Supplementary Material for BG 3rd Semester, SEC -

Medicinal Botany I

Compiled By

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Syllabus \*

**Unit 1: Introduction and Scope**

* Introduction to medicinal plants; status & scope of medicinal Botany.
* Indian contribution to medicinal botany; brief account of traditional medicinal systems – Ayurvedha, Unani, & Homeopathy.
* Some common herbal practices used to cure – fever, worms, diarrhea, cough & cold, Arthritis & rheumatism, stone in urinary tract, eczema or fungal infections.

**Unit 2: Cultivation technologies**

* Agro & Cultivation technology ( nursery raising, cultivation, inter-culture and fertilizers, pests & diseases, harvesting & profits) for some economically important medicinal plants *– Withania somnifera, Aloe vera, Rauvolfia serpentine, Podophyllum hexandrum, Arnebia benthamii & Lavendula*.
* Green House technology – principles, methodology & applications.
* Propagation of medicinal plants through cuttings, rhizomes, bulbs & seeds.

**Unit 3: Medicinal plant constituents**

* Plant secondary metabolites of medicinal importance – Alkaloids, glycosides, mucilages & sterols (Brief account).
* Sources and uses of Morphine, Reserpine, Atropine, Codine & Ephedrine in modern medicine.
* Chemicals constituents & Traditional uses of some medicinal plants of Kashmir Himalaya – *Aconitum heterophyllum, Artemisia absinthium, Fritillaria roylei, Thymus serpyllum & Crocus sativus.*

**Unit 4: Conservation of medicinal plants**

* Concept of IUCN, Red List criteria, threat categories; concept of endemism, threatened and endemic medicinal plants.
* Conservation, In-situ conservation strategies (National Parks, Sanctuaries, Biosphere reserves & sacred grooves), Ex-situ conservation (Botanical Gardens, Ethno-medicinal herbal gardens & Seed banks).
* Conservation through tissue culture and cryopreservation; Brief account of wild life protection Act 1972.

*\*Highlighted text headings have been covered.*

 *Un-highlighted text headings will be available soon.*

Unit I:

**Introduction and scope of Medicinal Botany:**

Herbal medicine also called Herbalism or Phyto-therapy is the use of plants, plant parts in whole, powdered, or extract forms for medicinal purposes or for supplementary diet. Although traditionally plant and plant parts were used directly without involvement of any scientific technology but there has now been a significant change in the trend. Scientific approach in terms of extraction composing and using of plants as medicines has become overwhelmingly common.

Archeological evidence indicates that use of medicinal plants dates back to Paleolithic age-approximately 60,000 years ago. However written evidence of herbal remedies dates back over to 5,000 years to the Sumerians (From Mesopotamia) who compiled list of plants.

Although for long period of time, herbalism was restricted only to the use of plant and plant parts as medicine but now the scope is sometimes extended to include fungal and bee products as well as mineral elements.

There is still majority of world population that has access only to traditional mostly herbal medicine. And now with the involvement of scientific techniques, herbal medicine is popular among industrialized societies as well. WHO estimates that 80% of population of some Asian and African countries presently uses herbal medicine for some or other aspect of health care.

Herbal medicine is generally less costly and in most of the cases doesn’t require prescriptions and as most of world’s population fall in average or below average line; there-fore herbalism has found its place despite availability of wide range of Chemical/English medicines.

According to WHO approximately 25% of modern drugs used in USA have been derived from plants. At least 7000 medical compounds in the modern Pharmacopoeia are derived from plants. Many Common acute illnesses, such as common cold, influenza, sinusitis, digestive upsets, insomnia etc can be treated successfully by these herbal medicines.

Most important use of herbal therapy is usually of higher significance in case of chronic conditions. It is because chronic conditions require extremely long period of medical therapies. Therefore for such long therapies herbal medicines are much safer than chemical medicines as they are associated with only minor side effects.

However in case of chronic dosages it should be emphasized that herbal medicine is unlikely to cure where conventional medicine has failed but herbal medicine is often highly successful in managing the symptoms of chronic conditions, resulting in improved quality of life for patient. The role of herbal medicine in serious or life threatening conditions is supportive and complementary to conventional medicine. For example- Herbal medicine cannot substitute for insulin in diabetes, or Chemotherapy in Cancer but can offer improved quality of life through improvement against secondary symptoms and side effects.

Although chemical medicines and other modern sophisticated therapies are on continuous growth but the ever increasing interest of researchers, pharmaceuticals in Herbalism has encouraged local, national and international bodies to extend scope of herbalism. For example- In India many universities offer Bachelors, Masters and Ph.D exclusively in Ayurveda, Siddha, Unani medicines; same is the case for other countries.

**India and herbal medicine:**

T HE Indian subcontinent is one of the mega-centres of crop-plant diversity. A wide spectrum of agro-climatic and regional topography ranging from humid tropical to semi-arid, temperate to alpine. makes it to grow all types of crop plants. The country also possesses cultural and ethnic diversity, including 550 tribal communities of 227 ethnic groups, spread over 5,000 forested villages who have further contributed significantly over the millennia to the diversification of agro-biodiversity. The Indian subcontinent is a centre for domestication and diversification of plants. India has about 15,000 species of higher plants occurring in 16 major vegetation types.

About 33 per cent of species are endemic. It is a treasure house of wild economic plants, which are largely under-utilised, particularly wild edible and medicinal and aromatic plants (Arora, 1996). Fast erosion of PGR due to fast-growing population pressure causing excessive collection and exploitation has depleted the forest wealth, where most of the indigenous plant genetic resources of medicinal and aromatic plants existed/and are still prevalent-therefore there is priority needs for their exploration, collection, maintenance, evaluation and their conservation for their use for the present and the future.

India possesses about 166 species of agri-horticultural crop plants and about 324 species of wild relatives of crop plants. The World Health Organisation (WHO) has compiled a list of20,000 medicinal plants used in different parts of the globe (Gupta and Chadha, 1995).

In all, over 7,000 plants are known to be used for medicinal and aromatic purposes in India. The heritage of medicinal plants use in India has an ancient history dating back to the pre Vedic culture, at least 4,000 years. Today it is estimated that at least 70 per cent of the country's population rely on herbal medicines for primary health care, and many others make use of such treatments in conjunction with other forms of medical therapy. The estimates concentrate mainly on well-documented systems such as Ayurveda, Siddha and Unani as well as Homeopathy and Allopathy.

**Indian contribution to medicinal botany:**

The traditional system of medicine in India prescribing plant extractives in therapy dates back to the early age of the *Rig Veda* (4500-1600 BC). There is ample proof of the application of various recipes ofindian herbs in curing many maladies. The therapeutic efficacy of herbal medicines led to the evolution (2500-600 BC) of Ayurveda, which literally means 'Science of Life' . According to Ayurveda, health is an indication of normal biological processes, which would help to maintain mental and physical alertness and happiness. *Charaka Samhita,* the first recorded treatise on Ayurveda, was followed by *Sushruta Samhita,* both compiled a century apart, believed to be not later than 900 BC. *The Encyclopaedia Britannica* (Macro 23, 886, 1988) however, recorded the period between 800 BC to the first century AD when *Charaka Samhita* appeared in its present form. *Charaka Samhita* dealt primarily with medicine, *Sushruta Samhita,* on the other hand, was concerned with the advanced state of knowledge on the general principles and details of treatment.

It was more systematic in its arrangement. Though mainly concerned with anatomy and surgery, it incorporated a comprehensive chapter on therapeutic *(Uttara Tantra)* dealing with general diseases such as fever, diarrhoea, lung diseases, etc. The most important treatise, *Astanga Hridaya Samhita,* unrivalled for principles and practice

of medicine, was written by Vagbhata, an Ayurvedic practitioner in the seventh century AD.

The period between 800 BC and 1000 AD could be considered as the golden age of the Indian system of medicine, particularly because of the availability of these three treatises which collectively became known as *Vridha Trayi* (Senior Triad) of Ayurveda. Of course, the place of *Kashyapa Samhita* in Ayurveda cannot be ignored since it embodied invaluable information about *Kaumarabhritya Tantra,* that is, maternity and child care (Chattetjee and Pakrashi, 1991). The details of the definite properties of drugs prepared from indigenous plants and their uses, the extensive Materia Medica which was further enriched by addition of a large number of newer drugs during the Buddhist period, and the methods of administration of drugs akin to the present-day practice clearly showed the extent of advancement ofthe Indian indigenous system of medicine as well as the depth of knowledge of the then practitioners with regard to drug therapy and toxicology.

It is amazing to find how even in the ancient times the Indian *Materia Medica* could classify drugs based on their physiological actions and specify the details ofthe habitat of different plants, the parts to be used and the proper time for their collection, method of storage, etc. It is, thus abundantly clear that the users of the Ayurvedic system were fully aware of the important factors regulating the yield of active principles and as such the efficacy of the drug preparation.

**Homeopathy:** This is a system of alternative medicine developed in 1796 by Samuel Hahenemann based on his doctrine of “like cures like”. It believes that a substance which causes symptoms of a disease in healthy people would cure similar symptoms in sick people. It believes that this substance in affected people stimulate the body’s natural healing process.

**Common herbal practices to cure common ailments:**

**Fever:**

Fever, also known as pyrexia, is a common medical symptom as well as a sign that indicates an increase in internal body temperature to levels above normal. Fever results from a temporary elevation in the body’s thermoregulatory set-point, which is usually set at a normal temperature of 37o C (98.6o F). Body temperature varies with time of the day, with lower levels in the morning and higher levels in the evening.

*Kiratatikta* powder of Swertia chirata: It consists of dried, matured pieces of whole plant of *Swertia chirata*, an erect, annual, herbaceous plant.

Composition:The formulation is a powder made from dried, matured pieces of whole plant of *Swertia chirata*.

Main chemical constituents**:** Xanthones, xanthone glycoside and mangiferine (flavonoid).

Method of preparation**:** Take dried whole plant of *Kiratatikta* and further dry it in the shade to remove moisture for easy powdering or making coarse powder for decoction.

(1) Grind the material in a grinder or pulverizer until fine powder or coarse powder is obtained.

(2) For obtaining the fine powder filter it through mesh size 85. Coarse powder is used as such for decoction, there is no need to filter it.

(3) The shelf life of the powder is four months but it can retain its potency if kept in an air-tight container and protected from direct sunlight and heat.

Dosage form**:** Dark-brownish bitter powder or warm, dark brownish bitter liquid.

Therapeutic properties**:** Anti-pyretic, anti-malarial, anthelmintic, anti-leishminial, antiinflammatory,

anti-tubercular, cholagogue, hepatoprotective, antidiabetic, laxative, stomachic, tonic.

Dose and mode of administration:The dose of *Kiratatikta* powder for adults is 1-3 grams and for childrenit is 250 mg to 500 mg, with water. The dose of decoction for adultsis 25-30 ml and for children, it is 5 ml to 10 ml, to be taken twicea day after meals.

**Diarrhoea:**

Diarrhoea is defined as the passage of abnormally liquid or unformed stools at an increased frequency, and denotes a change in the usual bowel movement. It is a symptom of various disease conditions of

the gastrointestinal system and is often considered as a disease itself. Diarrhoea can be acute and chronic as per its causes.

*Kutaja* powder is used to cure diarrhoea: It is a simple formulation prepared from the stem bark of *Holarrhena antidysenterica* (Roxb. ex Flem.) Wall., a small to medium-sized tree, found throughout India.

Composition:*Kutaja* powder is prepared from the stem bark of *Kutaja.*

Main chemical constituents**:** Conessine, conessemine, kurchine, kurchicine, etc.

Method of preparation**:** (1) Take 50 grams of dried stem bark of *Kutaja* and further dry itin the shade to remove moisture for easy powdering.

(2) Grind stem bark in a grinder or pulverizer till fine powder is obtained.

(3) Filter the powder through 85 mesh to remove coarse particles and fibers.

(4) The shelf life of the powder is four months but it can retain its potency for at least six months, if kept in an air tight container and protected from direct sunlight and heat.

Dosage form**:** Bitter brownish powder.

Therapeutic properties**:** The bark of *Kutaja* has anti-diarrhoeal, constipating, astringent, antidysenteric,anthelmintic, carminative and digestive properties.

Dose and mode of administration**:** The adult dose of *Kutaja* powder is 3-5 g and for children 500 mgto 1 g, twice or thrice daily with warm water, before meals.

**Cough:**

Cough is a reflex phenomenon characterized by a sudden, violent expulsion of air from the mouth, with or without sputum, after deep inspiration and closure of the glottis. This is the most frequent

respiratory symptom. Coughing is an important way to keep the throat and airways clear. However, involuntary excessive coughing means there is an underlying cause that compels the person to cough.

*Pippali* powder is used to cure cough and cold: It is a single-ingredient herbal formulation made from the fruits of long pepper, an aromatic climber with perennial woody roots. The fruits are harvested around January while still green and

unripe, as they are most pungent at this stage and of high medicinal value. Harvested fruits are dried in the sun till they turn grey or blackish. Use of *Pippali* as a multipurpose drug is first documented in *Charaka Samhita*, where it is listed among *Rasayana* (rejuvenative and immuno-enhancer) drugs and largely mentioned for the treatment of cough, respiratory distress, gastro-intestinal disorders, pulmonary

tuberculosis etc. Besides codified knowledge about its uses, *Pippali* is largely used as a home remedy and in folk medicine.

*Pippali* powder is made from dried fruits of *Piper longum*.

Main chemical constituents:Essential oil and alkaloids – piperine, sesamin and piplartine.

Method of preparation:(1) Dried long pepper fruits are cleaned and powdered in a grinderor mortar.

(2) Powder is sieved through mesh of 85 size and kept in an airtight plastic or glass container.

(3) Exposure to moisture should be avoided. It is advisable to prepare at least 50 grams of powder at a time.

Dosage form:Blackish green powder with aromatic odour and pungent taste.

Therapeutic properties**:** *Pippali* powder has anti-inflammatory, anti-phlegmatic, decongestant,anti-spasmodic, expectorant, anti-allergic, appetizer, anthelmintic,

immunostimulatory and tonic properties.

Dose and mode of administration**:** The adult dose of the formulation is 1 gram to 3 grams and thechildren’s dose is 125 mg to 250 mg, two or three times a day, mixed

with honey or warm water. Honey is the best vehicle for consuming *Pippali* powder. Jaggery or liquorice root powder may be used in place of honey, if the cough is dry, irritating and persistent. Warm water should be taken after consuming the medicine to facilitate its swallowing and fast absorption.

**Urinary stones:**

*Gokshura* powder is used to cure urinary diseases:

*Gokshura* is a prostrate, annual or biennial weed of the pasture lands growing in hot, dry and sandy regions in the rainy season. The herb has natural occurrence but it can be propagated by seeds. The fruits are small, rounded and spiny consisting of five woody chambers, each with many seeds. Harvesting should be done preferably in winter when the properly dried ripe fruits could be preserved to retain potency till the next rainy season. Fruits, roots and the whole plant alone or in combination with other medicinal plants are extensively used in Ayurvedic medicine for the treatment of genito-urinary disorders ranging from difficulty in urination to urinary stones and

sexual weakness. Simple and multi-ingredient formulations made of *Gokshura* are listed in the Ayurvedic Formulary2 and Pharmacopoeia of India1 and scientific studies have provided enough evidence of its varied usefulness in urinary and other diseases.

Composition:The powder and decoction of *Gokshura* are made from dried ripe

fruits or the entire plant.

Main chemical constituents**:** Potassium nitrate, sterols, sapogenin, diosgenin, chlorogenin.

Method of preparation**:** Depending upon the duration of treatment take 50 to 100 grams ofdried fruits or whole plant harvested not more than one year before.

The raw material should be dried further by keeping it in sunlight or in a drier.

Make fine powder in grinder and filter it through a 85 mesh sieve to remove coarse woody particles and fibers. Keep the powder in an airtight glass or plastic food container away from moist surroundings.

Decoction of *Gokshura* is prepared by boiling 20 to 30 grams of the coarse powder of the raw material in 160 to 240 milliliters water till one fourth liquid remains. Decoction has to be prepared daily and consumed fresh same day.

Dosage form**:** Fine, pale-coloured powder and straw-coloured decoction.

**Worms:**

Decoction of Artemesia absinthium is used to get rid of alimentary canal worms.

**Fungal infections:**

Chronic fungal infection of the skin, hair, or nails is caused by specific species of fungi such as Trichophyton, Microsporum and Epidermophyton. In layman’s terms, the condition is called “ringworm” or tinea infection which is extremely common in general practice. Ringworm is characterized by round lesions (rings) and there are

multiple terms for ringworm infection of various body sites such as; tinea corporis (body), tinea paedis (feet), tinea unguium (nail), tinea capitis (scalp) or tinea cruris (groin).

*Karanja* botanically known as *Pongamia pinnata* Linn., is a mediumsized tree with a short bole and spreading crown and found almost throughout India up to an altitude of 1200 metres. *Karanja* seeds are used internally as well as externally in various types of skin aliments including fungal skin disease. Seed oil is highly esteemed for

medicinal purposes and is indicated for local application in scabies, herpes, leucoderma and other cutaneous diseases. This remedy is also enlisted in Ayurvedic pharmacopoeia of India for management of various skin diseases.

Composition:Pongamia oil is extracted from *Karanja* seeds for local application

on affected parts.

Main chemical constituents**:** *Karanja* seeds contain fixed oil, flavones and traces of essential oil.

Method of preparation**:** (1) Preparation of powder:

• Clean the dried fruits of *Karanja* by removing dust and other foreign particles. Remove the seeds from the shells and grind them into powder form.

• Filter the powder through sieve. Store in air-tight container, away from direct sunlight and in a cool and dry place.

• It is always good to use fresh *Karanja* seed powder for better results. It can be used only up to four months.

(2) Preparation of oil:

• Pongamia oil is extracted by crushing seeds of *Karanja.* Purified Pongamia oil available in the market can also beused.

Dosage form:Dusty powder and yellowish orange oil.

Dose and mode of administration**:** (1) The adult dose of *Karanja* seed powder is 250 mg and forchildren the dose is 30 mg to 60 mg, to be taken orally twicedaily with lukewarm water after meals.

(2) Simultaneously, Pongamia oil is to be applied on the affected skin as per the requirement. Pongamia oil can be applied alone or in combination with sesame oil or neem oil.

**Eczema:**

Eczema is a term that denotes different types of allergic skin inflammation usually of chronic origin. The symptoms of eczema commonly include itching, reddened and dry skin. Since the skin is itchy, prolonged scratching leads to a leathery thickening of the skin.

Cracking and weeping of the skin may also occur and open sores may become infected.

*Shirisha* consists of the powder of the bark of *Albizzia lebbeck,* a large, deciduous tree, which is found all over India up to 900 meters in the Himalayas. It grows wild especially in the moist and dry deciduous forests. The bark of the tree is thick and dark or brownish grey with numerous short irregular cracks. The seeds are oval or oblong, pale

brown, smooth with a hard testa. *Shirisha* is described as one of the best *Vishaghna* (anti-toxin) drugs in Ayurvedic texts1. Clinical studies show that *Shirisha* acts as an antidote to animal poisons which are histaminic in nature and are also responsible for the production of allergic dermatitis, urticaria and anaphylactic.

Composition:*Shirisha* powder is prepared from its bark for oral use and decoction for

washing the affected skin.

Main chemical constituents**:** Condensed tannins and d-catechin, lebbecacidin, isomers of leucocyanidin, friedelin-3-one.

Method of preparation**:** (1) The powder of the bark is prepared by grinding dried bark in

a grinder or pulverizer and then filtering it through mesh size 85.

(2) The powder should be kept in a dry container and stored in a moisture-free area. Properly kept powder holds its potency for 4-6 months.

(3) For making decoction, coarse powder is used.

(4) It is good to use the powder within four months of its preparation.

Dose and mode of administration**:** (1) *Shirisha* bark powder is given orally to adults in a dose of 3to 6 g and to children in a dose of 1 to 2 g twice daily aftermeals with lukewarm water.

(2) The decoction is prepared by adding 16 times water to 10 g coarse powder of bark of *Shirisha* and then boiling on slow fire till about one fourth of water remains. The dose of the freshly prepared decoction is 40 ml twice a day after meals.

For better relief add 5 g of turmeric powder in the decoction of *Shirisha* just before taking it. To mask the taste sugar may be added to the decoction. Fresh decoction is to be prepared for every dose.

(3) The lesions may be washed with the decoction prepared from the bark of *Shirisha*.

(4) The treatment may be continued for 3 to 4 weeks or till cure is achieved, if relief of the symptoms is sustained.

(5) If the condition gets worse, seek doctor’s advice and check for allergic reactions.

Dosage form:Grayish-brown powder or warm dark brown liquid having bitter taste.

**Arthritis:**

Joint pain or arthralgia is caused by inflammation or degeneration of tissues in one or more joints. When associated with stiffness, swelling and painful joint movement it is called arthritis. Joint pain can be a manifestation of acute febrile illnesses, trauma, excessive mechanical stress, a variety of medical conditions elsewhere in the body or a more serious form of disabling arthritis which may be infective, non-infective or degenerative. The common non-infective joint diseases with joint pain as a major symptom are rheumatoid arthritis, osteoarthritis, gout, and non-specific inflammatory arthritis such as psoriatic arthritis.

*Ajamoda* consists of dried, aromatic fruits of *Apium leptophyllum*, an annual herb cultivated in the central and southern states of India. It is collected by thrashing plants on a mat and dried in shade or in drying sheds. *Ajamoda* is a well-known drug for rheumatism and gout. *Ajamoda* is one of the chief ingredients in many formulations useful in rheumatoid arthritis. Poultice of crushed fruits can also be

applied to painful joints along with oral use.

Main chemical constituents**:** Essential oil and fixed oil.

Method of preparation**:** (1) Clean the dried fruits of *Ajamoda* by removing the stalks, dust

and other foreign matters.

(2) Grind in a pulverizer or in a mortar and pestle to make a fine powder.

(3) Filter through a fine sieve of mesh size 85.

(4) Store in an air-tight container and consume within one year.

Dosage form:Aromatic, slightly bitter yellowish-brown powder giving a sensation

of warmth to the tongue.

Unit II

**Agro- and Cultivation technology for some important medicinal plants:**

**Withania somnifera:**

A 40-80 centimeter tall shrub of Solanaceae family that grows in some dried areas of India Nepal china Yemen and is now being cultivated in some other parts of Asia & Africa. It produces many alkaloids and steroidal lactones. Steroidal lactones of *W.Somnifera* are collectively called as Withanolides. Withafirin-A is most important Withanolide. Roots leaves and its fruits are the parts that are used as herbal medicine. Ashwagandha is often referred as Indian Ginseng because it is used in similar way in Ayurvedic medicine as Panay ginseng in Chinese traditional medicine. It is used in following ways-

As adaptogen to treat fatigue.

Treating nervous exhaustion and weak memory.

It is diuretic, Hypotensive and help in maintaining reproductive health of both males and females.

There is a lot of research going on for its ability to cure chronic illness like heart disease and cancer.

It is also being used for its antioxidant, immune-suppressive and anti- inflammatory properties.

Its growing requirements due to its increasing popularity has resulted in its large scale unrestricted exploitation. Moreover, as it grows in wild or in cultivation only rarely, the plant falls in the threatened category of IUCN Red List. According to Siddique *et al,* 2005 W. *somnifera* proved to 99.75% qualifying for endangered medicinal plant. According to Kavidra *etal, 2000, W. somnifera* has been depleted from its natural habitat and is now included in the list of threatened species by IUCN. It is also noteworthy to mention that viability of seeds of this plant is just around one year and seed germination success rate is also disappointing. Page | 20

**Micropropagation of *W. somnifera***

Due to the factors mentioned above propagation and conservation of this plant through tissue culture is most appropriate option available. And in this regard lot of research has been carried out to find out the most successful explant/explants, protocols, cultural media and effect of various PGRs (Plant Growth Regulators) on growth and production of active compounds.

Here is a generalized protocol for efficient propagation of W.*somnifera* along with significant accumulation of active compounds like withafirin-A:

**Step 1 Selection of explants**

Stem nodes, shoot tip of seedling, axillary meristems, leaves and parts of seeds; all proved good explants.

**Step 2 Glassware and equipment sterlization**

Dry heating, autoclaving, ethanol and laminar airflow are used at standard conditions.

**Step 3 Surface sterilization of explants**

It is carried out with the help of 0.1% HgCl2 for 10 minutes

Washing with ethanol (70%)

3-5 washing treatments with distilled water (each 5 minute long)

**Step 4 Inoculation**

Explants are transferred to MS Culture Media (Murashige & Skoog Media) in growth chambers maintained at 25 ± 2 °C with a 16 hour photoperiod. MS medium has been maintained at pH of 5.8 ± 0.1 with the help of NaOH and HCl.

MS + Low concentration of Benzyl Adenine (4.4μM BA) and 2.3μM 2, 4-D induces significant callus formation and multiple shoot formation. Low concentrations (2.5μM) of IBA induces rooting of shootlets (withafirin-A content =0.04-0.08%). It has been repeatedly observed that plants developed from the culture media where in above medium was supplemented with 4% Sucrose, there was enhancement of withafirin A content (0.16%). If it was supplemented with 10% coconut milk there is 27 fold increases in biomass and also enhancement in withafirin-A production (0.14%). Page | 21

**Step 5 Incubation, sub-Culturing, Hardening and Lab to Land Transfer**

8-9 centimeter long shoots with sufficient rooting are transferred to half strength MS Medium with filter raft for hardening for 2 weeks. Then plantlets are transferred to vermiculite and covered with polybags for 2 weeks to retain moisture. Finally the plants are transferred to fields.

Aloe vera:

**Seedling Preparation and Planting**

Since it is difficult to grow aloevera from seeds, seedlings are normally raised from roots of the plants. Sucker itself can be used as seedlings as in Banana. Rainy season is ideal for sucker

plantation. A spacing of 1.5 x 1 ft, 1 ft x 2 ft or 2 ft x 2 ft is followed.

**Land Preparation**

About 2-3 ploughings and laddering are done to make the soil weed free and friable. Land leveling is then followed. Along the slope, 15-20 ft apart drainage are made.

**Application of Plant Nutrients**

Before land preparation, about 8-10 tonnes FYM/ ha is applied. Before the last ploughing, 35 kg N, 70 kg P2 O5, and 70 kg K2 O/ha are added. For controlling termites problem, 350-400 kg Neem Cake / ha may be applied. In

September – October about 35-40 kg N as top dressing may be applied. If the soil is rich in organic matter, N dose can be reduced.

**Irrigation and Interculture**

After 40 days or so weeding and earthing up are done. Earthing up is also practised after top dressing of fertiliser. Aloe vera is slightly tolerant to drought, but very sensitive to water stagnation.

Therefore, proper drainage is more important than irrigation. As per need light irrigation during drought is enough.

**Yield**

Harvesting of leaves starts after 7-8 months of planting. Sharp knife is used for harvesting. Care has to be taken to reduce the loss of juice from the cut portion. If harvesting is done once in a year, October – November are the best period for harvesting. Second year gives maximum yield and for about 4-5 years good yield could be harvested. After harvesting leaves are dried in shade and then in sun before storages. Flowers are collected in December – January and preserved after proper drying.

**Rauvolfia:**

**Botanical name:** *Rauvolfia serpentina*

**Family:** Apocynaceae

**Origin:** India

 **Plant part:** Roots**.**

**Botany:** The genus *Rauvolfia* was named in honour of a sixteenth century traveler and botanist-Leonard Rauvolfia; serpentine refers to the long tapering snake like roots. *Rauvolfia serpentina* plant is an erect, small, perennial shrub, seldom attaining a height of 1 m when cultivated. Tap root is tuberous, soft, and sometimes irregularly nodular; bark pale brown corky with irregular longitudinal fissures. The plant is characterized by long elliptic, lanceolate or obovate leaves occurring in whorls of three to five at the nodes. Flowers appear in corymbose cymes, flowers are white or pink. Under cultivation, the plant flowers throughout the year but in nature flowering and fruiting are seen during May and October months only. In North India, plants shed leaves after October and sprout again during March-April. The fruit is a drupe, 0.6 cm in diameter, shining black when fully ripe.

**Climate:** *R. serpentina* grows wild under a wide range of climatic conditions. It flourishes better in hot and humid tropical areas and can be grown in the open or partial shade. A range of temperature from 10-380C appears to be well suited to the plant. The plant grows naturally in areas receiving a rain fall ranging from 250-500 cm per annum. The tropical or sub-tropical zones preferably with South West monsoon rains are considered ideal, the area should be frost free.

**Soil:** It grows on a wide variety of soils. The soils on which it grows wild are acidic in nature having a pH of 4 to 5. The soils should be rich in humus have high water holding capacity but with good drainage. Its commercial cultivation is found in rich soils with 6 .0 to 8.5 pH. Medium to deep well drained fertile soils, clay loam to silt loam soils rich in organic content are suitable for commercial cultivation.

**Propagation:** Rauvolfia can be propagated by **1.** Seeds **2.** Stem cuttings **3.** Root cuttings **4.** Stumps.

**Seed propagation:** Usually propagated by seeds. Only heavy seeds, which sink in water, should be used for sowing. The seeds must be collected from June to October for sowing. Seeds collected during other periods, don‟t germinate satisfactorily. The percentage germination is quite variable (10-50%).Two reasons are said to be responsible for poor germination **1**. Stony endocarp of the seed may be responsible to some extent **2.** But in many cases, the absence of embryo in the perfectly normal looking seeds due to either parthenocarpy or defective development of embryo. About *8kg seed* is sufficient to raise 1 ha plantation. Direct sowing of seeds in the main field is not successful and hence seedlings are raised in the nursery and transplanted in the field.

**Raising nursery:** The nursery should be located preferably in partial shade with adequate irrigation facilities. The selected land is cleaned of all weeds and worked to a fine tilth up to a depth of 30 cm. The nursery beds are incorporated with FYM and leaf mould @ 1 kg per square meter. Then the seed beds of convenient size with irrigation channels are laid out. The seeds before sowing are soaked in water over night and treated with thiram @ 3 g per kg seed before sowing. Under North Indian conditions the seeds are sown in April – May, while shallow furrows (10-15 cm apart) 2-3 cm with in the row at a depth of 1.5 – 2.0 cm. After sowing the beds are covered with a mixture of FYM and fine soil. The beds are watered immediately and kept moist, there after by regular watering. In areas of heavy rainfall it is preferable to sow the seeds in raised beds. Germination starts after 15-20 days and continues up to 40-45 days of sowing. Seedlings (40-45 days old) having 4-6 leaves are ready for planting in the main field.

**Vegetative propagation:**

**a. Stem cuttings:** Stem cuttings of 15-22 cm long with three internodes are considered ideal. The cuttings are planted in the nursery in June and kept moist until they sprout. Rooting of cuttings (hard wood cuttings) may be hastened by treating with IAA at 30 ppm for 12 hours. Roots appear with in 15 days. This method gives 40-65% success. **b. Root cuttings:** Root cuttings are taken from tap root as well as secondary roots. Root cuttings of 3-5 cm and 1to 1.25 cm thick are planted horizontally at 5 cm depth during spring and are covered with soil. The beds are kept moist through watering. The cuttings sprout with in 3 weeks and a success of 50-80% has been obtained. About 100 kg of root cuttings are required to plant one ha of land.

**Method:** Seedlings (40-45 days old) of 7-12 cm height having 4-6 leaves are carefully lifted from the seed bed. Avoiding injury to the long delicate roots, they are planted in rows at 60 x 30 cm spacing. A hole without bending the main root and the soil is then gently but firmly pressed. Immediately after planting the field is irrigated.

**Irrigation:** Till the newly planted seedlings establish well, they are frequently irrigated. Although *R. serpentine* can be cultivated under rain fed conditions yields can be increased by irrigation particularly in low to medium rainfall areas. Plants may be irrigated at an interval of 7-15 days during summer and 15-20 days during winter, depending on the soil and climatic conditions.

**Unit III:**

**Plant secondary metabolites of medicinal importance:**

**Alkaloids:**

Alkaloids are a class of naturally occurring organic compounds that mostly contain basic nitrogen atoms. Although this group may also include some related compounds with neutral and even weakly acidic properties but generally an alkaloid contains at least one nitrogen atom in an amine type structure i.e., one derived from ammonia by replacing hydrogen atoms with hydrogen-carbon groups called hydrocarbons. The name alkaloid (*alkali-like) was originally* applied to these substances because like the inorganic alkalis they react with acids to form salts. Alkaloid names generally end in the suffix "ine", a reference to their chemical classification as amines.

**General Properties of Alkaloids**

Most alkaloids contain oxygen in their molecular structure; those compounds are usually colourless crystals at ambient conditions.

Oxygen free alkaloids like nicotine, coniine are typically colorless, volatile and oily. Some alkaloids like berberine (yellow) ate coloured.

Most alkaloids are weak bases.

Many alkaloids dissolve poorly in water but readily in organic solvents.

Alkaloids have generally a bitter taste and many are poisonous when ingested.

**Atropine**

It is a true alkaloid. Chemically it is an enantiomeric mixture of *d-hyoscyamine and l-hyoscyamine.* It is naturally found in many members of Solonaceae family. Most common sources being *Atropa belladona, Datura inoxia, D. stromonium, D. metel* and *Hyocyamus* genra.

The species name of plant *Atropa belladonna* ("belladonna = beautiful woman") comes from the original use of this deadly nightshade to dilate the pupils of eyes for cosmetic effect.

**Isolation of Atropine from Plants**

Various methods are employed for extraction and isolation of Atropine from plants like *A. belladonna, Datura inoxia,* etc. These include liquid membrane technique, solid phase extraction, ultrasound extraction etc. But liquid membrane extraction and isolation is more common.

Some of common medicinal uses of atropine are:

1) Tropical atropine is used as a cycloplegic to temporarily paralyze the accommodation reflex, and as a mydriatic, to dilate the pupils.

2) Atropine eye drops have been shown to be effective in slowing the progression of myopia in children in several studies, but it is not yet available for this use, and side effects would limit its use.

3) Injections of atropine are used in the treatment of bradycardia (a heart ratet < 60 beats per minute).

4) It is also useful in treating secondary heart block mobitz type 1 and also to some extant, three degree heart block.

5) Atropine can inhibit salivary and mucus glands. The drug may also inhibit sweating via the sympathetic nervous system this can be therefore usefull in treating hyperhidrosis.

**Side Effects:** In overdoses atropine is poisonous. Adverse reactions to atropine include ventricular fibrillation, diziness, nausea, blurred vision, photophobia, dry mouth etc.

**Morphine**

It is a benzylisoquinoline alkaloid originally isolated by Friedrich Serturner; the who then named it "morphium" after the Greek god of dreams, Morpheus, as it has a tendency to cause sleep.

Morphine is the most abundant opiate found in opium, the dried latex extracted by shallowly scoring the unripe seed pods of the *Papaver somniferum* poppy*. Mor*phine is generally 8-14% of dry weight of opium, although specifically bred cultivars reach 26% or produce little morphine at all. The later varrieties including the 'Przemko' & 'Norman' cultivars of the opium, are used to produce two other alkaloids, thebaine and oripavine, which are used in the manufacture of oxycodone, etorphine and some other types of drugs.

Uses:

It is primarily used as analgestic and sedative. It is used to treat both acute and chronic severe pain. It is also used for pain due to myocardial infarction and for labor pains.

Morphine is also beneficial in reducing the symptom of shortness of breath due to both cancer and noncancer causes.

Morphine has also traditionally been used in the treatment of acute pulmonary edema. A 2006 review, though, found little evidence to support this practice. A 2016 Cochrane review concluded that morphine is effective in relieving cancer pain. Side effects of nausea and constipation are rarely severe enough to warrant stopping treatment.

**Codeine:** It is an addictive alkaloid narcotic derived from Opium and used as a hypnotic, analgesic and cough suppressant; often mixed with aspirin. It is used as an analgesic and obtained from Papaver somniferum.

**Ephedrine:** It is an alkaloid obtained from Ephedra vulgaris. It is commonly used as an anti-asthmatic drug.

**Reserpine:** It is an alkaloid isolated from Rauwolfia serpentine and used as an anti-psychotic and anti-hypertensive drug.

**Chemical constituents and traditional uses of some common medicinal plants of Kashmir Himalayas:**

**Aconitum heterophyllum**

Extracts from these plants are used in stomach ache and as an aphrodisiac. The roots contain alkaloids and have found use in the treatment of hysteria and throat diseases. They are considered astringent and are prescribed in diarrhoea, vomiting and cough. The root is also considered anti-diabetic and very efficacious for irritability of stomach and in abdominal pains.

Vernacular Names: Sanskrit and Bengali: Ativisha; Hindi: Atish; Tamil: Ativadayam;

English: Indian Atis.

Occurrence and Distribution: :Common in the alpine and sub-alpine belts of the Himalayan northwestern region at altitudes between 1,800 and 4,500 metres.

Botany of Plant: Family Rununculaceae. A perennial, erect, showy herb, stem 30.5-91.4 cm long, simple or branched from base, glabrous and puberulous above, broad, ovate or orbicular or somewhat five-lobed and toothed, upper three bid or entire. Flowers 2.5 cm long, helmet-shaped, bright, blue or greenish-blue with purple veins.

Useful Parts: Underground stem and root.

Medicinal Uses: Powdered root mixed with honey is effective for children suffering from cough, coryza. fever and vomiting. Root is considered to be aphrodisiac, digestive, valuable febrifuge, bitter tonic and useful in throat infections, abdominal pain and gastralagia.

Chemical Constituents: Diterpenoid alkaloid, alisine is the main constituent (0.4 per cent) of the root. Other includes atidine, histisine, helisine, hetidine, helerophyllisine, heterophylline, heterophyllidine, heteratisine, isoatisine, dihydroatisine, hestisinone and benzoyl heteratisine.

***Artemisia annua***

The anti-malarial compound artemisinin was first isolated by Chinese scientists in 1972. Other properties of the plant include anti-periodic, tonic, cardiac stimulant and expectorant. In an attempt to produce artemisin through *in vitro* methods, Fulzele *et al* (1975) established cultures of *Artemisia annua.* Shoot cultures from the bioreactor produced 1.08 mg per cent camphor on fresh weight basis. A protocol for quick regeneration oflarge number of plants was developed. Hairy root cultures have been obtained through genetic transformation by *Agrobacterium rhizogenes.*

For abdominal pain extract of whole plant is taken in small

doses. Extract of whole plant is also used for chronic fever and gout.

***Fritillaria roylei:***

The plant is commonly known as **Pei-mu** (Himalayan fritillary) in English and **Kakoli** in Hindi. *Fritillaria roylei* is among the 36 species of globally significant [**medicinal plant**](http://www.scialert.net/asci/result.php?searchin=Keywords&cat=&ascicat=ALL&Submit=Search&keyword=medicinal+plant)**s** of Western Himalaya.

**Ethnomedicinal uses:** It possesses anti-asthmatic, anti-rheumatic, febrifuge (treatment of fever), haemostatic, ophthalmic, anti-viral, anti-microbial, anti-tumor, anti-ulcer and anti-hypertensive properties. The bulbs of*F. roylei* (usually collected in 3rd year) are used traditionally in the treatment of asthma, bronchitis, burns, stomach troubles and as a stimulant. The roots are used for healing wounds, corms in *Ayurvedic* and *Unani* medicine. In Jammu and Kashmir, *F. roylei* is used traditionally for rheumatism, asthma, tuberculosis and as a tonic. The bulb of the species is boiled with orange peel and given in the treatment of tuberculosis and asthma. In Uttarakhand, the bulb powder is given with milk as tonic for body weakness. It is also believed that *F. roylei* is very strong cough suppressant (Anti-tussive) and source of expectorant drug in traditional Chinese medicine. The bulbs are an important constituent of a Chinese drug, Szechuan-Pei-Mu used as anti-pyretic, expectorant and lactagogue. In Pakistan, the powder of dry bulbs mixed with butter is used to treat [**urinary tract infection**](http://www.scialert.net/asci/result.php?searchin=Keywords&cat=&ascicat=ALL&Submit=Search&keyword=urinary+tract+infection)**s** and to soften and soothe the skin. The bulbs of the herb are important constituents of *Astavarga*, *Chyavanprash*, *Mahatraiphala Ghritham*, *Jeevanthyadi, Ghrutham* etc. (the *Ayurvedic* preparations in Indian system of medicine). The bulbs contain three major alkaloids, peimine, peiminine and peimisine.

**UNIT IV:**

**Conservation:**

Medicinal plants are potential renewable natural resources. Therefore, the conservation and sustainable utilisation of medicinal plants must necessarily involve a long term, integrated and scientifically oriented action programme. This should also involve the pertinent aspects of protection, preservation, maintenance, exploitation, conservation and sustainable utilisation. A holistic system will be a more desirable one. There are two broad lines of biodiversity conservation and development.

***In-Situ* Conservation**

It has been well established that the best and cost-effective way of protecting the existing

biological and genetic diversity is the *'in-situ'* or on the site conservation wherein a wild species or stock of a biological community is protected and preserved in its natural habitat. The prospect of such an 'ecocentric', rather than a species centred approach is that it should prevent species from becoming endangered by human activities and reduce the need for human intervention to prevent premature extinction. The idea of establishing protected area network has taken a central place in all policy decision processes related to biodiversity conservation at the national, international and global levels (Singh *e( aI,* 2003). Important *in-situ* conservation methods are as follows:

**National Parks and gene banks:** Areas of greatest genetic diversity should be demarcated and protected from human interference, so evolutionary potential of the local population of environment would be preserved. It will be preserved so the variability exists and also allow evolution to continue and create new types.

At present there are 87 National Parks and 447 Wild Life Sanctuaries extending over an area of about 1.5 lakh sq km, which is more than 4.5 per cent of the geographical area of the country. *In situ* conservation programme for medicinal plants in the national parks and sanctuaries would be taken up through the Chief Wildlife Wardens. The programme needs to be in consonance with the objectives of the national parks and sanctuaries. However, the details of medicinal plants which have been conserved by this approach are not available (Jakbar *et aI, 2003).*

**Biosphere Reserves**

There are areas of high endemism and biological diversity and possess rich genetic wealth of wild relatives of crop plants. The Department of Environment (Man and Biosphere Programme) has identified 12 biosphere reserves. These are reserves located in the:

(i). Humid tropical regions of Western Ghats.

(ii). The hilly tracts of North-East.

(iii). The temperate Himalayas.

**Sacred Groves**

There is no separate scheme for the conservation or restoration of sacred groves under the National Afforestation and Eco-Development Board (NAEB). Documentation of the sacred groves has been carried out by the regional centres of the NAEB under the scheme to "Support to Regional Centres." There are seven regional centres and their activities include helping the State/UT forest departments and Forest Development Corporation in formulation of projects, conduct study research and educational programmes for the protection, development and improvement of forest area and the degraded forest areas.

*In-situ* conservation of medicinal plants in India can be accomplished through the active support and participation of the people who dweII in or near and around the protected forest areas.

Involving the local mass in alI phases of conservation programmes, such as planning, policy-decision process, implementation, etc. will be a significant component in achieving efficient management and utilisation of medicinal plant resources. To enhance *in situ* conservation of medicinal plants, conservation areas must also be set up for repositories of the genetic material and the areas would be demarcated as "no harvest zones." One of the important features is the threat assessment of the medicinal plant species by conducting "Rapid Threat Assessment" using IUCN methodology. The programme comprises of extensive field visits and preparing herbarium sheets. The community programme envisaged under this project would provide an opportunity for interaction and exchange of views among the different communities. Extensive training programme is also envisaged to train different sections of the community, the forest officers and other field staff (Barthiott and Winiger, 1996).

**EX-SITU CONSERVATION**

Conservation of medicinal plants can be accomplished by the *ex-situ,* that is, outside natural habitat by cultivation and maintaining plants in botanical gardens/parks, other suitable sites and though long-term preservation of plant propagules in gene banks (seed bank. pollen bank, DNA libraries, etc.) and in plant tissue culture repositories and by cryopreservation.

**Botanical Gardens**

The importance of these establishments was realised in 1759 when the Royal Botanical Garden, Kew (London) was established. This garden is playing a key role in plant exploration, introduction and phytobiodiversity conservation. At present it has an areas of 225 acres with wellequipped laboratories of all the disciplines of plant sciences. More than 30 such botanical gardens have gained international reputation. India has a network of 140 botanical gardens which include 33 botanical gardens attached to 33 universities and their Botany departments. But hardly 30 botanical gardens have any active programme on conservation. Botanical gardens can playa key role in *ex-situ* conservation of plants, especially those facing imminent threat of extinction.

Several gardens in the world are specialised in cultivation and study of medicinal plants, while some contain a special medicinal plant garden or harbour special collection of medicinal plants (Singh,2002).

**Field Gene Bank of Medicinal Plants**

The concept of establishing field gene banks of plants provide ample options for long term preservation of the genetic variability (inter-specific) or species. Field gene banks are better established in degraded forests where efforts are made to reforest/restock the missing species complexes, trees, shrubs, herbs, climbers, etc. The field gene bank of the Tropical Botanical Garden and Research Institute (TGBRI), Thiruvananthapuram, has covered 30,000 accessions of 250 medicinal and aromatic plant species which include 100 endemic, rare and endangered medicinal and aromatic plants of the tropical regions ofindia. A broad spectrum ofthe genetic diversity of these species was captured and introduced in this gene bank which covered morphotypes, cytotypes and chemotypes and the number of samples from each species varied from 50-100 plants.

**Role of Seed-Propagule Banking System in Biodiversity Conservation and Development in Medicinal Plants**

Seeds and propagules are the basic requirement for plant propagation, production and also for biodiversity conservation and development. It is true for natural (forests, aquatics, ponds, lakes, deserts, etc.) as well as for man-made ecosystems (agro-ecosystem) and all other efforts revolve around this nuclear (central) input (Singh *et ai,* 1995; Mc Donald and Copeland, 1997). Seed is basically a mature ovule having potential of giving rise to a normal and healthy seedling. It develops after double fertilisation. However, there are deviations from this conventional definition and several other forms of planting material are grouped as seeds or propagules including corms, bulbs, rhizomes, tubers, cuttings, grafts, buds, layers, synthetic seeds (cultures, excised embryo with calcium alginate layer as protective covering). Modem plant biotechnology also includes some tissue culture regenerate plant segment, embryos, calli, anthers, ovules, cells, protoplast, shoot/root-like pollens, etc. (Kumar and Sharma, 2001).

**Botanical Gardens for the *ex situ* Conservation of Plant Biodiversity**

Botanical Gardens of the World

I. Padua, Italy

2 Pisa, Italy

3. Palenno, Italy

4. Vidlla Taranto, Italy

5. Leyden, The Netherlands

6. Royal Botanical Garden, Edinburgh, Scotland

7. Glasnevin, Ireland

S. Meise, Belgium

9. Munich, Gennany

10. Berlin-Dahlem, Gennany

II. J. D. Plantes, France

12. Les Cedres, France

13. Oxford Botanical Garden, England

14. Kew Botanical Garden-Royal Botigarden, England

15. Amoldarboretum, U. S. A.

16. Uppsalla, Scandinavia

17. New York Botanical Garden, U. S. A.

IS. Brooklyn Botanical Garden, U. S. A.

19. Long Wood Garden, U. S. A.

20. Missourie Botanical, U. S. A.

21. Huntington, U. S. A.

22. Fairchild, U. S. A.

23. Montreal, Canada

24. Moscow, Russia

25. Yalta, Russia

26. Bogor, Java

27. Peradeniya, Sri Lanka

28. Singapore Botanical Garden, Singapore

29. Melbourne Botanical Garden, Australia

30. Sydney Botanical Garden, Australia

31. Japan Botanical Garden, Tokyo

Important Botanical Gardens in India

I. Indian Botanical Garden, Kolkata

2. National Botanical Garden (N. B. R.I.), Lucknow

3. Lloyd Botanical Garden, Darjeeling

4. Botanical Garden FRI, Dehradun

5. Tropical Botanical Garden, Mysore

**Cryopreservation and tissue culture biotechnology to conserve medicinal plants**

Cryopreservation of seeds and propagules is the storage at ultra low temperature in cryogenic medium such as liquid nitrogen. This technique has been developed as modification of classic procedures such as chemical cryoprotection, slow dehydration, cooling, storage in liquid nitrogen, rapid thawing, washing and recovery (Kumar and Shanna, 2001). Cryostorage or long-tenn storage at -196°C in liquid nitrogen is potent in reducing the metabolism of seeds, propagules, tissues, cells and even protoplasts. Chin (1993) reviewed the literature and compared the relative merits and demerits and limitations of conventional propagule storage practice and modem techniques (cryopreservation). These techniques are integral parts of seed propagule banking system for biodiversity conservation purpose. Vitrification is a new addition to the technology of cryopresentation. Vitrification is the process of transition of water directly from liquid phase into an amorphous phase or glass, thus avoiding the formation of ice crystals in cells of seeds-propagules and tissue culture regenerates. This technique has been found still more successful in the cryopreservation of somatic embryos and synthetic seeds.

Ways to conserve plant biodiversity through tissue biotechnology have been comprehensively reviewed by Kumar and Sharma (2001) taking the example of several rare and threatened plant species.

**Medicinal Plant Biodiversity Conservation Through Tissue Culture Biotechnology**

No. Plant Explant Used Medium Mode of Regeneration

1. *Caralluma edulis* Shoot segments MS Clonal multiplication

2. *Commiphora wightii* Shoot segments MS Axillary shoot

3. *Coptis teeta* Hypocotyl segment MS Callus culture

4. *Gerbera qurantiaca* Axillary bud MS Axillary shoot proliferation

5. *Nepenthes khasiana* Mature nodal MSorWood Axillary bud

6. *Ocolea cathannensis* Zygotic MS Somatic embryogenesis

7. *Opcidium varicosum* Seeding Knudson Root tip culture

8. *Prorhiza kumba* Axillary bud MS Axillary shoot

9. *Podophyllum haxandrum* Zygotic embryo MS Somatic embryogenesis

10. *Rauwolfia serpentina*  MS

**Wildlife Protection Act, 1972:**

Prior to Wildlife Protection Act of 1972, India only had five designated national parks. This was the first umbrella act which established schedules of protected plant and animal species. By this act, hunting or harvesting these species was largely outlawed.

 Extends to the whole of India, except the State of Jammu and Kashmir which has its own wildlife act.

 There are **six schedules which** give varying degrees of protection.

 Out of the six schedules , Schedule I and part II of Schedule II provide absolute protection and offences under these are prescribed the highest penalties.

 The penalties for Schedule III and Schedule IV are less and these animals are protected.

 Schedule V includes the **animals which may be hunted**. These are **Common crow , Fruit bats, Mice & Rats only.**

 Schedule **VI contains the plants**, which are prohibited from cultivation and planting. These plants are as follows:

• Beddomes' cycad (Cycas beddomei)

• Blue Vanda (Vanda soerulec)

• Kuth (Saussurea lappa)

• Ladies slipper orchids (Paphiopedilum spp.)

• Pitcher plant (Nepenthes khasiana)

• Red Vanda (Rananthera inschootiana)]

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