

Unit-4

Pharmacognosy-I

B.Pharma 4 Semester Notes

UNIT-IV

Pharmacognosy in various systems of medicine:

- Role of Pharmacognosy in allopathy and traditional systems of medicine namely, Ayurveda, Unani, Siddha, Homeopathy and Chinese systems of medicine.

Introduction to secondary metabolites:

- Definition, classification, properties and test for identification of Alkaloids, Glycosides, Flavonoids, Tannins, Volatile oil and Resins

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Pharmacognosy in various systems of medicine:

Role of Pharmacognosy in Allopathy:

- Pharmacognosy, the study of natural products from plants, animals, and other organisms, plays a important role in the development and advancement of allopathic medicine.
- Allopathy, also known as conventional or Western medicine, relies heavily on evidence-based practices and pharmaceuticals.
- The Word “Allos means = Opposite” and “Pathos means= Suffering”
- In this system the drugs/medicine (tablets, Capsules, Injections, Tonics, etc.) are manufactured using synthetic chemicals or chemical derived from natural products like plants, animals, minerals, etc.
- Role of Pharmacognosy in Allopathy is that Natural products isolated from plants, Animals, marine, mineral acts as the major source for modern medicine. Ex: Taxol from taxus, Digoxin from digitalis, etc.

Advantage of Allopathy

- Modern Technology
- Immediate Response
- Various kinds of dosage forms are available
- Efficient management in emergency conditions.

Disadvantage of allopathy:

- High Cost
- Drug-Drug Interaction
- Long term medicine treatment cause side effect

Traditional systems of medicine namely:

- India is known for its traditional medicinal systems—Ayurveda, Siddha, and Unani. Medical systems are found mentioned even in the ancient Vedas and other scriptures. The Ayurvedic concept appeared and developed between 2500 and 500 BC in India.

Types:

- Ayurveda
- Unani
- Siddha
- Homeopathy
- Chinese systems of medicine

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Ayurveda System:

- Ayurveda, derived from the Sanskrit words "Ayur" (life) and "Veda" (science or knowledge), translates to "the science of life." It is one of the world's oldest holistic healing systems, developed more than 3,000 years ago in India.
- Ayurveda is a way of life that prioritizes harmony and balance in the body, mind, and spirit in addition to being a medical system.
- The ancient Indian writings known as the Vedas, especially the Atharva Veda, are the source of Ayurveda.
- The Charaka Samhita, Sushruta Samhita, and Ashtanga Hridaya are the three main canonical books of Ayurveda.
- These books provide a thorough foundation for comprehending the human body and psyche by outlining several facets of health, illness, and treatment options.

Fundamental Principles:

The Five Elements (Panchamahabhuta)

According to Ayurveda, the universe and everything in it, including the human body, are composed of five elements:

1. **Prithvi (Earth)**
2. **Jala (Water)**
3. **Teja (Fire)**
4. **Vayu (Air)**
5. **Akasha (Ether)**

These elements combine in various ways to form the three doshas (biological energies) that govern human physiology.

The Three Doshas

The doshas are fundamental principles that determine the physical and mental characteristics of an individual, as well as their predisposition to certain health conditions. The three doshas are:

1. **Vata (Air and Ether):** Governs movement, including the movement of nerve impulses, blood flow, and elimination. It is associated with qualities such as dryness, lightness, coldness, and mobility.
2. **Pitta (Fire and Water):** Responsible for transformation, including digestion, metabolism, and body temperature regulation. It is characterized by heat, sharpness, and intensity.
3. **Kapha (Earth and Water):** Controls structure and lubrication, providing stability, strength, and immunity. It is associated with heaviness, steadiness, and coolness.

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Health and Disease

In Ayurveda, health is defined as the balance of the three doshas, the seven tissues (dhatus), the digestive fire (agni), and the proper elimination of wastes (malas). Disease is seen as a result of imbalances in these elements, often caused by poor diet, improper lifestyle, environmental factors, and emotional disturbances.

Methods of Treatment

Nutrition and Diet (Ahara)

In Ayurveda, eating is considered the most important factor in preserving health and warding off illness. Nutritional advice is tailored according to the dosha of the individual, the season, and their particular health issue. Foods are classified based on their influence on the doshas, taste (rasa), potency (virya), and post-digestive effect (vipaka).

Medical Herbal (Dravya Guna)

Herbal remedies created from organic materials such as plants, minerals, and animal products are frequently used in Ayurvedic treatments. Herbs including ashwagandha, turmeric, tulsi (holy basil), triphala, and neem are frequently utilized. Certain qualities of these plants are said to balance the doshas and improve health.

Panchakarma

Panchakarma is a detoxification and rejuvenation therapy involving five primary procedures:

1. **Vamana (Emesis Therapy)**
2. **Virechana (Purgation Therapy)**
3. **Basti (Enema Therapy)**
4. **Nasya (Nasal Administration)**
5. **Raktamokshana (Bloodletting Therapy)**

These procedures are designed to eliminate toxins from the body and restore dosha balance.

Seasonal Regimens (Ritucharya)

- Seasonal changes can affect dosha balance, and Ayurveda prescribes specific regimens for different seasons to maintain health and prevent disease.
- This includes dietary adjustments, lifestyle modifications, and herbal supplements appropriate for each season.

Yoga and Meditation

- Yoga and meditation are integral parts of Ayurveda. They help in maintaining physical health, mental clarity, and emotional stability.

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- Yoga postures (asanas) promote flexibility, strength, and balance, while meditation practices (dhyana) enhance mental peace and self-awareness.

Diagnostic Methods

Ayurvedic diagnosis involves a holistic assessment of the patient, including:

1. **Nadi Pariksha (Pulse Diagnosis):** Evaluating the pulse to understand the balance of doshas.
2. **Jihva Pariksha (Tongue Examination):** Assessing the tongue for signs of imbalance.
3. **Drik Pariksha (Eye Examination):** Observing the eyes for clues about internal health.
4. **Sparsha Pariksha (Touch Examination):** Examining the skin, temperature, and texture.
5. **Shabda Pariksha (Sound Examination):** Listening to the voice and breathing patterns.
6. **Akruti Pariksha (General Appearance):** Observing the body's shape and overall appearance.

Unani System:

- The Unani medical system is one of the oldest and is based on the teachings of Hippocrates, the Father of Medicine, who, in 460 BC, freed medicine from the purview of superstition and magic to become a recognized science.
- It is a holistic approach to medicine that takes care of the body at every stage (well and ill).
- The system provides integrated healthcare with a focus on preventive, promotive, curative, and rehabilitative treatment. While UNANI comes from the term IONIAN, which indicates that it originated in modern-day Greece, TIBB is a name that suggests medicine (Unan).
- The Unani system originated in Persian and Arab regions. About a millennium ago, Arabs brought it to the Indian subcontinent.
- This became its permanent home and the pinnacle of its scientific advancement. This method has been so successfully assimilated into Indian culture over the ages that the Indian government now recognizes it as one of the Indian medical systems and includes it as a fundamental component of our country's healthcare delivery system.

Fundamentals of Unani System of Medicine:

In Unani system of medicine, human body is based on seven natural principles, known as "*Umure Tabiya*". These are the very factors responsible for the existence of the human body and are considered responsible for the maintenance of health.

The loss of any one of these components could lead even to death of the individual.

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These are as follows:

1. ELEMENTS (*Arkan Or Anasir*)
2. TEMPRAMENT (*Mizaj*)
3. HUMOURS (*Akhlat*)
4. ORGANS (*Aza*)
5. PNEUMA OR VITAL SPIRIT (*Arwah*)
6. FACULTIES OF POWER (*Quwa*)
7. FUNCTION (*Al-Af'al*)

Unani system is based on the Hippocratic theory which postulates that a perfect balance of "*Arkan*" (elements), "*Akhlat*" (humors) and "*Mizaj*" (temperament) keeps the body and mind healthy.

The theory presupposes the presence of four humours in human body- "*Dam*" (blood) "*Balgham*" (phlegm), "*Safra*" (Yellow bile) and *Sauda* (black bile). Every individual has an inherent power of self-preservation called the "*Quwwat-e-Modabbira*".

Unani system of medicine aims at restoring the equilibrium of various elements and faculties of the human body.

Prevention of Diseases & Promotion of Health:

- In Unani medicine much emphasis is on the prevention of the disease and promotion of health than to cure.
- It also recognizes the influence of surrounding and ecological conditions on the state of health of human beings. *Baqa-e-sehath* (preservation of health) has been defined under *Asbabe-Sittah Zaruriyah*. *Asbabe-Sittah Zaruriyah* (six essential factors of health) influence each and every individual and all mental and physical diseases are due to their imbalance.
- For the maintenance of good health these essential factors should be balanced in terms of quality, quantity and sequence in order to sustain good health.
- Balanced relationship between these factors keeps the humours and temperament on the right track. The best possible way of health promotion in this holistic system of medicine is improvement of *Tabiyat* (Medicatrix nature or immunity).

Asbab-e-sittah zaruriyah:

Asbab-e-sittah zaruriyah are six essential factors necessary for healthy life described by ancient Unani physicians.

Allama Nafees defined the *Asba-e-sittah zaruriyah* "these are the factors which accompany a person for whole life".

Unani scholars classified these factors into six therefore these are called *Asbab-e-sittah zaruriyah* (six essential factors for healthy life). It includes the following six factors.

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1. HAWA(Environmental Air)
2. MAKOOOL WA MASHROOB(Food and Drinks)
3. HARKAT WA SUKOOON BADNI(Physical Movement and Repose)
4. HARKAT WA SUKOOON NAFSANI (Psychic Movement and Repose)
5. NAUM WA YAQZA(Sleep and Wakefulness)

EHTABAAS WA ISTAFRAAGH (Retention of Nutritive material and Regular Excretion of waste material)

- **Diagnosis In Unani**

In unani system of medicine the most important aspect for the diagnosis of diseases are three in number, and they are *Nabz* (pulse), examination of *baul* (urine) and *Baraz* (stool).

- The surroundings and the ecological conditions are very much responsible for the state of health of a person. Much emphasis is laid on the causes for the prevention of health as (*asbab sittah zaruriyah*) are taken into consideration as well as on the *Mizaj* (temperament) of the diseased.

Siddha System:

- Siddha medicine is one of the most ancient medical systems of India. Siddha is the mother medicine of ancient Tamils/Draavidians of peninsular South India.
- The word Siddha means established truth. The persons who were associated with establishing such a Siddha school of thought were known as Siddhars.
- They recorded their mystic findings in medicine, yoga, and astrology in Tamil.
- According to the Siddha system, there are five elements that exist in nature: earth, water, fire, air, and ether, all of which form the original basis of all corporeal things.
- It is believed that there is an intimate connection between the macrocosm of the external world and the microcosm of the corporeal being.
- The Eight Methods of Examination (Envakai Thervukal) is used to determine diagnosis, etiology, treatment and prognosis.
- Siddha has safe herbal and herbo mineral treatment for psoriasis, eczema, alopecia, diabetic ulcer, warts, vitiligo, pemphigus, pompholyx, leprosy, and many more very common and rare diseases. Lifestyle modifications including diet are important.

Homeopathy System of Medicine:

- The Homeopathy word “Homois means like (similar)” and “Pathos means treatment”
- Homeopathy is an alternative medicine based on the theory of treating 'like with like'.
- The substance capable of causing disorder in health subjects are used as medicines in diluted form to treat similar pattern of disorder.

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- This system of medicine was introduced by Dr. Samuel Hahnemann in 1755 – 1843. He was a German physician, chemist and a pharmacist based on the natural law of healing. i.e like with like.

Principle of Homeopathy:

1. Law of Minimum: The dose needs to be as low as possible in order to excite the human body and cause noticeable change, which varies from person to person. The "Arndt-Schulz rule," which states that mild stimuli accelerate vital processes, moderate stimuli enhance them, and strong stimuli repress them, has long been recognized in the field of pharmacology.
2. The phenomenon known as "Hormesis" has recently attracted attention and, at the same time, provided homoeopathic microdosages with legitimacy by demonstrating that the effects of small doses are opposite those of big ones.
3. Law of Simplex: Simple and single drugs should be prescribed at a time.
4. Law of proving: Drugs are administered in minimum quantity to prevent unwanted side effects.
5. Drug proving: To apply drugs for therapeutic purpose their curative power should be known.
6. Individualization: Medicines can never be prescribed on the basis of name of disease without individualizing each case of disease.

Treatment:

- Patients will be asked about their medical history, diet, lifestyle, physical and emotional state.
- Suitable remedy will be prescribed on the basis of patient's individual symptoms.

Chinese systems of medicine:

- It is also ancient dated back to yellow Emperor's classic of Internal medicine (Huang Di Nei Jing)-200 BC and 100 AD.
- Based on the idea "all life is subject to natural laws"
- The hypothesis includes two two "yin and yang" theory
- Says that everything in the universe consists of a dark (yin) and light side (yang).
- The five elements (water, metal, earth, fire and wood).
- They differ in diagnosis and treatment

Traditional Chinese medicine system consists of 3 parts.

1. Theory:
 - a. Yin and Yang Theory

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b. Five elements Theory

2. Treatment:

- a. Herbalism
- b. Acupuncture
- c. Moxibustion
- d. Cupping
- e. Massage Therapy

3. Prevention:

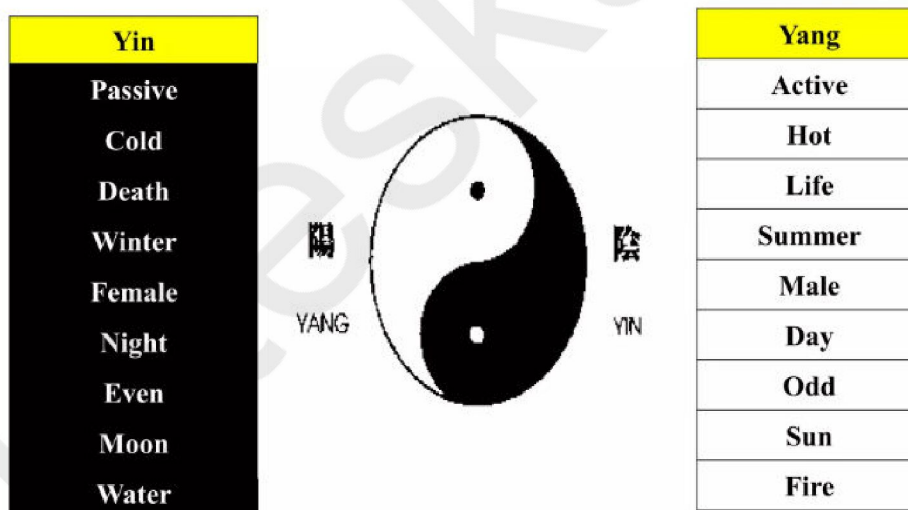
- a. Qi gong
- b. Tia-ji
- c. Meditation

1. Theory:

a. Yin and Yang Theory:

It is a concept of dualism. Yang predominates during the day and turns into yin after dark.

In human body when the Yin and Yang elements are well balanced the person is in good health. A person falls sick when the balance is disturbed.



Yin and Yang in Body:

| Yin | Yang |
|-------------------|--------------------|
| Lower Body | Upper Body |
| Chest and Abdomen | Shoulders and Back |
| Fluid | Gas |
| Interior | Exterior |
| Internal organs | Bowels |
| Nourish | Cleanse |

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b. Five elements Theory :

The five vital organs (the heart, liver, spleen, lungs, and kidneys) are each seen as corresponding to one of the five elements of earth, wood, metal, fire and water.

It is believed a pathological change in any of the vital organs will affect the health of the other organs.

2. Treatment:

- a. Herbalism: The practice of using plants for medicinal purposes. It involves using various parts of plants, like leaves, roots, flowers, and fruits, to create remedies for a wide range of health conditions. Herbalism has a long history across many cultures, and it's still practiced today, often alongside conventional medicine.
- b. Acupuncture: A traditional Chinese medicine (TCM) technique that involves inserting thin needles at specific points on the body. The goal is to stimulate the flow of qi (vital energy) and restore balance in the body. Acupuncture is often used for pain relief, but it may also be used for other conditions like nausea, anxiety, and allergies.
- c. Moxibustion: Another TCM technique that uses the burning of the herb mugwort near specific acupuncture points on the body. The heat is believed to stimulate the flow of qi and promote healing. Moxibustion is often used in conjunction with acupuncture for pain relief and other conditions.
- d. Cupping: A traditional therapy that involves placing suction cups on the skin. The suction can help draw blood to the surface, which is thought to promote healing, reduce pain, and improve circulation. Cupping therapy is sometimes used for muscle tension, pain, and respiratory problems.
- e. Massage Therapy: The practice of manipulating the soft tissues of the body (muscles, connective tissues, skin) to improve health and well-being. Massage therapy can help relieve pain, improve circulation, reduce stress, and promote relaxation. There are many different types of massage therapy, each with its own techniques and benefits.

3. Prevention:

- a. Qi Gong:
It is the Chinese form of exercise. It regulates the mind and breathing to promote the flow of energy.
- b. Tia chi:
It involves gentle dance like- body movements with mental focus, breathing and relaxation.

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Introduction to secondary metabolites:

- Definition, classification, properties and test for identification of Alkaloids, Glycosides, Flavonoids, Tannins, Volatile oil and Resins

Introduction to secondary metabolites:

Primary metabolites:

- Primary metabolites are compounds that are commonly produced by all plants and that are directly used in plant growth and development.
- They do not possess biological or therapeutic activity.
- They are widely distributed in plants in large quantities.
- These are directly involved in growth and development of plant. Non expensive to isolate from plant.

Eg: Carbohydrates, Proteins, Lipids

Secondary metabolites:

- These are biosynthesized from the primary metabolites and alkaloids, glycoside, tannins, flavonoids, volatile oils and resin.
- They are limited in distribution. Restricted to taxonomic group. Not directly involved in the growth and development.
- They are not present in all plants but are present in specific part of plant and family.

Eg:

- Alkaloids : Tannins
- Volatile Oils : Resins
- Glycosides : Flavonoids

Alkaloids:

- Alkaloids Alkaloids are a class of naturally occurring organic nitrogen-containing bases.
- They are found primarily in plants and are especially common in certain families of flowering plants.
- In fact, as many as one-quarter of higher plants are estimated to contain alkaloids, of which several thousand different types have been identified.
- Well-known alkaloids include morphine, strychnine, quinine, ephedrine, and nicotine.

Properties of Alkaloids

- Alkaloids are basic nitrogenous organic compounds found in plants.
- They are usually secondary metabolites, produced as a defense against herbivores.

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- Alkaloids are usually water soluble and basic ($\text{pH} > 7$), which makes them relatively polar.
- The basic structure of an alkaloid is a nitrogen-containing cyclic system with one or more rings.
- They almost uniformly evoke a bitter taste.

Identification Tests for Alkaloids:

There are several chemical tests for the identification of alkaloids.

1. Dragendorff's Test:

- **Reagent:** Dragendorff's reagent (potassium bismuth iodide solution).
- **Positive Result:** Orange or red precipitate.

2. Mayer's Test:

- **Reagent:** Mayer's reagent (potassium mercuric iodide solution).
- **Positive Result:** Cream or white precipitate.

3. Hager's Test:

- **Reagent:** Hager's reagent (saturated solution of picric acid).
- **Positive Result:** Yellow precipitate.

4. Wagner's Test:

- **Reagent:** Wagner's reagent (iodine in potassium iodide).
- **Positive Result:** Reddish-brown precipitate.

Classification of Alkaloids:

They are classified into 3 main classes:

1. **True Alkaloids**
2. **Protoalkaloids**
3. **Pseudoalkaloids**

True alkaloids:

- They derived from amino acids.
- They having nitrogen in heterocyclic ring.
- These alkaloids are highly reactive substances with biological activity even in low doses.
- True alkaloids may occur in plants

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- a) in the free state
 - b) as salts
 - c) as N-oxides.
- The primary precursors of true alkaloids are such amino acids as L- ornithine, L- lysine, L-phenylalanine/L-tyrosine, L-tryptophan and L- histidine.
 - Examples of true alkaloids include such biologically active alkaloids as cocaine, quinine, dopamine and morphine, nicotine, atropine, tubocurarine, strychnine.

Proto alkaloids :

- They derived from amino acids. But they do not have nitrogen in heterocyclic ring.
- Such kinds of alkaloid include compounds derived from L-tyrosine and L-tryptophan.
- Protoalkaloids are those with a closed ring, being perfect but structurally simple alkaloids.
- They form a minority of all alkaloids.
- Eg: tyramine, histamine, ephedrine, yohimbine ,mescaline, choline.

Pseudo alkaloids :

- Not derived from amino acids.
- They have nitrogen in heterocyclic ring.
- Pseudoalkaloids are compounds, the basic carbon skeletons of which are not derived from amino acids.
- In reality, pseudoalkaloids are connected with amino acid pathways. They are derived from the precursors of amino acids.
- They can also result from the amination and trans-amination reactions of the different pathways connected with precursors of amino acids.
- These alkaloids can also be derived from non-amino acid precursors.
- Eg: coniine, capsaicin, ephedrine, solanidine, caffeine and theobromine.

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Glycosides:

- Glycosides are defined as organic compounds from plants and animal sources, which upon hydrolysis give one or more sugar moieties along with a non-sugar moiety.
- Sugar portion is called glycon
- Non-sugar portion is called aglycon or genin.
- Sugar moiety can be glucose, xylose, galactose, mannose, rhamnose, etc.
- While non-sugar moiety or aglycon moiety can be alcohol, phenol, anthraquinone, sterol, flavanol, etc.
- Linkage between sugar and non-sugar portion is usually called as glycosidic linkage.

Properties of Glycosides

- Glycosides are usually solid and amorphous powder.
- They are mostly water-soluble but insoluble in organic solvents.
- Most glycosides are colorless, but some are colored.
- They are mostly bitter, except for certain types like Glycyrrhizin, Stevioside, Populin.
- They are odourless, except for Saponin glycoside.
- Glycosides are stable under neutral or basic conditions.

Identification Tests for Glycosides

There are several tests that can be used to identify glycosides

1. Legal's Test: This test involves observing the reaction mixture for any color change.
2. Antimony Trichloride Test: This test involves the formation of a pink color upon heating, indicating the presence of steroids and triterpenoids.
3. Tetranitro Methane Test: The formation of a yellow color indicates the presence of sterol and triterpenoid.
4. Libermann Burchard Test: The appearance of a violet ring followed by a blue color indicates the presence of a sterol group in the drug.
5. Salkowski Test: The appearance of a yellow-colored ring that turns red indicates the presence of a sterol group in the drug.

Classification of Glycosides:

- The glycosides can be classified by the glycone, by the type of glycosidal linkage, and by the aglycone.

On the Basis of Glycone

If the glycone group of a glycoside is glucose, then the molecule is a glucoside; if it is fructose, then the molecule is a fructoside; if it is glucuronic acid, then the molecule is a glucuronide, etc.

On the Basis of Glycosidic Linkage

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1. **O-glycosides:** Sugar molecule is combined with phenol or –OH group of aglycon, for example, Amygd-aline, Indesine, Arbutin, Salicin, cardiac glycosides, anthraquinone glycosides like sennosides etc
2. **N-glycosides:** Sugar molecule is combined with N of the –NH (amino group) of aglycon, for example, nucleosides
3. **S-glycosides:** Sugar molecule is combined with the S or SH (thiol group) of aglycon, for example, Sinigrin.
4. **C-glycosides:** Sugar molecule is directly attached with C—atom of aglycon, for example, Anthraquinone glycosides like Aloin, Barbaloin, Cascaroside and Flavan glycosides, etc.

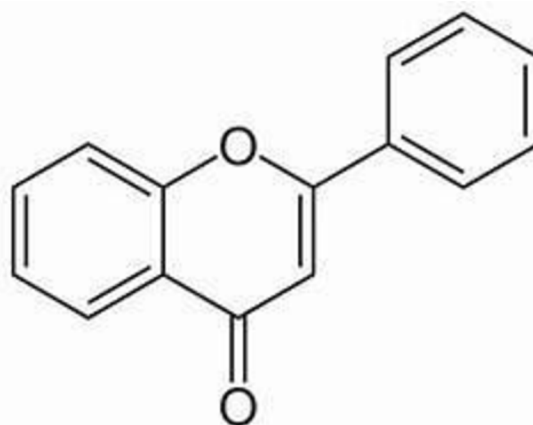
On the Basis of Aglycone

The various classes according to aglycone moiety are given below:

| S.No. | Class | Examples |
|-------|---|---------------------------------------|
| 1. | Anthraquinone glycosides | Senna, Aloe, Rhubarb, etc. |
| 2. | Sterol or Cardiac glycosides | Digitalis, Thevetia, Squill, etc. |
| 3. | Saponin glycosides | Dioscorea, Liquorice, Ginseng, etc. |
| 4. | Cyanogenetic and Cyanophoric glycosides | Bitter almond, Wild cherry bark, etc. |
| 5. | Thiocyanate and Isothiocyanate glycosides | Black mustard |
| 6. | Flavone glycosides | Ginkgo |
| 7. | Aldehyde glycosides | Vanilla |
| 8. | Phenol glycosides | Bearberry |
| 9. | Steroidal glycosides | Solanum |
| 10. | Bitter and Miscellaneous glycosides | Gentian, Piccrohiza, Chirata, etc. |

Flavonoids:

- Flavonoids are a type of phytochemical or plant chemical that are widely distributed in the plant kingdom.
- They create the vibrant colors of many fruits, vegetables, and flowers, and have been found to have a variety of health benefits.



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Properties of Flavonoids:

- Soluble in Water and alcohol.
- Insoluble in organic solvents.
- They are optically active.
- Crystalline solid with sharp melting point.
- They lowers the cholesterol level.

Test for Identification

1. Shinoda test: The extract is treated with magnesium turnings and hydrochloric acid. The development of a pink or red color indicates the presence of flavonoids.

2. Ferric Chloride Test

- **Procedure:**
 1. Add 1-2 mL of the plant extract to a test tube.
 2. Add a few drops of 1% ferric chloride (FeCl_3) solution.
 3. Observe the color change.
- **Positive Result:** Formation of a dark green, black, or blue-green coloration suggests the presence of phenolic hydroxyl groups, characteristic of flavonoids.

3. Lead Acetate Test

- **Procedure:**
 1. Add 1-2 mL of the plant extract to a test tube.
 2. Add a few drops of 10% lead acetate solution.
 3. Observe the formation of a precipitate.
- **Positive Result:** Formation of a yellow precipitate indicates the presence of flavonoids.

4. Alkaline Reagent Test

- **Procedure:**
 1. Add 1-2 mL of the plant extract to a test tube.
 2. Add a few drops of sodium hydroxide (NaOH) solution.
 3. Observe the color change.
 4. Acidify the solution with dilute hydrochloric acid (HCl).
- **Positive Result:** An intense yellow color that fades upon acidification indicates the presence of flavonoids.

5. Zinc Hydrochloride Reduction Test

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- **Procedure:**

1. Add 1-2 mL of the plant extract to a test tube.
2. Add a few pieces of zinc dust.
3. Add 1-2 drops of concentrated hydrochloric acid (HCl).
4. Heat the mixture gently.
5. Observe the color change.

- **Positive Result:** Development of a red color indicates the presence of flavonoids.

6. Sulfuric Acid Test

- **Procedure:**

1. Add 1-2 mL of the plant extract to a test tube.
2. Add a few drops of concentrated sulfuric acid (H₂SO₄).
3. Observe the color change.

- **Positive Result:** Development of a yellow or orange color indicates the presence of flavonoids.

Classification of Flavonoids:

Flavonoids can be classified into several groups based on their chemical structure. Here are the main classes of flavonoids:

1. **Anthocyanidins:** These are pigments found in red/blue fruits and flowers. Examples include cyanidin, delphinidin, and malvidin.
2. **Flavonols:** These are a type of flavonoid usually found in onions, leeks, and broccoli. Examples include quercetin and kaempferol.
3. **Flavanones:** Found mainly in citrus fruits. Examples include hesperidin and naringenin.
4. **Flavan-3-ols:** These are the most common type of flavonoid, including catechins which are found in green tea.
5. **Flavanonols:** A type of flavonoid that includes compounds like taxifolin.
6. **Flavones:** These are found in parsley and celery. Examples include apigenin and luteolin.
7. **Isoflavones:** These are most commonly associated with soy and soy products. Examples include genistein and daidzein.

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Tannins:

- Tannins are a class of astringent, polyphenolic biomolecules that bind to and precipitate proteins and various other organic compounds including amino acids and alkaloids.
- They are widely distributed in many species of plants, where they play a role in protection from predation (acting as pesticides) and might help in regulating plant growth.

Properties of Tannins:

1. Tannins are colloidal solutions with water.
2. Non crystalline substance.
3. Soluble in water (exception of some high molecular weight structures), alcohol, dilute alkali, and glyc-erin.
4. Sparingly soluble in ethyl acetate.
5. Insoluble in organic solvents, except acetone.

Identification test of Tannins:

Several tests can be used to identify the presence of tannins in a sample:

1. Ferric Chloride Test

- **Procedure:**
 1. Add 2-3 mL of the extract to a test tube.
 2. Add a few drops of 1% ferric chloride (FeCl_3) solution.
 3. Observe the color change.
- **Positive Result:** A blue-black, green, or dark blue color indicates the presence of hydrolyzable tannins. A brownish-green or black color indicates the presence of condensed tannins.

2. Gelatin Test

- **Procedure:**
 1. Add 2-3 mL of the extract to a test tube.
 2. Add a few drops of 1% gelatin solution containing 10% sodium chloride (NaCl).
 3. Observe the formation of a precipitate.
- **Positive Result:** The formation of a white or cloudy precipitate indicates the presence of tannins.

3. Lead Acetate Test

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- **Procedure:**
 1. Add 2-3 mL of the extract to a test tube.
 2. Add a few drops of 10% lead acetate solution.
 3. Observe the formation of a precipitate.
- **Positive Result:** The formation of a white or yellowish precipitate indicates the presence of tannins.

4. Bromine Water Test

- **Procedure:**
 1. Add 2-3 mL of the extract to a test tube.
 2. Add a few drops of bromine water.
 3. Observe the color change.
- **Positive Result:** Decolorization or a yellow precipitate indicates the presence of tannins.

5. Goldbeater's Skin Test

- **Procedure:**
 1. Soak a small piece of goldbeater's skin (ox skin) in 2% hydrochloric acid (HCl) for about 5 minutes, then rinse with distilled water.
 2. Soak the treated skin in the plant extract for about 5 minutes.
 3. Wash the skin with distilled water.
 4. Immerse the skin in a 1% ferric chloride solution for 5 minutes.
 5. Observe the color change of the skin.
- **Positive Result:** The skin turning brown or black indicates the presence of tannins.

6. Vanillin-Hydrochloric Acid Test

- **Procedure:**
 1. Add 1 mL of the extract to a test tube.
 2. Add 1 mL of vanillin-hydrochloric acid reagent (prepared by dissolving 1 g of vanillin in 100 mL of 8% HCl in ethanol).
 3. Observe the color change.
- **Positive Result:** The development of a pink or red color indicates the presence of condensed tannins.

7. Stiasny's Test

- **Procedure:**

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1. Add 10 mL of the extract to a test tube.
 2. Add 5 mL of Stiasny's reagent (a mixture of formaldehyde and concentrated HCl).
 3. Heat the mixture in a water bath at 70-80°C for 30 minutes.
 4. Observe the formation of a precipitate.
- **Positive Result:** The formation of a red-brown precipitate indicates the presence of condensed tannins.

Classification of Tannins:

- (i) Hydrolysable tannins
- (ii) Condensed tannins
- (iii) Pseudo tannins.

Hydrolysable tannins:

- These tannins are hydrolyzed by acids, or enzyme and produce gallic acid and ellagic acid. Chemically, these are esters of phenolic acid like gallic acid and ellagic acid.
- The tannins derived from gallic acid are known as gallitannins and from that of ellagic acid are known as gallitannins.
- The gallic acid is found in rhubarb, clove and ellagic acid is found in eucalyptus leave and myrobalans and pomegranate bark. These tannins treated with ferric chloride to produced blue or black colour.

Condensed tannins:

- These tannins are resistant to hydrolysis and they derived from the flavonols, catechins and flavan-3, 4-diols. On treatment with acids or enzymes they are decomposed into phlobaphenes.
- On dry distillation condensed tannin produce catechol.
- These tannins are called as catechol tannins.
- These tannins are found in cinchona bark, male fern, areca seeds, tea leaves and wild cherry bark, bahera fruits, Amla, etc. they produce green colour with ferric chlorides.

Pseudo tannins:

- They are phenolic compounds of lower molecular weight and do not show the goldbeater's test. They are found in catechu and nux-vomica, etc.

Volatile Oil:

- Volatile oils, also known as essential oils, are mixtures of hydrocarbon terpenes, sesquiterpenes, and polyterpenes and their oxygenated derivatives obtained from various parts of plants.
- They are responsible for the essence or odor of the plant. When fresh, volatile oils are colorless liquids, but a few are crystalline or amorphous solids.

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- On long standing, they become darker in color, especially when exposed to air and direct sunlight.

Properties

- Volatility: Volatile oils evaporate on exposure to air at ordinary temperature.
- Solubility: They are slightly soluble in water but are readily soluble in ether, alcohol, and most organic solvents.
- Color: When fresh, volatile oils are colorless liquids. A few are crystalline or amorphous solid.
- Odor: They emit strong, often pleasant odors.

Identification tests for Volatiles Oils:

Natural drugs containing volatile oils can be tested by following chemical tests:

1. Thin section of drug on treatment with alcoholic solution of Sudan III develops red colour in the presence of volatile oils.
2. Thin section of drug is treated with tincture of alkana, which produces red colour that indicates the presence of volatile oils in natural drugs.

Classification of Volatile Oils:

| Groups | Drugs |
|-----------------|---|
| Hydrocarbons | Turpentine oil |
| Alcohols | Peppermint oil, Pudina, Sandalwood oil, etc. |
| Aldehydes | Cymbopogon sp., Lemongrass oil, Cinnamon, Cassia, and Saffron |
| Ketones | Camphor, Caraway and Dill, Jatamansi, Fennel, etc. |
| Phenols | Clove, Ajowan, Tulsi, etc. |
| Phenolic ethers | Nutmeg, Calamus, etc. |
| Oxides | Eucalyptus, Cardamom, and Chenopodium oil |
| Esters | Valerian, Rosemary oil, Garlic, Gaultheria oil, etc. |

Resines:

- Resins are the class of secondary metabolites which are sticky, flammable, organic compounds insoluble in water and are exuded by some plants and trees.
- Plants secrete resins for their protective benefits in response to injury.
- It protects the plants from insects and pathogens.

Properties:

- They are insoluble in water and usually insoluble in petroleum ether.
- Chemically inert compounds known as resenes.

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Classification:

On the basis of occurrence with other secondary metabolites (Resin combination)

- i) **Oleo resin** : Naturally occurring mixture of resin & volatile oil ex: Ginger, capsicum, copaiba
- ii) **Gum Resin**: Resin associated with gum example: colophony, cannabis
- iii) **Oleo Gum Resin**: Mixture of volatile oil, Gum & resin Ex: Guggul, Asafoetida, Myrrh
- iv) **Balsam Resin**: Resinous mixture of benzoic acid/ cinnamic acid or esters of these acids in free or combined form Ex: Benzoin, Tolu balsam, peru balsam
- v) **Glycoresins**: occur in combination with sugar by Glycoside linkage Ex: Jalap, Podophyllum, Ipomoea

Identification Test for Resin:

1. Benzoin: Benzoin + Ether → shake → Extract + H_2SO_4 → sumatra benzoin deep brown color & siam benzoin (deep purple color)
2. Colophony : Drug + acetic anhydride + 1 drop of Conc. H_2SO_4
Purple color that rapidly changes to violet color
3. Myrrh: Triturate with solvent ether → Filter → Evaporate thin film → violet color on contact with Br_2 vapor
Triturate with water → Yellow emulsion
4. Podophyllum: Drug + alcohol → Macerate → Filter → Filtrate + strong copper acetate solution → Brown ppt
5. Tolu balsam: Acidic to litmus
Drug + $FeCl_3$ → Green color (Resinotannol)

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