia.
7.	<i>Centratherum anthelminticum</i> (Willd.) Kuntze (Fam. Asteraceae)	Seeds.	Somraj, Somraji, Aranya Jiraka.	as anthelmintic, tonic, diuretic, in skin diseases, in scorpion sting.
8.	<i>Elaeocarpus ganitrus</i> Roxb. (Fam. Elaeocarpaceae)	Fruit.	Rudraksha.	used in diseases of the head and epileptic fits and also in heart disease.

Sl No.	Name of the plant	Part(s) used	Ayurvedic name	used in/as
9.	<i>Gloriosa superba</i> Linn. (Fam. Liliaceae)	Root.	Langali, Kalihari.	as purgative, anthelmintic, used in leprosy, parasitical affections of skin, piles, colic. Starch from the root given internally in case of gonorrhoea.
10.	<i>Holarrhena antidysenterica</i> Wall. (Fam. Apocynaceae)	Bark & Seed.	Kutaja, Indrajaba (seed).	Bark in dysentery, dropsy, bleeding piles, seeds in diabetes, fever, diarrhoea, intestinal worms.

1.5 Siddha System of Medicine

1.5.1 Origin

The Siddha system of medicine is considered to be among the ancient systems of medicine with origins in what is today, Tamil Nadu, in India and Srilanka. Palm leaf manuscripts say that the Siddha system was first described by Lord Shiva to his wife Parvati. Parvati explained all this knowledge to her son Lord Muruga. He taught the knowledge to his disciple sage Agasthya. Agasthya taught it to 18 Siddhars viz. Nandisar, Tirumular, Bhogar, Punnakisar, Ramadevar and others. They spread this knowledge to human beings.

Siddha is said to have been inspired by two systems in its formative stages—the Yoga system of Patanjali having its association with Chakras, Kundalini and meditation and Chinese Taoism with its Yin (female) and Yan (male) principles and their association with mercury and sulphur. This system is as ancient as the Ayurveda. It is also popular in Sri Lanka, Myanmar, Malaysia and other South East Asian countries. In Tamil, Siddha medicine is called “Citta maruttuvam”.

1.5.2 Basis of Siddha system

The term 'Siddha' comes from the word 'siddhi' or supernatural power. In Indian Culture, there are eight supernatural power or 'Ashtamahasiddhi'. Those who attained or achieved these powers are known as siddhars. The eight supernatural powers are -

- (i) 'Animan' - the power to reduce oneself to an atom.
- (ii) 'Mahiman' - the power to grow oneself exponentially
- (iii) 'Gariman' - the power to become heavy
- (iv) 'Laghiman' - the power to become weightless
- (v) 'Prapti' - the power to access everything
- (vi) 'Prakamyā' - the power to will anything
- (vii) 'Isitva' - the power to have lordship over all
- (viii) 'Vasitva' - the power to subjugate all

The siddhars are individuals who have acquired all the eight powers after having performed hard religious works.

In Siddha the human body is regarded as a microcosm of the universe. It comprises the five elements—the 'Panchabhuta', three humors - Vatham, Pittham and Kapham and seven tissues - plasma, blood, muscle, fatty tissue, bone, bone-marrow and semen. When the normal equilibrium of the three humors (i.e. vatham, pittham and Kapham) is disturbed, disease is caused. The factors assumed to affect this equilibrium are environment, climatic conditions, diet, physical activities and stress. Under normal conditions the ratio between the three humors is believed to be 4:2:1.

According to this system of medicine diet and lifestyle play a major role in health and curing diseases. This concept of Siddha medicine is termed as Pathiyam and Apathiyam, which is essentially a rule based system with a list of do's and donots.

In diagnosis, examination of eight items (**enn vakaith thervu**) is required. These are—

(i) **Na (tongue)** : Black in Vatham, yellow or red in pittham, white in Kapham, ulcerated in anaemia.

(ii) **Varnam (colour)** : Dark in Vatham, yellow or red in pittham, pale in Kapham.

(iii) **Kural (voice)** : normal in vatham, light-pitched in pittham, low-pitched in Kapham, slurred in alcoholism.

(iv) **Kan (eyes)** : in Vatham muddy conjunctiva, yellowish or red in pittham, pale in kapham.

(v) **Thodal (touch)** : Dry in vatham, warm in pittham, chill in kapham.

(vi) **Malam (Stool)** : Black stool in Vatham, yellow in pittham, pale in kapham, dark red in ulcer and shiny in terminal illness.

(vii) **Neer (urine)** : Early morning urine is examined. Straw colour indicates indigestion, reddish-yellow colour in excessive heat, rose colour in blood pressure, saffron colour in jundice and looks like meat washed water in renal diseases.

(viii) **Naadi (pulse)** : The confirmatory method recorded on the radial artery.

The drugs used by the siddhars are classified into three groups - Thavaram (herbal products), Thadhu (inorganic substances) and Jangamam (animal products). The thadhu drugs are further classified as 'uppu' (water soluble inorganic substances or gives vapour when put into fire), 'Pashanam' (not dissolved in water but emit vapour when fired), 'uparasam' (similar to pashanam but differ in action), 'Loham' (not dissolved in water but melted when fired), 'Rasam' (soft) and 'Ghandhagam (insoluble in water, like sulphur).

The special chemical processes evolved in this system to convert the minerals and metals into potent therapeutic agents are unique in this pharmaceuticals. It is practically the key note of this system. The ancient uses of cinnabar or Hingula (red mercuric sulphide) and orpiment or Haritala (arsenic trisulphide) internally is unique to this system. There are about 1000 drugs in this system of which 600 are commonly used. Out of which 500 drugs are of plant sources, 80 are of minerals and 20 are of animal origin. At present, siddha system of medicine is known as Tamil medicine. It has specific remedies for diseases like mycosis, venereal diseases, leucoderma (vitiligo), asthma, leprosy etc.

1.5.3 Plants used in Siddha medicine

Sl. No.	Name of the plant	Part(s) used	Siddha name	used in/as
1.	<i>Adhatoda vasica</i> Nees (Fam. Acanthaceae)	Leaves.	Adathodal.	In bronchial asthma, eosinophilia and cough. The plant has antiulcer, antiinflammatory, hepatoprotective and antitussive properties.

Sl. No.	Name of the plant	Part(s) used	Siddha name	used in/as
2.	<i>Boerhaavia diffusa</i> Linn. (Fam. Nyctaginaceae)	Roots.	Mukaratee.	In asthma, dropsy, ascities, heart diseases, kidney stone and colitis. It has immunosuppressive effect associated with asthma and COPD (chronic obstructive pulmonary disease), used also as anti-bacterial, antidiabetic and antifungal agents.
3.	<i>Caesalpinia bonduc</i> Linn. (Fam. Caesalpiniaceae)	Seeds.	Kaliccikkai.	Used in the treatment of fevers, intermittent and chronic asthma, acute arthritis, palsy, painful and swollen testicles.
4.	<i>Ocimum sanctum</i> Linn. (Fam. Lamiaceae) (Fig. 1d)	Leaves and seeds.	Thulasi.	In asthma, bronchitis, eosinophilia, chronic cough. Volatile oil from fresh leaves and fixed oil from seeds showed antiinflammatory activity against serotonin and histamin-induced inflammation. The plant is widely used in fever, leucoderma, ophthalmia, ringworms and skin diseases.

Sl. No.	Name of the plant	Part(s) used	Siddha name	used in/as
5.	<i>Piper longum</i> Linn. (Fam. Piperaceae)	Fruits.	Thippili.	Used in cough and cold, asthma in hoarseness, hiccup, colic, flatulence, used as counter irritant, analgesic, etc.
6.	<i>Solanum nigrum</i> Linn. (Fam. Solanaceae)	Leaves and fruits.	Manathakkali	Used in bronchitis and asthma. Fresh extracts of leaves used for inhibiting swellings, enlargement of liver and spleen, in cirrhosis of liver. It has antipyretic, antitumor and antioxidative activities.
7.	<i>Strychnos potatorum</i> Linn. (Fam. Loganiaceae)	Fruits and seeds.	Tentakotal	Fruits and seeds are used in treating bronchitis and are also useful in chronic diarrhoea, diabetes gonorrhoea, boils and dysentery. It has also antiulcerogenic, hepato protective and diuretic properties.
8.	<i>Terminalia belerica</i> Roxb. (Fam. Combretaceae) (Fig. 1a)	Fruits.	Thandrikkal	Fruits are effective in cough, asthma, sore-throat, and also in dropsy, dysentery and diarrhoea. It has also antidiabetic,



Fig. 1a: BAHERA
(*Terminalia bellerica*)

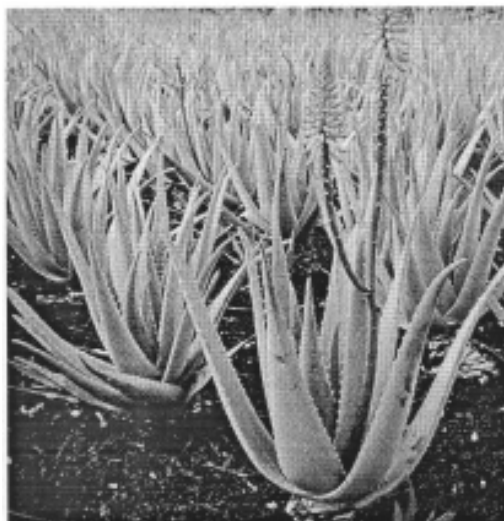


Fig. 1b: GHRITAKUMARI
(*Aloe sp.*)



Fig. 1c: BRAHMI
(*Bacopa monnieri*)



Fig. 1d: TULASI
(*Ocimum sanctum*)

(Taken from 'Herbal power'— The Agri-horticultural Society of India, Alipore, 2004 and
'Database on Medicinal Plants', Vol. 2, CCRAS, New Delhi, 2001.)

Sl. No.	Name of the plant	Part(s) used	Siddha name	used in/as
				antidepressant and antispasmodic activities.
9.	<i>Tylophora indica</i> Merrill (Fam. Asclepiadaceae)	Roots and leaves.	Kurinjan.	Both root and leaf are used in asthma. These parts are also used in diarrhoea, dysentery and syphilitic rheumatism.

1.6 Unani Medicine

1.6.1 History

The 'Unani or Yunani' system of medicine originated in Yunan (Ionia), a populated coastal area of Anatolia in ancient Greece (Modern Turkey). The Greeks adopted the initial concepts of medicine (Tibb) from Egypt and Mesopotamia and systemized them. Thereafter, the Romans further advanced these concepts. In the medieval period, this medical system travelled to the Arab, Central Asian countries and parts of Europe, where it was developed to a great extent.

The basic knowledge of Unani medicine as a healing system was developed by the Muslim scholar Avicenna (Ibn-Sina) in his encyclopedic work 'al-Qanun fi al-Tibb' or the 'Canon of Medicine'.

The time of origin was thus dated 1025 CE, when Avicenna completed his 'Canon of Medicine' in Persia. He was primarily influenced by the Greek and Islamic medicines and also influenced by the Indian medicinal teachings of Charaka and Sushruta. In India, the Unani system of medicine came from Arabia and Iran during 13th century with the establishment of Delhi Sultanate and it took its own course of development during the Mughal Empire. Alauddin Khalji (1316 CE) had several Eminent unani physicians (Hakims) at his royal courts. This royal patronage led to the development of Unani medicine in India and also the creation of Unani literature.

1.6.2 Concepts of unani system of medicine

The Unani system of medicine describes the man as being made up of the seven natural factors. This is known as Umoor-e-tabiya (natural factors) or the basic principles of Unani medicine. The seven factors are -

1. **Elements (Arkan)** : Everything in the universe (biological and non-biological) including human body and drugs are composed of the elements in varying amounts and proportion.
2. **Humours (Akhlat)** : the form is taken up by elements in living things. Their balance is health while disbalance is a disease.
3. **Temperament (Mizaj)** : It is the general quality of man. It is used as the qualitative measure for health and deviation from it. It is the basis of constitutional medicine.
4. **Organs (A 'da')** : the physical body
5. **Pneuma (Arwah)** : The subtle substance having vitality and acting as a carrier.
6. **Faculties (Quwa)** : The physiological power responsible for the corresponding basic functions of the organism i.e. life, nutrition, sensation, movement and reproduction.
7. **Functions (Af'al)** : Functions of various organs.

The basic elements (Arkan) in Unani medicine are simple invisible matter which provide the primary components for the human body and others. Each element has two sets of basic qualities (Kayfiyat) : hot or cold and dry or wet. The four elements are Fire (Nar), Air (Hawa), Water (Ma) and Earth (Ard). The basic qualities are

Fire - hot and dry

Air - hot and wet

Water - cold and wet

Earth - cold and dry

All things including man and drug are made up of these four basic elements.

Temperament or Mizaj : Human being are classified into four types which indicates their body, mind and pneuma. Each type is associated with a dominant humour and named accordingly as :

Sanguine (Damawi) - hot and wet

Choleric (Safrawi) - hot and dry

Phlegmatic (Balghami) - cold and wet

Melancholic (Sawdawi) - cold and dry

The temperament can also be described in terms of basic qualities, as shown in the second column. The temperament of man, can be diagnosed by ten categories of bodily and mental parameters (Ajnas 'Ashara) e.g. complexion, texture, built, hair, dreams etc.

Humours (Akhlāt) : The humours are fundamental liquid substance of living things these are four in number and characterized by the dominant basic qualities -

Blood (Dam) — hot and wet

Phlegm (Balgham) — cold and wet

Yellow bile (Safra) — hot and dry

Black bile (Sawda) — cold and dry

The humours are formed within various organs, primarily in liver and run together in the blood vessels. They have both subtle (Latif) and gross (Kathif) components.

Organs (A 'da') : The physical body is made up of organs/tissues (A 'da'). They are of two types - simple (Basit) and compound (Murakkab). the simple organs are tissues like fat, bone etc. while compound organs are poly-tissue structures like heart, brain, liver etc.

Pneumas (Arwah) : The Ruh (plural Arwah) is subtle, physical substance made of subtle components of the humours. It possesses vitality and provides life to the organism. It also acts as the seat and carrier of the physiological power of faculties (Quwa) which are responsible for producing the corresponding physiological processes, e.g. nutrition and growth, sensation and movements, etc.

Man possesses three pneumas, each generated in a vital organ :

Vital pneuma (Ruh Haywani) - Heart

Psychic pneuma (Ruh Nafsani) Brain

Natural pneuma (Ruh Tabi'i) - Liver

Mind corresponds to psychic faculty which subsists in psychic pneuma. Thus Unani system of medicine is very successful in curing psychiatric diseases by treating mind as a substance.

Faculties (Quwa) : These are physiological powers which give rise to the corresponding physiological functions. The faculties are non-substantial powers that can exist in the organism only by subsisting in the corresponding pneuma.

Functions (Af'al) : These are physiological functions and processes that the organs and tissues undergo due to operation of faculties or physiological powers. According to unani system health is divided into three states-stable optimum health, vulnerable optimum health and debility without disease. The first state is to be maintained by a healthy life style, a healthy environment and diet. The second and third stages require special diets, regimens (massage, exercise, etc.) and even drugs.

According to this system disease (Marad) is a pathological condition of the body provoked by a cause. These are of two types :

Single disease (Marad Mufrad)

Complex disease (Marad Murakkab)

Drugs are often used for preventive purposes. Roots of *Smilax china* Linn. (Chobchini) are used in healthy people when they enter the middle age (40-50 years). The use of honey and saffron (*Crocus sativus* Linn). is found to protect the body from ill-effects of cold climate. Some other drugs used prophylactically are *Glycyrrhiza glabra* Linn. (Rubb-us-soos) (Muleti), *Coriandrum sativum* Linn., (Kishneez sabz or Dhania) and *Berberis vulgaris* Linn. (Root bark of Kashmal).

Cause of disease (Sabab) corresponds with etiology. Causes are divided into two-external causes (Asbad Badiya) and internal causes (Asbad Batina). External causes affect the body from outside, viz. excessive hot or cold climate, polluted atmosphere, injury etc. Internal causes, on the other hand, affect the body internally, viz formation of stones inside the kidney or bladder.

1.6.3 Tumour treatment / therapy

Tumour or cancer is one of the major causes of death worldwide. It strikes more than one third of the worlds population. The knowledge of tumour both benign and malignant in the Unani system of medicine can be traced back to ancient times (131-200 CE).

According to Unani system, cancer or tumour is a disease of black bile, i.e. excessive production and collection of black bile (SAWDA). Malignant tumour mostly occurs in soft tissues like breast, uterus, stomach, intestine, pancreas, prostrate glands, oral cavity, lungs etc. The philosophy of Unani system describes cancer as the end stage of degeneration of

the metabolic efficiency of the body for incorrect diet and other imbalances in various aspects of the patient's life, usually occurring over a long period of time. Unani physicians or Hakims recognized the natural healing process as critical in achieving best possible health. They recommended following principle of treatment in given successive steps.

1. Venesection (Fasd) : it is surgical incision of a vein for blood letting used for relieving blood pressure preventing accumulation of waste matters in blood, reducing toxicity, stimulating metabolic processes and correcting heat in one's temperament.

2. Evacuation of morbid material (Tanqiya) : If the temperament is changed due to an increase in the quantity and volume of certain humours and morbid materials get accumulated, it should be evacuated with the help of some herbs.

3. Diet : diet should be easily digestible to reduce the excess production and accumulation of black bile and also to help in cooling and refreshing of the body.

4. Control of pain : Pain associated with tumour or cancer can be controlled or reduced with analgesic or sedative medicines.

5. Local medication for cancer or tumour : Routine allopathic chemotherapy for cancer treatment has several side and toxic effects. Since long time Unani medicine is being used to cure cancer. More than twenty Unani herbal drugs are being used for the prevention and treatment of different types of tumours and cancers. These unani herbal drugs may help to synergize the anticancer effects and reduce the side effects of conventional drugs. The most important pharmacological effects of these drugs are :

(i) Cytotoxicity : This means quality of being toxic to cells.

(ii) Apoptosis induction : Apoptosis is a form of programmed cell death that occurs in multicellular organisms.

(iii) Antioxidation : This is inhibition of oxidation.

(iv) Immunomodulation : It refers to any process in which an immune response is altered to a desired level.

The different plants used in the treatment of cancer or tumour in the unani system of medicine include the following :

Dillenia indica Linn.

Oroxylum indicum Vent.

Terminalia arjuna W. & A.

1.6.4. Polyherbal formulations in the unani system of Medicine

The Unani system of medicine includes a large number of traditional formulations used since a long time in India and abroad. This system consists of different types of formulations like Itrifal, Jawarish, Majun, Qurs and Habbs and has been ignored for scientific validation of these formulations as well as for the quality, control using modern techniques.

Some of the polyherbal formulations mentioned in the National formulary of unani medicines (NFUM), published by the Department of AYUSH, Govt. of India are stated below :

1. Tiryaq wabai : This is used as immunostimulator in elderly persons, useful for prophylaxis during epidemics of cholera, plague and other epidemic diseases. It consists of 3 ingredients :

- (i) Sibr (*Aloe barbadensis* Mill.) — dried juice of plant (Fig. 1b).
- (ii) Zaafran (*Crocus sativus* Linn) — dried style and stigma.
- (iii) Mur (*Commiphora myrrha* (Ness) Engl. — gum resin.

2. Habb-e-Real : used in diarrhoea and dysentery. It consists of two ingredients.

- (i) Gond Kikar (*Acacia arabica* Willd.) — gum.
- (ii) Raal Safed (*Vateria indica* Linn.) — fatty oil from fruit.

3. Majoon-e-Jalali : used in sexual debility, hydrospermia and general debility.

This drug consists of 11 plant materials :

- (i) Habbul Neel (*Ipomoea nil* (Linn.) Roth — seeds.
- (ii) Ajwain Khurasani (*Hyoscyamus niger* Linn.) — seeds.
- (iii) Balcharr (*Nardostachys jatamansi* DC.) — root stalk and rhizome.
- (iv) Darchini (*Cinnamomum zeylanicum* Blume) — stem bark.
- (v) Taj Qalmi (*Cinnamomum cassia* Blume) —stem bark.
- (vi) Zaafran (*Crocus sativus* Linn.) - dried style and stigma
- (vii) Indrajao Shirin (*Wrightia tinctoria* R. Br.) - stem bark and seed
- (viii) Mastagi Roomi (*Pistacia lentiscus* Linn.) - Resin
- (ix) Khusyatus Salab (*Orchis latifolia* Linn.) - tuber

(x) Ood Hindi (*Aquilaria agallocha* Roxb.) - heart wood and oil

(xi) Jaozbua (*Myristica fragrans* Houtt.) - seeds

4. Anushdaru Lului : used as tonic for normal functioning of brain, heart, nerves, liver and stomach, useful in heart palpitation, improves cardiac muscle, stops acid secretion in the stomach, used as protective medicine to gastritis, hyper acidity and dyspepsia. It is composed of 19 ingredients, in which 15 components are of herbal origin. The plant materials are :

- (i) Muqashsher (*Embllica officinalis* Gaertn.) - Fruits
- (ii) Gul-e-Surkh (*Rosa damascena* Mill.) - flower
- (iii) Saad Kufi (*Cyperus scariosus* R. Br.) - root
- (iv) Mastagi Roomi (*Pistacia lentiscus* Linn.) - gum resin
- (v) Asaroon (Tagara) (*Valeriana wallichii* DC.) - root
- (vi) Qaranfal-clove (*Syzygium aromaticum* (Linn.) - Merr & Perry - dried flower
- (vii) Sumbuluttib (*Nardostachys jatamansi* DC.) - rhizome & root stalk
- (viii) Bisbasa Jayitri (*Myristica fragrans* Houtt.) - fruit
- (ix) Dana Heel Khurd-Elachi (*Elettaria cardamomum* Maton) - seeds
- (x) Dana Heel Lalani - Bara elachi (*Amomum subulatum* Roxb.) - seeds
- (xi) Jaozbua (*Myristica fragrans* Houtt.) - seeds
- (xii) Khurfa - Luni (*Portulaca oleracea* Linn) - whole plant
- (xiii) Zaafran (*Crocus sativus* Linn.) - dried style and stigma
- (xiv) Zarnab (*Taxus baccata* Linn.) - fruit
- (xv) Kehraba (*Vateria indica* Linn.) - fruit

Other ingredients are pearl, coral and ruby.

5. Qurs-e-Hummaz : used as anti-inflammatory drug in the unani system of medicine. It is composed of ingredients of herbal origin. These are :

- (i) Beejband (*Rumex vesicarius* Linn.) - seed
- (ii) Tabashir (*Bambusa bambos* Druce) - bamboo manna, the calcarius deposition inside the stem (Bansolochan)

- (iii) Gul-e-Surkh (*Rosa damascena* Linn.) - flower
- (iv) Rasaut (*Berberis aristata* DC.) - fruit
- (v) Zarwand - i-Gird (*Aristolochia rotunda* Linn.) - root
- (vi) Zaafran (*Crocus sativus* Linn.) - root

Another ingredient of this formulation is lac resin (*Coccus lacca*)

1.7 Summary

The earliest mention of medicinal plants is found in the Rigveda (4500-1600 BCE) in which uses of 67 medicinal plants have been recorded. In Atharva Veda (2000-1500 BCE) about 290 plants are included for curing of diseases. Charaka (1000 BCE) and Sushruta (800 BCE), the two eminent physicians mentioned about 700 plant species in their Samhitas. Other ancient medical practitioners are Jivaka, Nagarjuna, Vagbhatta and Bhava Misra.

Ayurveda, Siddha and Unani systems of medicine are the three major indigenous medicinal sciences in India. Ayurveda is the science of life. It is prevalent in India since the Vedic period. The Charaka Samhita is scientific in contents and reason-based. It has eight sections. Sushruta Samhita, on the other hand, is mainly the science of surgery and contains two parts - the Purva-tantra and Uttara tantra. Ayurveda is based on Panchamahabhutas (i.e. Akasha, Vayu, Agni, Ap, Prithvi), Saptadhatu (Rasa, Rakta, Mamsa, Meda, Asthi, Majja, Sukra) and Tridosha (Pitta, Kapha and Vata). Rasayana is an important way of healing in Ayurveda. It means the science of mercury or cinnabar (red mercuric sulphide). Rasayana is divided into two types-Kamyā and Naimittika. Some of the Rasayana formulations are Brahmi Rasayana, Laxmivilas Ras, Makaradhwaaja Vati etc. Ayurvedic medicines may be monoherbal, polyherbal or herbo-mineral. Many plants are used in Ayurveda, viz. Vacha (*Acorus calamus*), Shatavari (*Asparagus racemosus*), Punarnava (*Boerhaavia diffusa*), Brahmi (*Bacopa monnieri*), Mandukaparni (*Centella asiatica*), etc.

Siddha system of medicine is considered to be originated in Tamil Nadu. In this system the human body is regarded as a microcosm of the universe. It comprises the five elements or Panchabhuta, three humours, e.g. vatham, pittam and kapham and seven tissues, e.g. plasma, blood, muscle, fatty tissue, bone, bone-marrow and semen. The drugs used in this system are Thavaram (herbal products) Thadu (inorganic substances) and Janagamam

(animal products). Many plants are used in Siddha system of medicine viz. Adathodal (*Adhatoda vasica*), Panaimaram (*Borassus flabellifer*), Kaliccikkai (*Caesalpinia bonduc*), Thippilil (*Piper longum*), etc.

The basic knowledge of Unani medicine was developed by Muslim scholar Avicenna in his work the Canon of Medicine (1025 CE). This system of medicine describes the man as being made up of seven natural factors or Umooor-e-tabiya. These are Elements, Humours, Temperament, Organs, Pneuma, Faculties and Functions. According to Unani system, cancer or tumour is a disease of black bile (Sawda). Polyherbal formulations of this system are mainly Tiryaaq Wabai, Habb-e-Raal, Majoon-e-Jalai etc. Roots of Chobchini (*Smilax china*), Zaafran (style and stigma of *Crocus sativus*), etc. are used for preventive purposes in Unani system of medicine.

1.8 Questions

1. What is meant by the indigenous medicinal science? Name three such systems developed in India.
2. What is Ayurveda? Name two books on Ayurveda.
3. Explain Panchamahabhutas.
4. What do you mean by Saptadhatus?
5. What are the three forces of human body according to Ayurveda?
6. What is Rasayana? Cite examples of some Rasayana formulations. Name some plants which are included in Rasayanas.
7. Name some plants with classical name which are used in Ayurveda in different diseases.
8. What are the basis of Siddha system of medicine?
9. Name three plants with siddha name used in respiratory diseases.
10. What is meant by Umooor-e-tabiya?
11. Describe different types of temperament (Mizaj) and humours (Akhlal) as stated in Unani system of medicine.
12. State the principle of treatment of tumour/cancer according to Unani system of medicine.

13. Name two polyherbal formulations of Unani system along with the ingredients and uses.
14. What is the main cause of cancer or tumour according to unani system of medicine.
15. State whether the following sentences are true or false
 - (i) Pranakamya is a type of Rasayana
 - (ii) The Charaka Samhita has twelve sections or sthanas.
 - (iii) Shilajit is a plant species.
 - (iv) *Centella asiatica* is known as Mandukaparni
 - (v) Herbal products are called Thavaram in Siddha system.
 - (vi) *Calotropis gigantea* is known as Arka in Siddha system.
 - (vii) Avicenna wrote the book entitled 'Canon of Medicine'.
 - (viii) Complex disease is called 'Marad Mufrad' in unani system
 - (ix) Black bile is called 'Sawda' in Unani system.
 - (x) Indrajaba is the seed of barley.

1.9 Answers

- (1) Article nos 1.3, (2) 1.4, (3) 1.4.4, (4) 1.4.5, (5) 1.4.6, (6) 1.4.7, (7) 1.4.8, (8) 1.5.2, (9) 1.5.3, (10) 1.6.2, (11) 1.6.2, (12) 1.6.3, (13) 1.6.4, (14) 1.6.3 (15) (i) true, (ii) false, (iii) false, (iv) true, (v) true, (vi) false, (vii) true, (viii) false (ix) true, (x) false.

1.10 References and further readings

1. Anonymous, 1999, 2001, The Ayurvedic Pharmacopoeia of India Part-I, Vol II & III, Dept of ISM & H, Govt of India, New Delhi
2. Chopra, R. N., Nayar, S. L. & Chopra I.C. 1956 Glossary of Indian Medicinal Plants. National Institute of Science Communication and Information Resources (CSIR), New Delhi.
3. Hati, A. K. 2014 History of Science in India, Vol II National Academy of Science, India (NASI) & The Ramakrishna Mission Institute of Culture, Kolkata.

4. Rao, K. K & Veluchamy, G 1983, Siddha medicine and its usefulness in Day-today life. Heritage of Tamil Siddha Medicine (edtd.) by Subramanian S.V. & Mahadevan V.R.) International Institute of Tamil Studies. Madras, India, pp 171-184.
5. Sharma, S. K. 1998, Medicinal Plants used in Ayurveda. National Academy of Ayurveda, Govt. of India, New Delhi.
6. Sivarajan, V.V. & Balachandran, I. 1999 Ayurvedic Drugs and their Plant Sources. Oxford & IBH Pblishing Co. Pvt. Ltd., New Delhi, Calcutta.

Unit 2 □ Conservation of Endangered and Endemic Medicinal Plants

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2.0 Objective

- From this unit you will be able to learn about the need of conservation for endangered and endemic medicinal plants.
- You will be able to know the importance of In-situ and Ex-situ conservation.
- You will be able to discuss the role of nursery and green house in conservation.

2.1. Introduction

Conservation is the protection, preservation, management or restoration of wildlife and natural resources, such as forests and water. India has a rich resource base of medicinal plants with about 8000 different species. According to the Government of India, traditional

medicines are the sole means of health care for about 65 percent of the population. The medicinal plants are the basic raw material for the production of Ayurveda, Unani and Siddha medicines. The bulk of the raw material (about 80% of the demand) is derived from the forests only. Hence, the forest areas have been over exploited in the past to meet the requirement of the pharmaceutical and allied industries. Consequently, many of the important plant species have been threatened and some of them are on the verge of extinction due to unscientific collection by untrained persons. Recently, medicinal plants have also been gaining immense popularity not only in developing countries, but also in developed countries due to various reasons related to safety and efficacy. Therefore the demand for the basic raw materials has been further increased and forest areas are hardly able to meet this increasing demand for industries. In view of above circumstances, there is an urgent need to conserve and to propagate some important medicinal plant species so as to save these from extinction and also to ensure greater availability of raw materials.

2.2. Why conservation is needed?

Through the conservation, the survival of many species and habitats can be ensured. The most obvious reason of conservation is to decrease the rate of extinction of species. Extinction is a natural phenomenon and has been going since life began. Extinction (i.e., the complete disappearance of a species from earth) is an important part of the evolution of life on Earth. The current biodiversity of species is a product of the processes of extinction and speciation throughout the previous 3.8 billion years history of life. There are three types of extinction processes :

1. Natural extinction : With the change in environmental conditions, some species disappear and others, which are more adapted to changed conditions, replace them.

2. Mass extinction : There have been several periods in the Earth's geological history when a large number of species became extinct because of catastrophe or sudden widespread disaster.

3. Anthropogenic extinction : This man-made extinction represents a very severe depletion of biodiversity, particularly because it is occurring within a short period of time.

We have no control in the above first two, but by conservation, we can control the third one. The rate of extinction can be increased several folds by Anthropogenic activities. The rate is at least 10,000 times greater than the natural rate of species extinction, as estimated using the fossil records.

2.3 Endemic and Endangered medicinal plants

2.3.1 What is endemism?

Endemism is a phenomenon which indicates the situation of an element (either plant or animal) restricted to a region or area of distribution. The phytogeographer or associated taxonomists recognize two types of endemism.

1. One is whether the element is of a young species or genus which may not yet have attained its maximum area as determined by its dispersal barriers. This is termed, in the strict sense, an endemic, e.g. some species of *Aponogeton* (*A. undulatus*, *A. microphyllous*, *A. crispus*, etc.) endemic to India and Srilanka.
2. The second type is one in which the element is old or relic occupying now a contracting and much smaller area than before, an element that is surviving but contributing to plant evolution it is termed as an epibiotic, e.g. *Welwitschia mirabilis*, endemic to the south west African coast. Endemism is of significance to the taxonomist since it is vitally concerned with the history of the flora.

According to D. Chatterjee (1962) more than 50% of dicotyledonous species in India are endemic. He stated that these endemic forms are specially concentrated in the Himalayas (3169 dicotyledons and about 1000 monocotyledons) and South India (2045 dicotyledons and 500 monocotyledons) The Indo-Gangetic plain is poor in comparison to the above two regions.

2.3.2 Endangered Medicinal Plants

Definition : The term ‘endangered’ is applied to species that possess a very high risk of extinction as a result of rapid population declines of 50 to more than 70 percent over the previous 10 years (or three generations), a current population size of fewer than 250 individuals, or other factors.

The species that possess an extremely high risk of extinction as a result of rapid population declines of 80 to more than 90 percent over the previous 10 years (or three generations), a current population size of fewer than 50 individuals, or other factors are called **critically endangered**.

In this connection IUCN’s Red List of Threatened species is noteworthy.

What is the IUCN (International Union for Conservation of Nature and Natural Resources) Red List? Established - 1964, the IUCN’s Red list of threatened species has evolved to become the world’s most comprehensive information source on global

conservation status of animals, fungi and plant species. The IUCN Red list, is a critical indicator of the health of the world's biodiversity. Far more than a list of species and their status, it is a powerful tool to inform and catalyze action for biodiversity conservation and policy change, critical to protection of the natural resources we need to survive.

It provides information about the range, population size, habitat and ecology, use and/or trade, threats and conservation actions that will help to inform necessary conservation decisions.

2.3.3 Red List Criteria

The IUCN system uses a set of five quantitative criteria to assess the extinction risk of a given species. In general these criteria consider :

1. The rate of population decline.
2. The geographic range.
3. Whether the species already possesses a small population size.
4. Whether the species is very small or lives in a restricted area.
5. Whether the results of a quantitative analysis indicate a high probability of extinction in the wild.

After a given species having been thoroughly evaluated, it is placed into one of several categories. In addition, three of the categories (CR-critically endangered, EN-endangered and VU-vulnerable) are contained within the border notion of threatened. The IUCN Red List of threatened species recognizes several categories of species status. These are -

1. **Extinct (EX)** : A designation applied to species in which the last individual has died or where systematic and time-appropriate surveys have been unable to log even a single individual.
2. **Extinct in the wild (EW)** : A category containing those species whose members survive only in captivity or as artificially supported populations for outside their historic geographic range.
3. **Critically Endangered (CR)** : The species which possess an extremely high risk of extinction, the rapid population declines of 80% to more than 90% over the previous 10 years (or three generations) and the current population size of fewer than 50 individuals, or other factors.

4. **Endangered (EN)** : The species that possess a very high risk of extinction as a result of rapid population declines of 50% to more than 70% over the previous 10 years (or three generations), a current population size of fewer than 250 individuals, or other factors.
5. **Vulnerable (VU)** : A category containing those species that possess a very high risk of extinction as a result of rapid population declines of 30% to more than 50% over the previous 10 years (or three generations), a current population size of fewer than 1000 individuals, or other factors.
6. **Near threatened (NT)** : A designation applied to species that are close to becoming threatened or may meet the criteria for threatened status in the near future.
7. **Lower Risk (LR)** : A category containing species that are pervasive or able to spread throughout and abundant after careful assessment.
8. **Data Deficient (DD)** : A condition applied to species in which the amount of available data related to its risk of extinction is lacking in some way. Consequently, a complete assessment cannot be performed. Thus, unlike the other categories in this list, this category is unable to describe the conservation status of a species.
9. **Not Evaluated (NE)** : A category used to include any of the nearly 1.9 million species described by the scientists but not assessed by the IUCN.

The Threatened Plants of India

IUCN's Red list species of flowering plants of India are represented in eFI (e-flora of India). IUCN data (IUCN Red List of Threatened species 2007-2017) indicates that 1314 species were assessed for threat status in India. Six are extinct (EX), two extinct in wild (EW), 75 critically Endangered (CR), 161 Endangered (EN), 131 Vulnerable (VU), 41 Near Threatened (NT), 1 Lower Risk (LR), 64 Data Deficient (DD) and the rest are not evaluated (NE). The complete list of threatened flowering plants in India is available at www.iucnredlist.org

e flora of India (eFI) during its 10 year journey (June 2007 to June 2017) has showcased a large number of Red Listed species from different wild habitats of India and botanical gardens. A search of eFI database reveals the following number of red-listed species.

Categories	Category Symbol	Total Number of species in India	Number of species represented in eFI
Extinct	EX	6	1
Extinct in Wild	EW	2	1
Critically Endangered	CR	75	17
Endangered	EN	161	29
Vulnerable	VU	131	45
Near Threatened	NT	41	10
Lower Risk	LR	1	1
Data Deficient	DD	64	12
Not Evaluated	NE	833	-

Some examples under above categories include :

A. Extinct (EX) : *Madhuca insignis* (Sapotaceae)

B. Extinct in Wild (EW) : *Corypha taliera* (Arecaceae)

C. Critically Endangered (CR) :

Aconitum chasmanthum (Ranunculaceae)

Commiphora Wightii (Bursleraceae)

Gentiana kurroo (Gentianaceae)

Nardostachys jatamansi (Valerianaceae)

Saussurea costus (Asteraceae)

D. Endangered (EN)

Aconitum heterophyllum (Ranunculaceae)

Curcuma caulina (Zingiberaceae)

Mangifera andamanica (Anacardiaceae)

Pterocarpus santalinus (Fabaceae)

Syzygium alternifolium (Myrtaceae)

E. Vulnerable (VU)

Aconitum violaceum (Ranunculaceae)

Aquilaria malaccensis (Thymelaeaceae)

Santalum album (Santabaceae)

Saraca asoca (Caesalpiniaceae)

Vanda spathulata (orchidaceae)

F. Near Threatened (NT) and Lower Risk (LR)

Aglaia edulis (Meliaceae)

Elaeocarpus munronii (Elaeocarpaceae)

Prunus jacquemontii (Rosaceae)

Vigna khandalensis (Fabaceae)

G. Data Deficient (DD)

Abrus fruticulosus (Fabaceae)

Corypha macropoda (Arecaceae)

Diospyros ebenum (Ebenaceae)

Magnolia pterocarpa (Magnoliaceae)

Magnolia doltsopa (Magnoliaceae)

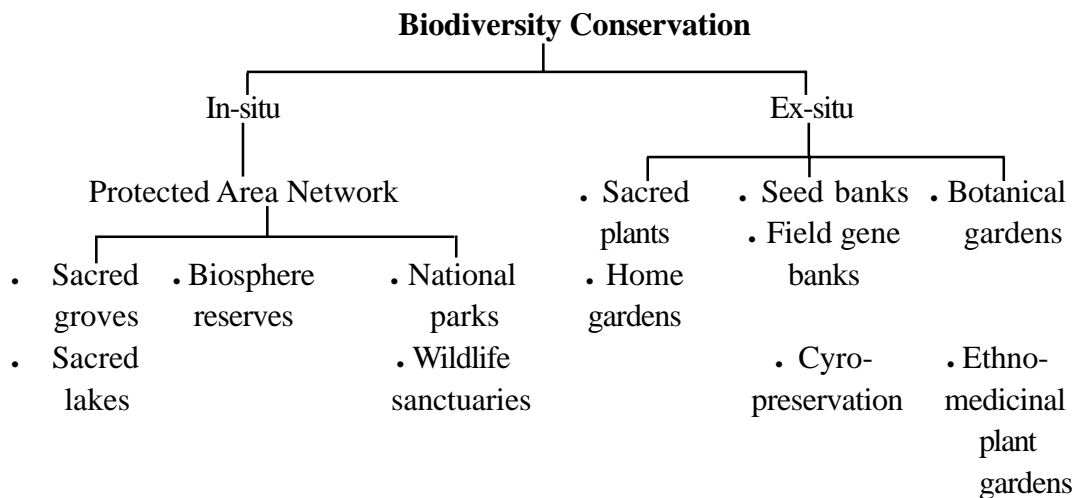
2.4 In-situ conservation

2.4.1 Definition and objectives

Two main strategies of **biodiversity conservation** are in situ (protection of species in their natural habitats) and ex-situ (protection of species outside their natural habitats). There is a need for coordinated conservation efforts based on these strategies. More information is required on medicinal plant production, utilization, trade, monitoring the stock of medicinal plants, development of sustainable harvesting practices, preservation of traditional knowledge and intellectual property rights. The World Conservation Union (formerly known as the International Union for conservation of Nature and Natural Resources) categorized plants Red Data List categories based on the detailed knowledge of the population dynamics and genetics of the species. Conservationists focus their attention exclusively species extinction rather than genetic erosion within individual gene pools, and the latter may be of equal importance in terms of loss of biodiversity.

Hence, it is imperative that viable strategies to conserve the populations and genetic resources of medicinally important species are essential to avoid further loss. Ongoing

efforts in India include both in-situ and ex-situ conservation measures viz., plant tissue culture, introduction of new crop genetic resources, research in habitat restoration, seed storage, tissue banking etc.



2.4.2 In-situ Conservation : Different Advantages

Most of the medicinal plants available in our country are endemic species and their medicinal properties are mainly because of the presence of secondary metabolites that respond to stimuli in natural environments and that may not be expressed under cultural or controlled conditions. In-situ conservation of whole communities allows us to protect indigenous plants and maintain natural communities. In-situ conservation also increases the amount of diversity that can be conserved and strengthens the link between resource conservation and sustainable use. In-situ conservation efforts have focused on establishing protected areas and taking an approach that is ecosystem-oriented, rather than species-oriented. Successful in-situ conservation depends on rules, regulations and potential compliance of medicinal plants within growth habitats.

2.4.3 Different advantages of in-situ conservation are as follows :

- (a) It is a cheap and convenient way of conserving biological diversity.
- (b) It offers a way to preserve a large number of organisms simultaneously, known or unknown to us.
- (c) The existence in natural ecosystem provides opportunity to the living organisms to adjust to different environmental conditions and to evolve in to a better life form.



Fig. 2a : Part of a Biodiversity Park.



Fig. 2b : Part of a Floral Plant Biodiversity.

The only disadvantage of in-situ conservation is that it requires large space of earth which is often difficult because of the growing demand for space. The protection and management of biodiversity through in-situ conservation involves certain specific areas known as protected areas which include Biosphere reserves, Sacred groves, National parks etc.

2.4.4 Biosphere reserves

Definition : Biosphere reserves or natural reserves are multipurpose protected areas with boundaries circumscribed by legislation. The main aim of the biosphere reserve is to preserve genetic diversity in representative ecosystems by protecting plants, traditional life style of inhabitant and domesticated plant genetic resources. These are scientifically managed allowing only the tourists to visit.

Importance of biosphere reserves :

- (a) These help in the restoration of degraded ecosystem
- (b) The main role of these reserves is to protect and preserve genetic resources, species, ecosystems and habitats without disturbing the habitats.
- (c) These maintain cultural, social and ecologically sustainable economic developments.
- (d) These support education and research in various ecological aspects.

Some important biosphere reserves in India are :

- Simlipal (Odisha) ;
- Sunderban (West Bengal) ;
- Kanha (Madhya Pradesh) ;
- Kaziranga (Assam) ;
- Manas (Assam) ;
- Nanda Devi (Uttarakhand) ;
- Nokrek (Meghalaya).

2.4.5 Sacred groves

Definition : Portions of forests preserved on religions faiths are known as sacred Groves. Many ethnic communities of India, residing in and around forests, keep certain

patches in surrounding forests as sacred. These are given different names in different regions, e.g. Devrai in the Western Ghat, Kavu in Kerala, Orans in Rajasthan and Law in Meghalaya. Hunting and logging are usually strictly prohibited within these patches. Other forms of forest usage like honey collection and deadwood collection are sometimes allowed on a sustainable basis. Sacred groves did not enjoy protection via federal legislation in India. Some Non Government Organisations (NGO) work with local villagers to protect such groves. Traditionally, and in some cases even today, members of the community take turns to protect the grove. However, the introduction of the protected area category community reserves under the Wild Life (Protection) Amendment Act, 2002 has introduced legislation for providing government protection to the community held lands, which could include sacred groves.

Indian sacred groves are often associated with temples, monasteries, shrines or with burial grounds. Historically, sacred groves find their mentions in Hindu, Jain and Buddhist texts. Many plant species are being conserved in the sacred groves of different regions in India. For example, the plant species named *Kunstleria keralensis* is still present in the Kavus of Kerala and not found anywhere else. In Law Lygdoh, a sacred grove in Meghalaya, species of *Castanopsis*, *Myrica*, *Quercus*, *Schima* and a few others form the dominant vegetation, but these are rarely seen in the provalent pine-forests of the area.

Similarly, the deo-rans or “goddess woods” in the Aravalli hills of Rajasthan are covered with prickly thorny trees typical of the region.

2.4.6 National Parks

These are the small reserves meant for the protection of life and their natural habitats. These are maintained by Government. The area of national parks ranges between 0.04 to 3162 Km. The boundaries are well demarcated and circumscribed. The activities like grazing forestry, cultivation and habitat manipulation are not permitted in these areas. There are about 89 national parks in India.

Important National Parks in India are :

- (i) Corbett National Park, Nanital, Uttarakhand (First National Park) ;
- (ii) Biological Park, Nandankanan, Odisha ;
- (iii) Kaziranga National Park, Jorhat, Assam ;
- (iv) Tudela National Park, Maharashtra ;

- (v) Hazaribagh National Park, Hazaribagh, Jharkhand ;
- (vi) Bandhavgarh National Park, Madhyapradesh ;
- (vii) Bandipur National Park, Karnataka ;
- (viii) Kanha National Park, Madhyapradesh ;
- (ix) Keibul Lamjao National Park, Manipur ;
- (x) Navegaon National Park, Maharashtra.

2.5 Ex-situ Conservation

2.5.1 Definition and objectives

Ex-situ conservation may be defined as conservation or protection of species outside their natural habitats. This type of conservation is not always separated from in situ conservation. It is an effective complement to it, especially for those overexploited and endangered medicinal plants with slow growth, low abundance and high susceptibility to diseases due to replantation. Ex-situ conservation aims to cultivate and naturalize threatened species to ensure their continued survival and sometimes to produce large quantities of different plant parts used for the preparation of medicines. It is often an immediate action taken to sustain medicinal plant resources. India has the rich sources of raw materials like Amlaki (*Emblica officinalis*), Ashwagandha (*Withania somnifera*), Guduchi (*Tinospora cordifolia*), Vasaka (*Adhatoda vasica*), Haridra (*Curcuma longa*) Safed Musli (*Chlorophytum tuberosum*), Kali Musli (*Curculigo orchioides*), Swarnapatri (*Cassia angustifolia*), Brahmi (*Bacopa monnieri*), Langali (*Gloriosa superba*), Arjuna (*Terminalia arjuna*), etc. In spite of rich resources, we are failing to produce these valuable medicinal plants in large scale. So it is high time to educate the farmer and to create awareness regarding cultivation of medicinal plants in large scale which is an immediate need.

2.5.2 Different advantages of ex-situ conservation

- (a) Different genetic techniques can be utilized in this process.
- (b) Tissue culture techniques may be applied for propagation of different species through different organs.
- (c) Germplasm can be stored in this process.

2.5.3 Some disadvantages of this type of conservation

- (a) The favourable conditions may not be maintained always.
- (b) New life forms cannot evolve.
- (c) Amount of active principles (e.g. alkaloids, glycosides, essential oils etc.) sometimes may be decreased due to change of habitats.

Some of the modes of ex-situ conservations are stated as—

2.5.4 Botanical Gardens

Botanical gardens are the most conventional methods of ex-situ conservation. The facilities provided through this mode of protection are not only housing and nurturing of endangered species, but also spreading knowledge to the visitors for creating awareness regarding the origin, utilisation and conservation of different plants. Botanical gardens are the most publicly visited ex-situ conservation sites.

Botanical gardens hold living collections. The botanical garden conservation could be considered as field gene bank or seed gene bank or both, depending on the conservation method being used. However, they tend to focus their conservation efforts on wild, ornamental, rare and endangered species (Figs. 2a & 2b). Most of the germplasm conserved in botanical gardens do not belong to the plant genetic resources for food and agriculture.

A botanic garden which wishes to start a small seed bank /gene bank would be advised to start with collection of germ plasm that is very well documented from their living plant collection. This would allow them to experiment with a wide range of species and find suitable facilities and techniques for their particular needs.

According to the database of World Information & Early Warning System (WIEWS) and the FAO, it is estimated that there are now more than 2000 botanic gardens around the world in over 150 countries. Together, they maintain more than 6 million accessions in their living collections and 142 million herbaria specimens in the botanic garden herbaria. 60% of the total number of accessions are known to be stored in medium-term or long-term facilities, 8% in short-term facilities and 10% in field gene banks, in vitro and under cryopreservation.

Some famous Botanical Gardens / Research Centres / Institutions

International

1. Royal Botanical Garden, Kew, England - It is the largest botanical garden in the World. Its herbarium is also largest in the World, having more than 6 million specimens.

2. ICRISAT - International Centre for Agriculture Research for Semi-Arid Tropics, Patancheru, Hyderabad, India.

National

1. Indian Botanical Garden, Sibpore, Howrah (near Calcutta). Largest botanical garden in India. Its herbarium is largest in India having more than 1 million specimens. It was first established as Royal Botanic Garden in 1787 by Colonel Robert Kyd. Initially the garden was set up for trading purposes of the East India Company. In 1950, 'Royal botanic Garden' Calcutta was renamed as the 'Indian Botanic Garden' and subsequently as 'Acharya Jagadish Chandra Bose Indian Botanic Garden' in 2009. In 1957 the herbarium of the "Royal Botanic Garden", Calcutta, was transferred to the Botanical Survey of India and soon this herbarium shot into fame as the 'Central National Herbarium' which acts as a repository of all type specimens gathered from any area in India.

2. National Botanic Garden, Lucknow—This was the garden of the Nawabs of Oudh, later it was converted into a botanic garden. It occupies an area of about 70 acres. It has a good herbarium with a collection of about one lakh specimens of plants from India and adjacent countries. It is financed by the Council of Scientific and Industrial Research, New Delhi.

2.5.5 Ethnomedicinal Plant Gardens

The medicinal plants used by different ethnic groups in India are of prime importance for future drug development. So conservation of these plants are necessary. In places, where the medicinal plant diversity is high MPCAs (Medicinal Plant Conservation Areas) have been declared. In these areas commercial exploitation is completely closed. Conservation of MPCAs will help in conserving the gene pool of medicinal plants species. Four MPCAs have been established in South Bengal, viz. Garh Panchkot, Bonnie camp, Kankrajhore and Susunia. Under National Medicinal Plant Board (NMPB) project it has supplied quality planting materials to different divisions for rising plantation by involving local people. In these four in-situ conservation centres different medicinal plants of indigenous uses are being nurtured in in-situ conditions.

The mangrove species having several medicinal properties viz. *Avicennia alba* (Paira Baen), *Excoecaria agallocha* (Genwa), *Heritiera fomes* (Sundari), *Sonneratia apetala* (Keora), etc. are being maintained in Bonnie camp MPCA situated in Mathurapur II Block, South 24 Parganas.

In Kankrajhore MPCA in Jungal Mahal (near Jharkhand Border) the area is Sal dominated, other plants are *Emblica officinalis* (Amloki), *Terminalia tomentosa* (Asan), *Flacourtia indica* (Baichi), etc.

In the Garh Panchkot MPCA, in Purulia the priority species for conservation are *Mucuna pruriens* (Alkushi), *Morinda citrifolia* (Ach), *Aristolochia indica* (Ishwarmul), *Gloriosa superba* (Bisalanguli), *Gymnema sylvestris* (Gurmar), etc.

In the Susunia MPCA in Bankura the important species are *Boswellia serrata*, *Dalbergia latifolia* (Sitsal), *Garuga pinnata* (Ghogar, Jum), *Helicteres isora* (Atmora), *Mallotus philippensis* (Kamala, Kamila), *Acacia catechu* (Khadir), etc.

Amlachati Ex-situ conservation site

Amalachati is 5 km away from Lodhasuli National Highway and 20 Km from Jhargram town. The ethno-medicinal plant garden is established by Forest Department, Govt. of West Bengal in 2 hectare area in the year 2000 with aim of preserving germplasm of medicinal plants. The medicinal plant garden has 2 lakh capacity of nursery for supply of seedlings under National Medicinal Plant Board (NMPB) scheme, this nursery has supplied quality planting materials for raising medicinal plantation in the South Bengal. Some important plants are listed below :

Abelmoschus moschatus (Latakasturi)

Chlorophytum borivillianum (Safed mushli)

Mesua ferrea (Nagkesar)

Thysanolaena maxima (Phooljharu)

Tylophora indica (Antamul)

Wedelia chinensis (Bhringaraj)

Zingiber cassumuner (Ban ada)

Digha Medicinal Plant Garden

It is situated in Digha town in the coastal area. It was established in 2002. It has collection of 146 species of medicinal plants. This medicinal plant garden has been created

for generating awareness for the tourists visiting Digha.

In addition to these ethnomedicobotanical gardens there are some gardens established for supply of plant materials in small scale and also for generating awareness to the people. These are -

1. Medicinal plant garden in Narendrapur Ramakrishna Mission, Garia, Kolkata.
2. Jawaharlal Nehru Ayurvedic Medicinal Plant Garden and Herbarium (JNAMPGH)-CCRAS, Kothrud, Pune.
3. Medicinal and Aromatic Plant Garden at CIMAP (Lucknow).

2.6 Propagation of Medicinal Plants

2.6.1 What is plant propagation ?

Propagation is a natural phenomenon in all plants. It may be defined as the process of multiplication of a plant by sexual or asexual means to ensure the continuation of its progeny. It is achieved artificially on the field by adopting techniques suitable to the specific plant and its growth cycle.

2.6.2 Significance of propagation

It ensures the continuation of the progeny of a species. In nature it allows a plant species to enter into different growth stages and cope up with the climatic changes. Propagation allows a species to flourish and develop into a population by making use of the available resources in a given region.

2.6.3 Methods of plant propagation

Plants perpetuate in nature through seeds or through vegetative parts or special and modified organs. Based on the mode of propagation, two types of propagation are usually recognised among plants (i) Sexual and (ii) Asexual propagation.

(i) Sexual method of propagation

In this method propagation takes place through seeds, which is a reproductive part that is the result of union between male and female gametes of a plant. Seeds are fertilised ovules caused through pollination and are generally developed inside the fruits. On germination a seed gives rise to a young seedling. Since seeds are produced periodically or regularly in the reproductive phase of a plants life cycle, it is a rather convenient method of propagation of plants.

Advantages of sexual method of propagation

- Sexual method of propagation is simple to follow and generally does not require any special care as the seeds germinate easily in most of the cases.
- Each plant will be able to produce a huge number of seedlings, since the number of seeds available from a single plant is generally high.
- As the seed production is a seasonal or an annual event in a plant's life cycle, this method can be followed regularly.
- As the seeds of many species are generally small in size with less moisture content, they facilitate cost effective storage in a smaller space for a longer period.

Disadvantages of sexual method of propagation

- As the seeds are the product of the union between two sexes of a plant, the seedlings obtained from such seeds will not resemble the mother plant completely. This is more expressed in the seedlings of those plant species which are cross-pollinated.
- Seeds of some species exhibit dormancy and propagation of such species using seeds is not easy.
- Seeds of certain species are known to exhibit poor viability and such species do not propagate easily.
- Special qualities or plus traits of a mother plant cannot be passed on in total to the young ones produced by using seeds.
- Plants raised by this method takes a long span to attain maturity.

(ii) Asexual method of propagation

In this mode of propagation, a plant multiplies with the help of plant parts other than seeds. It is carried out either by using the vegetative parts, e.g. stem, leaf and root, or by using special and modified parts, e.g. tuber, rhizome, corm, bulb, sucker etc. Asexual propagation in nature is found in many plants.

Advantages of Asexual method of propagation :

- Since the propagating material used is a part derived from a mature plant, the young ones always resemble the mother plant in all respects and retain all the characters of the mother plant.

- This method is useful for propagating those plants which do not produce seeds, or set seeds irregularly, those produce seeds which are sterile or non-viable and those which are male by sex.
- This method helps in maintaining the progeny of those plants which exhibit special characters.
- Since the parts used for propagation, would have attained physiological maturity at the time of planting, the young ones come to bear flowers and fruits at an early age.

Disadvantages or limitations of asexual method of propagation

- As the method involves separation and severing of the propagating organs from the mother plant, intensive collection of the planting materials may damage the mother plant.
- A single mother plant may not provide the required planting material in a large quantity, since the parts used are of a specific type.
- Since the method involves a definite procedure, it demands proper skills and time to carry out the exercise.
- This method cannot be implemented all through the year, since the planting material is specific and available only during certain growth stages of a plant.
- The propagation material cannot be stored for longer periods of time under room conditions, since the parts used are quite often fleshy.
- Since the new plants raised from this method are not capable of developing a strong tap root system, they are more prone to wind damage.

2.7 Objectives of the Nursery

2.7.1 What is a nursery?

- A nursery may be defined as a place where the seedlings and young saplings of a plant are raised, nurtured and maintained with care and attention till they attain a specified stage of maturity and ready for transplanting into the field or for distribution. A nursery may also be defined as a pool house of seedlings and juveniles of various species of plants.

2.7.2 Objectives

- Nursery serves as a means of ex-situ conservation. It plays an important role in ex-situ gene pool of different species. Nurseries provide a viable means for the collection and maintenance of seeds and seedlings of commercially important species.
- Nurseries are the reliable source of authentic planting material of medicinal plants for local healers and households.
- A nursery is an open-air classroom to study propagation and related subjects. A nursery often assumes the shape of a man-made forest and provides ample scope to study a plant from a close distance. In this way, it also serves as conservation education and learning centres.
- Since it serves the community at one hand, it can also become a common forum for local healers and medicinal plant growers to come together and share their experience.

2.7.3 Classification of nurseries

According to utilisation and economic purposes, nurseries may be classified as follows :

- (i) Retail nurseries :** Which sell seedlings or young plants to the general public.
- (ii) Wholesale nurseries :** Which sell only to business such as other nurseries and to commercial gardeners.
- (iii) Private nurseries :** Which supply the needs for institutions or private estates.

According to the environmental conditions followed for easy growing of the seedlings or saplings, nurseries may grow plants in open fields, on container fields, in tunnels or greenhouses. In open fields nurseries grow decorative trees, shrubs and herbaceous perennials.

On container field nurseries grow small trees shrubs and herbaceous plants, usually destined for sales in garden centres.

In the greenhouse or glasshouse grow plants requiring regulated climatic conditions.

2.7.4 Important components of a nursery

The essential components of a nursery are stated as :

- (i) Seedbed and Nursery bed :** For raising seedlings, some permanent or temporary structures for seedbed may be prepared. These beds will be minimum 0.5 to 0.75

m high from ground level. The beds may be 0.75m to 1.00 m in breadth and length may be as per availability of land. The nursery beds will be prepared for storing of perennial plants or the plants that are kept for sale.

- (ii) **Collection and planting of mother plants :** The plantation of mother plant is an important work for developing a nursery. The mother plant must be true to the type and true to the variety. The plants should be properly labelled. Collection of exotic type of mother plants is a continuous process or job.
- (iii) **Storage of dried, cleaned soil and compost manure :** For raising seedlings during rainy or winter season, the soil and compost manure would be stored during hot or summer season.
- (iv) **Production of seeds :** Production of seeds is highly specialized job. The seeds should be produced carefully. If the quality of seed is good, the percentage of seed germination, seedling vigour, vegetative and reproductive growth of the crop will be good.
- (v) **Storage of propagated plants in nursery bed :** The propagated plants are planted in nursery beds for better growth or hardening the plants.
- (vi) **Manuring :** Manuring is an important component of a nursery. Vigorous growth of a plant is always attractive to buyer. In case of medicinal plants only organic manure should be applied. Heavy manuring is not beneficial.
- (vii) **Watering :** Like manuring, watering is also important. Watering will be done according to need of the plant. Showering is needed in the seed bed. The nursery should have a water source of its own, long pipes are needed for watering. For this, digging a well (12 m deep x3 m diameter) and installing of a 2.0 HP pumpset with accessories are considered.
- (viii) **Drainage :** For sufficient vegetative and reproductive growth of plants, good drainage system must be developed in between beds and around the nursery. Adequately gentle slope in the pot bed surface is also desirable. It is extremely important to ensure that water logging does not occur in and around the pots and beds.
- (ix) **Plant protection :** Keen observation on attack of different pests and diseases (viral, fungal or bacterial) is required. Necessary control measures should be taken immediately on observation.

- (x) **Maintenance of an experimental laboratory :** An experimental laboratory (regarding tissue culture, testing of viability of seeds, formation and growth of roots in case of cutting and grafting, detection of fungal and other diseases, need of micronutrients) should be established in an ideal nursery. Different chemicals e.g. tetrazolium chloride (for viability test of seeds), Indole butyric acid (for rooting), dilute hydrochloric acid (for softening the hard seed coat), dilute solution of mercuric chloride (for surface sterilization of seeds), different plant hormones (Indole acetic acid, Gibberellic acid, etc.) should be kept in the laboratory of the nursery.
- (xi) **Harvesting and storage :** The seeds, bulbs, tubers, corms etc. should be harvested in the proper stage. Bulbs, corms and tubers are stored in single layer over dry sand, flat wooden trays or racks in a well-aerated store room with low temperature and low humidity. Living plants should be kept in shade. Seeds are stored in a cool and dry place or kept in desiccator.

For all the above-mentioned components, a nursery covering a total area of 0.5 acre is considered. To maintain a greenhouse and tissue culture room additional spaces are required.

2.7.5 Sowing and Pricking

2.7.5.1 Sowing : Sowing is the process of casting handfuls of seeds over a prepared ground or broadcasting the seeds over the land. Usually hand sowing is done. Practice is required to sow evenly and at the desired rate. A hand seeder can be used for sowing. Generally, a drag or harrow is employed to incorporate the seed into the soil.

In agriculture, most of the seeds are now sown using a seed drill, which offers greater precision. In this way the seeds are sown evenly maintaining the desired rate. The drill also places the seeds at a measured distance below the soil, so that less seed is required.

A seed rate of about 100 kg of seed per hectare of land is typical, though rates vary considerably depending on crop species, soil conditions and farmer's preference. Excessive seed rate may cause the crop to lodge, while too thin a rate will result in poor utilisation of the land, competition with weeds and a reduction in the yield.

Pre-treatment of seed before sowing - Before sowing, certain seeds first require a treatment prior to the sowing process. There is a proverb - 'As you sow, so you reap'. It is absolutely true. The treatment of seeds may be seed scarification, stratification, seed soaking or seed clearing, surface sterilization of seeds with dilute mercuric chloride etc.

Seed soaking is generally done by placing seed in water for at least 24-48 hours.

2.7.5.2 Pricking out seedlings : Pricking out is a process of putting single seedling into a cell or a pot for further growth and development in a wide space.

When seeds germinate the first two cotyledonary leaves arise, which are usually a pair of oval, fleshy leaves that bear no resemblance to the mature leaves of the plant. The conventional advice is that seedlings should not be pricked out or transplanted until the first true leaves appear, but the gardener must exercise common sense and move the seedlings when they are large enough to handle. Seedlings should be removed from the seed bed taking care and not damaging the delicate roots.

It is good planning to prepare the planting holes in the trays or pot or in the prepared land of well-moisted compost manure before lifting out the seedling from the sowing container.

Proprietary compost manures contain enough plant food to give the pricked out seedlings a good start in life.

2.8 Use of Greenhouse for nursery production

2.8.1 What is a greenhouse ?

A greenhouse (also called a glasshouse) is a structure with walls and roof made chiefly of transparent material, such as glass, in which plants requiring regulated climatic conditions are grown. These structures range in size from small sheds to industrial-sized buildings. A miniature greenhouse is known as a cold frame. The interior of a greenhouse exposed to sunlight becomes significantly warmer than the external ambient temperature, protecting its contents in cold weather. (Fig. 3)

Many commercial glass greenhouses or hothouses are high-tech production facilities for vegetables or flowers. The glass greenhouses are filled with equipments including screening installations, heating, cooling, lighting, and may be controlled by a computer to optimize conditions for plant growth. Different techniques are then used to evaluate optimality-degrees and comfort ratio of greenhouse micro-climate (i.e., air temperature, relative humidity and vapour pressure deficit) in order to reduce production risk prior to cultivation of a specific crop.

The warmer temperature in a greenhouse occurs because incident solar radiation passes through the transparent roof and walls and is absorbed by the floor, earth and



Fig. 3a : Part of a Nursery.

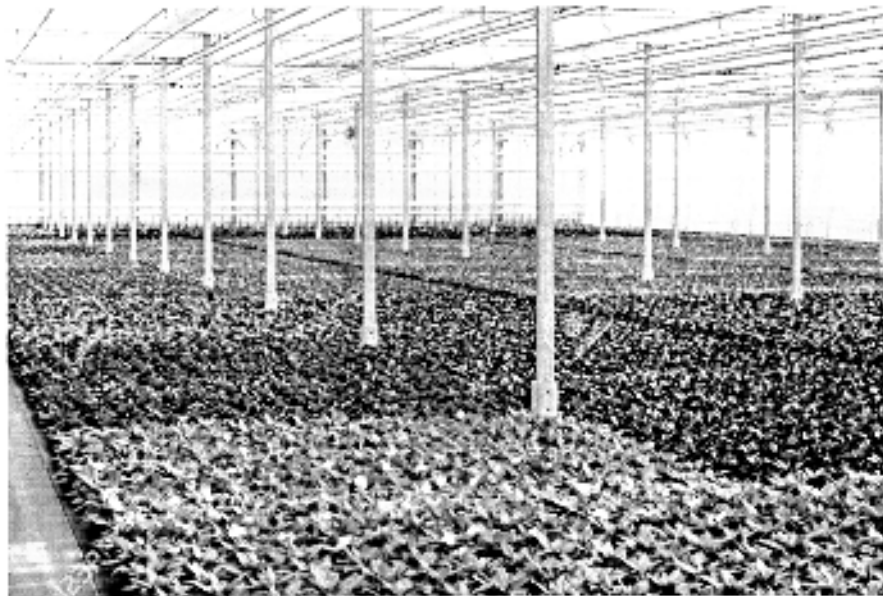


Fig. 3b : Part of a Green House Nursery.

contents, which become warmer. As the structure is not open to the atmosphere, the warmed air cannot escape via convection, so the temperature inside the greenhouse rises. This is so-called the **Greenhouse effect**.

2.8.2 Greenhouse for nursery

Greenhouses allow for greater control over the growing environment of plants. They may enable certain plants to be grown throughout the year. Greenhouses are of prime importance in the growth of seedlings and young plants under controlled atmospheric conditions. It is also useful for transplants. Many plants of medicinal importance viz. *Acorus calamus*, *Alpinia galanga*, *Mentha arvensis*, *Chlorophytum arundinaceum*, etc. if maintained in greenhouses grow with sufficient active principles. The relatively closed environment of a greenhouse has its own unique management requirement, compared with outdoor production. Pests and diseases are also controlled in greenhouse.

In case of endangered and threatened species greenhouse nursery is very much beneficial.

2.9 Propagation through cuttings

Propagation through cuttings is an easy and less expensive method of vegetative propagation. A cutting is usually a division of the stem or root or leaf of a plant. Cutting is extracted from a plant part and planted in the soil. The extracted cuttings are trimmed and planted in the soil horizontally or vertically depending on the need. Among all types of cuttings, stem cuttings are most widely used. Different types of cuttings are stated below :

1. Hardwood cuttings : Cuttings taken from the branches of the current years growth of a plant are usually considered to be hardwood cuttings. These usually measure 25-30 cm with 4-5 nodes. Cuttings of pencil thickness with uniform internodal growth are preferred. Some of the medicinal plants that are usually propagated by hardwood stem cuttings are *Hibiscus rosa-sinensis* (Jaba), *Punica granatum* (Dalim), *Lawsonia alba* (Mehendi), etc.

2. Semi hardwood cuttings : These cuttings are prepared from tender shoots and branches of the current year's growth that are not too hard but show brown blotches on the green stem. They usually measure about 20 cm with a pair of leaves retained at the tip. Some examples of semi hardwood cutting propagation are - *Adhatoda vasica* (Basak) *Tinospora cordifolia* (Gulanha), *Gymnema sylvestre* (Gurmar), etc.

3. Softwood stem cuttings : These type of cutting are prepared from the soft tender shoots remaining green in colour. These cuttings usually measure 8-10 cm with a growing tip and leaves are usually retained at the tip. Some of the medicinal plants that are usually

propagated by softwood stem cuttings are *Bacopa monnieri* (Brahmi), *Gymnema sylvestre* (Gurmar), etc.

2.10 Propagation through layering

In this technique a vegetative branch is made to root while it is still attached to the mother plant. The rooted branch will be later excised and planted as a new seedling. There are different type of layerings. (Fig. 4)

1. Air layering : Air layering may be carried out as follows - pencil size shoot of the current year's growth is to be selected. Preferably on the based portion of the selected shoot, a ring of bark is removed and exposed wood is scraped.

The exposed portion is further wrapped with moist inert rooting medium like sphagnum moss, moist coir etc. and covered with polyethene sheet making air tight.

This branch is left undisturbed on the mother plant for about 2-8 weeks depending on the species. During the course several adventitious roots emerge from the base of the exposed bark which is covered. The rooted branch will be later cut below the covered portion and planted as a separate seedling. This type of air layering is frequently followed in *Emblica officinalis* (Amlaki), *Tamarindus indica* (Tentul), etc.

2. Mound layering : It is another technique of layering and carried out as follows -

A long and supple or flexible branch is selected. Ring of bark is removed at the base and buried the soil.

In due course, roots emerge from the buried portion. After sufficient emergence of the roots the branch will be separated from the mother plant and planted as an independent plant. Examples of this type of layering are : *Merremia tridentata* (Daru jamjuri), *paederia scandens* (Gandha prasarani), etc.

3. Serpentine layering : A series of above mentioned layering done on a single long branch that is buried and exposed alternately makes serpentine layering. Serpentine layering can be tried for species which have drooping long and supple branches. In case of medicinal plants, serpentine layering is found in a very few species, e.g. *Tinospora cordifolia* (Gulanacha), *Celastrus paniculatus* (Jyotismoti).

2.11 Propagation through grafting

Grafting is a propagation technique usually employed to improve the quality of the nursery stock or to produce seedlings that carry special qualities or plus traits of a mother plant. It is carried out by bringing together two vegetative parts from two different plants of the same species and joining them together to grow as a single plant. Usually the stem branches are used for the purpose of grafting. The plant part which receives another plant part is called the stock, while the plant part that serves as the graft is called the scion. When these two i.e. stock and scion are joined together, graft union takes place. The scion always carries the positive qualities of the mother plant, while the stock serves as the root system for the young plant. After the completion of graft union, scion becomes the upper part and the stock acts as the basal part of the new plant. The stock plant is usually a plant that is already established and growing. The stock and scion are tied together with the help of tape to ensure the union. The graft is maintained in that condition for a specified time period. After the graft union is ensured, the remaining portion of the stock plant above the graft union is removed and the scion is encouraged to grow. After this, the graft is ready for planting. (Fig. 4)

Different types of grafting

(i) Approach grafting : This method involves causing the graft union between the two selected branches of stock and scion while the branches are still growing on the parent plants.

(ii) Wedge grafting : This method involves causing the graft union by inserting the scion, which is in the form of a wedge, on to an incision on the stock plant. The scion is usually a branch excised from the mother plant.

(iii) Epicotyl grafting : Grafting is done on the tender shoot of about 5-7 days old of a germinated seed with its epicotyl still intact.

(iv) Sofwood grafting : Grafting is done on the soft shoot of the stock plant which is a seedling of about 6 months.

In the case of medicinal plants grafting is found only with selected species of the genera *Artocarpus*, *Syzygium*, *Myristica*, *Garcinia*, etc.

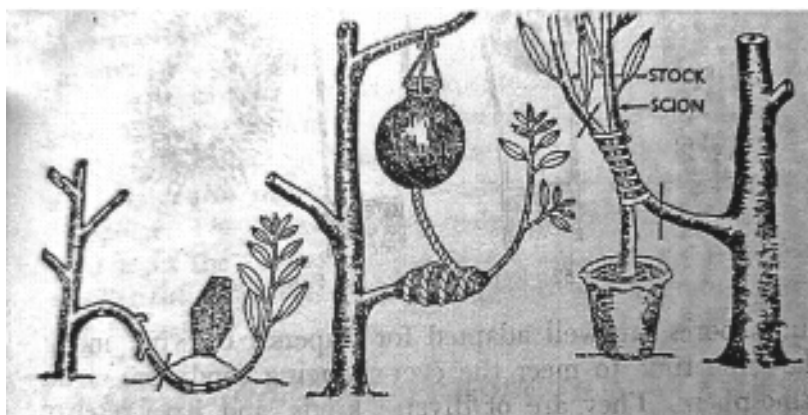


Fig. 4 : Layering and Grafting (After A.C. Dutta, 1980)

2.12 Propagation through Budding

- It is another technique of propagation where a vegetative bud is excised from a mother plant and used as scion material. The technique involves,
- The removal of selected vegetative bud alongwith a patch of bark from the scion plant and inserting it to the stock plant.
- The graft is further tied to keep the bud in place and maintained till the union takes place.
- After the union is ensured, the portion of the stock above the bud union is removed and the sprout from the scion bud is encouraged to grow further.

Different budding techniques viz. Shield budding, Patch budding, Ring budding are found in use, in which the scion material (in the shape of a shield, a small rectangular patch, a ring respectively) is inserted on to the stock plant. However, in the case of medicinal plants, budding is very rarely practised.

2.13 Summary

Conservation may be defined as the protection, preservation, management or restoration of wildlife and natural resources. The main objective of conservation is to decrease the rate of extinction of species.

The term endemism indicates the situation of an element (plant or animal) restricted to

a region or area of distribution. More than 50% of the dicotyledonous species in India are endemic. The term endangered is applied to species that possess a very high risk of extinction. The IUCN's Red list of threatened species recognises several categories of species status. These are - Extinct, Extinct in wild, Critically endangered, Endangered, Vulnerable, Near threatened, Lower risk, and Data deficient. IUCN's Red list species of flowering plants of India are represented in eFI (e-flora of India).

In-situ conservation is the protection of species in their natural habitats. Ex-situ conservation, on the other hand, is the protection of species outside their natural habitats. Sacred groves, Biosphere reserves National parks are the modes of in-situ conservation. Home gardens, seed banks, field gene bank, cryo-preservation botanical gardens etc. are the ways of ex-situ conservation.

Propagation of plants is a natural phenomenon-propagation can be made artificially through cuttings, layering, grafting or budding.

Nurseries of plants are of much importance for maintenance of seedlings and plantlets. There are various types of nurseries. Sowing of seeds and pricking out of seedlings are important in a nursery.

Greenhouse nursery is very important for maintenance of exotic plant species. They may enable certain plants to be grown throughout the year. The relatively closed environment of a greenhouse has its own unique management requirement, compared with outdoor production. In case of critically endangered or threatened species green house nursery is very much beneficial for proper growth and development of the plants.

2.14 Questions

1. What is conservation? Why conservation of plants is necessary?
2. What do you mean by Endemism? Cite examples of some endemic plants in India.
3. What is meant by endangered species?
4. What are the criteria of IUCN's Red list? Describe different categories of species status according to IUCN's Red list of threatened plants.
5. Name some critically endangered and vulnerable medicinal plants.
6. What is in-situ conservation?
7. Describe the advantages of in-situ conservation.
8. Explain biosphere reserves with suitable examples.
9. State the necessity of sacred groves in conservation of medicinal plants.

10. Give some examples of National Parks in India.
11. What is ex-situ conservation? Describe advantages and disadvantages of ex-situ conservation.
12. 'Botanical Gardens are the most conventional methods of ex-situ conservation of plants'—justify the statement.
13. Give some examples of ethnomedicinal plant garden.
14. Describe the objectives and different types of nursery.
15. What are the important components of a nursery?
16. What is meant by Greenhouse nursery? How it is maintained?
17. State different types of cuttings.
18. What is layering? State different types of layering.
19. Why grafting is necessary for propagation?
20. State different types of grafting and budding.
21. Fill in the blanks with suitable words in the bracket.
 - (i) Man-made extinction of plant species is known as _____ (Natural / Anthropogenic / Mass) extinction.
 - (ii) According to _____ more than 50% of the dicotyledonous species in India are Indemic (IUCN / David Prain / D. Chatterjee)
 - (iii) *Lilium polyphyllum* is a _____ plant (Vulnerable / Critically endangered / Endangered).
 - (iv) Cryo-preservation is a type of _____ conservation (in-situ, ex-situ, protected area).
 - (v) National Parks are the mode of _____ conservation (in-situ, ex-situ, natural)
 - (vi) Nurseries are the reliable source of _____ planting material (authentic, cheap, valuable)
 - (vii) Pretreatment of _____ is necessary before sowing (plantlets, seeds, seedlings)
 - (viii) Pricking out is a process of putting a single _____ into a cell or a pot for further growth. (tree, plant, seedling)
 - (ix) A miniature greenhouse is known as a _____ (glasshouse, cold frame, framehouse)

- (x) *Punica granatum* is propagated through — cutting. (hardwood, softwood, semi-hardwood)
- (xi) In *Amlaki plant* usually _____ layering is followed for propagation (Mound, Air, Serpentine).
- (xii) *Madhuca insignis* is an _____ species (extinct, endangered, vulnerable)

2.15 Answers

- (1) Article nos 2.1, (2) 2.3.1, (3) 2.3.2, (4) 2.3.3, (5) 2.3.3, (6) 2.4.1, (7) 2.4.2, (8) 2.4.4, (9) 2.4.5, (10) 2.4.6, (11) 2.5.1, 2.5.2, (12) 2.5.3, (13) 2.5.4, (14) 2.7.2, 2.7.3, (15) 2.7.4, (16) 2.8.1, (17) 2.9, (18) 2.10, (19) 2.11, (20) 2.11, 2.12
- (21) (i) Anthropogenic, (ii) D Chatterjee, (iii) Critically endangered, (iv) ex-situ (v) in-situ, (vi) authentic, (vii) seeds, (viii) seedling, (ix) cold frame, (x) Hardwood (xi) Air, (xii) extinct.

2.16 References and further readings

1. Anonymous, 2017. Medicinal Plant Resources of South Bengal. Research Wing, Directorate of Forests, Govt. of West Bengal.
2. Farooqi, A A and Sreeramu, B.S. 2001 Cultivation of Medicinal and Aromatic crops. Universities Press, Hyderabad.
3. Gupta, R 1987. Medicinal and Aromatic plants in Handbook of Agriculture, NBPGR, ICAR, New Delhi.
4. Jozwik, Francis X. 2000. The Greenhouse and Nursery handbook : A Complete guide to growing and selling ornamental container plants. Andmar Press, Garden Island
5. Paria, ND, Das, M.N. and Sensharma, P.D. 2014. History of Science in India Vol. IV, Part-I, Plant Science. The National Academy of Sciences, India (NASI) & The Ramakrishna Mission Institute of Culture, Kolkata.
6. Roy, P. K. 2012. Plant nursery management : How to start and operate a plant nursery. Scientific Publisher, Kolkata.

Unit 3 □ **Ethnobotany and Folk Medicines**

Structure

3.0 Objective

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3.2 Ethnobotany in India

3.3 Methods of study Ethnobotany

3.4 Application of Ethnobotany

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3.7 Folk Medicines of Ethnobotany

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3.11.2 Application of natural products to certain diseases

3.12 Summary

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3.0 Objective

- In this unit you will get an overview of Ethnobotany and Folk medicine.
- You will be able to discuss the importance of ethnomedicine and ethnic communities in India.
- You will become acquainted with several natural products used in certain diseases.

3.1 Introduction

The term ‘Ethnobotany’ is derived from two Greek words *ethnikos* or *ethnos* meaning nation, and *botanikos* or *botane* meaning plant. So etymologically the word ‘Ethnobotany’ means study of the plants related to nation(s). The term was first applied to modern studies by Harshberger in 1896 to the study of plants used by primitive and aboriginal people. Subsequently Jones (1941, 1962), Bank II (1957) and Schultes (1960, 1962, 1963) have independently interpreted ethnobotany as ‘total relationship between primitive people and their plant surroundings in the widest sense’.

According to Jain and De (1966), “the relationship between the indigenous people and their plant surroundings forms the subject of ethnobotany.” And they suggest that ethnobotany includes studies of the plants used by the indigenous people or aboriginals for their food, clothing and medicine and the impact of such usage on the survival of the plant growth. Ford (1978) suggested to include the modern economic uses of plants within the purview of ethnobotany.

It may be mentioned that the Man-plant relation cannot be restricted to the limits of Economic Botany and Environmental Studies only. Man-plant relation is multidimensional. All these relations can broadly be grouped into two classes :

(i) utilitarian and (ii) aesthetic.

The utilitarian group includes those relationships which are directly or indirectly associated with the support or subsistence of man, e.g. (a) food, (b) shelter, (c) garments, (d) medicine, (e) implements, (f) weapons etc. While the aesthetic group includes the impact of plants on the psyche of man as evidenced through man's attempt in beautification, decoration, welcoming guests with flower-bouquets, offering flowers and foliages at the feet of perceptor or deity as mark of submission and in literature (coining similies from plants, part(s) of the plant) In view of these Manilal (1988) states that the term ethnobotany denotes the entire realm of useful relationship between plant and man.

3.2 Ethnobotany in India

It has been over 100 years since John Harshberger (1896) first defined Ethnobotany and described a research agenda. Since then Ethnobotany has had a wonderful history in U.S.A. While Harvard University has become a leading centre, the University of Michigan has established an Ethnobotanical laboratory and many other Universities of USA have included ethnobotany as a subject of study and research. Canada has established 'Canadian Ethnobiology Service'. It has become a major subject in Mexico, Brazil and other countries of South America. The subject has become a major one in South Africa, West Indies, Uganda, Kenya, Indonesia, Australia, New Zealand. It has become a thrust area of research in Bangladesh and Nepal. The subject is receiving increasing attention in European countries like UK, France, Denmark, Portugal and others.

In India, while ancient and medieval literature in Sanskrit, Pali, Tamil, Persian and the regional languages include huge wealth of ethnobotanical information, seeds of modern investigation in ethnobotany were perhaps sown by Rev. P.O. Bodding (1925-40) through his publication on "Studies in Santal Medicine and connected folklore" The next important contribution was made by Late Professor G. P. Majumdar (1938) in the form of a book entitled 'Some Aspects of Indian Culture-from plant perspective'. Bodding collected his data from a living traditional community, viz the Santal. Majumdar collected information from Sanskrit and Pali sources. Sm Janaki Ammal emphasized on Ethnobotany in her duties of Economic botanist in Botanical Survey of India during 1958-59. Since 1960 methodical studies of different traditional societies were started under the execution of Dr. S. K. Jain. Previously Kirtikar and Basu (1935) in their 'Indian Medicinal Plants' mentioned a few plants used by the tribal people. B. D. Basu, the second author of this book has made substantial contributions on phytomedicine of Gond of Madhya Pradesh. The Department of Science and Technology, Govt. of India, in 1981, decided to set up in All India Co-

ordinated Research Project on Ethnobiology (AICRPE) under the head of 'Man and Biosphere' programme. Since July, 1982, the project is going on Eighteen units eg National Botanical Research Institute, Central Drug Research Institute, Birbal Sahni Institute of Palaeobotany, Ethnobotany and Plant Systematics Laboratory - Garhwal University, Nagpur University, Regional Research Laboratory, Jammu, Botanical Survey of India, Osmania University, Central Research Institutes of Ayurveda (CCRAS) and others are participating in the different phases of the programme. The project has covered now about 80% of the tribal area.

Ethnobotany has been incorporated in the curriculum of Botany in many Indian Universities, e.g. Manipur, Guwahati, Srinagar-Garhwal, Jodhpur, Calicut and Sagar. In West Bengal, University of Calcutta, Vidyasagar University, Vishwa Bharati, Netaji Subhas Open University, and some others have included this subject in their syllabi.

The Botanical Survey of India has created a section of Ethnobotany. Foundation of societies of Economic Botany, Ethnobotany and Ethnobiology and publication of their journals have elevated the status further. International society of Ethnobiology are sponsoring International Congress of Ethnobiology at regular intervals.

Many books and articles on Ethnobotany have been published by the Indian authors. Dr S. K. Jain has published and edited about 25 books and 250 articles. Some of his books are Glimpses of Indian Ethnobotany, A manual of Ethnobotany, Dictionary of Indian Folk Medicine and Ethnobotany. Pal and Jain (1998) published a book on 'Tribal Medicine' which is a remarkable work on Medico-ethnobotany. Dr. Jain also founded the society of Ethnobotanists and later the International Commission on Ethnobotany.

3.3. Methods to study Ethnobotany

The ethnobotanical data are the outcome of intensive studies conducted in the tribal pockets of different regions of a country. The cordial relationship with tribals should be created in the primary phase. Then the informations on tribal customs, culture, beliefs etc. should be gathered accordingly.

The tribals or aboriginals consider urban visitors, superior to them. They feel shy and hesitate in speaking to them about their knowledge. This situation can be changed by creating a healthy relationship by accepting the drinks and eatables offered by them, participating in their religious customs and festivals, advising them for their progress and upliftment in the community, conducting education programmes for them etc. An atmosphere of trust and confidence should be established among them so as to open up the secrets of

traditional plant lore, even though the traditional notion that ‘any secret is revealed, the curative property of the plant will vanish’ prevails among them.

More reliable informants are to be selected with the help of local officials and the persons of forest department. The number of informants may be 8-10, they should have rich experience and practical knowledge of plants used in the traditional system of medicine. These informants may be regarded as collaborators in ethnobotanical research.

Three methods of collecting ethnobotanical information are as follows :

1. First method is ‘Cat and Mouse’ technique as termed by Prof. R. E. Schultes (1962) of the Harvard University, USA. In this process, all the useful specimens are collected by the investigator and shown to the informants one by one giving the known uses. The informant will interrogate the investigator out of curiosity to confirm whether their knowledge coincides with that of the investigator’s thus revealing their secrets on medicinal plants.

2. In the second method, the knowledgeable informants are taken directly to the field and information was collected through in-depth interviews. Informal discussions are carried out with the informants having high degree of herbal knowledge.

3. In the third method the informants are employed on daily wages. They are allowed to take the role of a demonstrator or instructor to the investigator, thus helping in collecting the specimens from the field.

Proforma for Ethnobotanical Investigation -

- (i) State / District / Village - i.e. the place of investigation
- (ii) Boundary - surrounding area, the geographical boundary
- (iii) Topography - detailed description on map, natural or artificial features of the place
- (iv) Altitude
- (v) Area of the village
- (vi) Population
- (vii) Ethnic group
- (viii) Religious customs / beliefs
- (ix) Literacy
- (x) Language spoken

- (xi) Occupation
- (xii) Food habits
- (xiii) Economic status
- (xiv) Farming and agriculture
- (xv) River / Water supply
- (xvi) Geological studies rock, soil etc.
- (xvii) Climate-rainfall, temperature, humidity etc.
- (xviii) Area under forest and nature of the forest.

Regarding information collected in the field the proforma may be followed as :

1. Collection No.
2. Date of collection
3. Place of Collection
4. Name of the informant
5. The collected specimen is wild or cultivated
6. Local name of the plant and family with scientific name
7. Plant part(s) used -whether fresh, dried, powdered or mixture of other ingredients / herbs, if any.
8. Nature of use of plant / plant part (s) in detail
 - (a) Medicinal
 - Name of the disease
 - Symptoms of the disease
 - Method of preparation (decoction / juice/paste)
 - Mode of administration (oral/external/infusion)
 - Dosage (before/after food)
 - Duration (hours/days)
 - Case of study observed, if any

(b) Edible

- Way in which it is consumed
- Cereals / pulses
- Vegetables / fruits
- Oils / fats
- Condiments / Spices / Sweets

(c) Insecticide, Pesticide and fish stupifiers

(d) Magical and religious beliefs, taboos

(e) Miscellaneous uses of plants as

- Fodder / fibre
- Dye
- Gum and resin
- House building
- Art and culture

The information may be collected from both men and women folk. The knowledge of uses of medicinal plants related to gynaecological diseases / disorders may be gathered from the women folk who play a significant role in the discussions since they possess more knowledge about the utility of local herbal medicine. The recipes on the method of preparation of ethno-herbal products alongwith dosage, application and duration are also to be collected.

As in many other communities, the 'Mukhya' is the hereditary head among the tribal communities. He is regarded as informant. The knowledge about the uses of plants, particularly about the medicinal uses of plants in the treatment of different diseases among the tribal groups are often specialised and limited to a few number of people in the community who are recognised as medicine men or 'Vaidya'. Those persons are generally considered as respectable and indispensable members in the tribal society. Thus the informations may be gathered from two broad categories :

(i) From the recognized medicinemen of the localities

(ii) From other individuals possessing knowledge due to their personal efforts and interest.

Another important point is the authenticity of information. Once the information on a particular plant has been taken as reliable after repeated verification, its local name and

uses should be recorded. Details about the part utilised in the preparation of the medicine, the ailments, the mode of preparation and prescription are also to be recorded.

Herbarium specimens and field notes on herbarium sheets are the good source of information. In many cases, the observation on plant lore made by previous botanical explorers may be noted on herbarium labels.

Efforts may also be made to search out each and every herbarium sheets deposited in Botanical Garden, Calcutta and in the industrial section of Indian Museum. Some data which are not directly related to the tribal people may also be considered because of the fact that the plants and their uses are related to the other adjacent ethnic communities. So there is every possibilities that the uses are also known to tribal people. The photographs of the medicinal plants alongwith the tribal people may also be taken for authentication and documentation.

After identification of the plant species collected from various regions conventional characterizations of the plants should be done. These include Botanical origin, regional and classical name, part(s) used, macoscopic and microscopic charaters including organoleptic studies, cell contents, extractive values in water and different polar and nonpolar solvents, total ash and acid-insoluble ash, preliminary phytochemical studies etc. All these data would help in the pharmacognostic evaluation of the plants.

3.4 Application of Ethnobotany : National Interacts

According to Pal and Jain (1998) out of 3200 taxa so far known as medicinal plants in India a total number of 343 species under 298 genera and 98 families are known to be used as medicine by four major groups namely Santal, Munda, Oraon and Lodha. But Ethnobotany has been constructed not be limited only to vascular plants but also to include studies on algae, fungi, lichens and bryophytes. It is strongly linked with taxonomy, pharmacognosy, phytochemistry, pharmacology, ecology and conservation biology. Ethnobotany with no doubt remains the main revenue contributing to both orthodox and traditional medicine. A number of useful drugs have been developed based on ethnobotanical approaches. Ethnobotany is a multi-disciplinary subject. the growing interest in ethnobotany can be observed through the increased number of journals and periodicals on this subject. The selection of plants based on ethnobotanical studies has gained in popularity as a means to identify which plants contain relevant compounds for exploitation. This economic focus of biological prospecting, including the use of patents and other intellectual property mechanisms has highlighted important issues concerning indigenous rights, cultural knowledge and traditional resources.

This situation led to the emerge of what the so-called Socio-ethnobotany, a new sub-discipline of ethnobotany that deals with the question of how indigenous people can be compensated for sharing their ethnobotanical knowledge.

It has been stated earlier that Ethnobotany plays an important role in the development of new drugs. Many plants produce economically important organic compounds e.g. oils, resins, gums, tannins, waxes, dyes, flavours and fragrances, pesticides and pharmaceuticals. Many of the medicines used and/or currently in use viz. Aspirin, codeine, Ipecac, Pilocarpine, Pseudoephedrine, Quinine, Reserpine, Scopolamine, Theophylline, Vinblastine etc. have been derived from medicinal plants based on ethnobotanical research programmes. Recently, many of the reputed pharmaceutical companies have produced a number of herbal preparations based on ethnobotanical leads for different purposes. Few examples of these products and their botanical sources are given in the table below :

Botanical Name	Family	Ethnobotanical leads	Verified biological activities	Commercial product
<i>Acacia nilotica</i> (L.) Del. ssp. <i>indica</i> (Benth.) Bren.	Mimosaceae	<i>Acacia</i> gum has been used for healing wounds.	Antihypertensive, anti-spasmodic, anti-inflammatory.	Acacia liquid extract, Acacia gum capsules.
<i>Camellia sinensis</i> (L.) Kuntze.	Theaceae	Stimulant, treats conjunctivities, diuretic, relieves inflammation, allergies.	Anti-hypercholesterolemic, antioxidant antimicrobial.	Sbeltix peso exacto, etc.
<i>Capparis decidua</i> (Forsk.) Edgew.	Capparidaceae	Jaundice, rheumatic arthritis and to treat swells.	Strong anti-inflammatory anti-microbial properties.	Rista- <i>Capparis decidua</i> in brine.
<i>Balanites aegyptiaca</i> (L.) Del.	Simarou-baceae	Veneral diseases, rheumatism, digestion problem, dysentery, etc.	Anti-mycobacterial.	Balanites oil, Balanites fruit pulp.

Botanical Name	Family	Ethnobotanical leads	Verified biological activities	Commercial product
<i>Aloe barbadensis</i> Mill.	Liliaceae	Boils, softening of skin, jaundice liver complaints, skin disease, to wash hair, etc.	Scientific evidence for the cosmetic or therapeutic efficacy of <i>Aloe</i> is limited and frequently contradictory.	<i>Aloe vera</i>

3.5 National Interacts

Challenges and future perspectives of Ethnobotany and herbal medicine are the major criteria of national interaction. The increasing interest on plants and their ethnobotanical bioperspecting were in general based on the perception that herbal remedies or drugs are always safe. This is infact a false assumption. Herbs or herbal preparations sometimes may create a wide range of undesirable or adverse reactions, causing serious damages, life-threatening conditions and even death. In many regions, herbal medicines and related products are introduced in the market without any mandatory safety or toxicological evaluation. So efficacy and safety measures should be followed for the preparations of such medicines.

Another thing is Intellectual property rights and biopiracy. Information about the uses of specific plant species in a community is generally obtained via interviews of invididuals or groups of people and the scope of this information may vary based on the methods used.

The economic focus of biological prospecting based on these indigenous knowledge including the use of patents and other intellectual property mechanisms has highlighted important issues concerning indigenous rights, cultural knowledge and traditional resources.

Establishment of a guideline for protection of cultural knowledge of different ethnic communities and intellectual property rights could provide a significant control of ethical utilization and dissemination of cultural knowledge for both academic reserchers and industrial applications. These are the important criteria of national interacts.

3.6 Palaeo-ethnobotany

3.6.1. Definition

Palaeoethnobotany is the study of the remains of plants cultivated or utilized by man in ancient times, collected from different archaeological sites. It is based on the recovery and identification of plant remains and the ecological and cultural information available for modern plants. The major themes of research are the uses of different wild plants, the origin and domestication through agriculture and the co-evolution of human-plant interactions. It is more or less closer to Archaeobotany which have survived in archaeological context and different from Palaeobotany, which deals with any fossilised plant material, whether directly related or not with man in the geological past.

3.6.2 Preservation of the plant remains

Plant microfossils are preserved through four main modes of preservation at archaeological sites.

- (i) Firstly, plant remains usually cereal grains, chaff, seeds and charcoal are largely reduced to elemental carbon (charred) when they are heated in a reducing atmosphere; these are referred to as 'charred' or 'carbonised' plant remains.
- (ii) Secondly, plant remains deposited in permanently waterlogged anoxic conditions are preserved as the absence of oxygen generally prohibits microbial activity. This mode of preservation usually occurs in deep archaeological features such as wells, in urban settlements where organic refuse is rapidly deposited and at settlement adjacent to lakes and rivers. In this case the preserved plant remains include seeds, fruit stones, nutshells, leaves, straw and other vegetal materials.
- (iii) Thirdly, calcium phosphate mineralization of plant remains occur usually in toilet or latrine pits and in middens or refuse-heaps as the plant remains are completely replaced by calcium phosphate. In latrine pits, plant remains consumed by humans are the most common items, e.g. seeds of flavouring agents or spices, seeds and stones of fruits.
- (iv) Finally, plant remains may be preserved by desiccation or drying in arid environments, where the absence of water limits decomposition. Delicate plant remains are also preserved, e.g. onion skin or scale leaves, bracts of artichoke (*Helianthus tuberosus*) alongside fruit stones, cereal chaff and seeds of wild plants.

3.6.3 Methods of recovery of the plant remains

A variety of methods to recover and identify the plant remains may be used by the palaeoethnobotanists. Charred remains are usually recovered by flotation. The matrix (the soil from a suspected archaeological feature) is slowly added to agitated water. The heavy material including soil, sand etc known as heavy fraction sink to the bottom. Less dense organic material, e.g. charred seeds, grains and charcoal tend to float to the surface. The material that floats to the top, called light fraction, is poured into a sieve (usually 250-500 μm), the light fraction is then dried and examined later under a low power microscope. Samples of the heavy fraction are also collected for later analysis.

Waterlogged plant remains are separated from the matrix by a combination of wet-sieving and/or small-scale flotation in a laboratory. Desiccated or dried plant remains are usually recovered by dry-sieving using a stack of different sieves to separate larger items such as cereal straw and fruit stones from smaller items such as weed seeds.

3.6.4 Identification and Quantification of the samples

Identification of micro-remains is usually carried out under a stereomicroscope, using morphological characters, e.g., shape and surface in case of seeds, or micro-anatomy in case of wood or charcoal. Identification may be done by comparing the samples with modern plant materials. Depending on the type of material and its condition, other methods, e.g. thin sections or scanning Electron Microscope (SEM) technique may be applied.

Palaeoethnobotanists may also recover and analyze microremains, e.g. phytoliths and pollen, human and animal excrements (palaeofeces, sometimes called coprolites) or plant impressions in ceramic potsherd or broken piece of earthenware and clay.

The work done in palaeoethnobotany can be divided into field work, collections management, systematic description of species, and theories into the origins of human and plant interaction.

3.7 Folk Medicines of Ethnobotany

3.7.1 Definition

Folk medicine is also known as traditional or indigenous medicine. It comprises medical aspects of traditional knowledge that developed over generations within various ethnic societies before the onset of modern medicine. Folk medicine has a long history. According

to the World Health Organization (WHO), “Traditional or Folk medicine is the sum total of the knowledge, skills and practices based on the theories, beliefs and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness.”

WHO also stated that inappropriate use of traditional medicines or practices may have negative or dangerous effects and that further research is needed to ascertain the efficacy and safety of several of the practices and medicinal plants used by traditional medicine system.

3.7.2 History

‘Necessity is the mother of invention’—this dictum fully applies to different rural or primitive societies which have to discover solutions to almost all their needs and problems from natural resources around them.

In the written record, the study of herbs dates back 5000 years to the ancient Sumerians, who described well-established medicinal uses of plants. In ancient Egyptian medicine, the Ebers papyrus from c. 1552 BC records a list of folk remedies and magical practices.

Traditional medicine may sometimes be considered as distinct from folk medicine and considered to include formalized aspect of folk medicine. Under this definition folk medicines are long standing remedies passed on and practised by lay people. Folk medicine consists of the healing practices and ideas of body physiology and health preservation known to some in a culture, transmitted informally as general knowledge and practiced or applied by anyone in the culture having experience.

3.7.3 Folk medicines in different countries

Many countries have practices of folk medicine. This system of health care may coexist with science-based and institutionalized systems of medical practice represented by conventional medicine. Examples of folk medicine traditions are traditional chinese medicine, traditional korean medicine, Arabic Indigenous medicine, Japanese Kampo medicine, traditional Aboriginal Bush medicine, Georgian folk medicine, among others. Bush medicines are generally used by aboriginal and Torres strait Islander people in Australia. These are made from plant materials, e.g. bark, leaves and seeds, although animal products may be used as well.

In India folk medicines are used in different areas. Some of these are mentioned below:

Sl. No.	Name of the Plant	Local name	Part(s) used	Area in which used	Used in/as
1.	<i>Alstonia scholaris</i> (L.) Br. (Apocynaceae)	Buchong, Chhatim, Ealilam.	latex.	Assam region, Arunachal.	in child birth and tuberculosis.
2.	<i>Costus speciosus</i> (Koen.) Sm. (Costaceae)	Keokand, Besemati.	rhizome & stem.	Tamil Nadu, Meghalaya.	in Burns in Jaundice.
3.	<i>Gloriosa superba</i> Linn. (Liliaceae)	Karihari.	rhizome.	Rajasthan, Uttar Pradesh.	in leprosy in piles.
4.	<i>Justicia gendarussa</i> Burm. (Acanthaceae)	Trachamai, Amar, Jagatmadan.	leaf.	Meghalaya.	in bone dislocation and fracture.
5.	<i>Sida acuta</i> Burm. f. (Malvaceae)	Bala, Braphum, Holap.	leaf.	Meghalaya, and Assam.	to stop bleeding.
6.	<i>Vitex negundo</i> Linn. (Verbenaceae)	Nirgundi, Bagna, Ichur.	leaf.	Uttarakhand.	in boils and blisters.

3.8. Ethnomedicine

3.8.1. Definition

Ethnomedicine is certain type of medicine developed and originated from indigenous beliefs, concepts, knowledge and practices among an ethnic group, folk, people or race for preventing, lessening or curing disease and pain. Ethnomedicine is totally different from indigenous systems of medicine which have recognized levels of degree of learning, and organisation for registration of its practitioners, has also recognised institutions for teaching and text books.

Several interdisciplinary aspects of ethnomedicine are now in vogue, e.g.,

Ethnoepidemiology, Ethno-gynaecology, Ethno-ophthalmology, Ethno-orthopaedics and Ethno-pediatrics.

Scientific ethnomedical studies constitute either anthropological research or drug discovery research. The anthropological studies include the cultural perception and context of a traditional medicine. The purpose of drug discovery research is to identify and develop a marketable pharmaceutical product.

The pharmacological aspects of ethnomedicine is called Ethnopharmacology which is occasionally called ethnopharmacy. It is related study of ethnic groups and their use of drugs. It is the interdisciplinary science that investigates the perception and use of pharmaceuticals within a given human society. It involves studies of the following :

- Identification and ethnotaxonomy (cognitive characterization) of the natural material from which the remedy will be produced (Medico-ethnobotany)
- Traditional preparation of the pharmaceutical forms (Ethnopharmaceutics)
- Bio-evaluation of the pharmacological action of such preparations (Ethnopharmacology)
- Their clinical effectiveness (Clinical Ethnopharmacy)
- Socio-medical aspects implied in the uses of these pharmaceuticals (Medical Anthropology / Ethnomedicine)
- Public health and pharmacy practice-related issues concerning the public use and / or the re-evaluation of these drugs.

Ethnopharmacology is strongly linked to food science, since dietary modifications are traditionally used as a tool to modify health and disease conditions, and many plant species are traditionally used both as food and for medicinal purposes.

During investigation of a herbal product used by an ethnic group as a medicine, it is important that the methods of collection, extraction and preparation are the same or similar to those used by the ethnic group. This is to ensure consistency and legitimacy of the experimentation.

3.8.2 Form of Ethnomedicine

The preparation of drug and medicine among the ethnic or tribal communities is very methodical. Most of the medicines are prepared either from single plant or plant parts. The

combination with other plant, animal organ, rock, mineral, salts etc. in ethnomedicine is not uncommon. Different preparations are in the forms of -

(i) Infusion, (ii) Decoction, (iii) Mixture, (iv) Syrup, (v) Paste, (vi) Pills and small cakes, (vii) Powder, (viii) Extract-both in water and in alcohol, (ix) Fomentation, (x) Medicated oil-both from plant parts and from animal fats, (xi) Drops, (xii) Massage balm, (xiii) Fumes, (xiv) Burning ash, (xv) Plaster, (xvi) Fresh juice, (xvii) Alkali, etc.

3.9 Ethnoecology

3.9.1 Definition

Ethnoecology is the scientific study of how different groups of people living in different regions understand the ecosystems around them, and their relationships with surrounding environments. The prefix ‘ethno’ in ethnoecology indicates a localized study of a people in conjunction with ecology, signifies peoples’ understanding and experience of environments around them. Ecology is the study of interactions between living organisms and their environment. The development of this field lies in applying indigenous knowledge of Botany and placing it in a global context.

3.9.2 History

The term ‘ethnoecology’ was first coined in 1954 by Dr. Harold Conklin, a cognitive anthropologist who did extensive linguistic and ethnoecological research in Southeast Asia. Ethnoecology began with some of the early works of Dr. Hugh Popenoe, an agronomist and tropical soil scientist who also worked with Dr. Conklin. Ethnoecology is a major part of an anthropologist’s toolkit. It helps researchers to understand how the society conceptualizes their surrounding environment. This information can ultimately be useful for other approaches used in environmental anthropology. Modern anthropologists emphasize the interpretation of cultures as systems and its conjunction with ecosystems.

3.9.3 Traditional ecological knowledge

Traditional Ecological knowledge (TEK) also known as ‘Indigenous knowledge’ refers to the evolving knowledge acquired by indigenous and local peoples over hundreds or thousands of years through direct contact with the environment. It involves the accumulated knowledge, beliefs and practices widely held by a specific community through their relationship with the environment.

TEK has traditionally focused on Western Science. As a result the modern science may learn from these communities the cultural knowledge in the scientific structures.

Within the discipline of Ethnoecology, there is a clear emphasis on those societies that are deemed indigenous or traditional, a common trend in anthropological studies. Traditional societies often treat medical issues through the utilization of their local environment. According to World Health Organization (WHO) almost 80% of the World's population utilizes ethnobotanical methods as a main source of treatment for illness.

3.10 Ethnic Communities of India

India is a vast and diverse multiethnic country, that is a home to thousands of small ethnic and tribal groups. The Indus civilization, a society of the Indus river valley is thought to have been Dravidian-speaking, thrived from roughly 2500 to 1700 BCE. An early Aryan civilization-dominated by peoples with linguistic affinities to people in Iran and Europe-came to occupy northwestern and then north-central India over the period from 2000-1500 BCE and subsequently spread southwest ward and eastward at the expense of other indigenous groups. Despite of caste restrictions, that process was attended by intermarriage between groups which probably has continued to the present day. The complexity has been developed from a lengthy and involved process of migration also.

According to the current tribal demography of India, our sub-continent is home to about 645 tribes, most of whom have been living here since times immemorial. Indigenous tribes or ethnic communities comprise over 8% of the total population (2011 census Data).

3.10.1 A brief account of some ethnic groups in India :

1. **ABOR (ADI)** : A tribe in northeastern India, linguistically of Arunachal Pradesh, branch of Tibeto-Chinese family.
2. **ADIYAN** : About 8000 persons in South India, mainly in Kerala.
3. **ANDAMANESE** : A very small tribe of Negrito race of a few dozen persons inhabiting the Strait Island, off the east coast of Middle Andaman Islands in Bay of Bengal
4. **ANDH** : A large tribe of about 0.23 million in peninsular India, mainly Maharashtra and Andhra Pradesh.
5. **ASUR** : A tribe of about 12,000 persons mainly in Bihar, Jharkhand and West Bengal.



Fig. 5a : A Lodha couple in West Bengal



Fig. 5b : A Garo tribal with leaf of *Licuala peltata*
(From Dictionary of Indian Folk Medicine and Ethnobotany—S.K. Jain, 1991.)

6. **BHIL** : A large tribe of about 7.4 million people, mainly in Rajasthan, Gujarat, Madhya Pradesh and Maharashtra, linguistically Indo-European family.
7. **BHOTIA** : There are two tribal groups by this name, one in the high valleys of Himalaya, mainly in U.P. and Uttarakhand and the other in Sikkim and North Bengal. (i) Bhotia of UP and Uttarakhand - they inhabit high mountain regions at around 3500 m attitude. According to their habitat, they have different sections like Johari, Darmi, Byanshi and Chaudansi. They are about 32,000 (total) in number. (ii) Bhotia (Bhutia) of Sikkim region - they inhabit Sikkim, Bhutan and Darjeeling region. In Sikkim, they are about 50,000 in number and called as Drukpa. In North Bengal, they are about 40,000 in number and include Toto, Dukpa, Yolmo and Sherpa. They are linguistically of Tibeto Himalayan branch of Tibeto-Chinese family.
8. **BHUMIJ** - A tribe of about 75,000 persons in Odisha and Madhya Pradesh, also called DESUA.
9. **BIRHOR** - A tribe of about 4000 people in Bihar (including Jharkhand), 700 in West Bengal, 500 in Madhya Pradesh and 150 in Odisha. They are nomadic or seminomadic.
10. **BODO** - A tribe mainly in Brahmaputra and Barak Valleys in Assam. They are linguistically a group under Assam-Burmese Branch of Tibeto - Chinese family.
11. **CHAKMA** - A tribe of about 0.1 million persons in northeast India mainly Tripura, Mizoram and Assam.
12. **GADDI (GADI)** - A tribe of shepherds inhabiting Himachal Pradesh and some adjoining areas, population about 80,000.
13. **GARO** - A branch of BODO race, of about 0.45 million in northeastern India, mainly in Meghalaya, Assam and Tripura. Linguistically they belong to BODO group in Assam-Burmese branch of Tibeto-Chinese family.
14. **GOND** - A large tribal group 7.4 million, mainly in Madhya Pradesh, Odisha, Bihar, Jharkhand, Maharashtra, Andhra Pradesh, Telangana and Gujarat. They have several sub-divisions e.g. Raj-Gond, Durve-Gond, Muria Gond, Koda-Muria and Muria. They are linguistically of Munda branch of Austro-Asiatic family.
15. **JARAWA (JORAWA)** - A small tribe of about 250 persons inhabiting South and Middle Andaman Islands in Bay of Bengal. They live mostly by hunting and collecting. They are of Negrito race.

16. **KOL (or COL)** - About 0.13 million, mainly in the plateau region in Madhya Pradesh, Maharashtra, Bihar and Odisha. This term is also applied to some sections of Munda or Oraon origin in old Chota Nagpur region.
17. **KUKI** - about 1,30,000 persons in northeast India, mainly in Lushai hills, Mizoram, also in Tripura, Assam and Nagaland. There are several sub-troups or tribes under the name Kuki.
18. **LEPCHA** - This tribe of about 50,000 people has two main sections - Rong and Khamba. They inhabit a long stretch south of the Himalaya in Sikkim, North Bengal and Bihar in eastern India. Linguistically they are of Himalayan Group of Tibeto-Chinese family.
19. **LODHA** - A tribe of about 60,000 people, mainly in West Bengal (Fig. 5a) and Odisha.
20. **MIKIR** - About 0.2 million, mainly in Karbi-Anglong district of Assam, some are also inhabitant of Meghalaya, Mizoram and Nagaland.
21. **MUNDA** - Considered a sect of Kols. About 1.4 million in Bihar (including Jharkhand), Odisha, West Bengal, Tripura and Madhya Pradesh.
22. **ORAON** - A tribe of about 1.8 millions people, mainly in Bihar, Jharkhand, Odisha, West Bengal, Madhya Pradesh and Maharashtra, also called DHANGAR or DHANKA in M.P and KURUKH in Maharashtra. Linguistically they are of Dravidian Group in Dravidian family.
23. **PARHAIYA** - About 30,000 in Bihar (including Jharkhand) and West Bengal, also called BAIGA, but different from BAIGA of Madhya Pradesh.
24. **RABHA** - A branch of BODO race of about 0.14 million persons in Assam and West Bengal (north and northeast India)
25. **SANTAL (SANTHAL)** - A large tribe of about 4.3 million in Bihar, Jharkhand, West Bengal, Odisha usually in the region of south of the Ganges. They are linguistically of Munda branch of Austro-Asiatic family.
26. **SAVAR** - A tribe of about 0.5 million people mainly of Odisha, Andhra Pradesh and Madhya Pradesh.
27. **TODA** - A tribe of about 1000 persons in Nilgiri Hills in Tamil Nadu and adjoining areas. They are considered as one of the most Primitive surviving tribal groups. They are totally vegetarian, foods are mainly milk, butter, ghee and few cereals.
28. **TOTO** - A group of about 150 households in northern part of West Bengal. They are linguistically of Himalayan group of Tibeto-Chinese family.

3.11 Application of Natural Products to Certain diseases

3.11.1 What is natural product ?

A natural product is a chemical compound or substance produced by a living organism, that is found in nature. In the broadest sense, natural products include any substance produced by life. Natural products can also be prepared by chemical synthesis (both semisynthesis and total synthesis) and have played a central role in the development of the field of organic chemistry. The term natural product has also been extended for commercial purposes to refer to cosmetics, dietary supplements and foods produced from natural sources without added artificial ingredients.

The definition of natural products within the field of organic chemistry is usually restricted to mean purified organic compounds isolated from natural sources that are produced by the pathways of primary or secondary metabolism.

Within the field of medicinal chemistry, the definition is often further restricted to secondary metabolites. Secondary metabolites are not essential for survival, but they provide organisms an evolutionary advantage. Many secondary metabolites are cytotoxic and have been selected and optimized through evolution for use as chemical defence against prey, predators and competing organisms.

Natural products sometimes have therapeutic benefit as traditional medicines for treating diseases, yielding knowledge to derive active components as lead compounds for drug discovery.

3.11.2 Application of natural products to certain diseases

Sl. No.	Name of the disease	Name of the natural product(s)	Plant source (with family and local name)	Part(s)
1.	Jaundice	Guaranolides Behenin (crystalline lactone) Curcuminoids, Curcumol, Curdione Picroside I,	<i>Centaurea behen</i> Linn. (Asteraceae) Safed bahman <i>Curcuma zedoaria</i> Rosc. (Zingiberaceae) Sati, Kachura <i>Picrorhiza kurroa</i>	Root Rhizome Root

Sl. No.	Name of the disease	Name of the Natural products	Plant source (with family and local name)	Part(s)
		Picroside II, Kutkoside, (Iridoid glycosides).	Royle ex Benth. (Scrophulariaceae) -Katuka, Kutki.	
2.	Cardiac diseases	Saussurine, Guaianolide. Higenamine (Norcoclaurine). Cardiac glycosides- Digitoxin, Gitoxin, Gitaloxin. Glycosides- Scillaren A, Scillaren B (Digitalis-like action on heart).	<i>Saussurea lappa</i> C.B. Clarke (Asteraceae) -Kuth, Kushtha <i>Annona squamosa</i> Linn (Annonaceae) Sitaphal, Ata, Custard apple. <i>Digitalis purpurea</i> Linn. <i>Digitalis lanata</i> Ehrh (Scrophulariaceae) Foxglove, Hritpatri. <i>Urginea indica</i> (Roxb.) Kunth. (Liliaceae) Vana-palandam, Jangli Piyaz.	Root Root, Stem & Seed Leaves Bulb
3.	Blood pressure (Hypertension)	Reserpine (3,4,5-trimethoxyphenyl). Ajmaline (Rauwolfine). Carthamin	<i>Rauwolfia serpentina</i> Benth. ex Kurz <i>Rauwolfia canescens</i> Linn. (Apocynaceae) Sarpagandha. <i>Carthamus tinctorius</i> Linn. (Asteraceae) Safflower, Kusum.	Root Flower

Sl. No.	Name of the disease	Name of the Natural products	Plant source (with family and local name)	Part(s)
		Santalol.	<i>Santalum album</i> Linn. (Santalaceae) Chandan, Safed Chandan.	Wood
		Rhyncophylline.	<i>Mitragyna rotundifolia</i> (Roxb). Kuntze (Rubiaceae) Timi (Assam), Binga.	Leaf & Bark.
4.	Diabetes	Jambosine (Alkaloid) Ellagic acid. (-) epicatechin. Nonacosane, Hentriacontane, Gymnestrogenin.	<i>Syzygium cumini</i> (Linn.) Skeels (Myrtaceae) Jambu, Jam. <i>Pterocarpus marsupium</i> Roxb. (Fabaceae) Bajasar, Pitasal, Pitasara. <i>Gymnema sylvestre</i> R.Br. ex. Shult. (Asclepiadaceae) Meshashringi, Gurmer.	Seed. Stem-bark. Leaf.
5.	Skin diseases	Nimbidin (tertranortriterpenoid). Lawsone (2-hydroxy- ∞ -naphtho-	<i>Azadirachta indica</i> A. Juss. (Meliaceae) Nimba, Neem. <i>Lawsonia inermis</i> Linn. Syn. <i>L. alba</i> Lam	Seed Oil. Leaf and Stem-bark.

Sl. No.	Name of the disease	Name of the Natural products	Plant source (with family and local name)	Part(s)
		quinone. Para-methoxy salicylic aldehyde. 2-hydroxy-4-methoxy benzaldehyde. Hydnocarpic acid. Chaulmoogric acid, Gorlic acid.	(Lythraceae) Mehendi, Madayantika. <i>Hemidesmus indicus</i> R. Br. (Asclepiadaceae) Anantamul, Sariva. <i>Hydnocarpus Kurzii</i> (King) Warb. <i>H. laurifolia</i> (Dennst.) Sleumer (Flacourtiaceae) Chanlmoogra, Kowti, Memtam.	Root. Seed oil.
6.	Infertility (a) Female infertility	Loturin colloturin α -, β - and γ - caesalpin Prunasetin (isoflavone)	<i>Symplocos racemosa</i> Roxb. (Symplocaceae) Lodhra, Lodh. <i>Caesalpinia bonduc</i> (Linn.) Roxb. (Caesalpinaceae) Kuberakshi Nata-Karanja. <i>Prunus cerasoides</i> D. Don Syn. <i>P.</i>	Wood and Bark. Seed. Stem.

Sl. No.	Name of the disease	Name of the Natural products	Plant source (with family and local name)	Part(s)
		Puddumtin (flavone) Sakuranetin	<i>puddum</i> Roxb. ex. Wall. (Rosaceae)	
		Withanolide Non-phenolic sapogenetic glycoside & Ketosterol. Ferulic acid.	<i>Withania somnifera</i> Dunal (Solanaceae) Aswagandha. <i>Saraca asoca</i> (Roxb.) De Wilde (Caesalpiniaceae) Asok. <i>Ferula foetida</i> Regel (Apiaceae) Hingu, Hing.	Root. Stem-bark. Gum-resin.
	(b) Male infertility	Mucunine and Mucunadine. 1-triacontanol, Epifriedelinol. Yuccagenin and Lycorine (Alkaloids).	<i>Mucuna prurita</i> Hook. Syn. <i>M. pruriens</i> Bak. (Fabaceae) Atmagupta, Alkushi. <i>Argyrea nervosa</i> (Burm.f) Bojer Syn. <i>A. speciosa</i> Sweet (Convolvulaceae) Vridhdharaka. <i>Curculigo orchioides</i> Gaertn. (Amaryllidaceae) Talmuli, Musli, Krishnamusli.	Seed. Root and Leaf. Root.

3.12 Summary

Ethnobotany is a branch of Botany which deals with the total relationship between indigenous people and their plant surroundings. John Harshberger (1896) first defined ethnobotany. Modern investigation in ethnobotany was made by Rev. P.O. Bodding (1925-40). Prof. R. E. Schultes (1962) developed the methods of collecting ethnobotanical informations. Many medicines used currently have been derived from medicinal plants based on ethnobotanical research programmes. These are Aspirin, Codeine, Ipecac, Pilocarpine, Quinine, etc.

Palaeoethnobotany is the study of the remains of plants collected from different archaeological sites. This study can help to know the origin, domestication and utilisation of different plant species and the co-evolution of human-plant interaction.

The folk medicines are also important. Traditional or folk medicine is the sum total of knowledge, skills and practices based on theories, beliefs and experiences indigenous to different cultures. Ethnomedicines or tribal medicines are developed and originated from indigenous beliefs, concepts, knowledge and practices among an ethnic group. There are many interdisciplinary aspects of ethnomedicine, e.g. Ethnoepidemiology, Ethnoophthalmology, Ethno-gynaecology etc. Ethnoecology is the scientific study of how different ethnic groups of people living in different regions understand the ecosystems around them and their relationships with surrounding environments. This term was first coined in 1954 by Harold Conklin.

There are over 8% (of total population) ethnic communities or indigenous tribes in India. This sub-continent is home to about 645 tribes, most of whom have been living here since times immemorial. The major tribes are Abor, Asur, Bhil, Birhor, Chakma, Kuki, Lodha, Mikir, Santal, Toto etc. They use many plants in different ailments.

The active principles or the chemical compounds produced by a living organism found in nature are called natural products, e.g. Reserpine from Sarpagandha, Withanolide from Aswagandha, Andrographolide from Kalmegh. The natural products are of immense value in drug development. Many natural products are used as remedy in different diseases, viz. sphaeranthine (from *Sphaeranthus indicus*) is useful in jaundice, Reserpine (from roots of *Rauwolfia serpentina*) is useful in high blood pressure, Jambosine (from seeds of *Syzygium cumini*) is useful in diabetes, etc.

3.13 Questions

1. What is Ethnobotany? Who first applied the term to modern studies?
2. When the methodical studies on Ethnobotany were started and by whom?
3. Describe different methods for collecting ethnobotanical informations.

4. How Ethnobotany plays role in new drug development?
5. Why efficacy and safety measures are mandatory in case of herbal medicine?
6. What is meant by Palaeo-ethnobotany?
7. How plant remains or microfossils are preserved?
8. How the plant remains are recovered?
9. What is folk medicine?
10. What do you mean by ethnomedicine? How it differs from medicines used in indigenous systems?
11. What is Ethnoecology? Who first coined the term?
12. How many tribes or ethnic groups are living in India?
13. Name the state or union territory of India where the tribal population is (i) over 80% and (ii) very low percentage or negligible.
14. Name some important ethnic groups or tribes living in Kerala, Bihar, Assam, Andaman & Nicobar islands and West Bengal.
15. State a brief account on the following tribes - Kuki, Lodha, Mikir, Munda, Jarwa, Santal and Toto.
16. What do you mean by the natural products? Cite some examples of natural products with sources.
17. Name some natural products used as remedies in the following ailments :
(i) Jaundice, (ii) Cardiac trouble, (iii) Hypertension, (iv) Female infertility, (v) Skin diseases and (vi) Diabetes.
18. Name the plant sources of the following natural products :
Lawson, Reserpine, Digitoxin and Withanolide.
19. Match column A with column B as follows :

Sl. No.	Column A	Sl. No.	Column B
1.	J. Harshberger	1.	Jarawa
2.	<i>Aloe vera</i>	2.	Heart Disease
3.	Santal medicine	3.	Sarpagandha
4.	Ethnoecology	4.	Sphaeranthine
5.	Bhil	5.	Rajasthan
6.	Ajmaline	6.	Cosmetics
7.	Jaundice	7.	P.O. Boddington
8.	Andaman Islands	8.	Ethnobotany
9.	Arjunine	9.	Harold Conklin

3.14 Answers

(1) Article nos 3.1, (2) 3.2, (3) 3.3, (4) 3.4, (5) 3.5, (6) 3.6.1, (7) 3.6.2, (8) 3.6.3, (9) 3.7.1, (10) 3.8.1, (11) 3.9.2, (12) 3.10, (13) 3.10, (14) 3.10.1, (15) 3.10.1, (16) 3.11.1, (17) 3.11.2, (18) 3.11.2,

Answer to the question no. 19

Serial No. of Column A	Matches with Serial no. of Column A
1	8
2	6
3	7
4	9
5	5
6	3
7	4
8	1
9	2

3.15 References and further readings

1. Anonymous, 1990. Phytochemical investigation of certain medicinal plants used in Ayurveda. CCRAS, New Delhi.
2. Asolkar, L. V., Kakkar, K. K. & Chakre, O. J. 2005. Glossary of Indian Medicinal Plants with active principles. Part I (A-K) National Institute of Science Communication and Information Resources (CSIR) New Delhi.
3. Evans, W.C. 2001. Trease and Evans' Pharmacognosy, 14th Edn. W.B. Saunders Company Ltd., London, Philadelphia, Toronto, Sydney, Tokyo.
4. Jain, S.K. (Ed.) 1981. Glimpses of Indian Ethnobotany. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta.
5. Jain, S. K. 1990. Contributions of Indian ethnobotany. Scientific Publishers, Jodhpur.
6. Jain, S. K. 1991. Dictionary of Indian Folk Medicine and Ethnobotany. Deep Publications, New Delhi.
7. Jain, S. K. 1995. Manual of Ethnobotany. Scientific Publishers, Jodhpur.
8. Pal, D. C. & Jain, S.K. 1998. Tribal Medicine. Naya Prokash, Calcutta.