Basic Botany

First year Chemical Sciences Students- Botany

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1. Biological sciences are known since Paleothetic times. Biology started by illustrations of different plant and animal species where human survival mainly relied on the gathering knowledge of them.
2. **Morphology**; came first which describes the **external** structure of plants. Then with the invention of the light microscope, **Anatomy** came next with the extensive studies of the plant **internal** structure.
3. The electron microscopy was a revolutionary step for the start of many sciences such as **Microbiology** and **Genetics** where other branches were derived from as **Genetic Engineering**, **Molecular Biology** and **Biotechnology** .
4. **Molecular Biology** is concerned with the study of:

   1. Genetic structure 2. Micro-cellular structure

   3. Cellular differentiation..

- 5. Molecular analysis; comparing between different types of proteins, enzymes, hormones as well as amino acids' sequences in both DNA and RNA. Biology or life sciences are concerned with the study of a group of characters that characterizes only the living organism such as:

  1. Growth 2. Motility 3.Metabolism

  4. Reproduction 5.Adaptation

- **Anatomy** deals with the study of internal structure, function and evolution of the living being.
- **Cytology** deals with the structure and function of different cells.
- **<u>Scientific Information Resources</u>**:
  1. Where do we obtain them from?
  2. How to verify their credibility ?

Scientific Information Resources

It starts by observation and description

Information are gathered through experiments

Deduction of general relationships and discussions to come up with a hypothesis

If proven, the hypothesis becomes a theory and when generalized, it becomes a law. The verification of the studies done is the main core of science.

A new discovery can change previous laws, which is known as Scientific Criticism where it mainly relies on critical curiosity.

In conclusion, facts are only investigated through accuracy and honesty.

Research works are discussed through conferences and periodical meetings.

Researchers publish their research work as a research paper in specialized journals.

Scientific Nomenclature: is a formal system of naming species of living beings, structures, functions, even chemical components where Latin or Greek forms are used.

Measuring Units:

1. **Length Units:** micrometre (10^{-3} mm), nanometer (10^{-6} mm), Angstrom (10^{-7} mm).
2. **Weighing Units:** mg (10^{-3} g), micro gram (ηg) (10^{-6} g), Nanogram (10^{-9}g), Pico gram or Dalton (10^{-12} g).

Dalton: it is equivalent to the molecular weight of hydrogen atom. (the molecular weight of water molecule is 18 Daltons, while the molecular weight of hemoglobin is 64500 Daltons).

Earth Creation History

- **The Earth was created 2-5 billion years ago.**
- **Two out of four living groups were found to inhibit aquatic environment i.e. *Algae*.**

The Living Organism:

- **Any living being is called "Organism"**
- **Organism: an organized system**
- **With a specific identifiable shape**
- **Each organ within this system has a specific function i.e. growth, reproduction, sensitivity, metabolism, etc…**

Biodiversity:

- **Biodiversity: the variety and variability of living organisms, their types and numbers at the genetic, species and ecosystem level.**
- **Variability in the Ecosystem:**
  1. **Dominant species**
  2. **Relatively dominant species**
  3. **Or those rich and poor population in a biological community.**
- **Biodiversity with respect to seasonal and habitat variations:**

1. **Biodiversity increases in warmer habitats, while decreases in colder ones.**
2. **Biodiversity increases as you elevate higher from sea level especially in heavy rain fall areas.**
3. **Biodiversity is always rich in tropical regions, while poor in desert environments (either dry or glacial).**
4. **Tropical forests occupy 7% of the earth's area however comprise 90% of the biological species.**

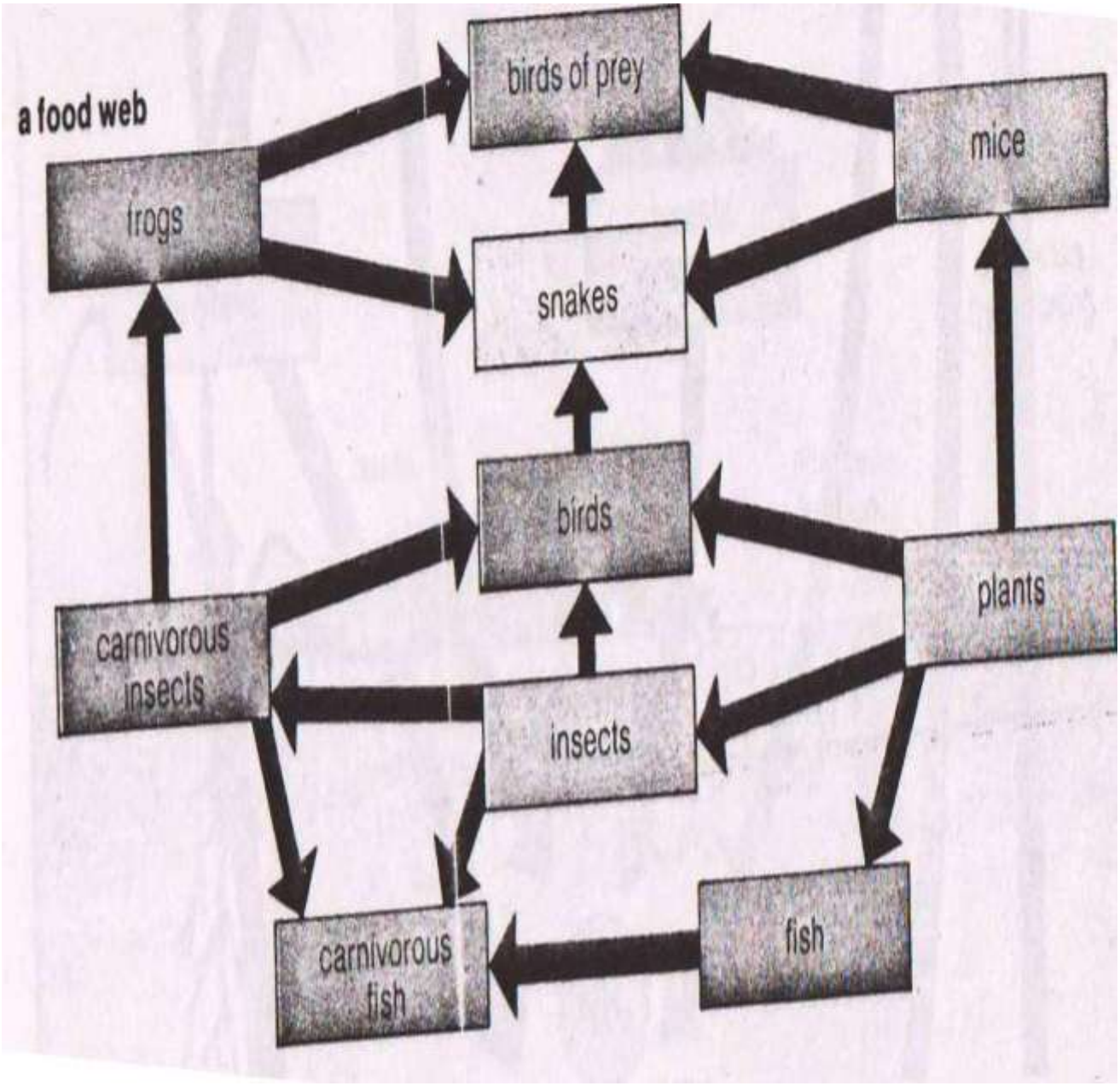


Fig. 1: Food Web

Fig. 2: Biodiversity with respect to habitat variations World wide

Classification Of Living Organisms:

- **Firstly, Organisms were classified as Plants and Animals for those reasons:**
  1. **A plant cell has a cellulosic (wooden) cell wall surrounding it, while animal cell has not, which allows it to change its shape i.e. *Amoeba***
  2. **Plant growth is unlimited unlike animal growth which is limited to a certain size**
  3. **Most animals have the ability to move**
  4. **Plants and animals differ in the type of nutrition: plants are auto- trophic, while animals are heterotrophic.**

- **Then, they were classified into *Prokaryotae* and *Eukaryotae*:**
  1. ***Prokaryotes* (primitive nuclei): Mostly primitive unicellular organisms or slightly multicellular that lacks a membrane-bound nucleus, their primitive nucleus is only comprised of DNA devoid of any nuclear membranes or nuclei. It divides by binary fission. i.e. *Monera***
  2. ***Eukaryotes* (True nuclei): Unicellular or multicellular organisms whose cell have a nucleus enclosed within membranes with chromatin matrix, nuclei, as well as organelles such as *Mitochondria* and Golgi apparatus. It reproduces vegetatively, sexually and asexually. i.e. *Fungi, Protista, Plantae* and *Anamilia*.**

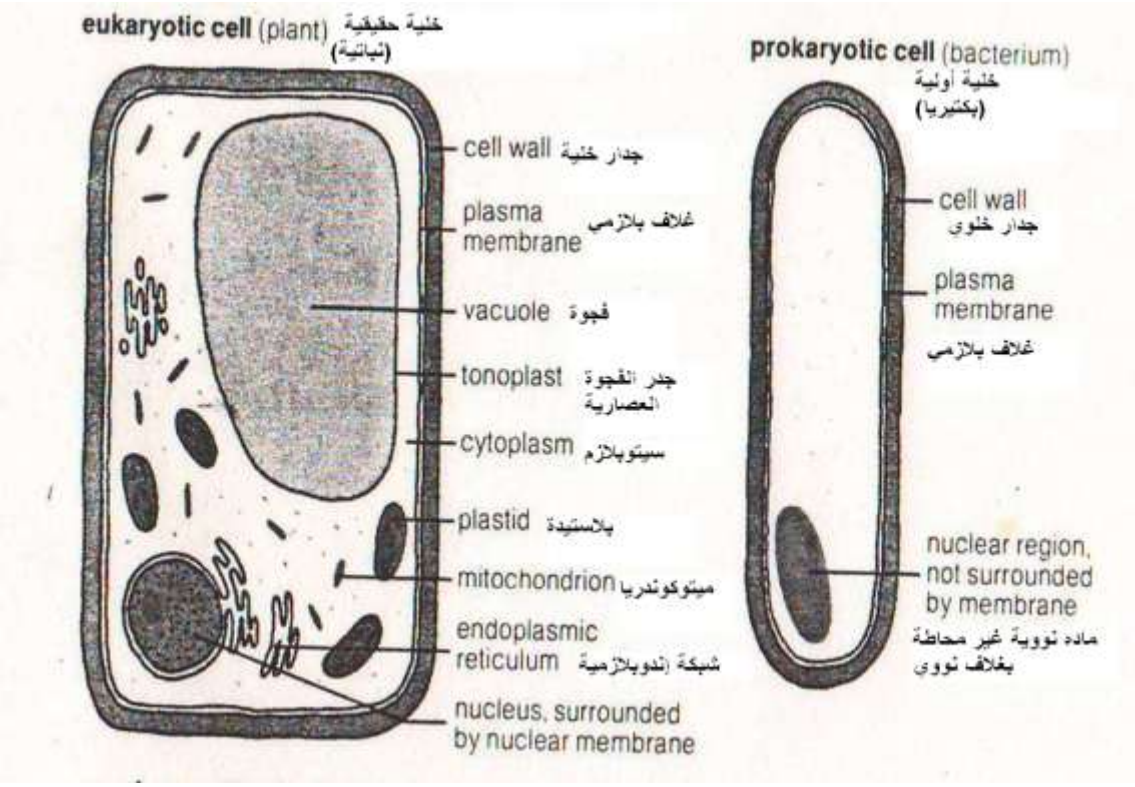


Fig. 3: Comparison between *Prokaryotes* and *Eukaryotes*

- **Finally, organisms were classified into five different groups according to different characters such as cell structure, form (shape), motility (movement) and nutrition.**

Table 1: Comparison bet\ween the five different kingdoms according to different characters:

Kingdom / Character	*Monera*	*Protista*	*Fungi*	*Plantae*	*Anamilia*
Cell Structure	**Prokaryotes**	**Eukaryotes**			
Form	**Unicellular**	**Mostly Unicellular**	**Multicellular**		
Nutrition	**Autotrophic or Heterotrophic**	**Phototrophic**	**Saprophytic, parasitic Or Symbiotic**	**Phototrophic**	**Holozoic**
Motility	**By flagella**	**By Flagella or Cilia**	**Non-motile**		**Contracting Fibrous tissue (muscles)**

Nutrition

Modes of Nutrition

A) Autotrophic:

- **Organisms that can make their own food through building their need from organic substances and inorganic ones.**
- **They were classified according to their use of energy into:**

1. Phototrophs **2. Chemotrophs**

1. **Phototrophic Nutrition:**

   • **Organisms who can obtain energy from sunlight like green plants which contain *Chlorophyll*.**

   $6CO_2 + 12H_2O \xrightarrow{\text{light energy}} C_6H_{12}O_6 + 6O_2 + 6H_2O$

   • **Also there's a type of bacteria named Green Sulfur bacteria rely on H_2S instead of H_2O as a source of Hydrogen.**

   $6CO_2 + 12H_2S \xrightarrow{\text{light energy}} C_6H_{12}O_6 + 12\ S + 6H_2O$

2. **Chemotrophic Nutrition:**
   Organisms obtain their energy through the oxidation of some organic substances such as ammonia. Those organisms possess a special enzymatic systems that helps in oxidizing and forming phosphoric bonds rich in energy.
   1. *Nitrosomonas* : Oxidizing ammonia into Nitrite
   $NH_3 + O_2 \rightarrow HNO_2 + H_2O + \text{Energy}$
   2. *Nitrobacter*: Oxidizing Nitrite into Nitrate
   $HNO_2 + O_2 \rightarrow HNO_3 + \text{Energy}$

B) Heterotrophs:

- **Organisms that can't make their own food by itself and so feed on the expense of other living organisms. They are divided into:**

1. **Holozoic** **2. Saprophytic**
3. **Parasitic** **4. Symbiotic**

1. ***Holozoic* Nutrition (Predation):**
   - ***Herbivores*: Organisms feeding on plants.**
   - ***Carnivores*: Organisms feeding on animals and insects.**
   - ***Omnivores*: Organisms feeding on both plants and animals.**

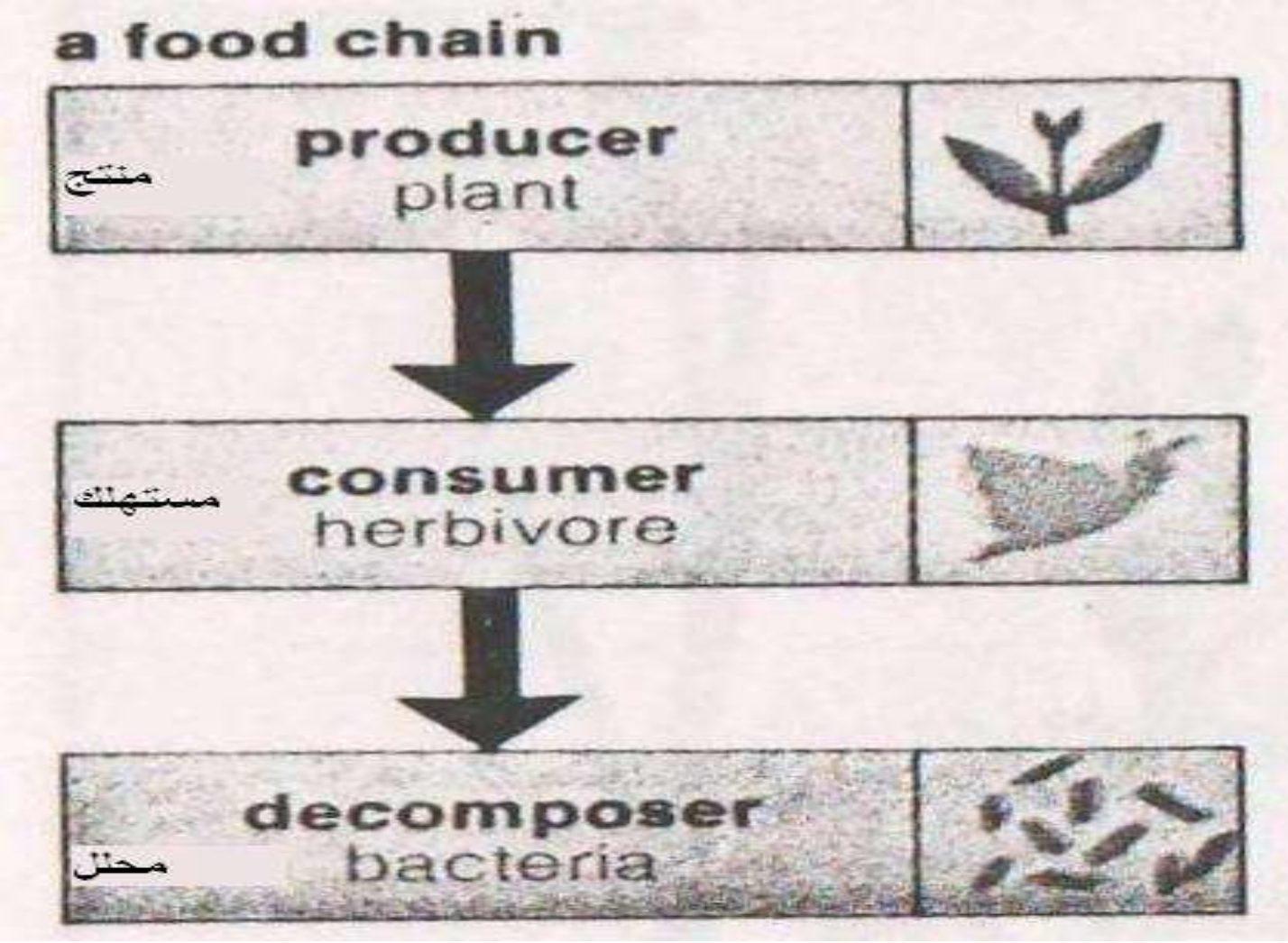
2. **Saprophytic Nutrition:**
   - **These organisms obtain their food from the bodies of decomposed plants and animals.**
   - **Examples of which are *Fungi* and yeasts as well as some bacteria.**
   - **They have the ability to secrete certain enzymes that can convert decomposed organic substances (as proteins, carbohydrates and fats) into simple substances that can be easily absorbed through their cellular membranes.**
3. **Parasitic Nutrition:**
   - **The Parasite organism gets its food from another organism called the Host.**
   - **Types of parasites:**
     1. **Obligate Parasites: Can not be cultivated in the lab *i.e. Poliovirus***
     2. **Facultative Parasites: Can be cultivated in the lab like many *Bacteria* and *Fungi.***

4. **Symbiotic Organisms:**

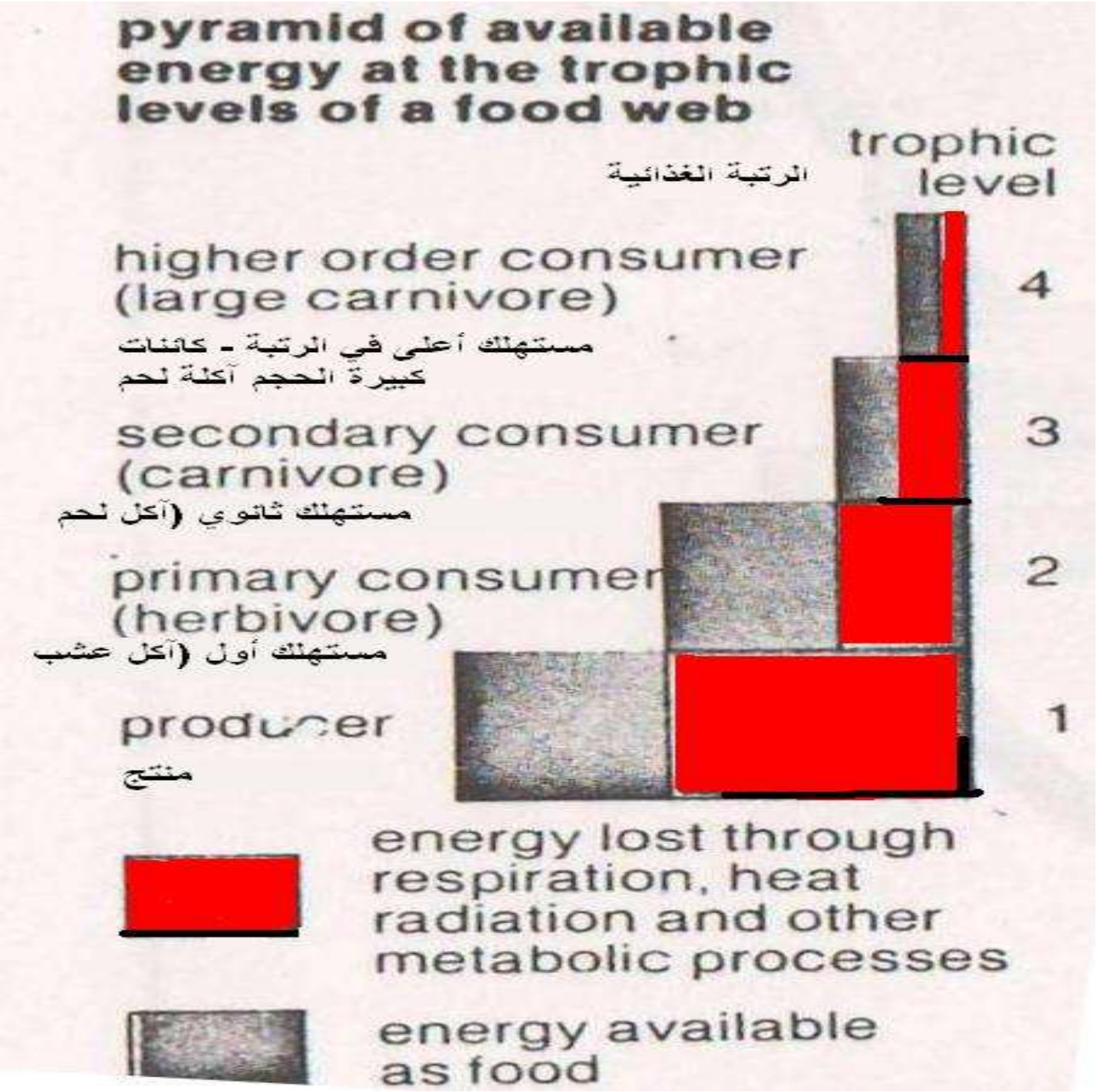
- **Some organisms can live together in cooperation where they exchange nutrients examples of which:**
  1. ***Lichens*: an *Alga* living in symbiosis with a *Fungus*.**
  2. ***Mycorrhizae* (root *fungi*): they exchange nutrients with roots of some plants.**
  3. **Bacterial nodules: *Rhizobia*; nitrogen fixing bacteria living in the root nodules of leguminous plants.**

Ecosystem

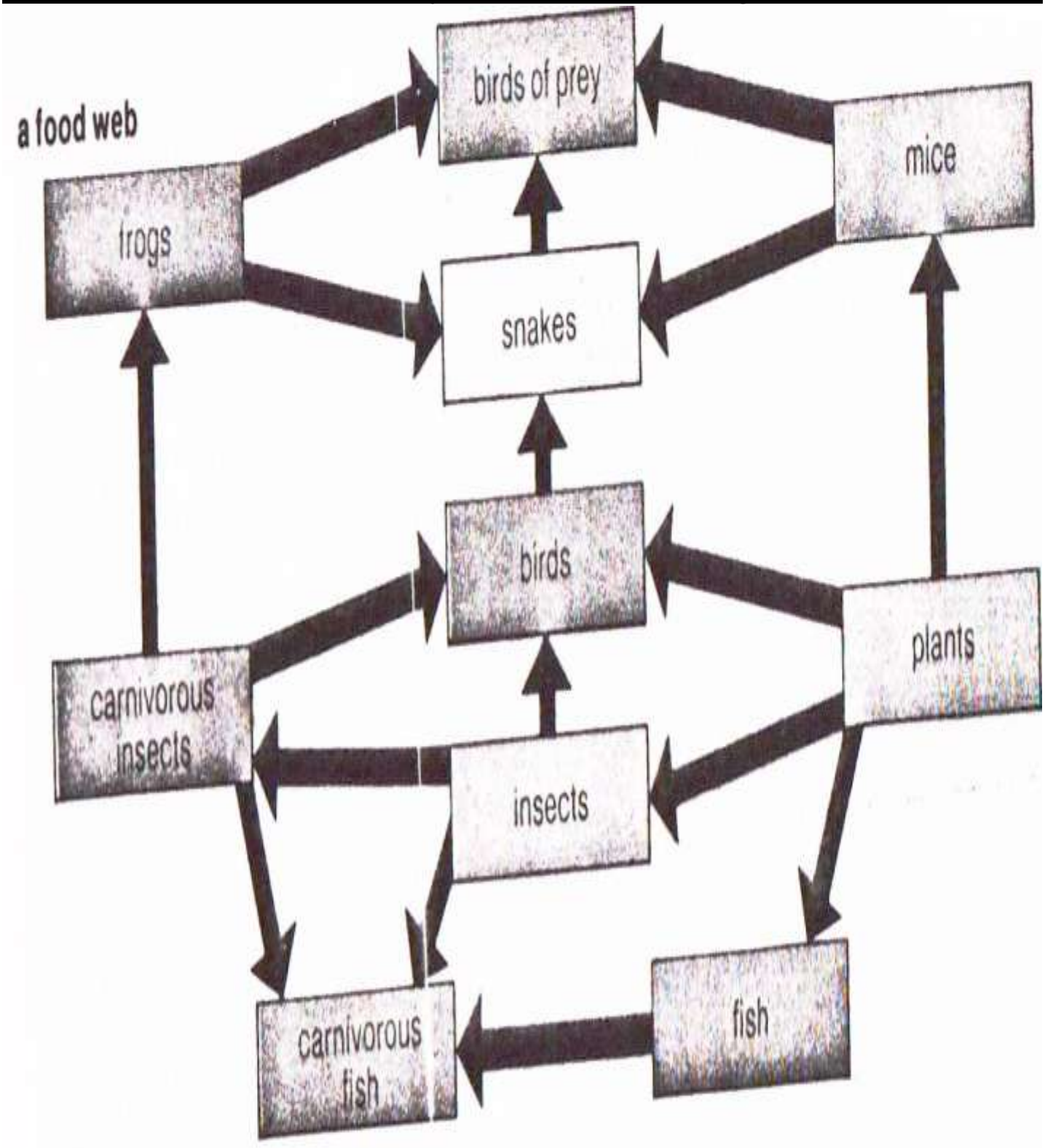
- **A community made up of living components (*<u>Biotic</u>*) and non-living ones (*<u>Abiotic</u>*), <u>interacting</u> as a system and functioning as a unit. The components of this system are <u>linked together</u> through <u>nutrient cycles</u> and <u>energy flows</u>.**
- **The biotic components consists of:**
  1. **Producers: Plants or algae**
  2. **Consumers: *Herbivores* and/or *Carnivores***
  3. **Decomposers: Saprophytes**



Energy Flow Of A Food Web:



A model of an Ecosystem demonstrating a food web:



Habitat and Ecologic Niche

- **Habitat: the place where the organism lives (Address).**
- **Ecologic Niche: the role of the organism (Job).**
- **One organism may live in different habitats and environments examples of that are:**
    1. **A tadpole (a frog stage) is a 1st consumer feeding on algae (*Herbivore*), while the mature frog is a 2nd consumer feeding on insects (*Carnivore*).**
    2. **Little tortoises are 2nd consumers as they feed on worms and snails (*Carnivores*), on the other hand mature tortoises are 1st consumers as they feed on algae (*Herbivores*).**

Inter- and Intra- specific Interactions:

A)Interspecific interactions: Environmental Interaction Between Different Species

- **Competition:**

1.Organisms living in the same habitat and competing for the same nutrients.

2. Examples: *Paramecium aurelia* , *P. caudatum*

- **Commensalism:**
    1. **A relation between two organisms where only one benefit without harming the other.**
    2. **Examples: Some worms find shelter on shells of marine organisms.**
- **Proto-cooperation:**
    1. **A relation between two organisms where they both benefit from this relationship with the possibility that one can live separately from the other.**
    2. **Examples: Some hermit crabs often pick up a sea anemone to attach to their shell to dissuade attackers, where sea anemone spreads out long stinging threads over the shell. These relationships go both ways as the anemones are able to pick up more food.**
- **Mutualism:**
    1. **Both organisms benefit from the relationship. Both organisms can't be apart and can't survive without each other.**

2. **Termites and microbes living in their guts, where termites depend on them to digest the complex sugars in wood into simpler molecules they can use for food. Digesting cellulose to acetic acid.**

- **<u>Amensalism:</u>**

  1. **A relation between two organisms in which one organism is inhibited or destroyed while the other remains unaffected .**

  2. **<u>Example</u>: Some organisms produce antibiotics affecting the growth of others. *i.e. Penicillum***

B) Intraspecific interactions: Environmental Interaction Between individuals of the same species. Two points of views were raised among ecologists:

1. **A group finds it positive for the community to cross-breed, reproduce and continue to thrive.**
2. **The other finds it negative for the community as they compete for limited resources.**

- **<u>Examples</u>:**

1. **A herd of deer and wolf (A wolf only chases the stray deer).**
2. **The experiment of the golden fish and the colloidal silver solution.**

Cellular structures and vital functions

- Any living being is called "Organism"
- Organism: an organized system
- With a specific identifiable shape
- Each organ within this system has a specific function *i.e.* growth, reproduction, sensitivity, metabolism, etc…
- So, it is easy to identify plants and animals as living organisms as well as rocks and stones as nonliving. On the other hand, it is not an easy task to define Viruses as living beings. Why?
- The living material is called the Cytosol (portion of the cytoplasm) is a translucent semifluid substance of the cell, colorless to slightly yellowish viscous liquid resembles egg white.
- The Cytosol is examined by the light or electron microscopy or by using diffractive analysis of X-ray.

Characters of living cell

1. Cellular organization: each organism has a specific form, shape and size by which it is identified. As each one consists of different parts that ends up with the cell.

   Body Systems Organs Tissues Cells

   The Cell: is the body building unit both in structure and function.

2. **Metabolism**: is essentially a collection of chemical reactions occurring within the body cell, where food is transformed into substances similar to that of the body. It consists of two processes:

1. **Anabolism**: A process where energy is consumed for building up complex substances such as proteins, lipids or carbohydrates from simple ones

2. **Catabolism**: A process where energy is released such as respiration or breaking up reserve food materials to simple substances to obtain energy during growth, mobility, reproduction, etc…

3. **Locomotion**: the ability of an organism to change place. This character differ from one organism to another. In plants, mobility is slightly noticed compared to animals, however plants mobility can be observed in blossoming of flowers and buds, opening and closure of stomata, streaming of the cytoplasm (cyclosis).

4. Response to Stimuli (Sensitivity): a reaction to an internal or external force i.e. phototropism or Geotropism.

5. Growth: Increase in size or weight till reaching a certain size. Growth is either limited (animals) or unlimited (plants).

6. <u>Reproduction</u>: it is the ability of the living organism to produce new individuals (offspring) when it reaches a certain age (maturation). As viruses have this character they were considered living beings, inspite of their inability to perform other characters such as growth, respiration, etc…

7. <u>Respiration</u>: a vital process which characterizes living organisms only.

$$C_6H_{12}O_6 + 6\ O_2 \qquad\qquad 6\ CO_2 + 12H_2O\ + Energy$$

8. <u>Adaptation</u>: the ability of the living organism to change slightly over time to be able to continue to exist in a particular environment. Adaptation can be quick or momentarily according to the response of enzymes, inhibitors or activators or it can be very slow in case of mutation or natural selection.

9. <u>Excretion</u>: a process by which metabolic wastes are eliminated from a living organism. It could be two contractile vacuoles as in *Chlamydomonas* or a complicated excretory system as in higher organisms.

- **<u>There are some common characters between living and non living which are</u>**:

1. **Increase in size**: like in crystals
2. **Movement**:

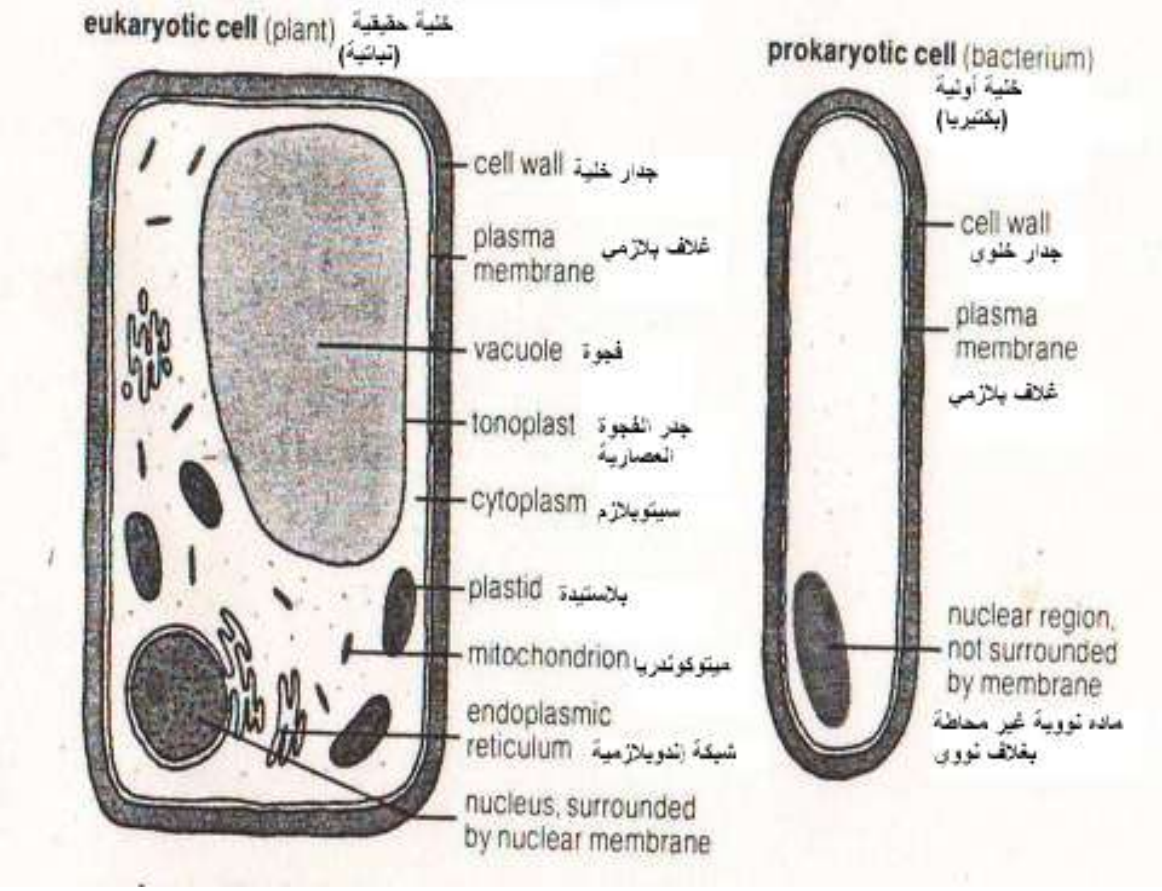
- a piece of metallic Sodium can move over water surface due to a chemical reaction.
- A drop of oil can move over water surface and form something like pseudopodia (false feet) in *Amoeba.*

Cellular Structures and Functions

- **The Cell**: is the body building unit both in structure and function.
- **Protoplasm**: It is called on the cell constituents.
- **Cellular Theory**: Plant and animal bodies consist of cells. New cells are only produced through the division of former existing cells (Schwan & Shleiden).
- Each cell consists of a nucleus surrounded by a nuclear membrane, with some exceptions as the Red Blood Cells (RBCs), losing its nuclei during maturation) or skeletal muscles (multinucleated).
-
- **<u>Organisms are either</u>**:

1. Cellular: either unicellular or multicellular
2. Acellular: Bodies whose cells never divide *i.e. Viruses*.

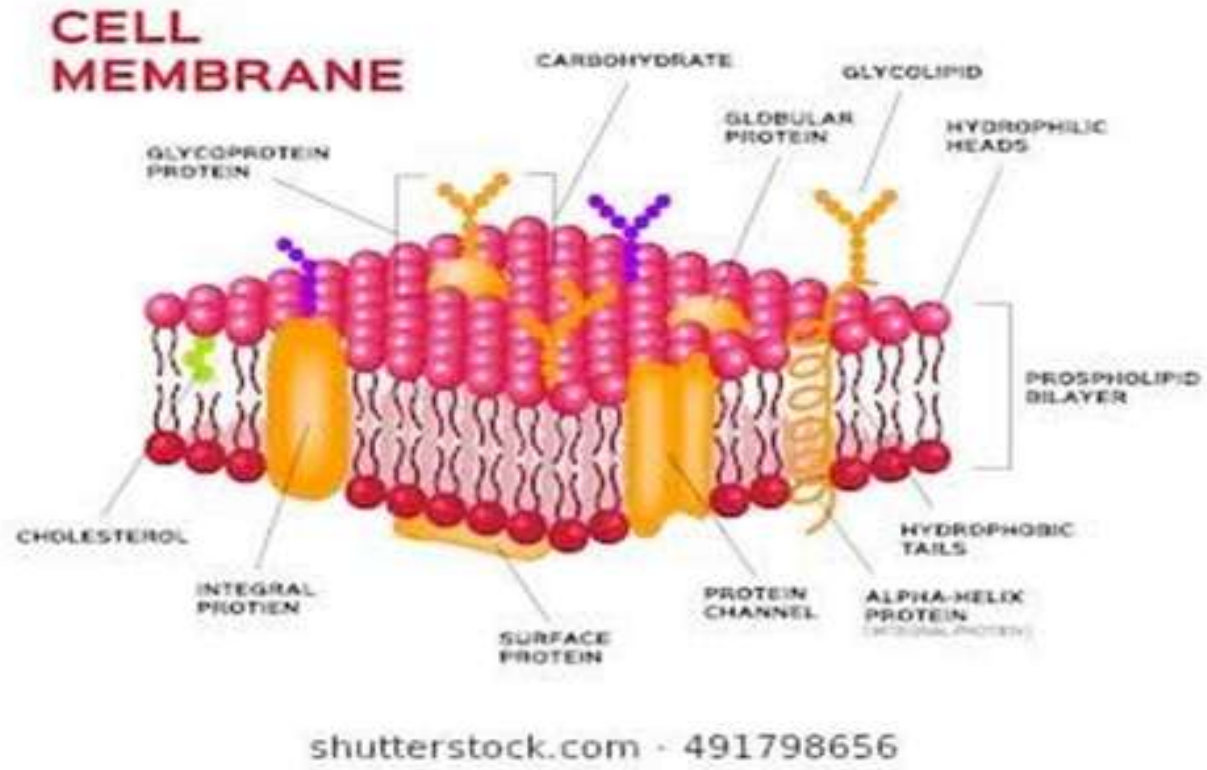
- Harrison-an American scientist-was able to cultivate *Salamander* cells in artificial media outside the body. Since then many plant and animal tissues were cultivated *in vitro* (in lab) by the help of Tissue Culture techniques.

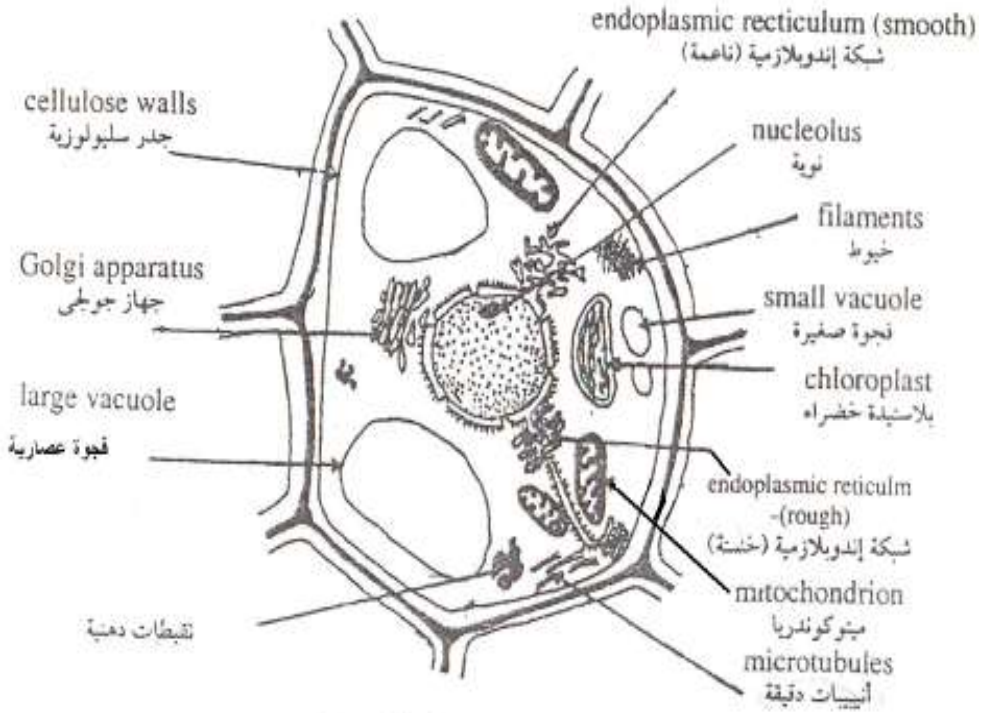


Exchanges of materials between cell and Environment

- **Plasma Membrane**: A membrane that regulates the possibility of substances or nutrients to pass in or out of the cell. They are living membranes that are selectively permeable. (they can allow the passage of substance even against concentration gradient).
- **Factors controlling the passage of a particle through cell membrane:**

1. Particle Size. 2. Solubility in lipids.
3. Number of water molecules adhered to the particle.
4. Electric charge carried on the particle.
5. Thickness of the *Endoplasmic reticulum* folds.





(شكل ٢): التركيب الدقيق لخلية نباتية

(Fig. 2) ultramicroscopic structure of plant cel

Endoplasmic Reticulum

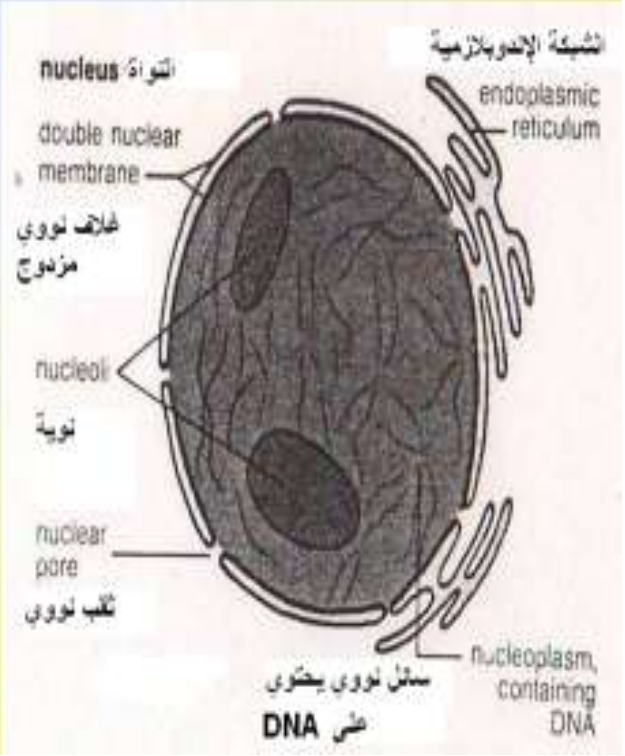
- ***Shape*:** Fine tubes and vesicles of two types:

1. Smooth
2. Rough: due to the presence of *Ribosomes*.

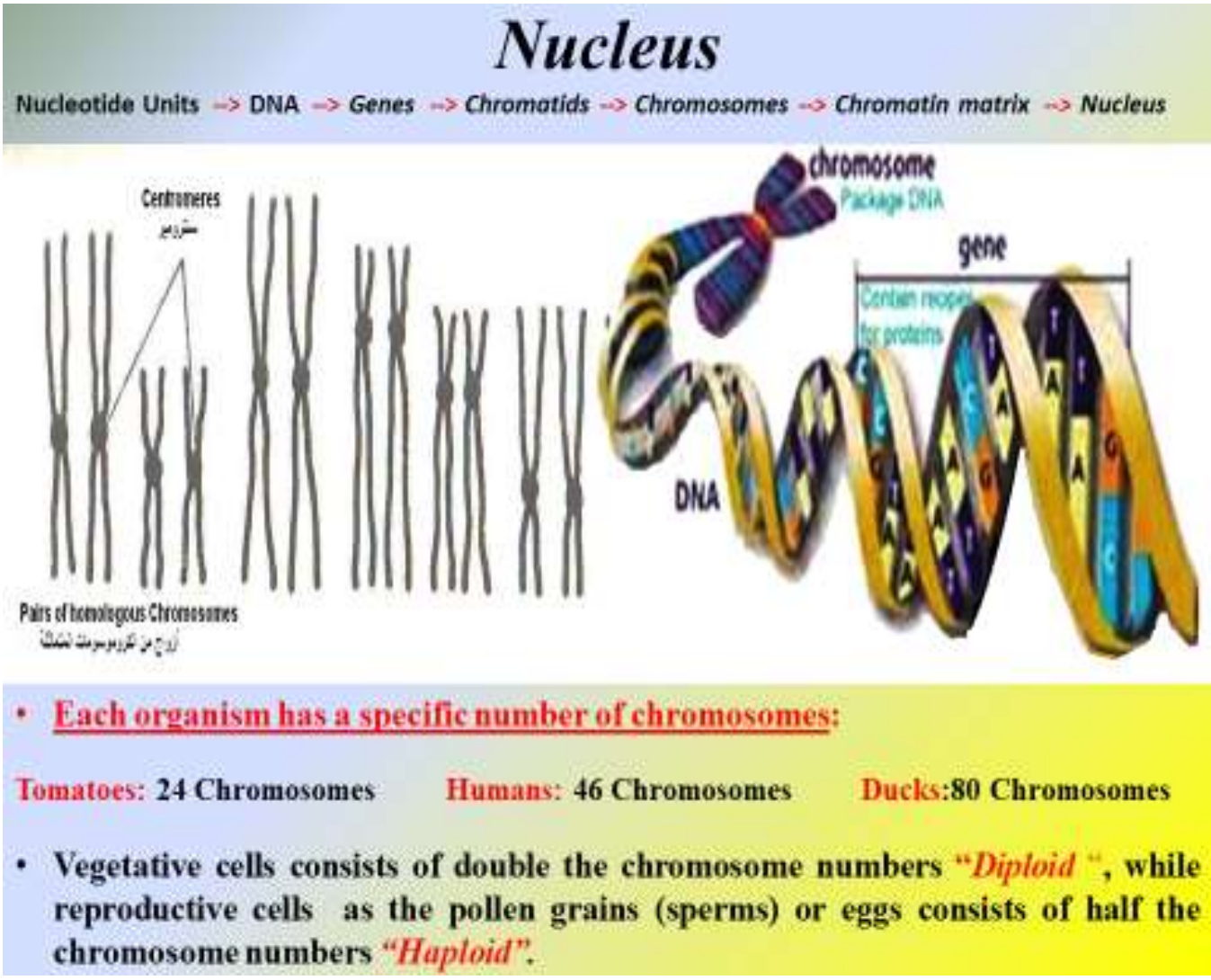
- ***Function*:** Passing and storing substances and nutrients inside the cell (specially the proteins)
- ***Ribosomes*:** Small protoplasmic bodies that maybe found free or attached to the rough *Endoplasmic reticulum*, *plastids*, *nuclei* and *mitochondria.*
- ***Function***: They attach to mRNA to synthesis protein in the cell.

Nucleus

- **A cell could be:**
  1. Uni-nucleated 2.Multinucleated
- **Also it could be:**
  1. Central: (*Meristematic* young cells).
  2. Lateral: (Permanent aged cells).
- ***Function*:** Controlling vital cellular functions.
- If the nucleus is separated from its cell, the cell dies.
- Due to the excess nuclear acids, they appear more viscous than the cytoplasm.
- ***Structure***: it contains DNA and different types of RNA as:
  1.mRNA (messenger)
  2. tRNA (transferring)
  3.rRNA (ribosomal)

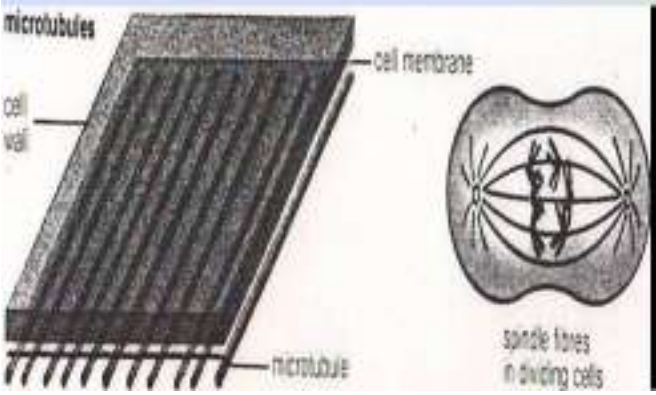


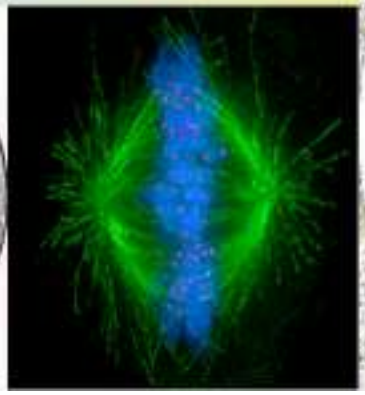
- It consists of a gelatinous substance rich in protein, fats and nucleic acids known as Nuclear Sap.
- It is enveloped by a nuclear membrane which is a bilayer membrane carries *Ribosomes* on its surface.
- One or more *Nuclei* is found in the nuclear sap.
- ***Nuclei***: A spherical body devoid of a membrane, more viscous than the nuclear sap as it is very rich with RNA and proteins with little DNA.
- ***Function***: Center of formation of RNA, proteins and *Ribosomes.*
- It is composed of a chromatin matrix from units called *Chromosomes.* Each *Chromosome* consists of two *Chromatids* connected by a *Centromere.*
- Each *Chromatid* consists of proteins and nucleic acids.
- Each *Chromatid* consists of *genes* that compose DNA.

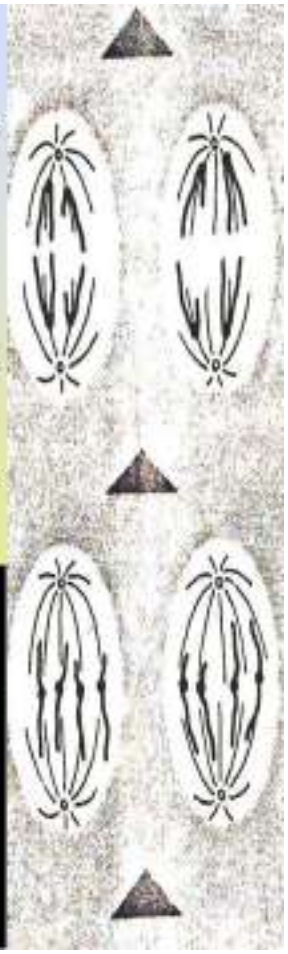


Centrioles

- Two small dark colored cylindrical bodies found near the nucleus.
- Found in animal cells and primitive plant cells.
- It plays a basic role in cell division.
- Form what is known as Spindle Fibers (Chromosomal & Continuous).
- **Spindle Fibers**: Microtubules radiating filaments, lies between the Chromosomes and on the cell poles.

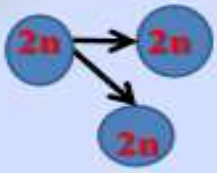




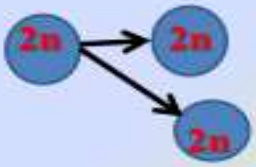


Cell Division

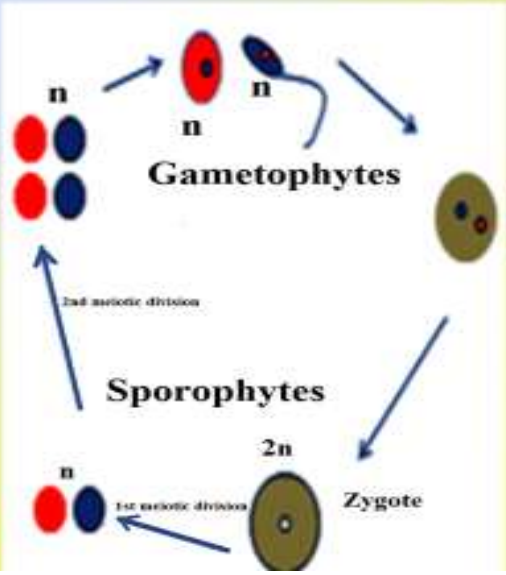
1. *Amitosis* (fission)

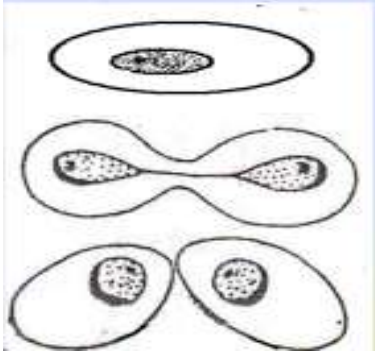


2.*Mitosis*



3.*Meiosis*

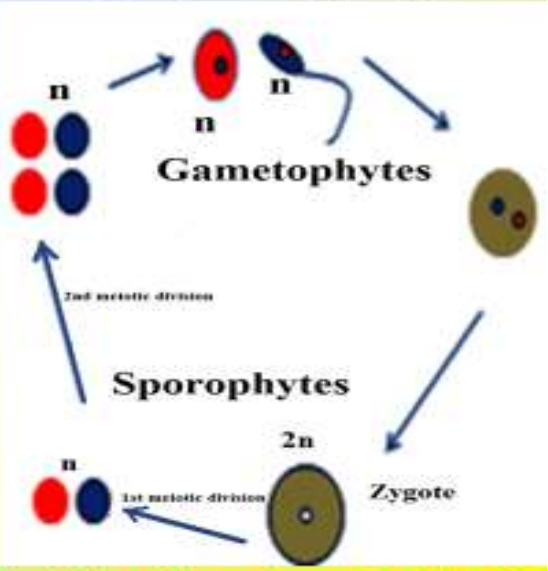




Cell Division
Meiotic Division

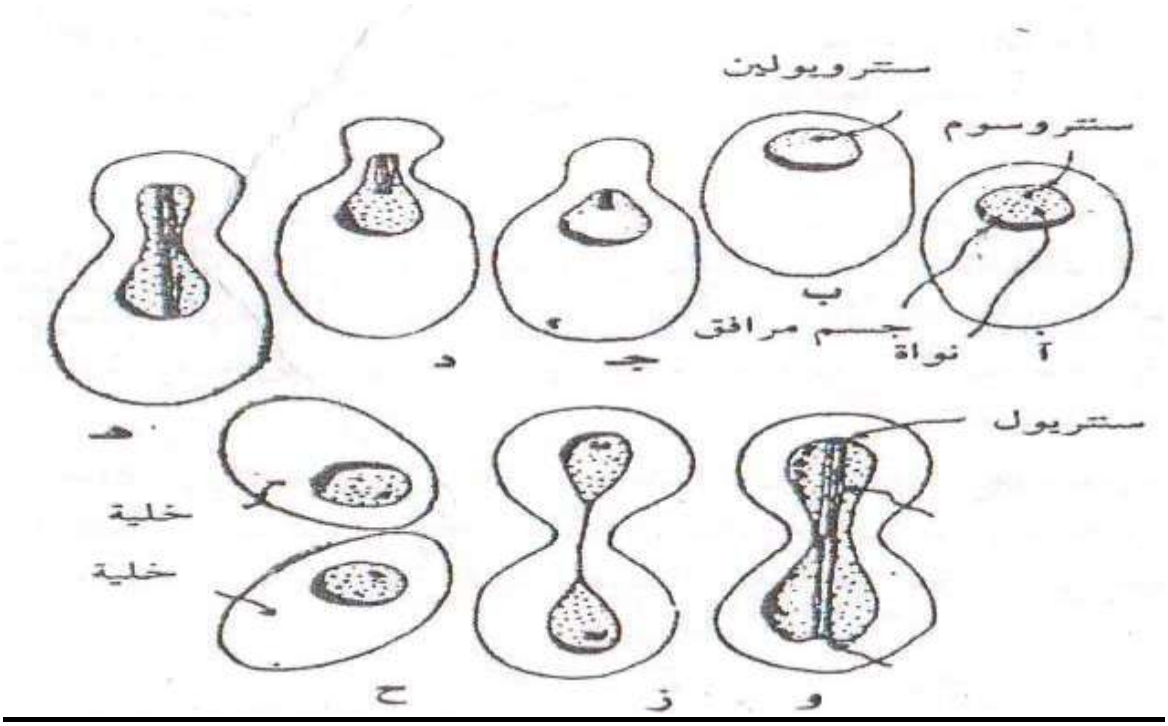
- Known as reduction division and happens in all higher plants (Sporophyte).
- Consists of two **consecutive divisions** where **four** gametes are produced:
- **In the first division:** Chromosomal number is reduced to half.
- **In the second division:** Chromosomal number remained the same, but the cells duplicate.
- In the final cell stage, a cellular lamella is formed that is then becomes the middle lamella on which cellulose deposits forming the primary wall.
- **Give Reason:**

Chromosomal numbers are reduced to half while cell numbers duplicate?



Cell division
1. *Amitosis* (Fission)

- It is also called Binary fission, it happens in lower organisms like *Bacteria* and some *Fungi*.



Cell division

2. *Mitosis*

- **It occurs in five stages**:

1. Interphase stage:

- DNA duplicates.
- Nucleus enlarges and cytoplasm becomes granular.

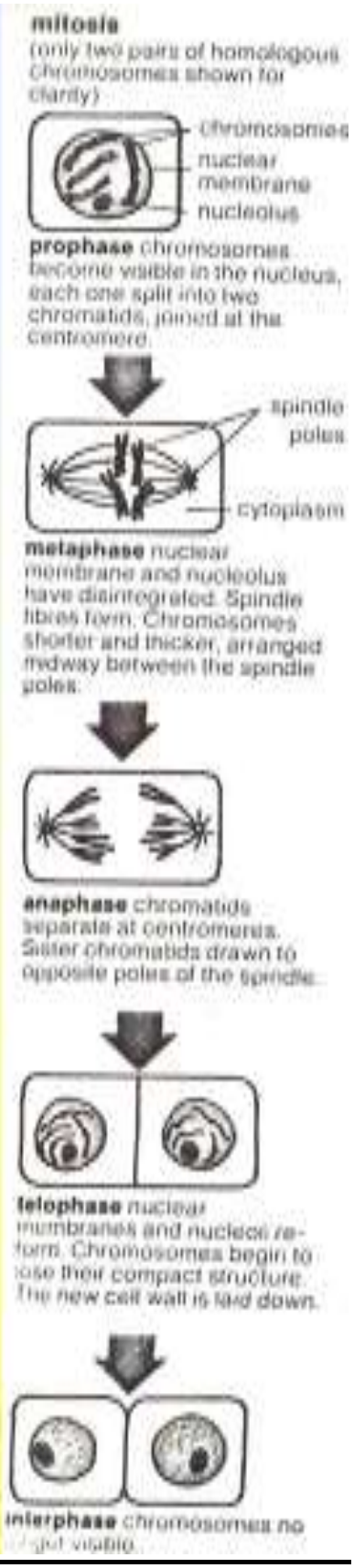
2. Prophase stage:

- Chromosomes get short, thicker and is coated by the matrix.
- Nucleus and nuclear membrane disappear.

3. Metaphase stage:

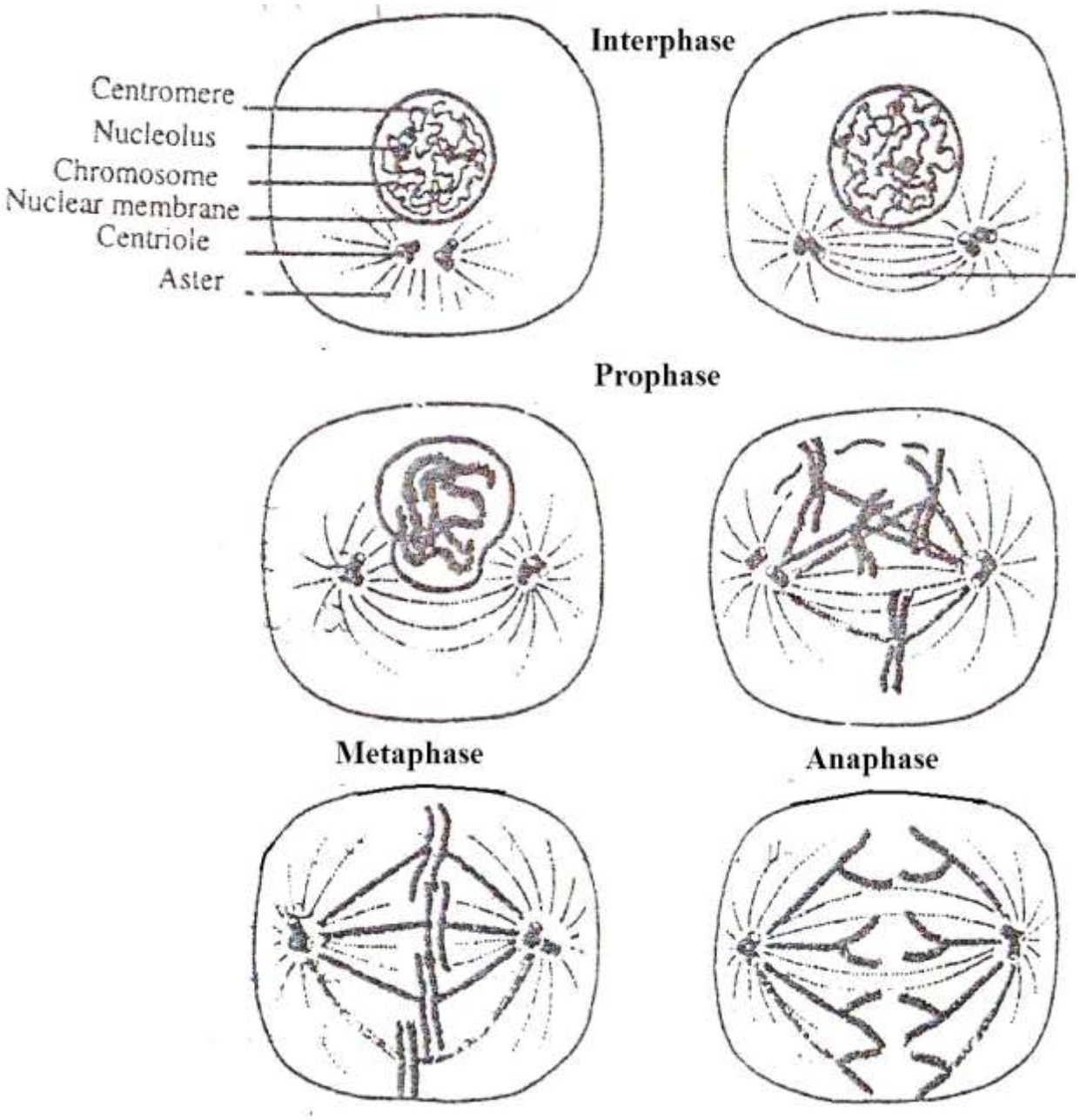
- Each centriole migrates to one pole of the cell.
- Spindle fibers form, those attached to the centromere are called "Chromosomal fibers" while the others are called "Continuous fibers".
- Chromosomes are arranged in midway.

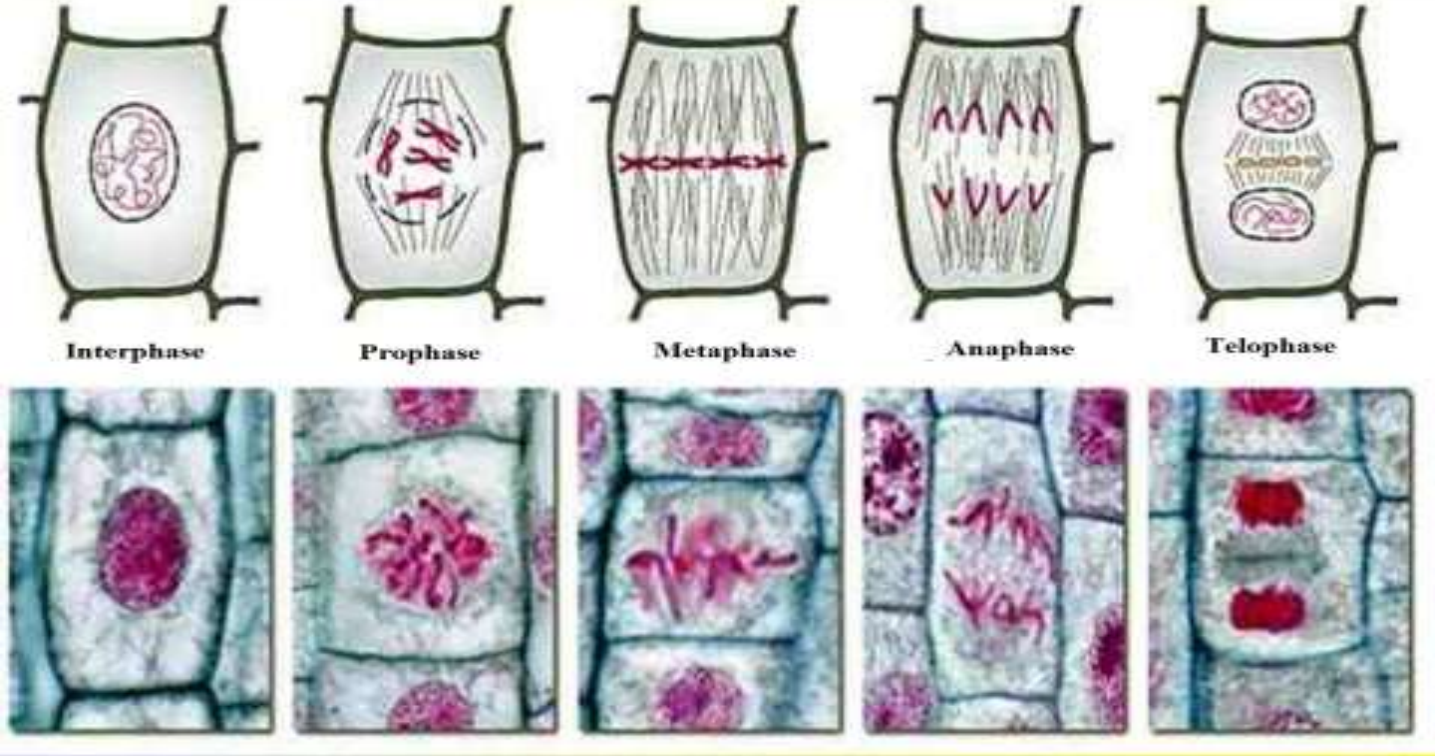
4.Anaphase stage: Chromosomes at the centromeres, sister chromatids drawn to opposite poles of the spindle.



5. Telophase stage: the steps are opposite to that of prophase, where:

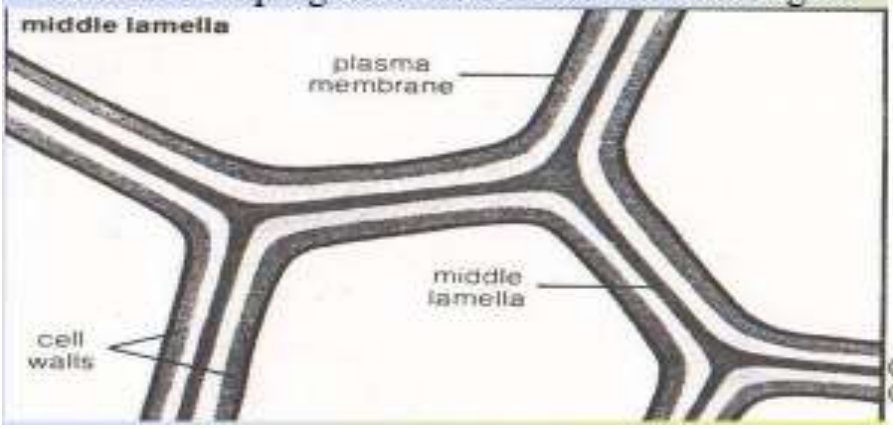
- The matrix disappears, the chromosomes become thinner and longer.
- Nuclear membrane and nucleoli reform.
- Vesicles are formed in the cell midway by Golgi apparatus forming the cell lamella which with two plasma membranes form the middle lamella on which cellulose is deposited to form the primary cell wall.

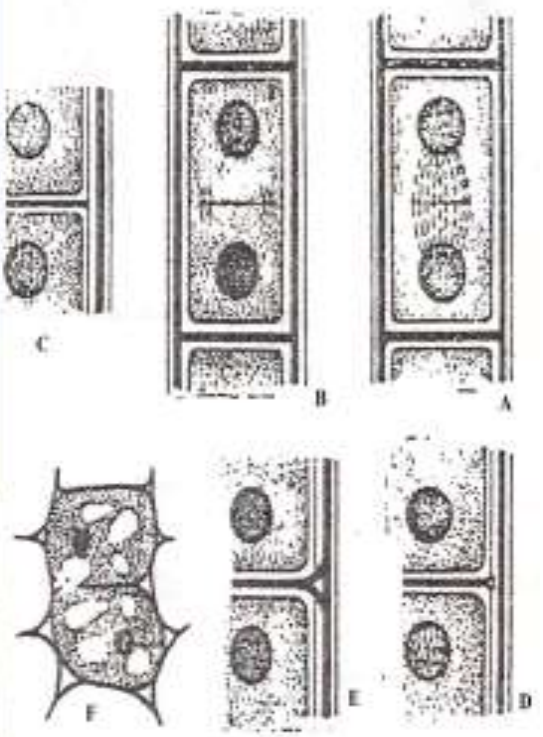




Cell Wall

1. **Cellular Lamella** is formed in between the two cells resulting from division.
2. Ca and Mg pectates are deposited to form the **Middle lamella**.
3. **Primary cell wall** is formed when cellulose is deposited.
4. **Secondary cell wall** is then formed of three layers, the middle is thick and the other two surrounding it are thin where they all are of cellulose impregnated with Suberin and Lignin





(شكل ٧) : خطوات تكوين الجدار الخلوي

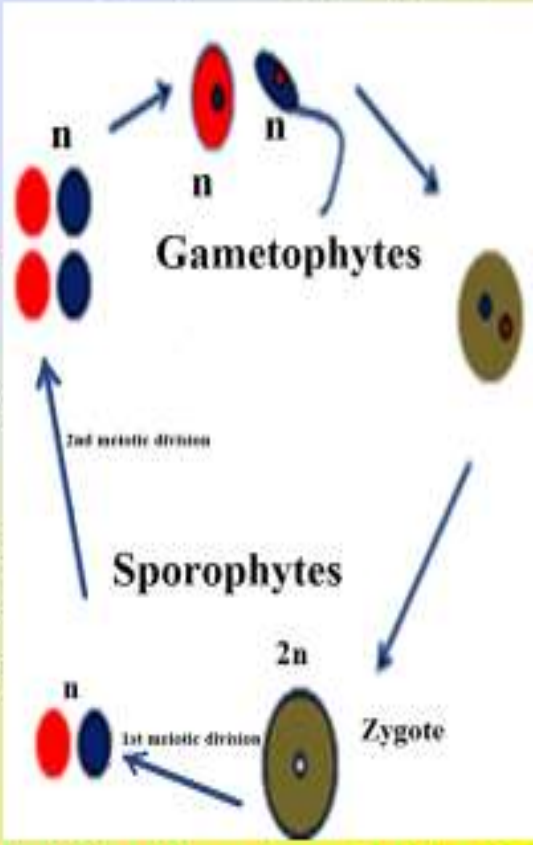
(Fig. 7) steps of cell wall formation

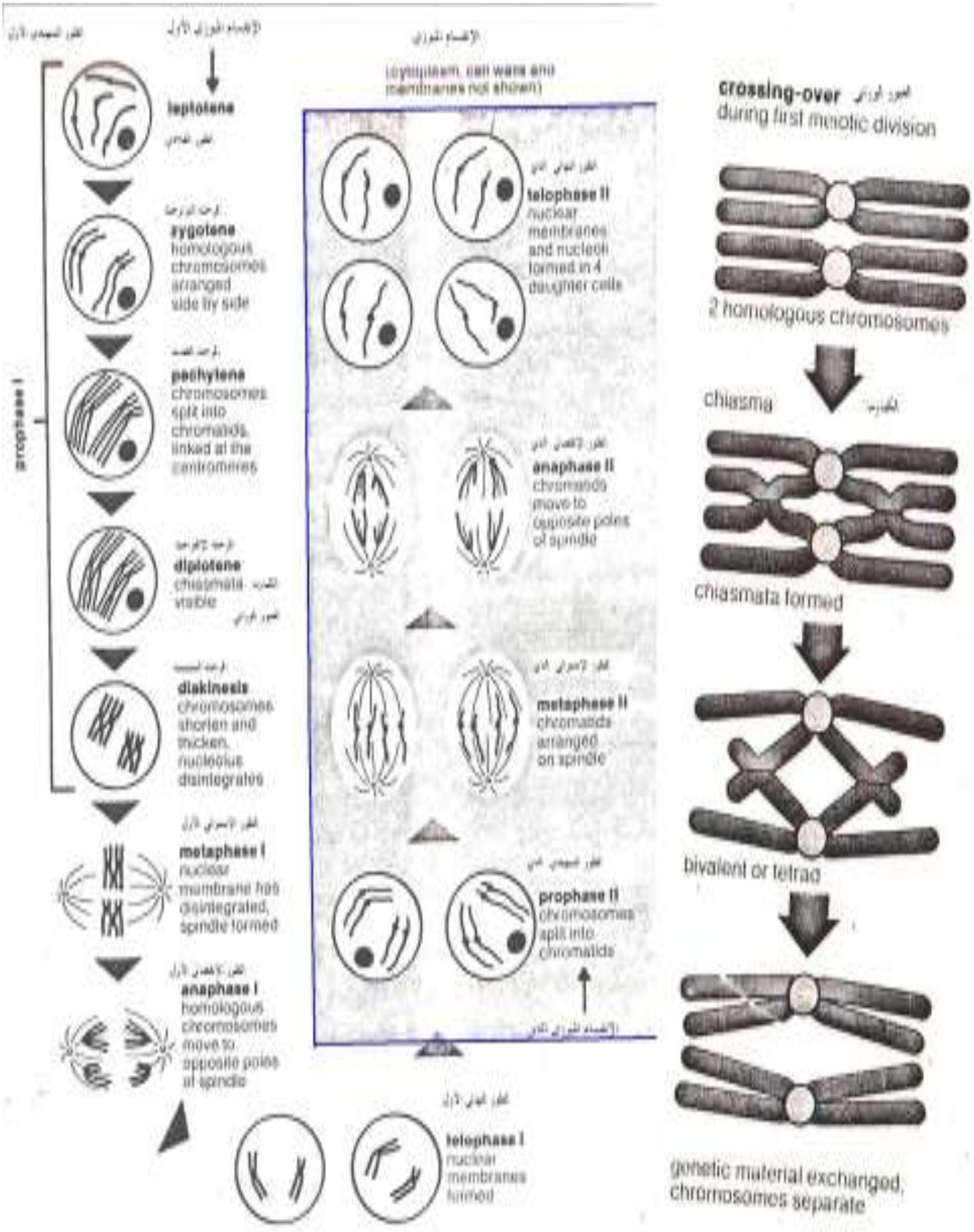
(A),(B) Cellular Lamella Formation (C) Middle Lamella Formation
(D),(E) Intercellular Spaces (F) Formation of Divided Cells

Cell Division
Meiotic Division

- Known as reduction division and happens in all higher plants (Sporophyte).
- Consists of two **consecutive divisions** where **four** gametes are produced:
- **In the first division:** Chromosomal number is reduced to half.
- **In the second division:** Chromosomal number remained the same, but the cells duplicate.
- In the final cell stage, a cellular lamella is formed that is then becomes the middle lamella on which cellulose deposits forming the primary wall.
- **Give Reason:**

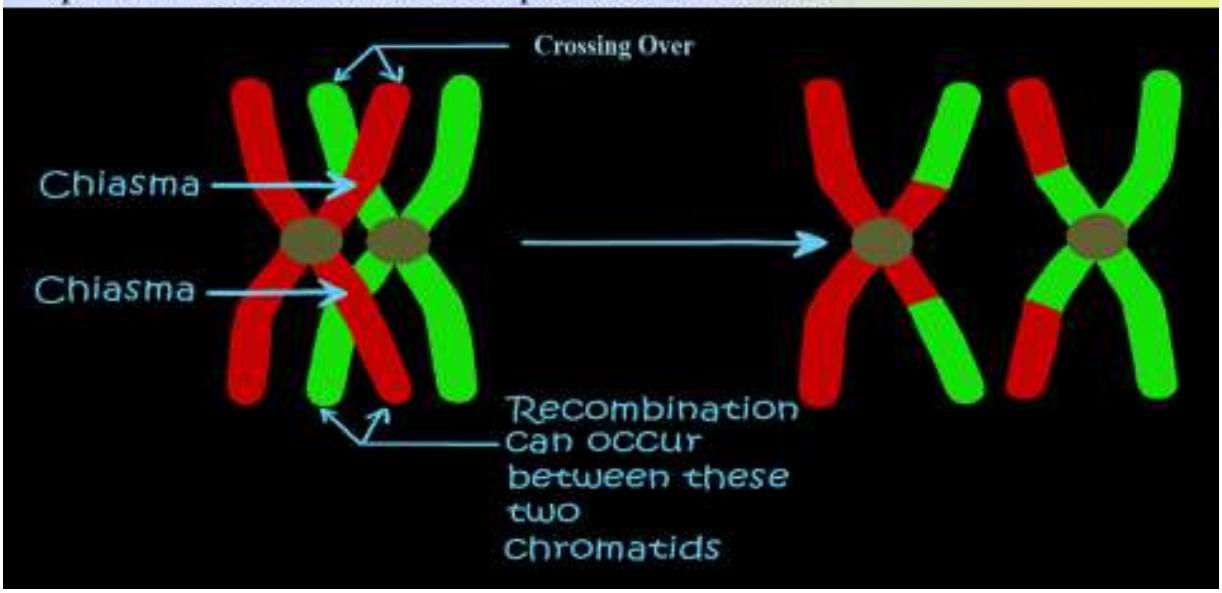
Chromosomal numbers are reduced to half while cell numbers duplicate?

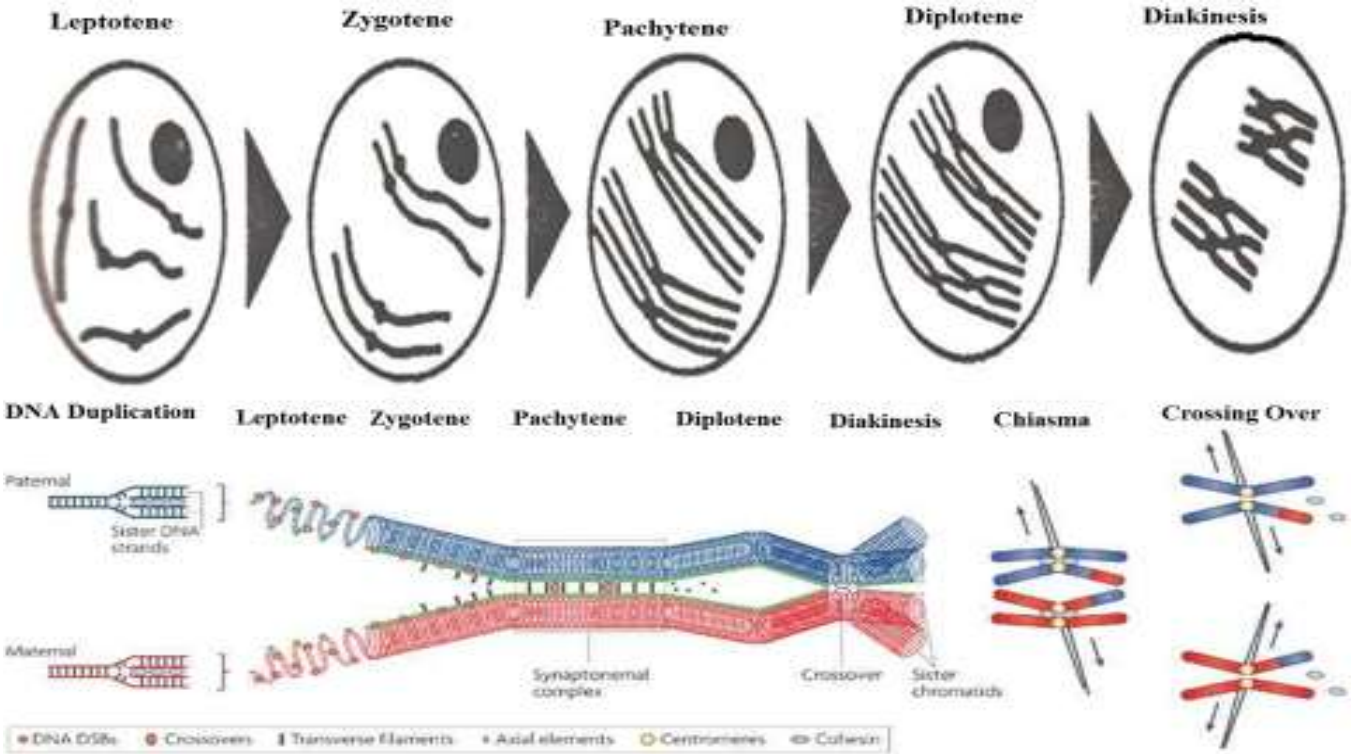



(cytoplasm, cell walls and membranes not shown)
prophase I
leptotene
zygotene
homologous chromosomes arranged side by side
pachytene
chromosomes split into chromatids, linked at the centromeres
diplotene
chiasmata visible
diakinesis
chromosomes shorten and thicken, nucleolus disintegrates
metaphase I
nuclear membrane has disintegrated, spindle formed
anaphase I
homologous chromosomes move to opposite poles of spindle
telophase I
nuclear membranes formed
telophase II
nuclear membranes and nucleoli formed in 4 daughter cells
anaphase II
chromatids move to opposite poles of spindle
metaphase II
chromatids arranged on spindle
prophase II
chromosomes split into chromatids
crossing-over
during first meiotic division
2 homologous chromosomes
chiasma
chiasmata formed
bivalent or tetrad
genetic material exchanged, chromosomes separate

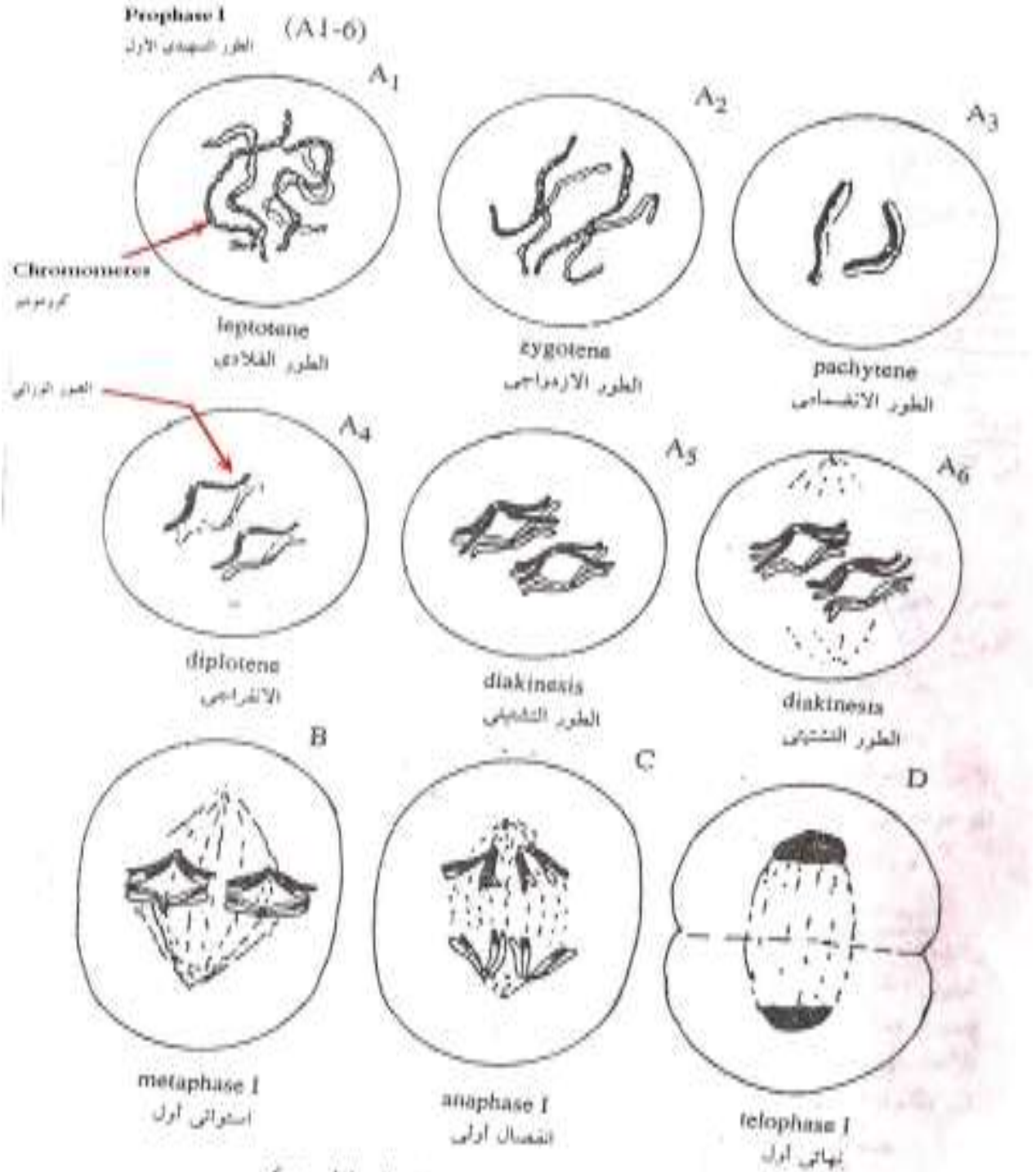
Meiotic Division

- **Chiasma:** The recombination of the internal chromatids of the two sister chromosomes during the diplotene phase in the 1st meiotic division.
- **Crossing Over:** The exchange of parental genetic material during the split of the chromatids at the points of chiasmata.





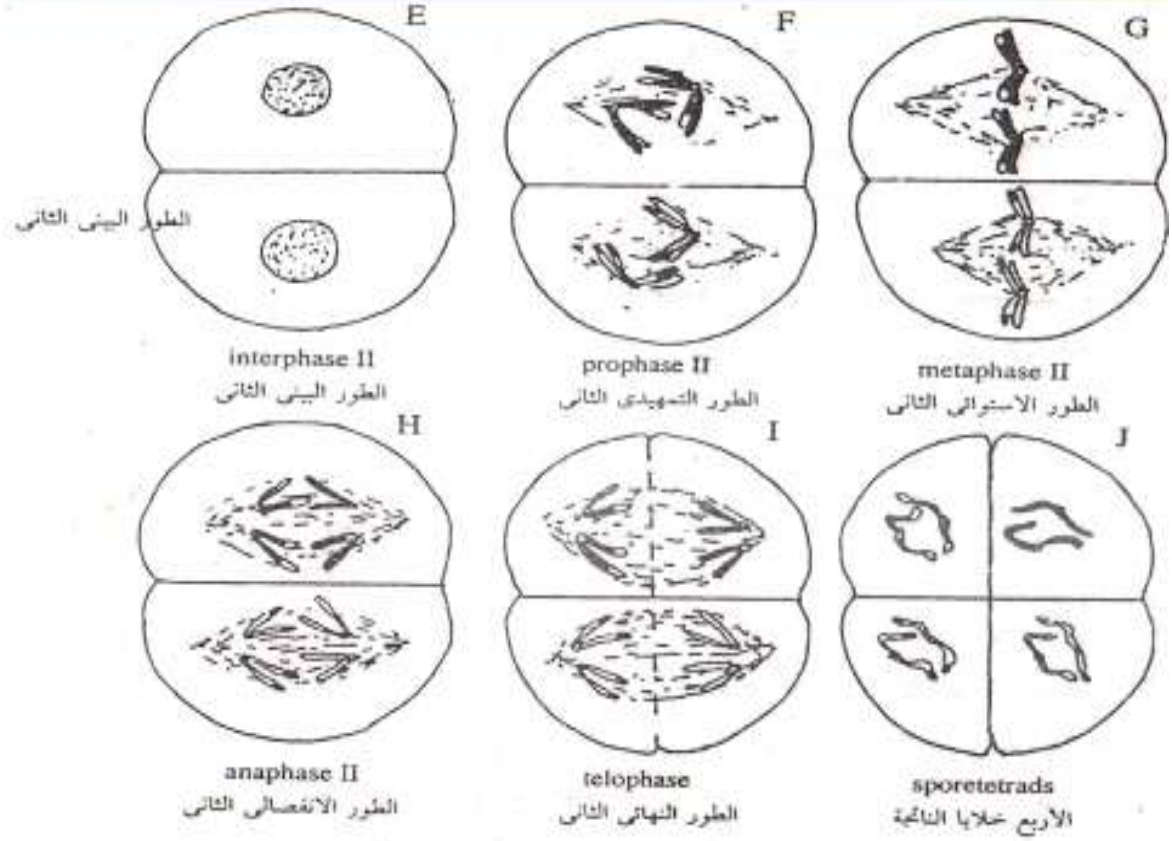
1st *Meiotic* Division



(شكل ٦): خطوات الانقسام الاختزالي (الميوزي)

(Fig. 6) stages of meiosis

2nd *Meiotic* Division



تابع (شكل ٦): خطوات الانقسام الاختزالي (الميوزي)
(Cont. Fig. 6) stages of meiosis

Cytoplasmic Organelles

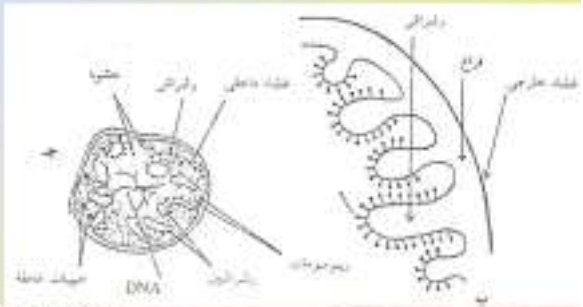
1. *Mitochondria*:

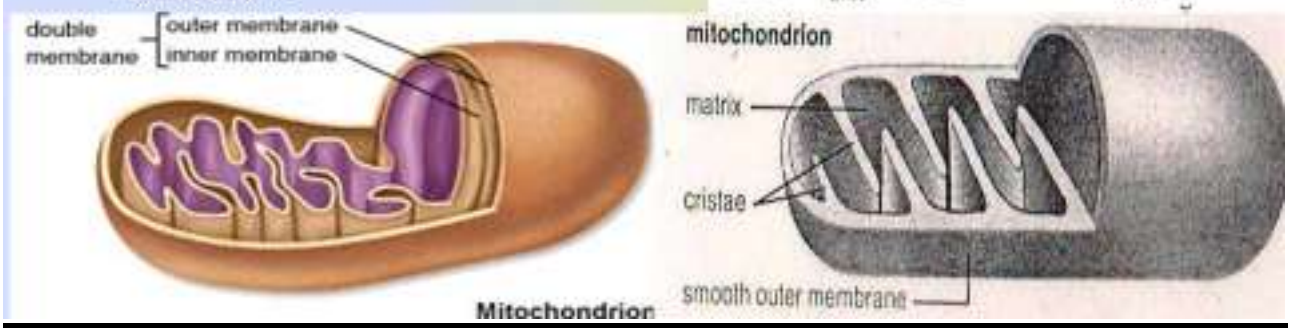
- **Shape:** Protoplasmic living bodies maybe circular, cylindrical or filamentous. It is formed of proteins (matrix). It has DNA and ribosomes.
- **Function:**

1. It possesses enzymes necessary for phosphorylation:

ATP ⟶ ADP ⟶ AMP

2. It contains Cytochrome enzymes necessary for Kreb's cycle during respiration reactions and energy formation.





2. Plastids:

Structure:

Protoplasmic living organelles that are able to grow and divide.

It is formed from small bodies called Proplastids.

It is not found in lower organisms like Bacteria and Fungi. The cell may possess one large plastid (as in Algae i.e. Chlamydomonas) or many plastids (as in higher plants).

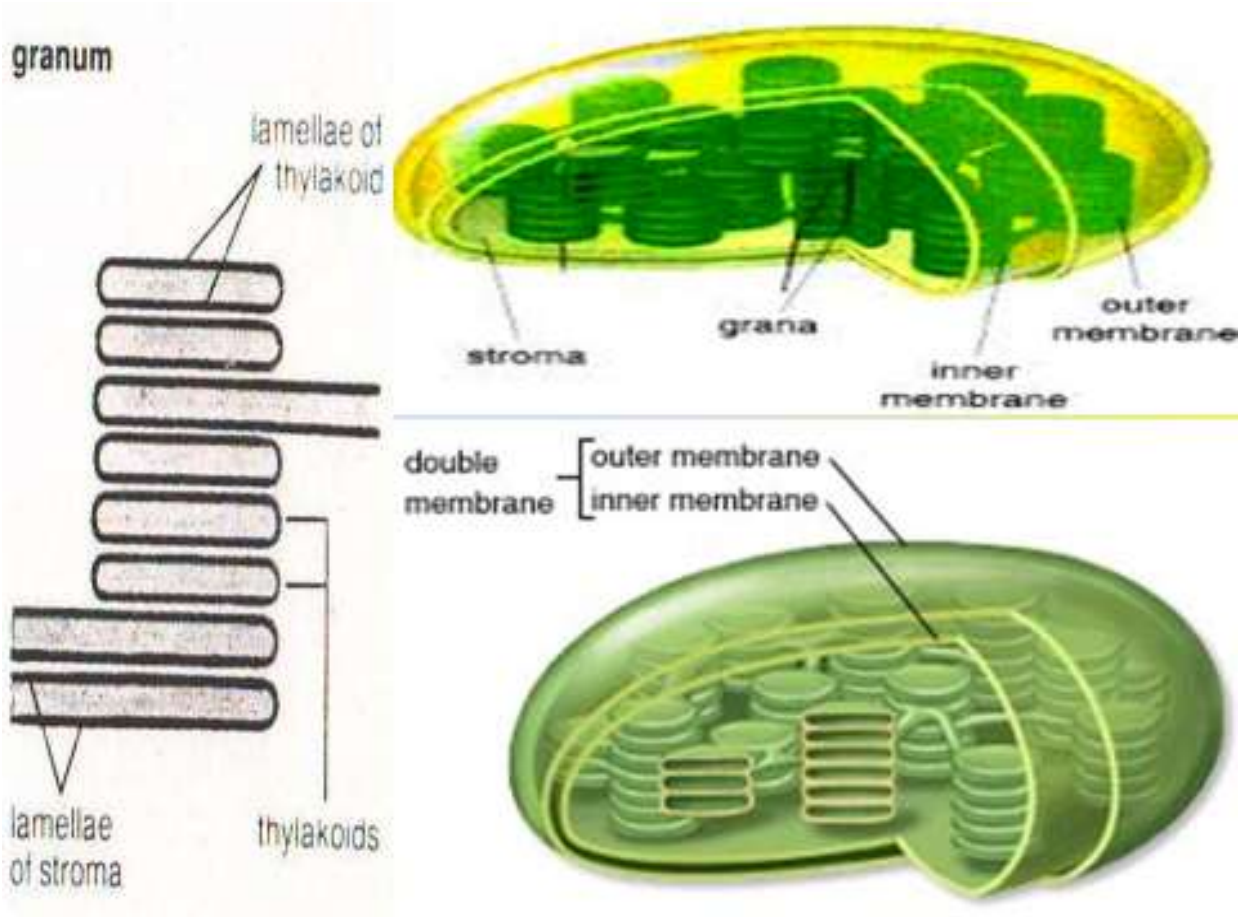
The plastids may be green, colored (pepper) or colorless (onion) and it can change from form to another when exposed to light.

It contains Chlorophyll A, B, Carotene and Xanthophyll.

Function:

It undergoes photosynthesis through transforming light energy into chemical energy.

Colorless plastids are centers of storing starch or any other substance.



chromoplasts in a root cell of *Daucus carota*

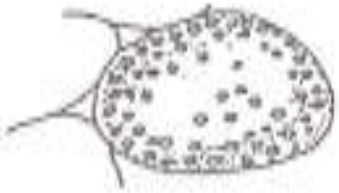
بلاستيدات ملونة في خلية لجذر نبات الجزر

leucoplasts in a young endosperm cell of *Zea mays.n*

بلاستيدات عديمة اللون في خلية صغيرة لاندوسبيرم نبات الذرة الشامية

chromoplasts in an epidermal cell from calyx of *Tropaeolum majus*

بلاستيدات ملونة في خلية بشرة الكأس لنبات أبو خنجر

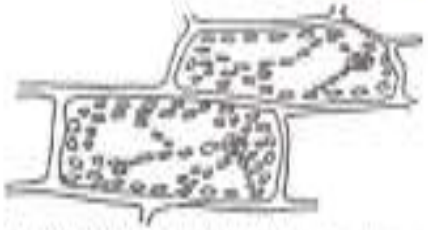


chromoplasts in a fruit cell of *Cucumis*

بلاستيدات ملونة في خلية ثمرة نبات القاقل

Spirogyra showing spiral - shape chloroplast

طحلب اسبيروجيرا لمشاهدة البلاستيدات الخضراء الحلزونية الشكل



Elodea leaf showing disc shape chloroplast

ورقة نبات الالوديا لمشاهدة البلاستيدات الخضراء القرصية الشكل

Zygnema showing star-shap chloroplast

طحلب الزيجنما لمشاهدة البلاستيدة الخضراء النجمية الشكل

(شكل ٩) أنواع البلاستيدات

(Fig. 9) types of plastids

Cytoplasmic Organelles

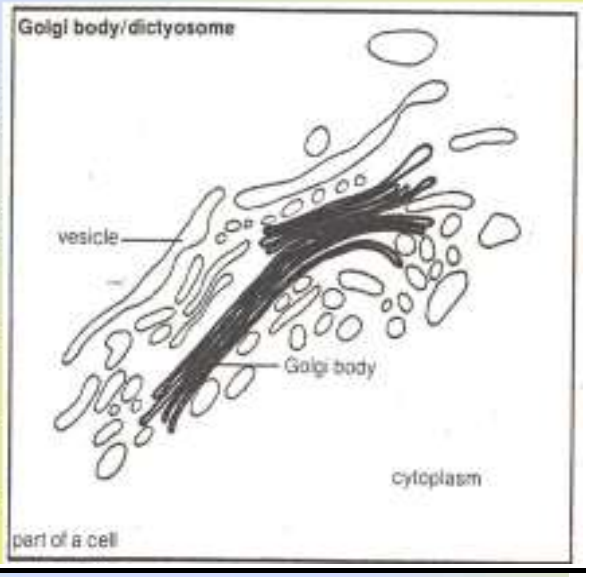
3. Golgi Apparatus: Found in all animal cells except sperms and RBCs.

- Shape:

1. It consists of group of bodies called ***Dictysomes***, which are hollow discs contains carbohydrates and proteins.
2. *Dictysome* wall is formed of a membrane made up of lipids and proteins.

- Function:

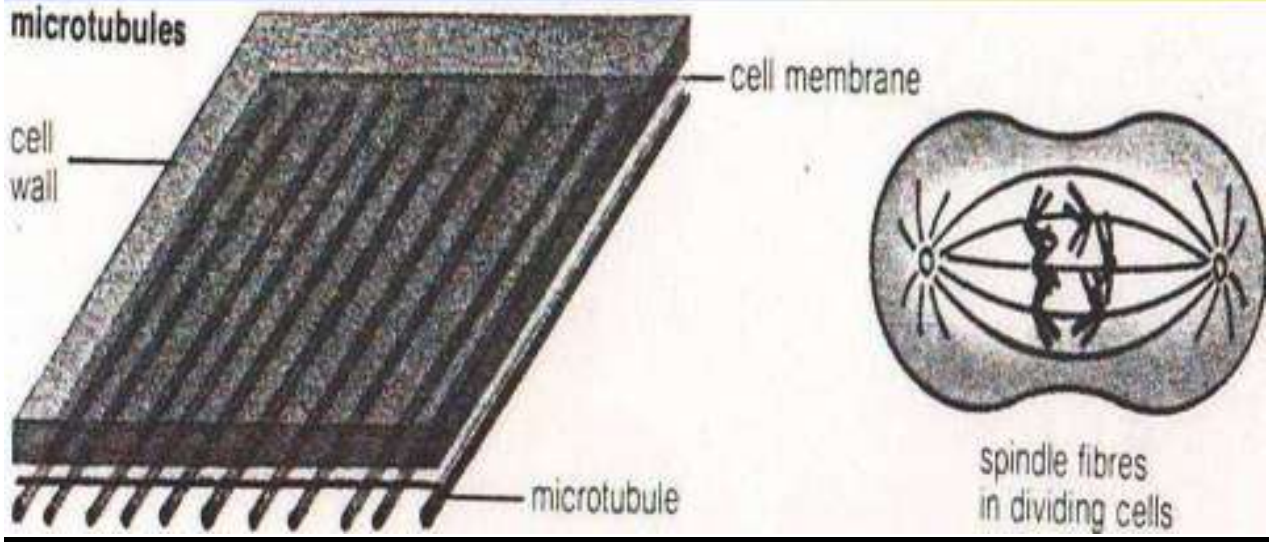
1. It secretes pectin substances necessary for the middle lamella formation.
2. It secretes mucilaginous substances to easy the penetration of root tips into the soil.
3. It secretes cellulose for cell wall formation.
4. Storage of proteins, carbohydrates and fats.
5. Transferring stored substances in and out of the cell



Cytoplasmic Organelles

4. *Microtubules*:

- **Shape**: Rod-like hollow proteinous membranes. It is formed of ß and ∝ tubulin (types of proteins).
- **Function**: 1. It controls cell shape
  2. It plays an important role in the movement inside the cell (chromosomes by spindle fibers) and the cytoplasm cyclosis.



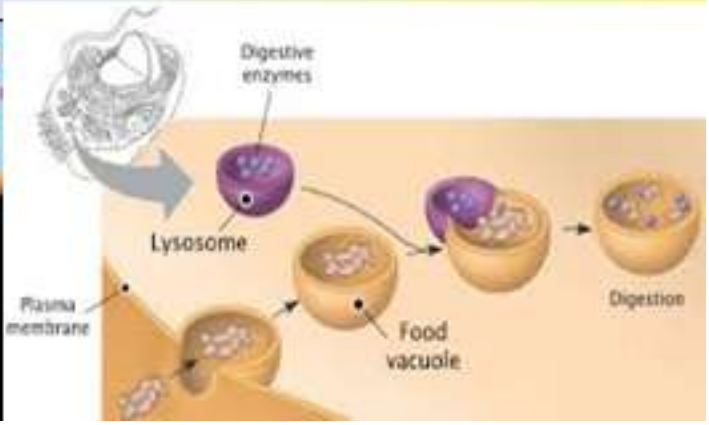
5. *Lysosome*:

- Shape:

1. It is found in most animal cells and if found in plant cells they are in small spherical bodies.
2. It appears as a vesicle surrounded by a membrane. It contains digestive active enzymes. When its walls ruptures it helps in destroying the cell.

- Function:

1. Secreting enzymes as lipases (digesting fats), proteases (digesting proteins) and nucleases (digesting nucleic acids and nuclear membranes).



Non-protoplasmic Components

Peroxisomes

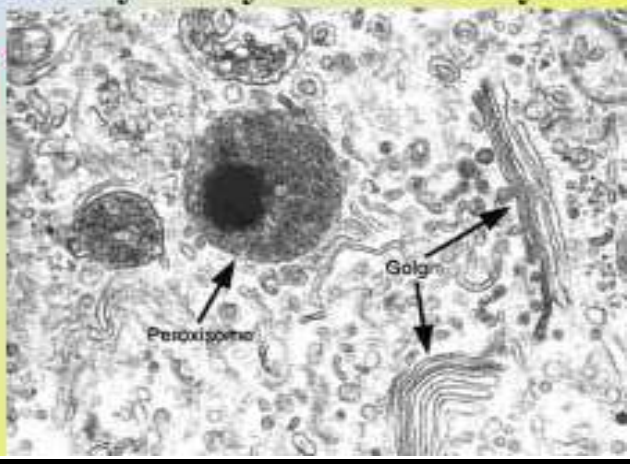
Structure:

- **They are vesicles the size of which reaches 1 mμ.**
- **They are filled with enzymes and proteins.**

Function:

- **They produce peroxides which are analyzed by Catalase enzymes during photosynthesis.**

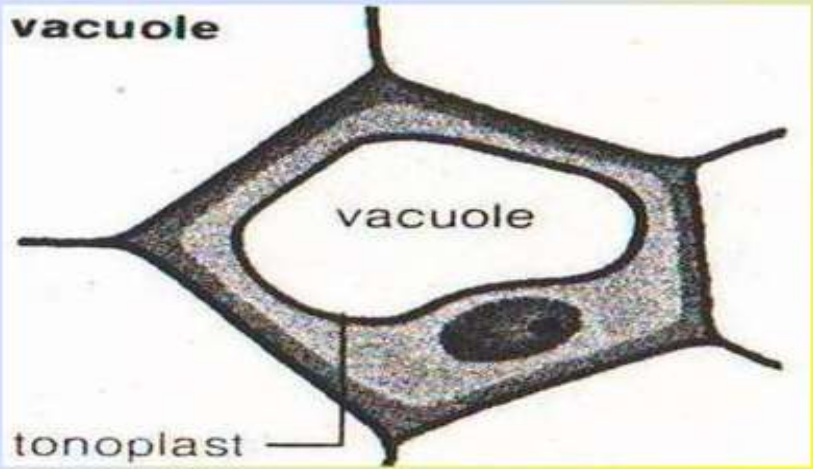
$$2\,H_2O_2 \xrightarrow{\text{Catalase}} 2\,H_2O + O_2\uparrow$$



Non-protoplasmic Components

Vacuole

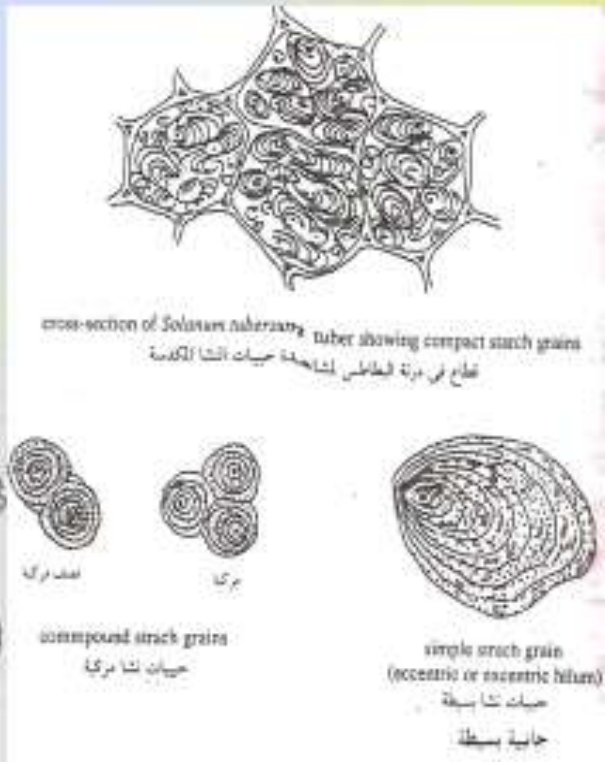
- It contains a colloidal solution, which consists of sugars, salts, proteins in addition to other metabolic wastes

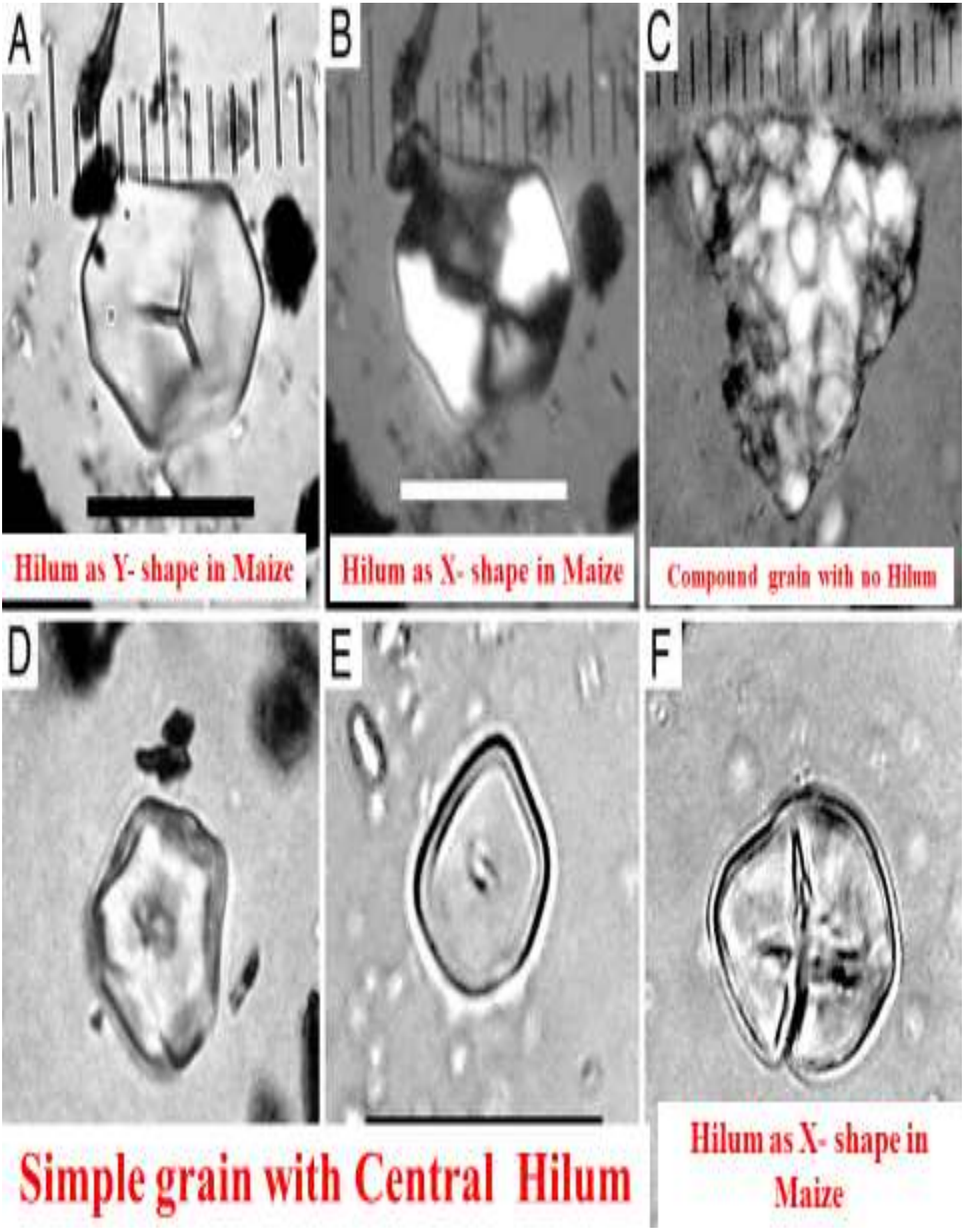


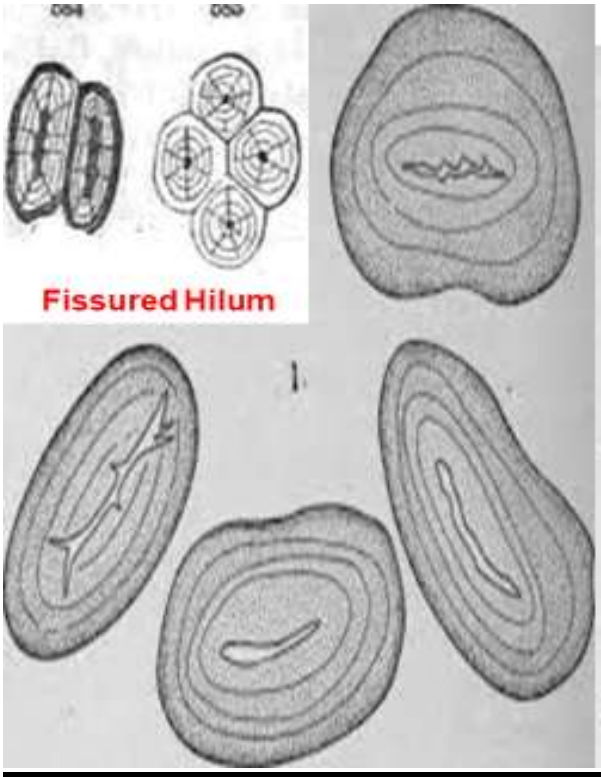
Non-Protoplasmic components

Starch grains

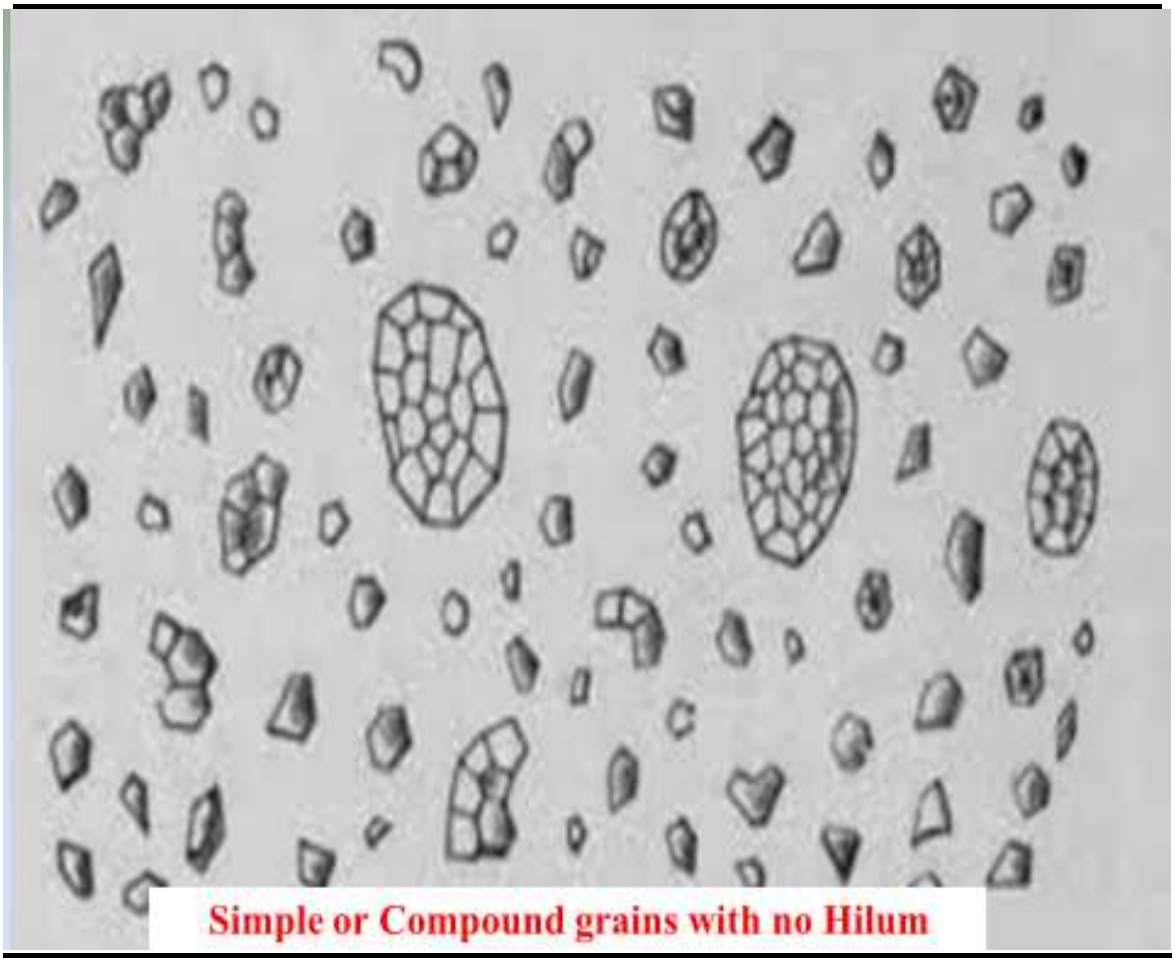
- Striations of starch formation around a central point called the "**Hilum**", where the starch grains are:
  - Either: **Simple** or **Compound**.
  - According to the position of the Hilum they are either **Central** or **Lateral**.
  - In some plants the Hilum appears as:
    1. X or Y- shaped: Maize.
    2. Fissure: Kidney beans or Peas.
    3. No hilum: Rice.




A
B
C
Hilum as Y- shape in Maize
Hilum as X- shape in Maize
Compound grain with no Hilum
D
E
F
Simple grain with Central Hilum
Hilum as X- shape in Maize

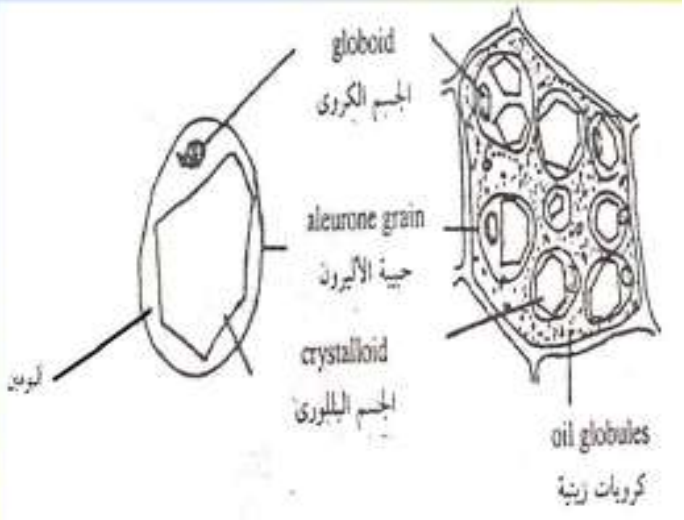

Fissured Hilum


X or Y-shaped Hilum


Simple or Compound grains with no Hilum

Non-Protoplasmic components

- **Proteins:**
- It consists of *Aleurone* grains which is composed of:
  - Globoid Body of proteins.
  - Crystalloid Body
- **Function:** it is responsible for seed germination by the production of enzymes.



(شكل ١٢): حبيات الإليرون فى خلية الندوسبيرم نبات الخروع

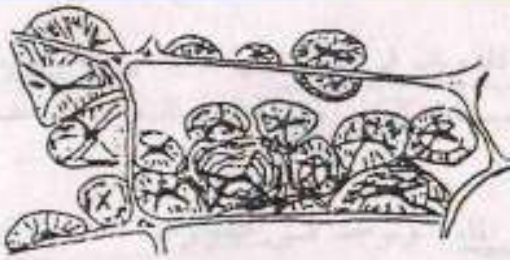
- **Fats and Oils:**

It is stored in fruits, seeds as well as rhizomes and tubers.

Non-Protoplasmic components

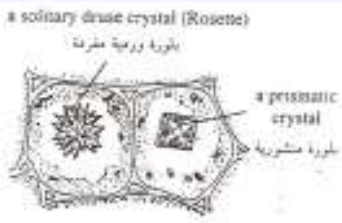
Crystals

- **Types:**
  1. **Proteinous**; in the form of small cubes.
  2. **Sugary**; like Inulin spherical crystals.
  3. **Salts**; Calcium crystals are one of the most widespread ones. It's divided into:
     - ✓**Ca-oxalate**:Solitary-Raphides-Druses.
     - ✓**Ca-carbonate**



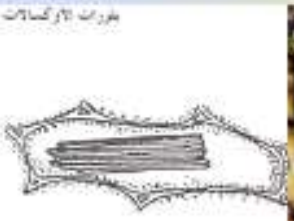
(شكل ١٣): بللورات الإنيولين فى خلايا درنة نبات الداليا

(Fig. 13) sphaerocrystals of inulin in cells of a Dahlia tuber



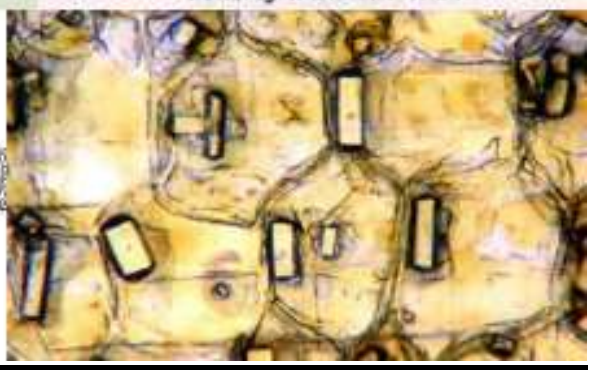
(شكل ١٤): خليتان من عنق نبات البيجونيا

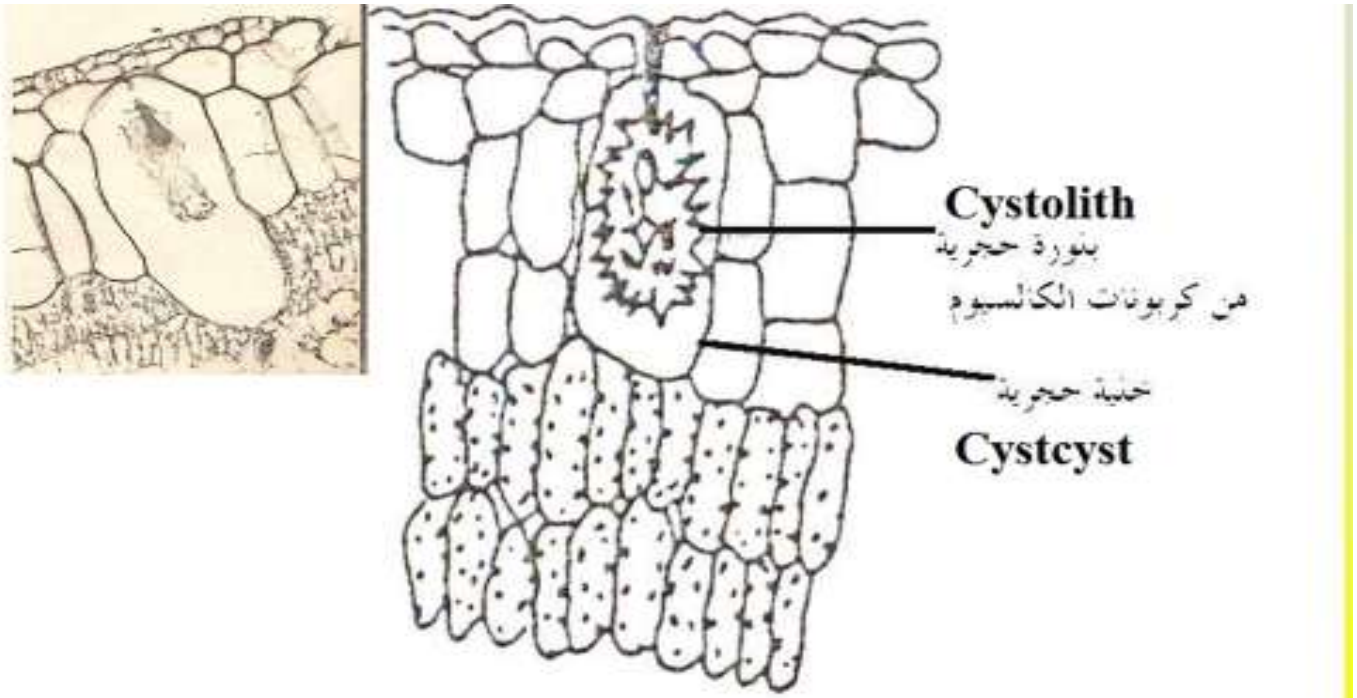
(Fig. 14) two parenchyma cells from the petiole of Begonia.



(شكل ١٤): حزمة من بللورات إبرية

(Fig. 14) a bundle of raphides.





T.S. in *Ficus elastica* leaf showing stone cell

(شكل ١٤): بلورة حجرية فى نصل ورقة نبات الفيكس المطاط

Non-Protoplasmic components

- **Tanins**: Phenolic compounds that is characterized by:

  Being colloidal in nature.

  It is found in dead tissues.

  It appears like thin or thick masses.

  It appears in red, yellow or brown colors.

  Function: 1. They protect the plants against drought.

  2. They are antioxidant in nature.

  3. They are antimicrobial agents.

- **Alkaloids**: Nitrogenous compounds, examples of which are:
- **Caffeine**:(In tea leaves or coffee beans) a nervous system stimulant
- **Opium**: the dried latex of Opium plants. Used as analgesic.

- **Quinine**: Isolated from the bark of Cinchona tree . Used to treat Malaria, but can cause deafness, irregular heart beat and sweating.
- **Pigments**: They are divided into two groups of pigments:
  1. Insoluble in water: They dissolve in alcohol. Examples of which are those pigments found in plastids as Chlorophyll and Carotene.
  2. Soluble in water: It includes Flavones and Anthocyanins

Flavones $\xrightarrow{(O)}$ Anthocyanins

<u>Anthocyanin changes its color according to the pH</u>:

a. It is Red in Acidic, and
b. Blue in Alkaline

Comparison between Plant and Animal Cells

Point of Comparisons	Plant Cell	Animal Cell
Centrioles	Do not exist	Exist
Plastids	Exist	Do not exist
Cellulosic Cell Wall	Exist	Do not exist
Plasma Membrane	They Both have plasma membranes	
Size	They range from 1µm to less than 1cm	

Methods Of Studying Cells

The Possibility Of Cell Cultivation In Laboratory:

1. It can be cultivated on nutrient media of:

    - Blood Plasma - Embryonic tissues -Salts &vitamins

2. The nutrient media is either liquid or solid (by adding agar)

3. The media is then sterilized to be used later.

Cell Microscopic Examination:

Chemical fixation of the tissue to stabilize the specimen's mobile macromolecular structure.

The tissue is sectioned into thin slices using a microtome.

A slice is then placed in a glass slide and covered by a thin cover; to be examined later under the microscope.

Parts of the cell can be stained (i.e. nucleus or mitochondria).

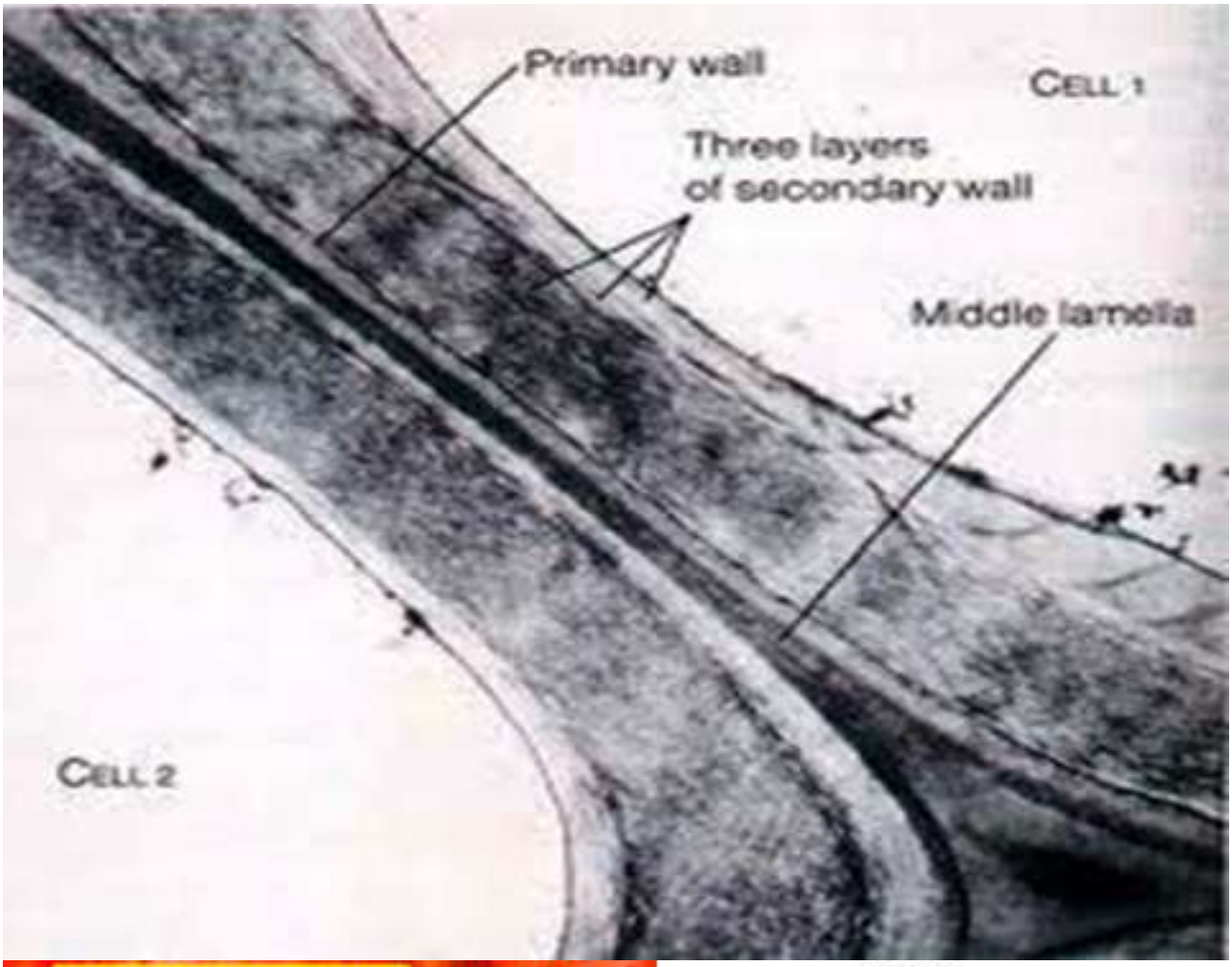
Using the electron microscope, the tissue is fixed by Osmic acid and embedded in acrylic plastic or resin to be sectioned by an ultra-microtome with glass or diamond.

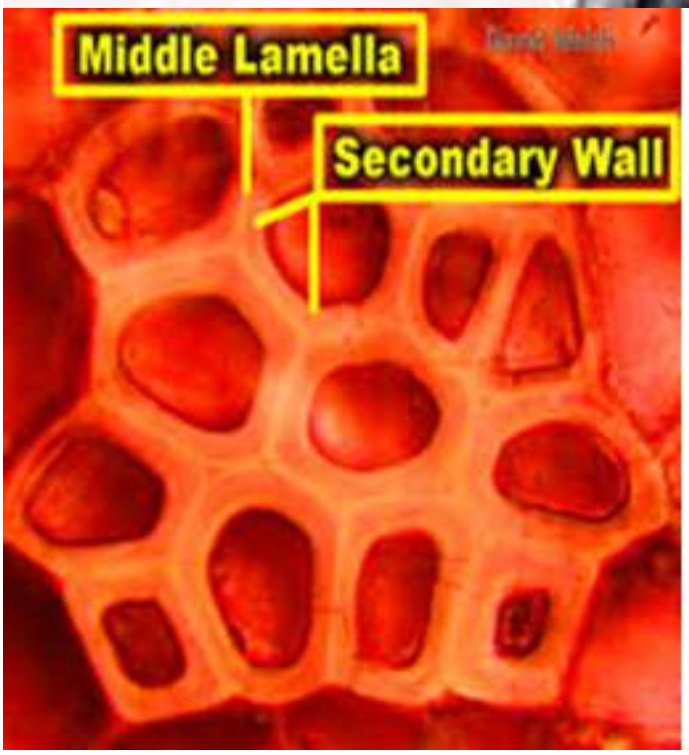
Electron Microscopy revealed the following:

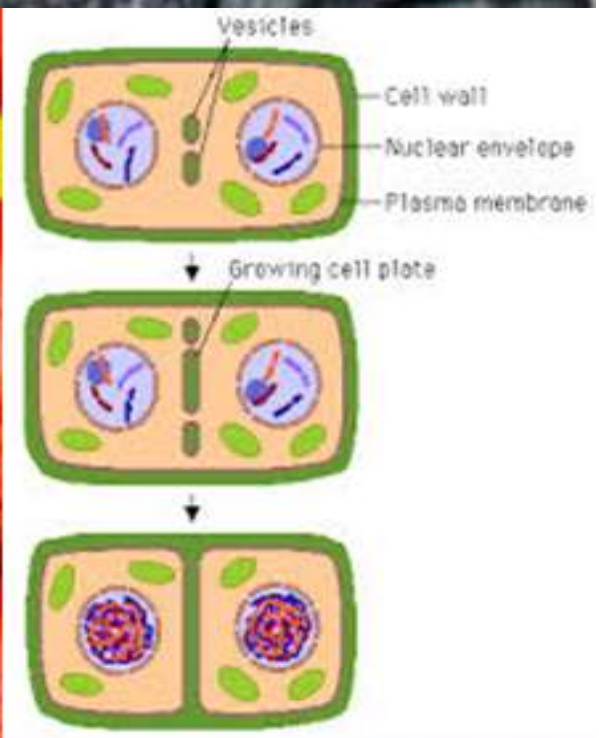
A skeletal network of cellulose in the form of bundles -with spaces in between- Cell wall: they are first collected as **microfibrils** then are gathered to form **macrofibrils** in the secondary cell walls. In these spaces different materials are deposited according to the type of wall as well as cell type and age.

Examples of which are:

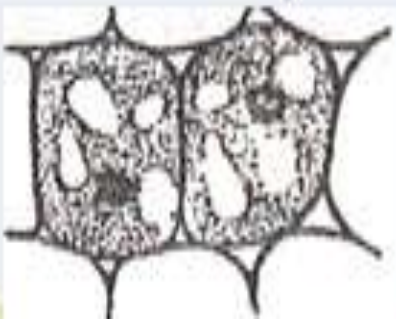
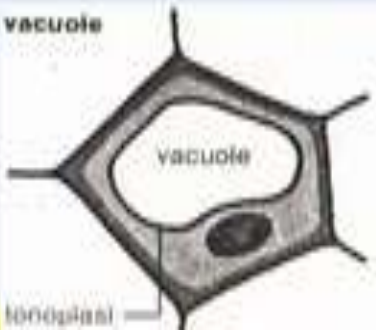
1. Primary cell walls are filled with Ca- and Mg- pectates.
2. Xylem Vessels are filled with lignin.
3. Epidermal Cell wall is filled with Cutin (impermeable to water)
4. Phellem is filled with Suberin (impermeable to water).
5. While Root Cell Wall -in secondary cell wall- is filled with water, like those in cotton plant.


Primary wall
CELL 1
Three layers
of secondary wall
Middle lamella
CELL 2


Middle Lamella
Secondary Wall


Vesicles
Cell wall
Nuclear envelope
Plasma membrane
Growing cell plate

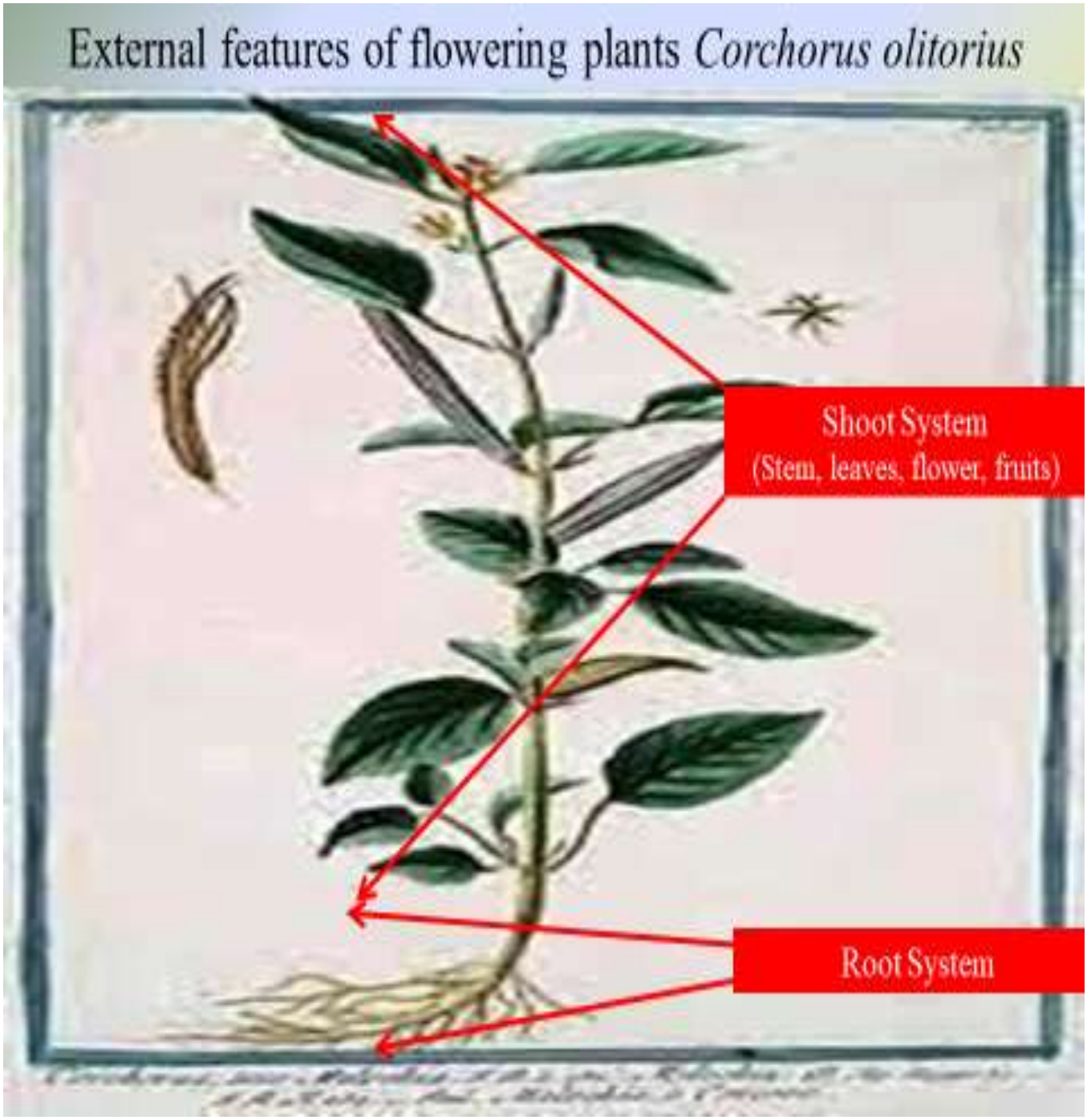
Comparison Between *Meristematic* and Permanent Tissues

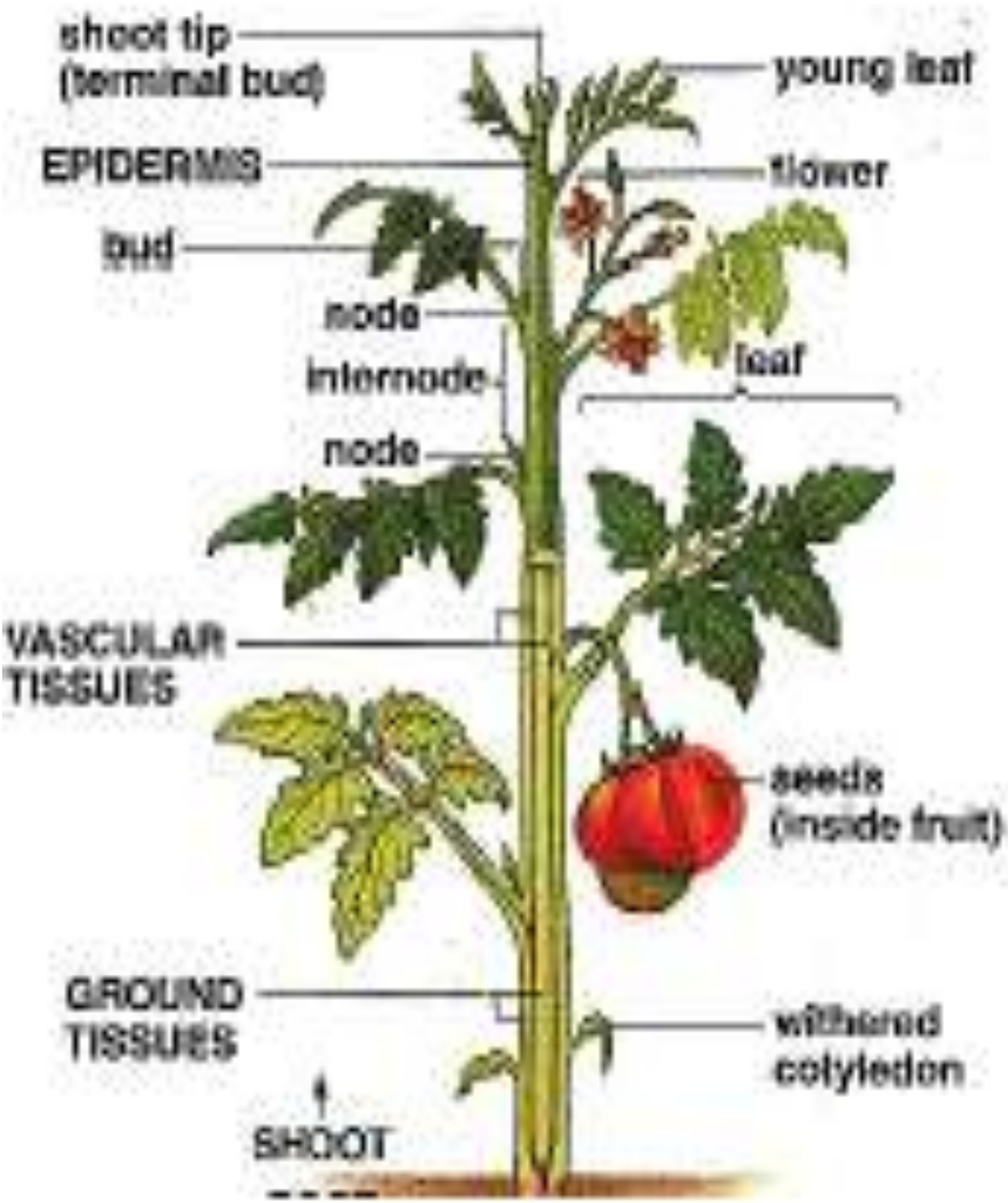
Points of Comparison	*Meristematic* Tissue	Permanent Tissue
Size	Small	large
Cell Wall	Thin	Thick
Vacuole	Does not exist and if found are small and scattered	Large
Intercellular Spaces	Exist	Does not exist
Cell Division	Divisible	Lost its ability to divide
Nucleus	Large & Central	Small & lateral
Nature	Subdivided into primary and secondary	-------
Shape		

External features of flowering plants:

Most plant consists of two parts:

1. **Shoot System: which lies above ground and is characterized into the Stem, leaves, flower, fruits.**
2. **Root System: which lies in most plants in the underground where the root carries the secondary roots and rootlets.**




shoot tip
(terminal bud)
young leaf
EPIDERMIS
flower
bud
node
internode
leaf
node
VASCULAR
TISSUES
seeds
(inside fruit)
GROUND
TISSUES
withered
cotyledon
SHOOT

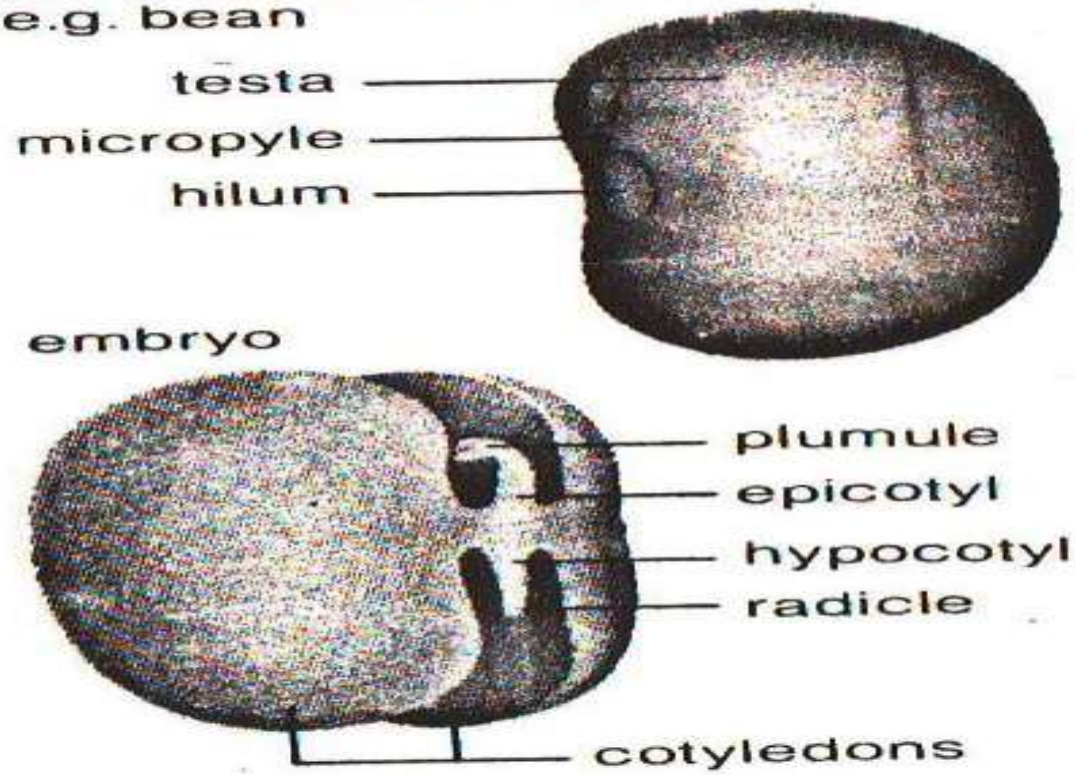
The Seed

- **<u>Seed:</u> A fertilized ovule. It consists of; a young *Dicot* plant called the Embryo in dormancy; feeds on a variable amounts of Endosperm (seed is <u>Endospermic</u> where it appears small in size) or none (seed is <u>Exendospermic</u> where it appears fleshy and large); and protective layers Testa. It has only one scar that represents the Hilum.**

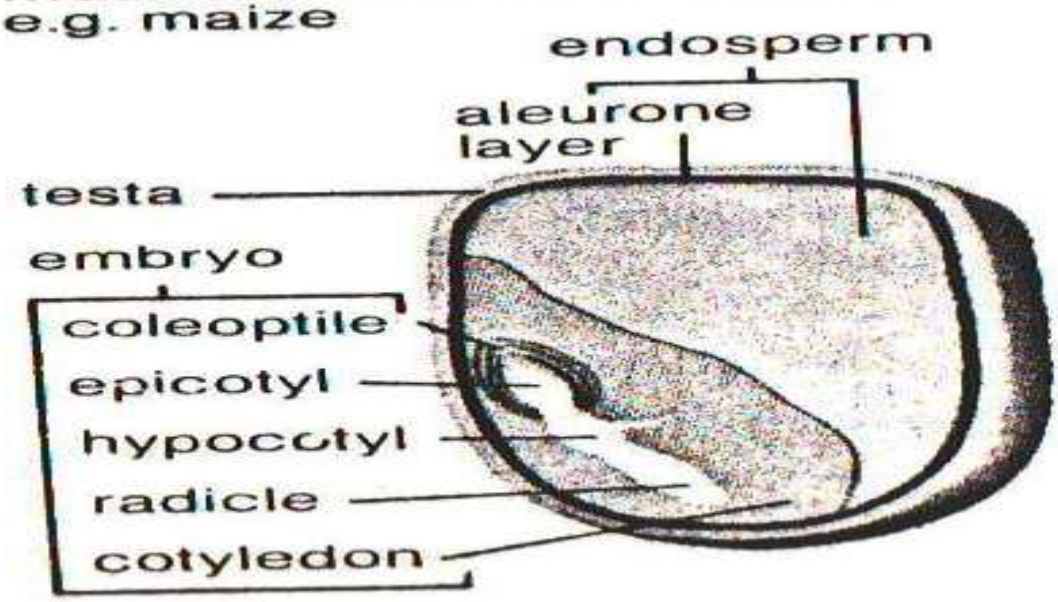
- **<u>Embryo</u>: It consists of one (Monocot) or two (*Dicot*) leaves Cotyledons; primary root Radicle; primary shoot Plumule.**
- **<u>Types of Seeds</u>:**
  - **<u>Endospermic (*Albuminous)* Seed:</u> A young embryonic plant with reserve food material to supply the developing embryo in its early stages of germination where it is kept outside the embryo in a separate tissue known as Endosperm. The seed is usually <u>small</u> in size.**
  - **<u>Exendospermic (*Exalbuminous)* Seed:</u> A young embryonic plant with no endosperm where the seed is <u>large</u> and the reserve food is stored in the cotyledons.**
- **<u>Grain:</u> A fertilized ovary. It consists of; a young embryonic *Monocot* plant; two scars : one represent the point of attachment to the style and the other is the point of attachment to the receptacle (Hilum).**
- ***<u>Micropyle</u>*: a hole where the seed obtain its water.**
- ***<u>Caruncle</u>* : a spongy tissue above the Micropyle**
- ***<u>Testa</u>* : Protective layers covering the embryo.**

- **<u>Types of Germination</u>:**
  1. ***<u>Hypogeal</u>*: Elongation of the *Epicotyl.***
  2. ***<u>Epigeal</u>*: Elongation of the *Hypocotyl***

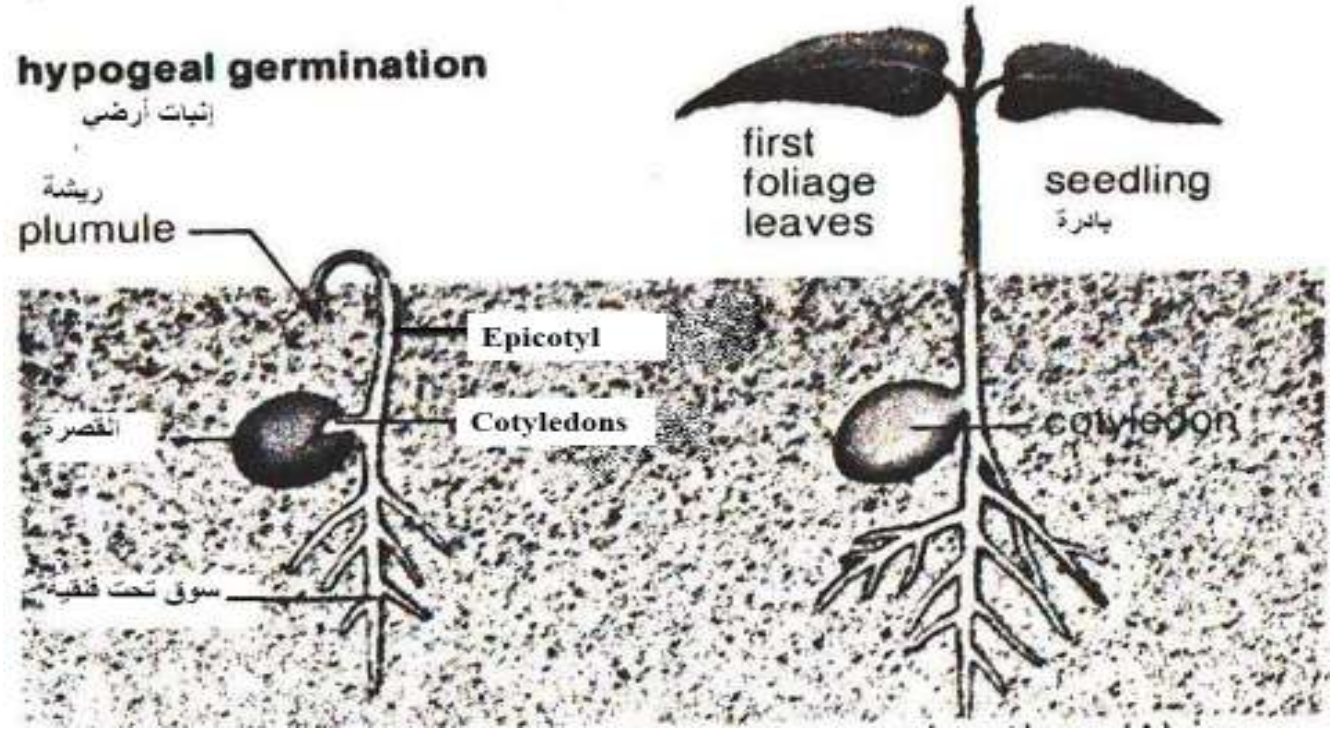
exalbuminous seed
food stored in cotyledons
e.g. bean



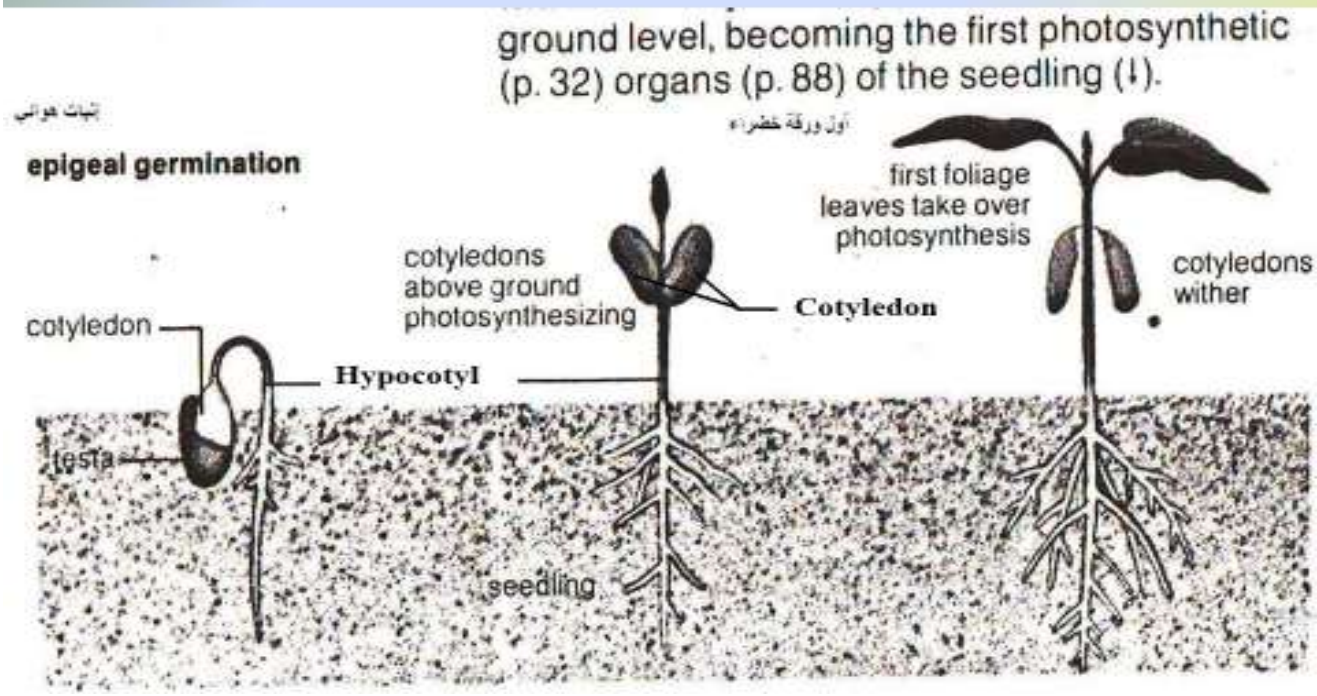
albuminous seed
most food stored in endosperm
e.g. maize



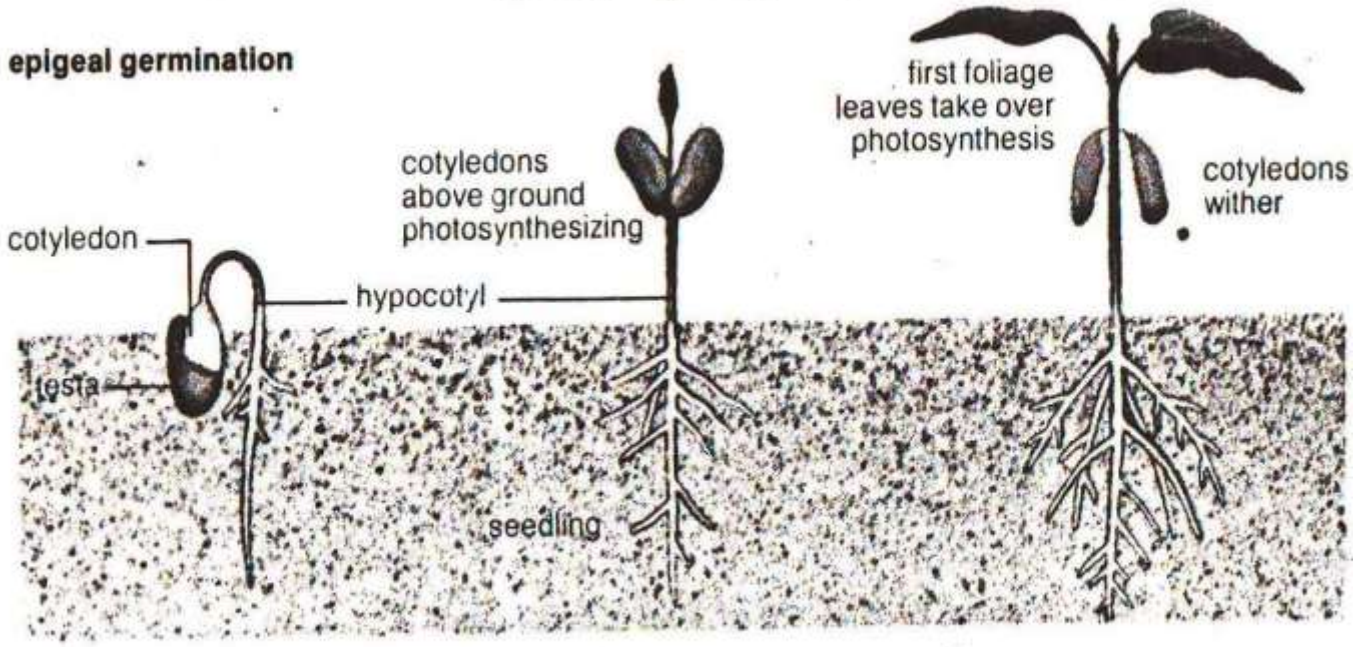
Hypogeal Germination

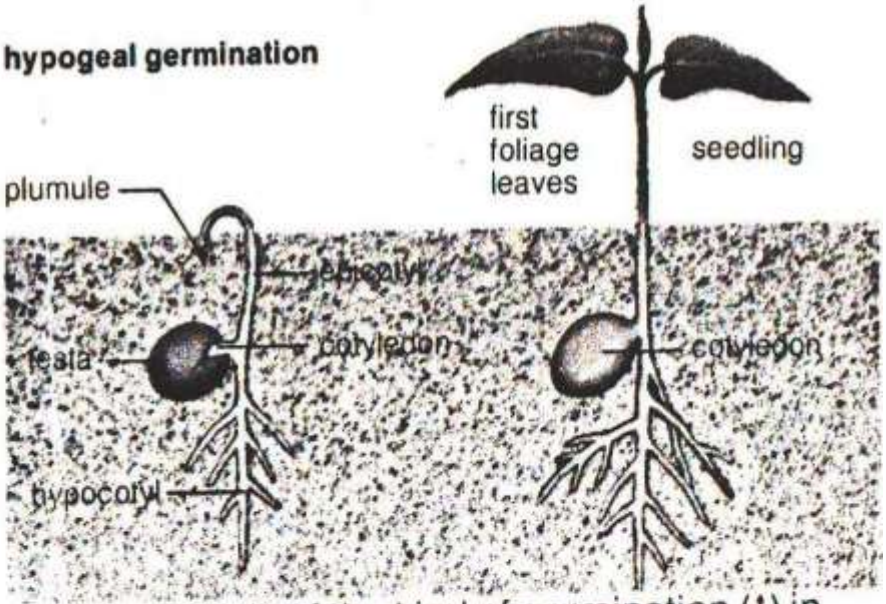


Eipogeal Germination



ground level, becoming the first photosynthetic (p. 32) organs (p. 88) of the seedling (↓).





hypogeal (*adj*) of the kind of germination (↑) in which the cotyledons (↑) remain below ground. Their stored food is used up in the early growth of the epicotyl (↑) and the hypocotyl (↑).

seedling (*n*) a young plant growing from its seed. It is usually called a seedling until it loses its cotyledons (↑).

Conditions necessary for germination:

- **<u>Internal</u>: (Concerning the Seed):**

  Vitality of the Embryo: It depends on the dormancy period of the embryo, seed storage in dry silos (water content of the seed is 1%). Some need long dormancy periods, short or no dormancy at all; it is according to the seed type and nature:

  1. ***Testa* Hardness**
  2. **Incomplete growth of the embryo.**
  3. **Genetic factors**

- **<u>External</u>: (Concerning environmental conditions):**

  1. Humidity (Water Content) **2.Oxygen**

  3.Temperature **4. Light**

- **<u>Other Factors</u>: *i.e.* mechanical removal of the Testa by:**

  1. Oxygen **2. Radiation**

  3. Acids **4. High Temperature**

  5. Mixing the host seeds with parasite seeds

Changes occurring in seed during germination:

<u>Seed changes during soaking in water</u>:

- **<u>Physical</u>: 1. Increase in Size** **2. Breakage of *Testa***
- **<u>Chemical</u>:**

  1. **<u>Catabolism</u>: the dissolution of the solid complex reserve food material to simple one through enzymatic activity.**
  2. **<u>Enzymatic Activity</u>:**

  Starch $\xrightarrow{\text{Diastase}}$ **Monosaccharide sugar**

  Protein $\xrightarrow{\text{Protease}}$ **Amino acids**

  Lipids $\xrightarrow{\text{Lipase}}$ **Triglyceride acids + Glycerin**

- **Vitality:**

  Physiological Activity:

  1. **The protoplasm turns from gel to sol (semi-solid).**
  2. **Cells get turgid (enlarged)**
  3. **Growth of the radicle and then the plumule.**
  4. **The seed becomes a seedling by forming its 1st foliage leaf.**

Stages of Germination

1st Stage: Swelling of seed and removal of *Testa*.

2nd Stage: Growth of Radicle.

3rd Stage: Growth of Plumule.

4th Stage: Formation of the first foliage leaf.

Types of Roots

- **Function:**

  1. Absorption 2. Anchor 3. Storage

- **Root forms:**

  1. **Smooth.**
  2. **Whitish or yellowish in color**
  3. **Tapering towards the end.**

- **Root Structure:**

  1. **Growing apex: A root cap protecting the delicate meristemtic cells (of growing point at the tip of the root) from injury. The root cap (Calyptra) is slimy to allow the root to slide easily in its course. It is continuously torn away and renewed from the underlying meristem.**
  2. **Elongation zone: A bare zone next to the growing zone. The increase in length of the whole root takes place in this region.**
  3. **Absorption Zone: limited area of length and life-span (that does its function for a few days and then dies out). They are covered by numerous root hairs.**

- **Root can be characterized by the presence:**

  1. **Bare zone: It lacks any root hairs.**
  2. **Permanent Zone: lateral roots are produced in succession, the youngest being the nearest to the root hairs. Root branches are almost always endogenous.**

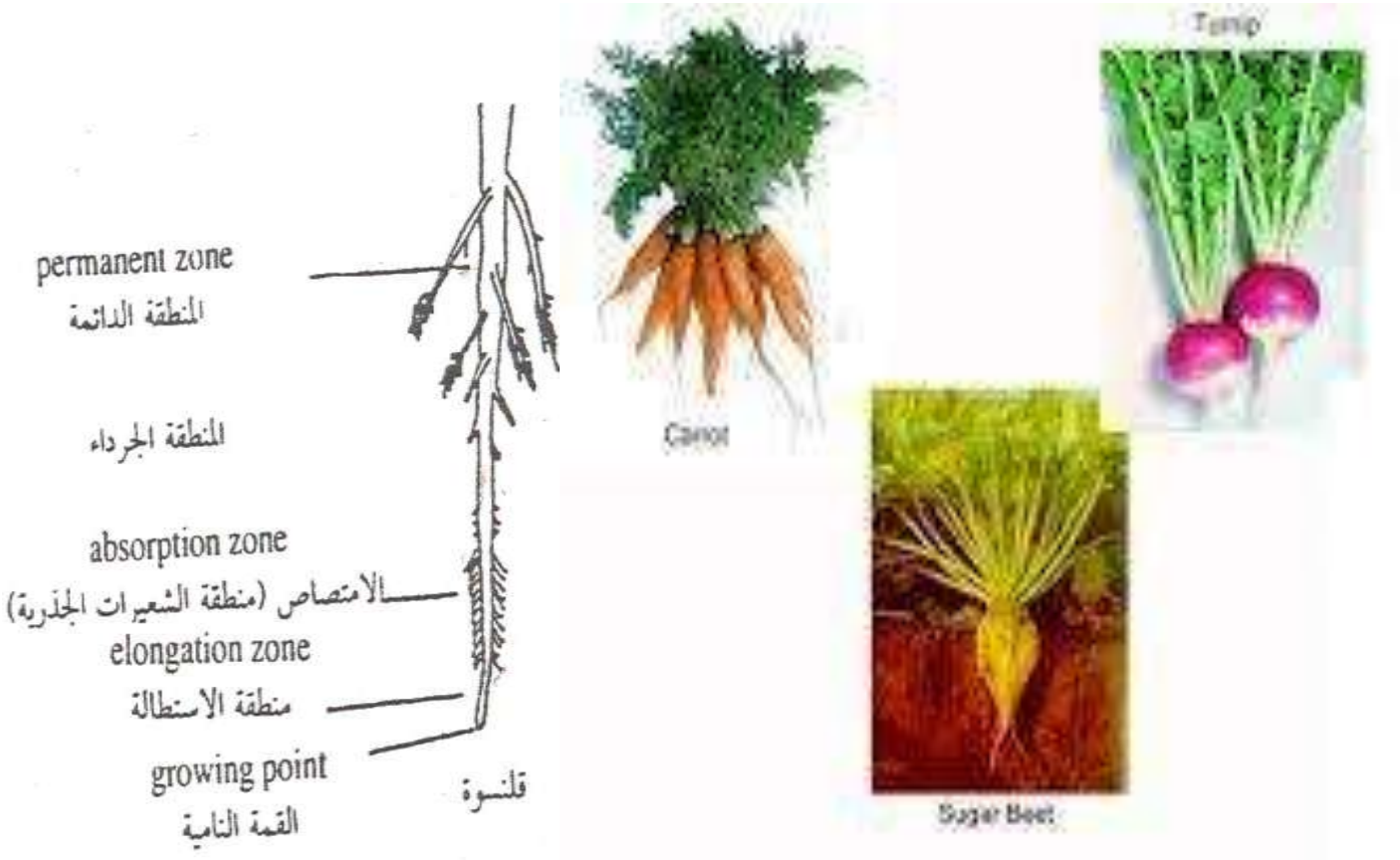
- **Root Forms:**

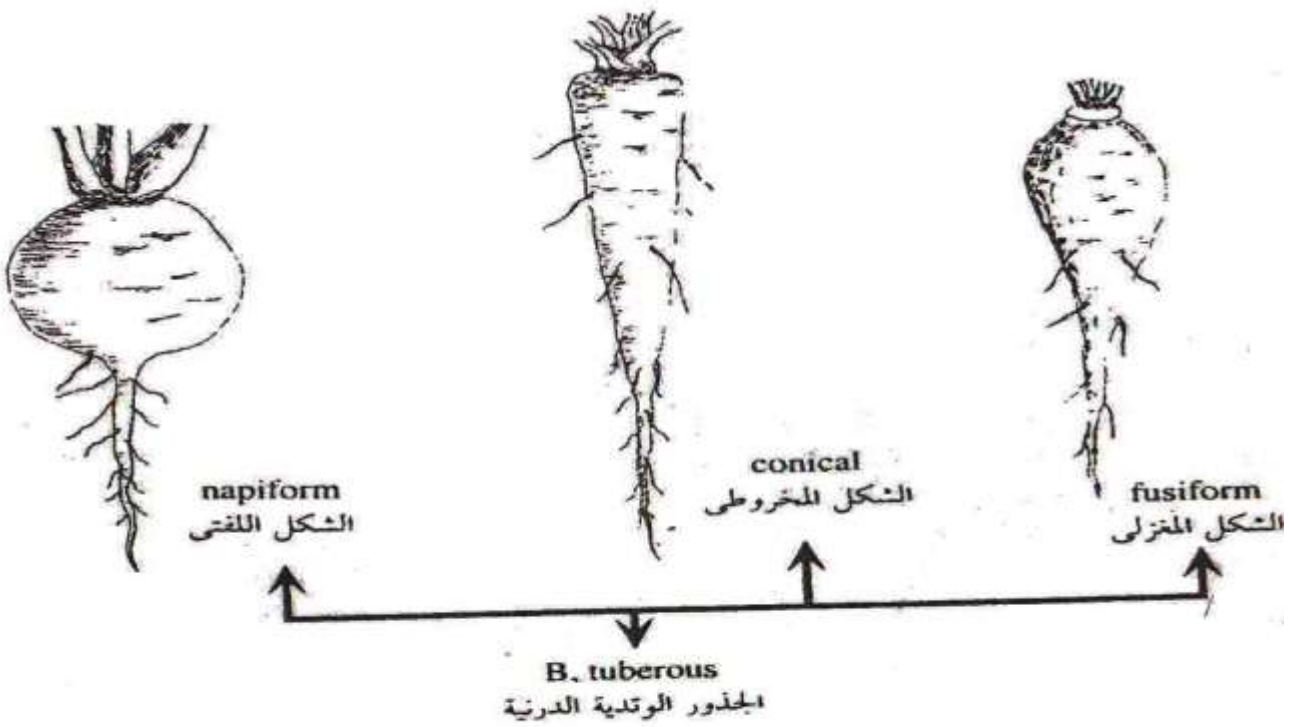
  1. **Primary Root: Originates from the embryo (radicle). It is divided into:**

     a. Normal Tap Root: Smooth, whitish or yellowish in color and tapering towards the end.

     b.Tuberous Root: It's thickened for storage, examples:

     - **Conical: *i.e.* Carrot**
     - **Fusiform: *i.e.* Radish**
     - **Napiform: *i.e.* Turnip**





(شكل ٣٦): الأنواع المختلفة للجذور الوتدية

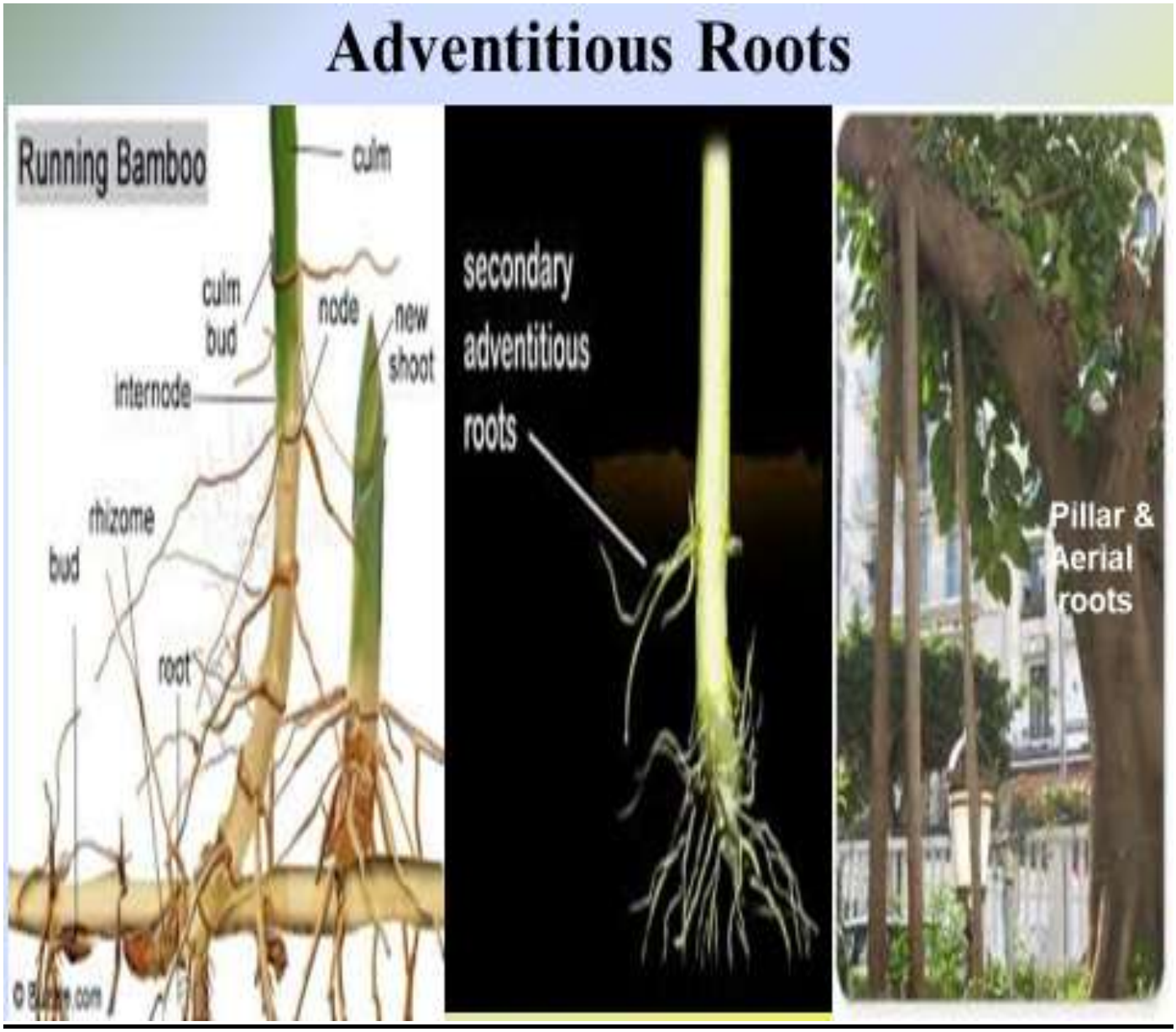
(Fig. 36) different types of tap roots.

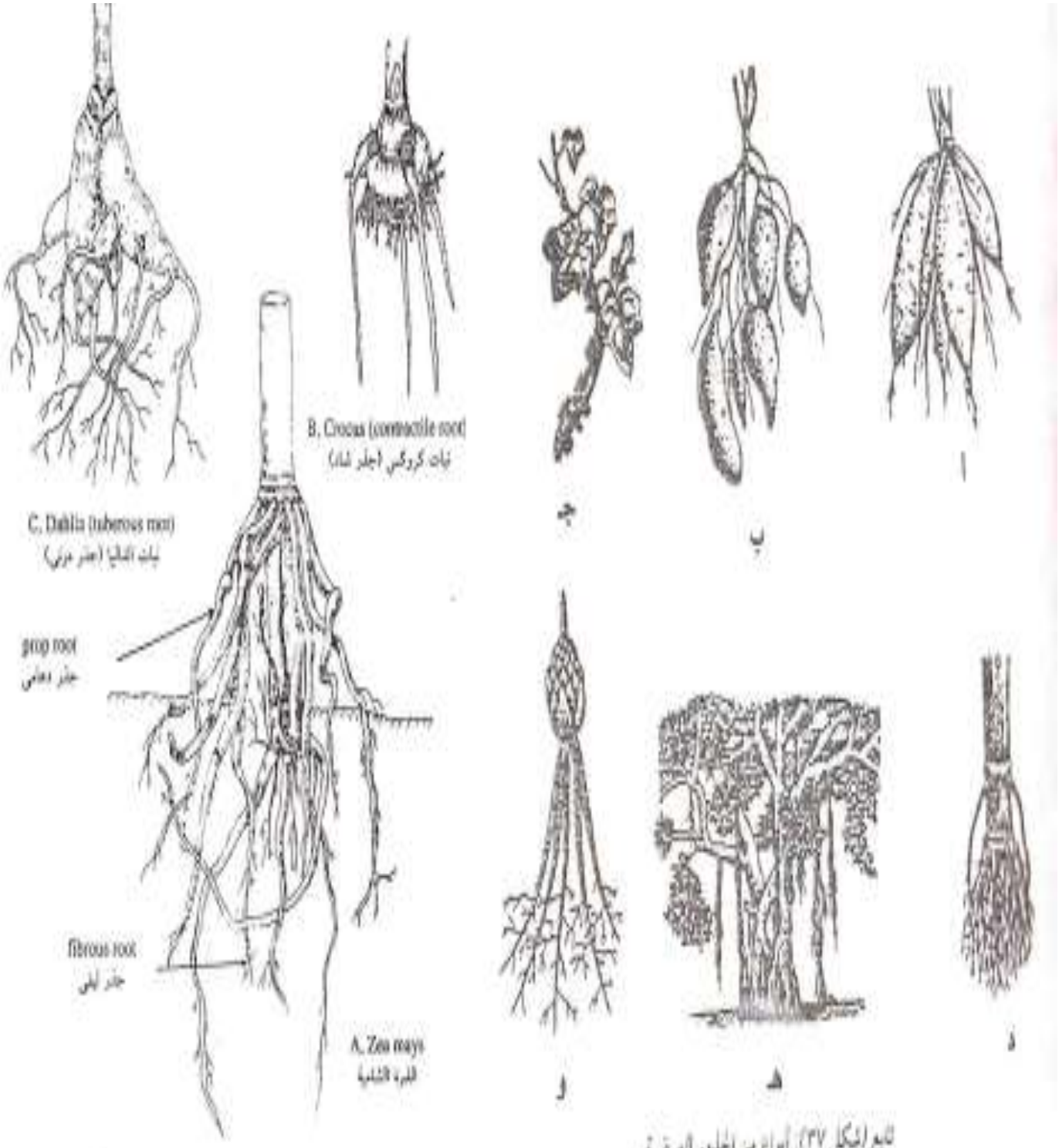
2. Adventitious Root: It arises from any parts of the plant *i.e.* stems and leaves. It is mostly found in *Monocots*. It is divided into:

1. Fibrous roots **2. Prop roots** **3. Storage roots**

4. Climbing roots **5. Aerial roots** **6. Haustoria**

7. Pillar roots **8. Contractile roots** **9. Respiratory roots**





(شكل ٣٧) الأنواع المختلفة للجذور العرضية

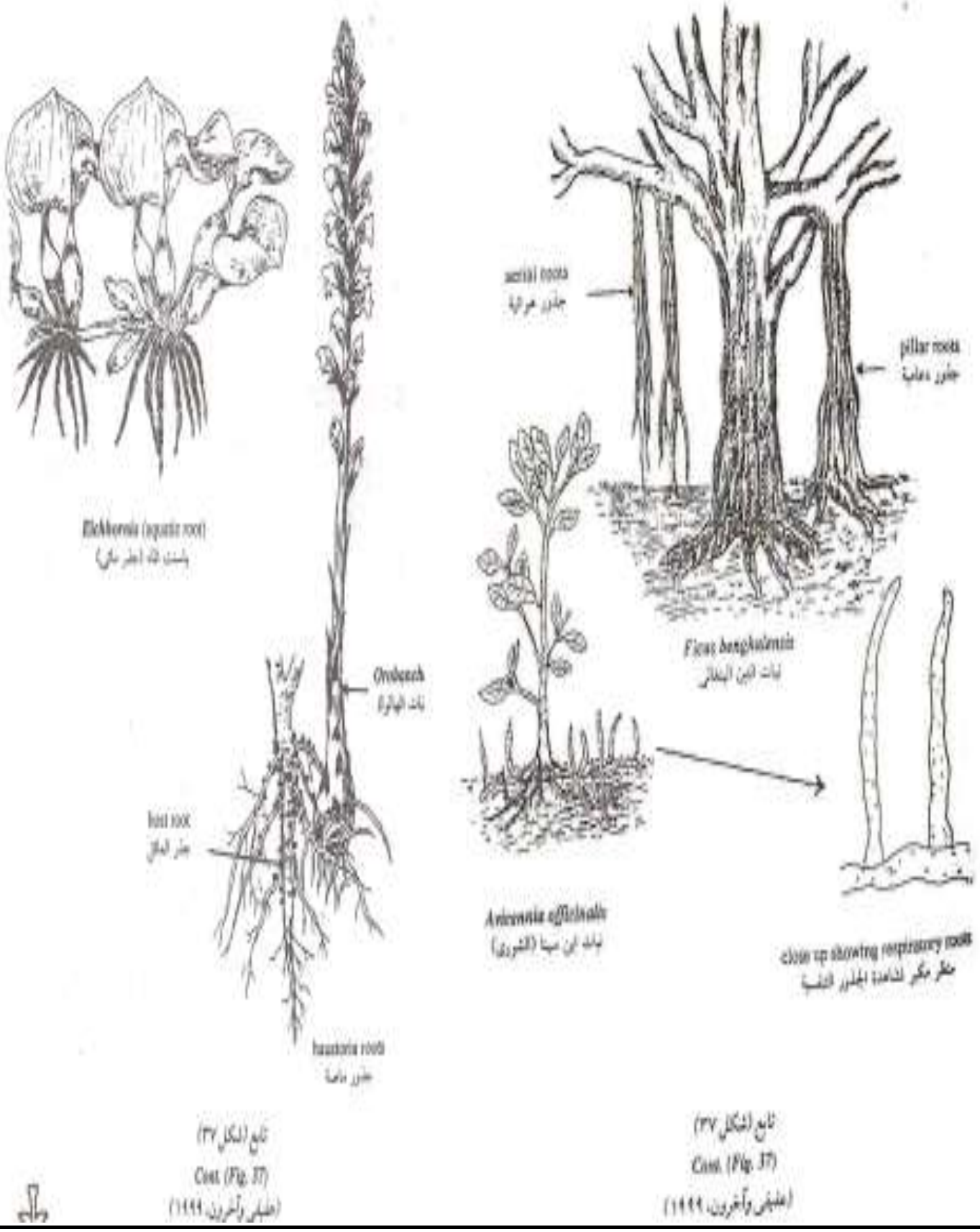
(Fig. 37) different types of adventitious roots

(عفيفي وآخرون، ١٩٩٩)

تابع (شكل ٣٧) أنواع من الجذور العرضية

Cont. (Fig. 37) types of adventitious roots

أ- جذور درنية في نبات الدالیا
ب- جذور درنية في نبات البطاطا
جـ- جذور معلاقية
د- جذور ليفية وساعدة
هـ- جذور هوائية دعامية
و- جذور شادّة



تابع (لشكل ٣٧)

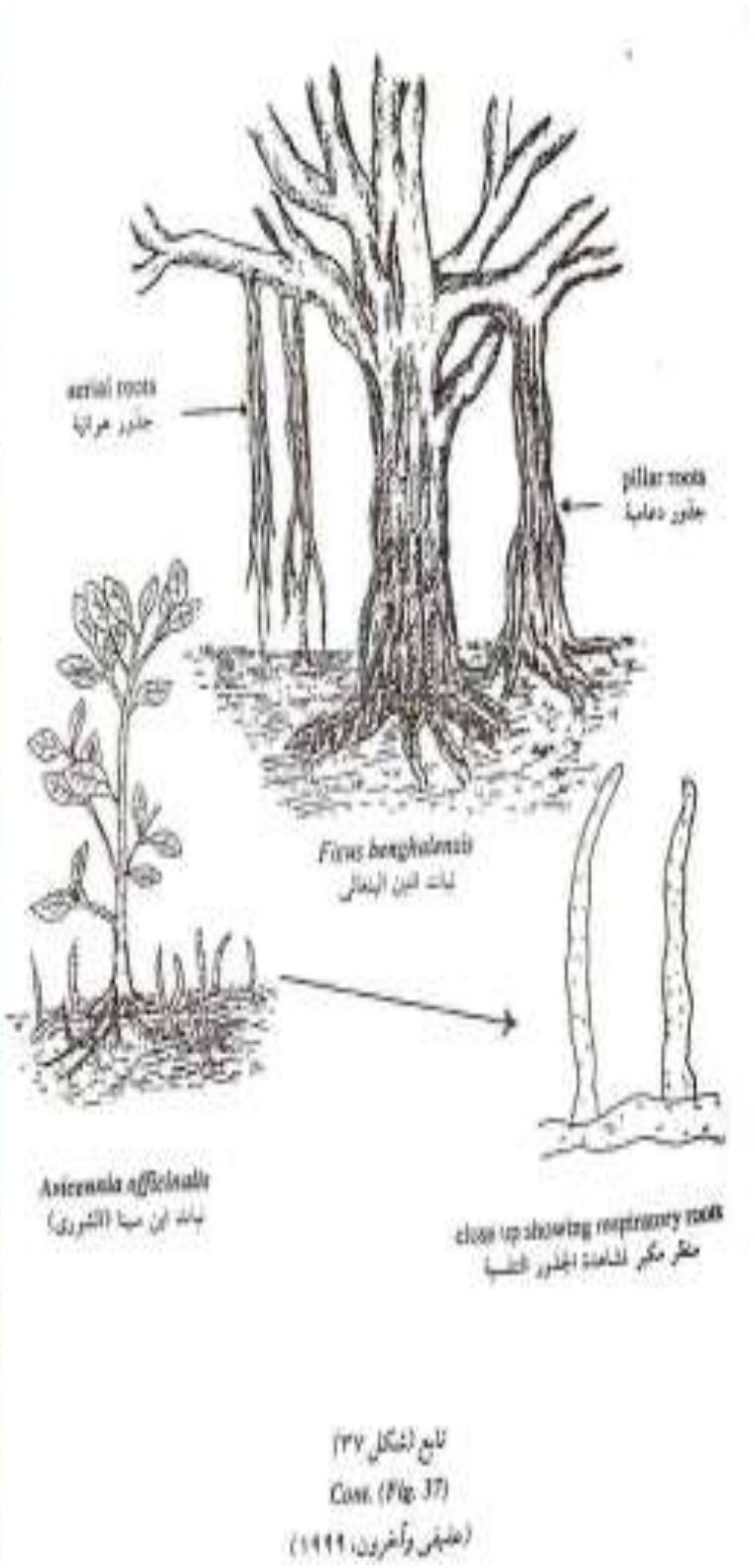
Cont. (Fig. 37)

(طبيلي وآخرون، ١٩٩٩)

تابع (لشكل ٣٧)

Cont. (Fig. 37)

(طبيلي وآخرون، ١٩٩٩)



تابع (شكل ٣٧)

Cont. (Fig. 37)

(عليقي وآخرون، ١٩٩٩)

Types of Stems

- **Morphology of different Stems**

Definition:

It's a leaf-bearing axis. It arises from the plumule. In the majority of plants, the stem, the leaves, buds, flowers and fruits collectively constitute the Shoot System.

Function:

1. **It carries leaves, buds and flowers.**
2. **It conducts the Xylem and Phloem sap.**

Types of Stems:

1. **Aerial**
2. **Subterranean (underground)**

Nature of the Stem:

1. **Woody or Herbaceous**
2. **Erect or Weak (Prostrate, twining or runner)**
3. **Long or dwarf**

T.S. in Stems:

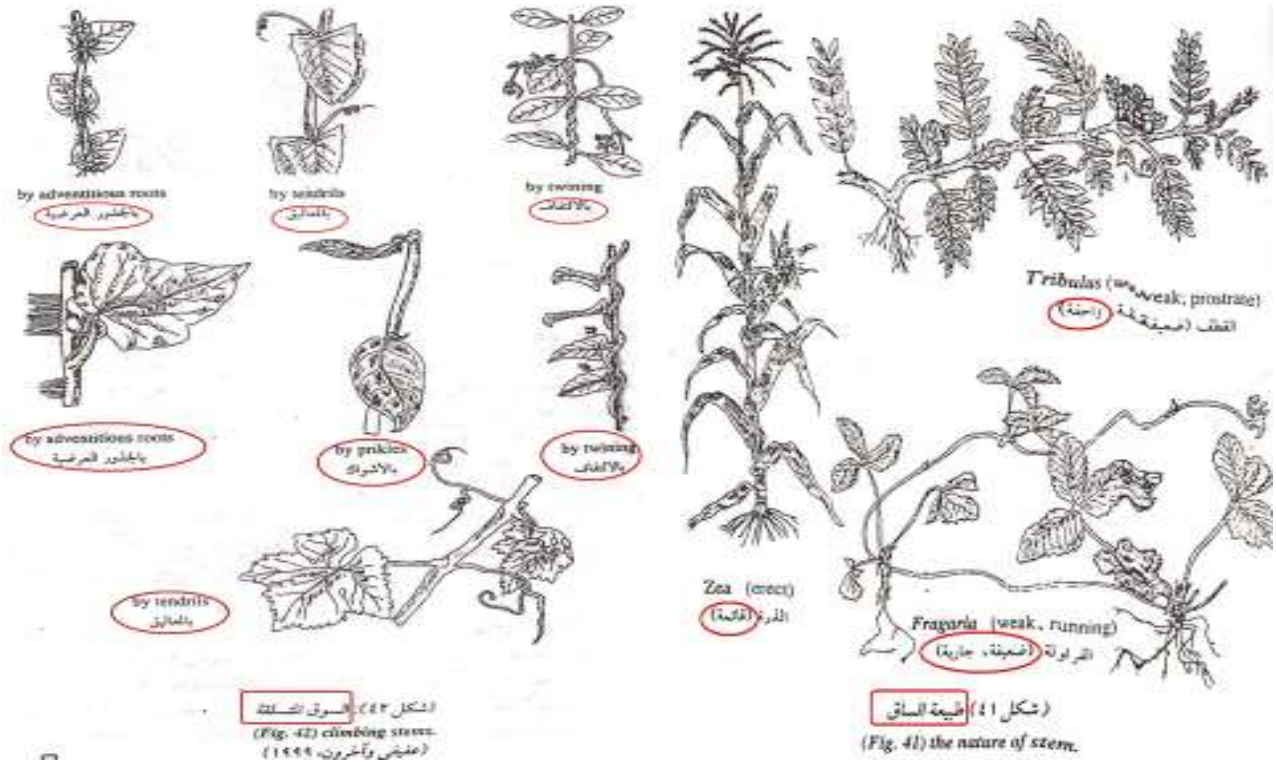
1. **Solid**
2. **Hollow**

Stem Outline:

1. **Circular**
2. **Flattened**
3. **Angular**

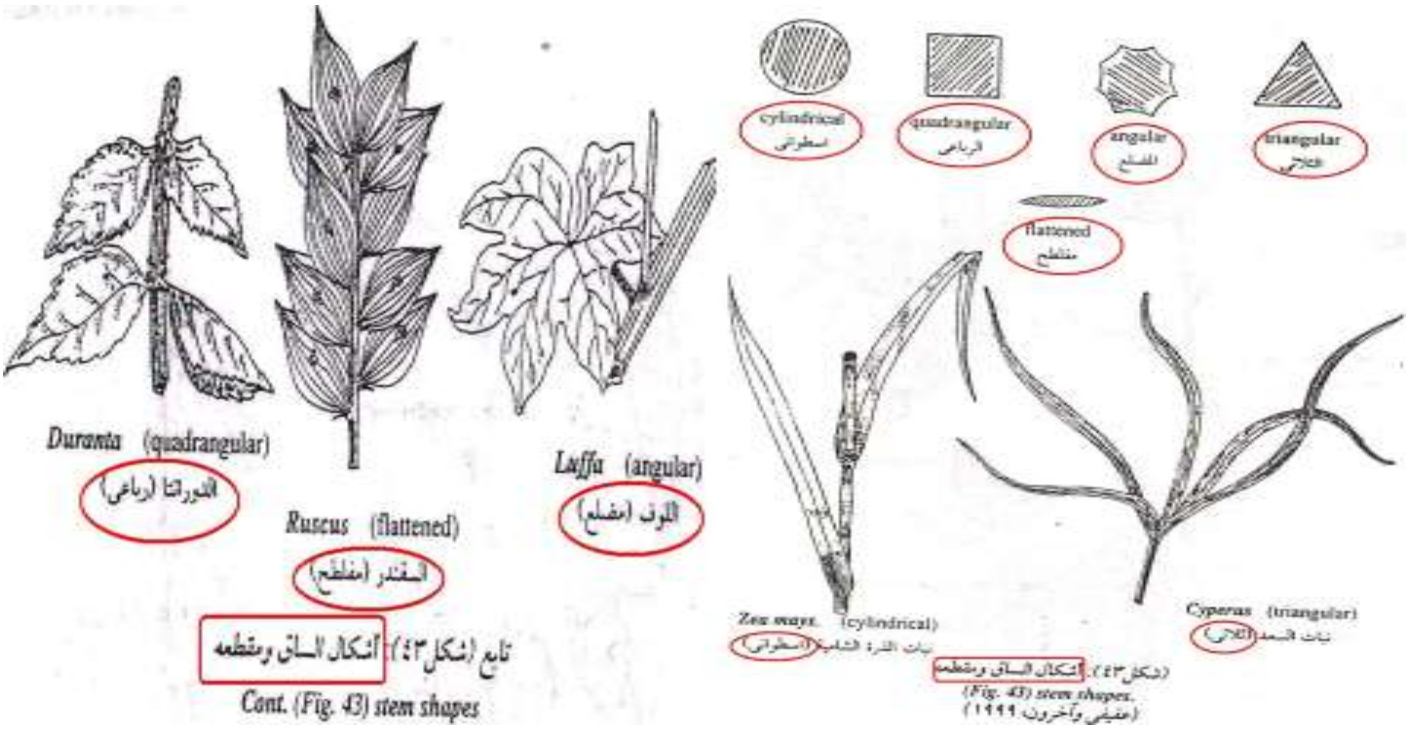
Surface:

1. **Smooth**
2. **Rough**
3. **Hairy or Prickly**



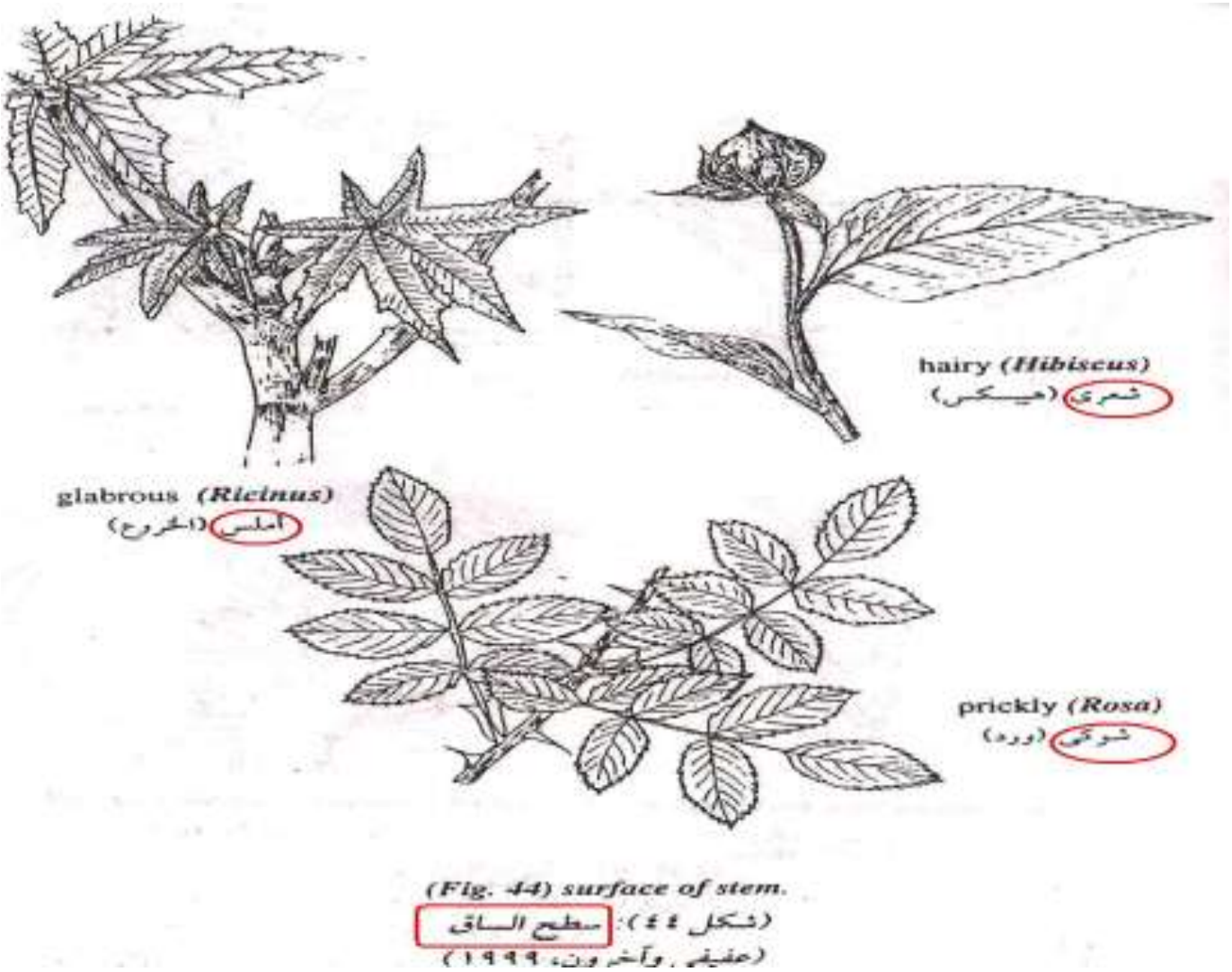
(شكل ٤٢) السوق المتسلقة
(Fig. 42) climbing stems.
(عفيفي وآخرون، ١٩٩٩)

(شكل ٤١) طبيعة الساق
(Fig. 41) the nature of stem.



تابع (شكل ٤٣) أشكال الساق ومقطعه
Cont. (Fig. 43) stem shapes

(شكل ٤٣) أشكال الساق ومقطعه
(Fig. 43) stem shapes.
(عفيفي وآخرون، ١٩٩٩)



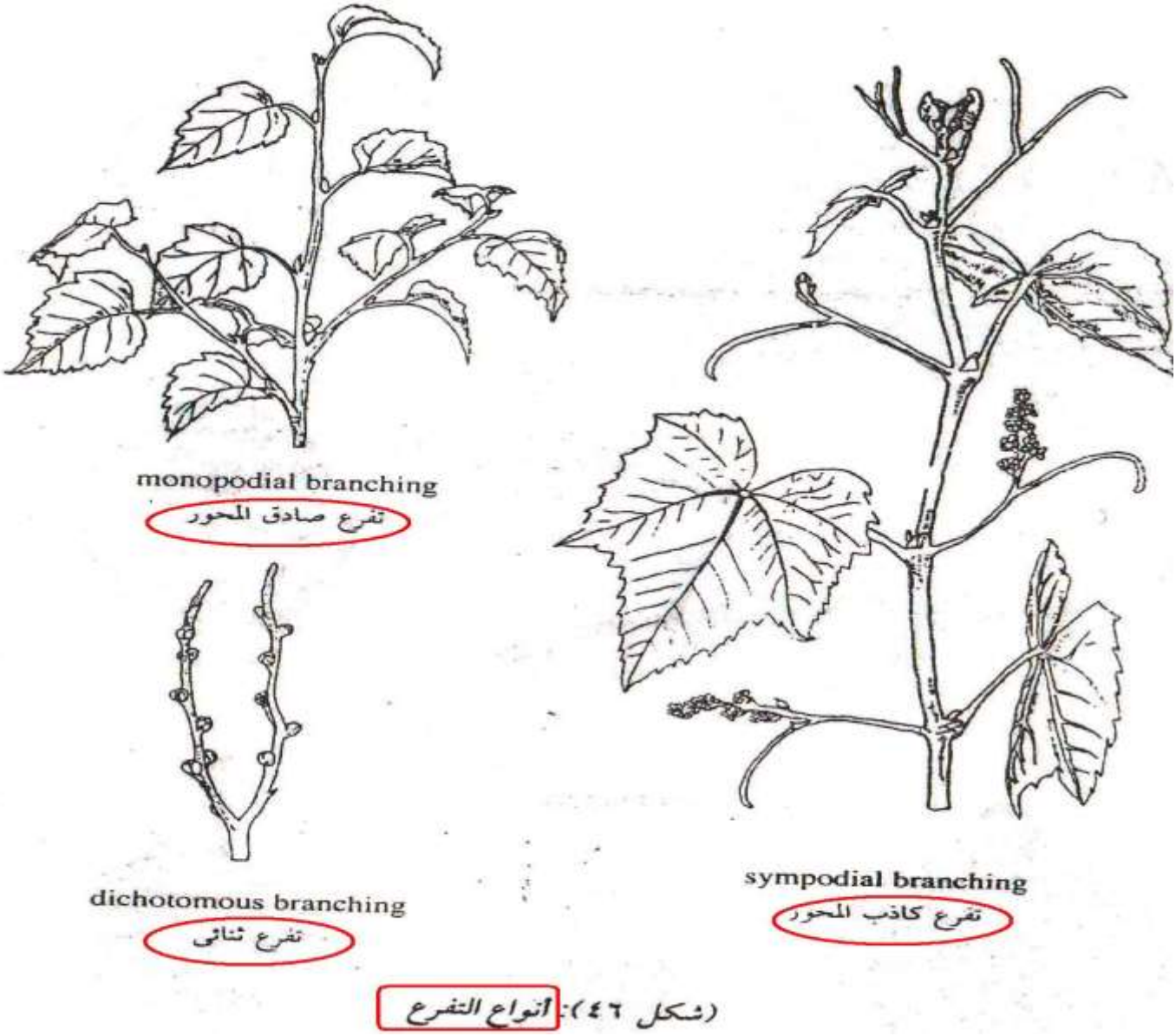
(Fig. 44) surface of stem.
(شكل ٤٤): سطح الساق
(حفيفي وآخرون، ١٩٩٩)

Branching:

1. **Apical: Dichotomy**
2. **Axillary:**

1. Monopodium: The apical bud retains permanently its capacity for active growth and the branches develop from axillary bud which remain lateral and subordinate to the main axis and again branch in the same manner.

2. Sympodium: Frequently the apical bud is transformed into a flower or tendril which ends its career. The axillary bud of the terminal leaf continues the growth of the axis forming one or more internodes which are terminated by another flower or a tendril and so on.



(شكل ٤٦): أنواع التفرع

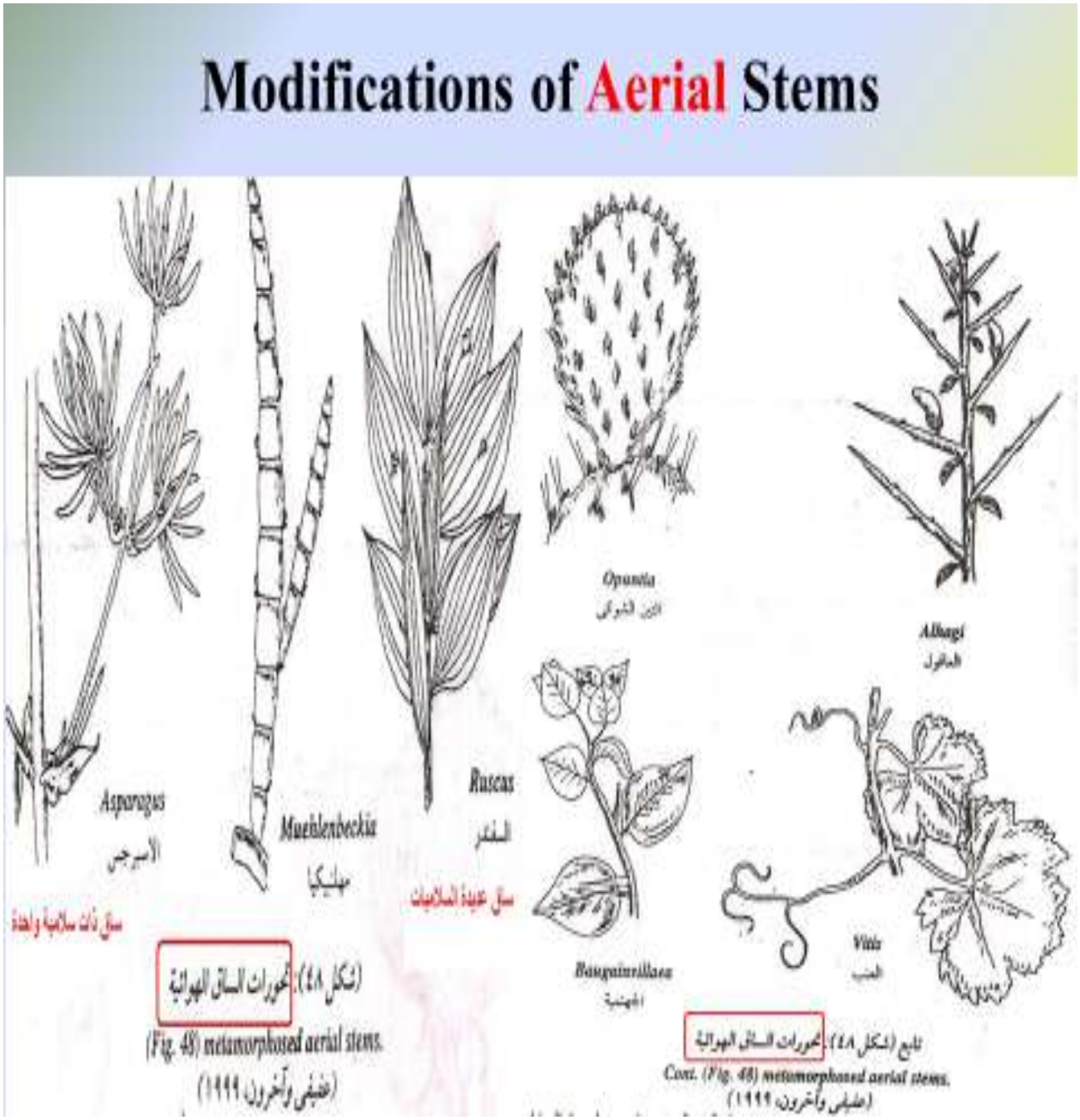
Stem Modifications:

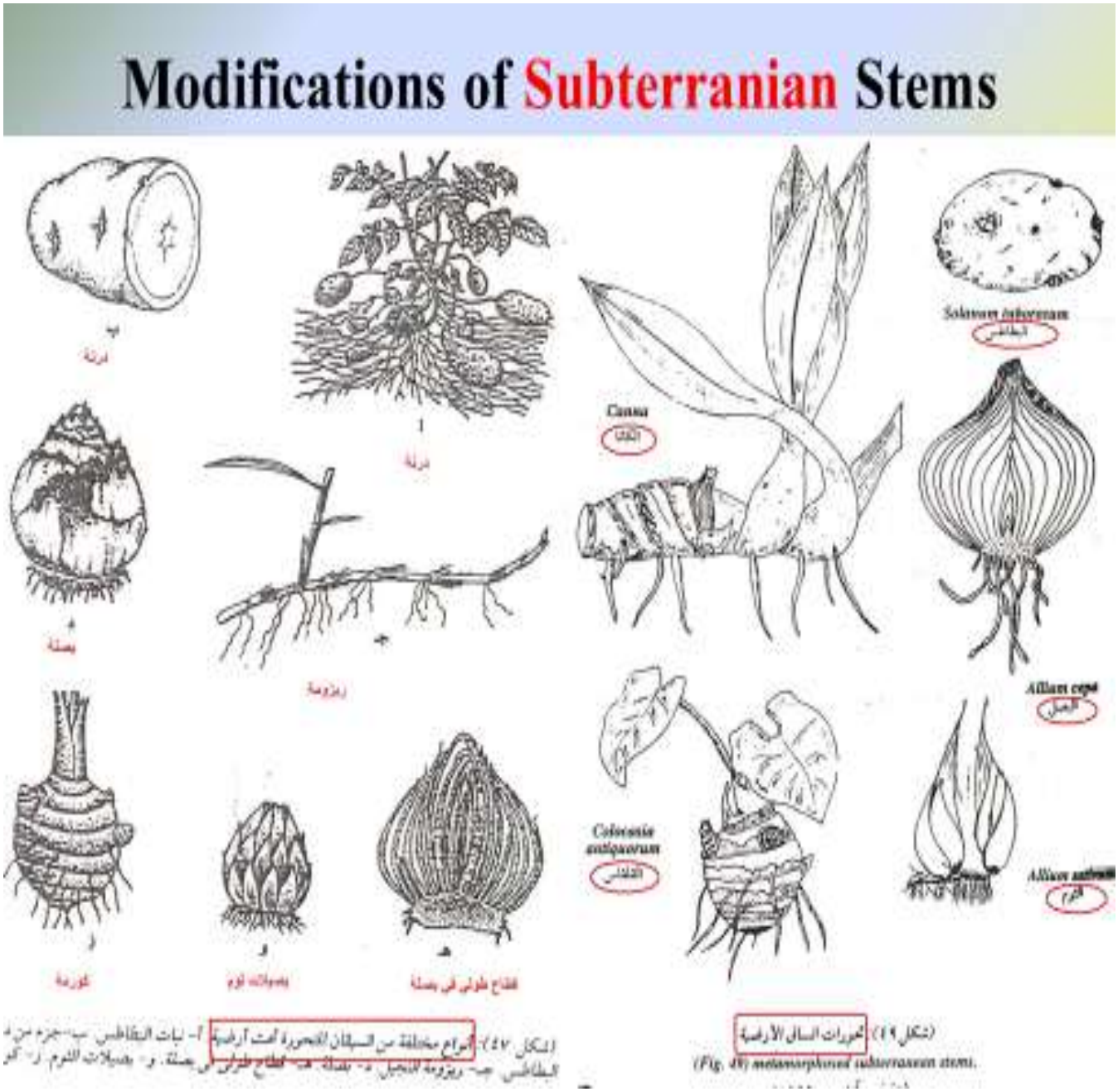
- **Aerial:**

  1. **Leafy stems: Leaves are reduced to mere scales. Leaf's function is taken over by modified flat branches containing chlorophylls tissue.**
     1. **Cladode: *Asparagus***
     2. **Phylloclade: *Ruscus***
  2. **Juicy Stems: *Opuntia***
  3. **Thorny Stems: *Zilla spinosa , Alhagi***

4. **<u>Stem Tendrils</u>: *Vitis***

- **<u>Subterranean</u>: In addition to perennation, they serve for food storage and also for vegetative reproduction. Types of which:**
  1. **<u>Rhizome</u>: *Cyperus***
  2. **<u>Corm</u>: *Colocasia***
  3. **<u>Bulbs&Bulbils</u>: Onion and garlic**
  4. **<u>Tubers</u>: potatoes**



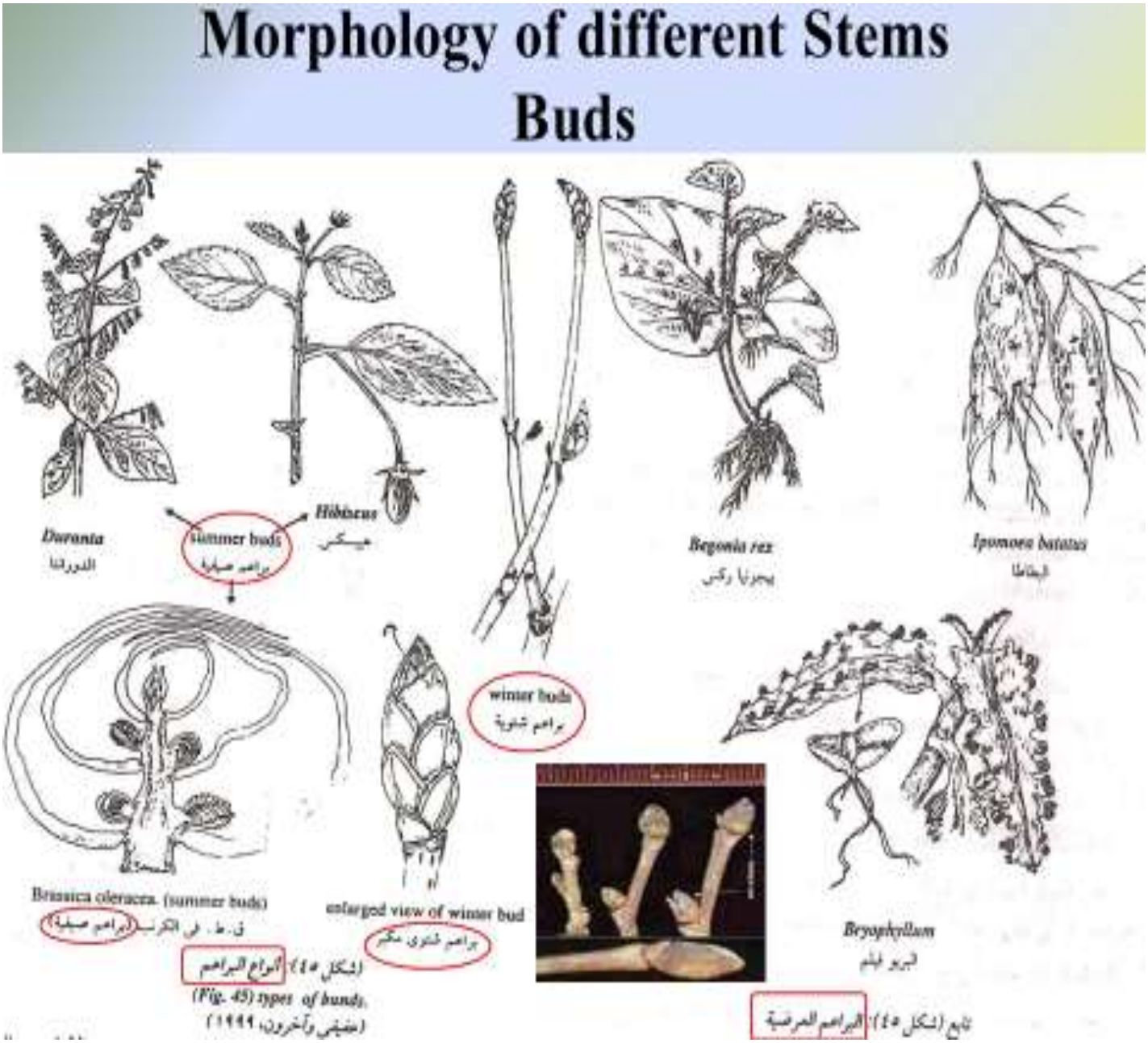


Buds

- **Divided into:**
    1. **Principal Bud: The largest in size.**
    2. **Accessory Bud: Additional buds.**
- **Types according to seasons:**
    1. **Summer Bud: Green and small in size**

2. **Winter Bud: Brown covered by scale leaves and are larger in size.**

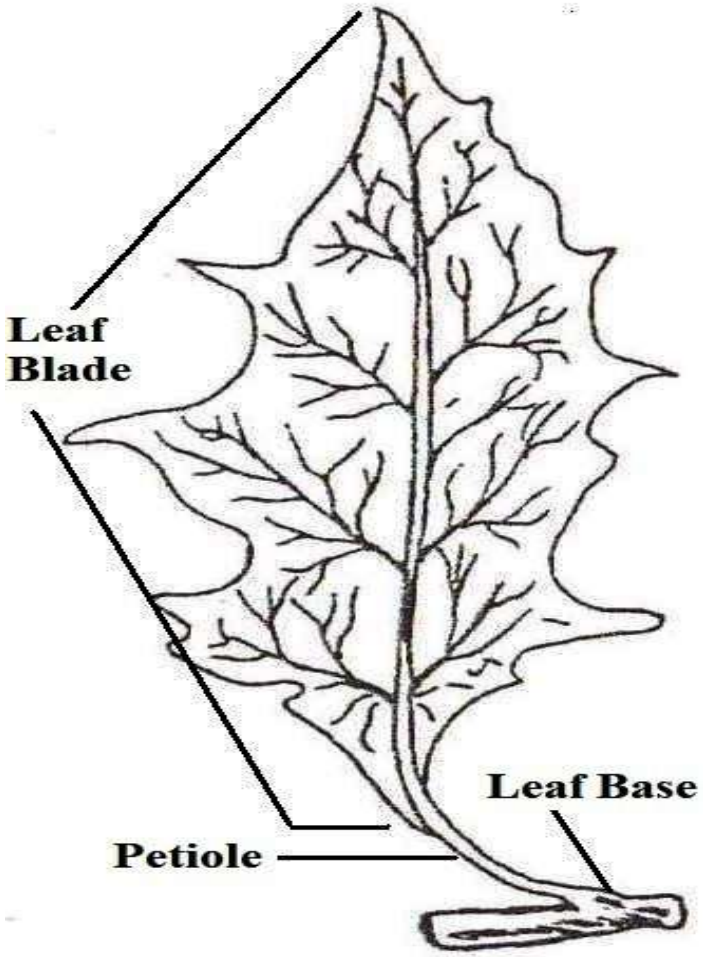
- **<u>Position:</u>**
  1. **Terminal: At the Apex of the stem**
  2. **Axillary: At the axis of the leaf.**
     - **<u>Cladode</u>**
     - **<u>Phylloclade</u>**



Types of Leaves

Leaf parts

- **Definition: They originate as lateral protuberances just behind the growing point. They arise in regular succession at the tip of the axis. They are exceedingly variable in form, but the most common ones are green-colored, flat and broad to allow maximum exposure to the sun rays.**
- **Function:**
  1. **Photosynthesis**
  2. **Anabolism**
  3. **Respiration**
  4. **Transpiration**
- **Leaf Composition:**
  1. **Leaf Base**
  2. **Leaf Stalk (Petiole)**
  3. **Leaf Blade (Lamina)**



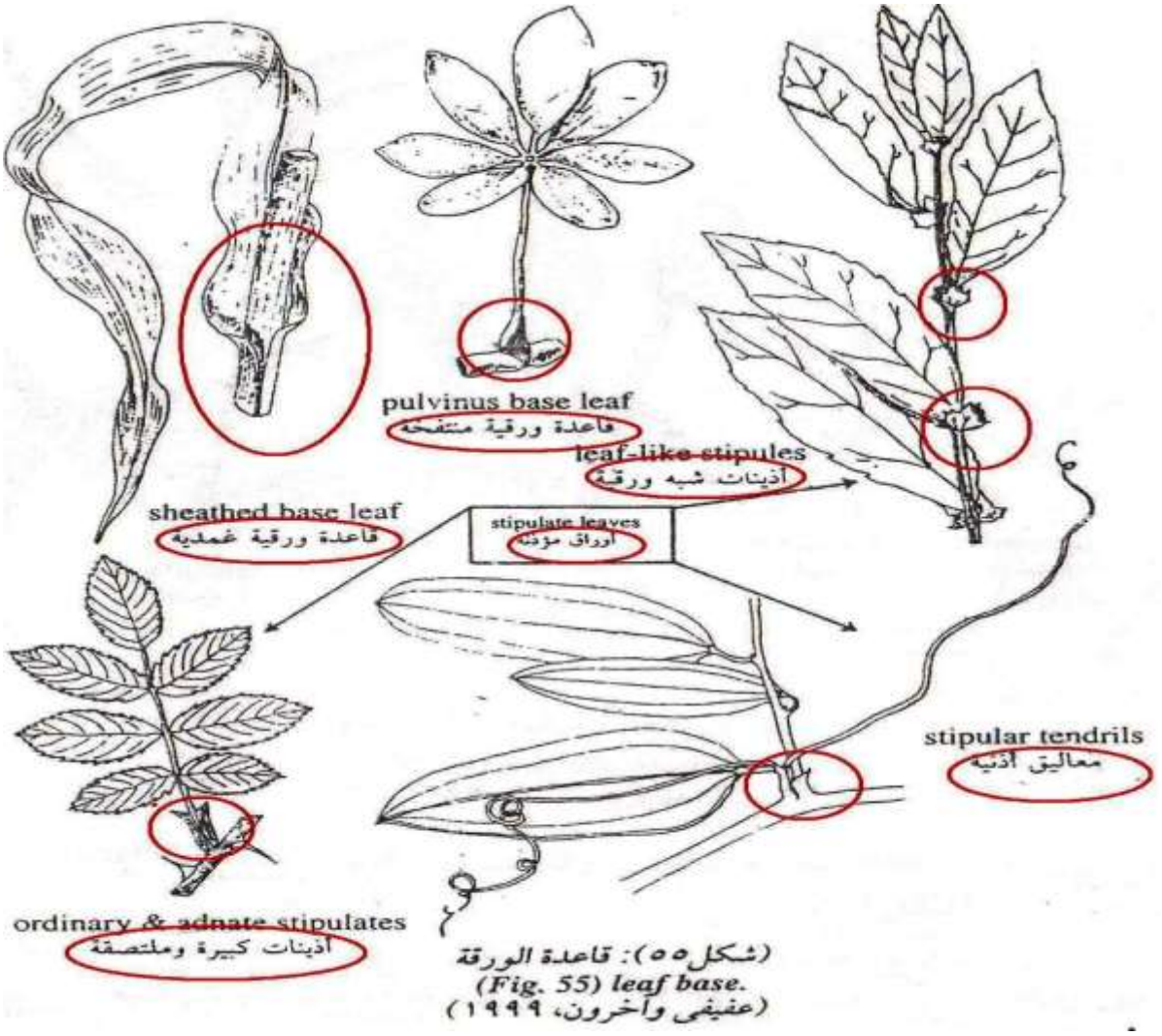
1. Leaf Base:

It is the part next to the stem at the node. It usually serves to protect the bud.

- **Enlargement:**
  It appears as a more or less marked enlargement at the base of the leaf which facilitate the movement of the leaf. Types of which are:

  1.Ordinary **2.Pulvinus** **3.Sheathed**

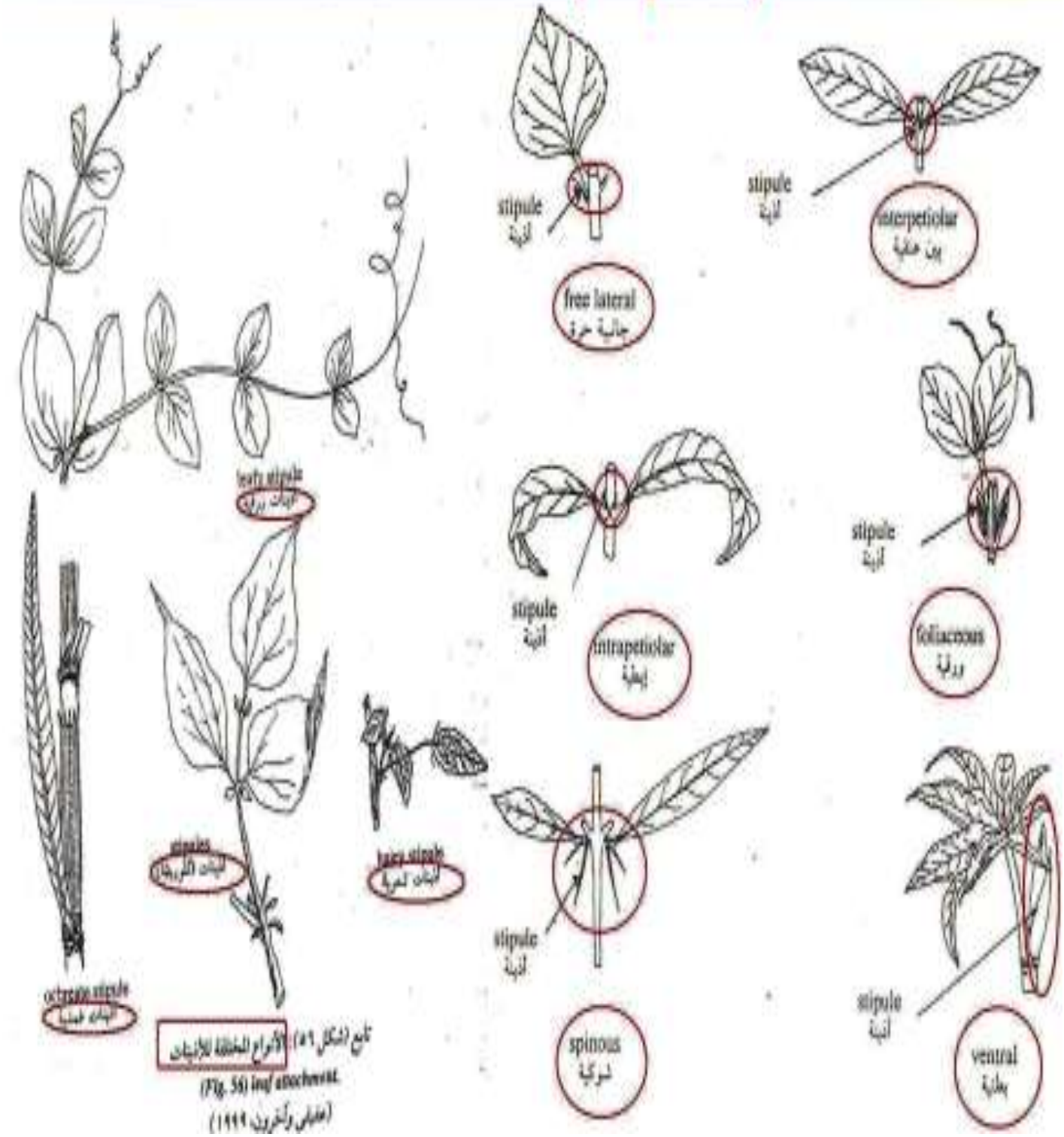
- **Stipules:**
  They frequently developed from the leaf base, forming a pair. Types of which are:
  1.Exstipulate
  2.Stipulate:
  - **Hairy**
  - **Foliaceous**
  - **Tendrillar**
  - **Spinous**
  - **Adnate**
  - **Ochreate**



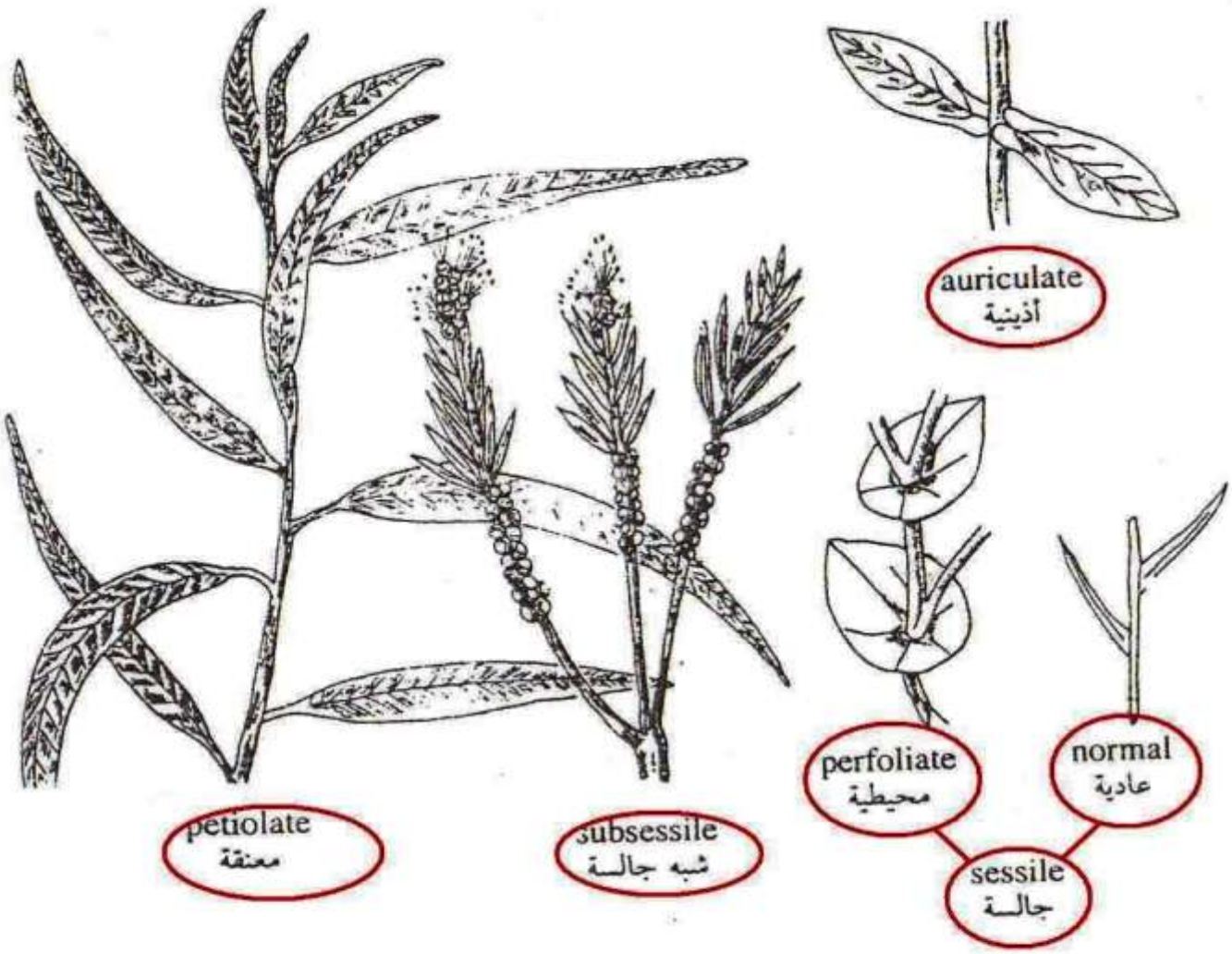
(شكل ٥٥): قاعدة الورقة
(Fig. 55) leaf base.
(عفيفي وآخرون، ١٩٩٩)

Leaf parts

1. Leaf Base (Stipules)



3. **Leaf Stalk (Petiole):**
    1. **Petiolate**
    2. **Subsessile**
    3. **Sessile**



(شكل ٥٦): اتصال الأوراق بالساق

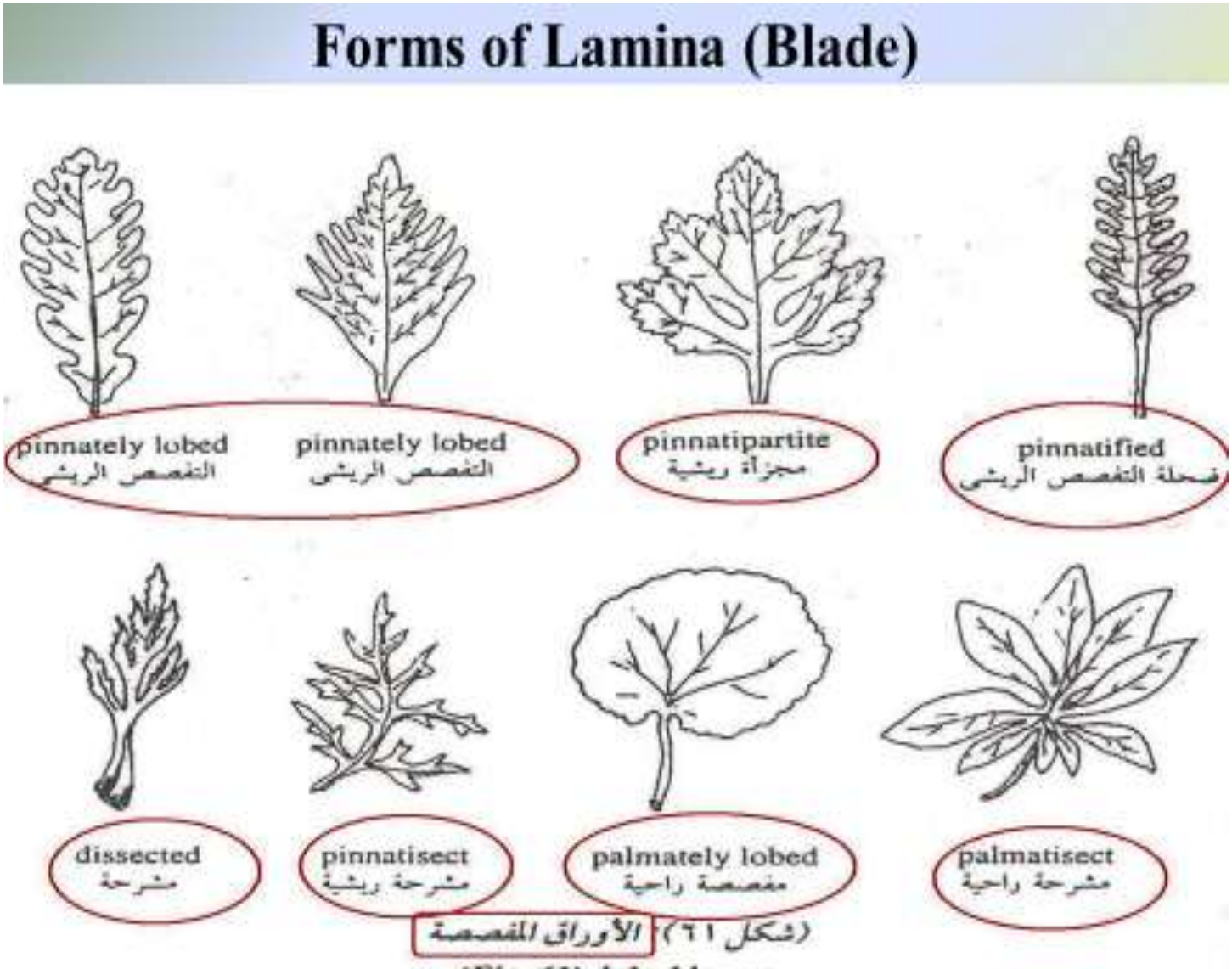
(Fig. 56) leaf attachment.

(عفيفى وآخرون، ١٩٩٩)

4. **Leaf Blade:**

- **Forms of Leaf Blade (Lamina):**
    1. **Simple: One continuous or slightly divided surface.**
    2. **Lobed: Incomplete deep divisions, divided into a number of lobes connected by an undivided portion (not reaching the midrib). Lyrate, Runcinate.**

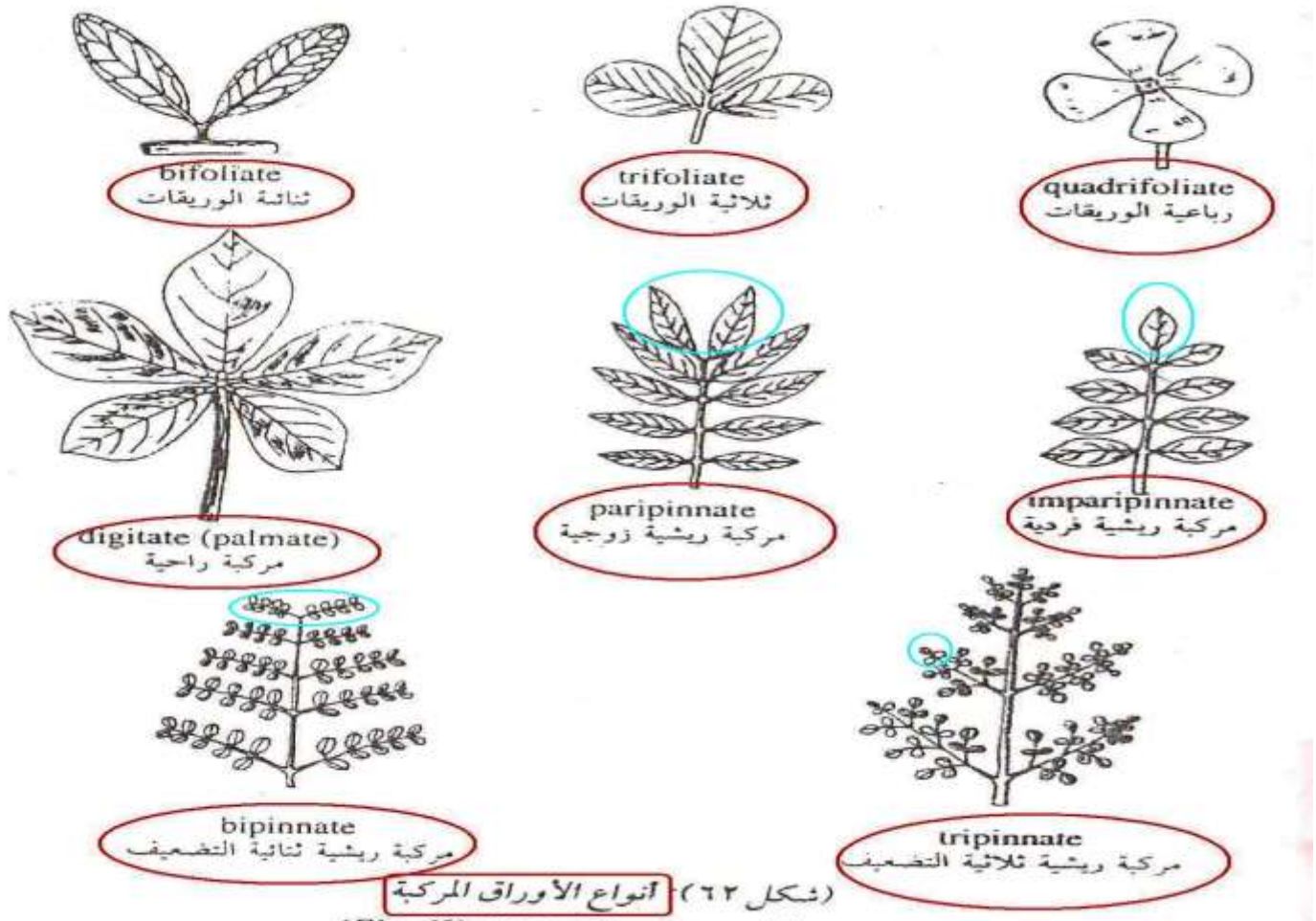
3. **<u>Dissectified:</u> Complete deep divisions (Close to the midrib).**
4. **<u>Palmate:</u> They are palm-like. If the incisions are less than half the distance between the margin and the midrib *i.e.* Palmatified, but if they are more than half *i.e.* Palmatisect.**
5. **<u>Pinnate:</u> If incisions are less than half the distance between the margin and the midrib *i.e.* Pinnatified, if they are more than half *i.e.* Pinnatipartite, but if incisions are so deep reaching the midrib *i.e.* Pinnatisect.**
6. **<u>Compound</u>: The divisions are so independent that they appear as distinct leaflets born on a common stalk (Palmately or Pinnately), (Bifoliate, Trifoliate, Paripinnate, Imparipinnate), or the leaflets of compound leaves themselves exhibit subdivision called *Pinna* (Bipinnate, Tripinnate).**



(شكل ٦١) الأوراق المفصصة

(Fig. 61) lobed leaves.

(حفيفي وآخرون، ١٩٩٩)



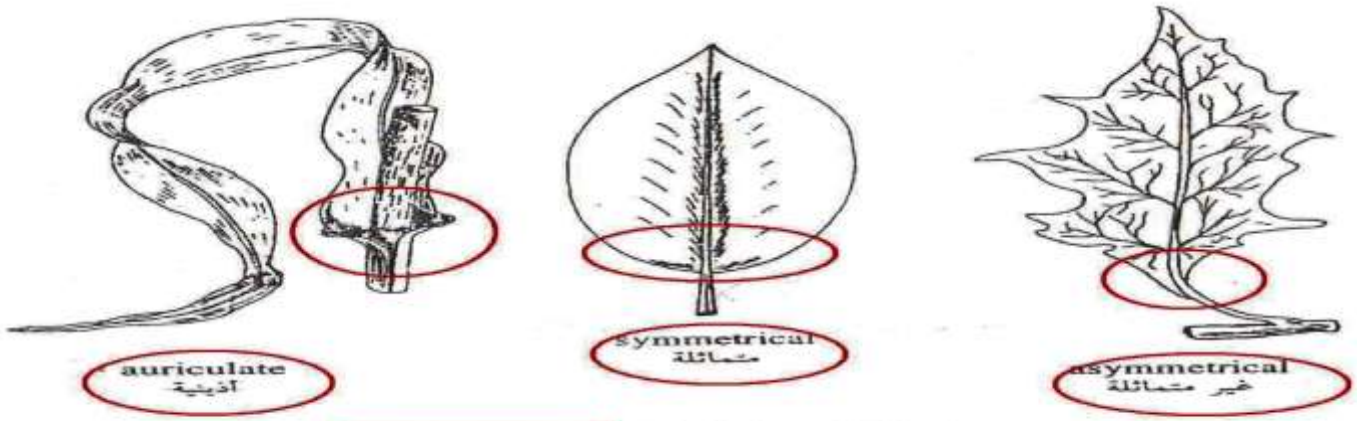
أنواع الأوراق المركبة (شكل ٦٢)

(Fig. 62) types of compound leaves.

Lamina

1. Base Of Lamina:

Symmetrical, Asymmetrical or Auriculate



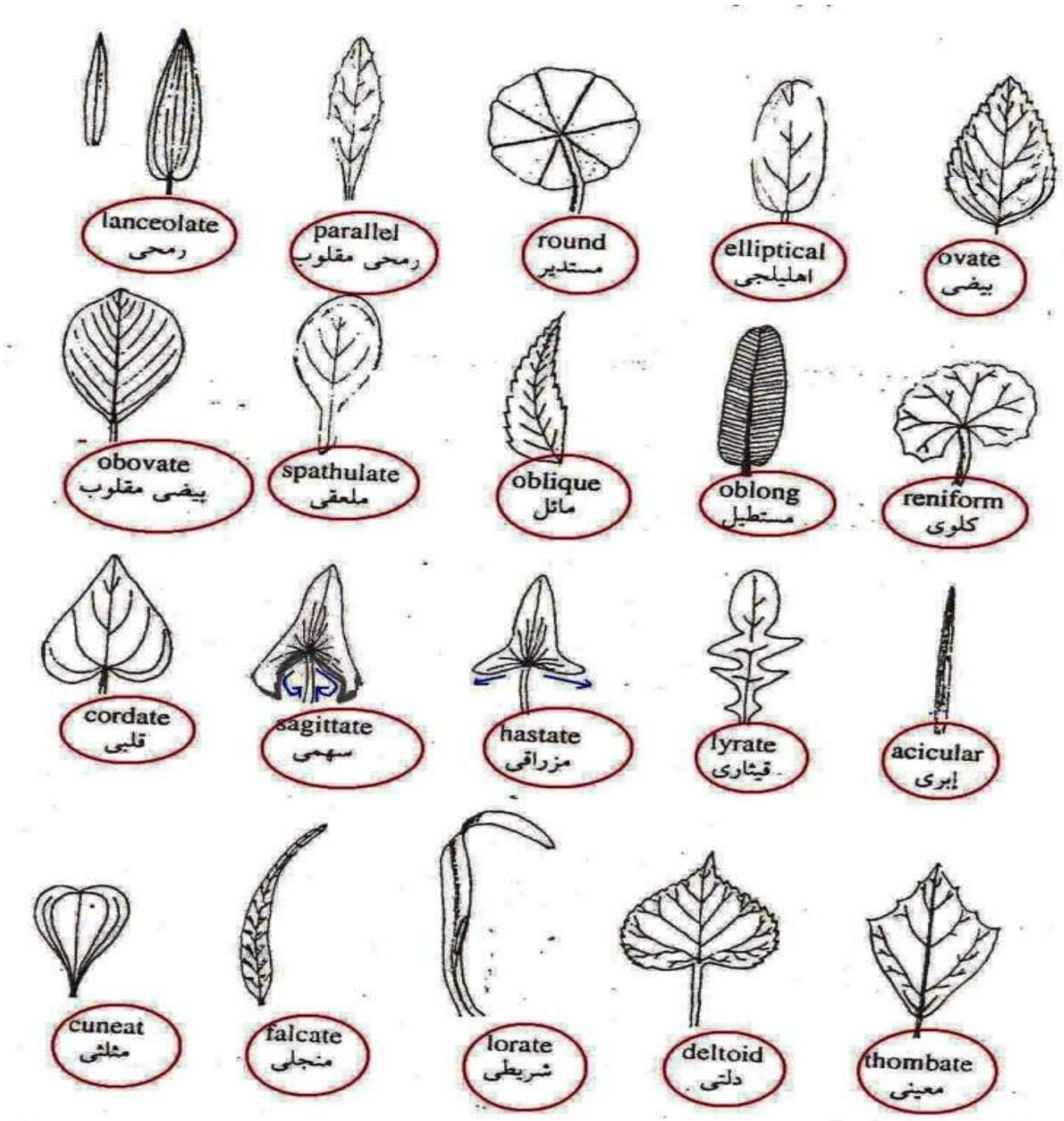
تابع (شكل ٥٥): أشكال قاعدة نصل الورقة

Cont. (Fig. 55) forms of the lamina base.

(هانيفي وآخرون، ١٩٩٩)

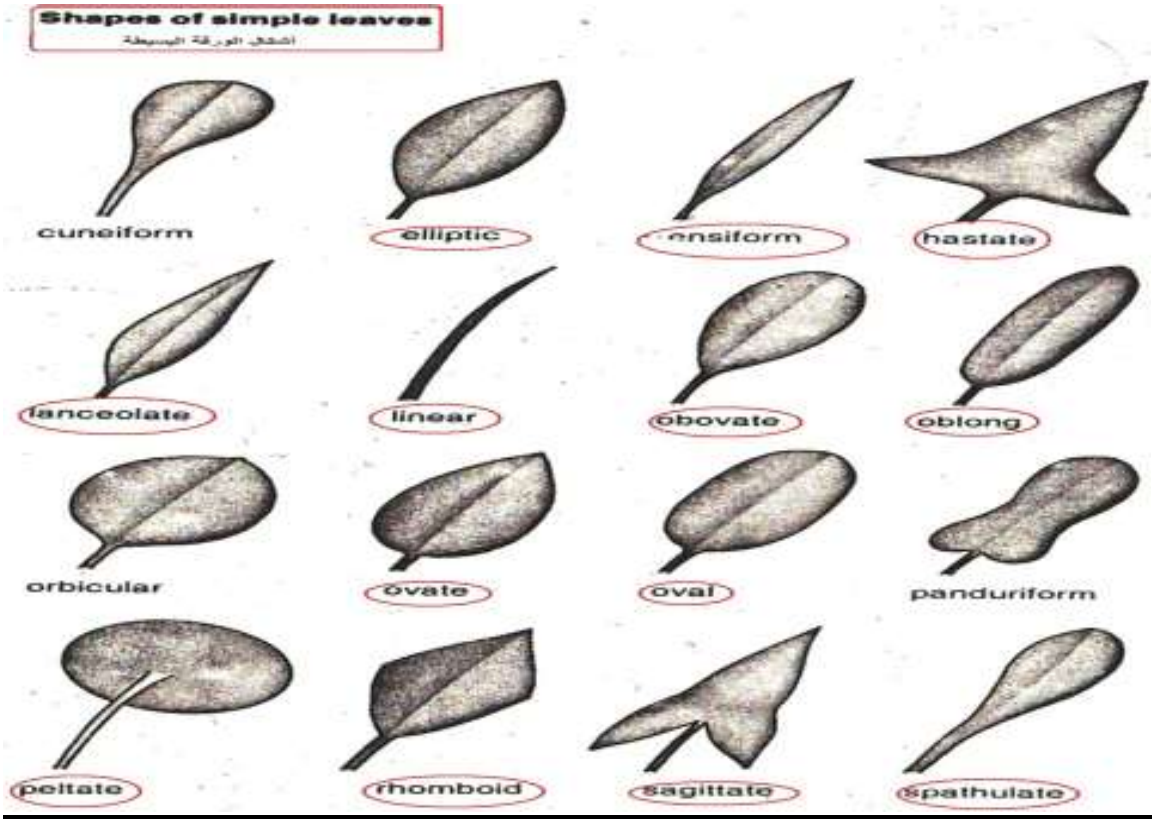
Shape Of Lamina:

Acicular, Tubular, Lanceolate, Ovate, Oblong, Spathulate, round, Reniform, Sagitate, Hastate, Lorate, Cordate, Lyrate, etc…



(شكل ٥٨): أشكال نصل الورقة

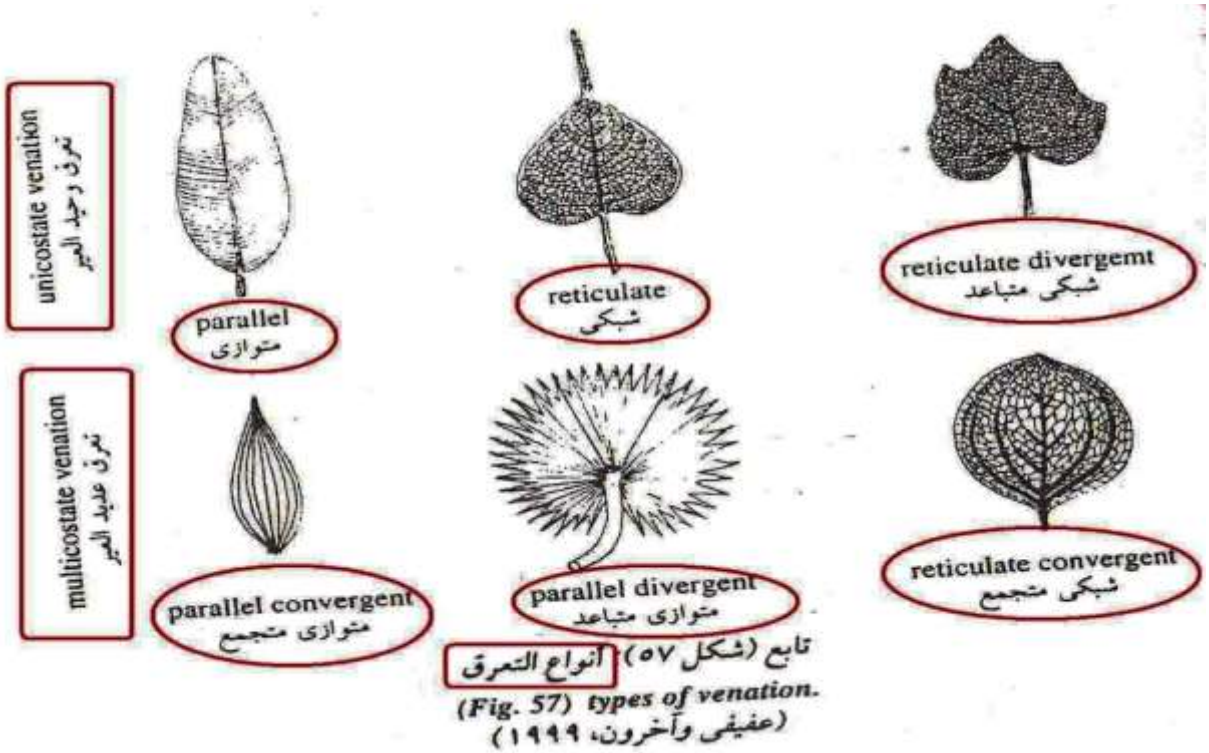
(Fig. 58) leaf shapes.



3. Leaf Vennation:

1. Reticulate

2.Parallel:(Longitudinal or Transverse)

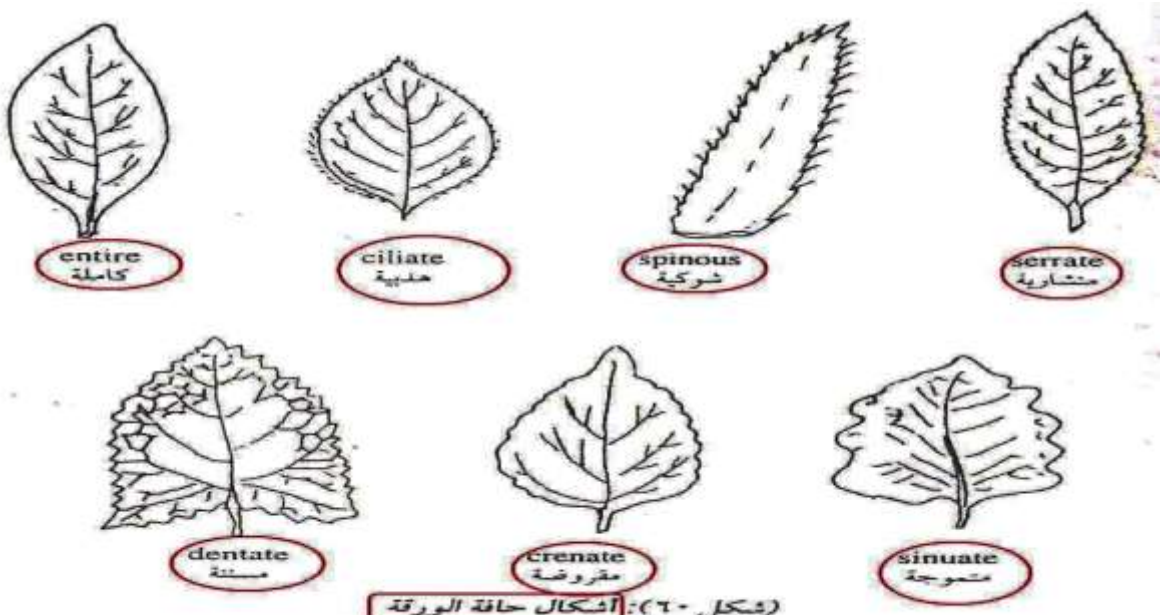


تابع (شكل ٥٧) أنواع التعرق

(Fig. 57) types of venation.
(عفيفى وآخرون، ١٩٩٩)

4. Margin Of Lamina:

Entire, Ciliate, Spinous, Serrate, Dentate, Crenate, Sinuate, *etc*…



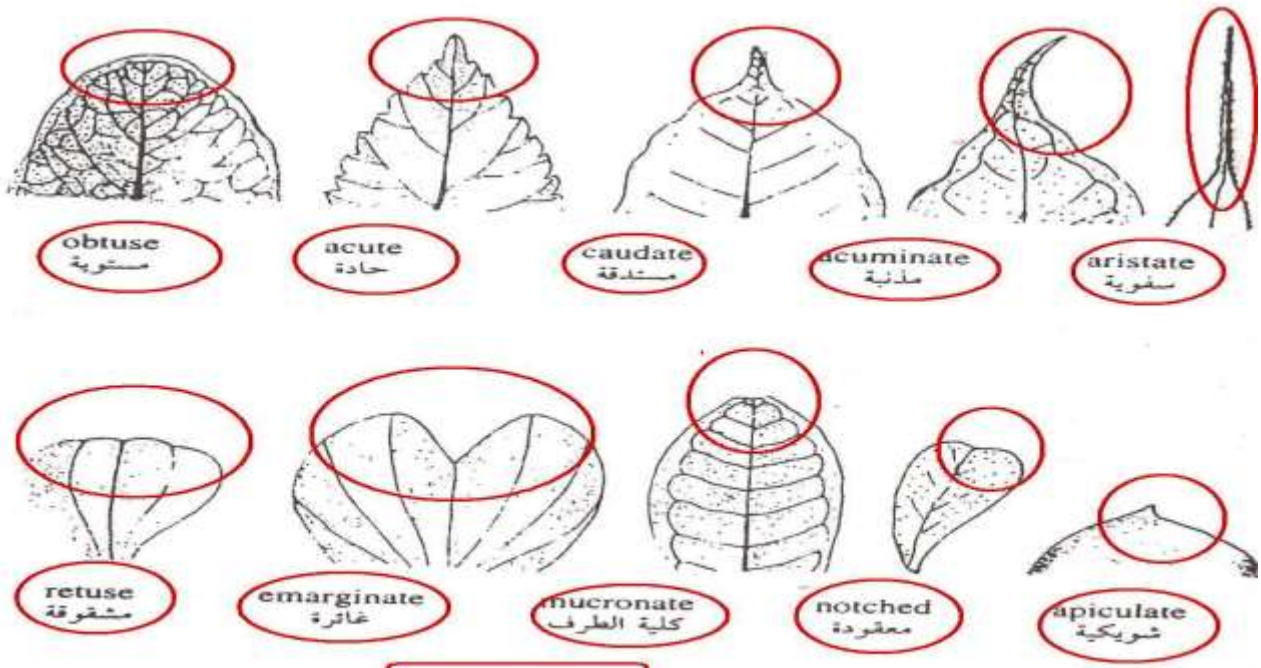
(شكل ٦٠): أشكال حافة الورقة

(Fig. 60) forms of the leaf margin.

(عفيفي وآخرون، ١٩٩٩)

5. Apex Of Lamina:

Obtuse, Acute, Caudate, Acuminate, Aristate, Retuse, Emarginate, Mucronate, Notched, Apiculate, etc…



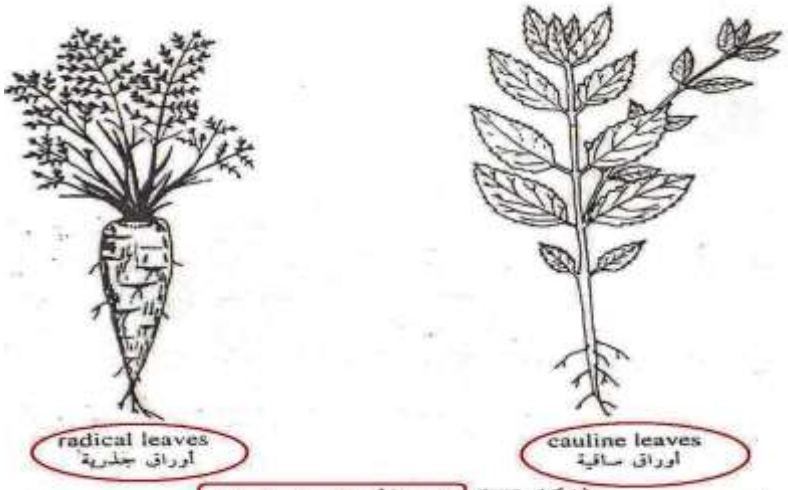
(شكل ٥٩): أشكال قمة الورقة

(Fig. 59) forms of the leaf apex.

(عفيفي وآخرون، ١٩٩٩)

Leaf Insertion

1. **Radical**
2. **Cauline**



(شكل ٦٣): وضع الأوراق على الساق

(Fig. 63) insertion of leaves.

Leaf Arrangement (*Phyllotaxis*):

1. **Dwarfed: Carrot**
2. **Alternate**
3. **Opposite superposed**
4. **Opposite decussate**
5. **Whorled**

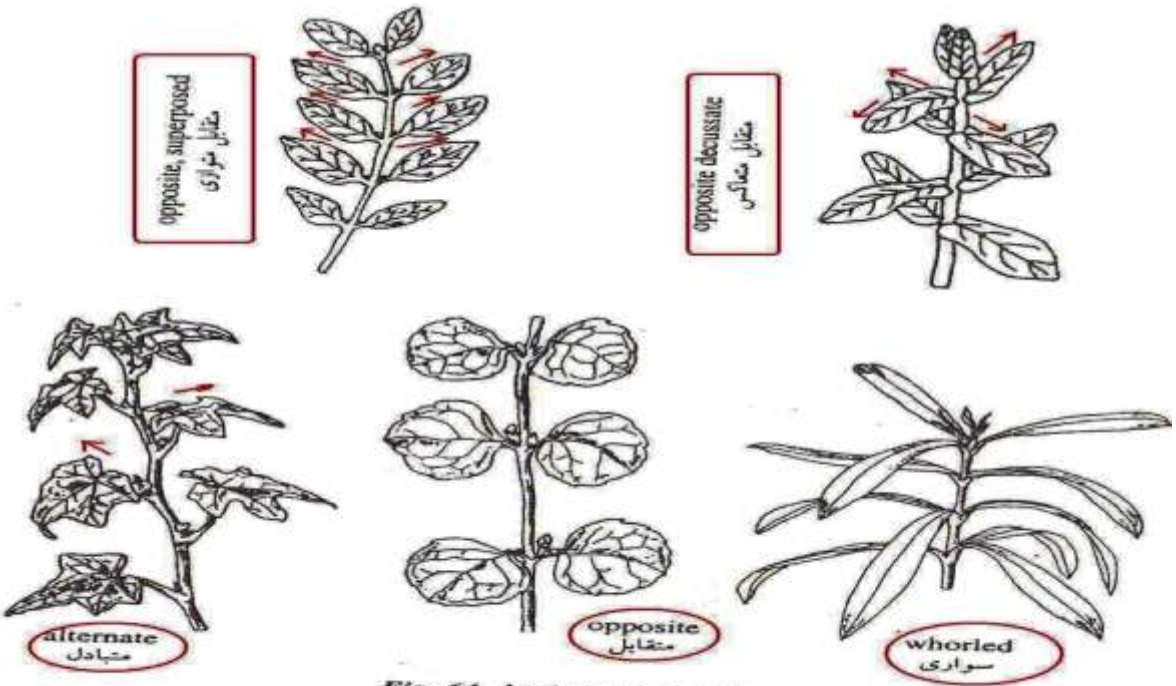
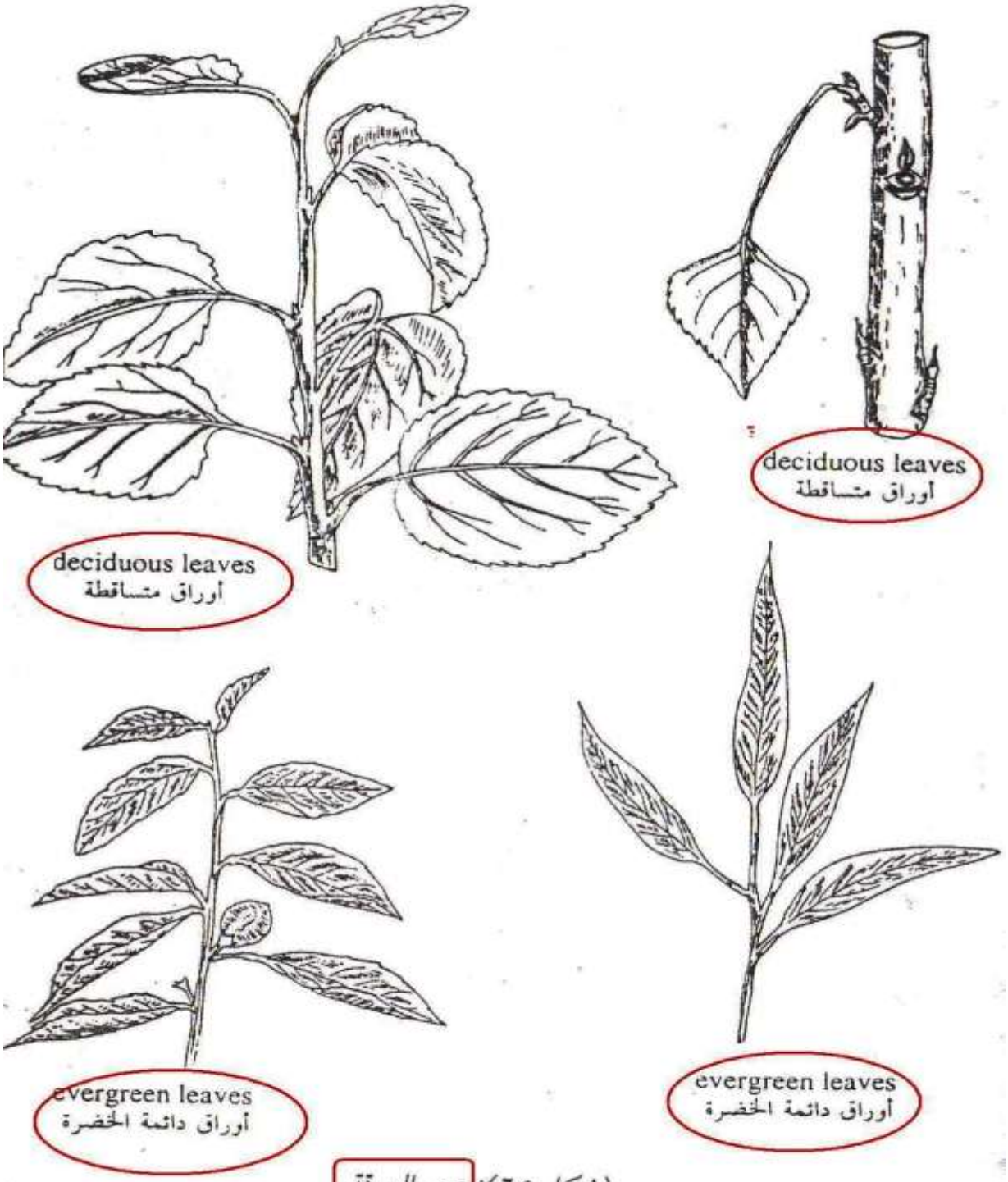


Fig. 64, leaf arrangement.

(شكل ٦٤): نظام الأوراق (ترتيب الأوراق)

Leaf Duration

1. Evergreen plants **2. Deciduous plants**



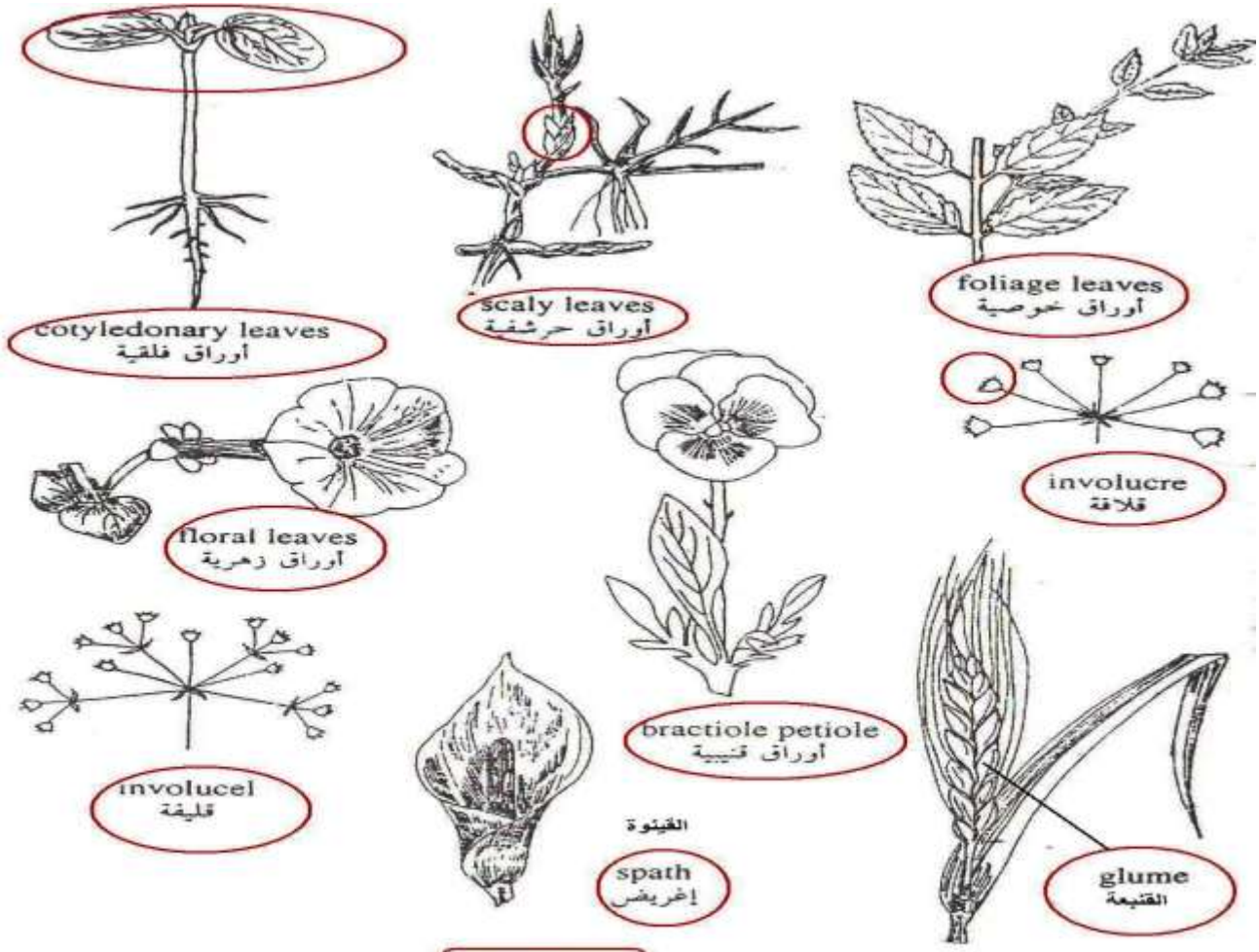
(شكل ٦٥): عمر الورقة

(Fig. 65) duration of the leaf.

Leaf forms

- **Cotyledonary leaves: *Epigeal* germination**
- ***Prophyllus*: *Fava* beans**
- **Scale leaves: Onion & Rhizomes**
- **Foliage leaves: Photosynthesis**
- **Floral leaves:**

1. Bract 2. Perianth (Invlocure) 3. Glume 4. Spath



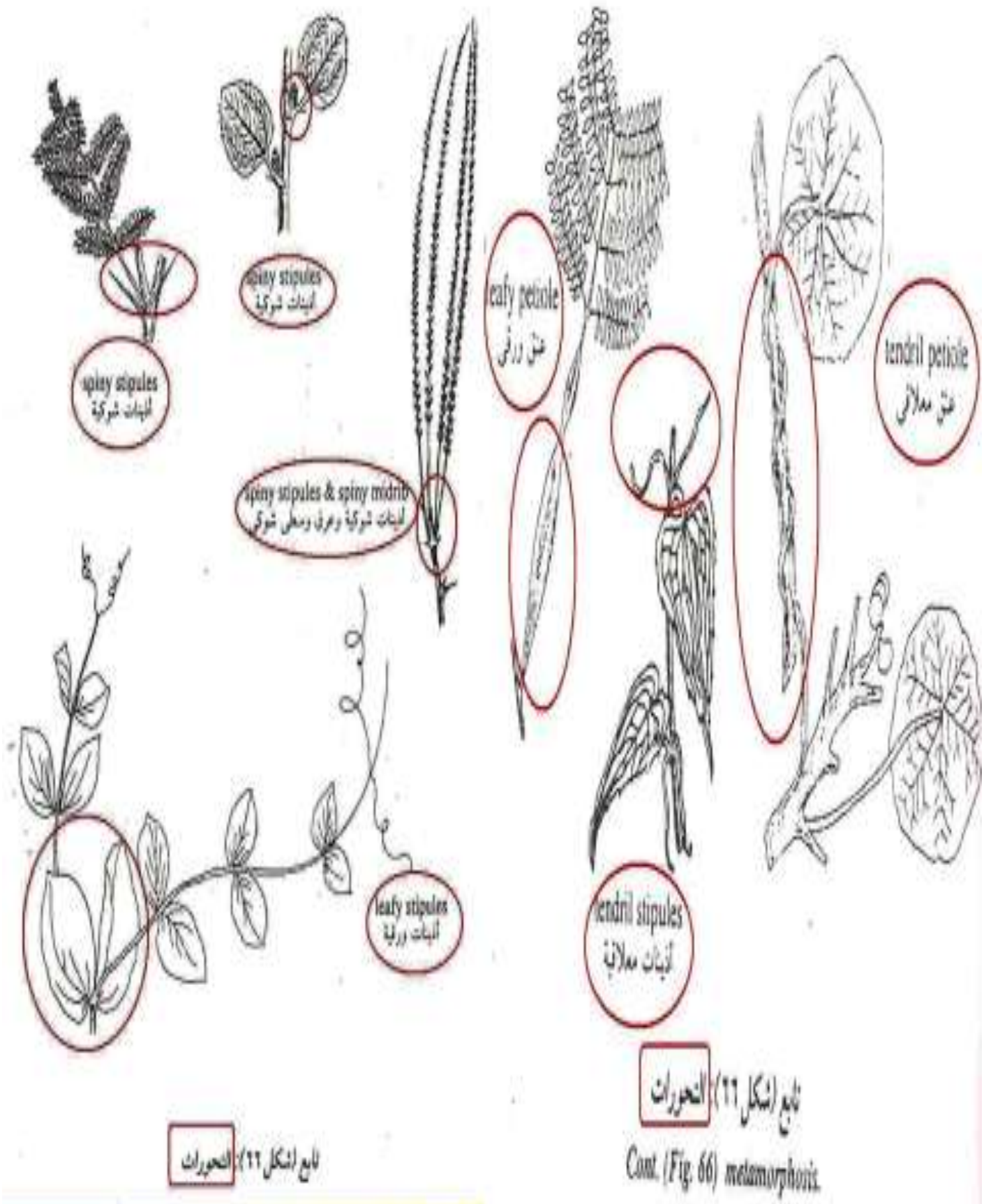
(شكل ٦٧): طراز الأوراق
(Fig. 67) kinds of leaves.
(عفيفي وآخرون، ١٩٩٩)

1. **Leaf Modifications:**
   - **Spiny leaves: *Berberis, Parkinsonia***
   - **Fleshy (Storage) leaves: *Zygophyllum***

- **Leaf tendrils:** ***Lathyrus decoratus***
- ***Phylloclade*** **(leafy petiole):** ***Zygophyllum, Acacia***
- **Insectivorous leaves:** ***Drocera***

(شكل ٦٦): بعض أنواع تحورات الورقة

(Fig. 66) some types of metamorphosis in the leaf.



تابع (شكل ٦٦) التحورات

Cont. (Fig. 66) metamorphosis.

Flower

- **Definition: It is a modified shoot carrying floral leaves.**
- **Function: Reproduction**
- **The flower is characterized by:**

1. **It arises from the axial of a leaf, called "Bract".**
2. **It is composed of a stalk "Pedicel". If there is no stalk, it is "Sessile".**
3. **Floral leaves are arranged on an extended end known as "Receptacle" or "*Thalamus*".**
4. **These floral leaves are usually found in whorls one inside the other, as:**

1. Calyx 2. Corolla 3.*Androceium* (A) 4. *Gynoecium* (G)

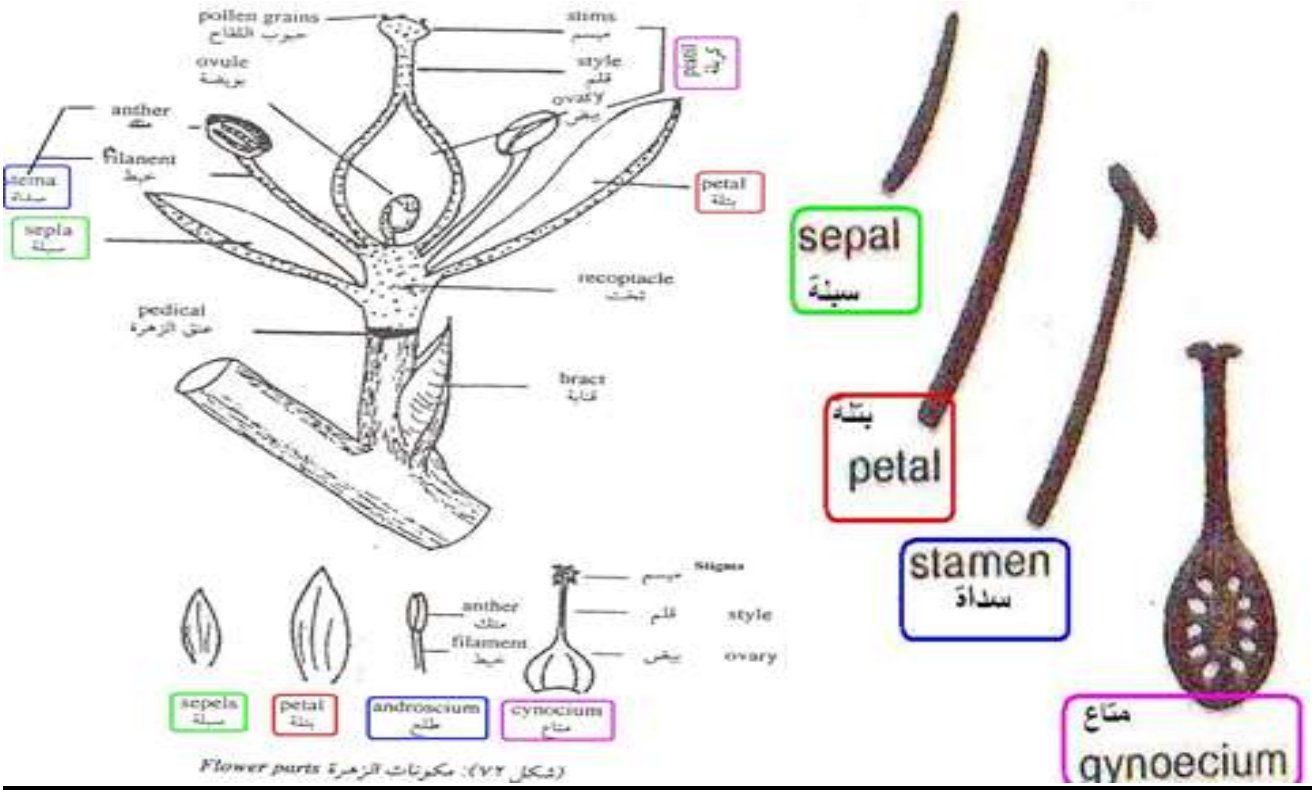
5. There maybe a floral whorl above the "*Calyx*" called the "*Epicalyx*"

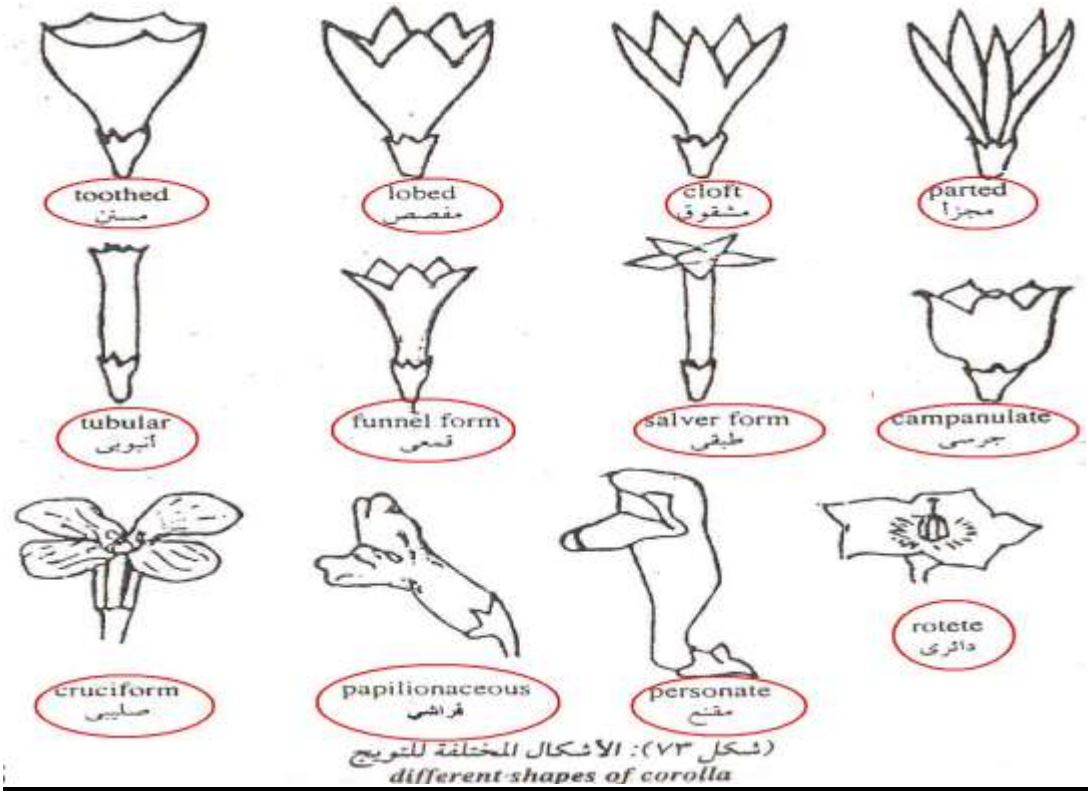
1. Calyx

- **It is the outermost whorl of floral leaves.**
- **It is composed of green leaf-like structures called "Sepals", varying in number from 2 -5, or sometimes more.**
- **When the sepals are free they are called "Polysepalous".**
- **And "Gamosepalous" when they are united.**

2.Corolla

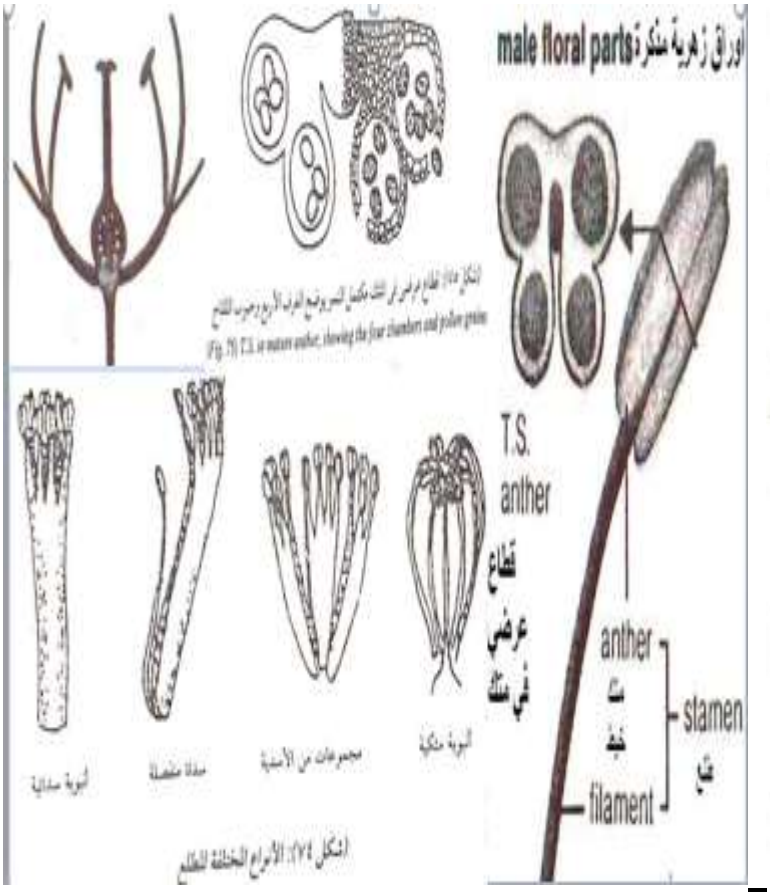
- **It follows the Calyx internally.**
- **It consists of colored leaf-like structures called "Petals".**
- **Petals always alternate with Sepals.**
- **When they are free, it is *Polypetalous* and when they are united, it is *Gamopetalous*.**
- **In some plants specially *Monocots* the sepals and petals are similar of tri-merious (3 or its replica) and designated collectively as Perianth (Tepals).**
- ***Dicots* are tetra- or penta-merious (4, 5 or their replica)**

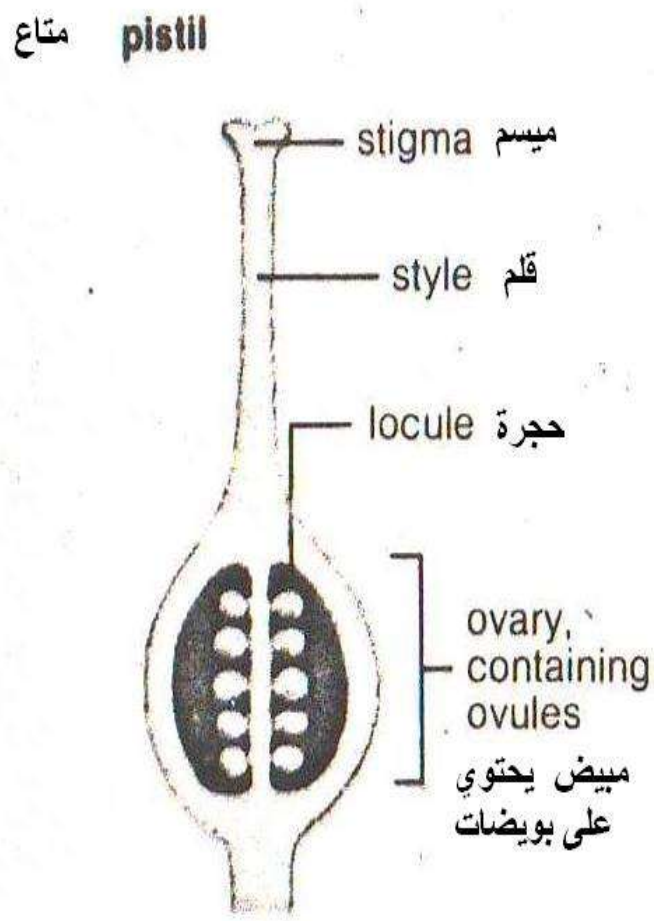

pollen grains
حبوب اللقاح
ovule
بويضة
anther
filament
خيط
sepla
سبلة
stims
ميسم
style
قلم
ovary
مبيض
petal
بتلة
recoptacle
pedical
عنق الزهرة
bract
قنابة
sepal
سبلة
petal
بتلة
stamen
سداة
gynoecium
متاع
Stigma
anther
filament
style
ovary
androecium
cynocium
(شكل ٧٢): مكونات الزهرة Flower parts


toothed
lobed
cloft
parted
tubular
funnel form
salver form
campanulate
cruciform
papilionaceous
personate
rotete
(شكل ٧٣): الأشكال المختلفة للتويج
different shapes of corolla

3.Androceium

It lies inside the Corolla and represents the male sexual organs. It is made up of a number of Stamens varying widely in number. Each stamen is composed of a filament ending with a lobe-like structure named the anther. The stamens maybe free or united by their filaments forming a tube "*Monadelphous*" or several bundles "*Polyadelphous*" or by their anthers "*Syngenesious*". They maybe separate from the petals or united "*Epipetalous*"



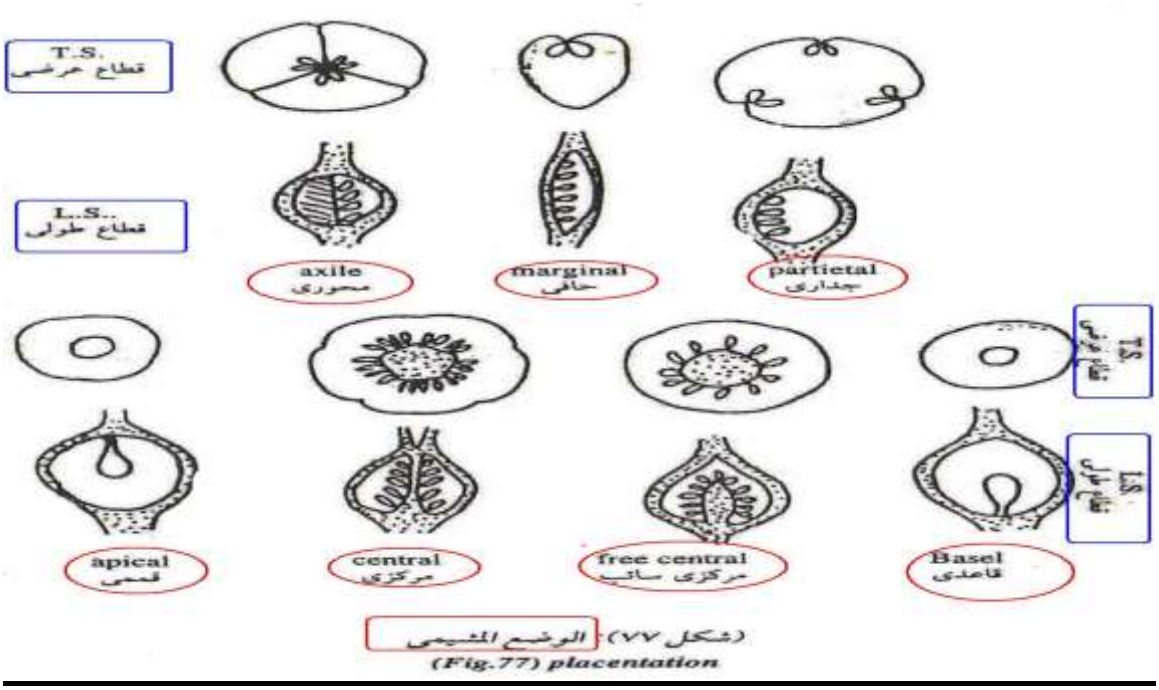


4.Gynoceium

It is present inside the *Androceium* and represent the male sexual organ. It is composed of one or more carpel. Fused carpels form the "*Pistil*" which is composed of Ovary, Style and Stigma. The ovary may contain one or more "Locules".

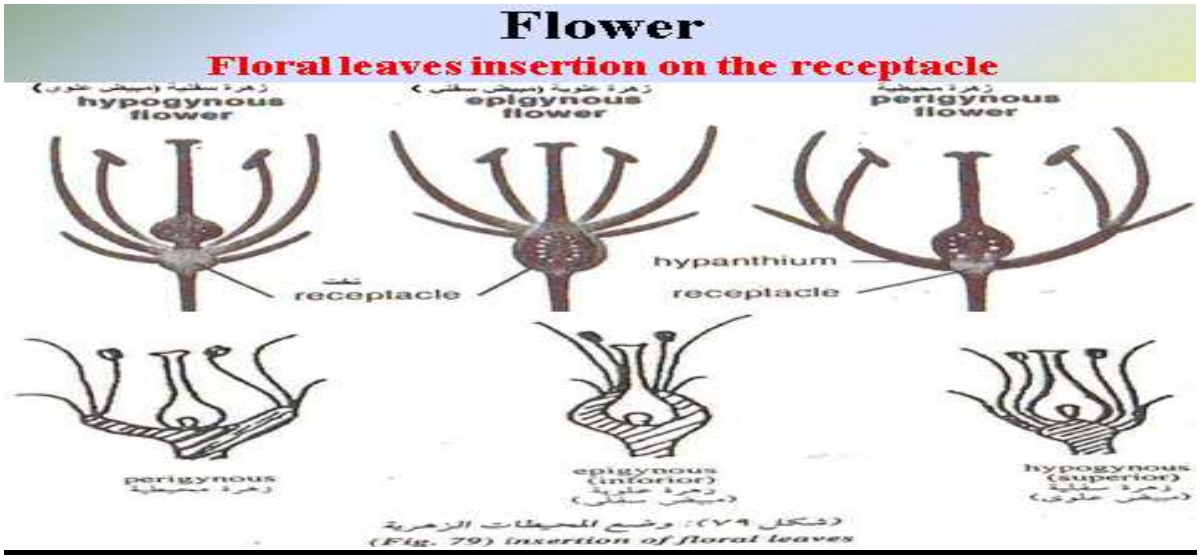
Placentation

It is the arrangements of ovules along "*Placenta* "



الوضع المشيمي (شكل ٧٧)

(Fig.77) placentation



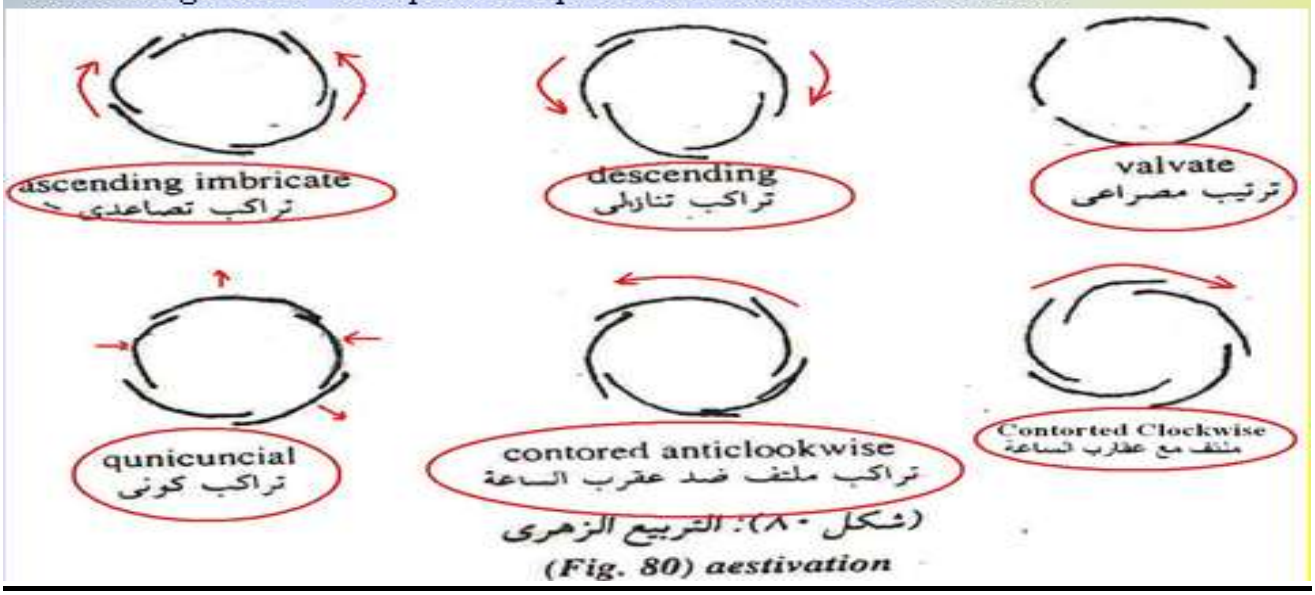
(شكل ٧٩): وضع المحيطات الزهرية

(Fig. 79) insertion of floral leaves

Flower

Aestivation:

The arrangements of sepals and petals in relation to each other.



(شكل ٨٠): التربيع الزهرى

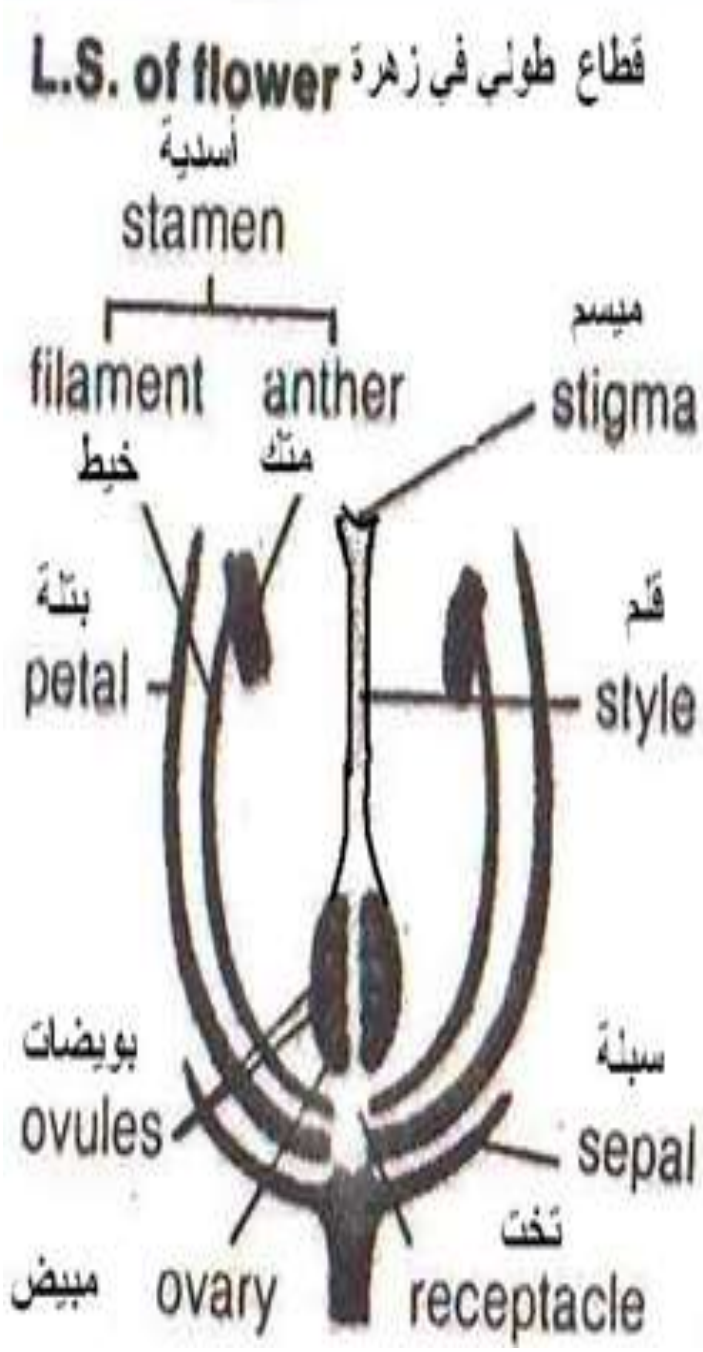
(Fig. 80) aestivation

The floral formula:

The characters of the flower can be described in brief by using a number of symbols that constitute what is known as the floral formula.

Actinomorphic flower (regular)	⊕
Zygomorphic flower (irregular)	%
Male flower (pistillate)	♂
Female flower (staminate)	♀
Bisexual flower (hermaphrodite)	⚥
Sepals	S
Petals	P
Androecium	A
Gynoecium	G

Flower


L.S. of flower قطاع طولي في زهرة
أسدية
stamen
filament
anther
خيط
متك
ميسم
stigma
بتلة
petal
قلم
style
بويضات
ovules
سبلة
sepal
مبيض
ovary
تخت
receptacle

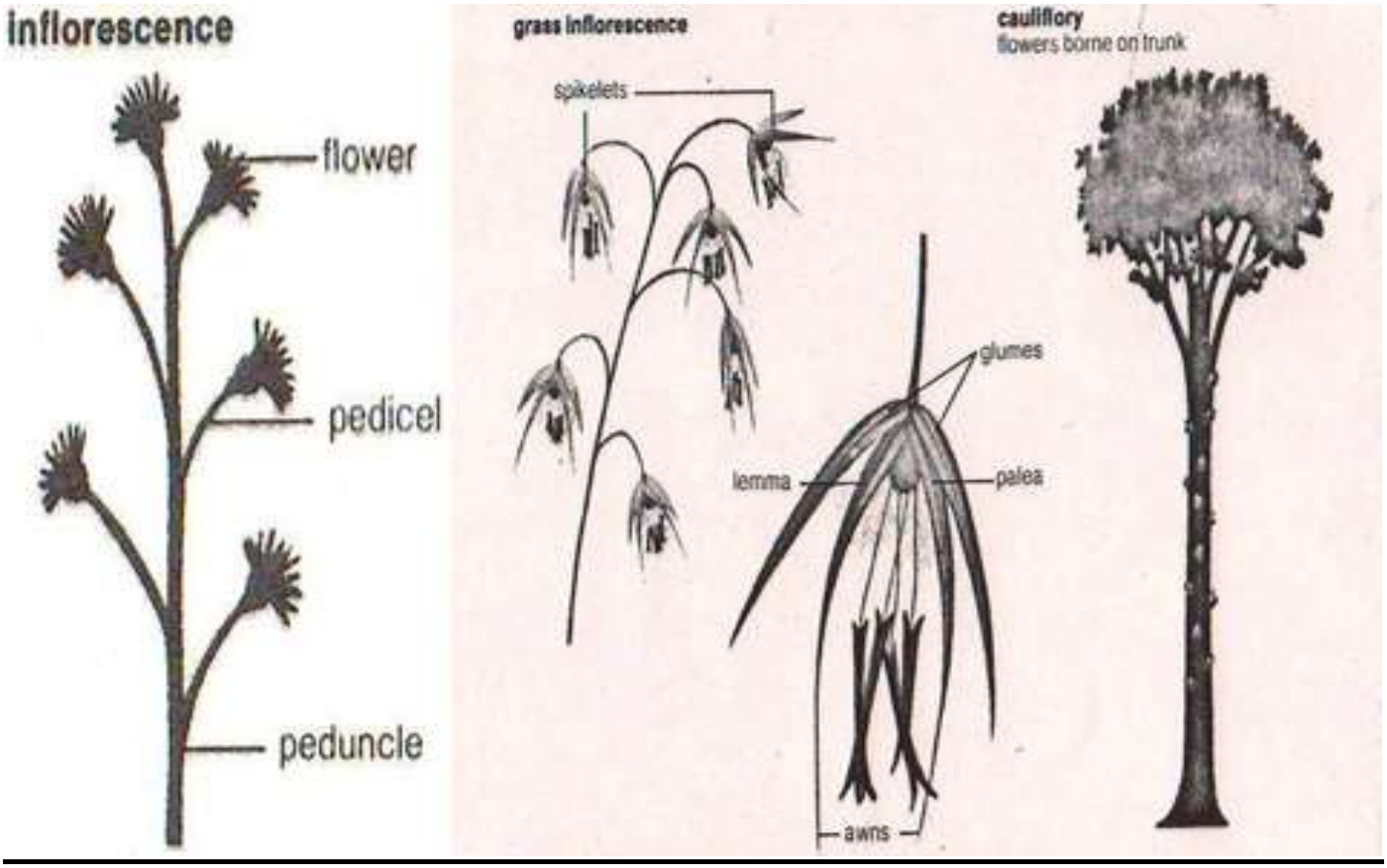

floral diagram مسقط زهري
a flower with 6 petals,
6 stamens, 6 sepals
ovary
مبيض
stamens
طلع
بتلات
petals
سبلات
sepals

Inflorescence

- **Inflorescence:** Sometimes flowers are solitary, but more commonly a number occurs on a flower-bearing shoot known as the axis "*Peduncle*" .
- **It is divided into:**

1. **Racemose (Indeterminate):** It is arranged in a *Monopodial* branching where flowers open from below upward, or from outside inward.
2. **Cymose (Determinate):** It is arranged in a *Sympodial* branching where flowers open from above downward, or from inside outwards.
3. **Mixed *Inflorescence*:** Two or more of the above types of inflorescence are combined together. It is represented by cymes arranged on a raceme axis and also by a *Dichasium* with the ultimate branched forming *Monochasia*.

- It arises from the axial of a small leaf "Bract", or a normal leaf.
-

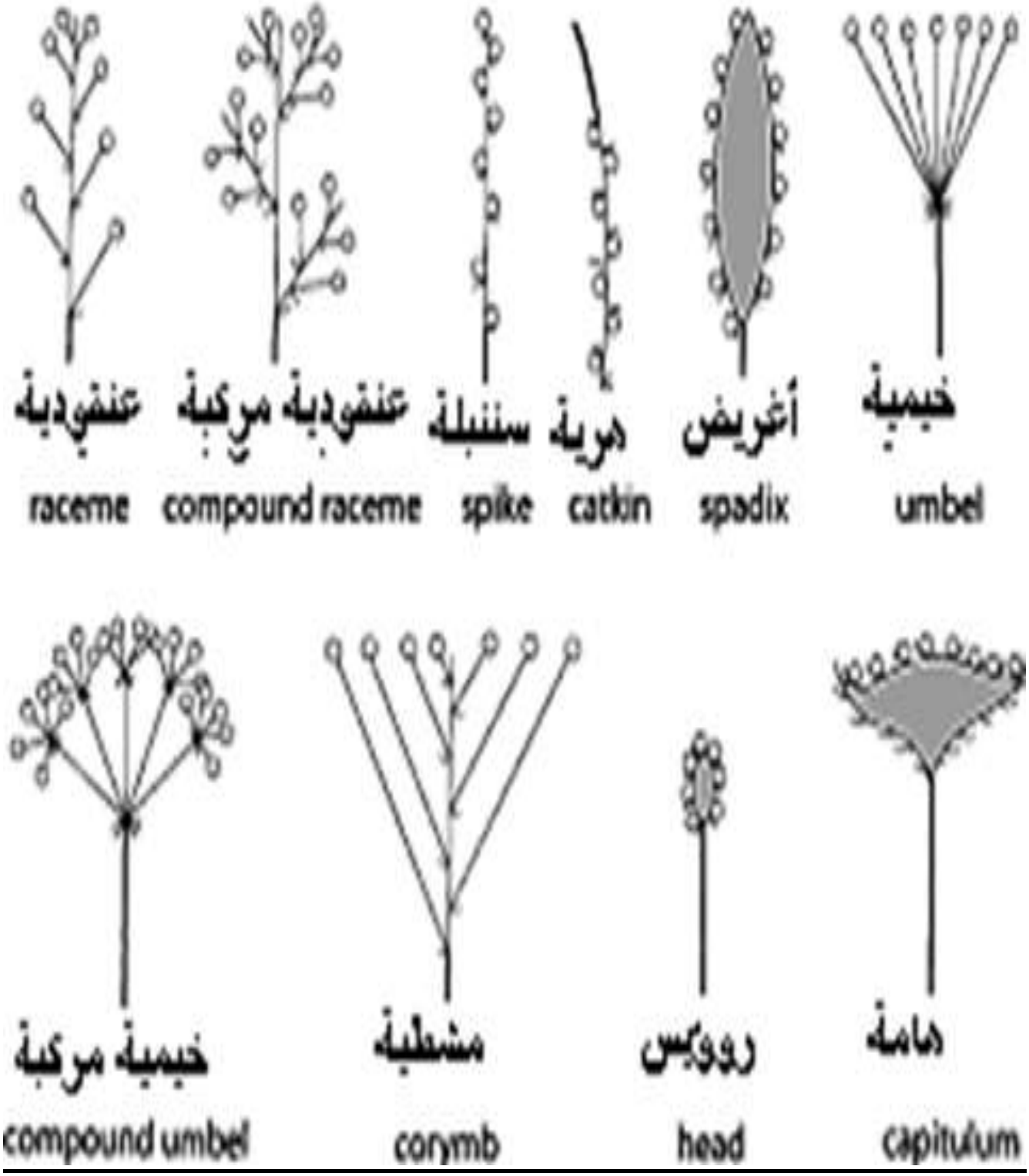


Racemose Inflorescence

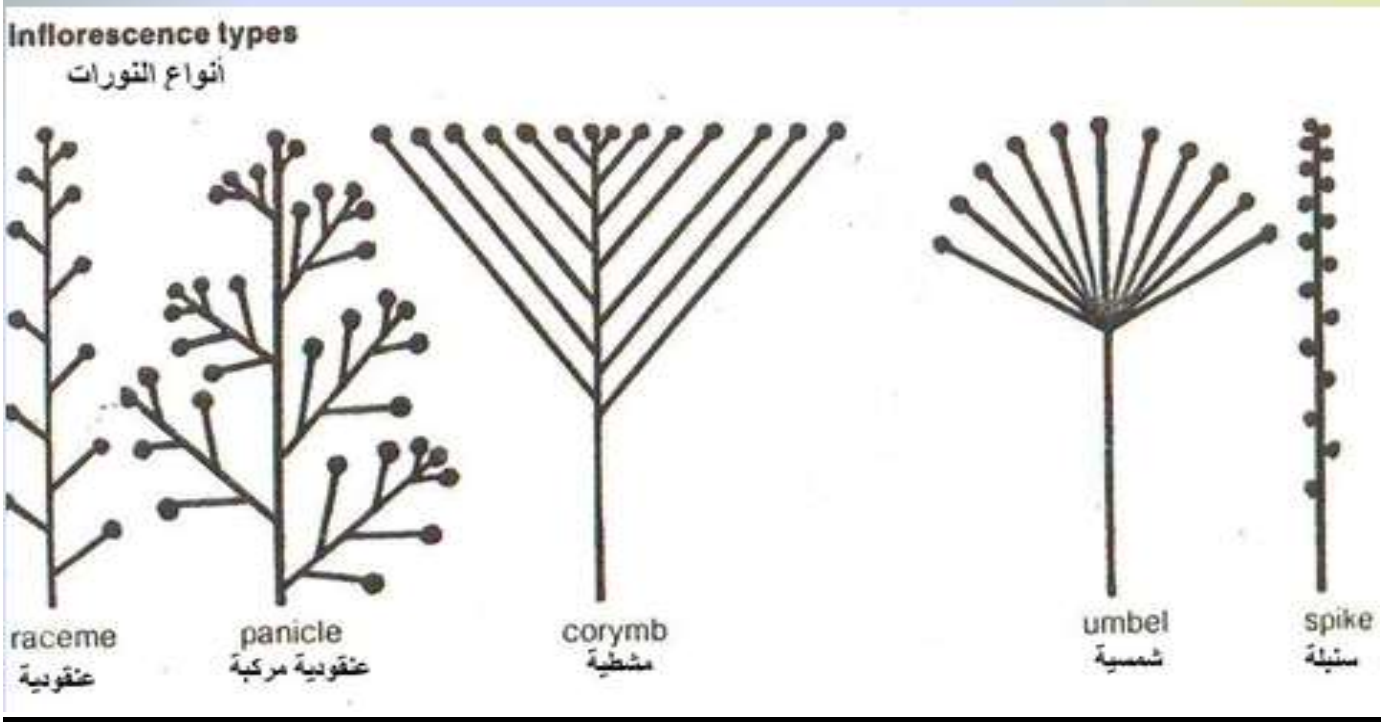
- **It is divided into:**

1. **Simple Raceme: Flowers are pedicellate and distributed along an axis with the youngest at the apex and the oldest at the base.**
2. **Compound Raceme (Panicle): The branches arising from the main axis of the inflorescence are themselves simple racemes.**
3. **Corymb: It is a simple raceme in which the pedicel of the lower most flowers become increasingly longer so that all flowers are on the same level.**
4. **Spike: It is a simple raceme with Sessile flowers.**
5. **Catkin: It is a pendulous spike often bears unisexual flowers and is frequently scaly-bracted.**
6. **Spadix: It is a spike with a fleshy axis. It often bears unisexual flowers and is enveloped by a leaf called Spathe.**
7. **Umbel: It is a simple raceme in which internodes are reduced so that the flower appears to arise from one point.**
8. **Compound Umbel: In which the flower of the simple umbels are replaced by small secondary umbels.**
9. **Capitullum (Head): It is a simple raceme with a short circular concave, flat or even convex pedicel on which sessile flowers are arranged.**

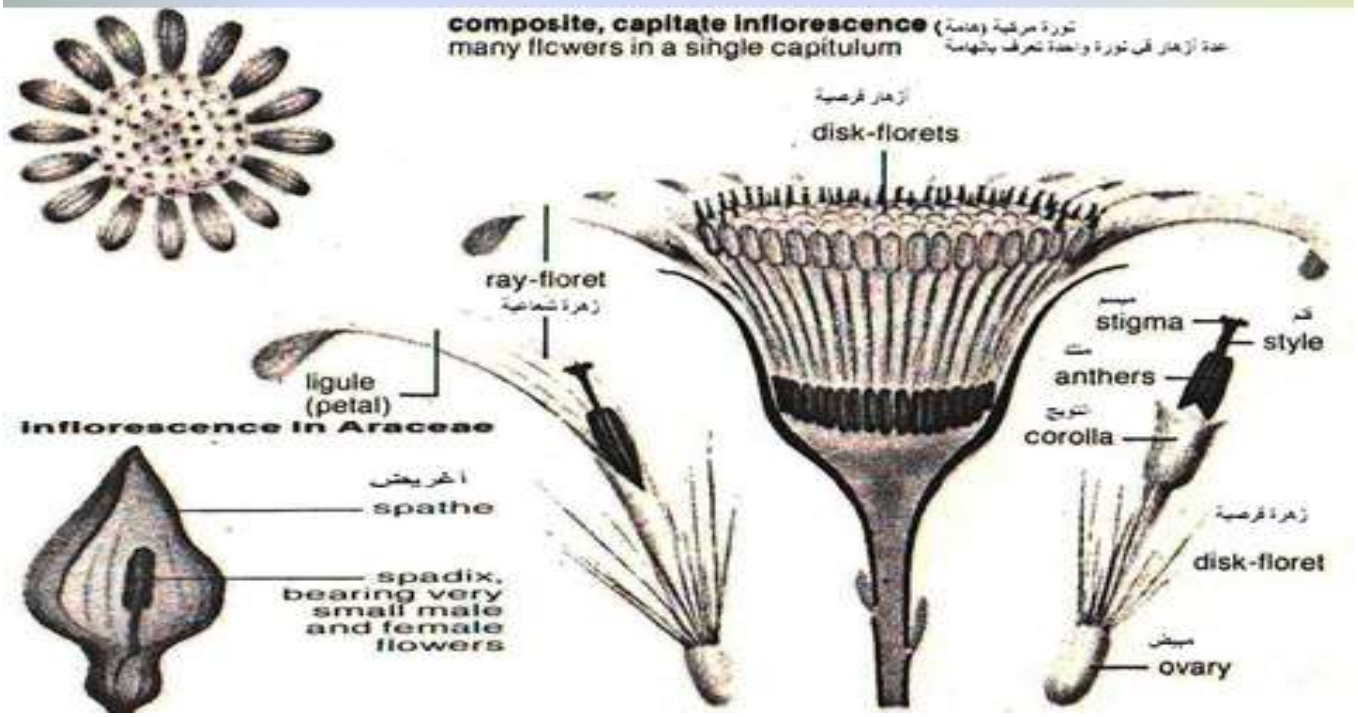
Racemose Inflorescence



Racemose Inflorescence



Racemose Inflorescence



Cymose Inflorescence

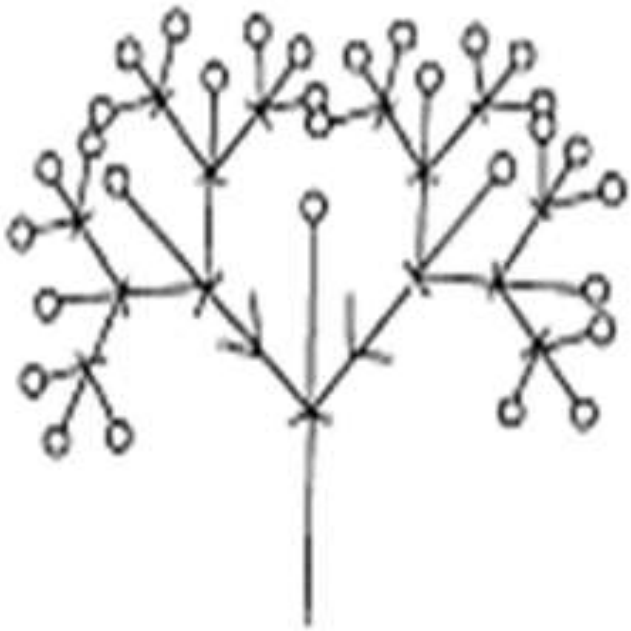
- **It is divided into:**

1. ***Monochasium*: The terminal bud is modified into a flower (the oldest), a lateral bud gives rise to a younger flower, etc…It is either Helicoid (bracts are on one side and flowers are on the other) or Scorpoid (bracts and flowers alternate).**

2. *Dichasium*: The terminal bud is modified into a flower, from the axil of the two opposite bracts arise two younger flowers.

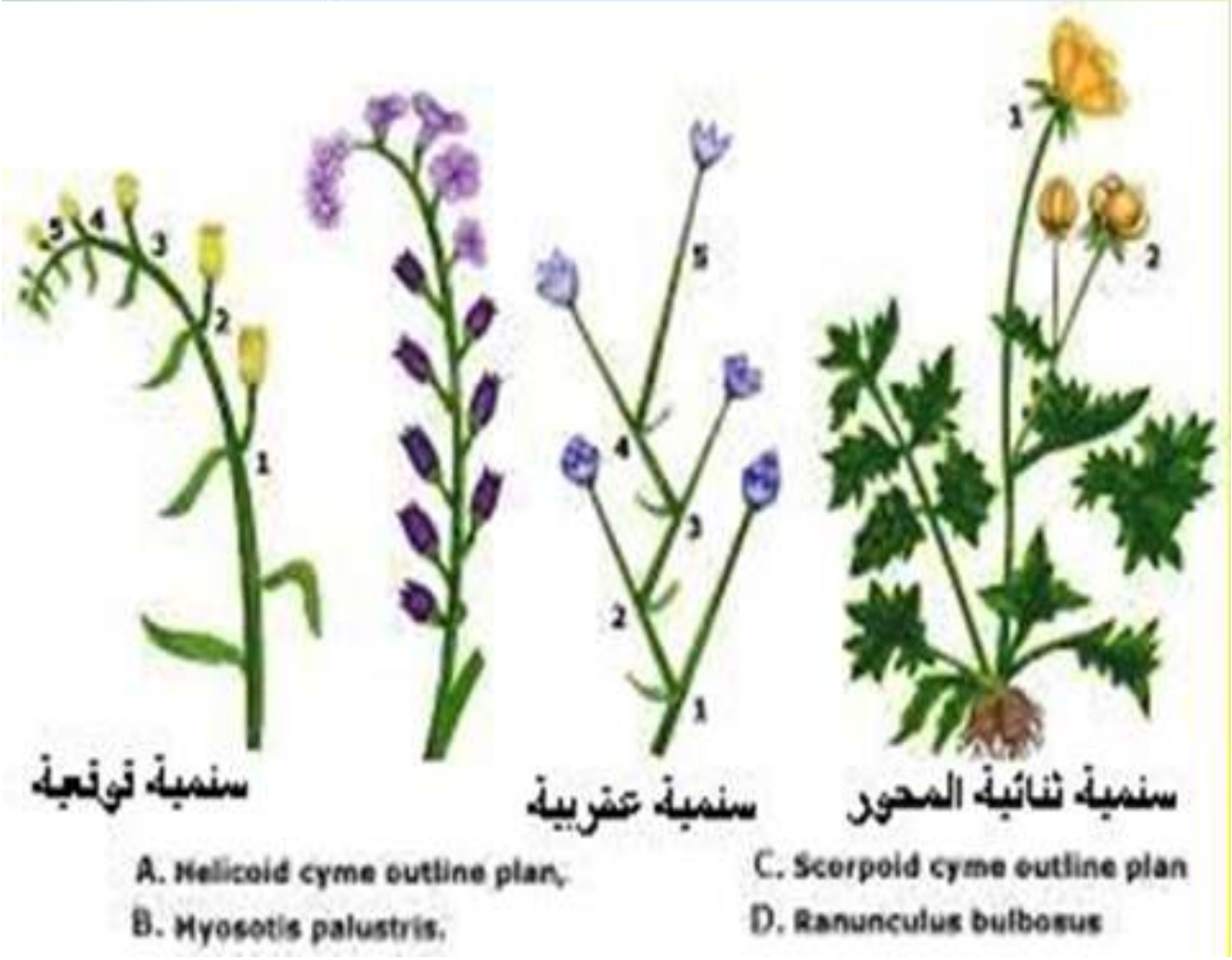
3. *Polychasium* (Determinate Umbel: The middle oldest flower is surrounded by several younger flowers.

monochasial cymes



dichasial cyme

Cymose Inflorescence



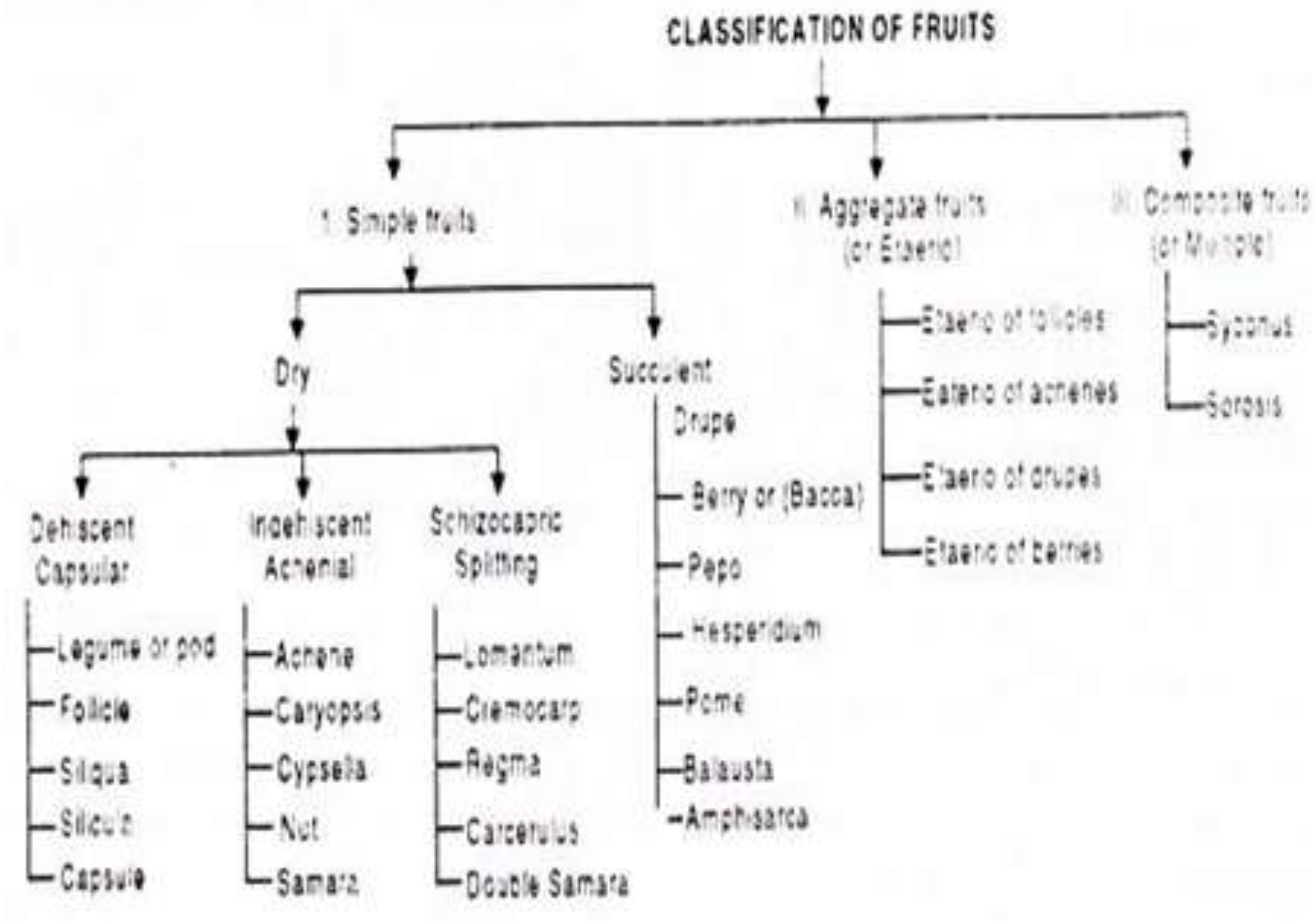
Fruits

<u>Fruit</u>: It is a mature ripened ovary of a flower, including one or more seeds, which are the matured ovules, enclosed by the pericarp.

- **After Fertilization is completed most of the floral leaves *i.e.* Calyx, Corolla, *etc*..., fall although some may remain attached to the fruit.**
- **A fruit has <u>two scars</u> (A grain of wheat, maize and rice are fruits):**

1. **The point of attachment to the <u>receptacle</u>, and.**
2. **The point of attachment the <u>style</u>.**

- **A seed has only <u>one scar</u> which is the point of attachment to <u>the ovary</u>.**
- **<u>True Fruit</u>: A fruit that is only formed from the ovary.**
- **<u>False (Accessory) Fruit</u>: A fruit that is formed from other parts of the flower or the vegetative parts besides the ovary. *i.e.* Strawberry, Pears and Apples.**



- **Fruits are classified into:**

1. **<u>Simple</u>: The fruit is produced from a *single flower*, the gynoecium of which composed of *<u>a single or several united carpels</u>*.**
2. **<u>Aggregate</u>: The fruit is produced from a *single flower*, the gynoecium of which composed of *<u>several free carpels</u>*.**
3. **<u>Composite (Multiple)</u>: A *<u>group</u>* <u>of flowers (inflorescence)</u> *i.e.* Mulberry**

Simple Fruits

- **Simple Fruits are classified into:**

1. **<u>Dry Fruits</u>: The wall of the fruit (pericarp) is dry, thin (or thick) and woody. They are subdivided into:**
    - **Indehiscent (Closed) Fruits: The pericarp remain closed and the seeds liberated after the disintegration of the pericarp. It is generally one-loculed (chamber) and one-seeded.**
    - **Dehiscent (Opened)Fruits: The pericarp opens in many ways for the liberation of seeds or breaking apart.**
    - **Schizocarpic (Split) Fruits: It is composed of more than one carpel fused together in the early stages, but when ripens it splits into an indehiscent dry parts (*Mericarps*) usually one-seeded.**
2. **<u>Succulent Fruits</u>: The wall of the fruit (pericarp) is fleshy and <u>the wall</u> is of three parts:**

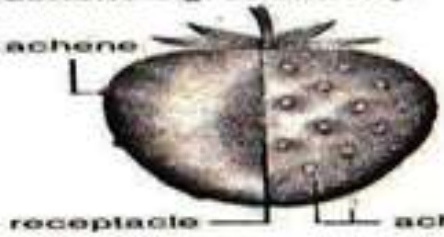
- *Endocarp* - *Mesocarp* -*Epicarp*

Fruit

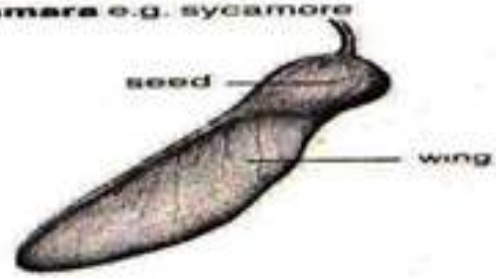
legume e.g. pea

capsule e.g. poppy

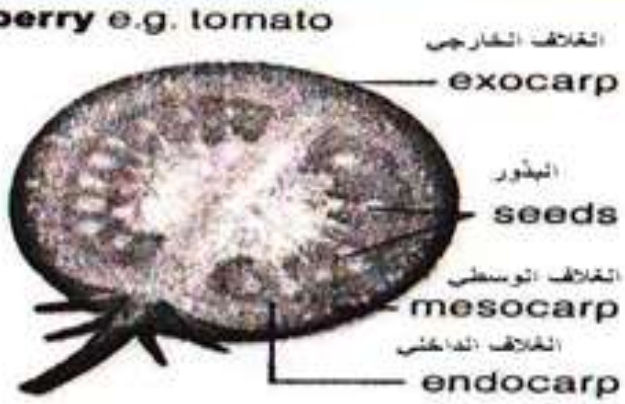
achene e.g. strawberry



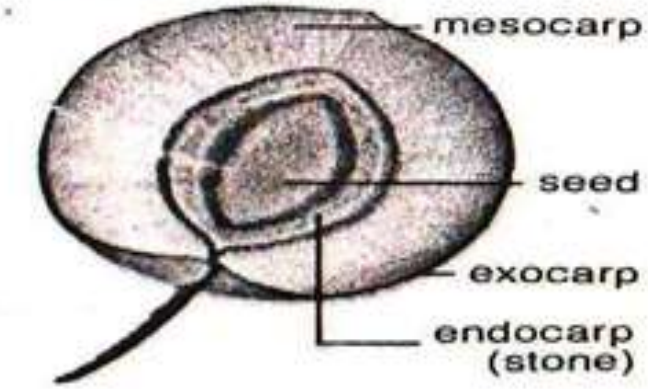
samara e.g. sycamore



berry e.g. tomato



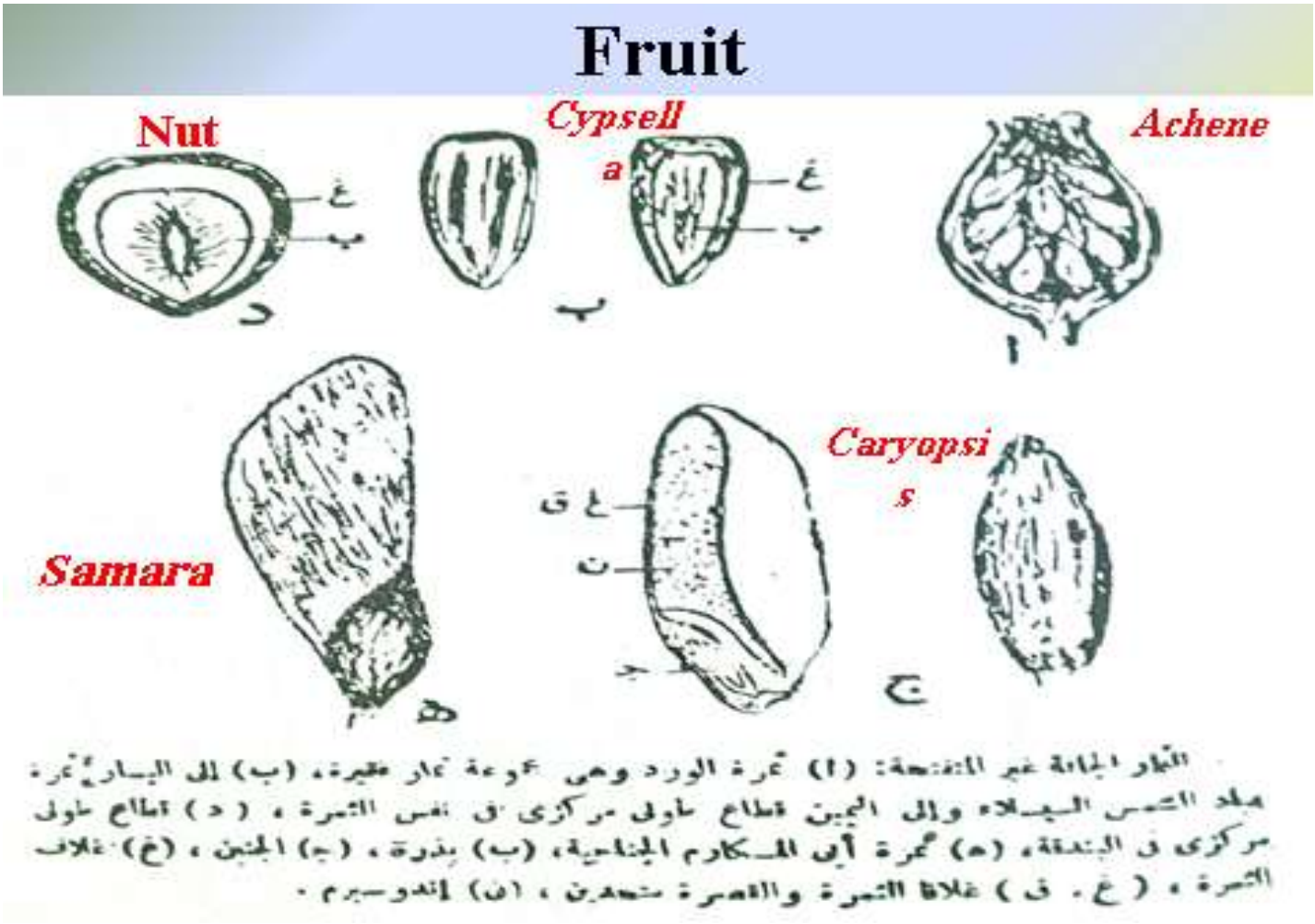
drupe e.g. apricot



Simple Dry Fruits

I. Indehiscent Fruits:

1. **Achene: Produced from a *superior ovary*, usually one-seeded, pericarp leathery not fused with Testa *i.e. Rosa*.**
2. **Caryopsis: It is similar to *achene*, but differs in having the *Pericarp* fused with the seed Testa , all grains *i.e.* grasses**
3. **Samara: It is similar to *achene*, but the *Pericarp* extends into a *wing i.e. Macharium tipa***
4. **Cypsela: Produced from an *inferior ovary*, *Pericarp* is leathery not fused with the Testa *i.e. Helianthus***
5. **Nut: It is formed of an ovary, *Pericarp* is *woody* or *leathery i.e. Corylus.***



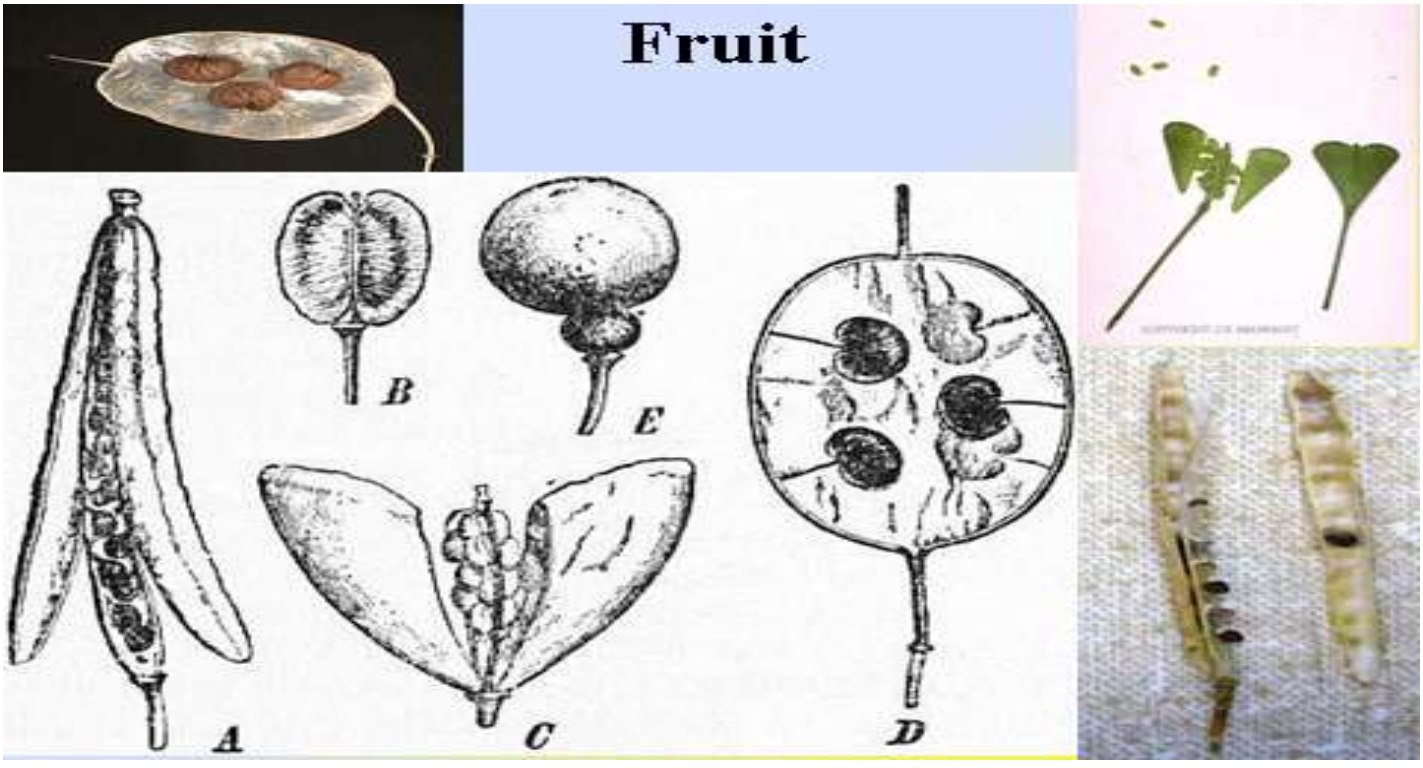
الثمار الجافة غير المتفتحة: (أ) ثمرة الورد وهي مجموعة ثمار صغيرة، (ب) إلى اليسار ثمرة عباد الشمس السيلاء وإلى اليمين قطاع طولى مركزى فى نفس الثمرة ، (د) قطاع طولى مركزى فى البندقة، (هـ) ثمرة أبى المكارم الجناحية، (ب) بذرة ، (ج) الجنين ، (غ) غلاف الثمرة ، (غ . ق) غلاف الثمرة والقصرة متحدين ، (ن) إندوسبرم .

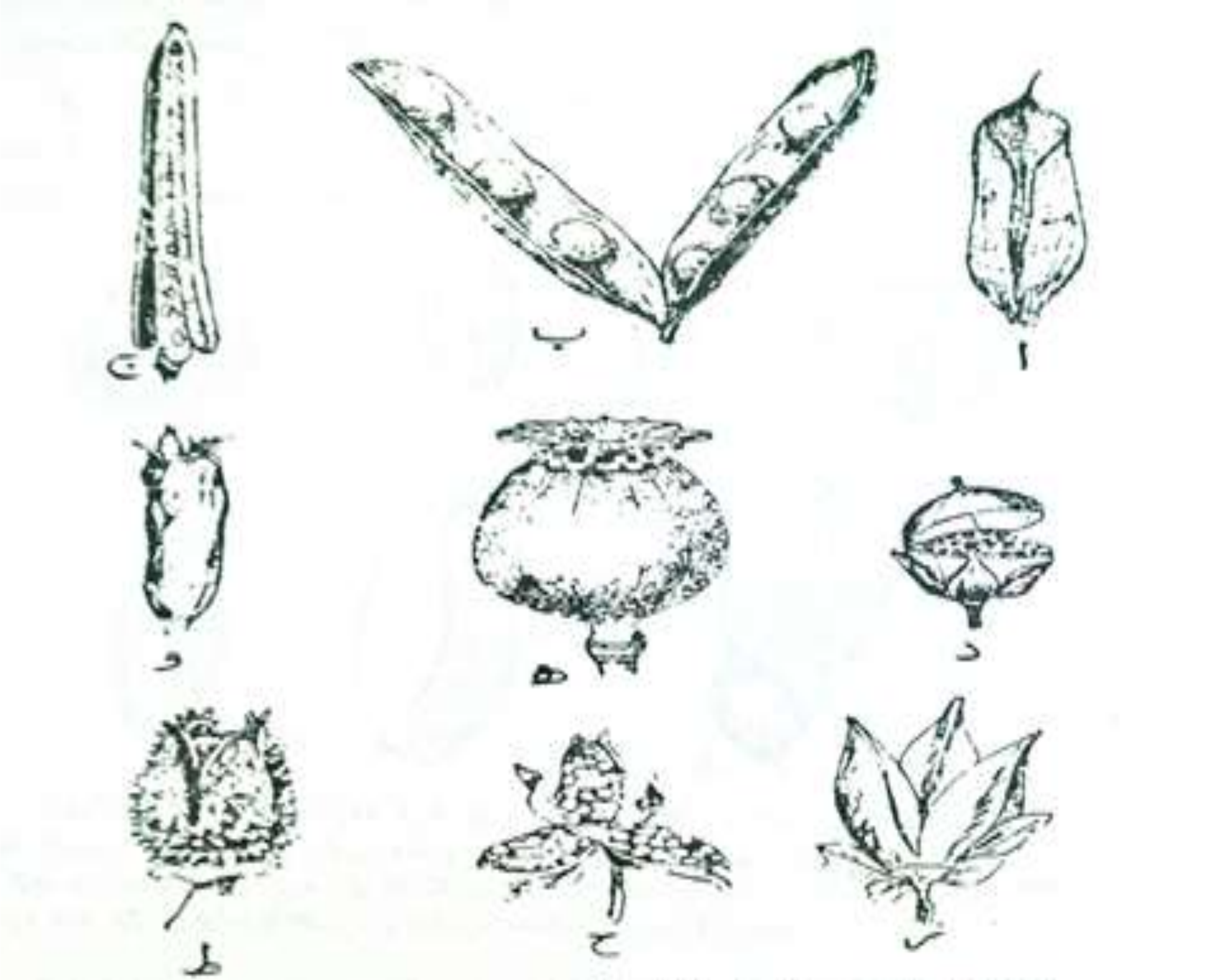
II. <u>Dehiscent Fruits</u>:

1. **Follicle: The fruit is composed of a single carpel that opens along <u>a single ventral suture</u>.**
2. **Legume: The fruit is composed of a single carpel (one to many seeded) and dehiscens along the <u>ventral and dorsal sutures</u>. The dehiscence starts at the top of the fruit and proceeds downwards leading to the formation of valves which becomes twisted to release the seeds by force. *i.e. Lathyrus* and *Vicia* fruits**
3. **Siliqua: The fruit is composed of two carpels separated by a false septum. It is <u>usually long and narrow</u>, but <u>when it is short and flat</u> it is called "Silicula".**
4. **Capsule: The fruit is generally composed of more than one carpel. According to the way of dehiscence, they are divided to capsules opened by:**

- Lid (*Pyxis*) - Pore (*Porocidal*) - Teeth (*Denticidal*) - Valve: which is divided into:

1. ***Septicidal*: Splitting from the septa**
2. ***Loculicidal*: Splitting between the septa and into the locules**
3. ***Septifragal*: Splitting from both the septa and the locules.**



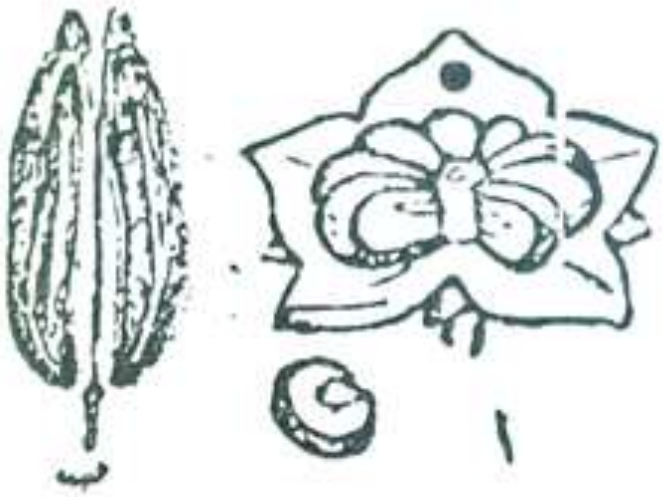


الثمار الجافة المتفتحة (أ) ثمرة العايق الجرابية ، (ب) ثمرة الفول القرنية ، (ج) ثمرة المنثور الخردلية ، (د) ثمرة عين القط ، وهي ثمرة تتفتح أفقياً على امتداد خط دائري ، (هـ) ثمرة الخشخاش وهي علبة تتفتح بالثقوب ، (و) ثمرة [illegible] وهي علبة تتفتح بالأسنان (ز) ثمرة القطن وهي علبة انفتاحها مسكني ، (ح) ثمرة البنفسج ، وهي علبة انفتاحها مصراعي ، (ط) ثمرة الداتورة وهي علبة انفتاحها صمامي.

Simple Dry *Schizocarpic* fruits

- ***Schizocarpic* (Split) Fruits:** It is composed of more than one carpel fused together in the early stages, but when ripe it splits into an indehiscent dry parts (*Mericarps*) usually one-seeded. *i.e. Coriandrum*

(شكل ٢٨٨)



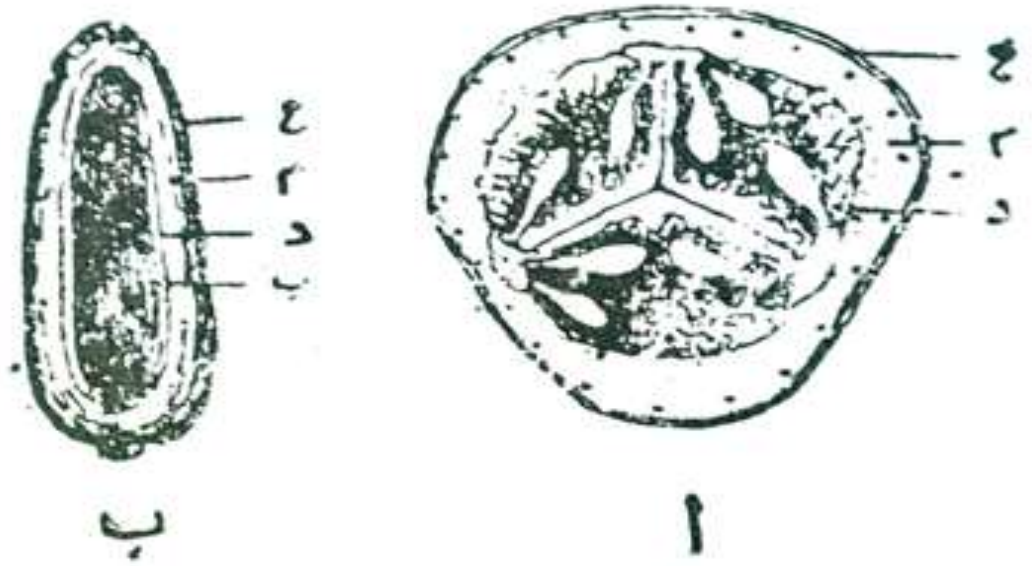
الثمار المشقة (أ) ثمرة الحلبة وبأسفلها ثمرة جرثيلة ، (ب) ثمرة البقدونس

Simple Succulent Fruits

- **Succulent Fruits are classified into:**

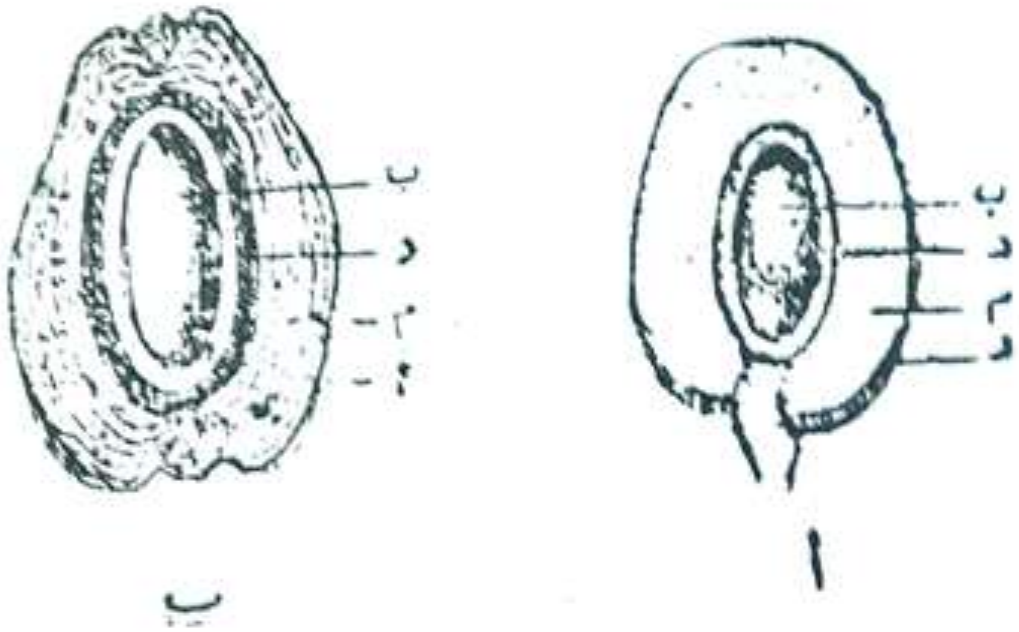
1. **Berry: Fleshy fruits with one or more seeds. The *Epicarp* may be hard, firm or leather, while the *Meso-* and *Endocarp* are soft and maybe separated or homogenous. *i.e.* Tomato and Orange**
2. **Drupe : Fleshy fruits in which the *Endocarp* is woody. *i.e.* Apricot and Olives**
3. **Pome : Fleshy fruits in which the *Epicarp* is soft and the center contains a papery cartilaginous structure enclosing the seeds. The receptacle is fleshy concave while the ovary inferior (False fruit) *i.e.* Apples, Pears and Figs**

(شكل ٢٩٠)



الثمار الطرية طبيعية ، ويرى إلى اليمين المماع مستعرض فى ثمرة للخيار وإلى اليسار
ع طولى فى ثمرة البلح . (ب) بذرة ، (خ) الطبقة الخارجية من الغلاف الثمرى ،
الطبقة الداخلية منه ، (م) الطبقة الوسطى .

(شكل ٢٨٩)



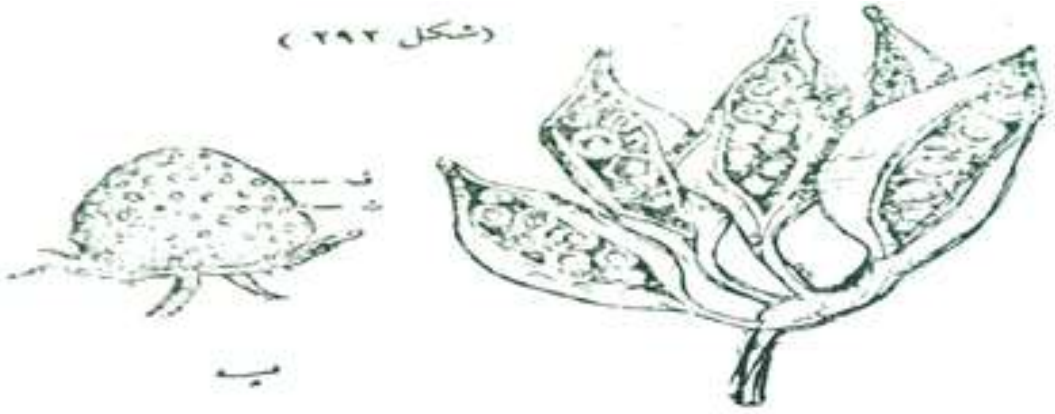
ا ب

اثمار الطرية المحلية : (ا) قطاع طولى فى ثمرة المشمش ، (ب) قطاع طولى فى ثمرة الدوم . (ب) بذرة ، (خ) الطبقة الخارجية من الغلاف الثمرى (د) الطبقة الداخلية من ذلك الغلاف ، (م) الطبقة الوسطى.

Aggregate Fruits

- **Aggregate Fruits are classified into:**

1. **Aggregate of Follicles: The fruit is composed of a number of follicles grouped together and produced by a single flower. Each follicle represents a mature carpel.**
2. **Aggregate of Achenes: The fruit is composed of a number of achenes inserted on a fleshy receptacle *i.e.* Figs, Strawberry.**

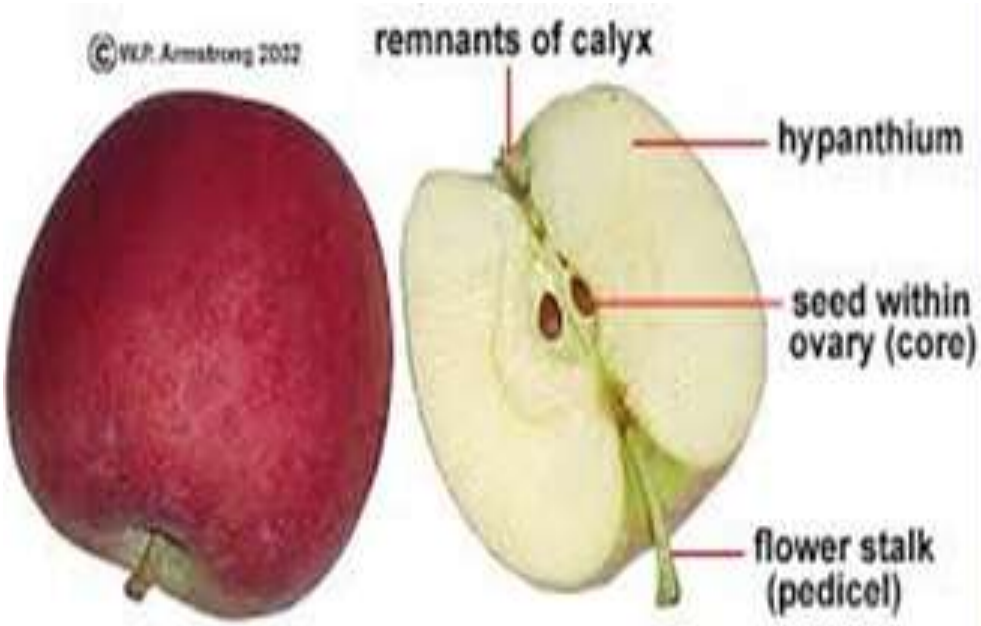


(شكل ٢٩٢)

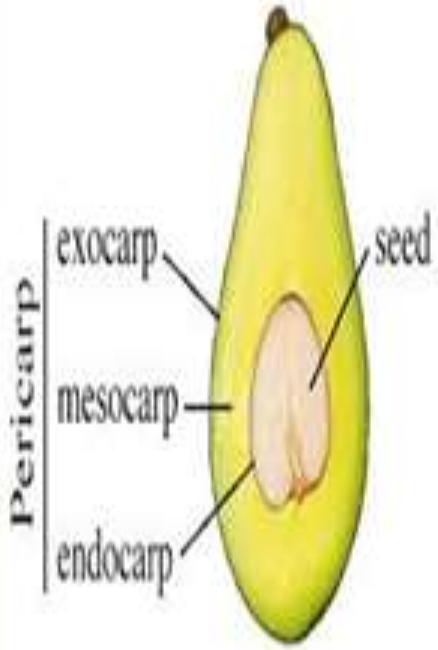
الثمار المجتمعة : (أ) ثمرة يوجرة العقربت وفيها الوحدات جرابية ، (ب) ثمرة الشقلك وفيها الوحدات فقيرة (ث) الأنف ، (ب) ثمرة مفردة .

(شكل ٢٩٣)

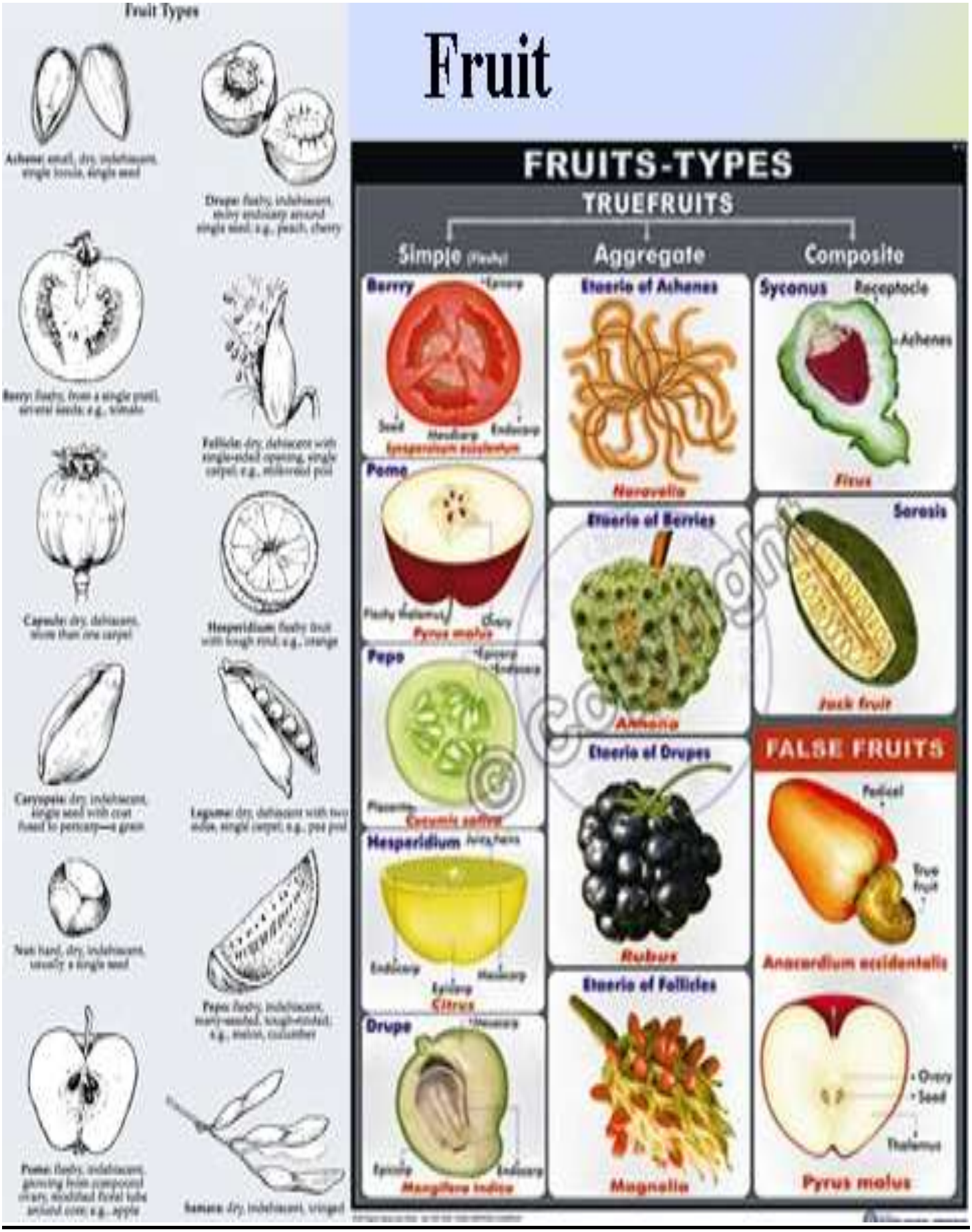
الثمار المركبة : (أ) قطاع طولى فى ثمرة التين البرشومى ، (ب) سنكارب ثمرة التوت .



Pome (ovary surrounded by fleshy hypanthium)
e.g. apple (*Malus domestica* cv. 'gala')



Types of Fruit


Fruit Types
Fruit
FRUITS-TYPES
TRUEFRUITS
Simple
Aggregate
Composite
Berry
Pome
Pepo
Hesperidium
Drupe
Etaerio of Achenes
Etaerio of Berries
Etaerio of Drupes
Etaerio of Follicles
Syconus
Receptocle
Achenes
Sorosis
FALSE FRUITS
Anacardium occidentalis
Pyrus malus
Mangifera indica
Magnolia
Rubus
Citrus

REFERENCES

1. **Khalil *et al.* (1975). General botany. Cairo Univ. Press.**
2. **Sinnott andWilson (1983). Botany Principles and Problems Mc Graw-Hill Company 6th edition.**
3. **Eskarous *et al.*(1987). Practical Botany. Cairo Univ. Press.**
4. **Megahed *et al.*(1996). General Botany. Anglo Press. 7th edition.**
5. **Afiffy *et al.* (2004). General Botany. Dar El Fikr El Araby Pub.**
6. **Kamel *et al.* (2005). Basics of Plant Sciences. Dar El Fikr El Araby Pub. 2nd edition.**
7. **Plant Atlas (2010).**

GRADING

1. **Student activities & attendance (5 marks): 2 lab notebook+2quiz+1attendance**
2. **Practical exam: 10 marks**
3. **Final written exam: 60 marks**

TEACHING HOURS

1. **Lectures: 1 hour**
2. **Lab: 2 hours**