Chromatography

Chromatography is a technique for separating mixtures into their components in order to analyze, identify, purify, and/or quantify the mixture or components.

Definition of Chromatography

Detailed Definition:

Chromatography is a laboratory technique that separates components within a mixture by using the differential affinities of the components for a mobile medium and for a stationary adsorbing medium through which they pass.

Terminology:

- *Differential* – showing a difference, distinctive
- *Affinity* – natural attraction or force between things
- *Mobile Medium* – gas or liquid that carries the components (mobile phase)
- *Stationary Medium* – the part of the apparatus that does not move with the sample (stationary phase)

Simplified Definition:

Chromatography separates the components of a mixture by their distinctive attraction to the mobile phase and the stationary phase.

Explanation:

- Compound is placed on stationary phase
- Mobile phase passes through the stationary phase
- Mobile phase solubilizes the components
- Mobile phase carries the individual components a certain distance through the stationary phase, depending on their attraction to both of the phases

Types of Chromatography

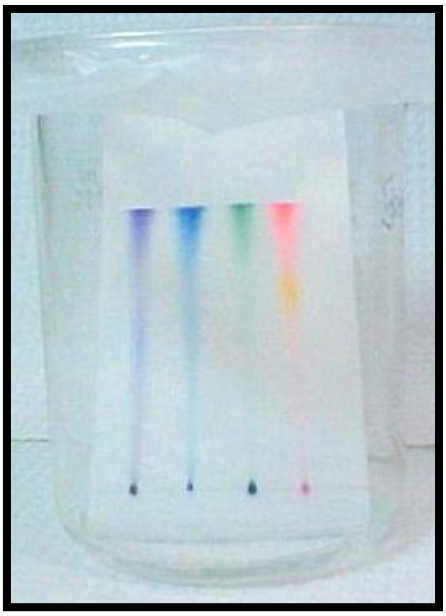
- Liquid Chromatography – separates liquid samples with a liquid solvent (mobile phase) and a column composed of solid beads (stationary phase)
- Gas Chromatography – separates vaporized samples with a carrier gas (mobile phase) and a column composed of a liquid or of solid beads (stationary phase)
- Paper Chromatography – separates dried liquid samples with a liquid solvent (mobile phase) and a paper strip (stationary phase)
- Thin-Layer Chromatography – separates dried liquid samples with a liquid solvent (mobile phase) and a glass plate covered with a thin layer of alumina or silica gel (stationary phase)

Principles of Paper Chromatography

- Capillary Action – the movement of liquid within the spaces of a porous material due to the forces of adhesion, cohesion, and surface tension. The liquid is able to move up the filter paper because its attraction to itself is stronger than the force of gravity.
- Solubility – the degree to which a material (solute) dissolves into a solvent. Solutes dissolve into solvents that have similar properties. (Like dissolves like) This allows different solutes to be separated by different combinations of solvents.

Separation of components depends on both their solubility in the mobile phase and their differential affinity to the mobile phase and the stationary phase.

What Color is that Sharpie



Purpose:

To introduce students to the principles and terminology of chromatography and demonstrate separation of the dyes in Sharpie Pens with paper chromatography.

Time Required:

Prep. time: 10 minutes

Experiment time: 45 minute

HPLC

- HPLC is a form of liquid chromatography used to separate compounds that are dissolved in solution. HPLC instruments consist of a reservoir of mobile phase, a pump, an injector, a separation column, and a detector.
- HPLC is thus basically a highly improved form of column liquid chromatography. Instead of a solvent being allowed to drip through a column under gravity, it is forced through under high pressures of up to 400 atmospheres.

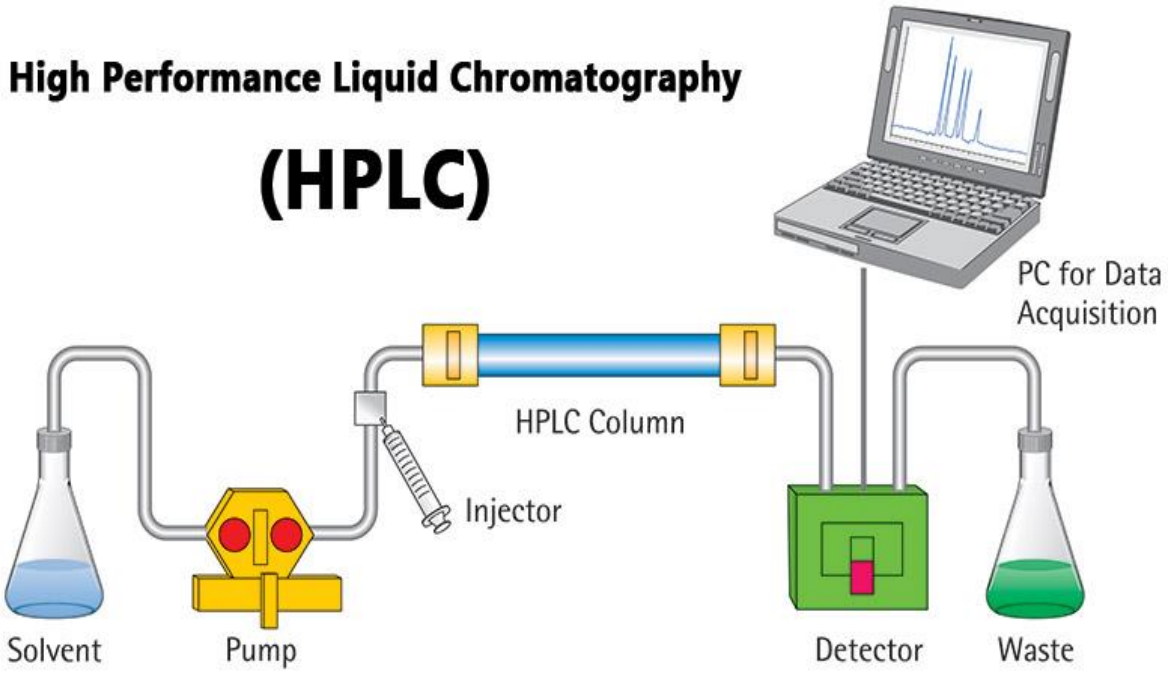
Principle of (HPLC)

- The purification takes place in a separation column between a stationary and a mobile phase.

- The stationary phase is a granular material with very small porous particles in a separation column.
- The mobile phase, on the other hand, is a solvent or solvent mixture which is forced at high pressure through the separation column.
- Via a valve with a connected sample loop, the sample is injected into the mobile phase flow from the pump to the separation column using a syringe.
- Subsequently, the individual components of the sample migrate through the column at different rates because they are retained to a varying degree by interactions with the stationary phase.
- After leaving the column, the individual substances are detected by a suitable detector and passed on as a signal to the HPLC software on the computer.

COMPOSITION OF A LIQUID CHROMATOGRAPH SYSTEM

- Solvent
- Solvent Delivery System (Pump)
- Injector
- Sample
- Column
- Detectors (Diode Array)
- Waste Collector
- Recorder (Data Collection)



HPLC columns

The column is one of the most important components of the HPLC chromatograph because the separation of the sample components is achieved when those components pass through the column. The High performance liquid chromatography apparatus is

made out of stainless steel tubes with a diameter of 3 to 5mm and a length ranging from 10 to 30cm.

Normally, columns are filled with silica gel because its particle shape, surface properties, and pore structure help to get a good separation. Silica is wetted by nearly every potential mobile phase, is inert to most compounds and has a high surface activity which can be modified easily with water and other agents. Silica can be used to separate a wide variety of chemical compounds, and its chromatographic behavior is generally predictable and reproducible.

Several column types

- ***Normal phase***
- ***Reverse phase***
- ***Size exclusion***
- ***Ion exchange***

Normal phase

In this column type, the retention is governed by the interaction of the polar parts of the stationary phase and solute. For retention to occur in normal phase, the packing must be more polar than the mobile phase with respect to the sample.

Reverse phase

In this column the packing material is relatively nonpolar and the solvent is polar with respect to the sample. Retention is the result of the interaction of the nonpolar components of the solutes and the nonpolar stationary phase. Typical stationary phases are nonpolar hydrocarbons, waxy liquids, or bonded hydrocarbons (such as C18, C8, etc.) and the solvents are polar aqueous-organic mixtures such as methanol-water or acetonitrile-water.

Size exclusion

- **In size exclusion the HPLC column is consisted of substances which have controlled pore sizes and is able to be filtered in an ordinarily phase according to its molecular size. Small molecules penetrate into the pores within the packing**

while larger molecules only partially penetrate the pores. The large molecules elute before the smaller molecules.

Ion exchange

- **In this column type the sample components are separated based upon attractive ionic forces between molecules carrying charged groups of opposite charge to those charges on the stationary phase. Separations are made between a polar mobile liquid, usually water containing salts or small amounts of alcohols, and a stationary phase containing either acidic or basic fixed sites.**

Selectivity Factor

- **K' values tell us where bands elute relative to the void volume. These values are unaffected by such variables as flow rate and column dimensions. The value tell us where two peaks elute relative to each other. This is referred to as the selectivity factor or separation factor (now and then as the chemistry factor).**

Applications of (HPLC)

- **Analysis of drugs**
- **Analysis of synthetic polymers**
- **Analysis of pollutants in environmental analytics**
- **Determination of drugs in biological matrices**
- **Isolation of valuable products**
- **Product purity and quality control of industrial products and fine chemicals**
- **Separation and purification of biopolymers such as enzymes or nucleic acids**
- **Water purification**

Column chromatography

In chemistry, Column chromatography is a technique which is used to separate a single chemical compound from a mixture dissolved in a fluid. It separates substances based on differential adsorption of compounds to the adsorbent as the compounds move through the column at different rates which allow them to get separated in fractions. This technique can be used on a small scale as well as large scale to purify materials that can be used in future experiments. This method is a type of adsorption chromatography technique.

Column Chromatography Principle

When the mobile phase along with the mixture that needs to be separated is introduced from the top of the column, the movement of the individual components of the mixture is at different rates. The components with lower adsorption and affinity to stationary phase travel faster when compared to the greater adsorption and affinity with the stationary phase. The components that move fast are removed first whereas the components that move slowly are eluted out last.

The adsorption of solute molecules to the column occurs in a reversible manner. The rate of the movement of the components is expressed as:

R_f = the distance travelled by solute/ the distance travelled by the solvent

R_f is the retardation factor.

Column Chromatography Procedure

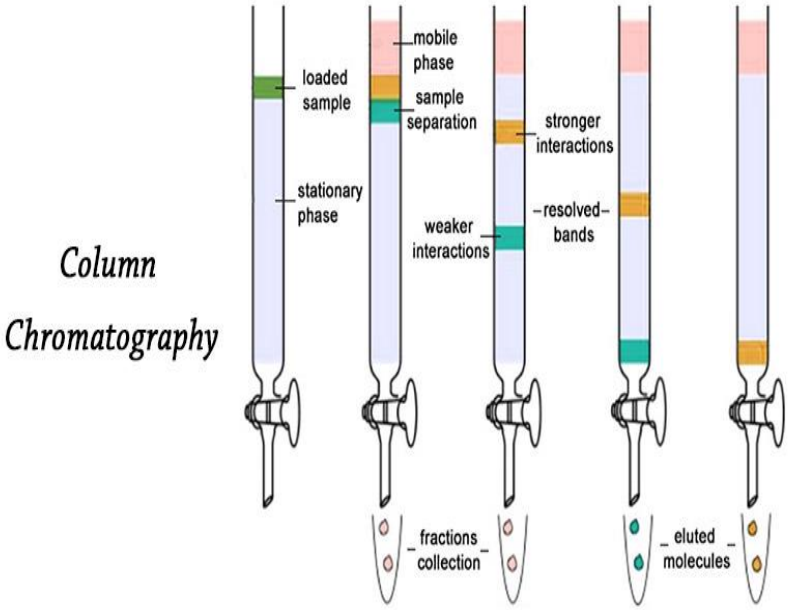
Before starting with the Column Chromatography Experiment let us understand the different phases involved.

Mobile phase – This phase is made up of solvents and it performs the following functions:

1. It acts as a solvent – sample mixture can be introduced in the column.
2. It acts as a developing agent – helps in the separation of components in the sample to form bands.
3. It acts as an eluting agent – the components that are separated during the experiment are removed from the column
4. Some examples of solvents used as mobile phase based on their polarity are – ethanol, acetone, water, acetic acid, pyridine, etc.

Stationary phase – It is a solid material which should have good adsorption property and meet the conditions given below:

1. Shape and size of particle: Particles should have uniform shape and size in the range of 60 – 200μ in diameter.
2. Stability and inertness of particles: high mechanical stability and chemically inert. Also, no reaction with acids or bases or any other solvents used during the experiment.
3. It should be colourless, inexpensive and readily available.
4. Should allow free flow of mobile phase
5. It should be suitable for the separation of mixtures of various compounds



Column Chromatography Applications

- Column Chromatography is used to isolate active ingredients.
- It is very helpful in Separating compound mixtures.
- It is used to determine drug estimation from drug formulations
- It is used to remove impurities.
- Used to isolation metabolites from biological fluids.

Types of Column Chromatography:

1. Adsorption column chromatography – Adsorption chromatography is a technique of separation, in which the components of the mixture are adsorbed on the surface of the adsorbent.

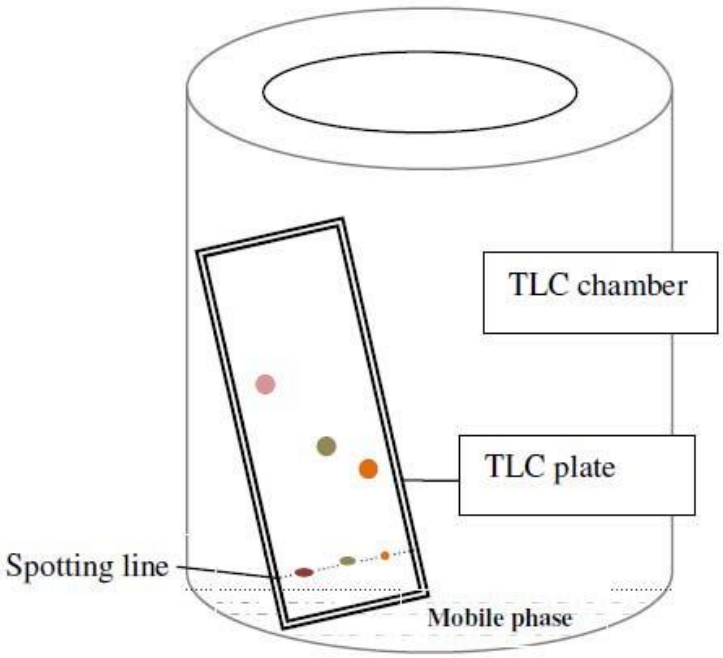
2. Partition column chromatography – The stationary phase, as well as mobile phase, are liquid in partition chromatography.

3. Gel column chromatography – In this method of chromatography, the separation takes place through a column packed with gel. The stationary phase is a solvent held in the gap of a solvent.

4. Ion exchange column chromatography – A chromatography technique in which the stationary phase is always ion exchange resin.

Thin Layer Chromatography

- Chromatography is an important biophysical technique that enables the separation, identification, and purification of the components of a mixture for qualitative and quantitative analysis.
- In this physical method of separation, the components to be separated are distributed between two phases, one of which is stationary (stationary phase) while the other (the mobile phase) moves in a definite direction. Depending upon the stationary phase and mobile phase chosen, they can be of different types.
- Thin Layer Chromatography can be defined as a method of separation or identification of a mixture of components into individual components by using finely divided adsorbent solid / (liquid) spread over a plate and liquid as a mobile phase.



Principle of Thin Layer Chromatography (TLC)

- Thin-layer chromatography is performed on a sheet of glass, plastic, or aluminium foil, which is coated with a thin layer of adsorbent material, usually silica gel, aluminium oxide (alumina), or cellulose. This layer of adsorbent is known as the stationary phase.
- After the sample has been applied on the plate, a solvent or solvent mixture (known as the mobile phase) is drawn up the plate via capillary action. Because different analytes ascend the TLC plate at different rates, separation is achieved.

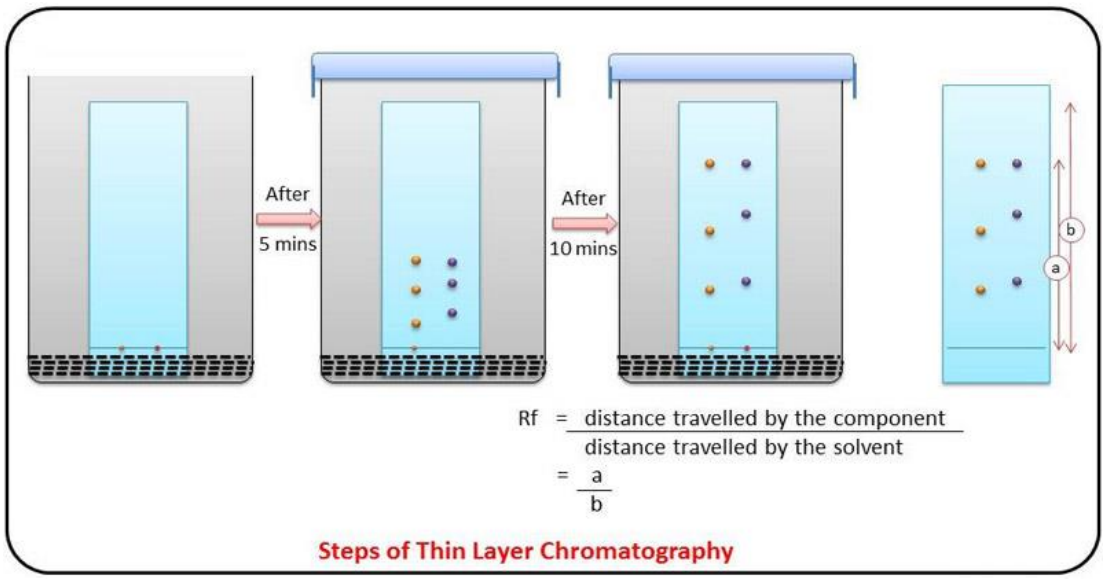
- It is thus based on the principle of adsorption chromatography or partition chromatography or combination of both, depending on adsorbent, its treatment and nature of solvents employed. The components with more affinity towards stationary phase travels slower. Components with less affinity towards stationary phase travels faster.
- Once separation occurs, the individual components are visualized as spots at a respective level of travel on the plate. Their nature or character is identified by means of suitable detection techniques.

Components of Thin Layer Chromatography (TLC)

TLC system components consists of:

1. **TLC plates,** preferably ready made with a stationary phase: These are stable and chemically inert plates, where a thin layer of stationary phase is applied on its whole surface layer. The stationary phase on the plates is of uniform thickness and is in a fine particle size.
2. **TLC chamber-** This is used for the development of TLC plate. The chamber maintains a uniform environment inside for proper development of spots. It also prevents the evaporation of solvents, and keeps the process dust free.
3. **Mobile phase-** This comprises of a solvent or solvent mixture The mobile phase used should be particulate-free and of the highest purity for proper development of TLC spots. The solvents recommended are chemically inert with the sample, a stationary phase.
4. **A filter paper-** This is moistened in the mobile phase, to be placed inside the chamber. This helps develop a uniform rise in a mobile phase over the length of the stationary phase.

Procedure of Thin Layer Chromatography (TLC)



The stationary phase is applied onto the plate uniformly and then allowed to dry and stabilize. These days, however, ready-made plates are more commonly used.

1. With a pencil, a thin mark is made at the bottom of the plate to apply the sample spots.
2. Then, samples solutions are applied on the spots marked on the line in equal distances.
3. The mobile phase is poured into the TLC chamber to a leveled few centimeters above the chamber bottom.
4. A moistened filter paper in mobile phase is placed on the inner wall of the chamber to maintain equal humidity (and also thereby avoids edge effect).
5. Now, the plate prepared with sample spotting is placed in TLC chamber so that the side of the plate with the sample line is facing the mobile phase. Then the chamber is closed with a lid.
6. The plate is then immersed, such that the sample spots are well above the level of mobile phase (but not immersed in the solvent) for development.
7. Sufficient time is given for the development of spots.
8. The plates are then removed and allowed to dry.
9. The sample spots are then seen in a suitable UV light chamber, or any other methods as recommended for the given sample.

Some common techniques for visualizing the results of a TLC plate include

1. UV light
2. Iodine Staining: is very useful in detecting carbohydrates since it turns black on contact with Iodine
3. KMnO4 stain (organic molecules)
4. Ninhydrin Reagent: often used to detect amino acids and proteins

Retention Factor (R_f) Value

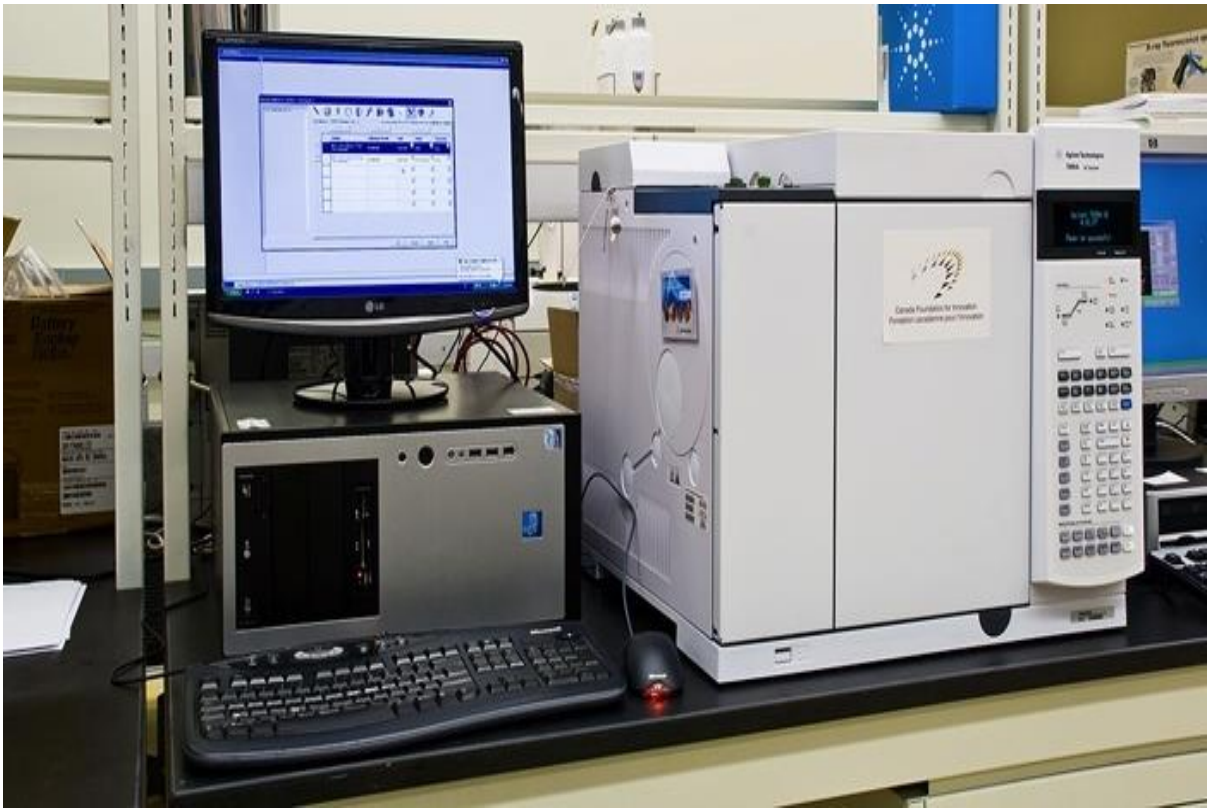
- The behaviour of a compound on a TLC is usually described in terms of its relative mobility or Rf value.
- Rf or Retention factor is a unique value for each compound under the same conditions.
- The Rf for a compound is a constant from one experiment to the next only if the chromatography conditions below are also constant:
- solvent system
- adsorbent
- thickness of the adsorbent
- amount of material spotted
- temperature
- Since these factors are difficult to keep constant from experiment to experiment, relative Rf values are generally considered.
- Relative Rf" means that the values are reported relative to a standard.
- The Rf value is calculated using the following equation:

Applications of Thin Layer Chromatography (TLC)

- It is a simple process with a short development time.
- It helps with the visualization of separated compound spots easily.
- It helps in isolating of most of the compounds.
- The separation process is faster and the selectivity for compounds is higher (even small differences in chemistry is enough for clear separation).
- The purity standards of the given sample can be assessed easily.
- It is a cheaper chromatographic technique.

Gas chromatography

- Gas chromatography differs from other forms of chromatography in that the mobile phase is a gas and the components are separated as vapors.
- It is thus used to separate and detect small molecular weight compounds in the gas phase.
- The sample is either a gas or a liquid that is vaporized in the injection port. The mobile phase for gas chromatography is a carrier gas, typically helium because of its low molecular weight and being chemically inert.
- The pressure is applied and the mobile phase moves the analyte through the column. The separation is accomplished using a column coated with a stationary phase.



Parts of Gas chromatography

Carrier gas in a high-pressure cylinder with attendant pressure regulators and flow meters

- Helium, N_2, H, Argon are used as carrier gases.

- Carrier gas from the tank passes through a toggle valve, a flow meter, (1-1000 ml/min), capillary restrictors, and a pressure gauge (1-4 atm).
- Flow rate is adjusted by means of a needle valve mounted on the base of the flow meter and controlled by capillary restrictors.
- The operating efficiency of the GC is directly dependant on the maintenance of constant gas flow.

Sample injection system

- Liquid samples are injected by a microsyringe with a needle inserted through a self-scaling, silicon-rubber septum into a heated metal block by a resistance heater.
- Gaseous samples are injected by a gas-tight syringe or through a by-pass loop and valves.
- Typical sample volumes range from 0.1 to 0.2 ml.

The separation column

- The heart of the gas chromatography is the column which is made of metals bent in U shape or coiled into an open spiral or a flat pancake shape.
- Copper is useful up to 250^0
- Swege lock fittings make column insertion easy.
- Several sizes of columns are used depending upon the requirements.

Liquid phases

- An infinite variety of liquid phases are available limited only by their volatility, thermal stability and ability to wet the support.
- No single phase will serve for all separation problems at all temperatures.

Detector

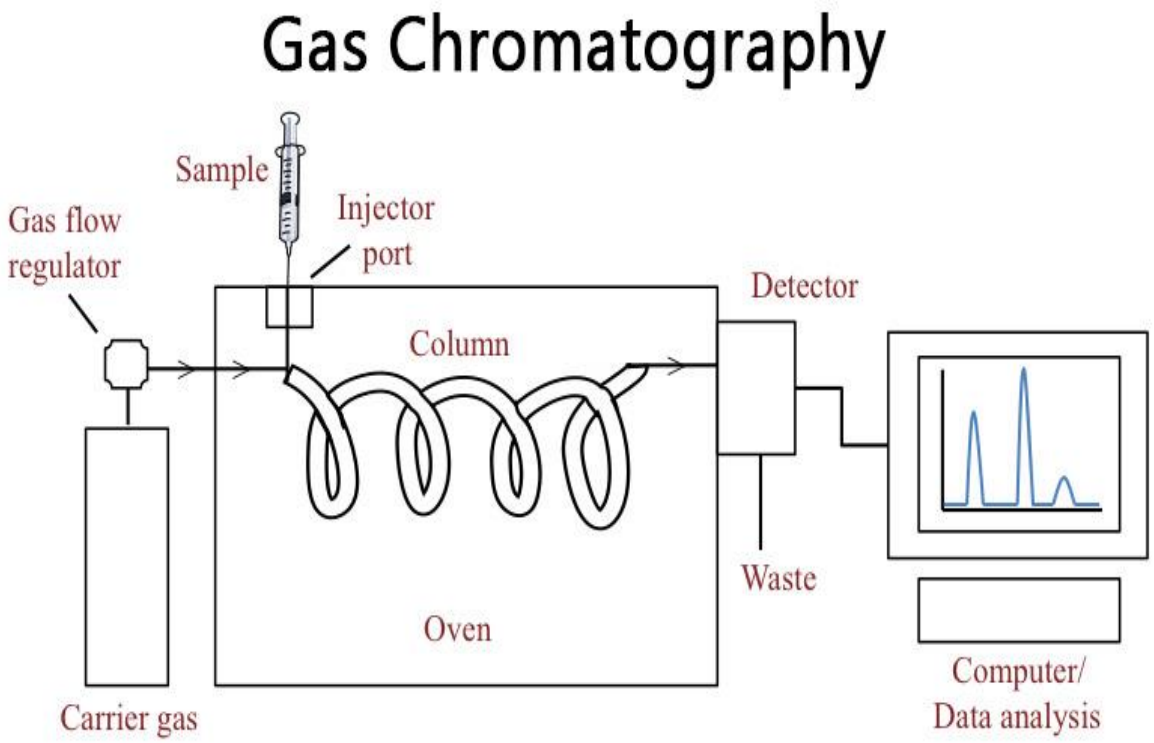
Detectors sense the arrival of the separated components and provide a signal.

- These are either concentration-dependent or mass dependant.

- The detector should be close to the column exit and the correct temperature to prevent decomposition.

Recorder

- The recorder should be generally 10 mv (full scale) fitted with a fast response pen (1 sec or less). The recorder should be connected with a series of good quality resistances connected across the input to attenuate the large signals.
- An integrator may be a good addition.



Procedure of Gas Chromatography

- A small amount of liquid sample to be analyzed is drawn up into a syringe.

- The syringe needle is positioned in the hot injection port of the gas chromatograph and the sample is injected quickly.

- The injection of the sample is considered to be a “point” in time, that is, it is assumed that the entire sample enters the gas chromatograph at the same time, so the sample must be injected quickly.
- The temperature is set to be higher than the boiling points of the components of the mixture so that the components will vaporize.
- The vaporized components then mix with the inert gas mobile phase to be carried to the gas chromatography column to be separated.

Separation in the Column

- Components in the mixture are separated based on their abilities to adsorb on or bind to, the stationary phase.
- A component that adsorbs most strongly to the stationary phase will spend the most time in the column (will be retained in the column for the longest time) and will, therefore, have the longest retention time (Rt). It will emerge from the gas chromatograph last.
- A component that adsorbs the least strongly to the stationary phase will spend the least time in the column (will be retained in the column for the shortest time) and will, therefore, have the shortest retention time (Rt). It will emerge from the gas chromatograph first.

Detecting and Recording Results

- The components of the mixture reach the detector at different times due to differences in the time they are retained in the column.
- The component that is retained the shortest time in the column is detected first. The component that is retained the longest time in the column is detected last.
- The detector sends a signal to the chart recorder which results in a peak on the chart paper. The component that is detected first is recorded first. The component that is detected last is recorded last.

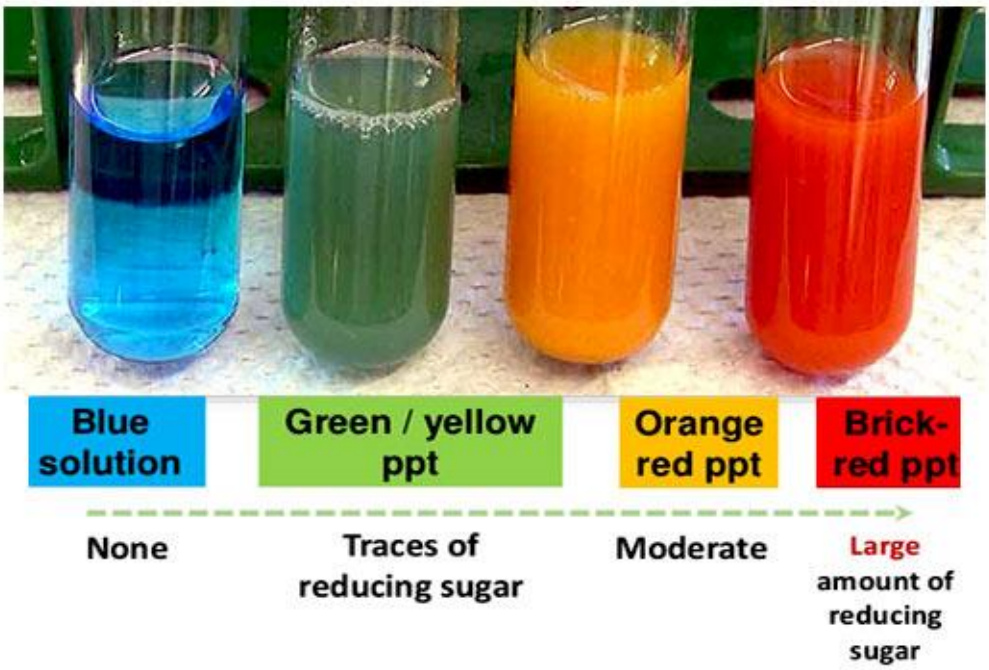
Applications

- Gas chromatography is used in the analysis of:

(a) air-borne pollutants
(b) performance-enhancing drugs in athlete's urine samples
(c) oil spills
(d) essential oils in perfume preparation

Measuring toxic substances in soil, air or water Identification and quantification, arson investigation, paint chip analysis, and toxicology cases, employ GC to identify and quantify various biological specimens and crime-scene evidence.

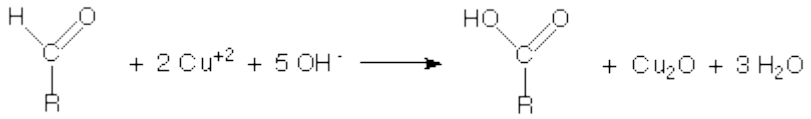
Color reaction of sugars



Benedict's Test- Principle, Composition, Preparation, Procedure and Result Interpretation

Benedict's Test is used to test for simple carbohydrates. The **Benedict's test** identifies reducing sugars (monosaccharide's and some disaccharides), which have free ketone or aldehyde functional groups. Benedict's solution can be used to test for the presence of glucose in urine.

Some sugars such as glucose are called reducing sugars because they are capable of transferring hydrogens (electrons) to other compounds, a process called reduction. When reducing sugars are mixed with Benedicts reagent and heated, a reduction reaction causes the Benedicts reagent to change color. The color varies from green to dark red (brick) or rusty-brown, depending on the amount of and type of sugar.



Benedict's quantitative reagent contains potassium thiocyanate and is used to determine how much reducing sugar is present. This solution forms a copper thiocyanate precipitate which is white and can be used in a titration. The titration should be repeated with 1% glucose solution instead of the sample for calibration

Principle of Benedict's Test

When Benedict's solution and simple carbohydrates are heated, the solution changes to orange red/ brick red. This reaction is caused by the reducing property of simple carbohydrates. The copper (II) ions in the Benedict's solution are reduced to Copper (I) ions, which causes the color change.

The red copper(I) oxide formed is insoluble in water and is precipitated out of solution. This accounts for the precipitate formed. As the concentration of reducing sugar increases, the nearer the final colour is to brick-red and the greater the precipitate formed. Sometimes a brick red solid, copper oxide, precipitates out of the solution and collects at the bottom of the test tube.

Sodium carbonate provides the alkaline conditions which are required for the redox reaction. **Sodium citrate** complexes with the copper (II) ions so that they do not deteriorate to copper(I) ions during storage.

Complex carbohydrates such as starches DO NOT react positive with the Benedict's test unless they are broken down through heating or digestion (try chewing crackers and then doing the test). Table sugar (disaccharide) is a non-reducing sugar and does also not react with the iodine or with the Benedict Reagent. Sugar needs to be decomposed into its components glucose and fructose then the glucose test would be positive but the starch test would still be negative.

Composition and Preparation of Benedict's Solution

Benedict's solution is a deep-blue alkaline solution used to test for the presence of the aldehyde functional group, – CHO.

Anhydrous sodium carbonate = 100 gm
Sodium citrate – 173 gm
Copper(II) sulfate pentahydrate = 17.3 gm

Procedure of Benedict's Test

1. Approximately 1 ml of sample is placed into a clean test tube.
2. 2 ml (10 drops) of Benedict's reagent ($CuSO_4$) is placed in the test tube.
3. The solution is then heated in a boiling water bath for 3-5 minutes.
4. Observe for color change in the solution of test tubes or precipitate formation.

Result Interpretation of Benedict's Test

If the color upon boiling is changed into green, then there would be 0.1 to 0.5 percent sugar in solution.

If it changes color to yellow, then 0.5 to 1 percent sugar is present.
If it changes to orange, then it means that 1 to 1.5 percent sugar is present.
If color changes to red,then 1.5 to 2.0 percent sugar is present.
And if color changes to brick red,it means that more than 2 percent sugar is present in solution

Phenol is a hydroxyl group (-OH) on an aromatic ring or simply the hydroxy derivatives of aromatic compounds are known as phenols. Phenols are weaker acids than carboxylic acids. It undergoes substitution reaction easily. Phenol is one of the most versatile and important industrial organic chemicals.

Aim:

To identify the presence of phenolic functional group in a given organic compound.

Theory:

Any of the following test can be carried out to detect the phenolic functional group.

1. Litmus test
2. Ferric chloride test
3. Libermann's test
4. Bromine water test
5. Phthalein dye test

(a) Litmus Test:

Scientists use litmus paper to test whether the given solution is acidic or basic. Red litmus paper turns blue while blue litmus paper remains unchanged in the presence of a base.

Phenol turns blue litmus paper red. This shows that phenol is acidic in nature. Carboxylic acid also give this test. Compare to carboxylic acid phenol is weakly acidic and it does not give an effervescence with aqueous sodium carbonate.

(b) Ferric Chloride Test:

Aqueous solution of phenol reacts with freshly prepared ferric chloride solution gives coloured complex. Most phenols give dark coloured solution.

The chemical reaction is given below.

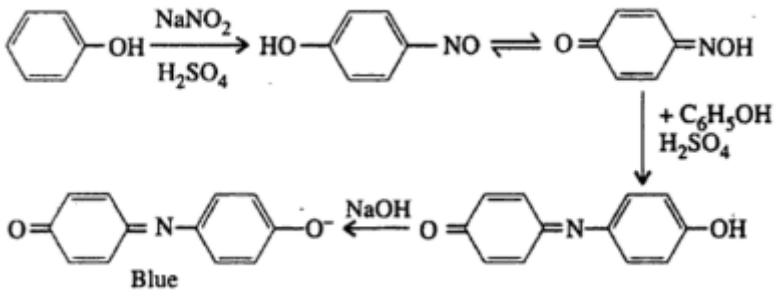
$6C_6H_5OH + FeCl_3 \rightarrow [Fe(C_6H_5O)_6]^{3-}$ (violet colour complex)+ $3HCl + 3H^+$

The colours produced by simple phenolic compounds with ferric chloride solution is listed below.

Phenol, resorcinol, Ortho cresol, Para cresol	Violet or blue colouration
Catechol	Green colouration
Hydroquinone	Violet or transient blue color
Pyrogallol	Blue rapidly changing to red

(c) Libermann's Test:

Phenol reacts with concentrated sulfuric acid and sodium nitrite forms a yellow colour quinone monoxime complex. With excess of phenol and sulfuric acid a deep blue indophenol complex is formed. On dilution a red colour indophenol is formed which turns to deep blue colour sodium salt solution of indophenol on treatment with sodium hydroxide.

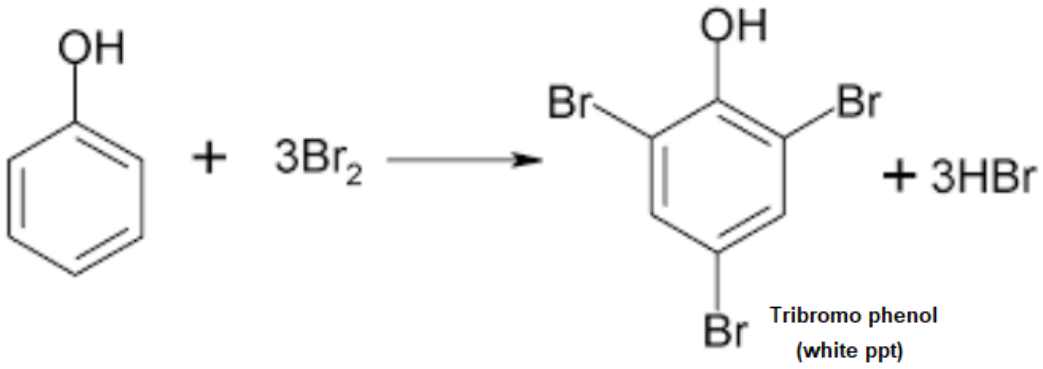


Note: *This test is given by phenols which contain a free para position.*

(d) Bromine Water Test:

Phenol undergoes electrophilic substitution reaction with bromine. When bromine water is added to aqueous solution of phenol the brown colour of bromine disappears and a white precipitate of tribromophenol is formed.

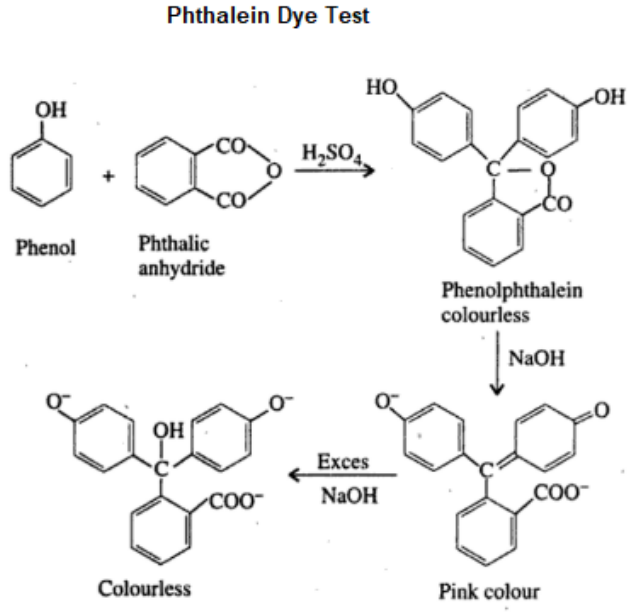
The chemical reaction is given below.



(e) Phthalein Dye Test:

Phenol on heating with phthalic anhydride in the presence of concentrated sulfuric acid forms a colourless condensation compound called phenolphthalein. On further reaction with dilute sodium hydroxide solution gives a pink colour fluorescent compound called fluorescein. Characteristic colours are produced by different phenolic compounds which can be viewed under white background.

The chemical reaction is given below.



The colours produced by different phenolic compounds in phthalein dye test is listed below.

Phenol	Reddish pink

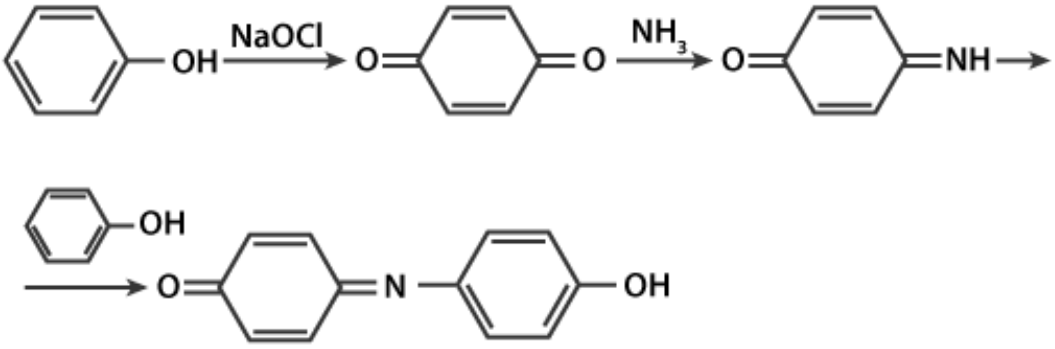
o-cresol	Red
m-cresol	blue or violet blue
1-naphthol	green
2-naphthol	faint green
Resorcinol	yellow-green fluorescence
Hydroquinone	deep purple

Materials Required:

1. Blue litmus paper
2. Ferric chloride solution
3. Sodium nitrite
4. Concentrated sulfuric acid
5. Sodium hydroxide
6. Bromine water
7. Phthalic anhydride
8. Organic compound to be tested
9. Test tubes
10. Test tube holder
11. Dropper
12. Beaker

PHENOL IDENTIFICATION

Indophenol test (Blue colur)



Ferric chloride test (Violet colur)

Procedure:

Preparation of Reagents:

1. ***Ferric chloride solution:*** Neutral solution of ferric chloride is prepared by adding diluted solution of sodium hydroxide to ferric chloride solution drop by drop until a small but permanent brown precipitate appears. Filter the solution and use the clear filtrate for the test.
2. ***Bromine Water:*** Take 5ml of bromine add 100ml of distilled water and shake well. Decant off the clear liquid.

(a) Litmus Test:

1. Place the drop of given organic solution or a small crystal on moist blue litmus paper.
2. Observe the change in colour, if it changes to red then phenolic group may be present.

(b) Ferric Chloride Test:

1. Dissolve the given organic compounds in water.
2. Add neutral solution of ferric chloride slowly dropwise.
3. Observe the change in colour.
4. A red, blue, green or purple colouration indicates the presence of phenol.

(c) Libermann's Test:

1. Place the crystals of sodium nitrite in a clean dry test tube.
2. Add 1ml of phenol to sodium nitrite solution.
3. Heat the mixture gently and allow it to cool.
4. Add 1ml of concentrated sulfuric acid to it and shake the contents.
5. Observe the change in the colour of the solution.
6. Dilute the solution with water so that the given compound turns red if phenolic group is present.
7. Now add sodium hydroxide solution, the blue colour solution or green colour solution appears.

(d) Bromine Water Test:

1. Dissolve the given organic compound in glacial acetic acid.
2. Add bromine water solution to this dropwise.
3. If the colour of bromine disappears then it indicates the presence of phenol.

(e) Phthalein Dye Test:

1. Take the organic compound to be tested in a test tube.
2. Add 200mg of phthalic anhydride to it.
3. Add drops of concentrated sulfuric acid to the mixture.
4. Heat the solution for 2-3 minutes.

5. Cool the mixture and pour it into a beaker containing dilute sodium hydroxide solution.
6. Dilute the whole mixture with equal volume of water.
7. Observe the change in the colour in a white background.
8. If fluorescence colour exists the view it in a black background.

Observations:

Litmus test	Phenol turns blue litmus paper red.
Ferric chloride test	Violet or blue colouration shows presence of phenol.
Libermann's test	Deep blue colour solution shows presence of phenol.
Bromine water test	Formation of white precipitate shows presence of phenol.
Phthalein dye test	Pink colour solution shows presence of phenol.

Precautions:

1. The ferric chloride solution used should be freshly prepared should be neutral and very dilute.
2. Phenol should be handled with care because it is toxic and corrosive nature.
3. Bromine should not be inhaled because it causes irritation.
4. Concentrated acids should be handled with care.

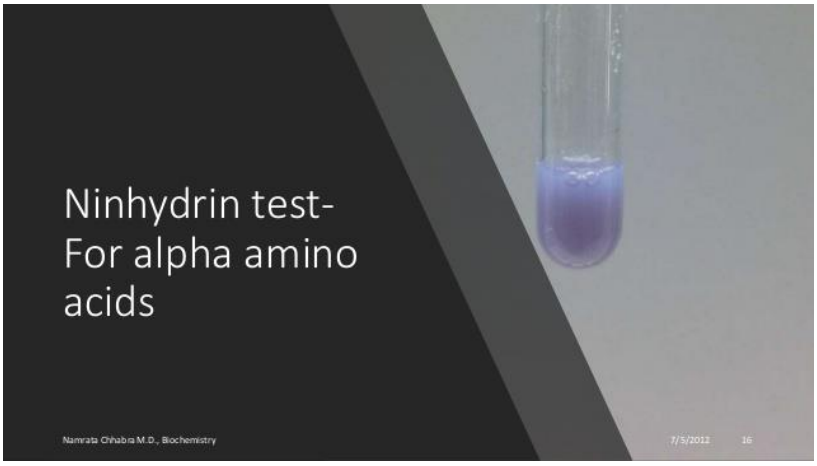
CHEMISTRY Related Links	
Limitations Of Valence Bond Theory	xylene

CHEMISTRY Related Links	
Molecular Formula Of Sugar	Unsaturated Solution
S Block Elements	Sodium Bicarbonate Uses
What Is Borax	Heterogeneous Catalyst
Atomic Mass Of Carbon	Methanol Formula

Color Reactions of Amino acid

Experiment 1: Ninhydrin Test

This test is widely used in biochemistry and in food science. Although compounds amino acids also give positive reactions, standard procedures used in the analysis can make the reaction a positive test for amino acids.



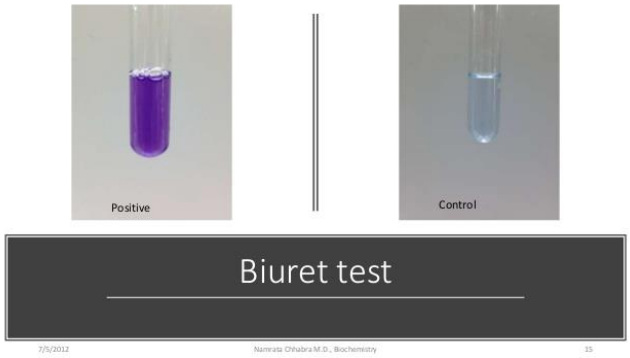
Procedure

- Dissolve the contents of the vial marked “gelatin” in 100 mL water. In this case, more heat may be employed. Avoid boiling! Dissolve the contents of the vial marked “arginine” in 200 mL water.

- Do likewise with the contents of vials marked “glutamic,” “glycine,” “cysteine,” “tryptophan,” and “unknown.”
- Do not use the cysteine or tyrosine vials yet. Dissolve the contents of the vial marked “ninhydrin” in 200 mL ethanol.
- Set up a number of test tubes and into each, put 2.0 mL (34 drops) of ninhydrin reagent.
- Into each tube add 2 drops (0.1 mL) of each solution to be tested. Mix the solutions and boil in a water bath for 2 minutes.
- In this way, test albumin, gelatin, the unknown compound, and at least two of the ammo acids.
- If you wish to test cystine or tyrosine simply add a small speck of the powder to ninhydrin in one of the test tubes and boil with the others. (Note: The result and colors that develop)

Experiment 2: Biuret Test

Biuret is a compound obtained when the area is heated to 108^0C . It reacts with copper sulfate in alkaline solution to give a violet color with an absorption maximum at 550 nm. This compound has given its name to the color reaction which was also found to occur with other compounds-those having two or more amide groups or peptide bonds joined directly together, or through a single atom of carbon or nitrogen.



Procedure

- Use biuret reagent provided and each of the solutions prepared for Experiment 1.
- Set up a number of test tubes. Into each put 1.0 mL (17 drops) of biuret reagent.
- Then add the solution to be tested into the biuret tube (1.0 mL). Mix the solutions and note any changes in color that occur over the next ten minutes.
- In this way, test albumin, gelatin, the unknown, and two amino acid

Experiment 3: Solubility of Amino acids

You will already have dissolved a number of amino acids in water for the previous experiments. In this test try to dissolve tyrosine and cysteine in water and note the result.

Procedure

- Put 2.0 mL (34 drops) of water in a clean test tube. Take a small portion of the contents of the vial marked "tyrosine" on a spatula and add it to the water.
- Shake well. Note if the tyrosine has dissolved. If it has not, then heat the test tube and note if the tyrosine dissolves.
- Is tyrosine readily soluble/sparingly soluble/insoluble in water? Repeat this procedure with cystine.

Experiment 4: Test for Cysteine and Cystine

The sulfur group of cysteine and cystine are liberated by heating with a strong alkali. If lead ions are present lead sulfide is formed as a dark precipitate. This reaction distinguishes between these two amino acids and methionine. Treatment with alkali does not liberate S from methionine.

Procedure

- Dissolve the contents of the vial marked "lead acetate" in 50 mL water. Dissolve the contents of the vial marked "NaOH" in 50 mL water. Put 20 mL aside for use in a later experiment.

- In 30 mL NaOH dissolves the cysteine, shaking well to ensure dispersal. Set up test tubes as follows: one with 2.0 mL glycine solution, one with 2.0 mL cysteine solution, one with 2.0 mL "unknown compound" and one with 2.0 mL cystine solution.
- To each tube add 2 drops lead acetate solution, and heat the tubes for 5 minutes in a boiling water bath. Note the results.

Experiment 5: Sakaguchi's Test for Arginine

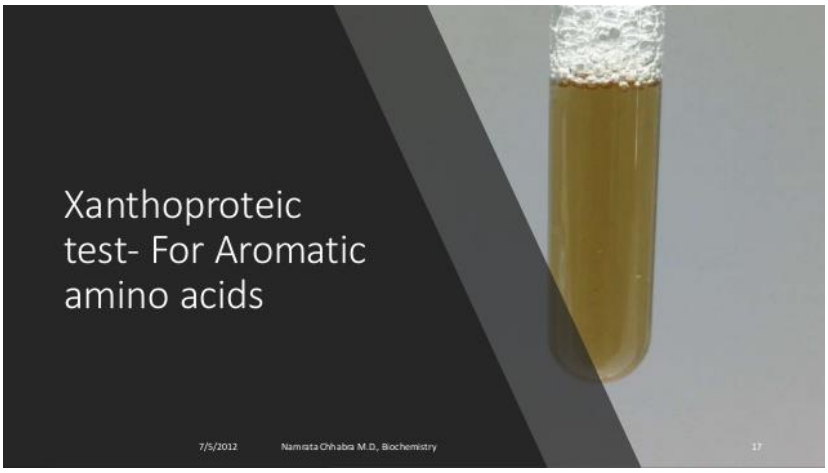
Ammonia and ammonium ions give positive reactions to this test. For this and other reasons, the reagents always give some color in the reaction. Therefore, a blank or control containing reagents only should be prepared for comparison.

Procedure

- Prepare a 4% solution of NaOH by adding 20 mL 40% NaOH made up for experiment 4 to 180 mL water.
- Set up a number of test tubes as follows: one with 2.0 mL water, one with 2.0 mL arginine solution, one with 2.0 mL unknown compound, one with 2.0 mL glutamic acid solution, and one with 2.0 mL albumin solution.
- To each of these add 1.0 mL 4% NaOH solution, and then add 2 drops of alpha-naphthol reagent. Add 1.0 mL of sodium hypochlorite reagent to each solution and mix.
- Observe any color change which occurs over the next 5 minutes. What color is positive for arginine? Does albumin contain arginine
-

Experiment 6: Xanthoproteic Test for Tyrosine and Tryptophan

The reaction of concentrated nitric acid with some substituted aromatic rings gives a yellow color (Xanthos = yellow in Greek).



Procedure

Set up test tubes as follows:

- In one tube put 2 drops of tryptophan solution, in another 2 drops of an unknown compound, in another 2 drops of glycine solution, and in another about 5 mg tyrosine powder.
- Then with great care, add 1.0 mL concentrated nitric acid (HNO_3) to each test tube. Hold the tubes so that they do not point at you or anyone else.
- Heat the tubes gently in a water bath until they boil. Cool the tubes slowly and add the 4% NaOH, drop by drop, until the solutions are alkaline

Color reactions of carbohydrate

Carbohydrates are widely prevalent in the plant kingdom, comprising the mono-, di-, oligo-, and polysaccharides. The common monosaccharides are the glucose, fructose, galactose, ribose etc. the disaccharides, i.e., the combination of two monosaccharides include sucrose, lactose and maltose. Starch and cellulose are polysaccharides consisting of many monosaccharide residues. Cellulose is most abundant organic compound on this planet since it forms part of cell wall in plants.

Aldehydes (-CHO) and ketones (=CO) are active groups in carbohydrates. Carbohydrates

contain many hydroxyl groups as well. The number of hydroxyl groups varies with the number of carbon atoms. Monosaccharides contain the free aldehyde group (maltose) and some do not have the free ones (sucrose). The polysaccharides, starch and cellulose, are polymers of monosaccharides linked through the active groups.

The chemical properties of the saccharides vary depending upon the number of hydroxyl groups and the presence or absence of –CHO/=CO groups. These variations are the basis in the development of color reactions to identify the saccharides.

Some simple tests used to identify the presence/absence of certain saccharides are listed below:

Reagents

- *Iodine Solution:* Add a few crystals of iodine to 2% potassium iodide solution till the color becomes deep yellow.
- *Fehling's Reagent A:* Dissolve 34.65g copper sulphate in distilled water and make up to 500mL.
- *Fehling's Reagent B:* Dissolve 125g potassium hydroxide and 173g Rochelle salt (potassium sodium tartrate) in distilled water and make up to 500mL.
- *Benedict's Qualitative Reagent:* Dissolve 173g sodium citrate and 100g sodium carbonate in about 800mL water. Heat to dissolve the salts and filter, if necessary.
- Dissolve 17.3g copper sulphate in about 100mL water and add it to the above solution with stirring and make up to volume to 1L with water.
- *Barfoed's Reagent:* Dissolve 24g copper acetate in 450mL boiling water. Immediately add 25mL of 8.5% lactic acid to the hot solution. Mix well. Cool and dilute to 500mL.
- *Seliwanoff's Reagent:* Dissolve 0.05g resorcinol in 100mL dilute (1:2) hydrochloric acid.
- *Bial's Reagent:* Dissolve 1.5g orcinol in 500mL of concentrated HCl and add 20 to 30 drops of 10% ferric chloride.

The reactions of carbohydrates are given in table as below:

Reactions of Carbohydrates

	Experiment	**Observation**	**Remarks**
1.	*Molisch's Test* Add two drops of Molisch's Reagent (5% 1-naphthol in alcohol) to about 2mL of test solution and mix well. Incline the tube and add about 1mL of concentrated sulphuric acid along the sides of the tube. Observe the color at the junction of the two liquids.	A red-cum-violet ring appears at the junction of the two liquids	The color formed is due to the reaction of alpha-naphthol with furfural and/or its derivative formed by the dehydration of sugars by concentrated sulphuric acid. All carbohydrates react positively with this reagent.
2.	*Iodine Test* Add a few drops of iodine solution to about 1mL of the test solution	Appearance of deep blue color	This indicates the presence of starch in the solution The blue color is due to formation of starch-iodine complex.
3.	*Fehling's Test* To 1mL of Fehling's solution 'A', add 1mL of Fehling's solution 'B' and a few drops of the test solution. Boil for a few minutes.	Formation of yellow or brownish-red precipitate	The blue alkaline cupric hydroxide present in solution, when heated in the presence of reducing sugars, gets reduced to yellow or red cuprous oxide and it gets precipitated. Hence, formation of the colored precipitate indicates the presence of reducing sugars in the test solution.
4.	*Benedict's Test* To 2mL of Benedict's reagent add five drops of the	Formation of red, yellow or green color/precipitate.	As in Fehling's test, the reducing sugar because of having potentially free aldehyde or keto

	Experiment	Observation	Remarks
	test solution. Boil for five minutes in a water bath. Cool the solution.		group reduce cupric hydroxide in alkaline solution to red colored cuprous oxide. Depending on the sugar concentration yellow to green color is developed.
5.	*Barfoed's Test* To 1mL of the test solution add about 2mL of Barfoed's reagent. Biol it for one minute and allow to stand for a few minutes.	Formation of brick-red precipitate.	Only monosaccharides answer this test. Since Barfoed's reagent is weakly acidic, it is reduced only by monosaccharides.
6.	*Seliwanoff's Test* To 2mL of Seliwanoff's reagent add two drops of test solution and heat the mixture to just boiling.	Appearance of deep red color	In the concentrated HCL, ketones undergo dehydration to yield furfural derivatives more rapidly than do aldoses. These derivatives form complexes with resorcinol to yield deep red color. It is a timed color reaction specific for ketones.
7.	*Bial's Test* To 5mL of Bial's reagent add 2-3mL of solution and warm gently. When bubbles rise to the surface cool under the tap	Appearance of green color or precipitate	It is specific for pentoses, they get converted to furfural. In the presence of ferric ion orcinol and furfural condense to yield a coloured product.
8.	Test for non-reducing sugars such as sucrose:		
a)	Do Benedict's test with the test solution	No characteristic color formation	Indicates the absence of reducing sugars in the given solution
b)	Add 5 drops of concentrated HCl to 5mL of test solution	Appearance of red or yellow	Indicated the formation of reducing sugars from non-

	Experiment	Observation	Remarks
	in another test tube. Heat for five minutes on a boiling water bath. Add 10% sodium hydroxide solution to give a slightly alkaline solution (test with red litmus paper). Now perform Benedict's test with this hydrolysed solution	color	reducing sugars after hydrolysis with acid.
9.	*Mucic Acid Test* Add a few drops of conc. HNO_3 to the concentrated test solution or substance directly and evaporate it over a boiling water bath till the acid fumes are expelled. Add a few drops of water and leave it overnight	Formation of crystals	The both end carbon groups are oxidized to carboxylic groups. The resultant saccharic acid of galactose is called mucic acid which is insoluble in water.
10	*Osazone Test* To 0.5g of phenyl hydrazine hydrochloride add 0.1g of sodium acetate and 10 drops of glacial acid. To this mixture add 5mL of test solution and heat on a boiling water bath for about half an hour. Allow the tube to cool slowly and examine the crystals under a microscope.	Glucose, fructose and mannose produce needle-shaped yellow osazone crystals. Whereas lactosazone in mushroom-shaped. Different osazones show crystals of different shapes. Maltose produces flower-shaped crystals.	The ketoses and aldoses react with phenyl-hydrazine to produce a phenylhydrazone which in turn reacts with another two molecules of phenylhydrazine to form the osazone.

Ultraviolet-visible spectroscopy or ultraviolet-visible spectrophotometry

UV/Vis

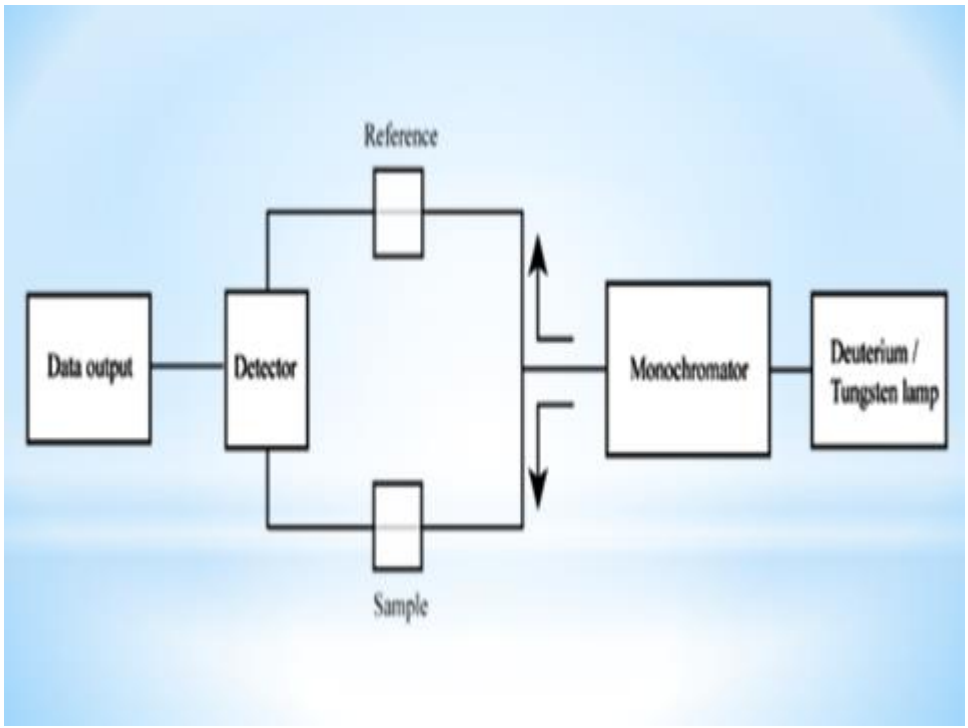
Ultraviolet-visible spectroscopy or ultraviolet-visible spectrophotometry (UV-Vis or UV/Vis) refers to absorption spectroscopy in the ultraviolet-visible spectral region. This means it uses light in the visible and adjacent (near-UV and near-infrared (NIR)) ranges. UV/Vis spectrophotometer is used in the quantitative determination of concentrations of the absorber in the solutions of transition metal ions and highly conjugated organic compounds.

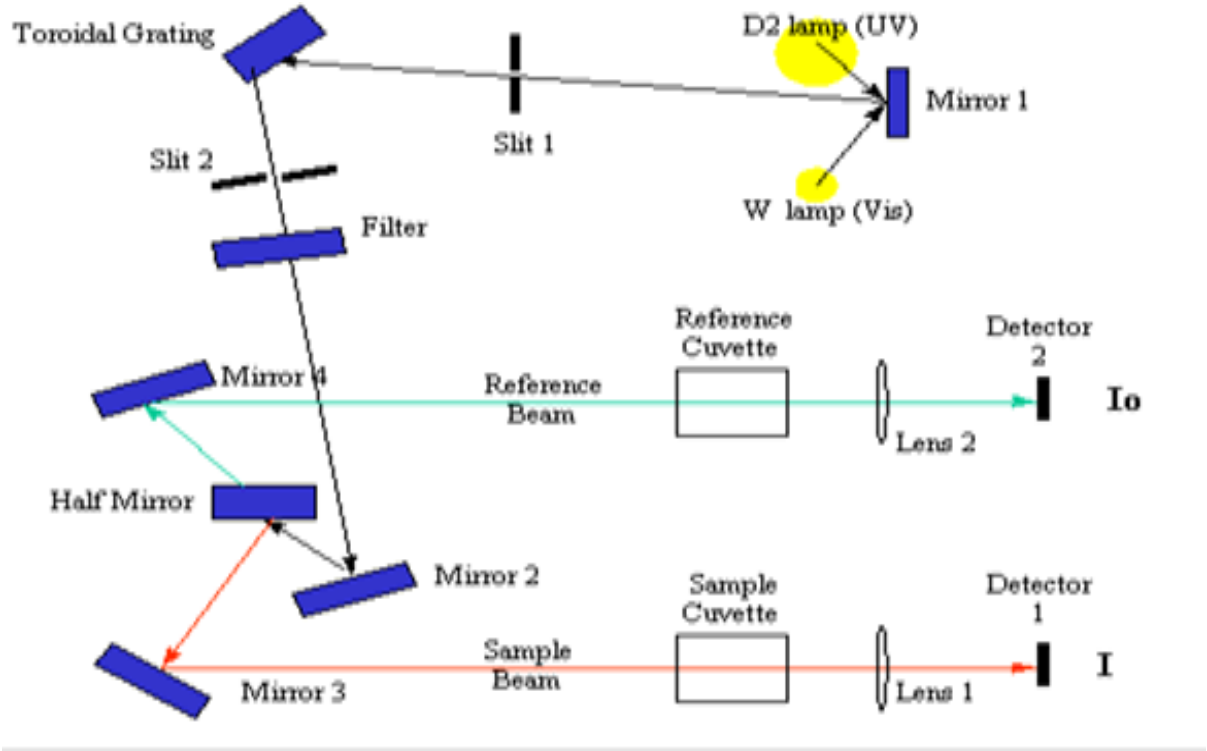
Basic Principle

The Beer-Lambert law states that the absorbance of a solution is directly proportional to the concentration of the absorbing species in the solution and the path length. Thus, for a fixed path length, UV/Vis spectroscopy can be used to determine the concentration of the absorber in a solution. The absorbance changes with concentration. This can be taken from references or more accurately, determined from a calibration curve.

When ultraviolet radiations are absorbed, this results in the excitation of the electrons from the ground state towards a higher energy state. Molecules containing π-electrons or non-bonding electrons (n-electrons) can absorb energy in the form of ultraviolet light to excite these electrons to higher anti-bonding molecular orbitals. The absorption of ultraviolet light by a chemical compound will produce a distinct spectrum which aids in the identification of the compound.

Instrumentation of UV Spectroscopy





Light Source

* Tungsten filament lamps and Hydrogen-Deuterium lamps are most widely used and suitable light source as they cover the whole UV region.

* Tungsten filament lamps are rich in red radiations; more specifically they emit the radiations of 375 nm, while the intensity of Hydrogen-Deuterium lamps falls below 375 nm.

Monochromator

* Monochromators generally is composed of prisms and slits.

* Most of the spectrophotometers are double beam spectrophotometers.

* The radiation emitted from the primary source is dispersed with the help of rotating prisms.

* The various wavelengths of the light source which are separated by the prism are then selected by the slits such the rotation of the prism results in a series of continuously increasing wavelength to pass through the slits for recording purpose.

Sample and reference cells

* One of the two divided beams is passed through the sample solution and second beam is passé through the reference solution.
* Both sample and reference solution are contained in the cells.
* These cells are made of either silica or quartz. Glass can't be used for the cells as it also absorbs light in the UV region.

Detector

* Generally two photocells serve the purpose of detector in UV spectroscopy.
* One of the photocell receives the beam from sample cell and second detector receives the beam from the reference.
* The intensity of the radiation from the reference cell is stronger than the beam of sample cell. This results in the generation of pulsating or alternating currents in the photocells

Amplifier

* The alternating current generated in the photocells is transferred to the amplifier.
* The amplifier is coupled to a small servometer.
* Generally current generated in the photocells is of very low intensity, the main purpose of amplifier is to amplify the signals many times so we can get clear and recordable signals.

Recording devices

* Most of the time amplifier is coupled to a pen recorder which is connected to the computer.
* Computer stores all the data generated and produces the spectrum of the desired compound.

Applications of UV Spectroscopy

* It is useful in the structure elucidation of organic molecules, such as in detecting the presence or absence of unsaturation, the presence of hetero atoms.

* UV absorption spectroscopy can be used for the **quantitative determination of compounds** that absorb UV radiation.

* UV absorption spectroscopy can characterize those types of compounds which absorbs UV radiation thus used in qualitative determination of compounds. Identification is done by comparing the absorption spectrum with the spectra of known compounds.

* This technique is used to detect the presence or absence of functional group in the compound. Absence of a band at particular wavelength regarded as an evidence for absence of particular group.

* Kinetics of reaction can also be studied using UV spectroscopy. The UV radiation is passed through the reaction cell and the absorbance changes can be observed.

* Many drugs are either in the form of raw material or in the form of formulation. They can be assayed by making a suitable solution of the drug in a solvent and measuring the absorbance at specific wavelength.

* Molecular weights of compounds can be measured spectrophotometrically by preparing the suitable derivatives of these compounds.

* UV spectrophotometer may be used as a detector for HPLC

FTIR

Fourier-transform infrared spectroscopy

(**FTIR**)-an infrared spectrum is a technique used to obtain absorption or emission of a solid, liquid or gas. An FTIR spectrometer simultaneously collects high-spectral-resolution data over a wide spectral range. This confers a significant advantage over a dispersive spectrometer, which measures intensity over a narrow range of wavelengths at a time.

The term *Fourier-transform infrared spectroscopy* originates from the fact that a Fourier transform (a mathematical process) is required to convert the raw data into the actual spectrum.

FTIR spectrometers are the third generation infrared spectrometer. FTIR spectrometers have several prominent advantages:

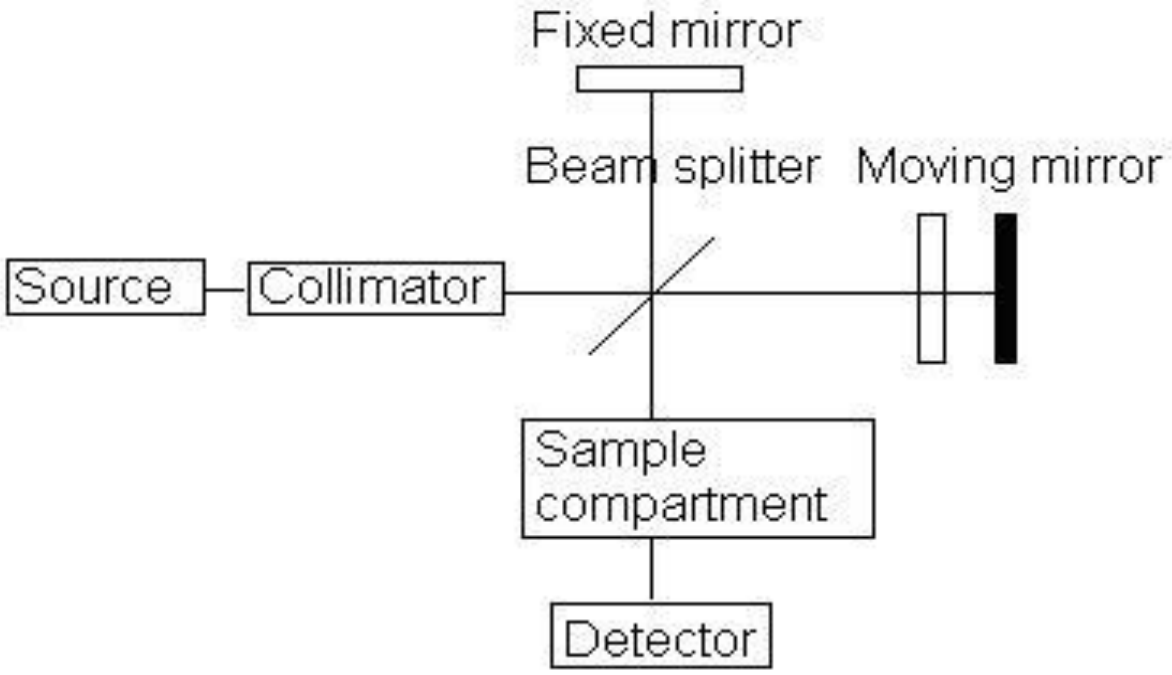
- The signal-to-noise ratio of spectrum is significantly higher than the previous generation infrared spectrometers.
- The accuracy of wave number is high. The error is within the range of ± 0.01 cm^{-1}.
- The scan time of all frequencies is short (approximate 1 s).
- The resolution is extremely high (0.1 ~ 0.005 cm^{-1}).
- The scan range is wide (1000 ~ 10 cm^{-1}).
- The interference from stray light is reduced. Due to these advantages, FTIR Spectrometers have replaced dispersive IR spectrometers.

The Components of FTIR Spectrometers

A common FTIR spectrometer consists of a source, interferometer, sample compartment, detector, amplifier, A/D convertor, and a computer.

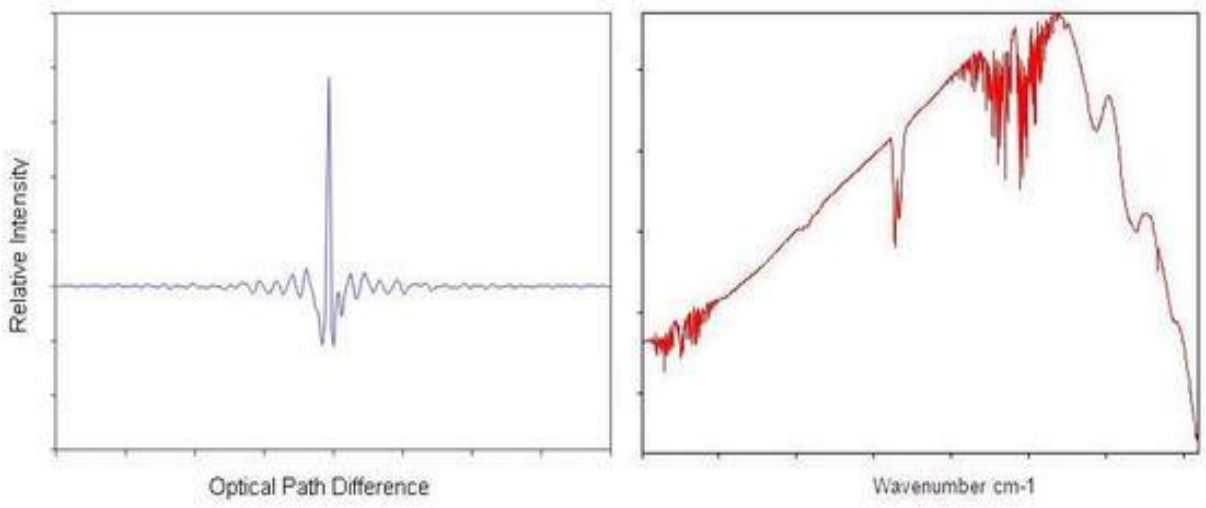
The source generates radiation which passes the sample through the interferometer and reaches the detector. Then the signal is amplified and converted to digital signal by the amplifier and analog-to-digital converter, respectively. Eventually, the signal is transferred to a computer in which Fourier transform is carried out.

Block diagram of an FTIR spectrometer



Interferogram to Spectrum

The interferogram is a function of time and the values outputted by this function of time are said to make up the time domain. The time domain is Fourier transformed to get a frequency domain, which is de-convolved to product a spectrum.



Operation of an FTIR Spectrometer

Step 1: The first step is sample preparation. The standard method to prepare solid sample for FTIR spectrometer is to use KBr.

(About 2 mg of sample and 200 mg KBr are dried and ground. Then, the mixture is squeezed to form transparent pellets which can be measured directly).

For **liquids** with high boiling point or viscous solution, it can be added in between two NaCl pellets. Then the sample is fixed in the cell by skews and measured.

(It is dissolved in CS_2 or CCl_4 to form 10% solution. Then the solution is injected into a liquid cell for measurement).

Gas sample needs to be measured in a gas cell with two KBr windows on each side. The gas cell should first be vacuumed. Then the sample can be introduced to the gas cell for measurement.

Step 2: Getting a background spectrum by collecting an interferogram and its subsequent conversion to frequency data by inverse Fourier transform. We obtain the background

spectrum because the solvent in which we place our sample will have traces of dissolved gases as well as solvent molecules that contribute information that are not our sample.

Step 3: Next, we collect a single-beam spectrum of the sample, which will contain absorption bands from the sample as well as the background (gaseous or solvent).

Step 4: The ratio between the single-beam sample spectrum and the single beam background spectrum gives the spectrum of the sample.

Step 5: Data analysis is done by assigning the observed absorption frequency bands in the sample spectrum to appropriate normal modes of vibrations in the molecules.

FTIR spectrometers (Fourier Transform Infrared Spectrometer) are widely used in organic synthesis, polymer science, petrochemical engineering, pharmaceutical industry and food analysis. In addition, since FTIR spectrometers can be hyphenated to chromatography, the mechanism of chemical reactions and the detection of unstable substances can be investigated with such instruments.

Infrared absorption spectroscopy is the method which scientists use to determine the structures of molecules with the molecules' characteristic absorption of infrared radiation.

Spike

Cyme

Catkin

Capitulum

Raceme

Corymb

Umbel

Compound umbel

Panicle

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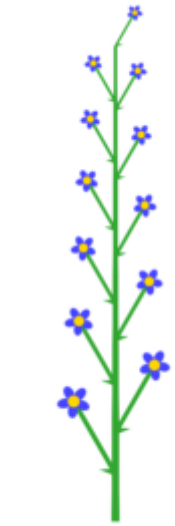


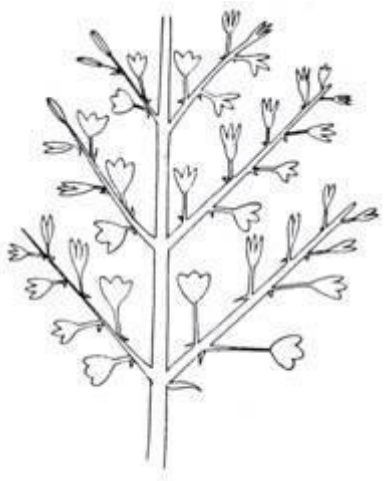
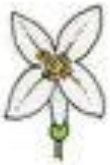


Fig. 34.54. Inflorescence. Panicle.

Saccate
lowest petal sac like
eg. Nemanthus

Cyanthiform
cup or bowl shaped
eg. Buttercup



Cruciform
Cross like, 4 petals
eg. Bedstraw

Coronate
Crown like
eg. Daffodil

Rotate
Wheel like,
with un-fused petals
eg. Tomato

Campanulate
Bell shaped
eg. Harebell

Labiate / Bilabiate
Lipped / 2-lipped
eg. Mint flower

Salverform
Tube with disc
of petals at the top
eg. Plumbago

Funnelform
Funnel or
tumpet like
eg. Morning glory

Ligulate
Made of strap-like petals
eg. Daisy, many compositae

Stellate
Star shaped
eg. Day-lily,
many flowers with tepals

Urceolate
Urn shaped
eg. Heather

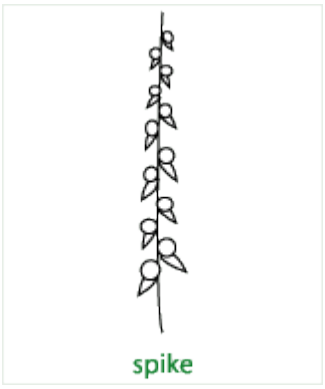
Papilionaceous
Butterfly like
eg. Vetch, the Pea family

Galeate
Hooded, or helmeted
eg. Dead nettle

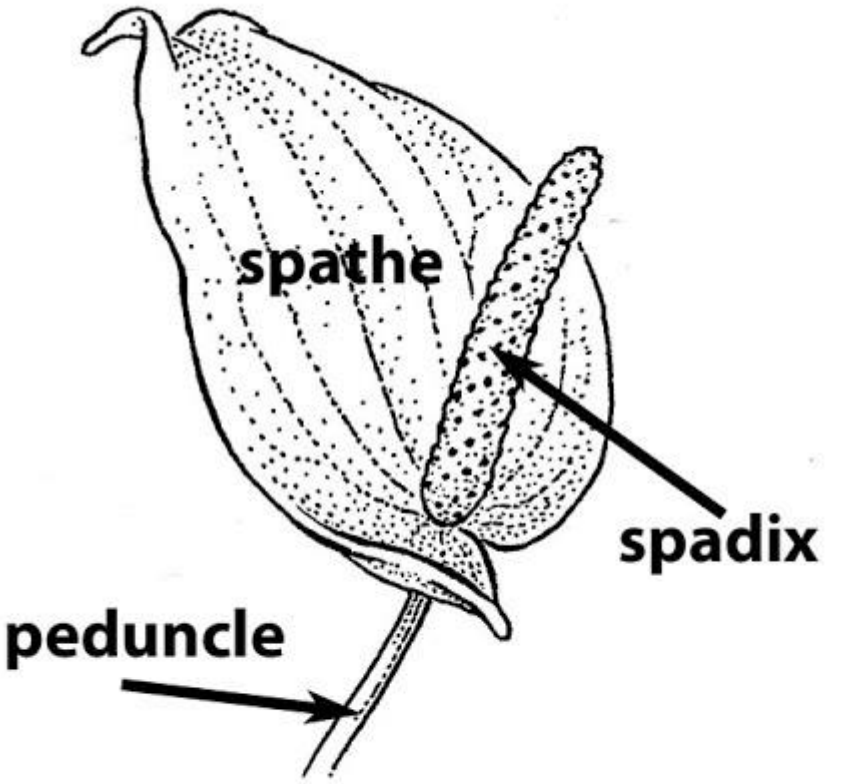
Calceolate
Shoe or slipper-like
eg. Slipper orchid

Tubulate
Tube like
Corolla similar
width to tube
eg. Cigar flower

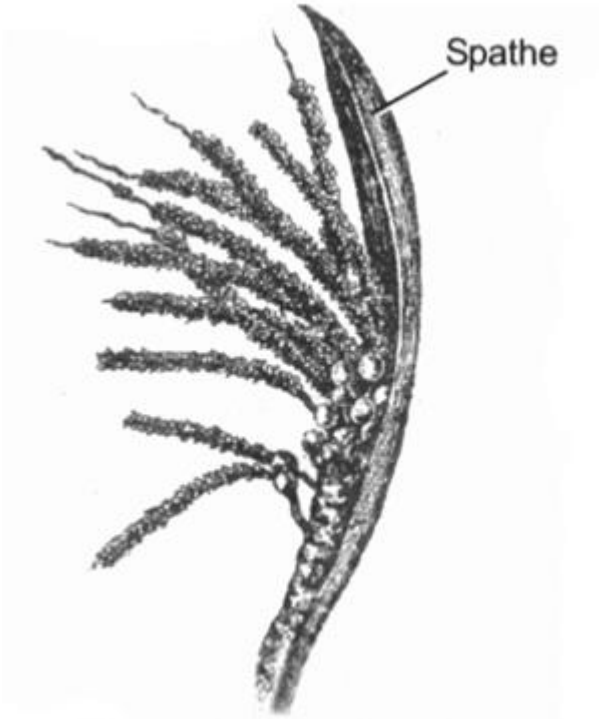
Crateriform
Shallow - bowl like
eg. California poppy



spike

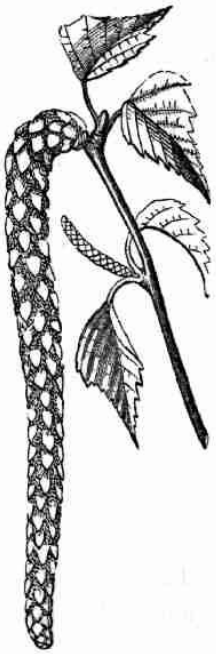


Inflorescence of an Araceae



Compound spadix of ***Cocos.***

panicle



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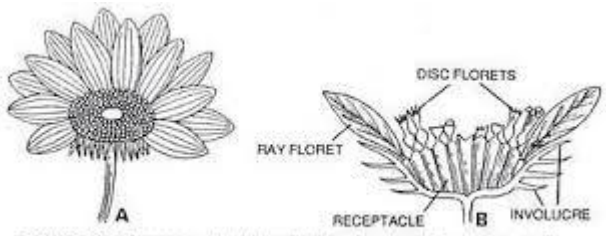
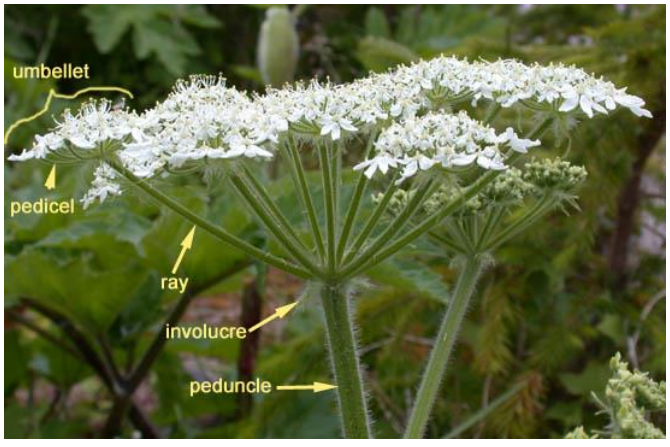


Fig. 34.52. Inflorescence. Head (capitulum)—A, a head; B, a head in L.S.


umbellet
pedicel
ray
involucre
peduncle

சைடியம் குஜாவாமெக்சிகோ மற்றும் தென் அமெரிக்காவிலிருந்து தோன்றியதாக நம்பப்படுகிறது மிர்ட்டேசி குடும்பம்

சைடியம் குஜாவா என்பது மரம் போன்ற பசுமையான புதர் ஆகும், இது 6 முதல் 25 அடி உயரத்தை எட்டும்

இது சுமார் 133 இனங்களையும் 3,800 க்கும் மேற்பட்ட இனங்களையும் கொண்டுள்ளது.

ஒரு பொதுவானது வெப்பமண்டல பழம் பல வெப்பமண்டல மற்றும் மிதவெப்ப மண்டல பிரதேசங்களிலும் சாகுபடி செய்யப்படுகிறது.இது பழத்திற்காக ஏராளமாக வளர்க்கப்படுகிறது. பல நாடுகளுக்கு கொய்யாவை மருத்துவ நோக்கங்களுக்காகப் பயன்படுத்திய நீண்ட வரலாறு உண்டு.

பெரும்பாலும் சாப்பிடும் இனங்கள், மற்றும் பெரும்பாலும் "கொய்யா" என்று குறிப்பிடப்படுவது ஆப்பிள் கொய்யா (சைடியம் குஜாவா) ஆகும்.

ஊட்டச்சத்துக்கள்

குவாஸ் உணவு நார்ச்சத்து மற்றும் வைட்டமின் சி ஆகியவற்றில் நிறைந்துள்ளது, மிதமான அளவு ஃபோலிக் அமிலம். குறைவான கலோரி வழக்கமான பரிமாறப்படும் என்ற அளவிலும், சில அத்தியாவசிய சத்துக்கள் , ஒரு ஒற்றை பொதுவான கொய்யா பழம் 257% ஐ கொண்டுள்ள அன்றாட மதிப்பில் வைட்டமின் சி (டிவி) (அட்டவணை). [13] கொய்யா சாகுபடிகளில் ஊட்டச்சத்து உள்ளடக்கம் மாறுபடும் . என்றாலும் ஸ்ட்ராபெரி கொய்யா (பி littorale வார். Cattleianum) பொதுவான வகைகளில் உள்ள வைட்டமின் சி-யை மட்டுமே 39%, 100 கிராம் அதன் உள்ளடக்கத்தை சேவை (90 மிகி) இன்னும் டிவி 100% வழங்குகிறது. [14]

பைட்டோ கெமிக்கல்ஸ்

கொய்யா இலைகள் ஆகிய
இரண்டும் கரோட்டினாய்டுகள் மற்றும் பாலிபினால்கள் போன்ற gallocatechin - (+) மற்றும் leucocyanidin . [15] இந்த பைட்டோ கெமிக்கல்களில் சில பழங்களின் தோல் மற்றும் சதை நிறத்தை உருவாக்குவதால், சிவப்பு-ஆரஞ்சு நிறமான கொய்யாக்கள் மஞ்சள்-பச்சை நிறங்களை விட பாலிபினால் மற்றும் கரோட்டினாய்டு உள்ளடக்கத்தைக் கொண்டிருக்கின்றன

குவாஸ், பொதுவானது

100 கிராம் (3.5 அவுன்ஸ்) ஊட்டச்சத்து மதிப்பு	
ஆற்றல்	285 kJ (68 கிலோகலோரி)
கார்போஹைட்ரேட்டுகள்	14.32 கிராம்
சர்க்கரைகள்	8.92 கிராம்
நார்ச்சத்து உணவு	5.4 கிராம்
கொழுப்பு	0.95 கிராம்
புரத	2.55 கிராம்
வைட்டமின்கள்	அளவு% டிவி †
வைட்டமின் ஏ சமம். பீட்டா கரோட்டின்	4% 31 µg 3% 374 µg
தியாமின் (பி 1)	6% 0.067 மி.கி.
ரிபோஃப்ளேவின் (பி 2)	3% 0.04 மி.கி.
நியாசின் (பி 3)	7% 1.084 மி.கி.
பாந்தோத்தேனிக் அமிலம் (பி 5)	9% 0.451 மி.கி.
வைட்டமின் பி 6	8%

	0.11 மி.கி.
ஃபோலேட் (பி 9)	12% 49 µg
வைட்டமின் சி	275% 228.3 மி.கி.
வைட்டமின் கே	2% 2.2 µg
தாதுக்கள்	அளவு% டிவி †
கால்சியம்	2% 18 மி.கி.
இரும்பு	2% 0.26 மி.கி.
வெளிமம்	6% 22 மி.கி.
மாங்கனீசு	7% 0.15 மி.கி.
பாஸ்பரஸ்	6% 40 மி.கி.
பொட்டாசியம்	9% 417 மி.கி.

சோடியம்	
	0% 2 மி.கி.

இலைகள், பூக்கள், பழம், விதைகள் மற்றும் பட்டை.

கொய்யா பழத்தில் வைட்டமின் ஏ, சி, இரும்பு, பாஸ்பரஸ் மற்றும் கால்சியம் உள்ளன. இது ஆரஞ்சை விட வைட்டமின் சி அதிகம். பழத்தில் சப்போனின், ஓலியானோலிக் அமிலம், லிக்சோபிரனோசைடு, அராபோபிரானோசைடு, குய்ஜாவரின், குர்செடின் மற்றும் ஃபிளாவனாய்டுகள் உள்ளன

இந்த ஆலை வயிற்றுப்போக்கு, வயிற்றுப்போக்கு, இரைப்பை குடல் அழற்சி, உயர் இரத்த அழுத்தம், நீரிழிவு நோய், கேரிஸ் மற்றும் வலி நிவாரணம்.

குர்செடின் மற்றும் ஃபிளாவனாய்டுகள் உள்ளன அஸ்கார்பிக் அமிலம் மற்றும் சிட்ரிக் அமிலம் கொய்யாவின் முக்கிய பொருட்கள் ஆகும், அவை பிறழ்வு எதிர்ப்பு செயல்பாட்டில் முக்கிய பங்கு வகிக்கின்றன.

வயிற்றுப்போக்கு காய்ச்சல், வயிற்றுப்போக்கு, இரைப்பை குடல் அழற்சி, உயர் இரத்த அழுத்தம், நீரிழிவு நோய், நோய்கள், வலி நிவாரணம் மற்றும் காயங்கள் போன்ற பல நோய்களைக் குணப்படுத்துவதற்காக

கொய்யாவில் இரண்டாம் நிலை வளர்சிதை மாற்றங்கள் போன்ற கரிம மற்றும் கனிம சேர்மங்களின் உயர் உள்ளடக்கம் உள்ளது எ.கா. ஆக்ஸிஜனேற்ற, பாலிபினால்கள், ஆன்டிவைரல் கலவைகள் மற்றும் அழற்சி எதிர்ப்பு சேர்மங்கள்.கொய்யாவில் ஏராளமான சேர்மங்கள் உள்ளன, அவை புற்றுநோய் எதிர்ப்பு நடவடிக்கைகளைக் கொண்டுள்ளன. இதில் அதிக எண்ணிக்கையிலான வைட்டமின்கள் மற்றும் தாதுக்கள் உள்ளன. ஃபிளாவனாய்டுகள் போன்ற பீனாலிக் சேர்மங்களும் கொய்யாவில் ஒரு முக்கிய இடத்தைக் காண்கின்றன. லைகோபீன் மற்றும் ஃபிளாவனாய்டுகள் முக்கியமான ஆக்ஸிஜனேற்றிகள். அவை புற்றுநோய் செல்களை குணப்படுத்த உதவுகின்றன, மேலும் காலத்திற்கு முன்பே தோல் வயதைத் தடுக்க உதவுகின்றன [27]. கொய்யா மாரடைப்பு ஐனோட்ரோபிசத்தை பாதிக்கும் [28]. கொய்யா தோல் சாறு 21 நாட்கள் சிகிச்சையின் பின்னர் நீரிழிவு அளவைக் கட்டுப்படுத்தலாம்

கொய்யா இலைகளில் எஸ். ஆரியஸின் வளர்ச்சியைத் தடுக்கக்கூடிய சாற்றில் அதிக பாக்டீரியா எதிர்ப்பு செயல்பாடு உள்ளது . பி. குஜாவாவின் தாவர இலை மற்றும் பட்டை மெத்தனாலிக் சாற்றில் அதிக ஆண்டிமைக்ரோபியல் செயல்பாடு உள்ளது. இந்த சாறுகள் பேசிலஸ் மற்றும் சால்மோனெல்லா பாக்டீரியாவைத் தடுக்கலாம் [31]. கொய்யாவின் மெத்தனாலிக் சாறு ஒரு குறிப்பிடத்தக்க ஆண்டிமைக்ரோபியல் செயல்பாட்டைக் கொண்டுள்ளது. பேசிலஸ் மற்றும் சால்மோனெல்லா பாக்டீரியாக்களின் இனங்கள் இந்த சாறுகளால் கட்டுப்படுத்தப்படலாம். செயலில் ஃபிளாவனாய்டுகள் சேர்மங்கள் இருப்பதால் இது பிளேக் எதிர்ப்பு செயல்பாட்டைக் கொண்டுள்ளது

ஃபிளாவனாய்டு கலவைகள் மற்றும் அவற்றின் வழித்தோன்றல்கள் கொய்யாவிலிருந்து தனிமைப்படுத்தப்படலாம். இந்த சேர்மங்கள் வெவ்வேறு நீர்த்தங்களில் வெவ்வேறு பாக்டீரியாக்களின் வளர்ச்சியைத் தடுக்கலாம். டெர்பினீன் மற்றும் பினீன் ஆகியவை தாவரத்தின் இலைகளின் அக்வஸ் சாற்றில் உள்ளன, இது ஆண்டிமைக்ரோபையல் செயல்பாட்டைக் காட்டுகிறது. நோய்க்கிரும பாக்டீரியாக்களில் பாக்டீரியோஸ்டேடிக்

விளைவுகள் காரணமாக இது இருமல், வயிற்றுப்போக்கு, வாய்வழி புண்கள் மற்றும் சில வீங்கிய ஈறுகளில் [1, 33] மருந்தாகவும் பயன்படுத்தப்படுகிறது

கிளேட் :	ஆஞ்சியோஸ்பெர்ம்ஸ்
கிளேட் :	யூடிகாட்கள்
கிளேட் :	ரோசிட்கள்
ஆர்டர்:	மிர்டேல்ஸ்
குடும்பம்:	மிர்ட்டேசி
பேரினம்:	சைடியம்
இனங்கள்:	பி. குஜாவா

மஞ்சரி சிறப்பு வகைகள்:

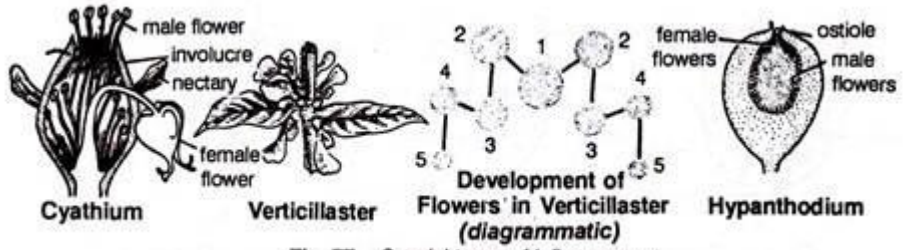


Fig. 77. Special types of inflorescence.

1. சைத்தியம்:
தேன் சுரக்கும் சுரப்பிகளைக் கொண்ட ஒரு கோப்பை வடிவ ஈடுபாடு, மையமாக வைக்கப்பட்டுள்ள ஒற்றை பெரிய பெண் மலர், இது பிஸ்டிலாகக் குறைக்கப்படுகிறது, மற்றும் பல ஆண் பூக்கள் மகரந்த வடிவில் உள்ளன, எ.கா., யூபோர்பியா.

2. வெர்டிகில்ஸ்டர்:
ஒருவருக்கொருவர் எதிரே அமைக்கப்பட்டிருக்கும் ப்ராக்ட்களின் அச்சில் பூக்கள் எழும்போது. இந்த வகை மஞ்சரிகளில் உள்ள ஒவ்வொரு கொத்து பூக்களும் லாபியாட்டே உறுப்பினர்களைப் போலவே டிகாஷியல் சைமையும் குறிக்கின்றன.

3. ஹைபான்டோடியம் அல்லது சிக்கோனியம்:
இது உச்சியில் ஒரு சிறிய ஆஸ்டியோல் மூலம் ஒரு வெற்று, குடுவை வடிவ, சதை அச்சு திறக்கிறது. குறைக்கப்பட்ட பல பூக்கள் அதன் உள்

மேற்பரப்பில் நெருக்கமாக அமைக்கப்பட்டிருக்கும். ஆண் பூக்கள் சுற்றளவுக்கு அருகில் அமைந்துள்ளன மற்றும் பெண் பூக்கள் மையத்தில் உள்ளன, எ.கா., ஃபிகஸ்.

சிறப்பு மஞ்சரி

மஞ்சரிகள் எந்தவொரு வளர்ச்சி முறை வகைகளும் சிறப்பு வகை மஞ்சரிகளின் கீழ் வகைப்படுத்தப்படுவதைக் காட்டவில்லை.

1. சத்தியம்: சைத்தியம் மஞ்சரி ஒரு ஒற்றை மலரைப் பிரதிபலிக்கும் ஒரு பொதுவான ஈடுபாட்டால் சூழப்பட்ட சிறிய ஒற்றை பாலின மலர்களைக் கொண்டுள்ளது. ஆண் பூக்கள் ஒரு ஸ்கார்பியாய்டு முறையில் ஒழுங்கமைக்கப்படுகின்றன. பெண் மலர் தனியாகவும், மையமாகவும் ஒரு நீண்ட பாதத்தில் அமைந்துள்ளது. ஆண் மலர் மகரந்தங்களால் மட்டுமே குறிக்கப்படுகிறது மற்றும் பெண் மலர் பிஸ்டிலால் மட்டுமே குறிக்கப்படுகிறது. Cyathiumஅக்டினோமார்ஃபிக் இருக்கலாம் (உதாரணம்: *மண்டியிட்ட*) அல்லது அகவிதழ்களுடன் (உதாரணம்: *Pedilanthus* .). அமுக்கத்தில் அமிர்தம் உள்ளது .

Figure 4.9: (a) diagrammatic, (b) Cyathium

2. ஹைபான்டோடியம் : ரெசெப்டாக்கிள் என்பது ஒரு வெற்று, **பூகோள** அமைப்பு ஆகும், இது வாங்கியின் உள் சுவரில் **ஒரே பாலின** மலர்களைக்

கொண்டுள்ளது. **ஆஸ்டியோல்** என்று அழைக்கப்படும் ஒரு சிறிய **திறப்பைத்** தவிர்த்து **ரெசிப்டாக்கிள்** மூடப்பட்டுள்ளது, இது தொடர்ச்சியான **ப்ராக்ட்களால்** மூடப்பட்டுள்ளது. ஆண் பூக்கள் ஆஸ்டியோலுக்கு மிக அருகில் உள்ளன, பெண் மற்றும் நடுநிலை பூக்கள் கலவையான முறையில் கீழே இருந்து காணப்படுகின்றன. எடுத்துக்காட்டு: *Ficussp* . (பனியன் மற்றும் பிபால்).

3. **கோனந்தியம்** : **மையத்தில் பிஸ்டிலேட் பூக்களைத் தாங்கி, சுற்றளவில் மலர்களைத் தடுமாறும்** சதை திறந்த வாங்குதல் போன்ற வட்ட வட்டு . எடுத்துக்காட்டு: *டோர்ஸ்டீனியா*

Figure 4.9: (c)
Hypanthodium

Figure 4.9: (d)
Coenanthium