Botany 1

Plant Morphology

1st year Physical and Chemical sciences - Botany

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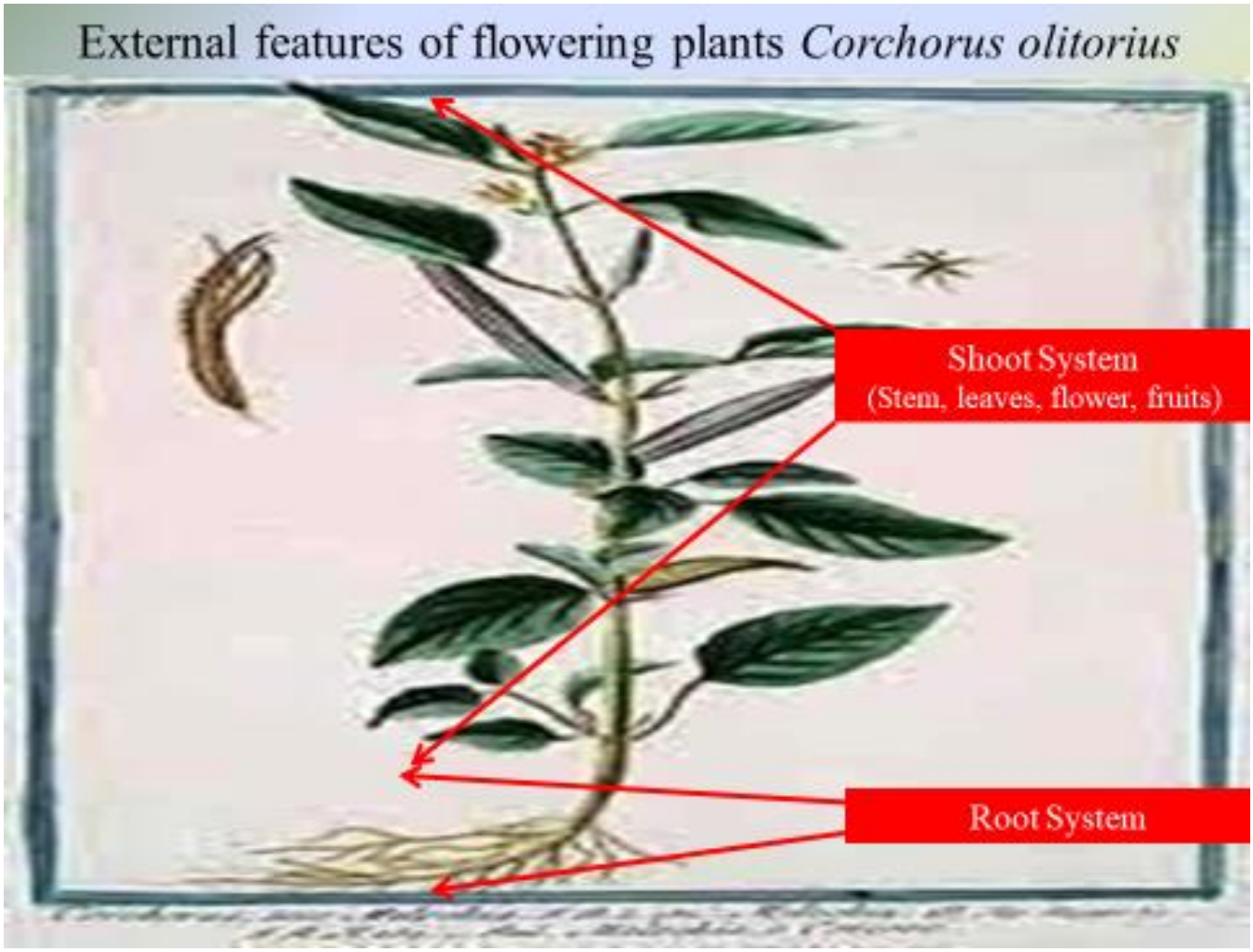
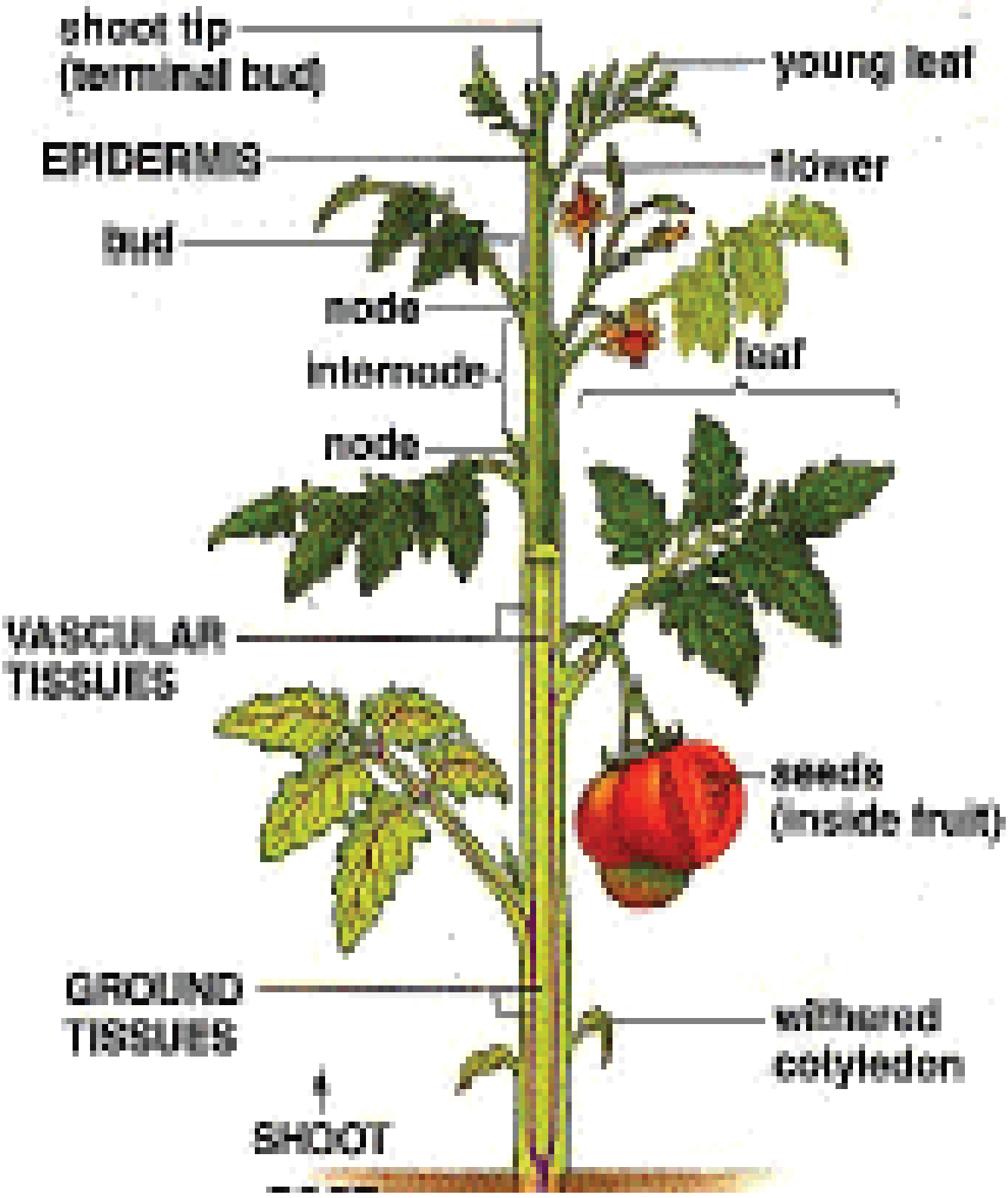
External features of flowering plants:

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

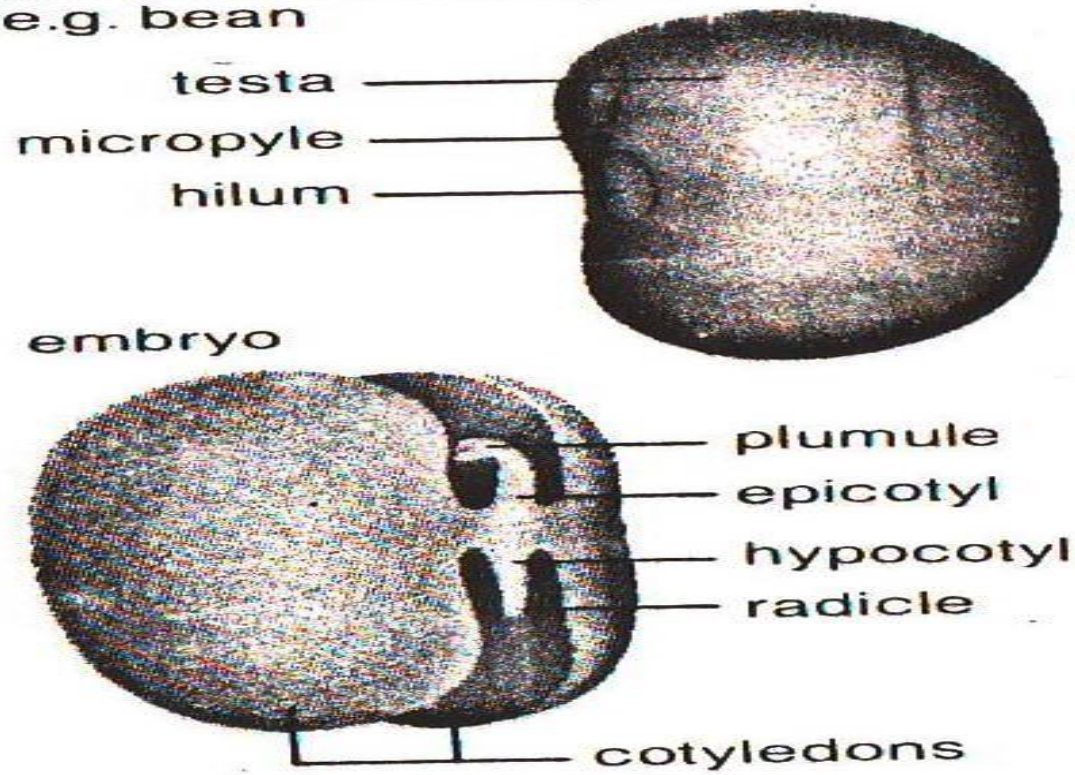
The Seed

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

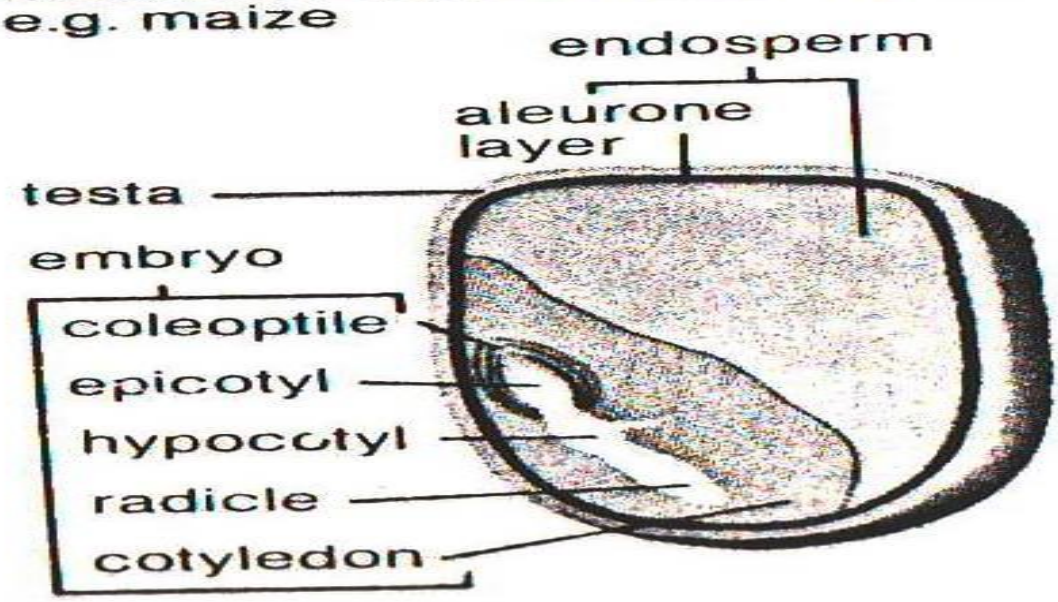
- **Embryo: It consists of one (Monocot) or two (*Dicot*) leaves Cotyledons; primary root Radicle; primary shoot Plumule.**
- **Types of Seeds:**
  - **Endospermic (*Albuminous)* Seed: A young embryonic plant with reserve food material to supply the developing embryo in its early stages of germination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

- **Types of Germination:**
  1. ***Hypogeal*: Elongation of the *Epicotyl.***
  2. ***Epigeal*: Elongation of the *Hypocotyl***

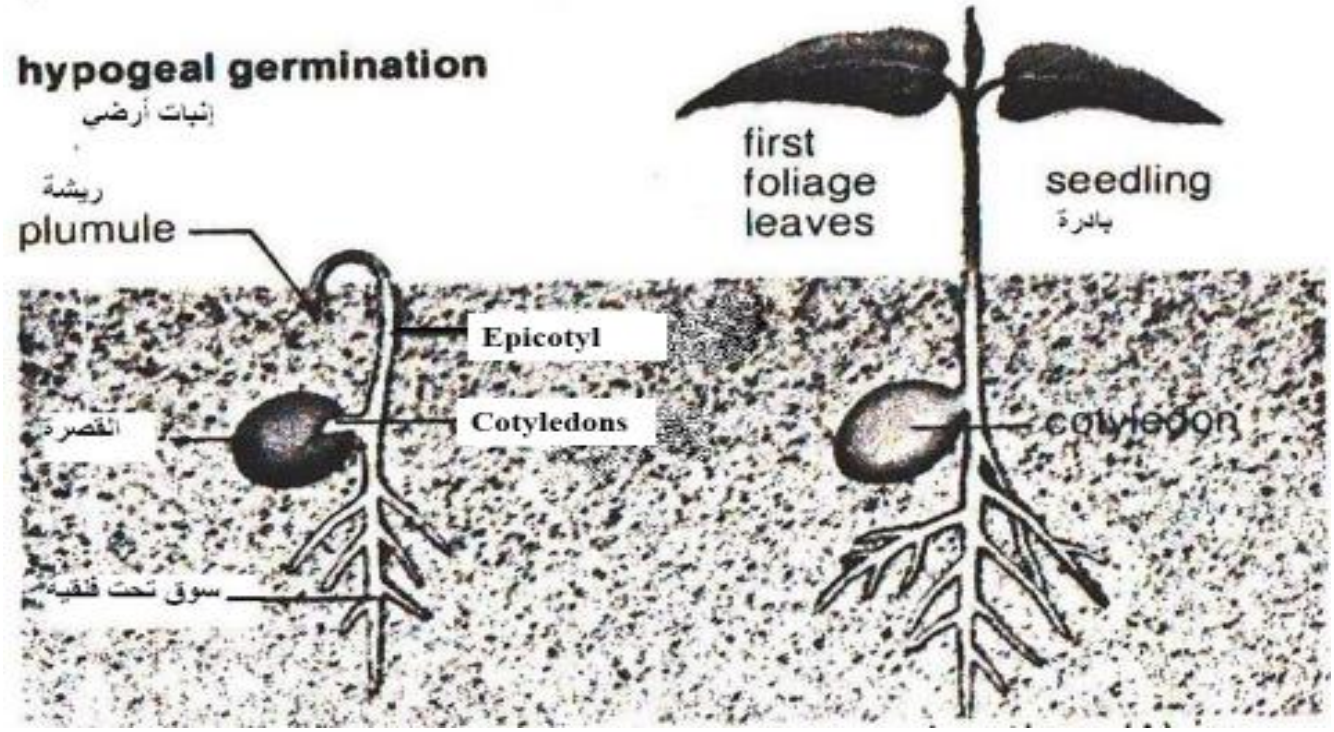
exalbuminous seed
food stored in cotyledons
e.g. bean



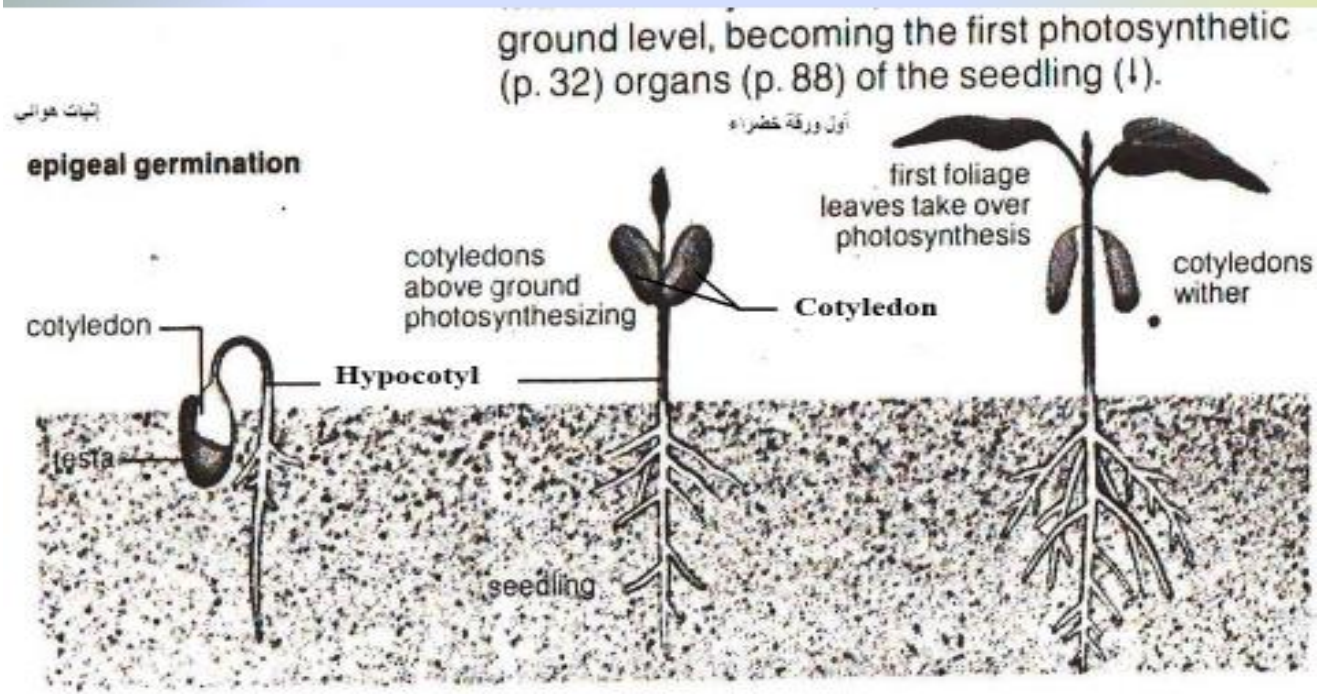
albuminous seed
most food stored in endosperm
e.g. maize



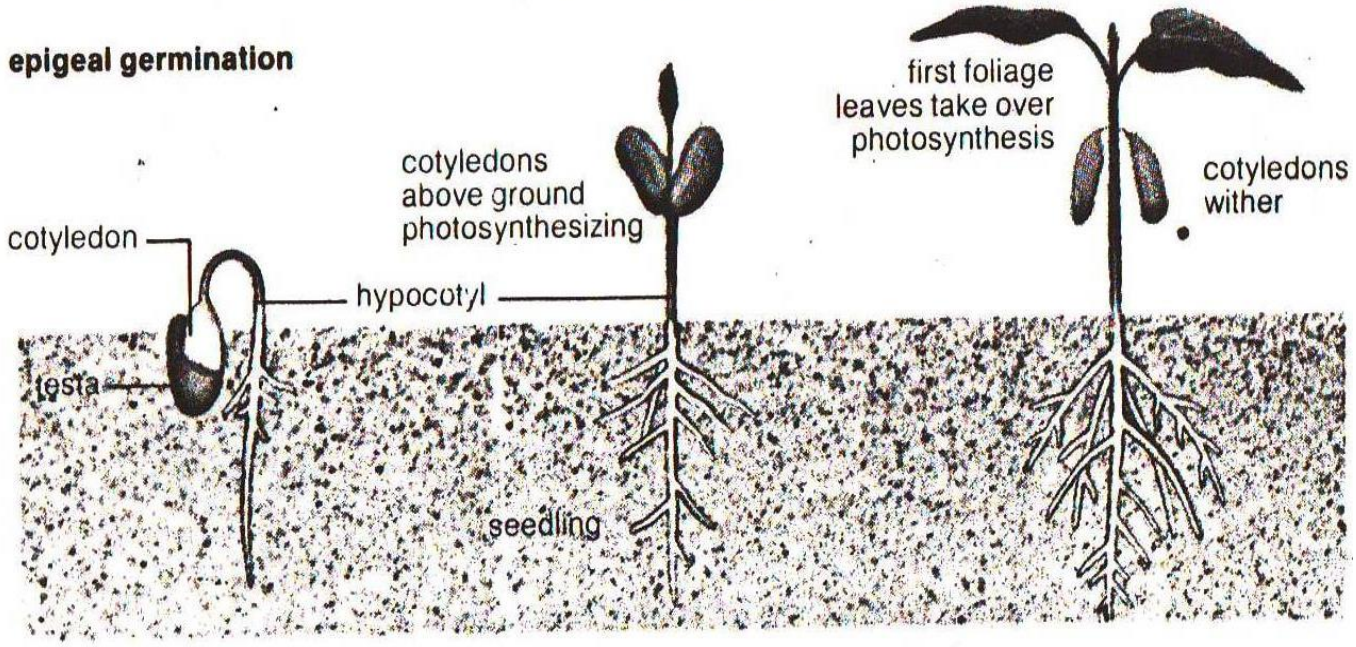
Hypogeal Germination

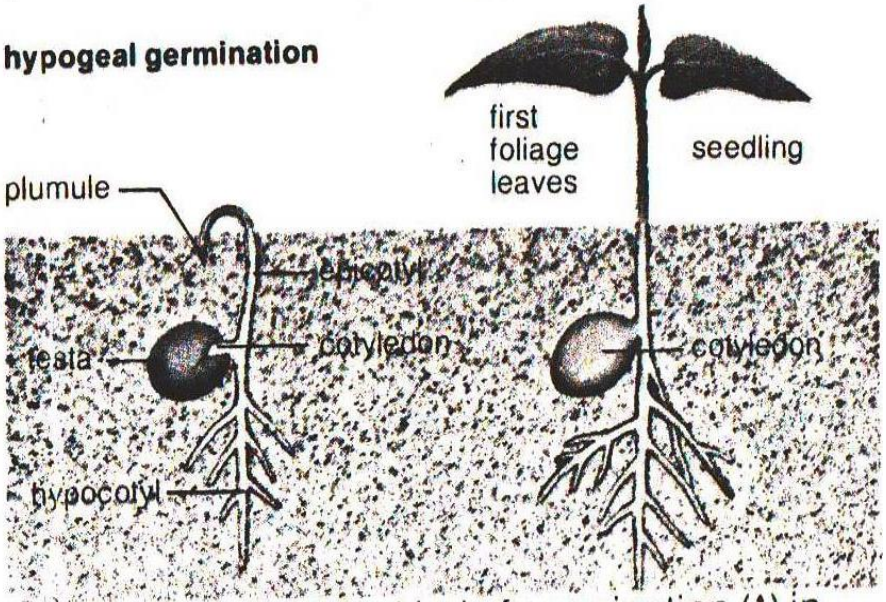


Eipogeal Germination



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

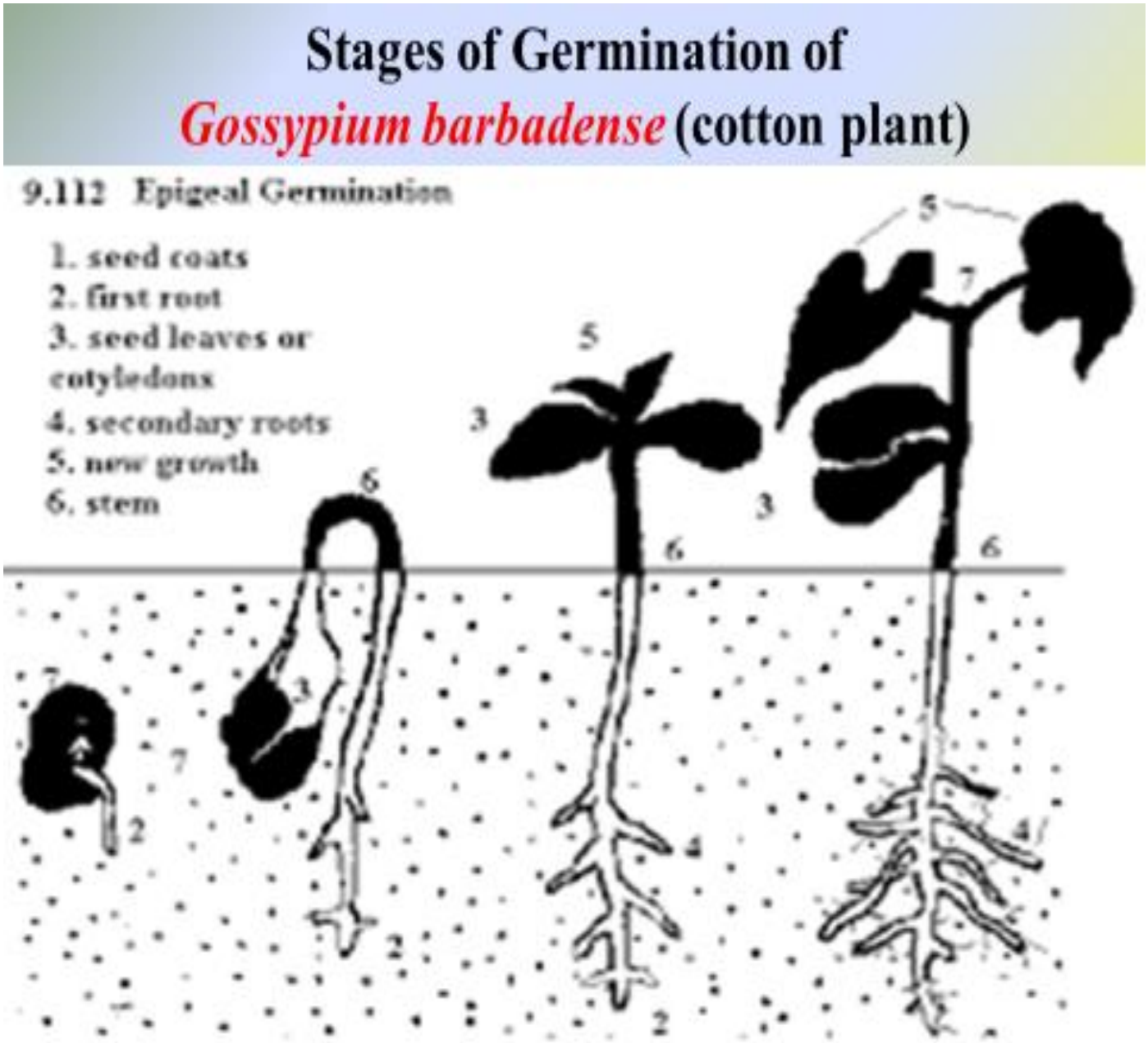
1st Stage: Swelling of seed and removal of *Testa*.

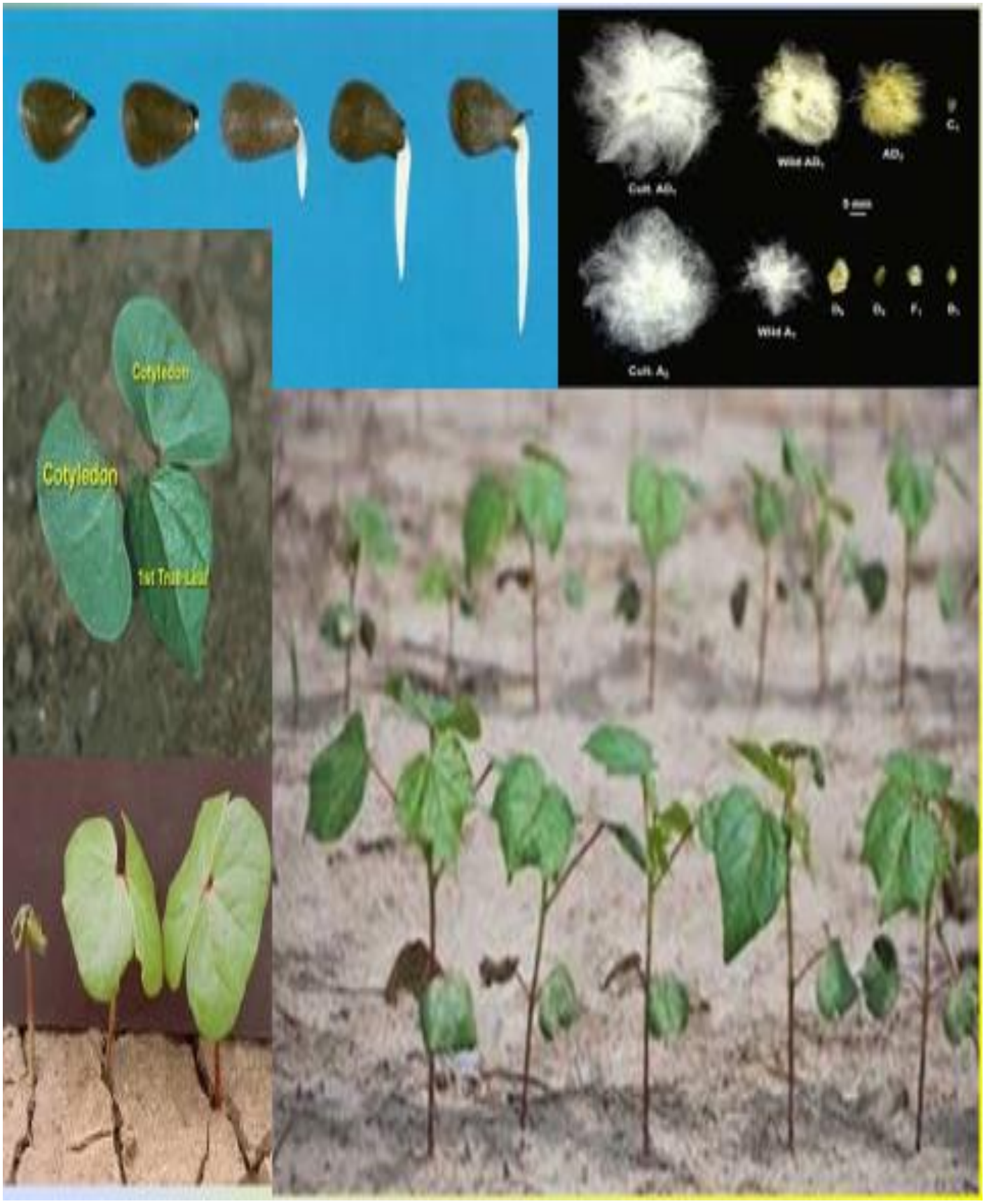
2nd Stage: Growth of Radicle.

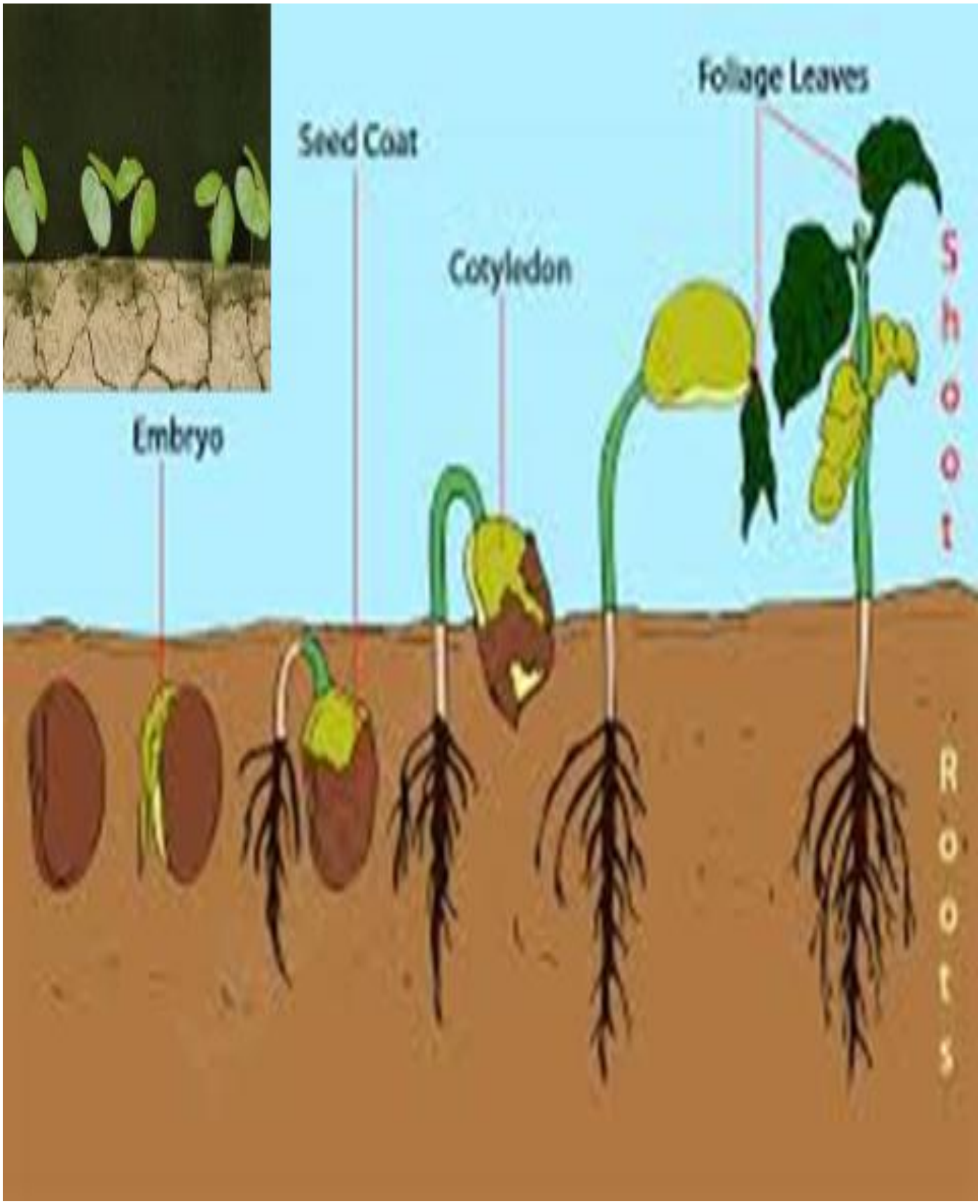
3rd Stage: Growth of Plumule.

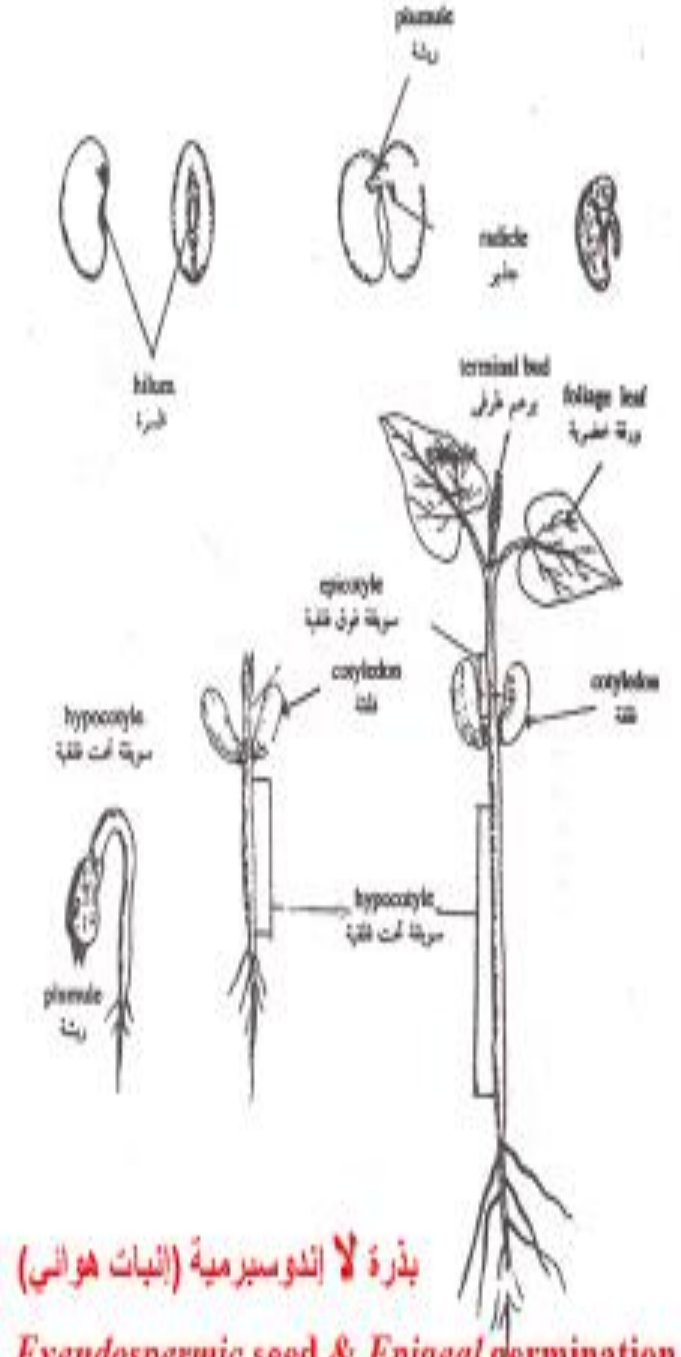
4th Stage: Formation of the first foliage leaf.

Examples of *Dicotyledonous* Seeds and seedlings




Cotyledon
Cotyledon
1st True Leaf


Foliage Leaves
Seed Coat
Cotyledon
Embryo
Shoot
Roots

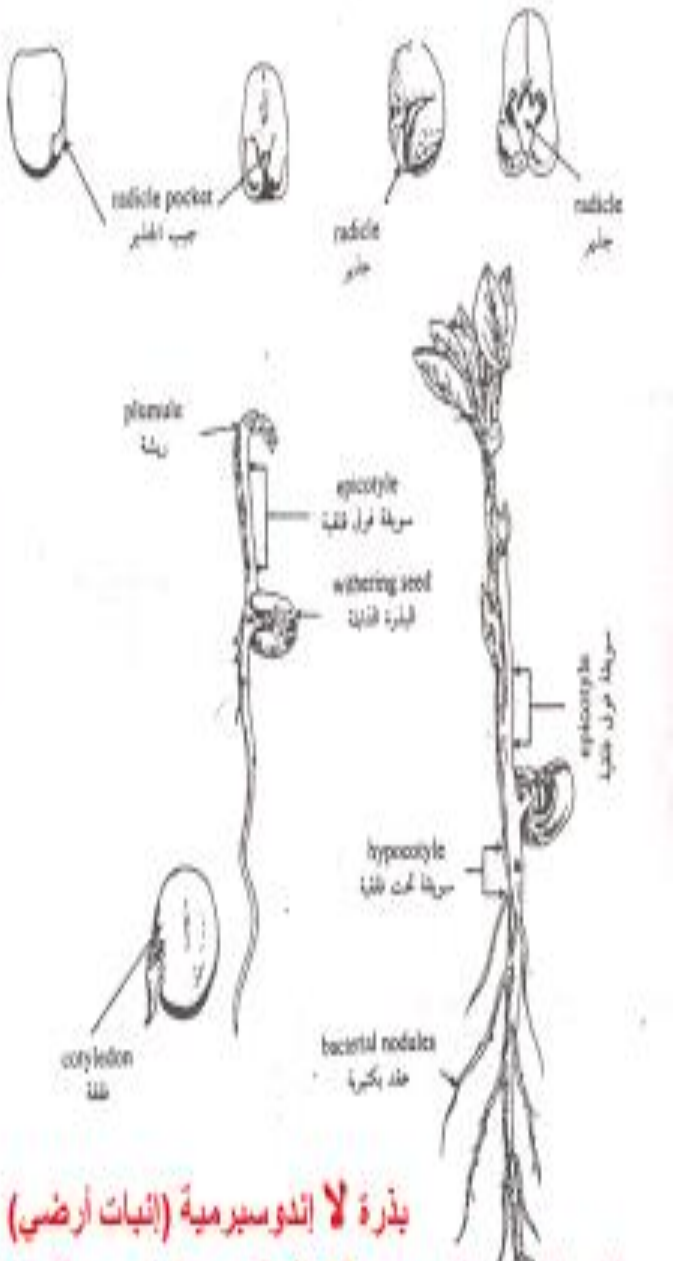


بذرة لا إندوسبرمية (النبات هوائي)

Exendospermic seed & *Epigeal* germination

(Fig. 31) Phaseolus vulgaris seed & germination.

(شكل ٣١): بذرة نبات الفاصوليا وإنباتها

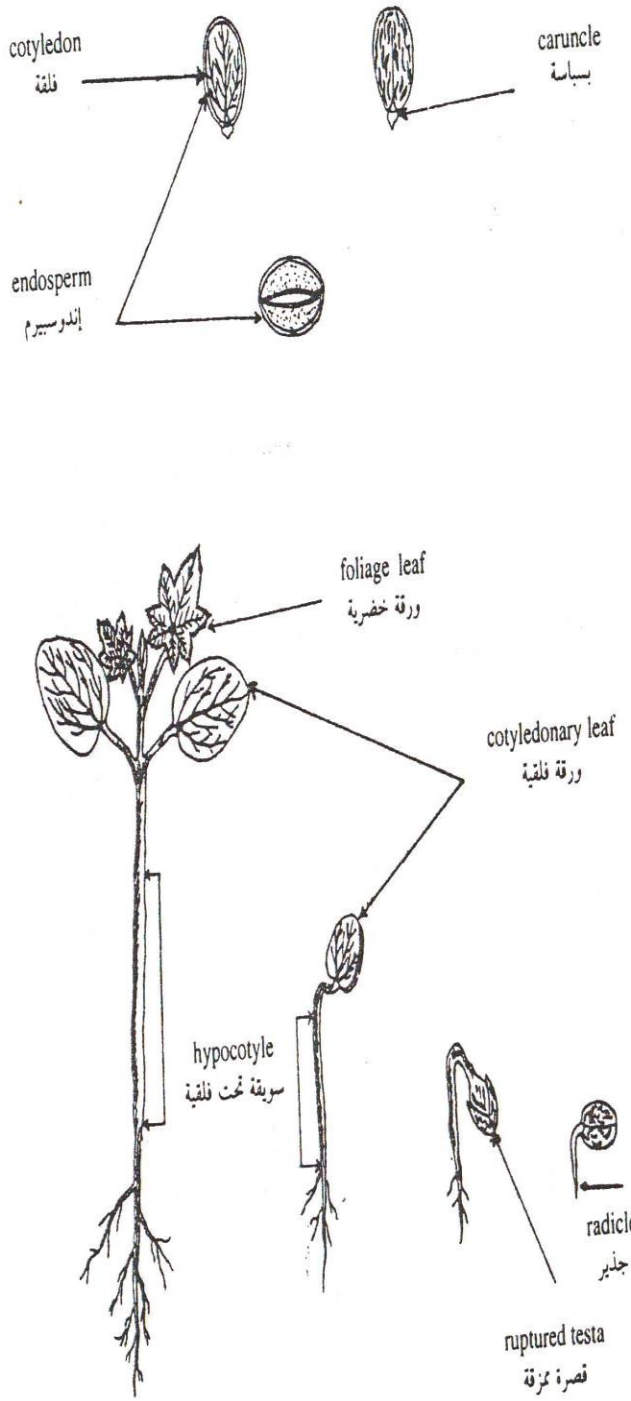


بذرة لا إندوسبرمية (إنبات أرضي)

Exendospermic seed & *Hypogeal* germination

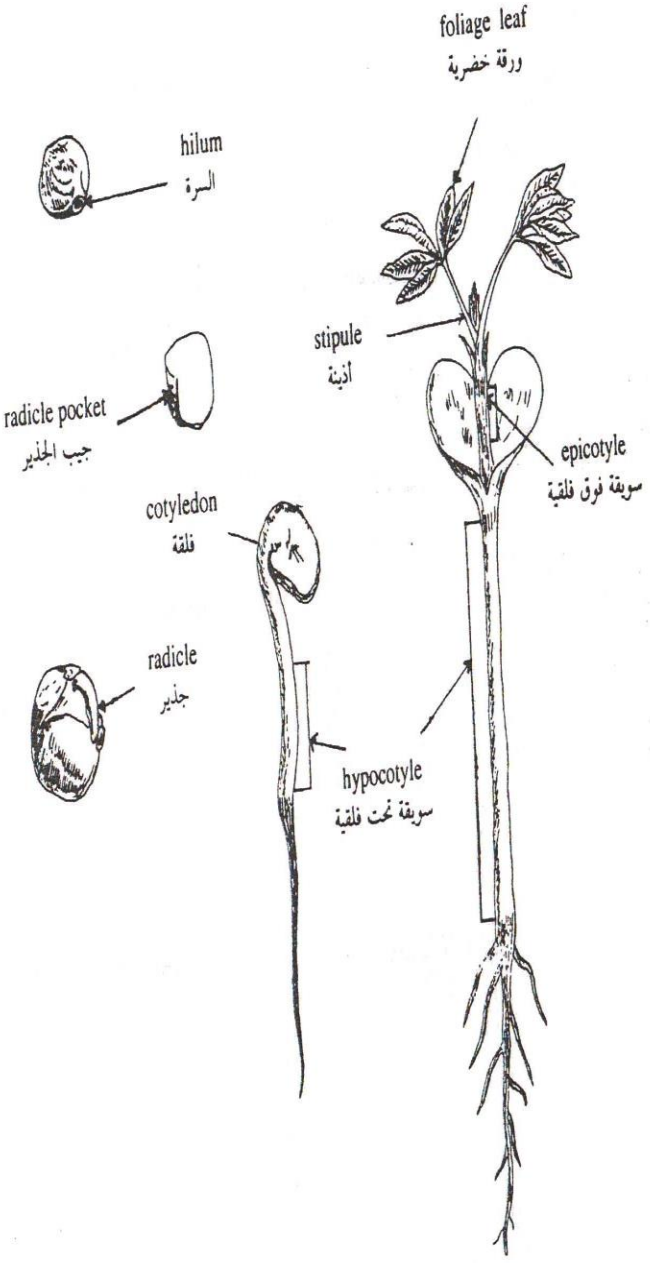
(شكل ٣٠): بذرة الفول الرومي وإنباتها

(Fig. 30) vicia faba seed & germination.



(Fig. 32) Ricinus communis seed & germination.

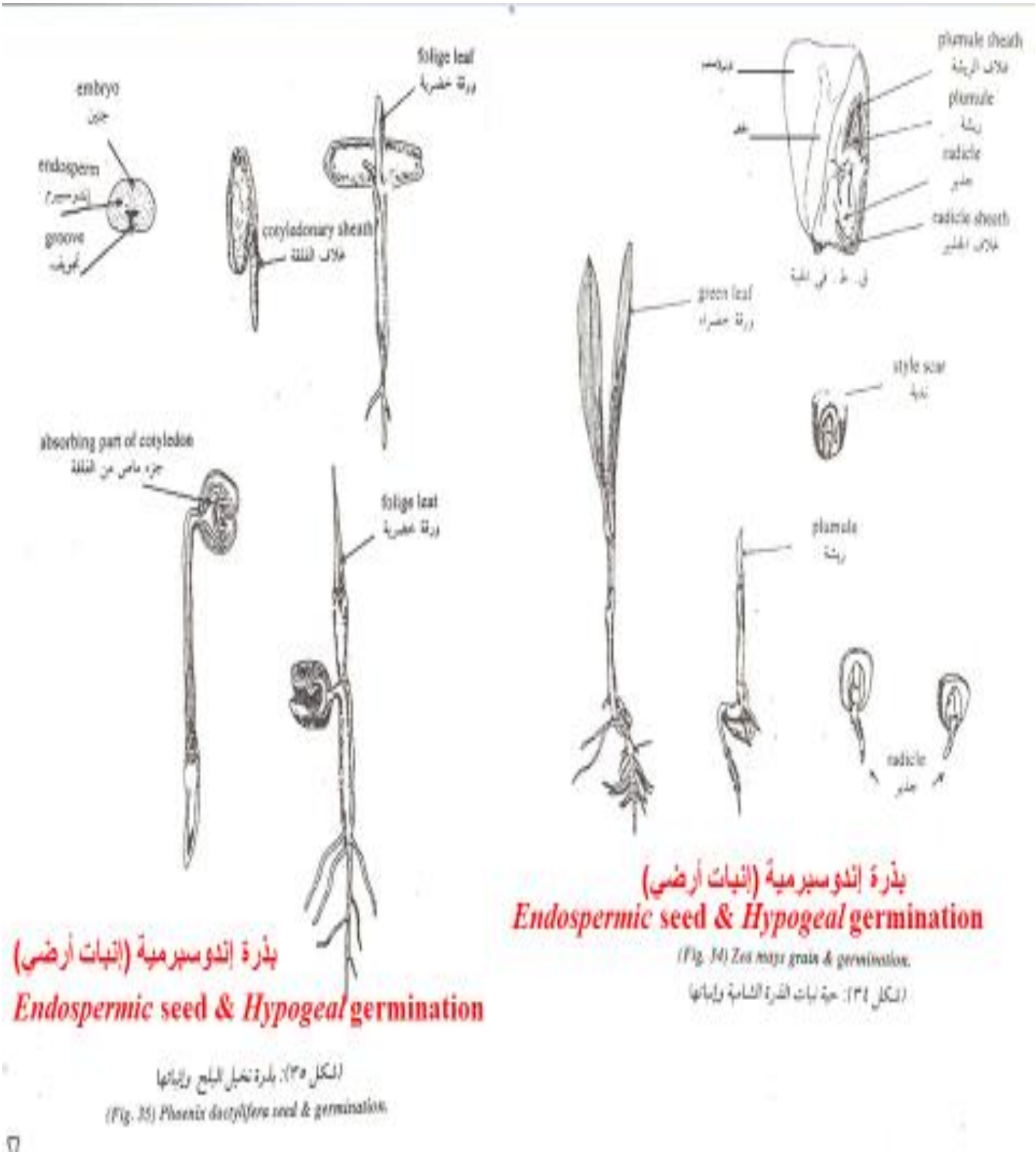
(شكل ٣٢): بذرة نبات الخروع وإنباتها



(Fig. 33) Lupinus termis seed & germination.

(شكل ٣٣): بذرة نبات الترمس وإنباتها

Examples of *Monocotyledonous* Seeds and seedlings



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.**

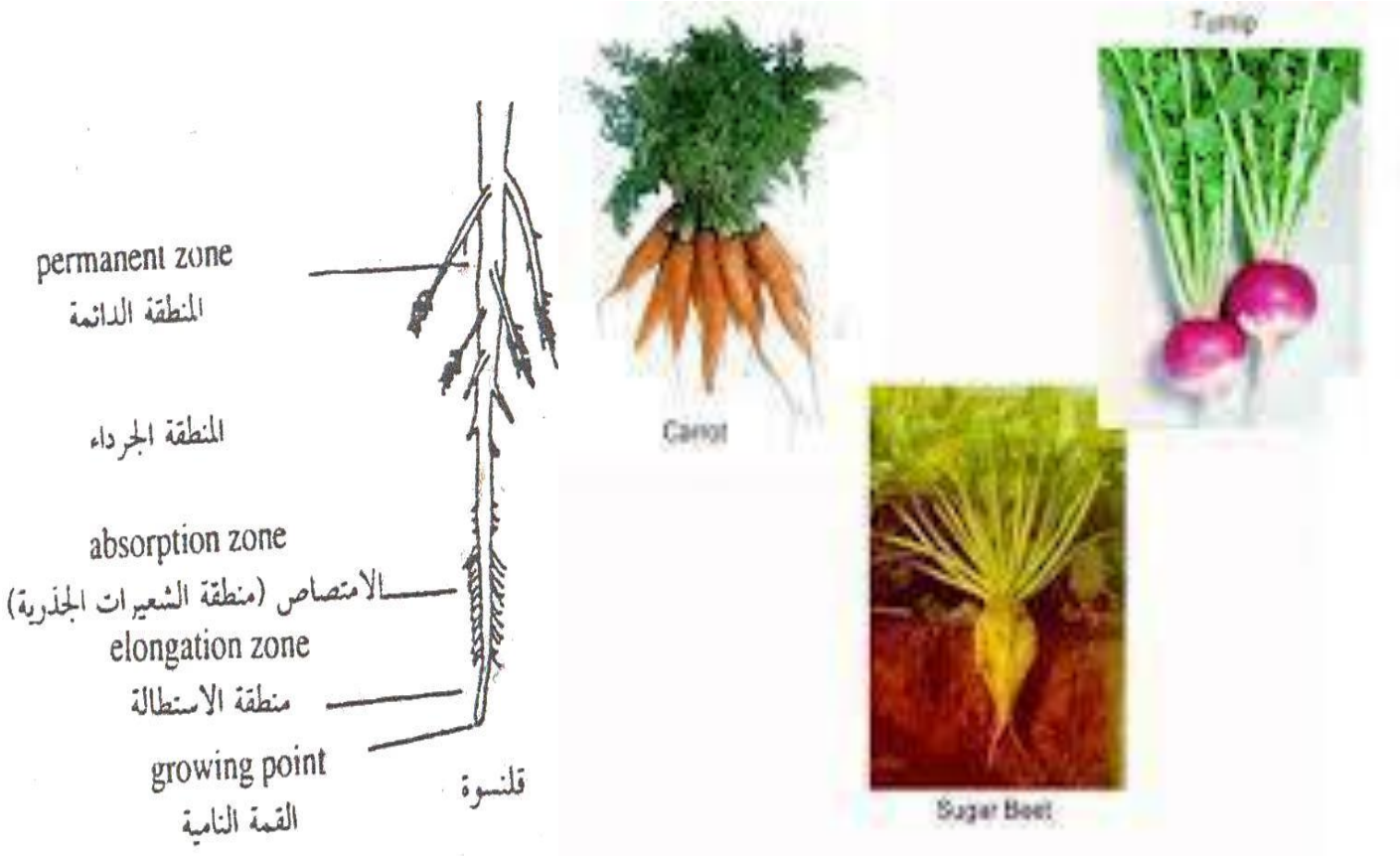
- **Root Forms:**

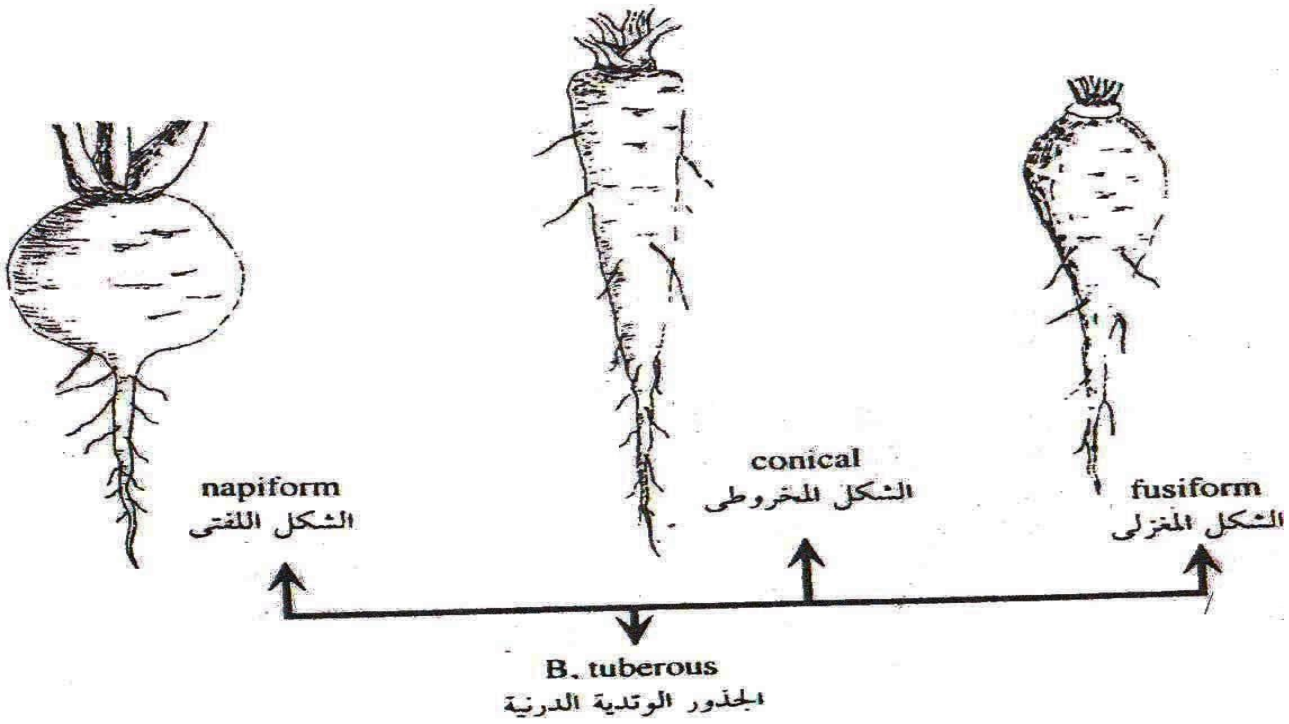
  1. **Primary Root: Originates from the embryo (radicle). It is divided into:**

     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

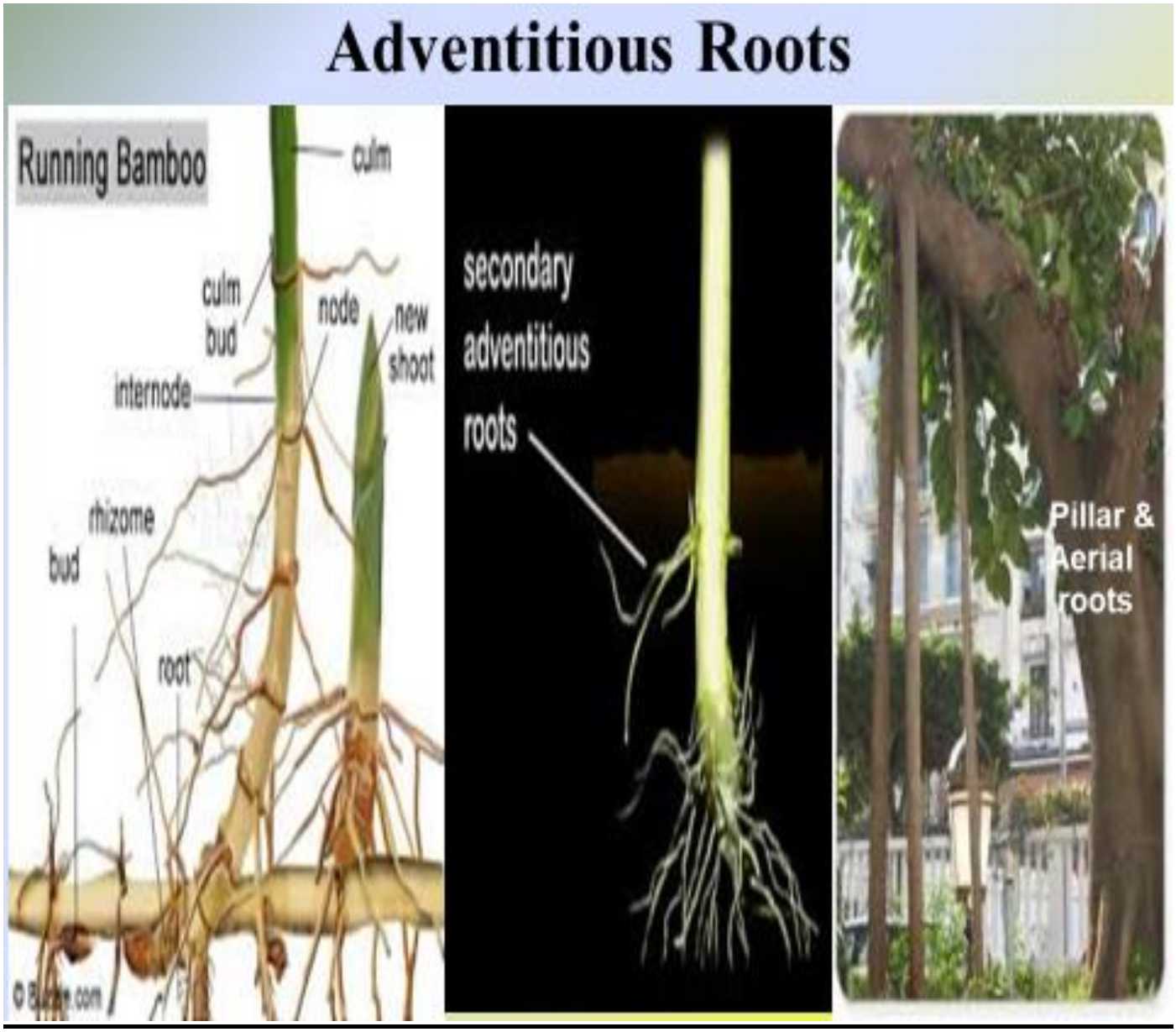
(Fig. 36) different types of tap roots.

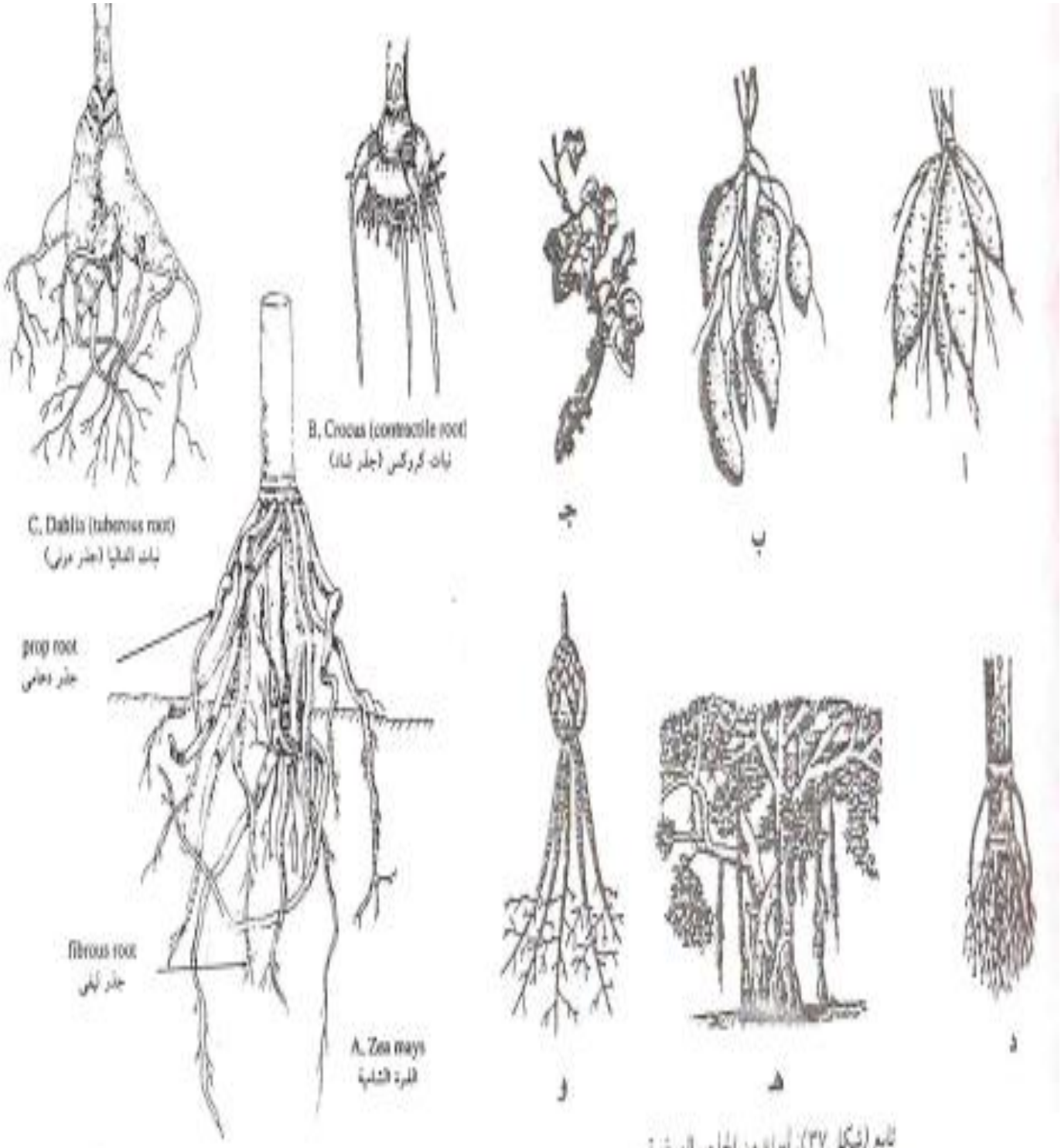
2. Adventitious Root: It arises from any parts of the plant *i.e.* stems and leaves. It is mostly found in *Monocots*. It is divided into:

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

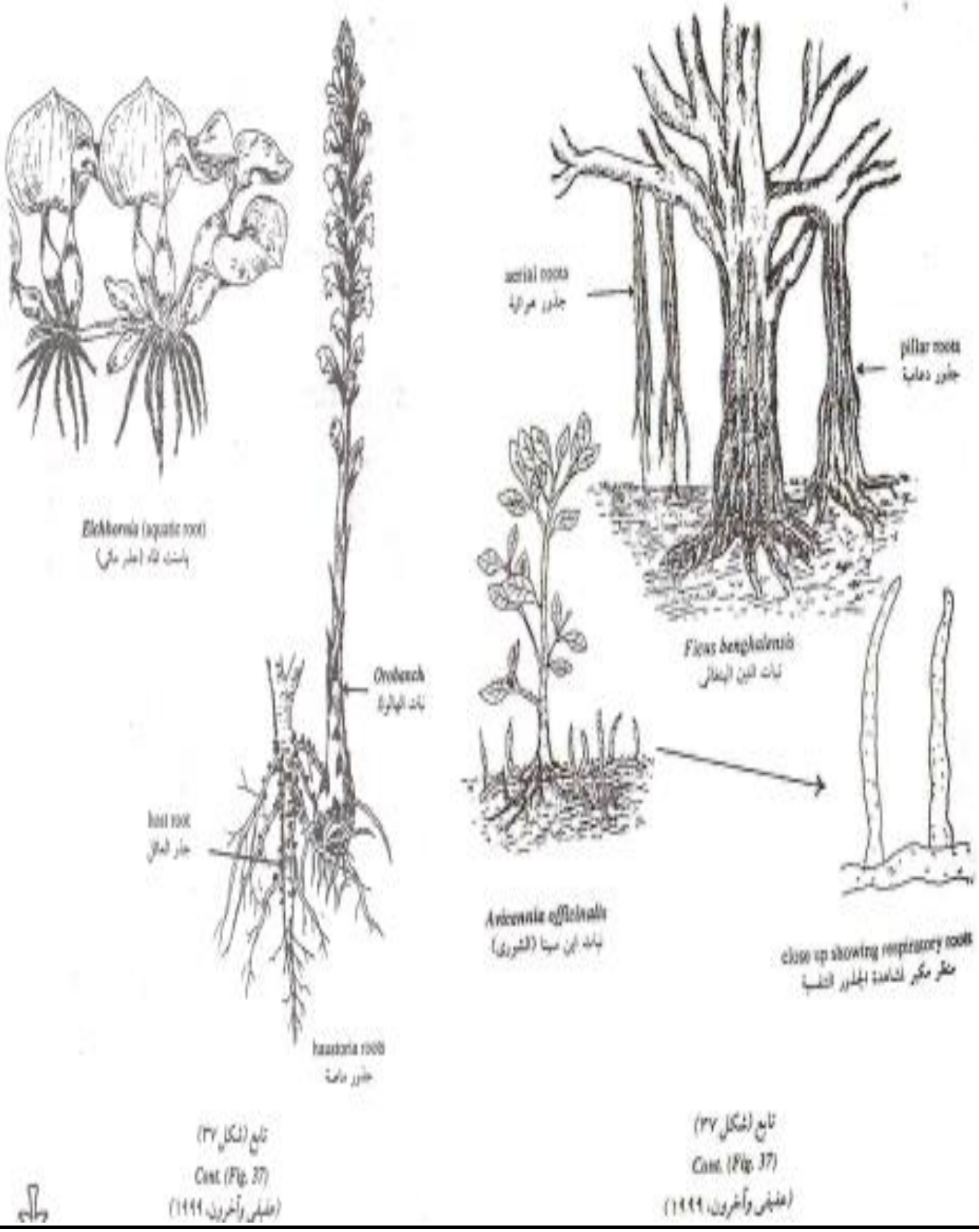
(Fig. 37) different types of adventitious roots

(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 لبنية ومساعدة
هـ- جذور هوائية دعامية
و- جذور شادّة



تابع (شكل ٣٧)

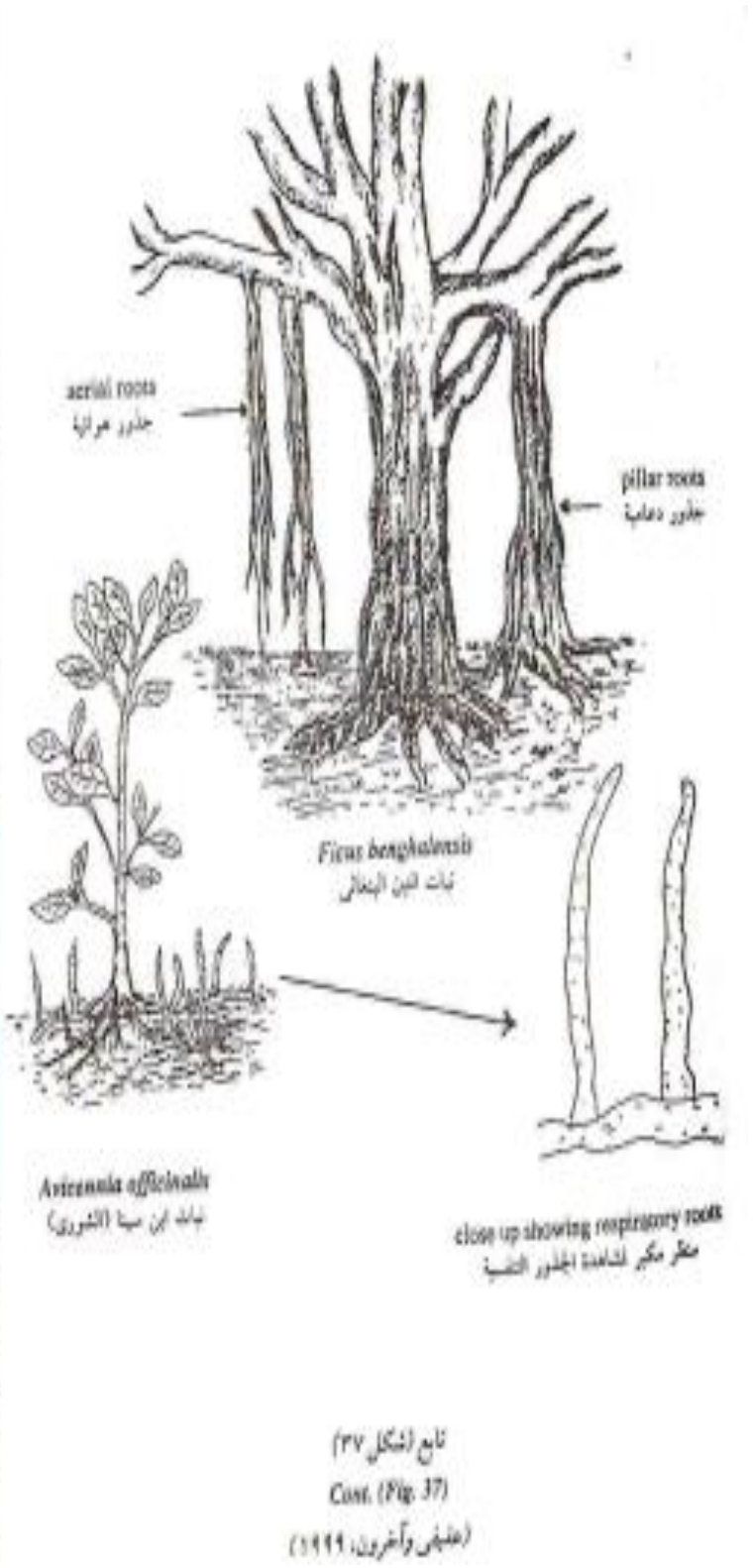
Cont. (Fig. 37)

(عفيفي وآخرون، ١٩٩٩)

تابع (شكل ٣٧)

Cont. (Fig. 37)

(عفيفي وآخرون، ١٩٩٩)



تابع (شكل ٣٧)

Cont. (Fig. 37)

(عفيفي وآخرون، ١٩٩٩)

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:

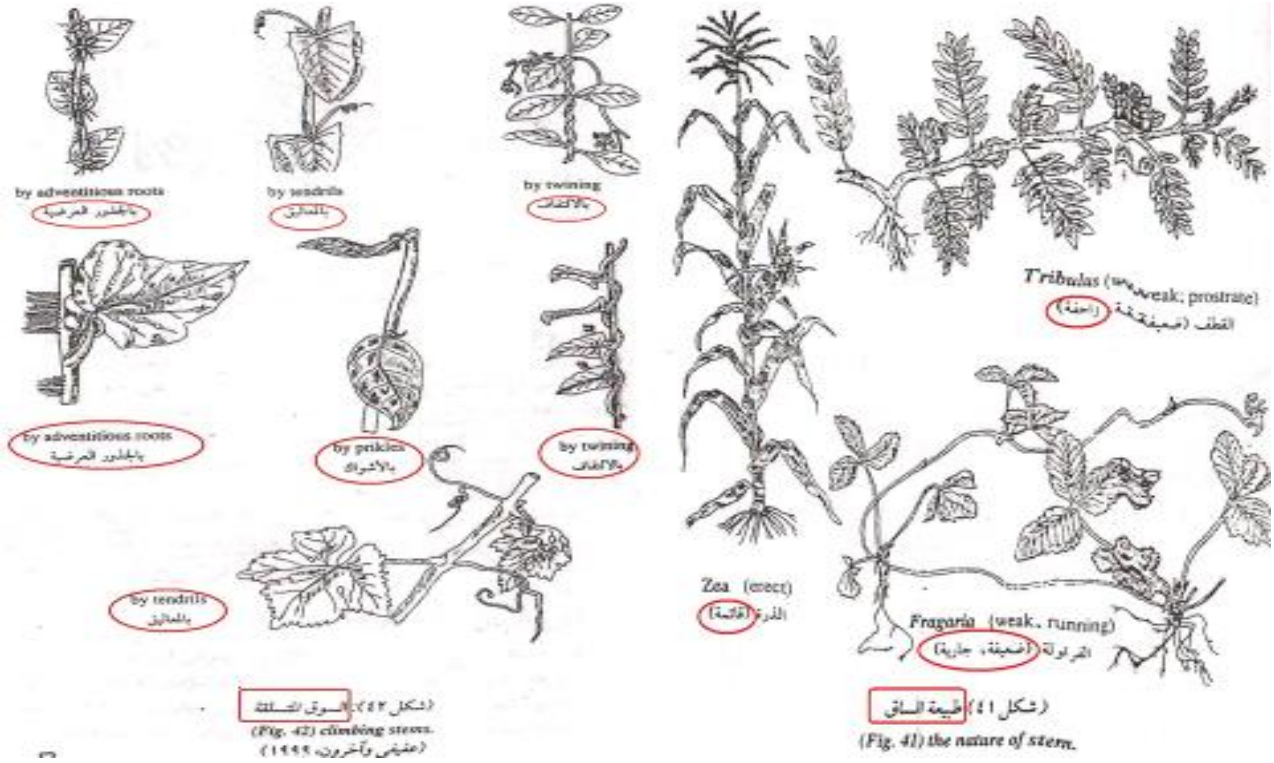
1. **Solid**
2. **Hollow**

Stem Outline:

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

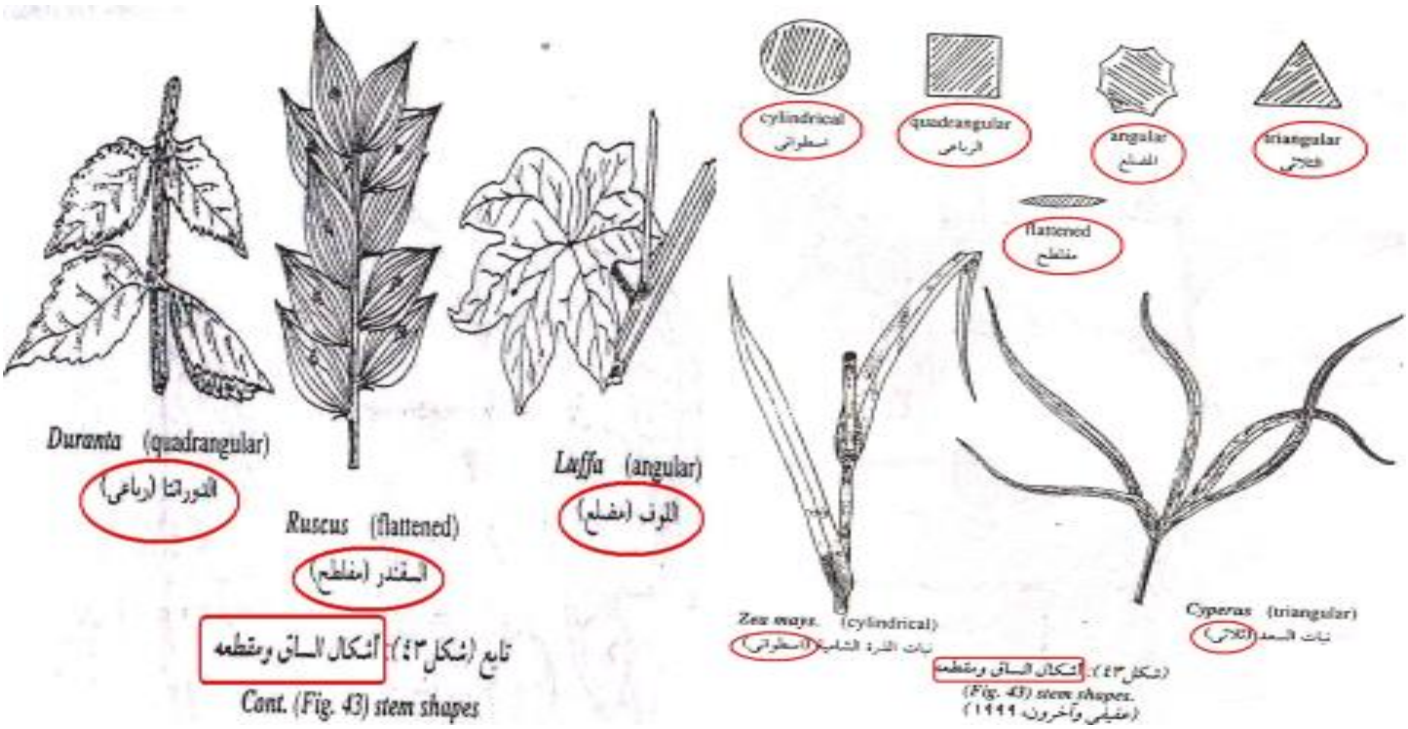
Surface:

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



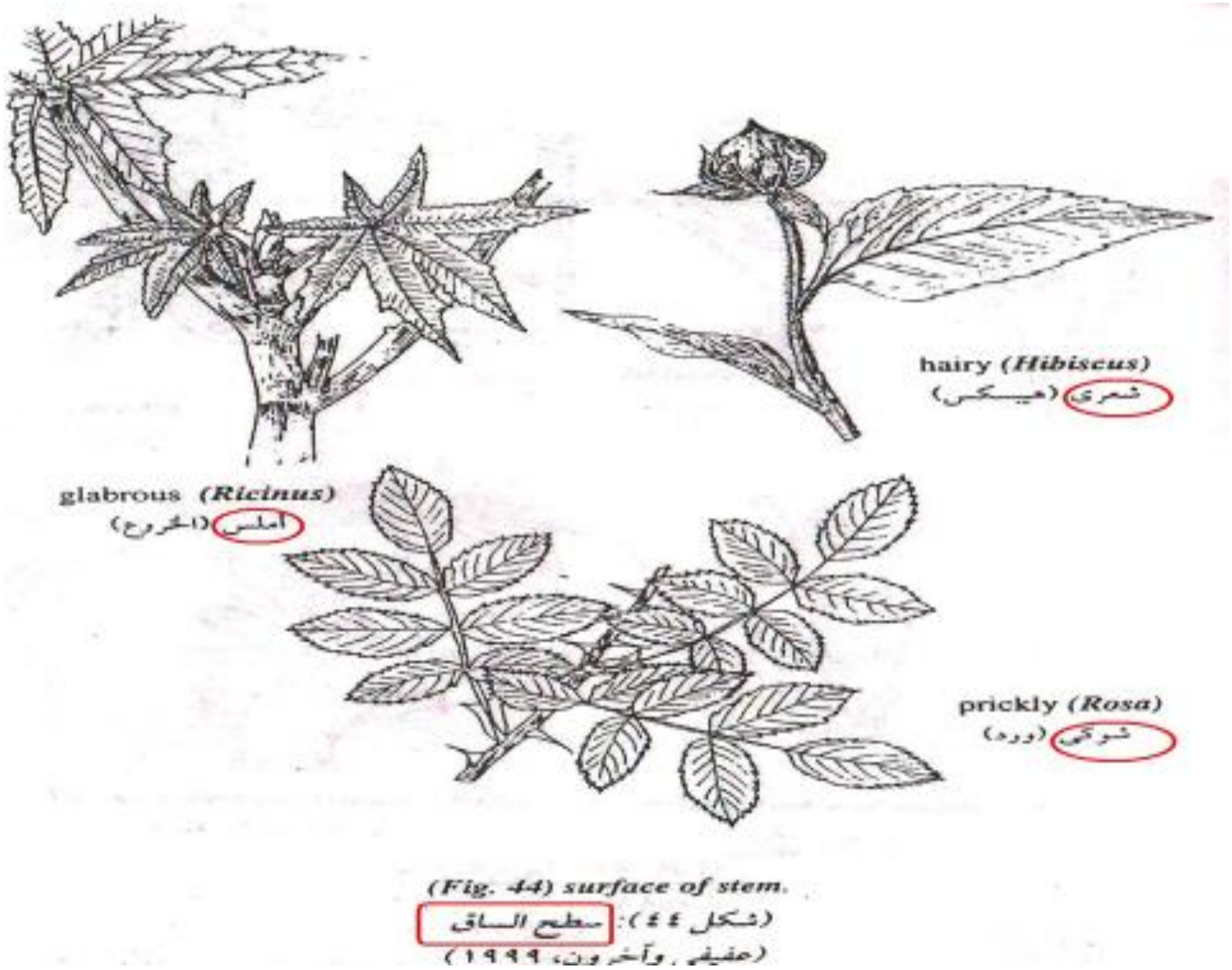
(شكل ٤٢): السوق المتسلقة
(Fig. 42) climbing stems.
(عفيفي وآخرون، ١٩٩٩)

(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)



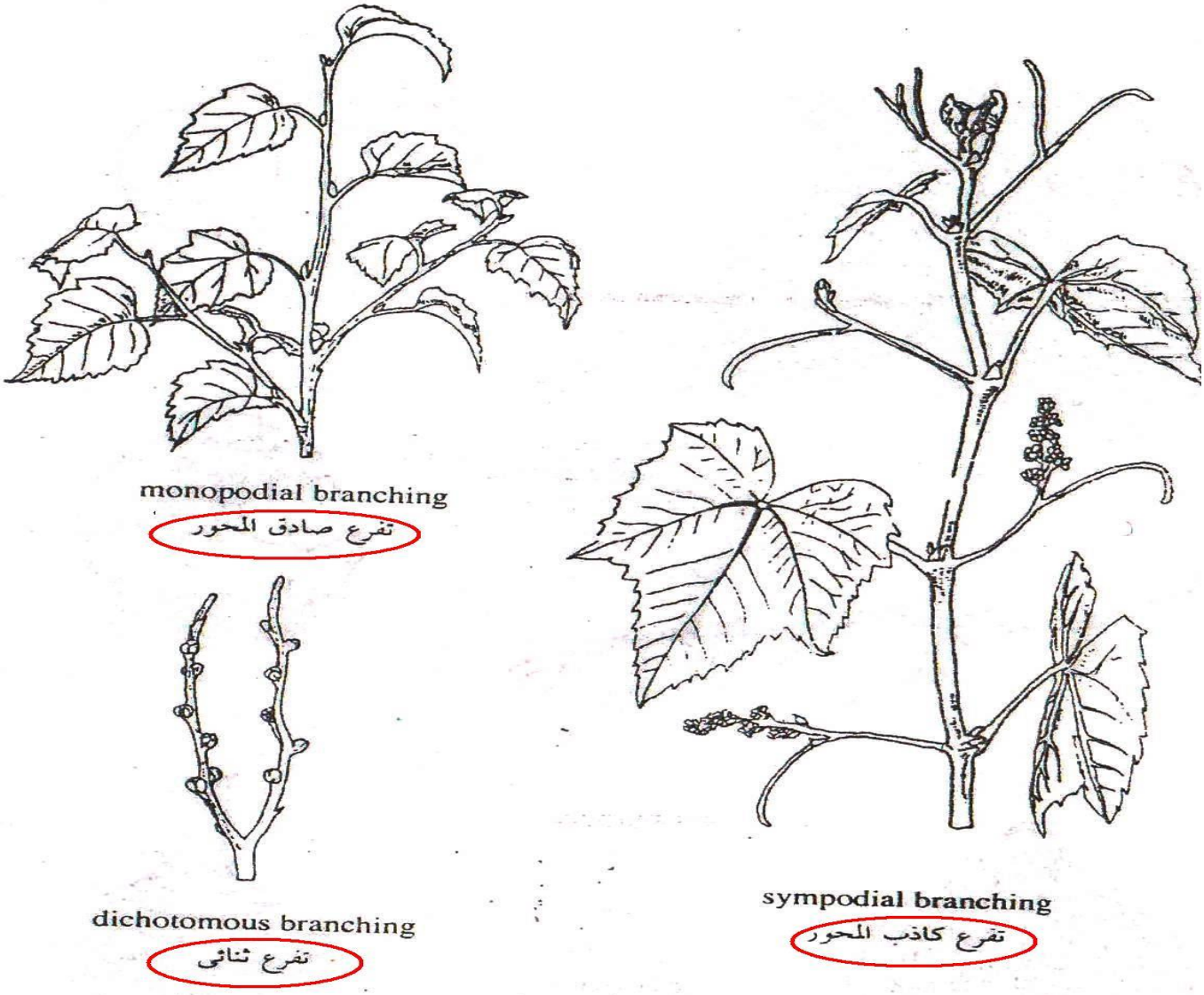
(Fig. 44) surface of stem.
(شكل ٤٤): سطح الساق
(حفيظ وآخرون، ١٩٩٩)

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

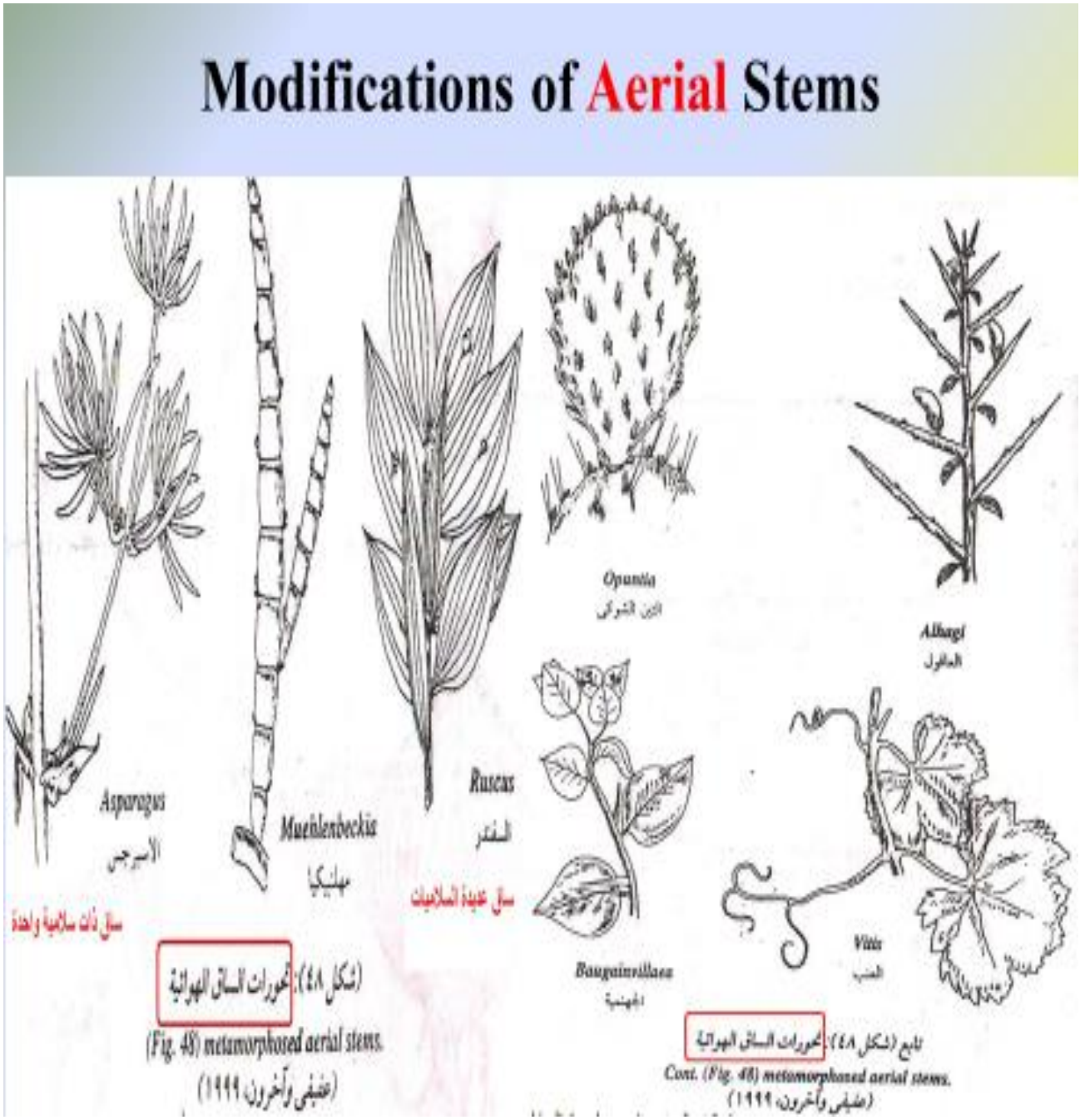
Stem Modifications:

- **Aerial:**

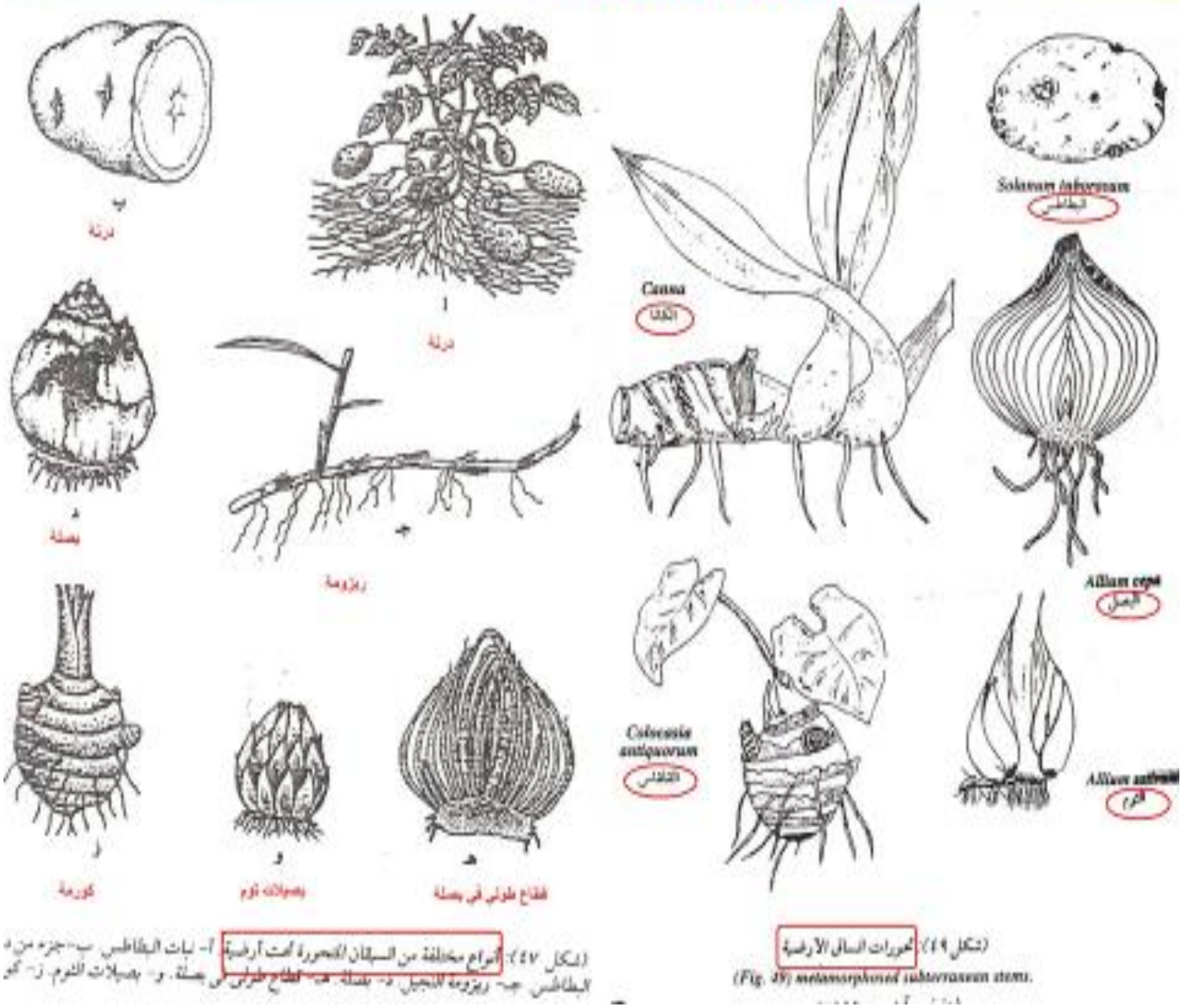
  1. **Leafy stems: Leaves are reduced to mere scales. Leaf's function is taken over by modified flat branches containing chlorophylls tissue.**
     1. **Cladode: *Asparagus***
     2. **Phylloclade: *Ruscus***
  2. **Juicy Stems: *Opuntia***
  3. **Thorny Stems: *Zilla spinosa , Alhagi***

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**



Modifications of Subterranian Stems



(شكل ٤٧): أنواع مختلفة من السيقان المحورة تحت أرضية أ- نبات البطاطس ب- جزء من درنة البطاطس جـ- ريزومة الزنجبيل د- بصلة هـ- قطاع طولي في بصلة و- بصيلات الثوم ز- كورمة

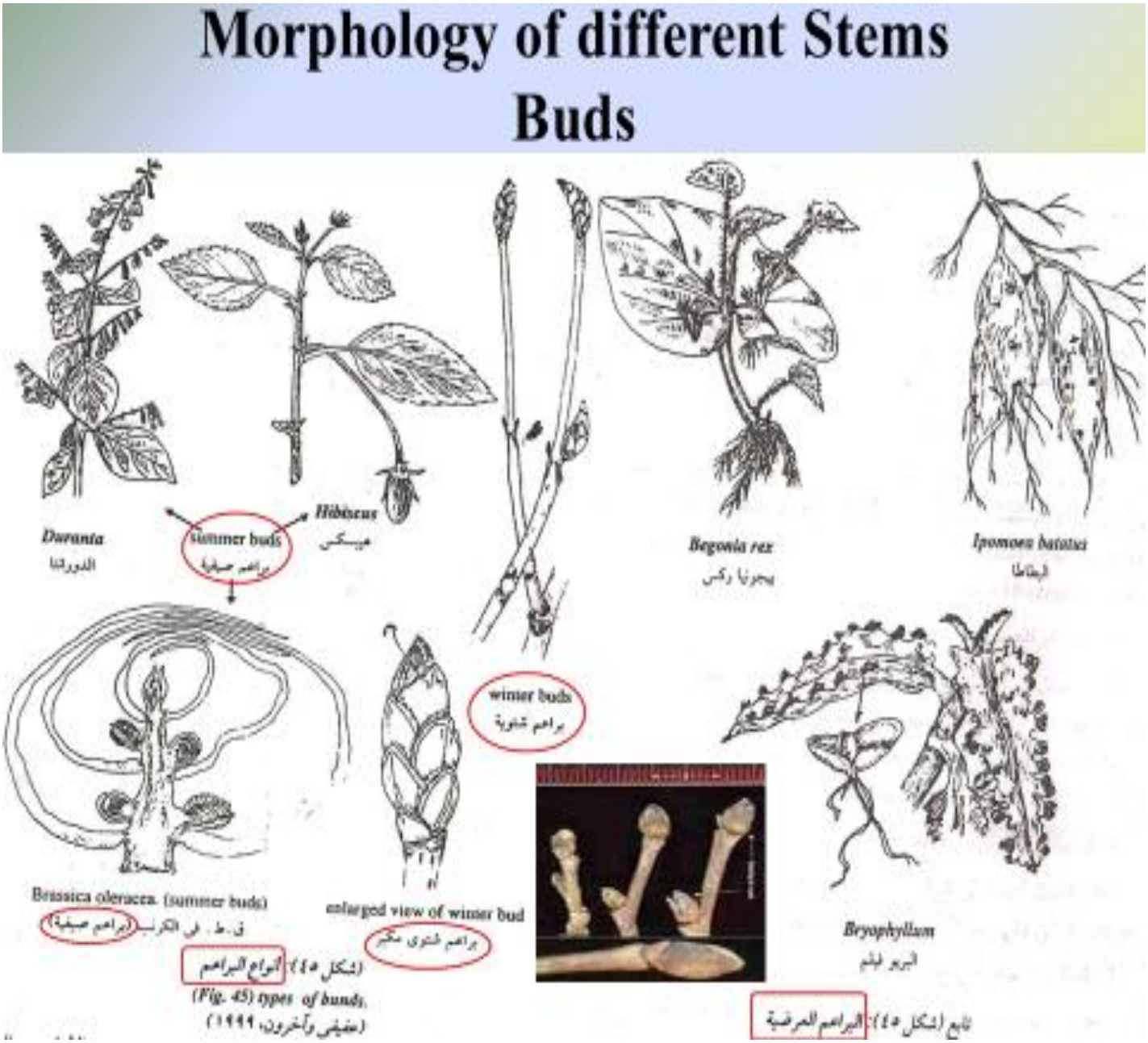
(شكل ٤٩): محورات الساق الأرضية
(Fig. 49) metamorphosed subterranean stem.

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.**

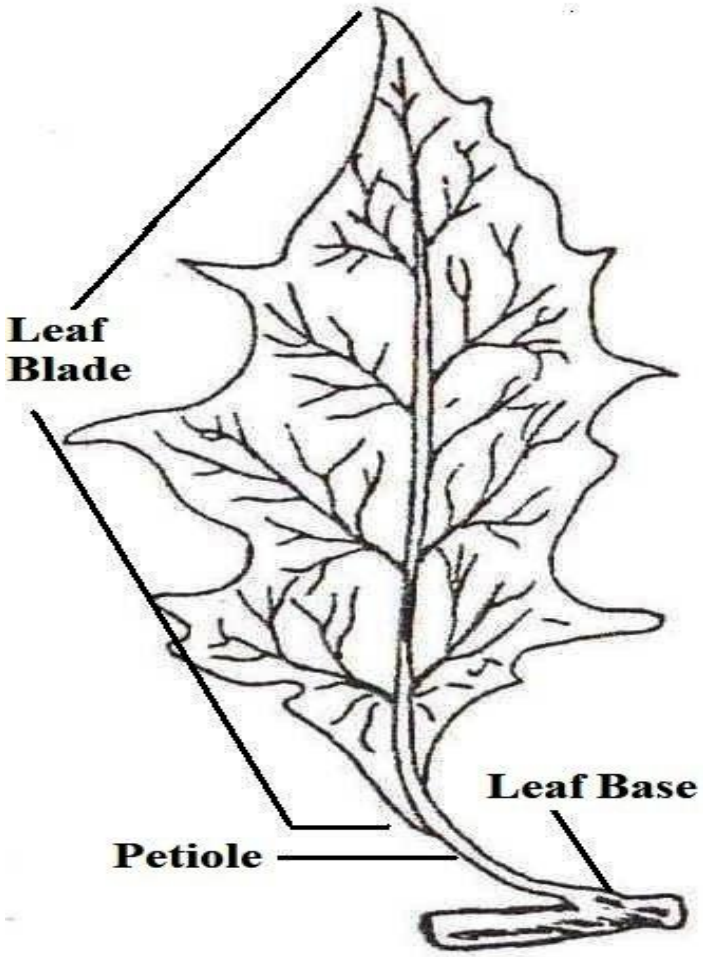
- **<u>Position:</u>**
  1. **Terminal: At the Apex of the stem**
  2. **Axillary: At the axis of the leaf.**
     - **<u>Cladode</u>**
     - **<u>Phylloclade</u>**



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)**



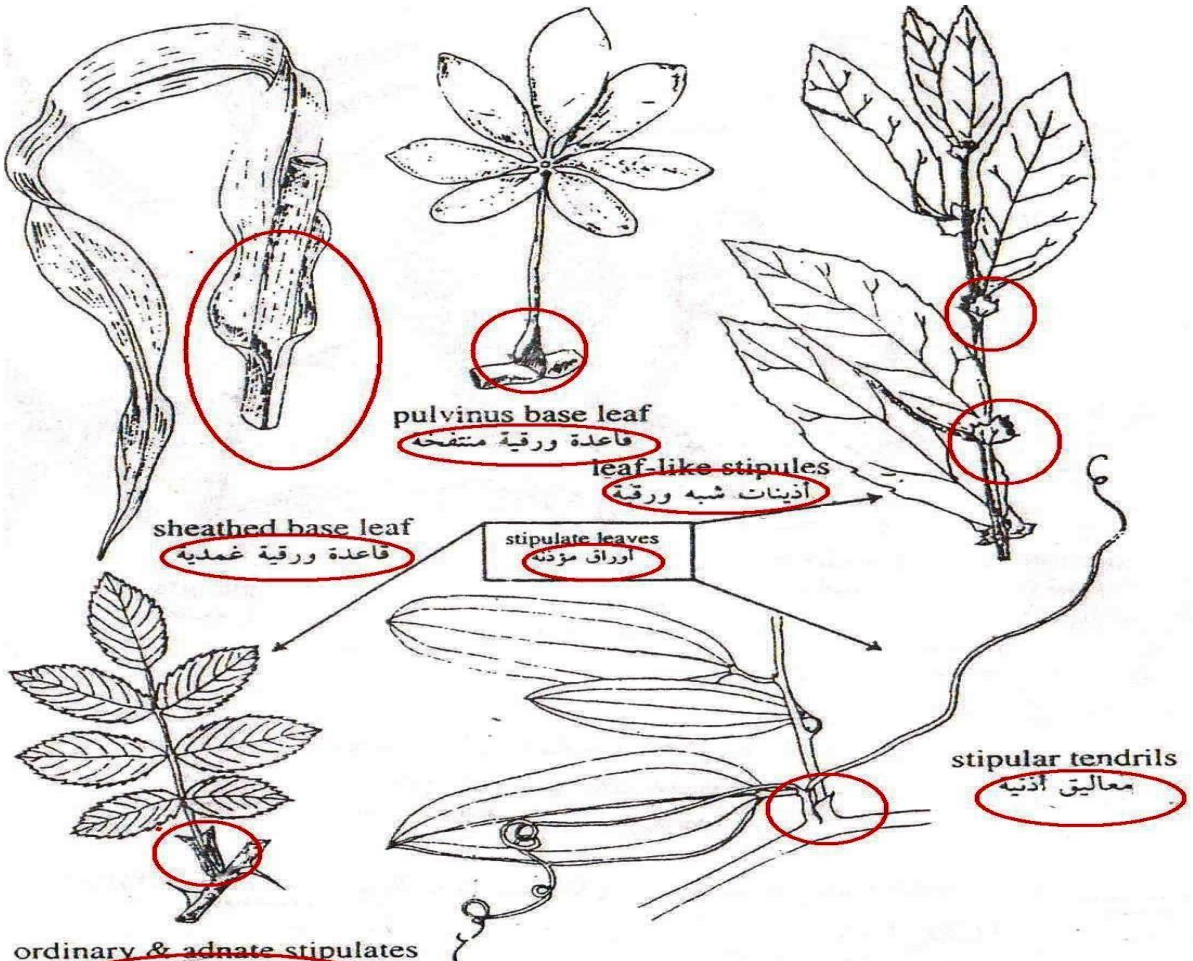
1. Leaf Base:

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**

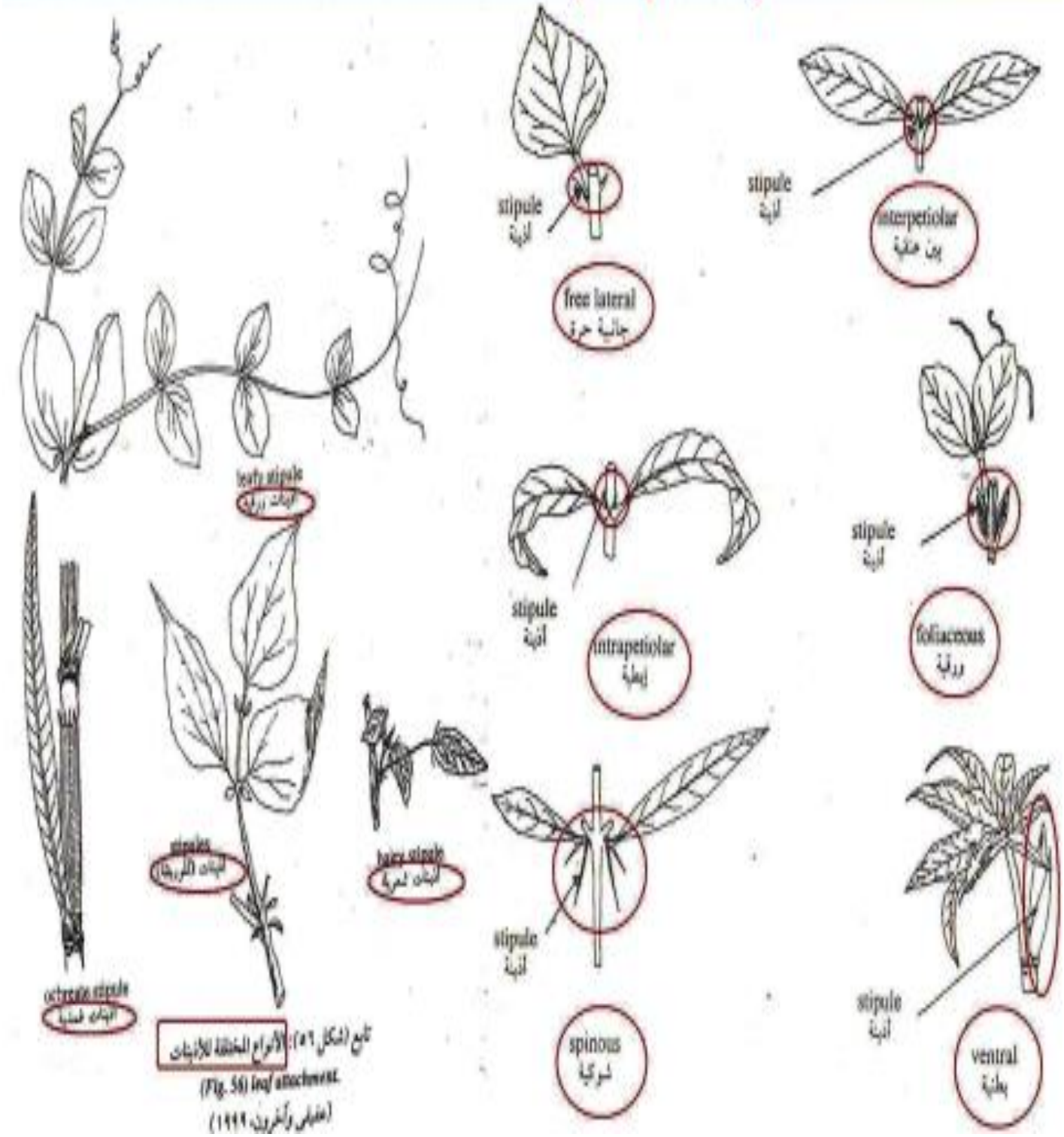
- **Stipules:**
  They frequently developed from the leaf base, forming a pair. Types of which are:
  1.Exstipulate
  2.Stipulate:
  - **Hairy**
  - **Foliaceous**
  - **Tendrillar**
  - **Spinous**
  - **Adnate**
  - **Ochreate**



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

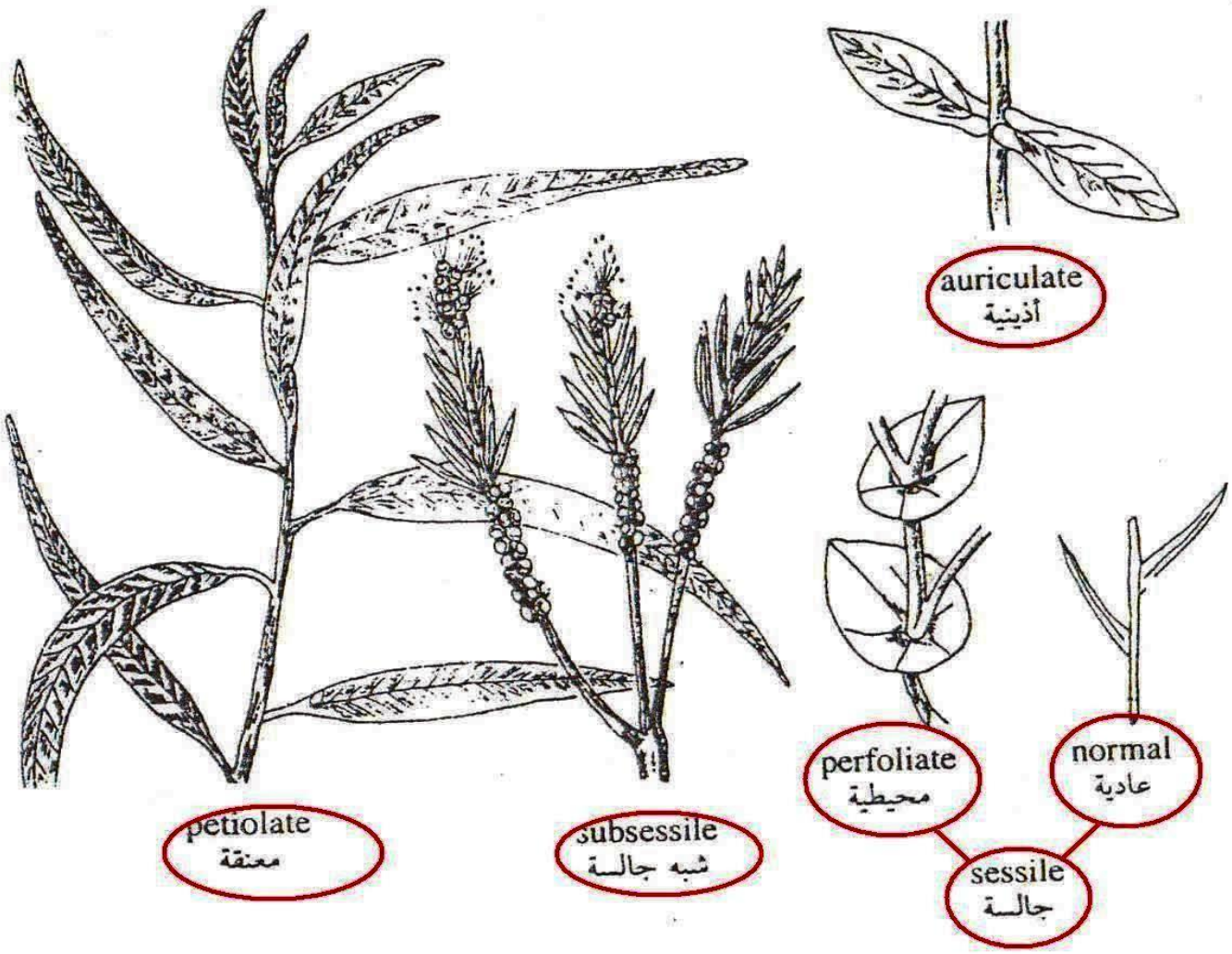
Leaf parts

1. Leaf Base (Stipules)



تابع (شكل ٥٦): الأنواع المختلفة للإذينات
(Fig. 56) leaf attachment.
(عفيفي وآخرون، ١٩٩٩)

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



(شكل ٥٦): اتصال الأوراق بالساق

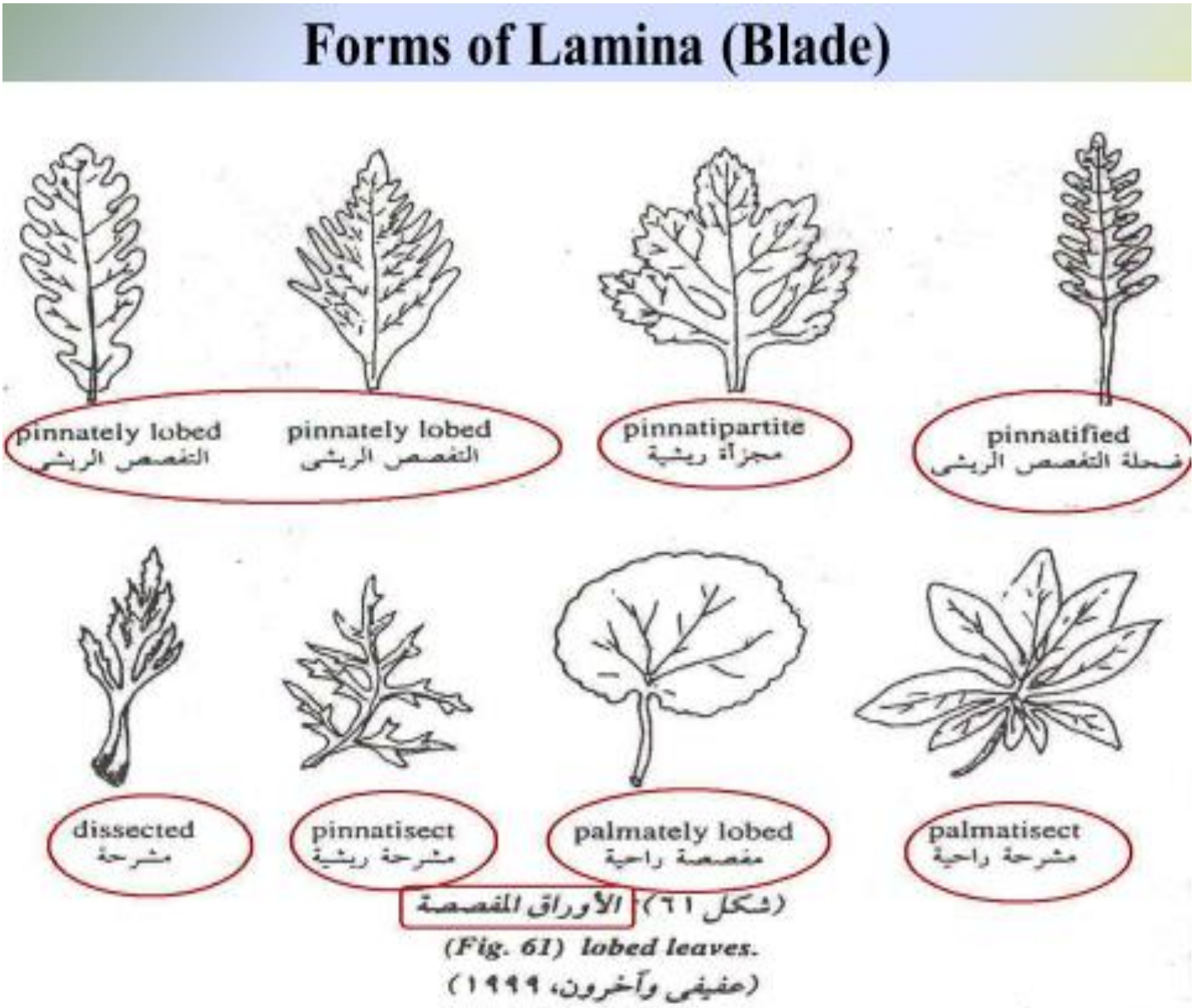
(Fig. 56) leaf attachment.

(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.**

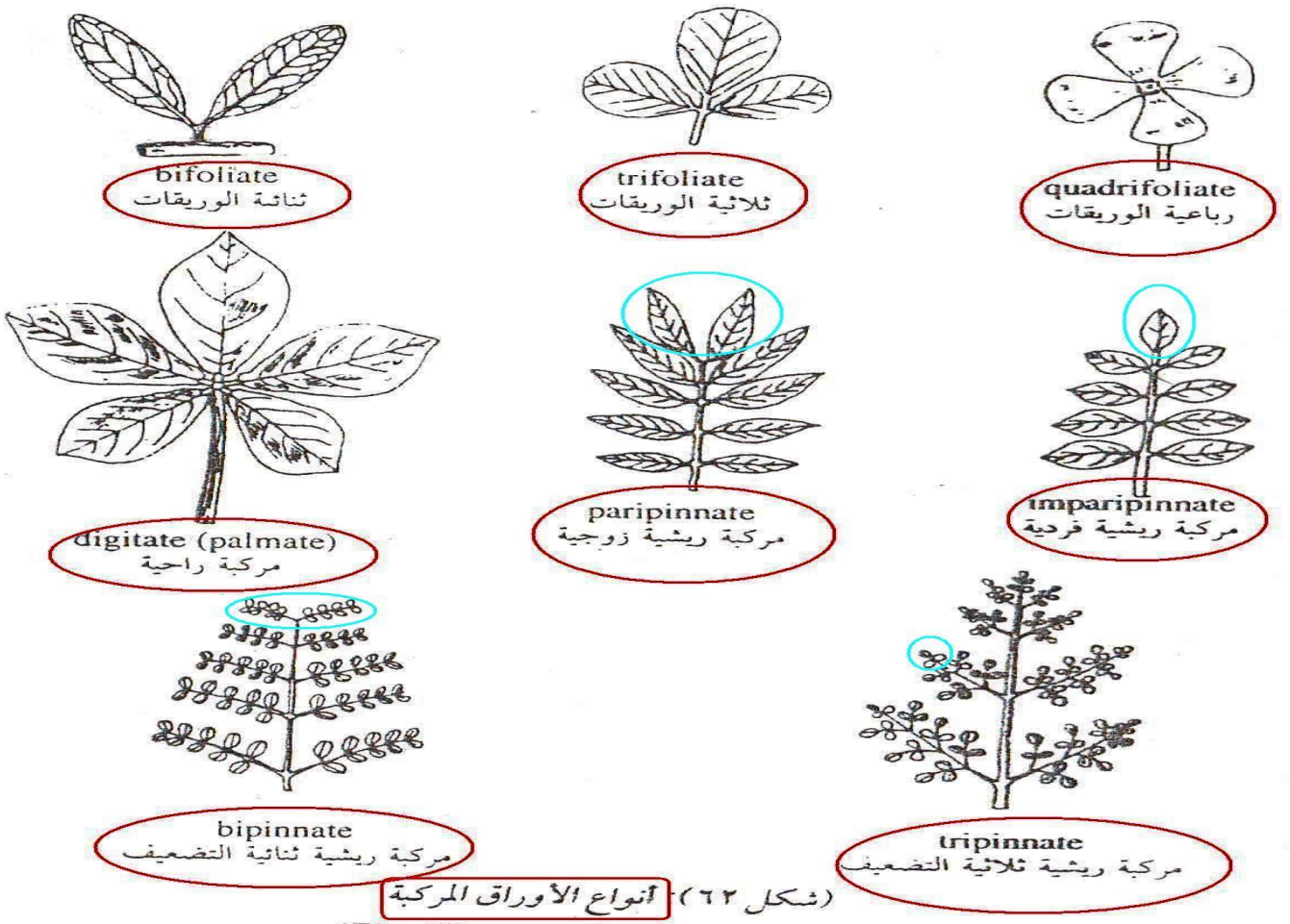
3. **<u>Dissectified:</u> Complete deep divisions (Close to the midrib).**
4. **<u>Palmate:</u> They are palm-like. If the incisions are less than half the distance between the margin and the midrib *i.e.* Palmatified, but if they are more than half *i.e.* Palmatisect.**
5. **<u>Pinnate:</u> If incisions 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)



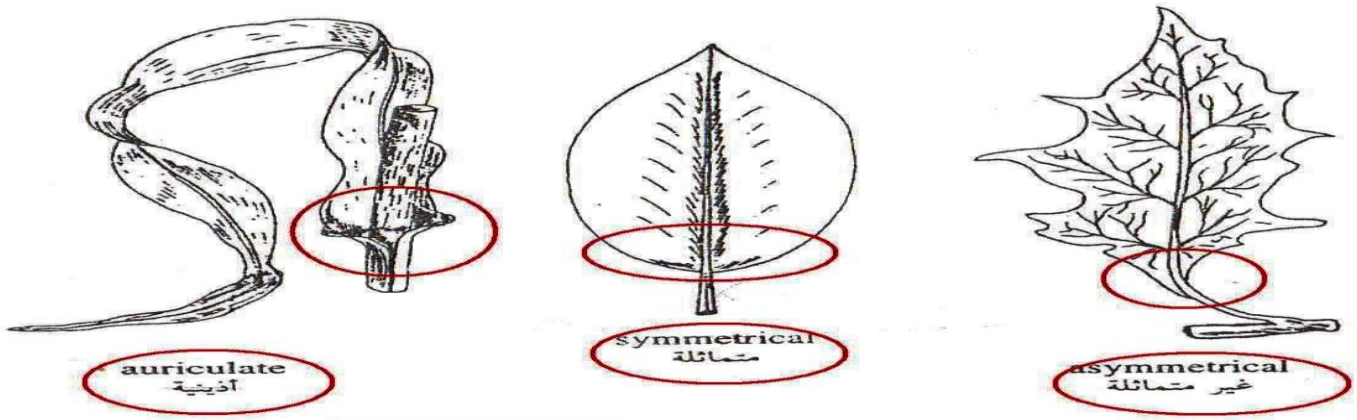
أنواع الأوراق المركبة (شكل ٦٢)

(Fig. 62) types of compound leaves.

Lamina

1. **Base Of Lamina:**

   Symmetrical, Asymmetrical or Auriculate



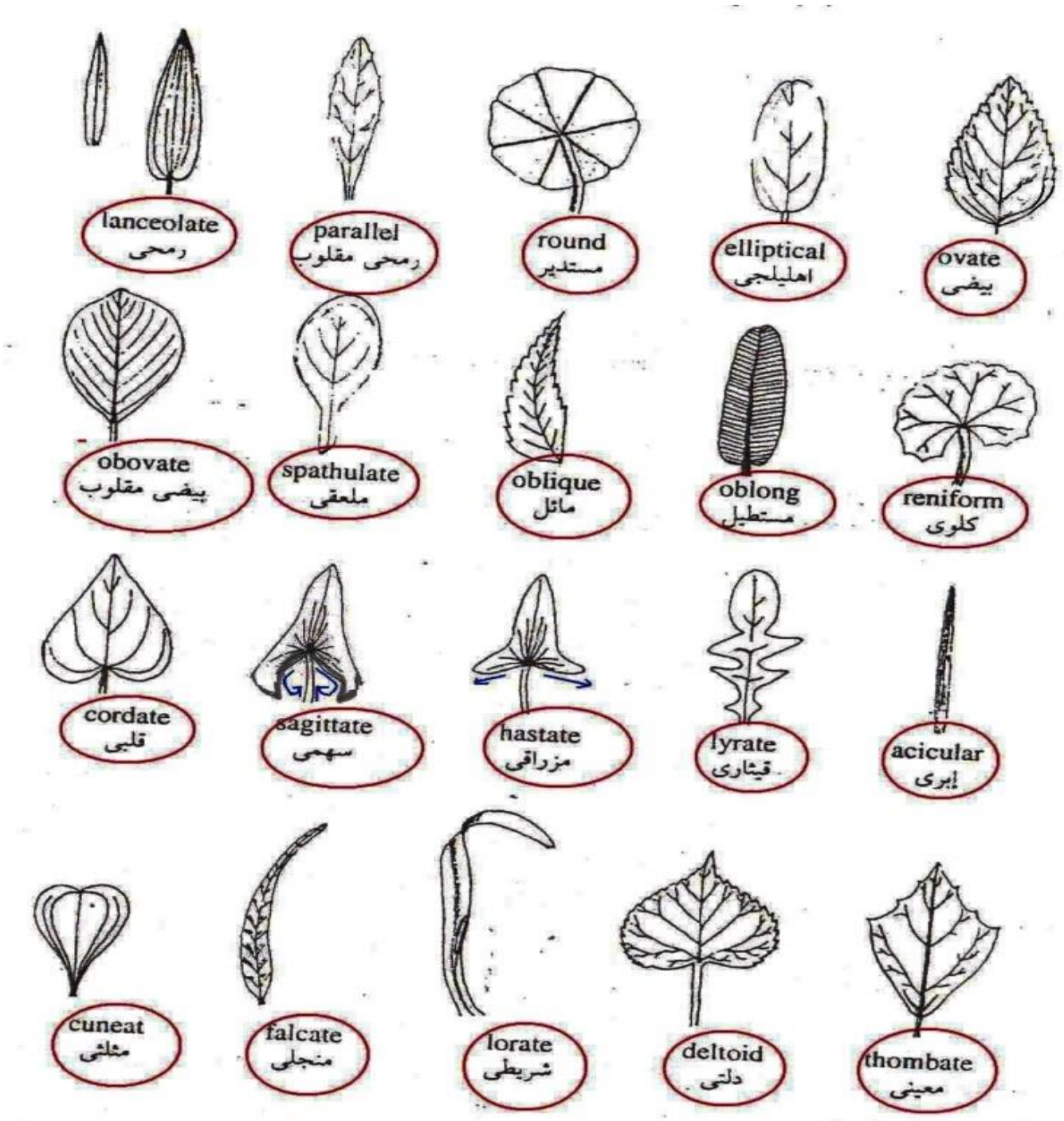
تابع (شكل ٥٥): أشكال قاعدة نصل الورقة

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

(عفيفي وآخرون، ١٩٩٩)

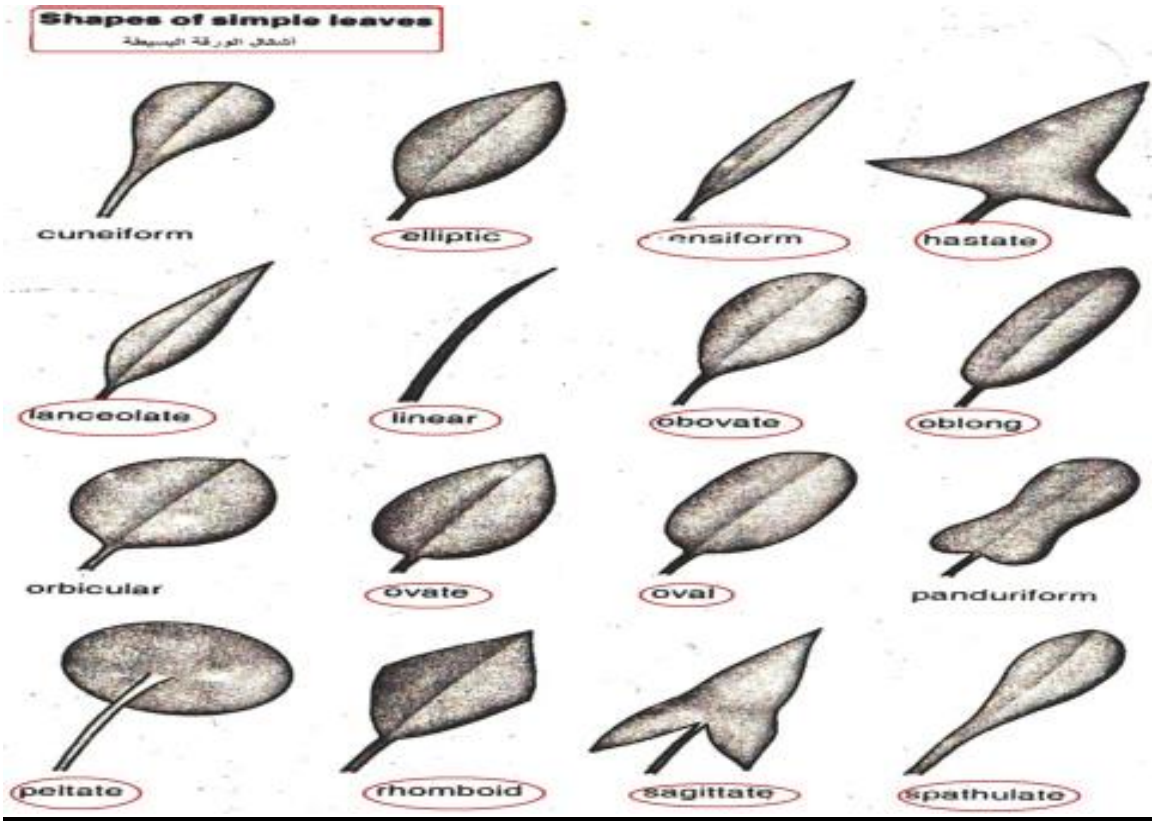
Shape Of Lamina:

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



(شكل ٥٨): أشكال نصل الورقة

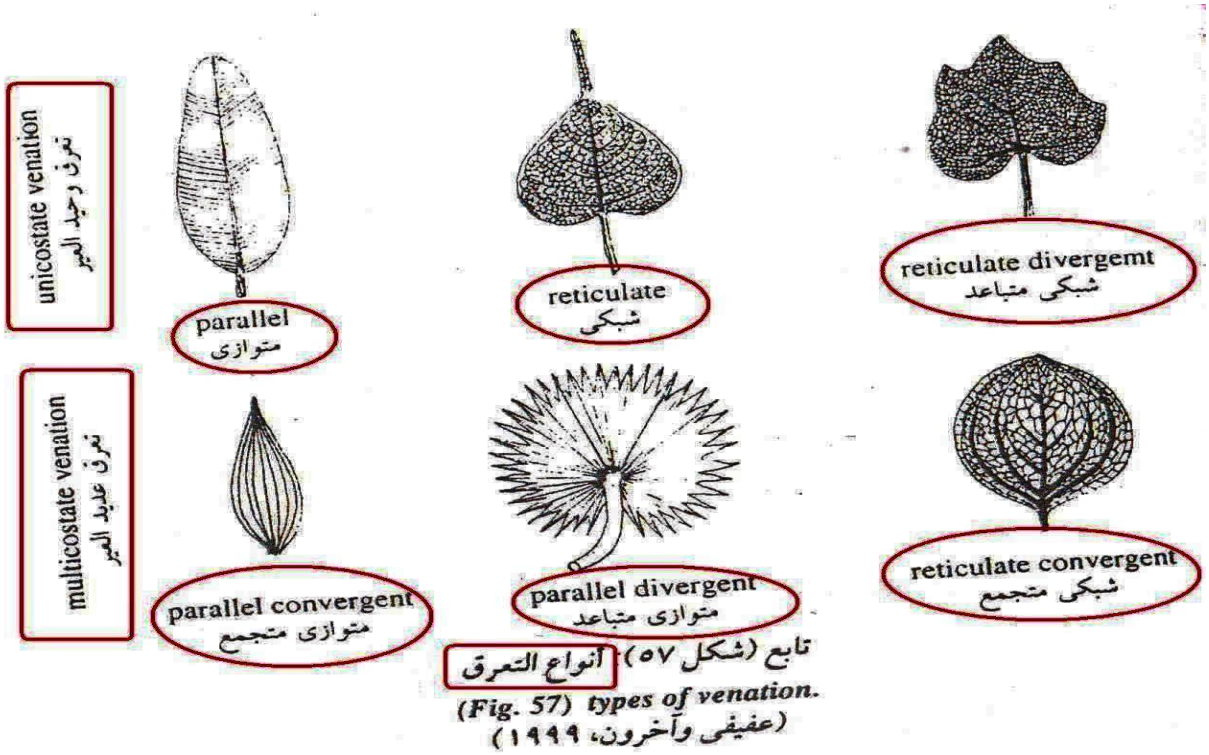
(Fig. 58) leaf shapes.



3. Leaf Vennation:

1. Reticulate

2.Parallel:(Longitudinal or Transverse)

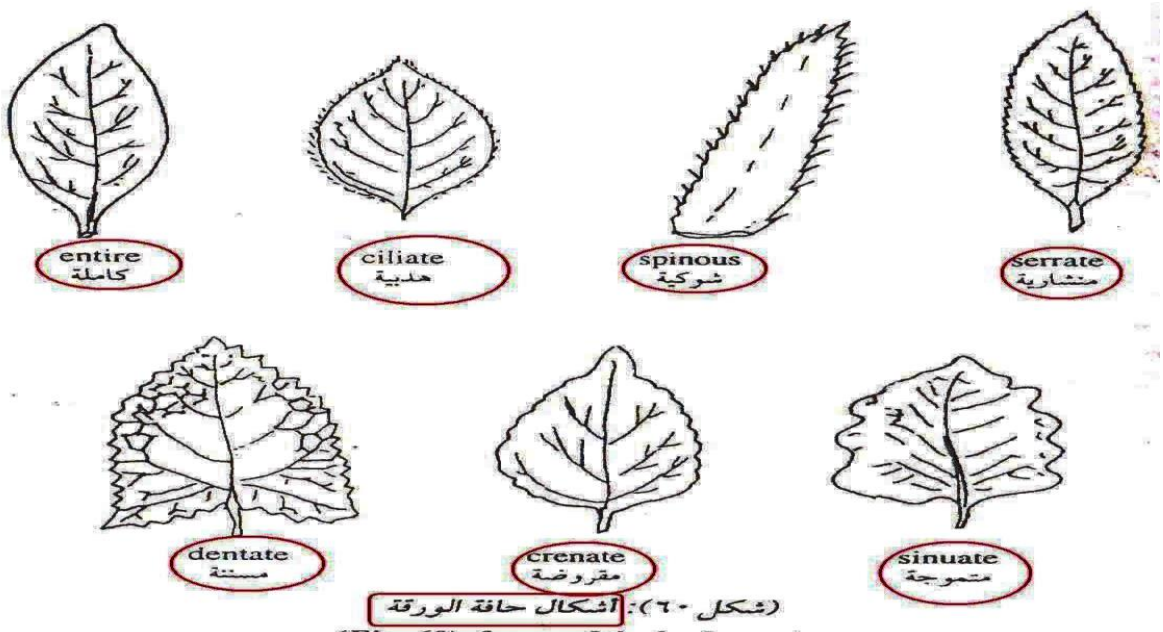


أنواع التعرق تابع (شكل ٥٧)

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

4. Margin Of Lamina:

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



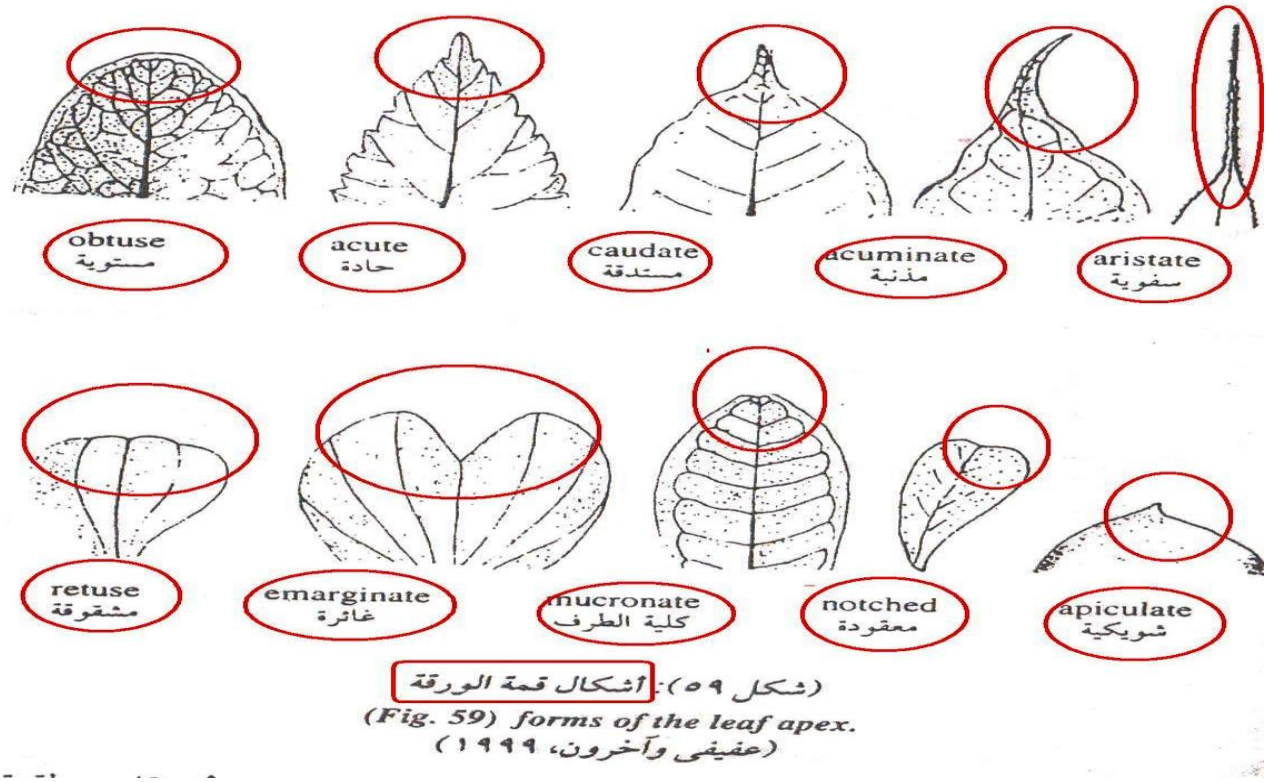
(شكل ٦٠): أشكال حافة الورقة

(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…



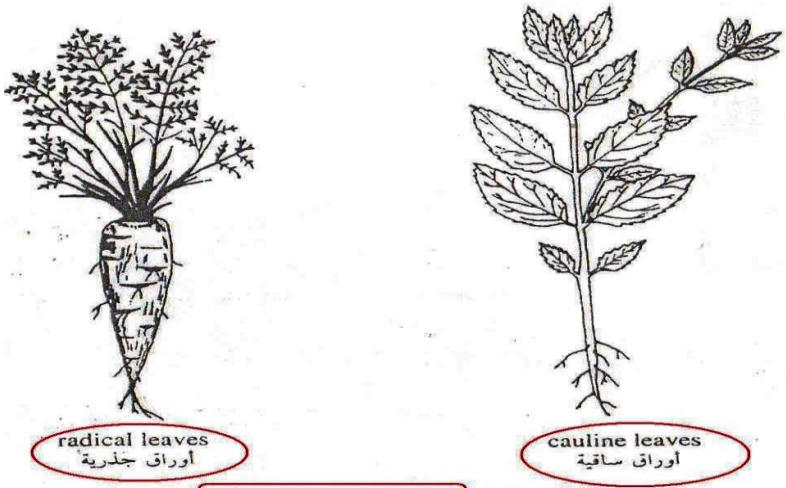
(شكل ٥٩): أشكال قمة الورقة

(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**

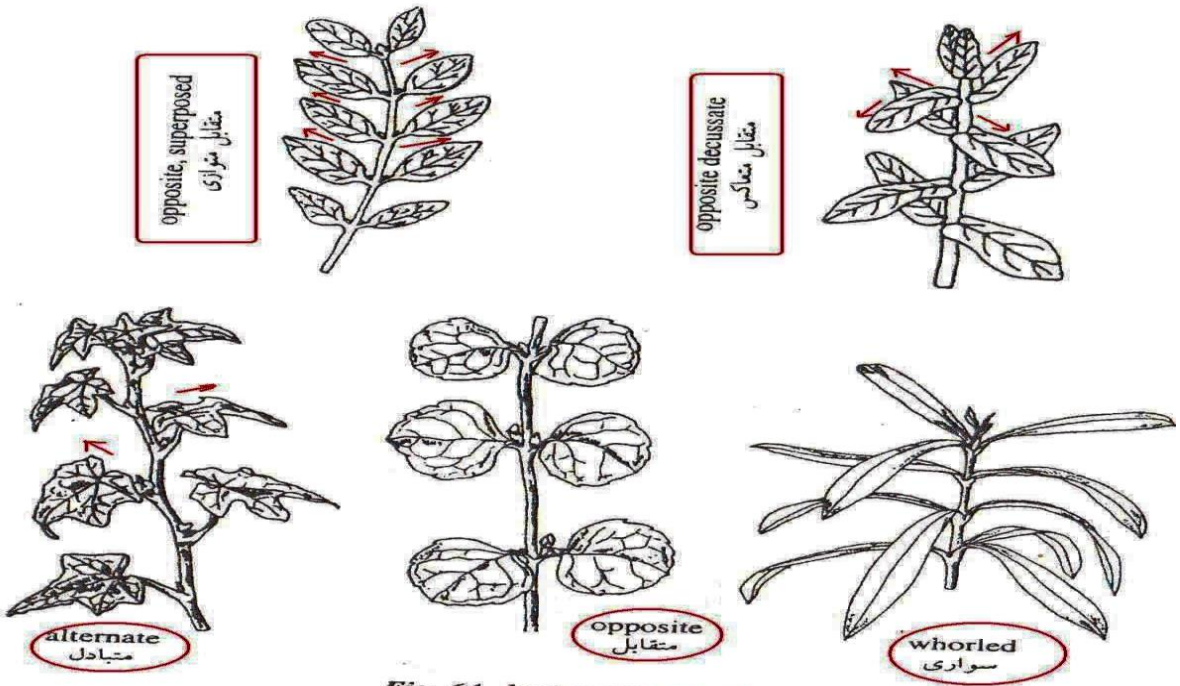


Fig. 64, leaf arrangement.

(شكل ٦٤): نظام الأوراق (ترتيب الأوراق)

Leaf Duration

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

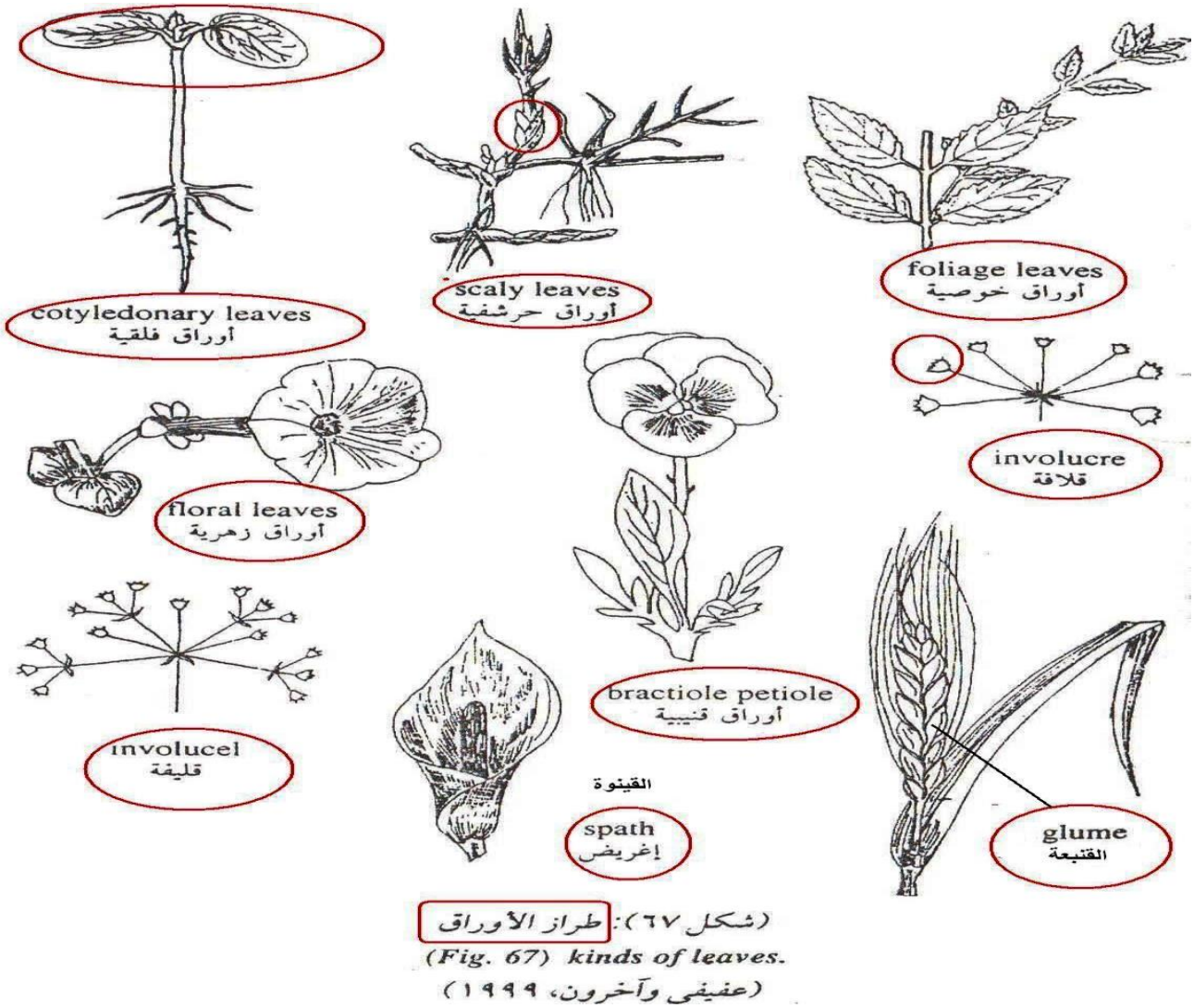
(شكل ٦٥): عمر الورقة

(Fig. 65) duration of the leaf.

Leaf forms

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

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



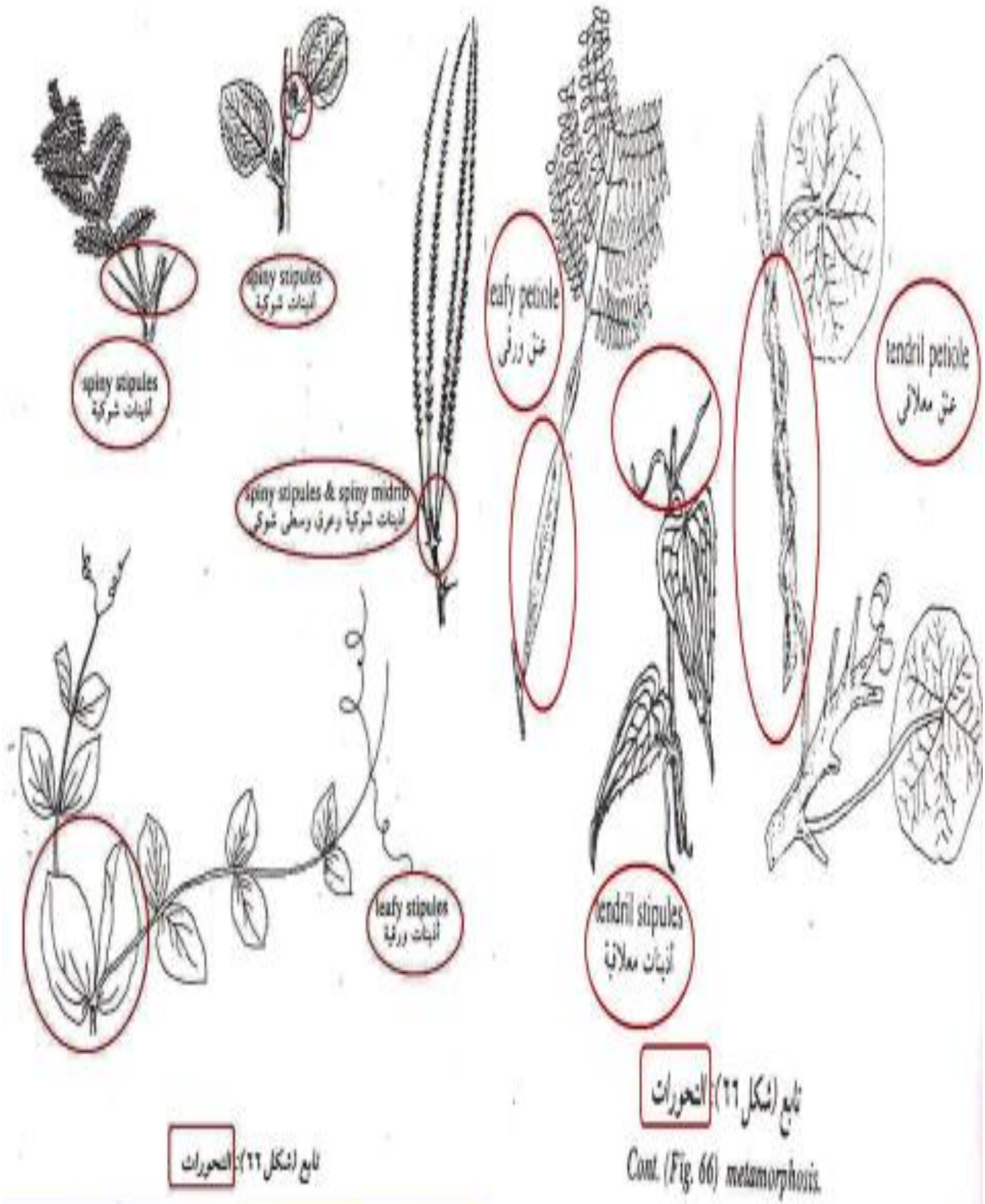
(شكل ٦٧): طراز الأوراق
(Fig. 67) kinds of leaves.
(عفيفى وآخرون، ١٩٩٩)

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

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

(شكل ٦٦): بعض أنواع تحورات الورقة

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



تابع (شكل ٦٦): التحورات

Cont. (Fig. 66) metamorphosis.

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4. **Megahed *et al.*(1996). General Botany. Anglo Press. 7th edition.**
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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: 2 hours**
2. **Lab: 2 hours**