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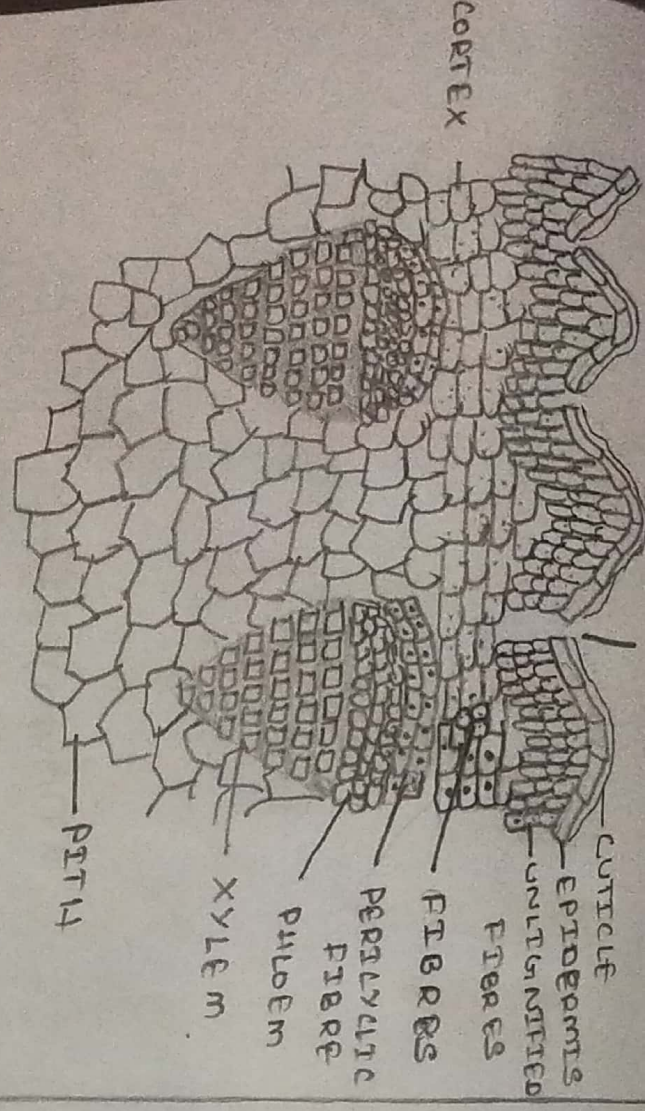
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Roll No. _____ Subject COGNOSY School/College ~~PHARMACOGNOSY~~

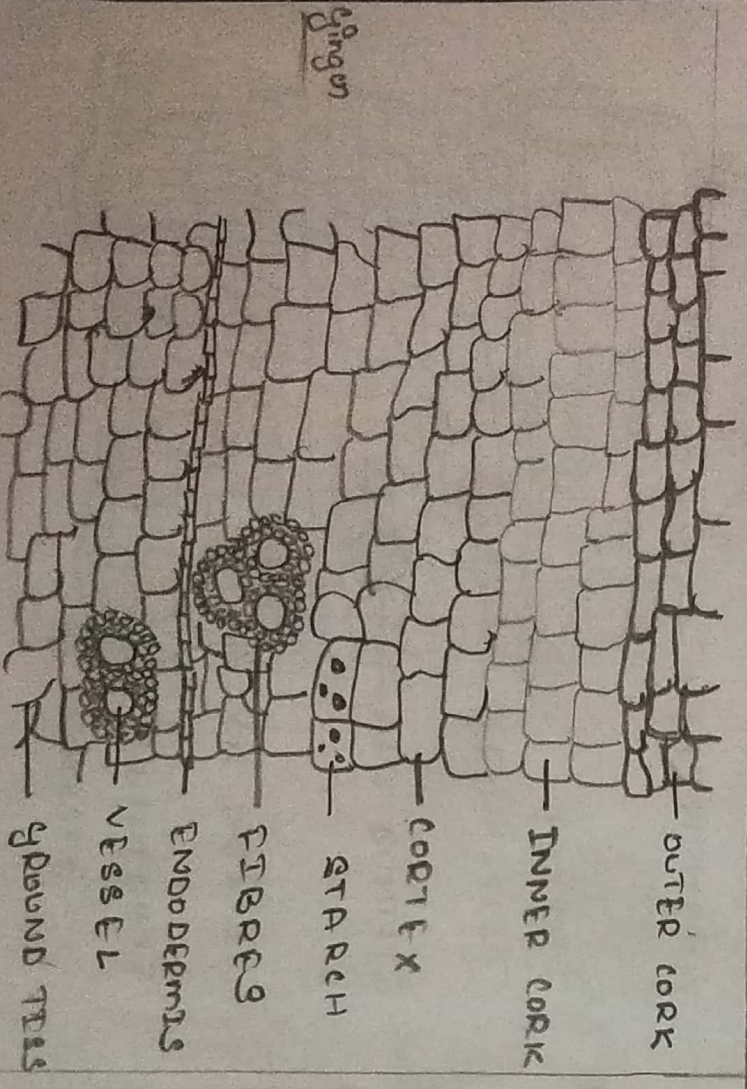
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10 mark important concepts

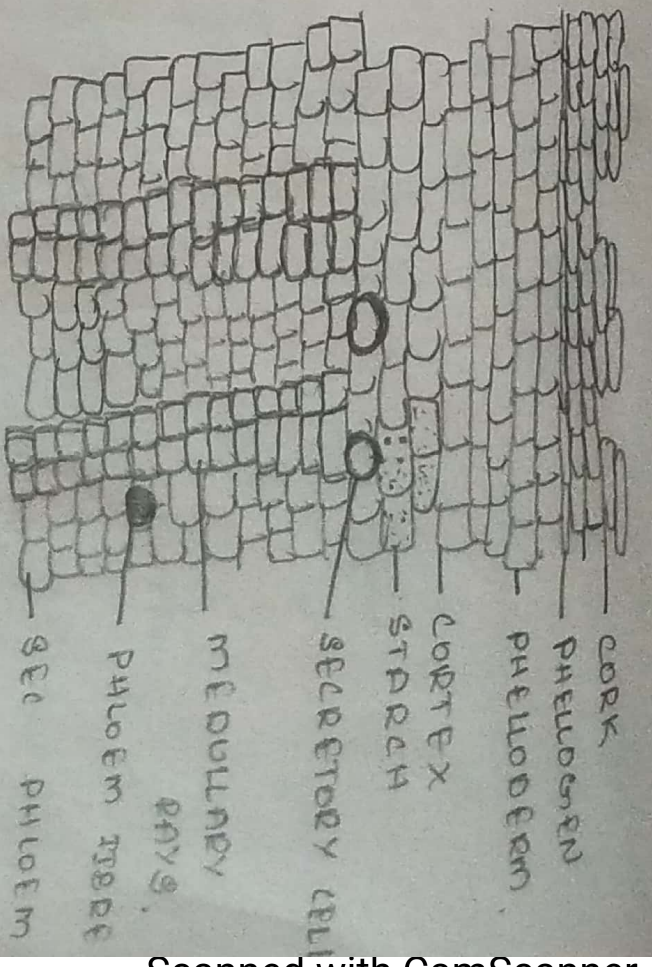




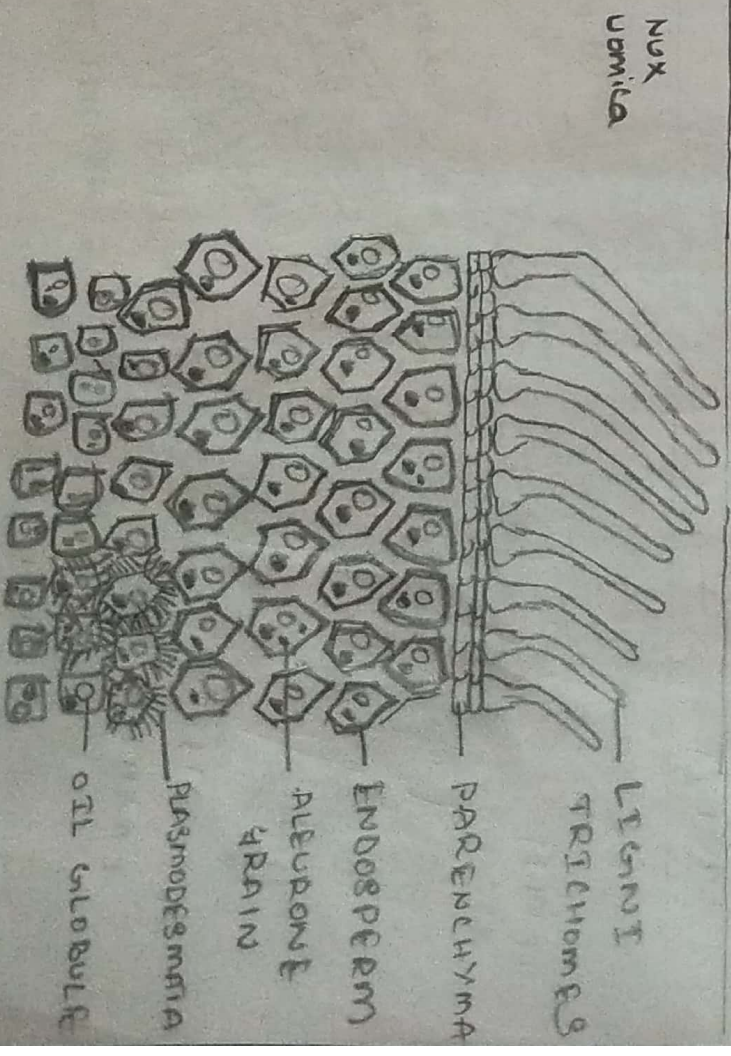
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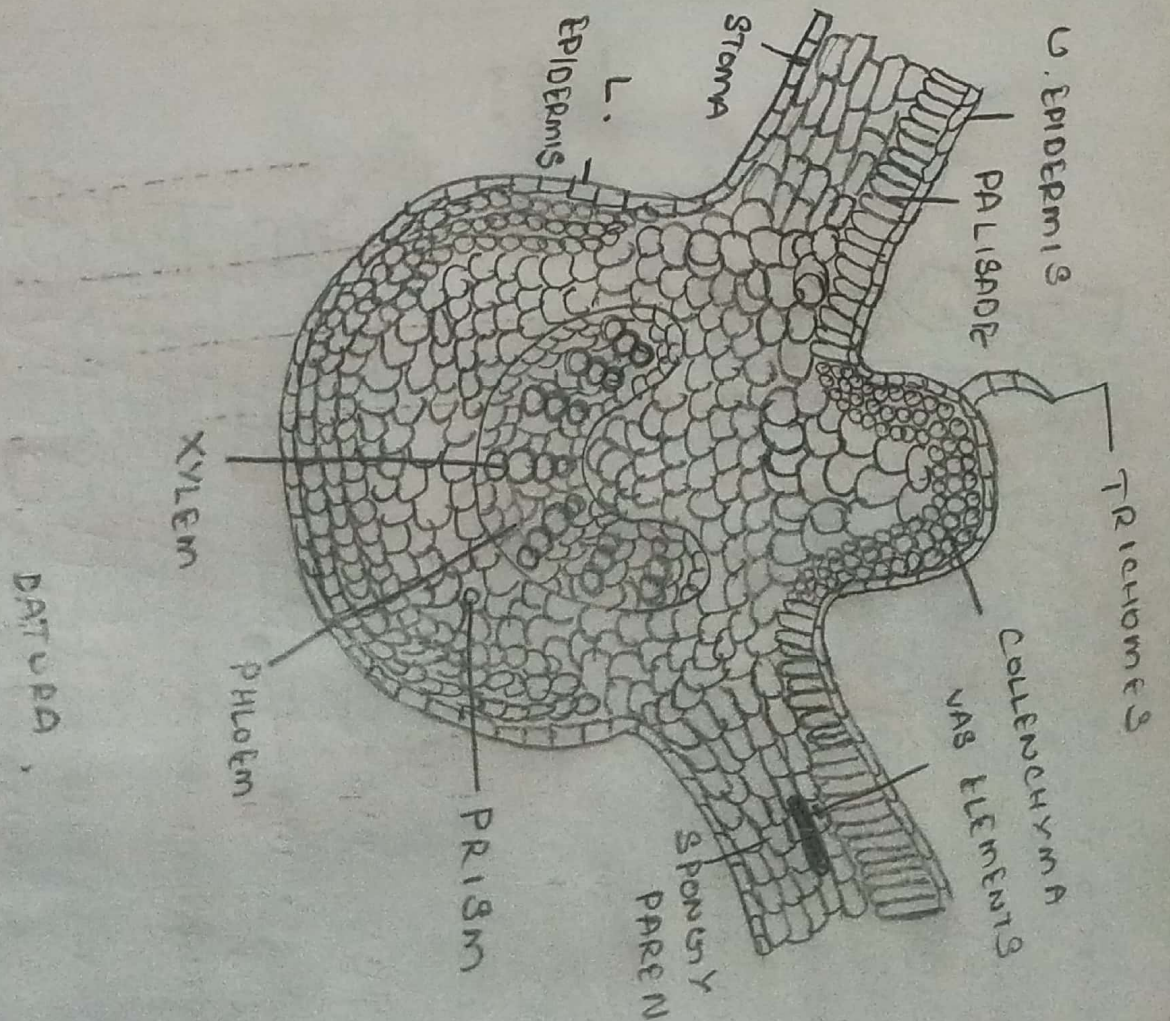
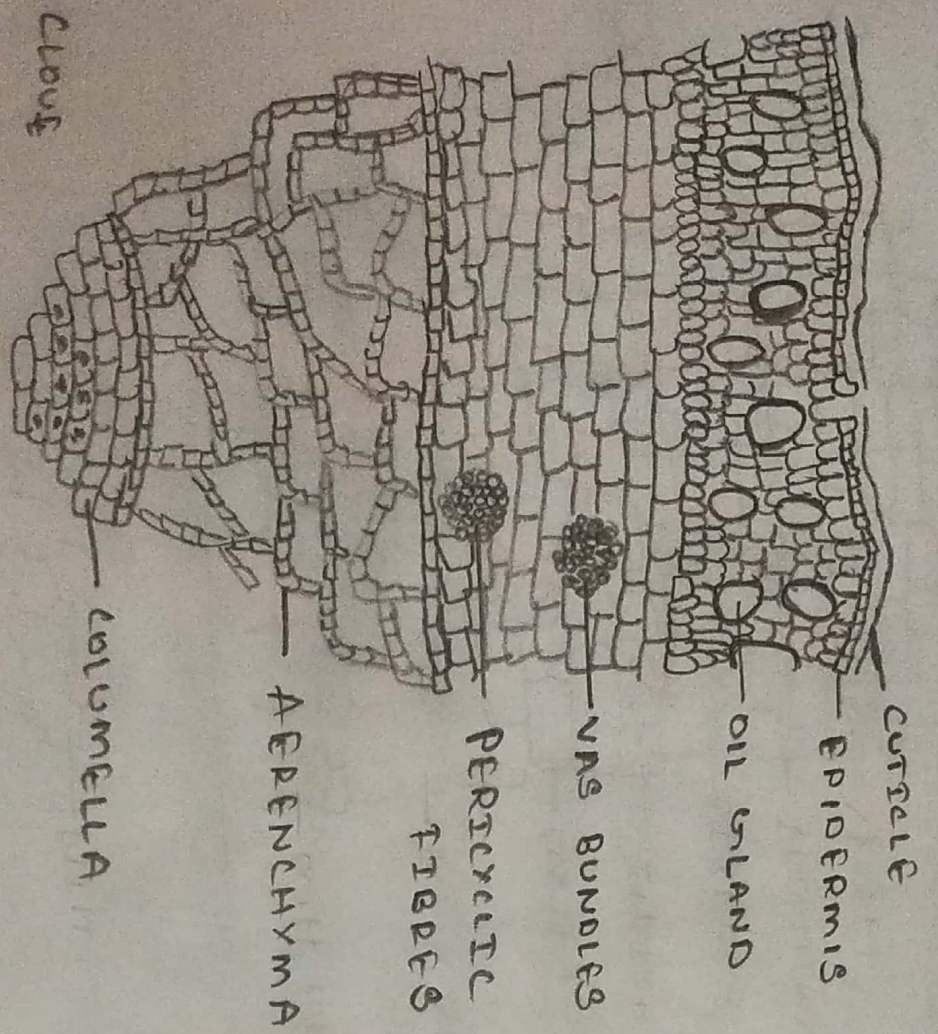
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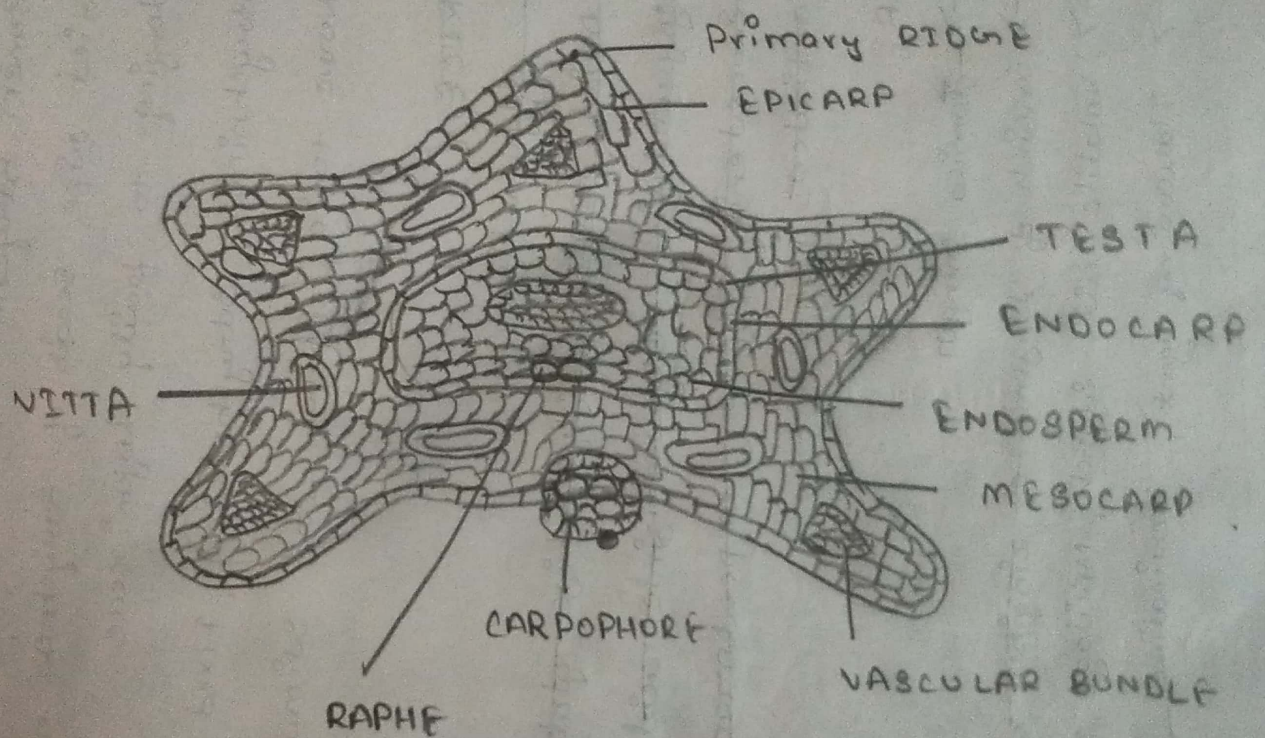


CINNAMON



NUX
vomica





FENNEL

① Define crude drug. Discuss various methods of classification of crude drugs with examples and merits and demerits of each of the method.

crude drug'. It is substance either used directly or indirectly as a drug, which have not been modified in its chemical composition.

① Alphabetical classification. ★

* It is the simplest way of classification of any disconnected items

* Some of pharmacopoeia which classify crude drugs according to this system are:

- ① Indian pharmacopoeia
- ② International pharmacopoeia
- ③ United States pharmacopoeia
- ④ British pharmacopoeia

Examples

A - Acacia,
B - Benzoin
C - cinnamon
D - Digitalis
E - Eriogon
F - Fennel
G - Ginger
H - Honey
I - Isopogon
J - Jalap
K - Kalmegh

L - Liquorice
M - Myrrh
N - Nutmeg
O - opium
Q - Quassia
R - Rauwolfia
S - Senna
T - Tripterygium
V - Vasaka
W - whale oil
Y - Yeast powder
Z - Zedoary

merits.

- ① It is easy to locate the drug.
- ② It is suitable when quick reference is needed.

Demerits

- ① Except drug name, no other information is revealed.
- ② It doesn't show whether the drug belongs to organized or unorganized category.
- ③ It doesn't reveal source of drug.
- ④ It doesn't reveal inter-relationship between the drugs.

② Taxonomical classification (Biological) ★

* crude drug of plant kingdom and Animal kingdom are divided according to Bentham and Hooker's system of classification.

* Drug is classified based on - Kingdom, phylum, class, order, family, genus, species.

Example:

phylum	- Rhodophyta
Subdivision	- Thallophyta
order	- Gelidiales
Family	- Gelidiaceae
drug	- Agar

Merits

- * It enables to study all the characteristics of a family.
- * It helps to study all the botanical characters of the plant.

Demerits

- * It does not show whether the drug belongs to organized or unorganized category
- * It failed to include active constituents of the crude drug
- * It does not reveal pharmacological action of a crude drug
- * It does not include mineral form of drug

③ Morphological classification. ★

- * In this classification ~~source~~ of crude drug is classified into organized and unorganized
- * organized drug represents a part of the plant while unorganized drugs are extracts obtained from crude drug.

	Plant part	Drugs (Organized)
④	Rhizome	Ginger, Turmeric
	Roots	Rauwolfia, Jalap
③	Woods	Sandalwood, Quassia
②	Barks	Cinnamon, Cinchona
①	Leaves	Vasaka, Senna
⑤	Flower	Clove, Saffron
	Fruit	Coriander, Fennel

Seeds	Carden, Isabgol
Entire plant	Vinca, Tergat.

unorganized crude drug

Extract	Drug
Dried latex	opium, popain
Dried Extract	Agar, gelatin
Dried Juice	Aloe, Red gum
Gums	Acacia, Tragacanth
Resins	Bengoin, Tolu
volatile oil	Camphor oil, Eucalyptus oil
Fixed oil	Castor oil, olive oil

Merits

- * It is useful during practical studies
- * It helps to determine whether the drug is adulterated or not.

Demerits

- * It groups unrelated drugs, chemically & therapeutically
- * It does not indicate morphology of the source
- * It does not give any idea about chemical constituents of the drug.
- * difficult to classify drug from Animal kingdom

① chemical classification. ★

* In this classification drugs are classified based on their main chemical constituents.

category	drug
carbohydrates	Acacia, Tragacanth.
lipids	Castor oil, olive oil
glycosides	digitalis, genna,
Alkaloids	Coffee, Tea
vitamins	Cod liver oil, Shark liver oil
protein	Casein, gelatin
Enzymes	pepsin, Trypsin

merits

- * This classification exhibits pharmacological action of drugs
- * It helps in phytochemical studies

Demerits

- * It fails to classify the drugs which possess two categories of chemical constituents
- Ex: Nutmeg → Fixed oil & volatile oil

⑤ pharmacological classification (therapeutic) ★
 In this classification drugs are classified according to the pharmacological action

Pharmacological category	Example
--------------------------	---------

① drug acting on GIT

carminative	cardamom, Fennel
Laxatives	Isapgol, Banana
purgative	Castor oil, Senna
cathartic	Senna

② drug acting on Respiratory System

Expectorants	Nasaka, liquorice
Antitussives	Opium
Bronchodilators	Ephedra, Tea

③ drug acting on Cardiovascular System

vasoconstrictors	Ergot, ephedra
vasodilators	Coffee, Opium
Antihypertensive	Rauwolfia

④ Drugs acting on central nervous system

CNS stimulants	Tea, Coffee
CNS depressants	Opium, Rauwolfia
Hallucinogens	Cocaine, Cannabis

Anticancer	vinca, Taxus
Immuno-modulatory agents	Tulsi, Ashwagandha
Drugs acting on skin and Mucous membrane	olive oil, Anachis oil,
Local anaesthetics	coca

Merits

- ① It is useful to classify those drugs whose chemical nature is difficult to find
- ② Various drugs showing particular action can be grouped together
- ③ Numerous drugs can be classified with this system.

Demerits

- ① It allows a drug to be grouped under more than one class
- ② This classification does not give any idea about the drug, whether it belongs to organized or unorganized category
- ③ Various aspects such as morphology, taxonomy etc are not considered

⑥ Chemotaxonomical classification ^{★ along with taxonomy}

- * The character most often studied in chemotaxonomy are 2° metabolites such as alkaloids, glycosides and flavonoids
- * DNA hybridization, amino acid sequencing in proteins gaining significance in this method of classification.

Eg: presence of Berberine alkaloid in Berberis
Flavonoids in higher plants

② Mention the advantages and disadvantages of cultivation of medicinal plants with Ex.

Advantages

- * quality and purity of medicinal plants can be assured by the process of their cultivation.
- * Drugs with highest content of active constituents like ginger, Turmeric and Licorice can be obtained by their systematic cultivation.
- * production of drugs of good quality is possible by maintaining uniformity in all operation during cultivation.
- * crude drugs with highest therapeutic quality can be achieved.

* Because of well planned cultivation, regular supply of crude drugs to the Industries is possible.

* Rapid growth of phytopharmaceuticals perfumery Industry is possible due to cultivation of medicinal and aromatic crops

* Cultivation improves the yield of the products.

Disadvantages

* Cultivation of medicinal plants is a costly affair.

* There may be huge loss of drug by natural hazards like storms, landslides.



③ Define cultivation? Explain various factors affecting cultivation of medicinal plants?

Ans: Cultivation is a process of preparation and use of land for growing plants.

① Altitude.

* It means height above the sea level.
* It is an exogenous factor which affects the cultivation of medicinal & aromatic crops.

Altitude

plant

1000 - 1500 m

Tea

1500 - 2000 m

Camphor

1000 - 2000 m

Coffee

② Temperature and Humidity.

- * It influence the growth and development of plants
- * optimum temperature is necessary for the growth of the plant
- * The quality of medicinal plants is adversely affected by high temperatures as well as by frost.

Optimum temp (°F)

plant

50 - 70

Coffee

70 - 90

Tea

- * Coffee and Tea cannot survive at low temperature, while Saffron grow well in cold climate

③ Radiation and Day-length

- * Requirement of light varies with every plant. Some plant requires shade for successful growth.

* The amount of active constituents produced can be determined by light.

* Full sunshine yields higher content of alkaloids in belladonna, cinchona.

(4) Rainfall or Irrigation.

* Irrigation is the application of water to soil for the purpose of supplying moisture to the plant essential for its growth.

* Different stages of plant growth needs different amount of water.

* Irrigation must be provided according to moisture content of soil.

(5) SOIL.

* Soil is a natural medium which supports the growth of all plants.

* Soil facilitates water absorption. plant growth depends upon physical properties of soil like soil texture, soil composition.

* Types of soil

percentage of Area
covered by clay

Type of soil

> 50%

clay soil

30 - 50%

loam soil

10 - 20%

Sandy Loam soil

> 70%

Sandy soil.

Organic matter

Type of soil

$< 0.5\%$

Poor soil

$0.5 - 1.5\%$

Intermediate soil

$> 5\%$

Rich soil

⑥ Manures and Fertilizers

* Application of fertilizers and manures is essential to maintain the soil fertility

→ Manures

* These are organic substances derived from biological source by the action of microorganisms.

Eg: farm yard manure, poultry manure

→ Fertilizers

* These are inorganic compounds which are used to supply the essential elements to the soil

Eg: Nitrate fertilizers, potassium fertilizers

④ write a note on various methods of cultivation of medicinal plants ★

① seed propagation (sexual method)

② vegetative propagation (Asexual method)

③ Tissue culture

① seed propagation

* In this method, seedlings are grown by sowing seeds.

methods of sowing seeds

① Broadcasting method

* This method is used for the seeds which are extremely small in size

* seed drills are used to spread the seeds over the surface of ploughed soil

② Dibbling

* This method is applicable for those seeds which are average in size and weight.

* seeds are sown into the holes on the ground

③ Other methods

* most of the plants are grown by sowing seeds in nursery beds

* These plants are then transplanted to farms for further development.

Stimulus for seed germination

* Complete immersion of seeds in water for a day
Ex: castor seeds.

* Immersion of seeds in H_2SO_4 .

* To stimulate germination, plant growth regulators such as Auxins, cytokins, gibberellins are used.

Advantages

- * Cultivation of plants by this technique is inexpensive
- * Seed propagation is the only method of choice for plants which cannot be grown by vegetative propagation.
- * plant propagated from seeds lasts for a long time
- * plants bear more fruits

Disadvantages

- * Harvesting and pest control are highly expensive
- * plants take more time to bear fruit

(2) vegetative propagation

- * There are two methods for propagating plants by vegetative means.

(i) Natural method

(ii) Artificial method

(1) Natural method

plant

vegetative part

onion

Bulb

ginger

Rhizome

potato

Tubers

oxalis

Runners

* In this method, new plants are raised from vegetative parts like stem, root, bulb

② Artificial method

→ Cuttings

* In this method portion of plant which are capable of developing into new plant are placed in soil for development of roots.

portion of plant

Stem

Rose

Root

Brahmi

Leafbud

Bryophyllum

→ Layers

* The part of plant that has grown out from stem is slitted

* The slitted portion is then planted in a trench, portion begins to develop roots when it comes in contact with the soil
Ex: simple layering in lemon plants

→ Grafting

* In this process, piece is cut and removed from living plant and fixed to another plant. So two surfaces grow together.

Ex: Grafting Cinchona to yield higher amount of alkaloid

③ Micropropagation / Tissue culture

- * It is a new method for the production of medicinal crops
- * In this method, fine segment of plant is developed into new plant under aseptic condition in artificial medium
- * The artificial medium is provided with nutritional and hormonal requirements which facilitates the growth of cell cultures

Advantages -

- * Disease free plants can be produced

Disadvantages

- * This process is Expensive
- * plant cannot withstand draught condition

⑤ write about collection of medicinal plants ★

① Roots and Rhizomes

- * Roots of the plant are collected just before flowering
- * Rhizomes are collected when they contain maximum amount of reserved food and active constituents

Ex: Licorice, ginger

② Bark

* The bark of the plant is collected when there is moisture in the atmosphere.

Ex: cinchona, cinnamon.

③ Gum and Latex

* They are collected by making incisions on the plant parts.

Ex: Acacia, opium.

④ Leaves

* Leaves of the plant are collected when the flowers reach maturity.

Ex: Indian Senna, Belladonna.

⑤ Flowers

* The flowers of the plant are collected before pollination takes place. They are collected when the weather is dry.

Ex: clove, Saffron.

⑥ Fruits

* Fruits are collected from the plant when they are fully grown in size. They may be collected in ripe or unripe condition.

Ex: Fennel, Black pepper.

⑥ write a note on processing and storage & preservation of crude drug processing of medicinal plants ★

① Harvesting.

- * Harvesting should be done when the active constituents of the drug are maximum
- Roots are dug up at the end of summer season by mechanical devices
- Bark of the trees is harvested after the rainy season
- Leaves are harvested when they are fully grown
- Flowers are harvested before they bloom completely

② Drying ★

- * This process is carried out to store drugs for longer duration

* Drying lowers the activity of enzymes, hence potency of drug is maintained.

methods of drying

① Air Drying

- * It is carried out by using fans or windows
- * The plants are dried in dark to prevent loss of chemical constituents.

② Natural Drying

- * Sunlight is used for drugs, whose constituents do not decompose on exposure to light

Ex: Acacia, seeds, fruits.

(ii) pressing of plants.

* This process is carried out by pressing the parts of the plant.

(iv) Dehydrating Agents.

* They are used to absorb moisture from crude drugs.

Ex: silica gel.

(v) Drying by Artificial heat.

→ Tray Dryer.

* It provides continuous flow of hot air by mechanism of forced convection.

* This method is used to remove moisture from crude drugs.

→ Vacuum Dryer.

* It is used to remove moisture from crude drugs at a temperature 25-30°C by vacuum.

→ Spray Dryer.

* It removes moisture at a very rapid rate.

* It is used to dry plant and animal constituents instead of drying crude drugs.

(3) Dressing

* It is the process of sorting sand, dirt, organic debris and cleaning the desired parts of the plant.

* It is carried out so that the drug passes the pharmacopoeial standards.

④ packing.

* It depends on morphological nature, chemical nature and surrounding environmental condition.

→ Quills of cinnamon is packed one inside the another.

→ Cod-liver oil is packed in amber coloured bottles.

→ Aloe is packed in goat skin.

★ Storage and preservation of crude drugs

Factors to be considered during Storage.

① Contamination

* Crude drugs may contaminate with dust, Animal excreta etc.

* This could be prevented by taking proper packaging measures.

② Stability of the product

* The crude drugs may become unstable when exposed to moisture, temperature changes, light, humidity, oxygen.

③ Reaction with the container

* The product may interact with the containers, hence evaluation of containers should be done with care.

* The container should be water proof, light proof, fire proof.

④ Change in product

* crude drug may undergo change in crystal size when storage conditions are not met properly.

⑤ Moisture

* Drug storage crude drugs may absorb moisture.

* Excess moisture leads to enzymatic reaction, which decomposes the active constituents of the product.

⑥ Temperature

* Low Temperature should be maintained while storing the drugs

* optimum or high temperature increases the enzymatic reaction, thereby decreases the quality of the product.

→ Acora should be stored in air tight containers in a cool place.

→ shark liver oil should be stored in light resistant containers.

→ volatile oil should be tightly sealed and kept in cool place.

→ ginger is stored after coating them with lime

Store house

- * They should be well built with steel & concrete.
- * They should be rodent proof.
- * Store house should be cool, dark and well ventilated with dry air.

⑦ Explain conservation of medicinal plants and its importance ★

- * Establishment of seed and gene banks
- * Cryo - preservation
- * In situ conservation of existing bioresources
- * maintaining natural Ecosystems
- * Development of agro-practices
- * Following of standard methods of cultivation
- * cultivating and utilization of crude drug without over exploiting them
- * Adopting newer techniques for develop plant varieties
- * Creating ^{gati} different climatic condition
- * preserving endangered species

⑧ Define adulteration? Explain various methods.



Adulteration

It is a practice of substituting original crude drugs partially or whole with other similar looking substance.

Deliberate adulteration

* It is done intentionally where crude drug is substituted with inferior products which look similarly.

① Substitution with inferior quality.

* Replacement with substandard drug.

* Adulterant resembles the original crude drug morphologically, chemically, therapeutically but cheaper in cost.

① Indian Senna with Arabian Senna, dog Senna

② Toragolanth with Hog Toragolanth

③ Strichonans nux-vomica with Strichonans nuxblendia

④ Substitution with exhausted crude drug

* Isolation of active constituent may does not change morphology of drug. And the extracted drug is called exhausted drug.

* There is a chance to adulterate with this

① Exhausted clove to clove

② Exhausted cardamom to cardamom

③ Exhausted ginger to ginger

③ Substitution with artificially manufactured substances

* Here substances are artificially prepared to resemble the original drug.

① Honey with Invert sugar.

② Bee wax with paraffin wax.

③ Coffee with chicory.

④ Substitution with harmful substances

* Here defective or harmful substances are admixed with unorganized drug

① Colerut oil with white oil.

② Cocoa Butter with paraffin.

Indeliberate adulteration

* It occurs unintentionally without bad intention of the supplier, sometimes in absence of proper evaluation.

① Faulty collection of crude drug

* Certain drugs are collected in specific season only. If not then conc of chemical constituents may vary.

Drug

Collection Season

cherry bark

autumn

Cinnamon bark

Rainy Season

② Imperfect preparation.

* Adulteration may take place by collection of undesirable and inert part instead of desired part.

DRUG

Desired part

undesired part.

Fennel

Fruit

Undeveloped fruit.

Ginger

Rhizome

root.

③ Improper Storage.

* Storage condition affects quality of drug
Improper storage may lead to spoilage.

DRUG

STORAGE CONDITION.

volatile oil

Stored in dark room

cod liver oil

Stored in ambered
coloured bottle.

Q) what are natural pesticides ? Adv & disadv of natural pesticides ★

NATURAL PESTICIDE

It is any toxic substance used to kill animals or plants that cause economic damage to crop

Advantages

- * They are cheap.
- * They are less harmful to human beings and more effective against pest
- * They are more stable and can be kept for prolonged period
- * They are used to control vectors

Disadvantages

- * The onset of action is slow.
- * The quantity of pesticides required more

(10) Explain Tobacco, pyrethrum, neem

TOBACCO

Synonym: Tambaku

Chemical constituent: Nicotine

MOA

- * In insects nicotine is fast acting nerve toxin
- * It competes with acetylcholine by bonding with its receptors and causes uncontrolled nerve firing
- * The disruption of normal nerve impulse activity results in rapid failure of system.

uses.

- * Antibiotic
- * Antispasmodic
- * Anthelmintic
- * Sedative
- * Narcotic
- * Emetic

PYRETHRUM.



Synonym: Insect flower

Chemical constituent: Pyrethrin

MOA.

- * It disrupts sodium and potassium ion exchange processes in insect nerve fibres and interrupts normal transmission of nerve impulse.
- * It is extremely fast acting and causes paralysis.

uses - Insecticide

NBBM

Synonym: mangosa.

chemical : Nimalon

constituents

MOA:

- * It causes insects to stop feeding by the hormonal effects
- * It disrupts normal development by interfering with chitin synthesis

uses

- * Insecticides
- * antifeedants
- * nematocides
- * antimicrobial agent.

★
① Define pharmacognosy? write history & scope of pharmacognosy?

→ It is the branch of science which deals with the study of biological, chemical and therapeutic aspects of all crude drugs of plants, animals & inorganic origin.

History

- * History of herbal medicine is old as human civilization
- * In the nineteenth century, the term "materia medica" was used for the subject which is now known as "pharmacognosy"

- * Herbal medicines were practiced by practiced by India, china, Egypt and Greece even before christian era (BC), which is proved by the work of Papyrus Ebers
- * of Egypt
- * the symbol of medicine "Snakes twisted around the staff" is the symbol used to represent greek god of healing "Asclepius"
- * Hippocrates, the father of medicine mentioned about 300 - 400 plants used for various illness during 400 BC
- * In 1803, Narcotics was isolated from opium
- * In 1806, Morphine was Isolated from opium
- * An atlas describing anatomical features of powdered drug is published in the yr 1904
- * A German Scientist discovered the term pharmacology in the year 1815.
- * A large portion of Indian population, even today depends on Indian System of medicine "Ayurveda"

Scope

- * The Scope Includes the study of physical, chemical and therapeutic properties of crude drugs of biological origin
- * Cultivation & collection of medicinal plants
- * Extraction, Isolation & Analysis of phytochemicals
- * Research tool in new drug delivery system
- Isolation of active constituents → Formulation of Suitable dosage form.

- * used as pharmaceutical aid such as flavouring agent, coloring agent
- * Natural product acts as model for synthesis of new drug.
- * Herbal preparations.

★

12. Explain cell wall constituents & cell inclusions

Cell wall constituents

The cell wall of plant cell composed of cellulose, lignin, cutin, suberin, mucilage.

(i) cellulose

* It is the main constituent of plant cell wall, chemically a polysaccharide consists of long chain of β -glucose

(ii) lignin ★

* It is present in middle lamella of woody tissue and other thickened cell

* Chemically, it is complex phenylpropanoid polymer.

Test

pinch of cassia powder on slide + ^{equal} ~~5~~ drops of phloroglucinol & conc HCl + Transfer a portion into another slide and add few drops of chloral hydrate.

Obs

Spindle shaped fibres take pink colour due to presence of lignin.

(iii) cutin

- * It is the characteristic constituent of the cuticle
- * It is the oxygenated form of fatty acids known as cutinogenic acid, which is relatively impermeable to water & gas.

(iv) Suberin

- * It is present in the wall of cork cell ^(dead) preventing the entry of water.
- * It is the condensed or oxygenated form of fatty acids known as suberinogenic acid.

(v) Mucilage ★

- * Mucilage is a polysaccharide complex of sugar and uronic acid.
- * They are insoluble in alcohol but swell and dissolve in water.

Tests

Pinch of Isapgol powder on slide + few drops of ruthenium red (observe under microscope).

Obs

Epidermal cells swell up and take pink colour due to mucilage.

Cell Inclusions

- * They are living and non living cell inclusions (organic substances).
- * Non-living cell inclusions are further classified into reserve food, excretory & secretory products.

Starch grains.

* Starch is present in different parts of the plant in the form of granules

* chemically starches are polysaccharide containing β amylose & amylopectin

* Starch of pharmaceutical interest is obtained from maize, potato, rice, wheat

volatile oil.

* occurs as droplets in plant cell. It is soluble in alcohol & sparingly soluble in water

Calcium oxalate

* These are considered as excretory product of plant metabolism.

5 mark important concepts



① write a note on differences between organized and unorganized drugs with ex.



organized drug

① It is a part of plant or animal with definite cellular organization

~~② These are solid in nature~~

② These are solid in nature

③ Identified by microscopic characters.

④ Botanical or zoological terminology can be used to describe these drugs.

Ex: clove, fennel

unorganized drug.

① It is produced from plant or animal which lacks definite cellular organization.

② These are solid, semi solid or liquid in nature.

③ Identified by chemical tests.

④ There is no any terminologies to describe these drugs

Ex: - Castor oil, opium

REQUIREMENTS

① CINCHONA ★

Climate: Tropical
Temp: 60-70°F
Humidity: High
Rainfall: 250-350 cm/ann
Soil: Sandy soil
pH: 4.2-5.2
Altitude: 1000-3000 m

② CINNAMON
Climate: Tropical
Temp: 60-70°F
Humidity: High
RF: 150-250 cm/ann
Soil: Sandy soil
pH: 4.2-5.2
Altitude: 800-1000 m

CULTIVATION ★

- * Seeds are sown in soil under moist environment in nursery beds
- * As they grow into plantlets uniform distance is maintained b/w them
- * When plantlets attain 25 cm height they are transplanted to field 24 cm apart
- * Fungal infection to the plants can be avoided by supplying organic fungicides

- * Seeds are sown in soil under moist environment in nursery beds
- * As they grow into plantlets uniform distⁿ is maintained b/w them
- * When plantlets attain 25 cm height they are transplanted to field 24 cm apart
- * Fertilizers are applied in 2 equal doses to encourage the growth

COLLECTION ★

- * Harvesting is carried out when the tree is 10 yr old
- * The highest quantity of quinine at this age
- * The trunks and branches are beaten with sticks to loosen the bark, then it is removed using a knife
- * The strips obtained are then dried

- * Harvesting is done in grading season when it is easy to peel off the bark from shoots
- * Longitudinal & transverse incisions are made, strips thus formed are made into bundles
- * During drying bark contracts into longer quills to form compound quills
- * Smaller quills are inserted into longer quills to form compound quills

③ Clove.

Climate :- Tropical.

Temp :- 60-70 °C

Humidity :- High.

RF :- 150/250 cm/ann

Soil :- Sandy Soil

PH :- 4.2 - 5.2

Altitude :- 800 - 1000 m.

- * Seeds are sown in soil under moist environment in nursery beds from August - September.
- * As they grow into plantlets uniform dist' is maintained b/w them.
- * When plantlets attain 25 cm height they are transplanted to field 24 cm apart.
- * Fertilizers like Ammonium Sulphate Superphosphate are applied in 2 equal doses to encourage the growth.

- * Harvesting is done 10 yr old when the tree is 10 yr old.
- * Leaves are handpicked or collected by beating with bamboo.
- * Cloves are dried in the sun, freed from foreign materials & graded.
- * The leaves on drying turn brownish-black in colour.

④ Datuna

Climate :- Tropical region

Temp :- 60 - 70 °C

Humidity :- High.

RF :- 250 - 350 cm/ann

Soil :- Sandy Soil

PH :- 4.2 - 5.2

Altitude :- 1000 - 2000 m.

- * Seeds are sown in soil under moist environment from August - September.
- * Germination is very slow, rate of germination is increased by soaking in water.

- * When plantlet attain 25 cm weeding and thinning are necessary.
- * Fertilizers are applied in 2 equal doses to encourage the growth.

- * Harvesting is done 12 months after 4 months of its cultivation.
- * Leaves are branches are removed.

- * Dreg is dried in the sun and marketed by packing in gunny bags.

⑤ PHEEDRA.

Climate: Tropical

Temp: 60-70°F

Humidity: High

RF: 50 cm/ann

Soil: Bandy Soil

pH: 4.2 - 5.2

Altitude: 2500-3000m

⑥ FENNEL

Climate: Cool

Temp: 50-60°F

Humidity: High

RF: 250/350 cm/ann

Soil: Red Soil

pH: 4.2 - 5.2

Altitude: 1000-1500m

- * Seeds are sown in soil under moist environment in the spring at a distance of 5cm.
- * When plant attain 25cm
- * Fertilizers are necessary
- * Fertilizers are applied in 2 equal doses to encourage the growth

- * Fennel is cultivated by dibbling method. Quality fruits are sown just before the spring
- * Four to five seeds are put at a time in holes at a distance of 25cm in between them.
- * When plant attain 25cm height
- * Irrigation & weeding are necessary
- * Fertilizers like Ammonium Sulphate, Superphosphate are applied in 2 equal doses to encourage the growth

- * Harvesting is carried out when the plant is 4yr old.
- * Alkaloid content of the drug varies from season to season. It is found to be maximum in autumn
- * Drug is dried in the sun and stored in well closed containers

- * Harvesting is carried out when the fruits are ripe
- * Fruits are dried in the sun and separated by thrashing

⑦ LIQUORICE

Climate :- Cold
Temp :- 50-60°F
Humidity :- High
RF :- 50-100cm
Soil :- Sandy soil
PH :- 5-8
Altitude :- 1000-1500 m

- * Propagation of the plant is done with young pieces of stolons
- * plant requires sandy soil which is well prepared and added with farmyard manure
- * when plants attain 25cm height thinning & weeding are necessary
- * Fertilizers are applied in 2 equal doses to encourage the growth

- * Harvesting is carried out when the plant is 14 yr old
- * Roots are dug up before it bears fruits
- * drug is washed and dried in sun & then in shades

⑧ NUX-VOMICA

Climate :- Tropical
Temp :- 60-70°F
Humidity :- High
RF :- 250-350 cm
Soil :- Sandy soil
PH :- 4.2 - 5.2
Altitude :- 1000-1500 m

- * seeds are sown in soil under moist environment during May-June in polythene bags
- * germination is very slow, rate of germination is increased by soaking in water
- * when plants attain 25cm height they are transplanted to field in rows

- * Harvesting is carried out when the plant is 4yr old
- * Ripened fruits are collected and seeds are freed of pulp. They are washed thoroughly
- * seeds are dried on mat and packed in gunny bags for marketing

⑨ QUASSIA

Climate: Tropical
Temp: 60-70°F
Humidity: High
RF: 250-350 cm/ann
Soil: Sandy soil
PH: 4.2-5.2
Altitude: 1000-1500m

- * Seeds are sown in soil under moist environment during summer
- * Germination is very slow, rate of germination is increased by soaking in water.
- * About 500g seeds are sufficient for 1 hectare, seeds are sown at a distance of 6m.
- * When plant attain 25cm height thinning & weeding is necessary

⑩ RAUWOLFIA

Climate: Tropical
Temp: 60-70°F
Humidity: High
RF: 250-350 cm/ann
Soil: Sandy soil
PH: 4.2-5.2
Altitude: 1000-1500m

- * Seeds are sown in soil under moist environment in nursery beds
- * As they grown into plantlets uniform distance is maintained b/w them.
- * When plantlets attain 25cm height they are transplanted to field 24cm apart
- * Fertilizers like Ammonium Sulphate, Super phosphate are applied in 2 equal doses to encourage the growth.

* Harvesting is carried out during flowering stage

- * Wood is obtained from trunk & branches
- * Woods are cut into small chips. Then immediately dried to prevent growth of mould
- * Wood turns from white-yellow colour on drying.

- * Harvesting is carried out when the plant is 14 yr old.

- * When plants are uprooted roots are cut properly & it is washed to remove earthy matter
- * Then roots are dried in air and packed in well closed container

② Define & classify carbohydrates with ex

Carbohydrates

Carbohydrates are organic compound which yield polyhydroxy aldehyde or polyhydroxy ketone on hydrolysis.

- They consists of three functional groups.

-OH group

(Hydroxy)

>C=O group

(Keto)

-CHO group.

(Aldehyde)

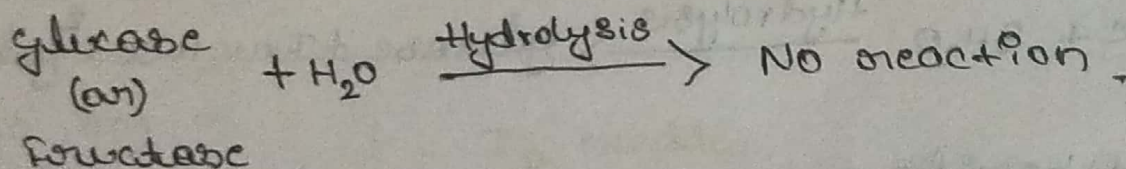
Classification.

Based on no of sugar units obtained upon hydrolysis

① Monosaccharides.

* These are the carbohydrates which consists of single sugar unit and cannot undergo further hydrolysis

* They are also known as simple sugars.



② Oligosaccharides.

* These are carbohydrates which consists of 2-10 units of monosaccharides and can undergo further hydrolysis.

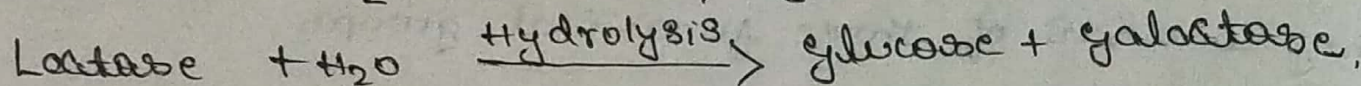
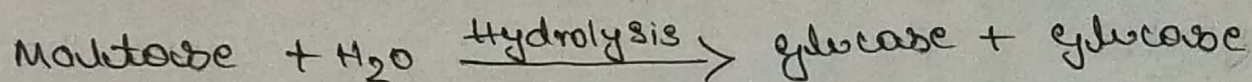
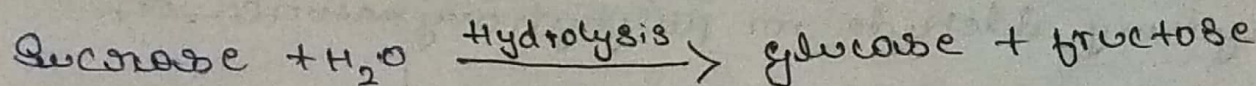
- Oligosaccharides are classified based on no of monosaccharide units produced, upon hydrolysis

5-6:30

- Disaccharides.

They give two units of monosaccharides upon hydrolysis

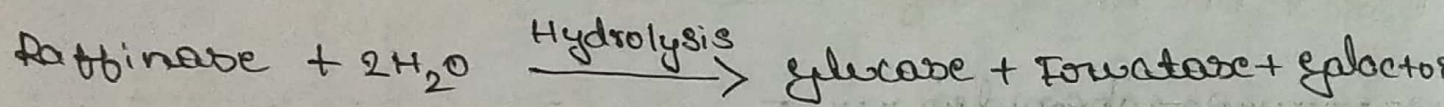
Ex: Sucrose, Maltose, Lactose



- Trisaccharides.

They give three units of monosaccharides upon hydrolysis

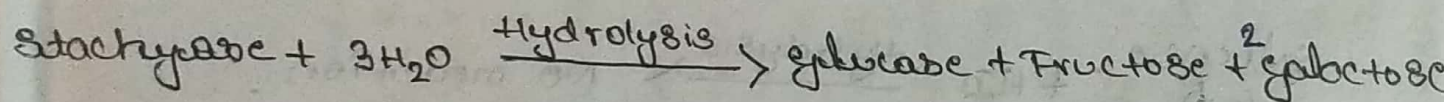
Ex: Raffinose



- Tetra Saccharides

They give four units of monosaccharides upon hydrolysis

Ex: Stachyose



② Polysaccharides

These are carbohydrates which consists of more than 10 units of monosaccharides and can undergo hydrolysis.

Ex: Starch, Inulin, glycogen

④ give general Identification Test of Reducing Sugar / carbohydrates

TEST	OBSERVATION	INFERENCE
Fehling's Test		
Fehling's sol + Few drops of SS (Boil).	Yellow-Red precipitate	Reducing sugar present.
Tollen's Test.		
Sample Sol + Few drops of Tollen's reagent	precipitate of Silver.	Reducing sugar present.
Osazone formation Test		
Sample Sol + phenylhydrazine + Acetic Acid + Sodium Acetate	If Needle shaped crystals forms.	Reducing sugar present.
Molisch's Test		
Sample Sol + Molisch's reagent + few drops conc. H_2SO_4	Formation of violet-purple colour.	carbohydrate present.

⑤ Explain difference b/w gums & mucilage with ex.



Gums

- * They are pathological products consisting of Ca, Mg, K Salts
- * They are Sugars and uronic acid

* They are not normal products of plant metabolism but as a result of injury.

* They are plant exudates

* They are used in dental and other adhesives

Ex: Acacia

Trogonth.

Mucilage

* They are physiological products

* They are Sulphonic acid esters

* They are normal products and are produced without injury to the plant.

* They are not exudates of plants

* They are used as demulcents, bulk laxatives

Ex: Desoghula

Agar

⑥ Method of analysis of lipids? ★

Iodine value

* Iodine value is the number, which expressed in grams is calculated as Iodine absorbed by 100g of substance under specific condition.

procedure

① castor oil in 250ml Iodine flask + 1ml carbon tetrachloride + 20ml Iodine monochloride sol + 15ml KI sol

② ~~add~~ titrate with Sodium thiosulphate ($\text{Na}_2\text{S}_2\text{O}_3$) using starch as Indicator.

$$\text{Iodine value} = \frac{1.269 (b-a)}{w}$$

a = ml of starch

b = blank

w = weight of oil

saponification value

* It is the no of milligrams of KOH required to neutralize 1g of sample of oil.
free fatty acids resulting from complete hydrolysis of

procedure

① 2g of oil in RBF + refluxed with 25ml ethanolic KOH + phenic powder + 1ml phenolphthalein sol

② Titrate with 0.1 N HCl

$$\text{Saponification value} = \frac{28.05 (b-a)}{w}$$

a = ml of HCl

b = blank.

w = weight of oil

Acid value

* Acid value is the no of milligrams of KOH required to neutralize the fatty acids present in 1 g of oil sample

procedure

- (i) 1g of oil + 5ml (ethanol & ether) + 0.1 ml phenolphthalein
- (ii) Titrate with 0.1M KOH until pink colour appears

$$\text{Acid value} = 5.61 \times \frac{n}{w}$$

n = mg of KOH

w = wt of sample

7 write a note on plant fibres ★

* Natural fibres are hair like raw materials obtained from plant & vegetable source

plant fibre

Stem	→	Jute, Banana
Leaf	→	palm
Seed	→	Cotton
Fruit	→	Cashew
Grass	→	Bamboo

uses

- * preparation of Surgical dressing, Sutures & ligatures
- * In Insulation purpose, manufacture of gunny bag

COTTON

Synonym

→ Raw cotton, purified cotton, Absorbent cotton

Biological source

* Epidermal trichomes of the seeds of cultivated species *Gossypium herbaceum* belonging to family malvaceae.

chemical const.

- (i) 90% cellulose
- (ii) 8% moisture
- (iii) 2% Pates, oil, cell content.

uses.

- * As a filtering medium.
- * In surgical dressing
- * Absorbent cotton absorbs blood, pus, mucus & prevents infections in wounds.

preparation of cotton.

- * plants after flowering, bear fruits known as capsules bearing numerous seeds covered with hairs known as bolls
- * Bolls collected, dried and taken to ginning press where trichomes are separated from seeds.

2 types of gins.

(1) Saw gins

- * Circular saws grip the fibres and pull them through narrow slot. produces variety with shorter length, which are used in manufacture of absorbent cotton.

(2) Roller gins,

- * has rough rollers to grab the fibres & pull it under rotating bar, long fibres are used for production of cloth.
- * Impurities are removed, washed, bleached, dried, packed & sterilized by gamma radiation.

8) Define & classify protein with suitable examples

* proteins are complex nitrogenous organic substances of plants & animal origin

* proteins contain carbon, hydrogen, oxygen, nitrogen & rarely sulphur

* They are synthesized by the living cells and are essential part of structure of the cell

Proteins

only
Cysid AA on hydrolysis)

Simple protein

① Albumin

Ex: Egg albumin
lactalbumin

② Globulin

Ex: Serum globulin
myosin

③ Glutamines

Ex: glutenin of wheat
oryzenin of Rice

④ Proteamines

Ex: gliadin of wheat
hordein of barley

⑤ Histones

Ex: globin

non protein
component
Cysid AA & prosthetic group

Conjugated protein

① Chromoprotein

Ex: Haemoglobin
chlorophyll

② Lipoprotein

Ex: lecithin of fatty acids

③ Metalloproteins

Ex: Haemoglobin
myoglobin

④ Nucleoproteins

Ex: Tobacco mosaic virus

⑤ Mucoprotein

Ex: Egg albumin
Serum globulin

derived proteins (degradation products)

Ex: amino acids

polypeptides

denatured proteins

④ chemical const, uses & method of production of honey?
chemical const.

* glucose, fructose, sucrose

* dextrin, formic acid

* Also contains enzymes, proteins, vitamins

uses

* used as demulcent and sweetening agent

* used as antiseptic

* applied to burns & wounds

* used in creams, lotion, soft drinks

collection & preparation

* Nectar from certain plants is taken by worker bee

* Nectar mainly contains sucrose, it passes through oesophagus and comes in contact with enzyme invertase, which present in salivary secretion

nectar $\xrightarrow{\text{Invertase}}$ Invert Sugar

* worker bees deliver the honey

* Removal of bees by smearing of comb

* Honey is Expresed by centrifugation

* Applying the pressure is not suggested as honey is liable to contamination of bee wax present in comb.

* Honey obtained from the comb is heated to 80°C so that impurities floating on surface are removed.

* Density of honey is adjusted to 1.35 - 1.37

* After heating and removal of impurities, honey should be cooled rapidly to avoid colour darkening on storage.

(10) Chemical tests for protein

TEST	OBSERVATION	INFERENCE
Biuret Test		
Sample + 1ml NaOH + 1ml CuSO_4 + shake well	Appearance of Bluish - violet colour	protein present
Xanthoproteic test		
Sample + con H_2SO_4 + shake well + Heat	yellow colour	protein present
Millon's Test		
Sample + millon's reagent + shake well	white ppt	protein present

Ninhydrin Test

Sample + Ninhydrin sol
+ shake well + heat

deep blue
colour
appears

protein
present

(II) Cultivation & collection of opium

- * The seeds of opium are cultivated in batches
- * The cultivation is done b/w Sept & April
- * A gap of 25 cm should be maintained b/w two consecutive plants
- * Before sowing the seeds, they are mixed with sands properly
- * About five - six capsules appear on each plant
- * After petals fall from poppy, pod is lanced and opium latex is exuded,

Collection

- * Generally lanced in afternoon & opium latex is collected in early morning
- * Each pod can be lanced 4 to 7 times
- * Opium collected is weighed on a daily basis before an officer of the Narcotics dept
- * Opium is transported to weightment centre and transferred to standard containers of known weight.

12. Stomata

* Stomata is a minute epidermal opening present on arial parts of the plant with following characteristics

- (i) A central pore
- (ii) Two kidney shaped guard cells and epidermal cells covering the guard cells

Types of Stomata

* According to the type of guard cells

- (i) moss type
- (ii) gymnospermous type
- (iii) gymnospermous type
- (iv) Dicotyledonous type

13. write a note on Surgical Dressing

* The word surgical dressing ~~is used~~ includes all the materials which are used alone or in combination to cover the wound

* The purpose of application of dressing is to protect the wound and favour its proper healing

* A material which holds the dressing in desired position is known as bandage

Dressing are meant for following functions

- * To reduce or prevent infections
- * To offer protection to healing wound
- * To offer mechanical

Surgical dressing.

- * They should be sterilized before use
- * They should be stored in well ventilated place
- * Adhesive products should not be allowed to freeze
- * They should not dyed unless mentioned in monograph

Surgical dressing^{are} classified as:

(a) Fibres — [Medicated
non-medicated

Ex: Cotton, wool, silk

Ex: Boric acid wool

(b) Fabric — [Medicated
Non-medicated

Ex: Absorbent lint

Ex: Boric acid lint.

(c) Bandages — [Medicated
Non-medicated

Ex: zinc oxide plaster
oil impregnated material

Ex: cotton bandage.

14. different parts of ^{plant} cell with functions

(1) Cell wall

- * The primary function is to protect and provide structural support to the cell
- * It determines cell shape
- * Support & mechanical strength
- * prevents cell membranes from bursts
- * physical barriers to pathogens.

② Cell membrane,

* plays important role in entry and exit of specific substances within the cell

③ Nucleus

* The vital function of a nucleus is to store DNA or hereditary information required for cell division, metabolism & growth.

→ Nucleolus - It manufactures cells protein producing structures and ribosomes

→ Nucleopore - Nuclear membrane is perforated with holes called nucleopore that allows proteins & nucleic acids to pass through

④ Plastids

* It includes leucoplasts & chloroplasts

* leucoplasts are involved in storage of protein, lipid, starch.

* chloroplasts are involved in photosynthesis

⑤ Ribosomes

* These are the sites for protein synthesis, hence referred as protein factories of the cell

⑥ Lysosome

* They provide energy by breaking down carbohydrate and sugar molecules, hence referred as power house of cell.

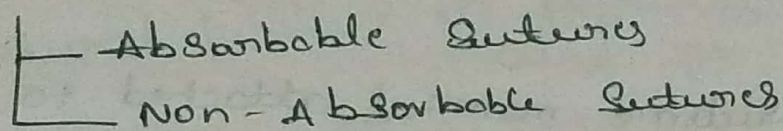
⑦ Lysosome

- * They are called as suicidal bags as they hold digestive enzymes in an enclosed membrane
- * They perform function of cellular waste disposal by digesting worn out organelles, food particles & foreign bodies in the cells.

15. What are ligatures & Sutures? classify them with ex

Sutures

A surgical suture is a fibre used to hold wound edges during healing



① Absorbable Sutures

- * Absorbable sutures are those materials that are capable of digested by the body.

Ex: polyglycolic acid
polygalactine
polypropylene

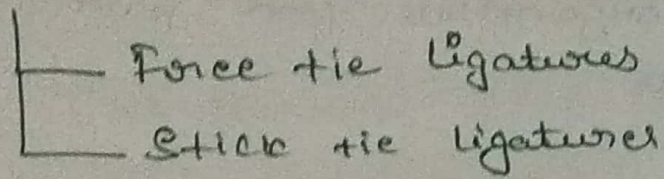
② Non-Absorbable Sutures

- * Non absorbable Sutures are not absorbed. They are made of silk, nylon, stainless steel

Ex: silk
nylon,

Ligatures

* A ligature is a suture without a needle which is used to tie blood vessel and other tissues together.



Force tie ligatures

* Single strands of suture material used to ligate a vessel duct or other structure.

Stick tie ligatures

* Single strands of suture material attached to a needle to ligate a vessel duct or other structure.

16. What are growth regulators? classify them with ex.

* plant growth regulators include plant hormones and also chemicals, which influence their growth and development.

5 recognized groups

- (i) Auxins
- (ii) gibberellins
- (iii) Cytokinins
- (iv) Ethylene
- (v) Abscissic acid

* All plant hormones are growth regulators, but all growth regulators are not hormones.

Hormones

① Natural hormones

* These are produced by some tissues in the plant.
Also called as Endogenous hormones.

Eg: Auxins (IAA)

② Synthetic hormones

* These are produced artificially and are similar to natural hormone in physiological activity. Also called as Exogenous hormone.

Eg: Auxin (IBA)

Classification

① plant growth promoters

* They promote cell division, cell enlargement, flowering, fruiting & seed formation.

Ex: Auxins, gibberellins & cytokinins

② plant growth inhibitors

* These chemicals inhibit growth and promote dormancy and abscission in plants.

Ex: Ethylene, Abscissic acid

17. write a note on Isabgol & Swelling Index

Synonym: ~~Isa~~ Isabgol, Ispagol

BS :- dried seeds of *Plantago ovata* belonging to family *Plantaginaceae*.

cc :- (i) pentosans and aldobionic acid

(ii) proteins & fixed oil

uses :- (i) used as laxative in constipation

(ii) used in the treatment of dysentery

(iii) demulcent

(iv) stabilizing agent in ice cream preparation

(v) used in enteric coating tablets

(vi) sustained release of drug formulation

(vii) disintegrating agent for tabs

Swelling factor

* It is used to determine the purity of the drug

* Around 4 g of Isabgol seeds are taken in a 25 ml measuring cylinder.

* 20 ml water is added to it with constant shaking

* The content is left undisturbed for about 1 hr

* The volume occupied by the seeds is known as Swelling factor

* The Swelling factor of Isabgol seeds is 10-14.

Bee wax

Synonym :- white & yellow bee wax

Bio source :- purified wax of *Apis* species belongs to family *Apidae*.

preparation

* Yellow bee wax

- * After obtaining honey from the bee-hive, the hives are subjected to boiling water, which leads to oozing of the wax
- * During boiling, Impurities and the remains of honey dissolves and settle down
- * The melted wax floats on the water surface
- * It is further cooled to enable its solidification
- * The wax obtained is further purified to obtain yellow bee wax.

white bee wax

- * It is a bleached yellow bee wax
- * The melted form of yellow bee wax is bleached by direct sunlight or treated with charcoal, caustic, chromic acid or chlorine to obtain white bee wax

cc :- hydrocarbons, Lactones, cholesterol esters

uses :-

- (i) manufacturing candles

- (ii) In dentistry

- (iii) emulsifying agents in preparation of ointment

- (iv) preparation of lipsticks & ointments

2 mark important concepts



① List out various types of plant constituents

- * Acids
- * Alcohols
- * Carbohydrates
- * Alkaloids
- * Glycosides
- * Lipids
- * Proteins
- * Vitamins
- * Enzymes

② Types of phytoconstituents in plants

- * Alkaloids
- * Glycosides
- * Tannin
- * Flavonoid
- * Emidogale
- * flavonoid

③ Glycosides

- * Glycosides are naturally occurring complex organic compound consists of sugar linked to non-sugar part in a particular manner

Ex: Digitoxin

Atoin

④ primary cell constituents ? give ex

- * Primary cell constituents are the chemicals from which the plants are made. These constituents are original in nature & synthesized by the plants.

Ex': carbohydrates
lipids
proteins
vitamins

⑤ pharmacognosy & current studies [Seydler]
* pharmacognosy is the study of crude drugs obtained from plants, animal & minerals & their constituents.

→ ppl have realized that drug from natural origin is not only economical even safer too
→ Active constituents from plants led to rapid development in pharmacognosy.

⑥ Define primary metabolites with ex.
* primary metabolites are compounds synthesized by plants as essential part of metabolic pathway like normal growth, development, reproduction etc.
Ex': Alcohol, amino acids, vitamins.

* Secondary metabolites are compounds synthesized by plants not as essential part of metabolic pathway but as side product.

Ex': gums, rubber, toxins, terpenoids

Alkaloids, pigments

⑦ what is latex? give ex

* latex is a sticky, milky colloid drawn off by making incision & collecting the fluid in a vessel in a process called 'tapping'

Ex: opium, Papain

⑧ Define garbling

* It is a important process in preparation of crude drugs which involves removal of unwanted matter such as part of some plant, matter, discoloured, dried plant, dirt, soil or added adulterants

⑨ coppicing

* coppicing is the process of cutting trees down and allowing the stumps to regenerate for a no. of yrs and then harvesting the resulting stems

* It makes the use of natural regeneration properties

⑩ felling

* It is the process of cutting down individual trees, an element of the task of logging

⑪ mulching

* It is the process of applying some material to the surface of your garden soil to some certain purpose

* To retain soil moisture

* Reducing weed

* Improving fertility & health of soil.

Adulteration & Substitution

12. * Adulteration is a practise of substituting original crude drugs partially or whole with other similar looking substance

* Substitution with artificially more featured substances prepared to resemble original drugs

13. Saponification value / Acid value

* It is the no of milligrams of KOH required to neutralize free fatty acids resulting from complete hydrolysis of 1g of sample of oil.

Sign

* It indicates length of carbon chain.

* It gives idea about average molecular weight.

K₂ Acid value

* Acid value is the no of milligrams of KOH required to neutralize the fatty acid present in 1g of oil sample.

Sign

* It is the indication of rancid state. Generally rancidity cause free fatty acids.

(3) Iodine value & Sign

* Iodine value is the number, which expressed in grams is calculated as iodine absorbed by 100g of substance under specific condition

Sign

* It measures relative degree of unsaturation in oil

(4) Ester value & Hydroxyl value

* Ester value is the no of mg of KOH required to saponify the ester in 1.0g of substance

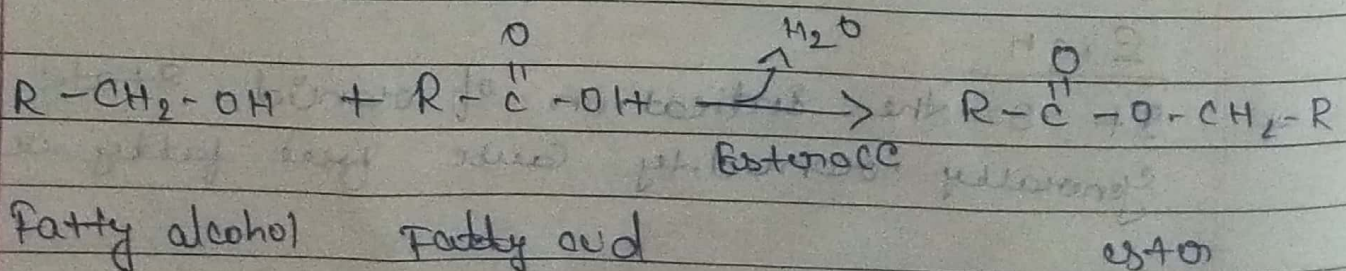
* Hydroxyl value is the no of mg of KOH equivalent to the Hydroxyl content of 1.0g of substance

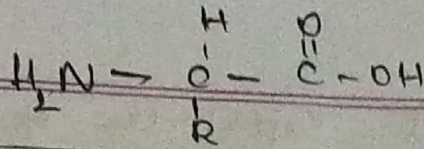
(5) Rancidity

* Rancidity is the process of complete or incomplete oxidation or hydrolysis of fats & oils when exposed to air, light or moisture resulting unpleasant taste & odour.

(6) Chemistry of lipids

* Lipids are organic compounds formed mainly from alcohol & fatty acids combined together by ester linkage.





proteins

proteins are polypeptide chains of amino acids
they are formed of carbon, oxygen, hydrogen,
nitrogen may also contain S, P

Actin, myosin, keratin, collagen

(8) conjugated protein & derived protein

* protein associated with non protein part
or prosthetic group are conjugated protein
Nucleoproteins, Lipoproteins, glycoproteins, mucoproteins
metalloproteins, chromoproteins

* Derived proteins are degradation products
obtained by partial hydrolysis of simple
protein by acids or enzymes.
peptones, peptides, polypeptides, metaproteins
coagulated proteins

(9) properties of proteins

Taste: Tasteless, Hydrolytic product

Odour: Odourless

Viscosity: depends upon, pH, conc, size & shape

Shape: globular, oval, fibrous or elongated

(10) gelatin & its uses

* gelatin is a protein made from animal
products

* used for aging skin
arthritis
brittle bones & nails
obesity.

11. pharmaceutical Importance of proteins

- * protein-based drugs are fastest growing class of drugs
- * In production of Hormones
- * In production of Enzymes
- * In production of Insulin
- * In Vaccines
- * In producing Antibodies

12. Source & chemical constituents of ^{olive} oil

Source

- * Olive oil is a fixed oil obtained by expression from pericarp of ripe fruits of *Olea europaea* belonging to family Oleaceae.

chemical const

- * oleic acid, palmitic acid, stearic acid, linoleic acid

13. Shark liver oil

Source

- * obtained from liver of shark *Hypoprion brevirostris* used in

uses ~~const~~ : Xerophthalmia & nutritive

14. Ephedra

Source

Dried young stem of *Ephedra glandiana* belonging to family Ephedraceae

uses

- * Employed in asthmatic condition.
- * Sympathomimetic.

15. Source & uses of Quassia

Source

poised wood of stem *Aeschynomene Fexella* belonging to family *Simarubaceae*

uses

- * Bitter tonic
- * Insecticide
- * Anthelmintic
- * Antifungal, Antitumor.

16. chemical const & uses of Licorice

chemical const

- * glycyrrhizin
- * glucuronic acid
- * Sugars
- * Resins, volatile oil

uses

- * antioxidant
- * anti-inflammatory
- * antimicrobial