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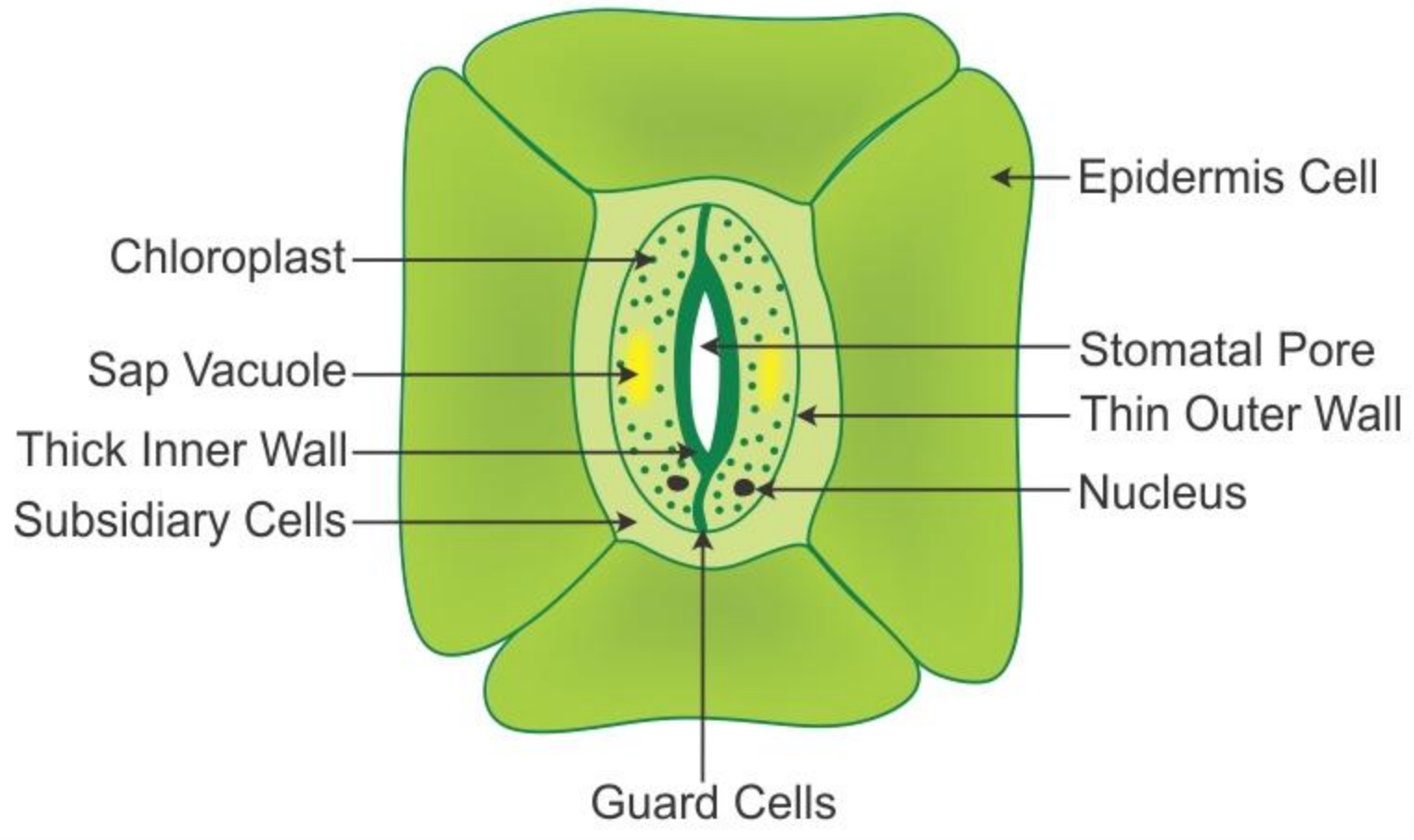
Department of Botany



**CLASS SYBSc Bo .245 Plant Anatomy and Embryology Paper I Term II**

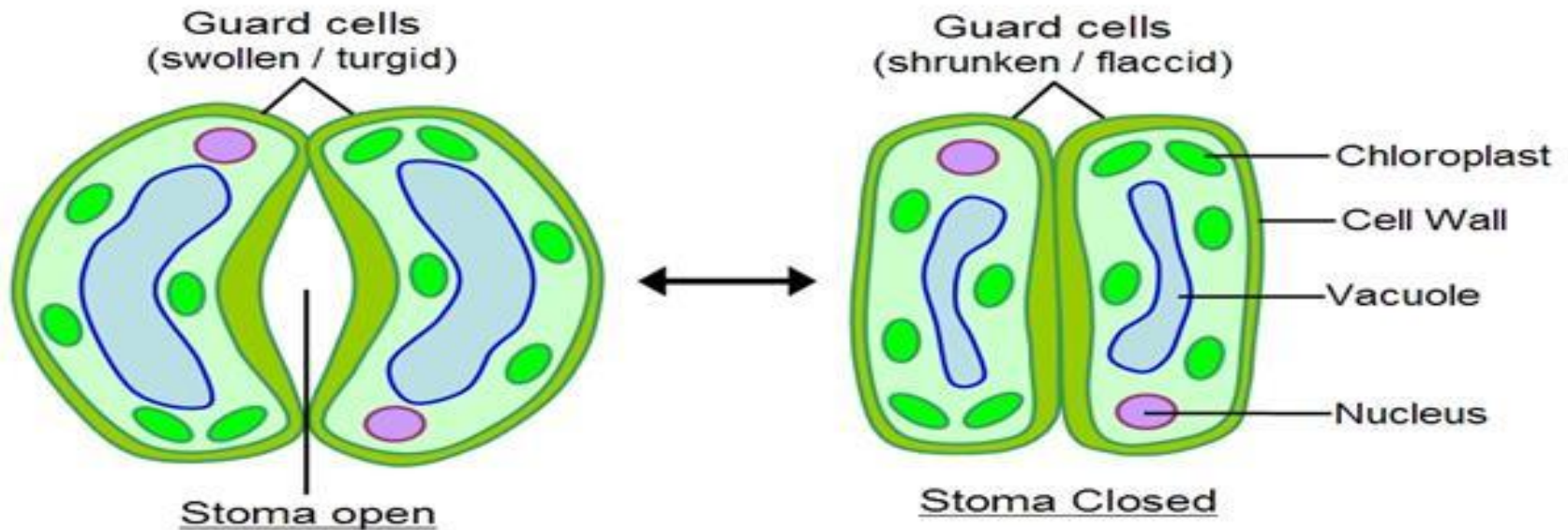
**Topic: Stomata Structure Types Functions**

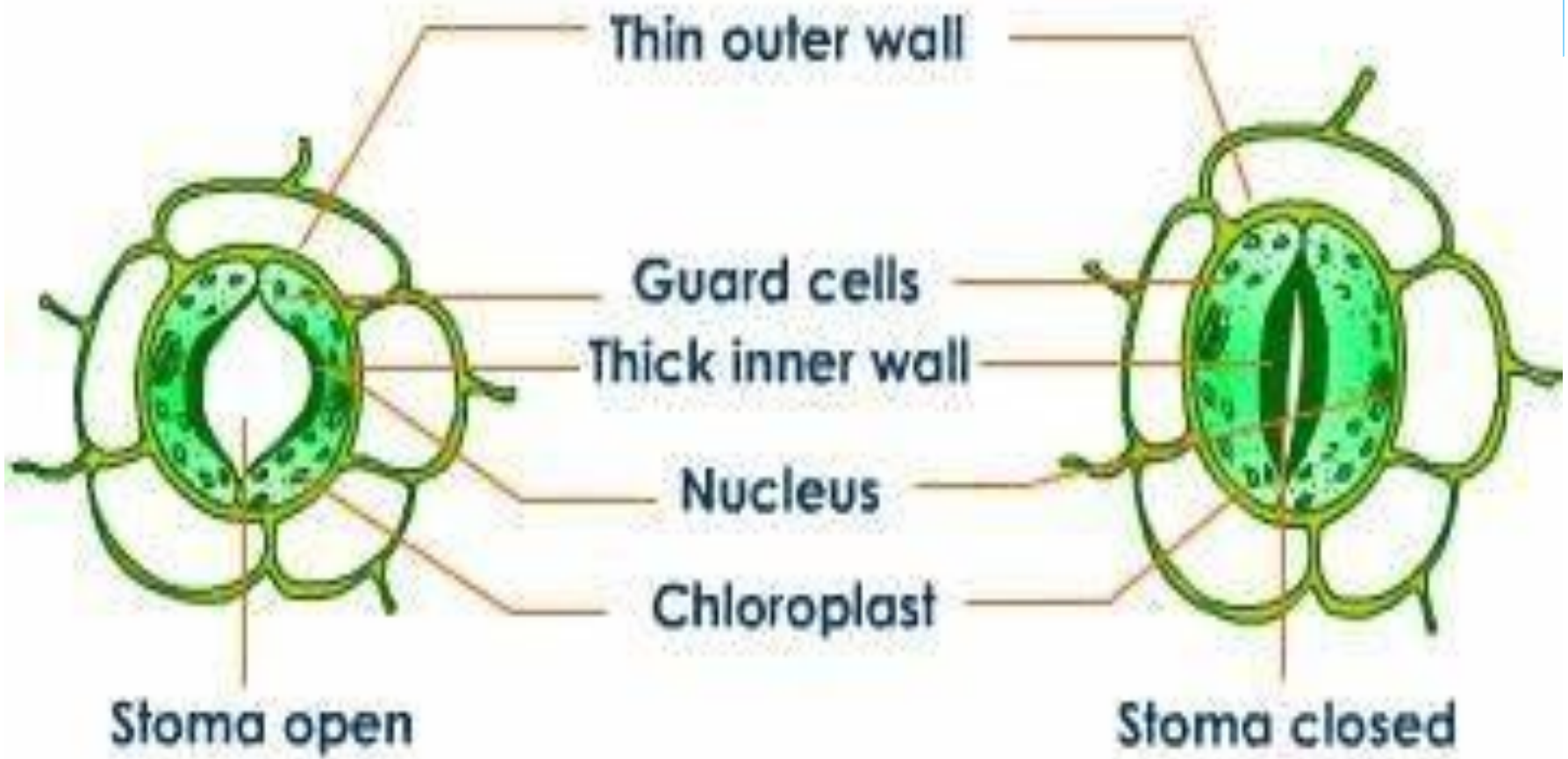
**Presented by Dr Vikhe P.S**



## Stomata

- **Stomata** (sing. stoma) = pores in a leaf, mostly on the undersurface
- Each pore is surrounded by a pair of **guard cells**
- Guard cells can change shape to open or close the stoma







- \* Definition of Stomata and Their Distribution

- \* The stomata are apertures in the epidermis, each bounded by two guard cells. In Greek, stoma means “mouth”, and the term is often used with reference to the stomatal pore only. Esau (1965, p. 158) uses the term stoma to include the guard cells and the pore between them, and we will use her definition. The plural of stoma is stomata. There is no such word as “stomates”.

- \* Stomata occur in vascular plants. Vascular plants include the lower vascular plants such as horsetails (*Equisetum*), ferns (class Filicinae), gymnosperms, and angiosperms. As noted before, the angiosperms are the flowering plants and this group consists of the two large classes: Monocotyledoneae (monocotyledons) and Dicotyledoneae (dicotyledons) (Fernald, 1950).

# STOMATA – STRUCTURE

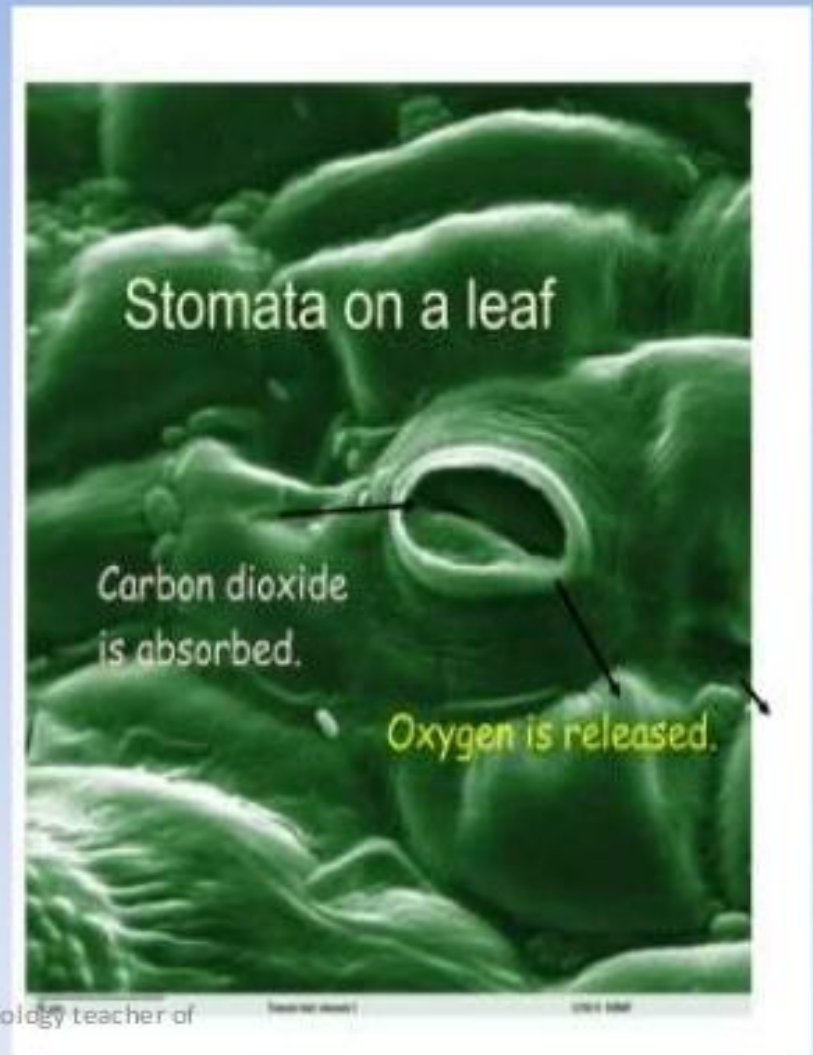
- Found on the lower (and sometimes upper) epidermis (surface) of leaves
- Holes/pores in leaf
- Singular – stoma, plural – stomata
- Hole is surrounded by two guard cells
- These can open by becoming turgid and close by becoming flaccid
- Guard cells contain chloroplasts
- Usually open during the day and closed at night

# What Are Stomata?<sup>1</sup>

- A microscopic pore in the epidermis of plants
- surrounded by guard cells
- In leaves and stems of a plant
- allows gas exchange between the environment and the interior of the plant
- Surrounded by guard cells which control the opening and closing of the stomata

# About Stomata

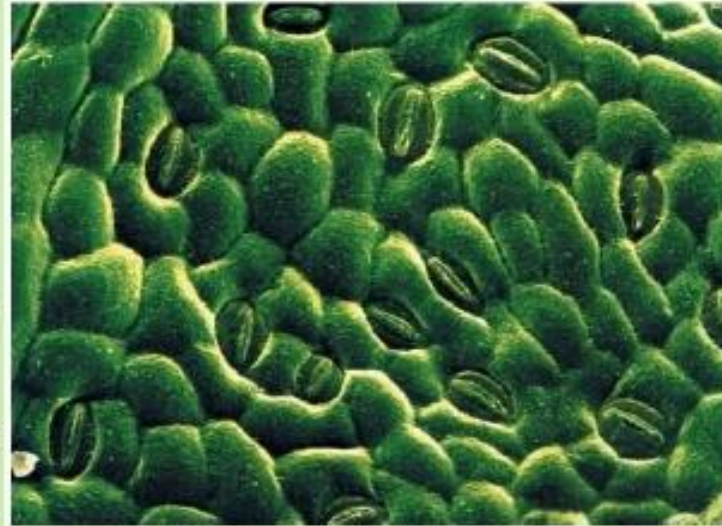
- Usually Stomata was placed in epidermis layer of leaf wherever lower or upper layer
- Stoma consist 2 closing cells/ guarding cells/ cell protector shape like liver and had many chlorophyll
- There are little amount of closing cells than the total of epidermis cells in the layer



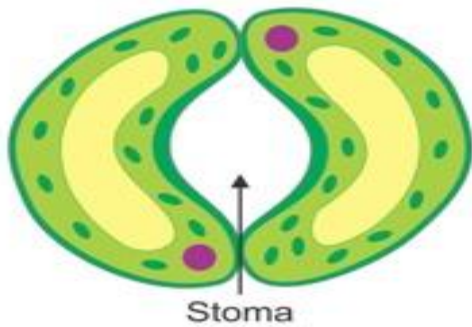


# Stomata

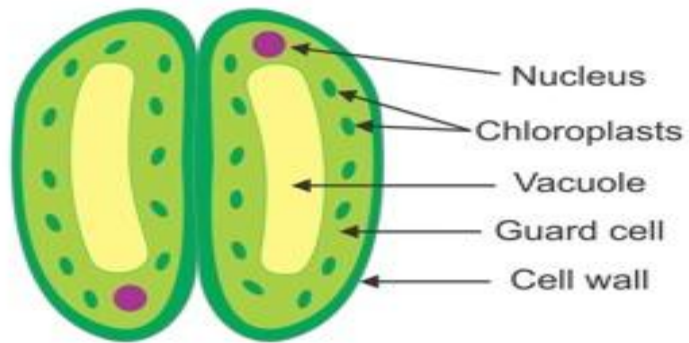
- There are holes found in leaves called **stoma**
- These holes allows **gases to diffuse in and out of the leaves**
- The stoma are formed by **two highly specialized epidermis cells**.
- These cells, called **guard cells**, are the only epidermis cells that contain chloroplasts.
- The **stoma open and close** depending upon the requirements of the plant.
- It is through these stoma that **water** leaves the leaf, the process that powers **transpiration**.



**Stoma open**

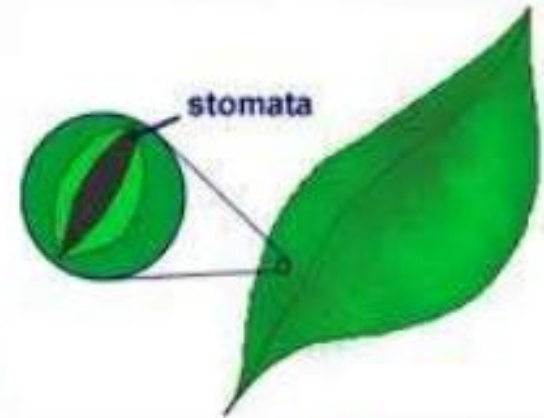
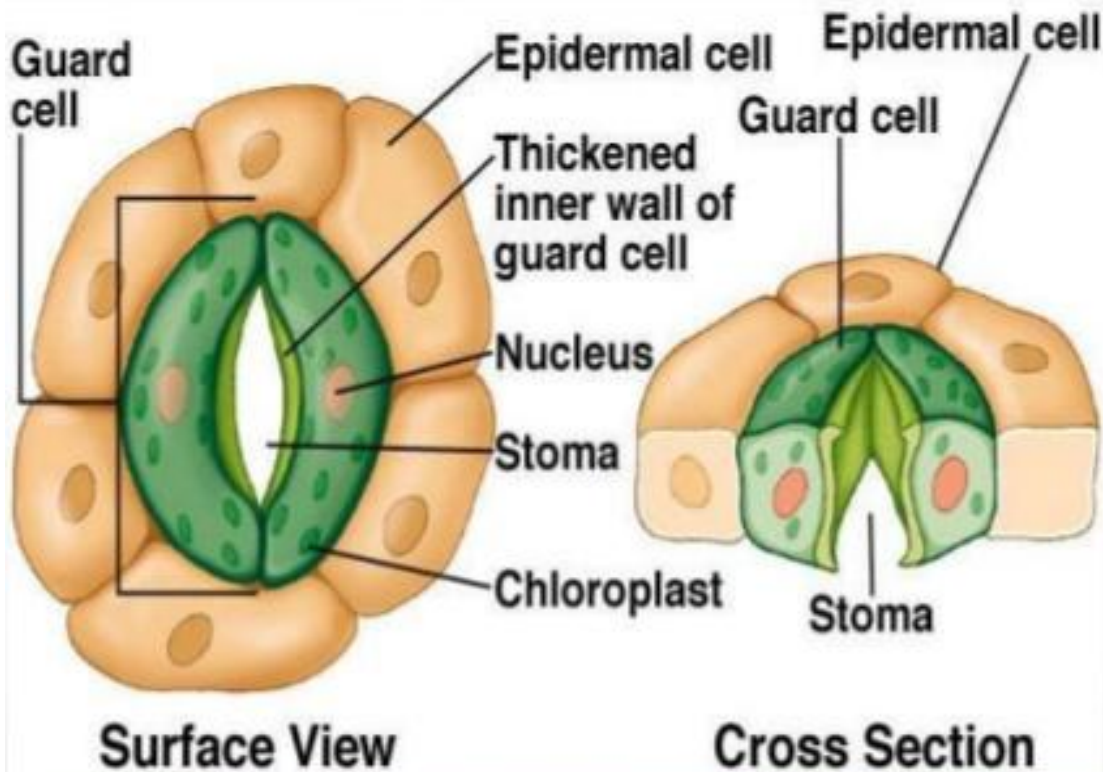


**Stoma closed**



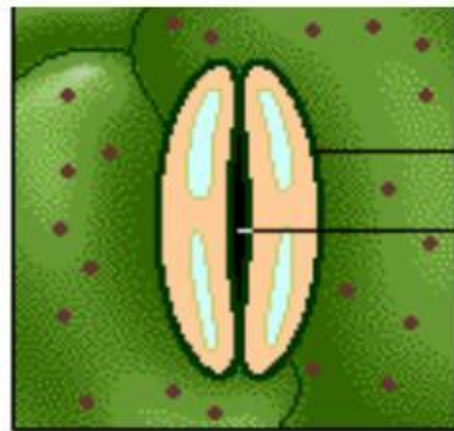
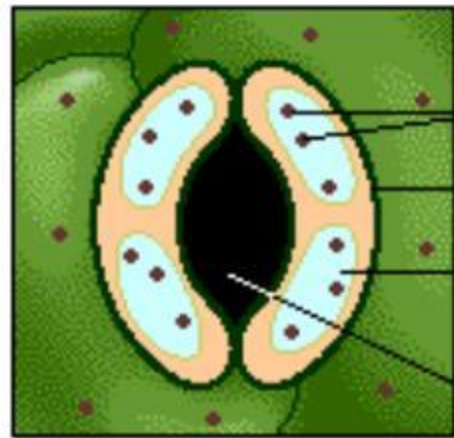
# Stomata

- **Stomata** - pores for **gas exchange**
  - present on one or both surfaces of Leaves.



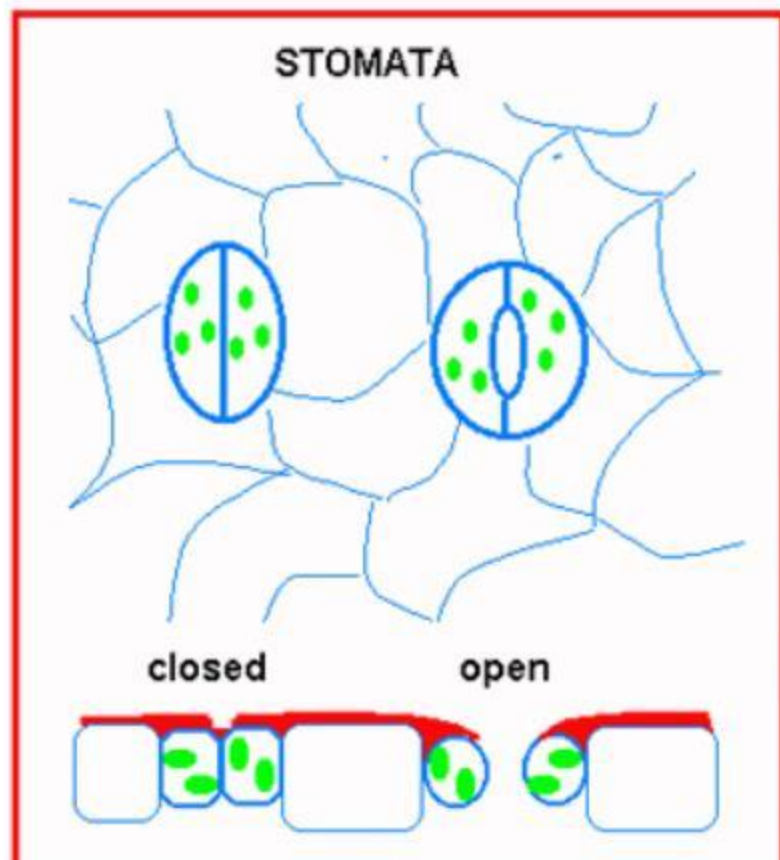
# Structure and function of stomata

- Stomata consists of two guard cells: When there is high water pressure guard cells open. Low water pressure in the guard cells cause stomata to close.
- Stomata allow carbon dioxide, oxygen and water vapor to diffuse into and out of the leaf by opening and closing.

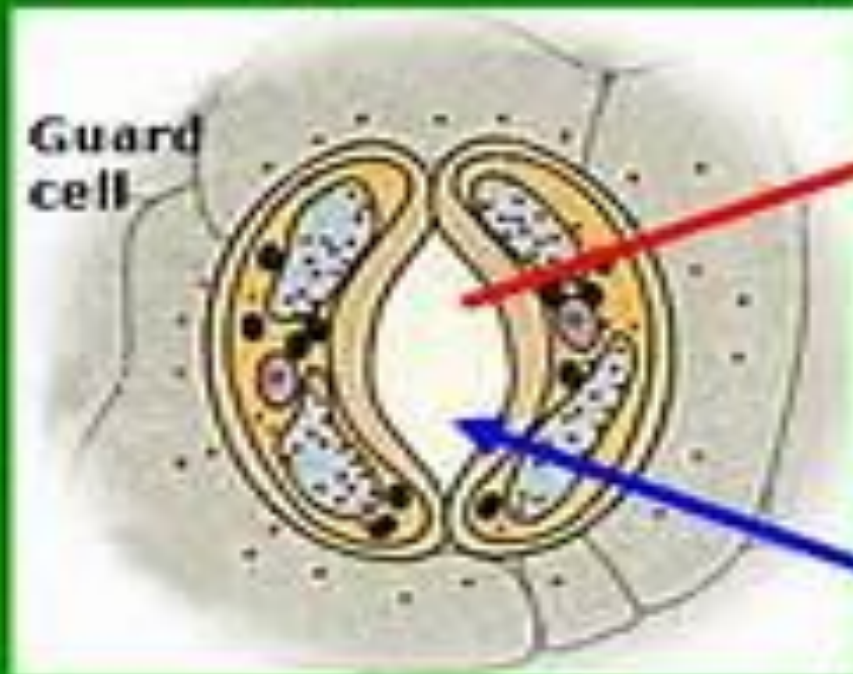


# Stomata: Functions

- The stomata are responsible for the *interchange of gases for respiration and photosynthesis*.
- The stomata *allow for the loss of excess water in the form of water vapour*, which also allows for cooling.



# Stoma function is for gas exchange in the leaf



oxygen

Provided plant is photosynthesizing

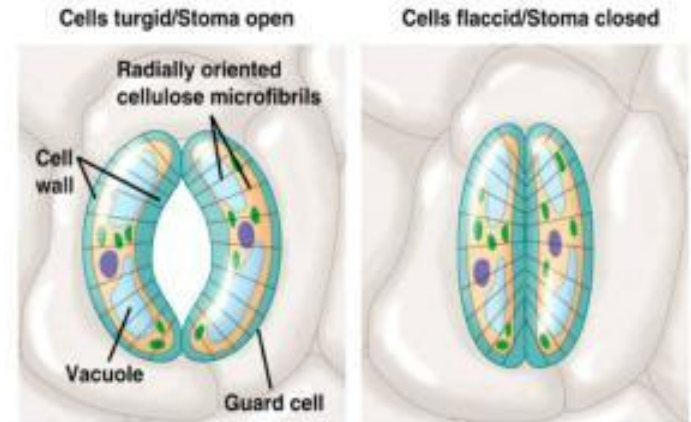
Carbon dioxide

# STOMATA – ROLES, FUNCTIONS

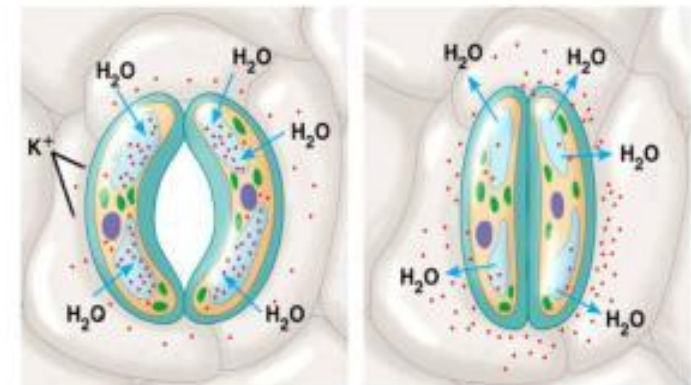
- To control the entry and exit of gases into and out of the leaf
- Guard cells open and close to control this
- Stomata respond to outside conditions
- When conditions are right for photosynthesis, stomata open wide for gas exchange
- When it is too dry or dark, stomata close up.
- Closed stomata prevent water loss in plant

# Stomata control transpiration

- Opened by:
  - photosynthesis
  - low  $\text{CO}_2$  in leaf
  - circadian rhythm
- $\text{K}^+$  regulates stomata opening
- When  $\text{K}^+$  is pumped in
  - Water follows  $\rightarrow$  turgid
  - Stoma opens
- When  $\text{K}^+$  is pumped out
  - Water follows  $\rightarrow$  flaccid
  - Stoma closes



(a) Changes in guard cell shape and stomatal opening and closing (surface view)

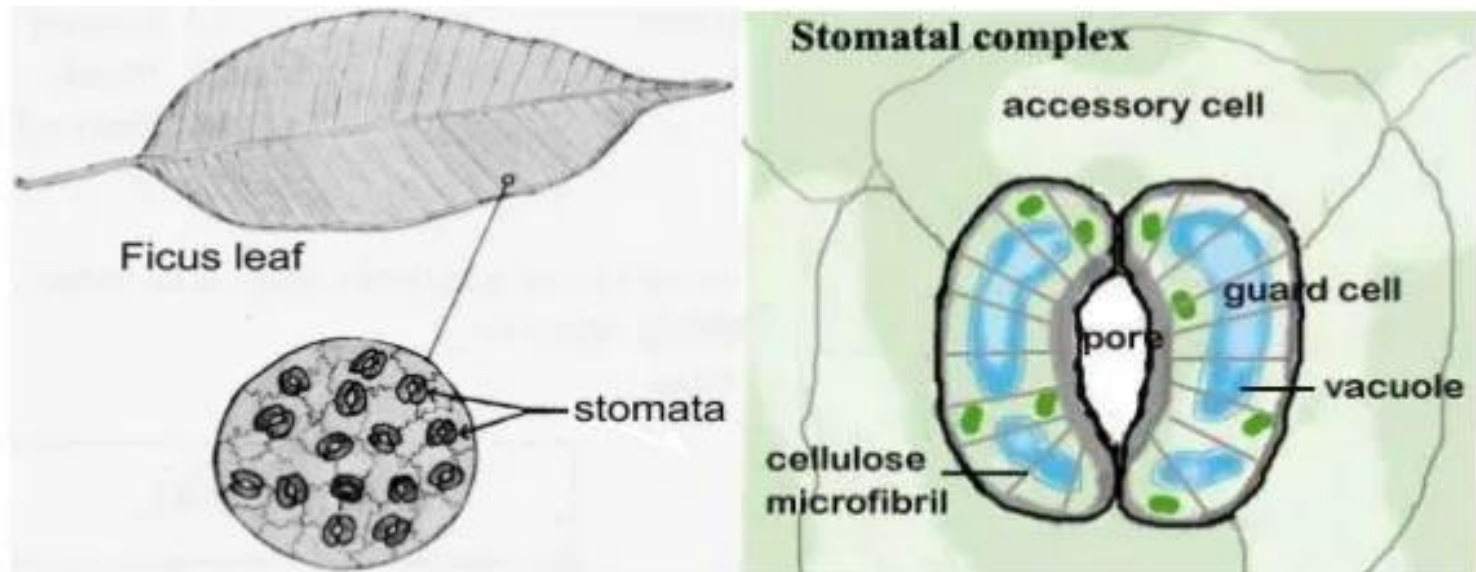


(b) Role of potassium in stomatal opening and closing



# Types of Transpiration

**3. Stomatal Transpiration:** Stomata are minute pores confined to **epidermis** of green shoot and leaves.

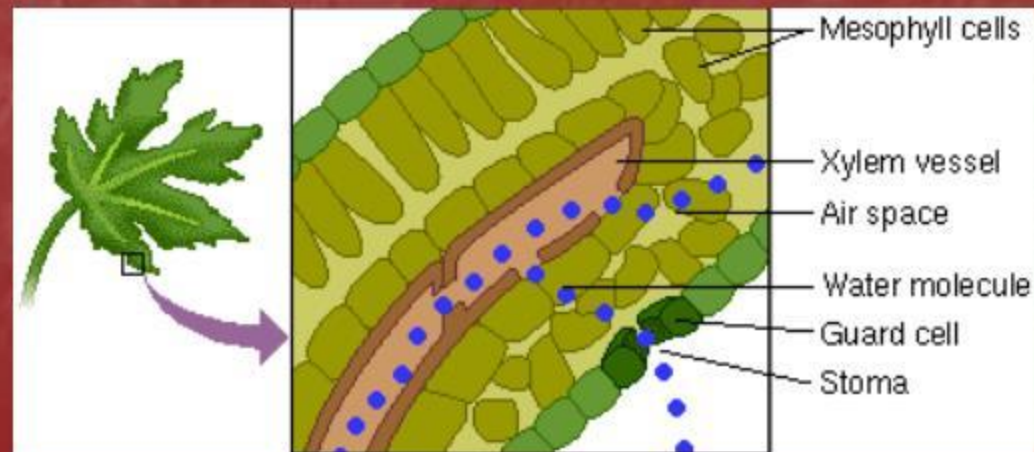


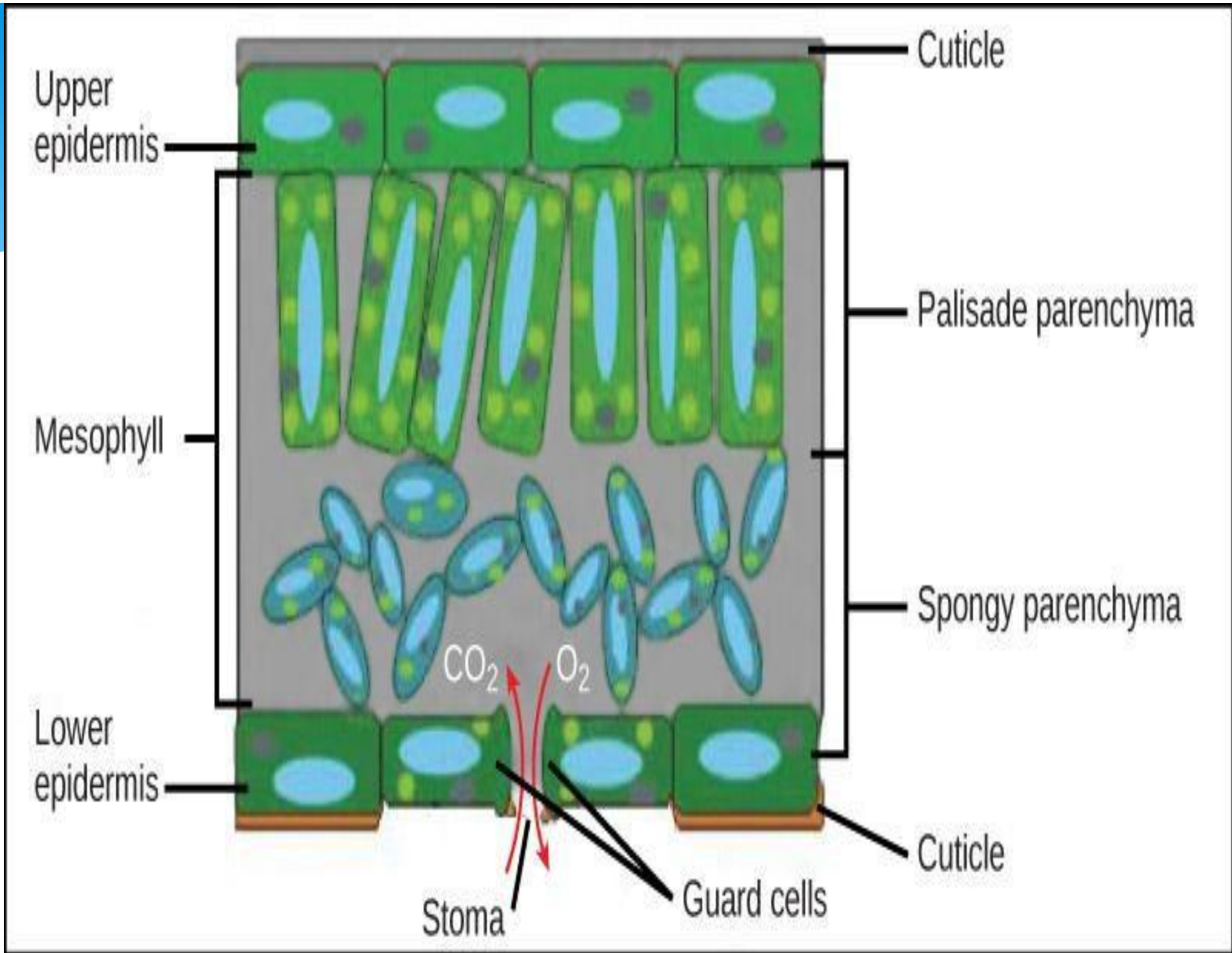
# Stomata Open During Daytime

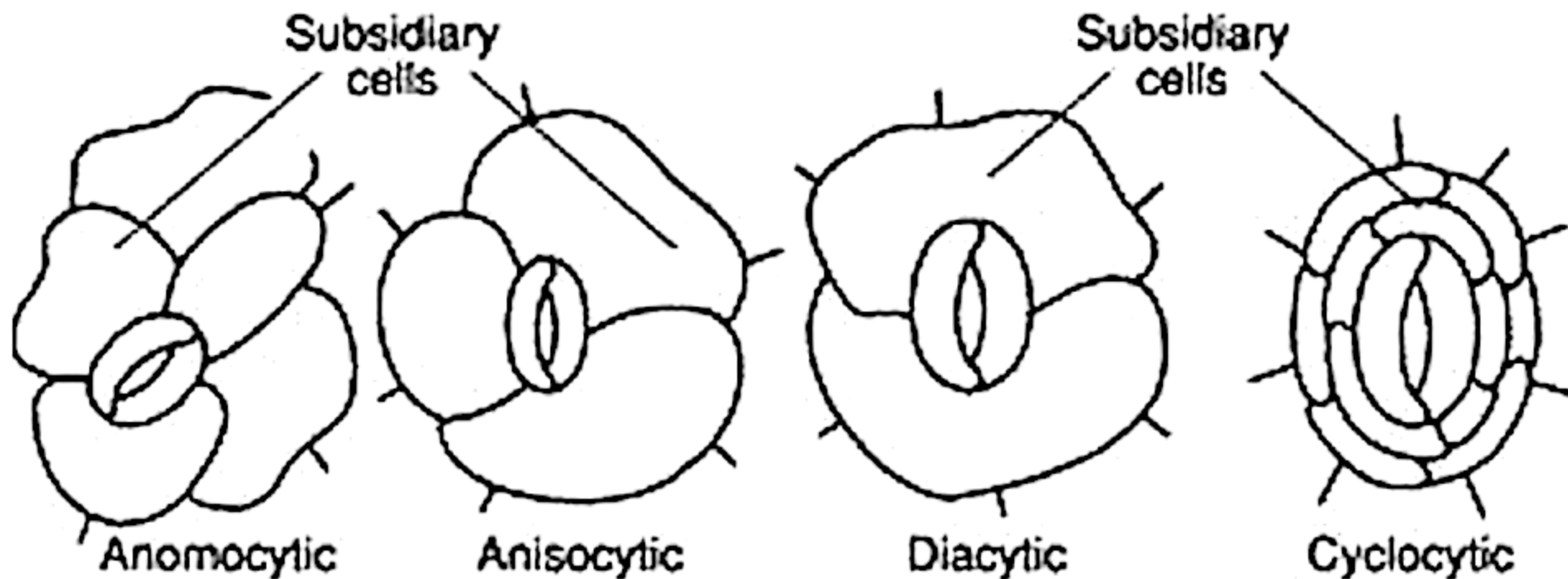
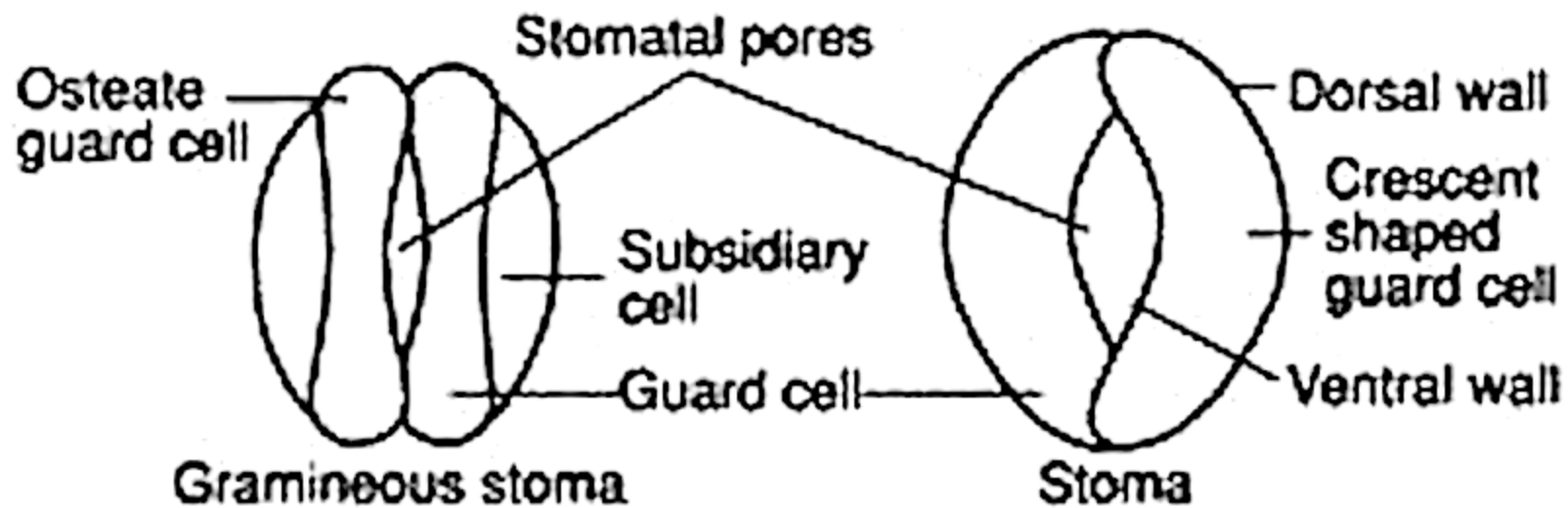
- Because water is lost faster from the leaf when temperatures are higher, plants risk losing a lot of water when they open their stomata during the daytime.
- In most plants, the benefits of opening their stomata in the daytime to allow CO<sub>2</sub> to be used in Calvin Cycle is greater than the costs of losing water.

# Structure and Function of Stomata

- If water enters the guard cells, they swell up and the stomata opens
- If water leaves the guard cells, they become soft and the stomata closes

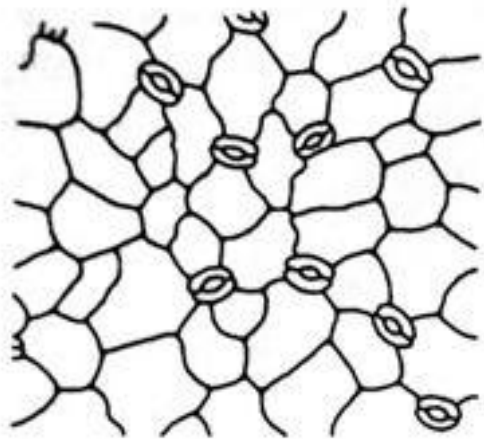






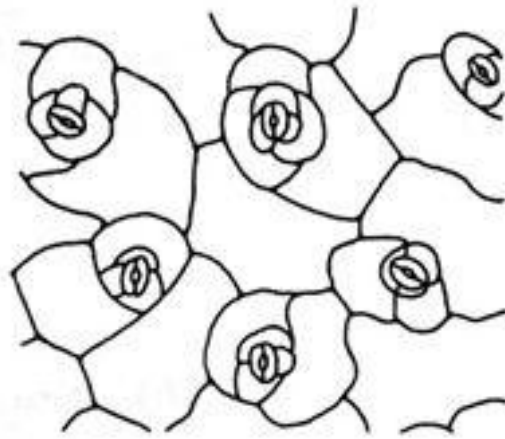
Subsidiary (cell)

Subsidiary (cell)



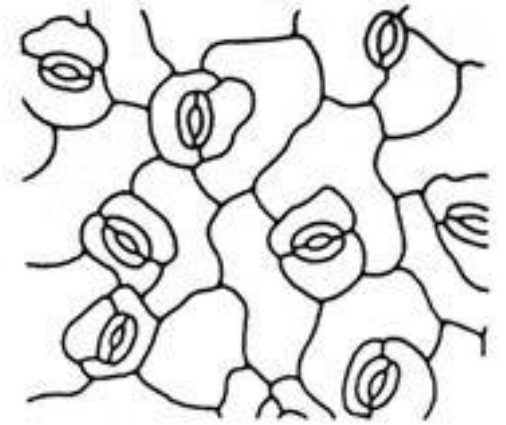
*Citrullus* – anomocytic

**A**



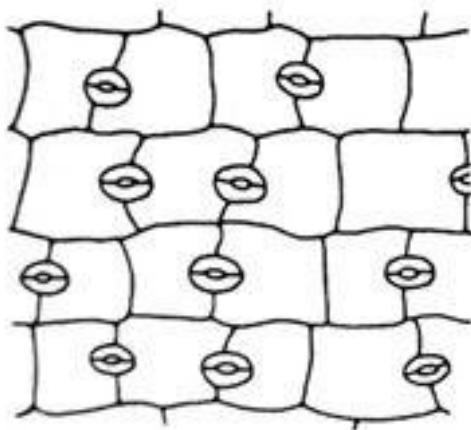
*Sedum* – anisocytic

**B**



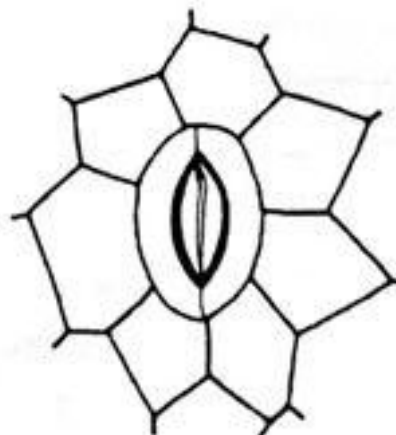
*Vigna* – paracytic

**C**



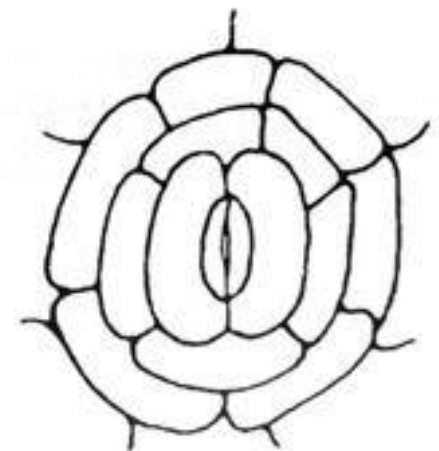
*Dianthus* – diacytic

**D**



*Lannea* – actinocytic

**E**

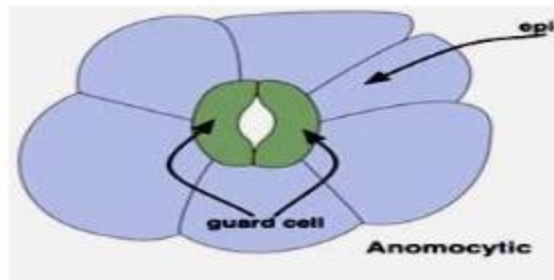


*Schinopsis* – cyclocytic

**F**

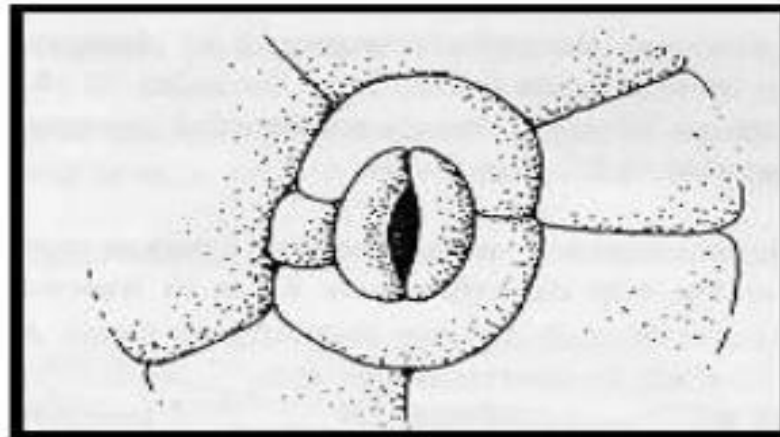
## A) Anomocytic or Ranunculaceae

- ▶ The surrounding epidermal cells have no special arrangement, they are all similar & there are no subsidiary cells, so all the cells are normal epidermal cells without any modification, like to stomata of digitalis, see the following example pictures.



## *B) Anisocytic type or Cruciferae*

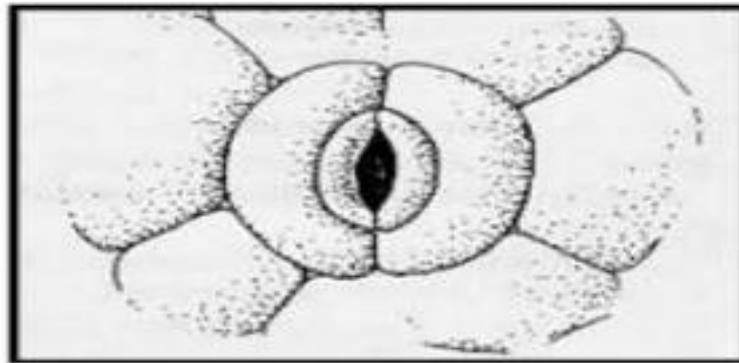
- ▶ The stomata is surrounded by 3 or more subsidiary cells, one of them is distinctly smaller than the others like in *Hyoscymus niger*, check the following picture.





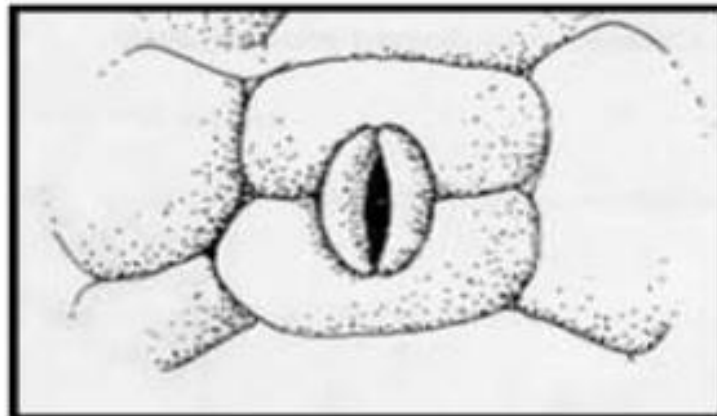
## *C) Paracytic type or Rubiaceae*

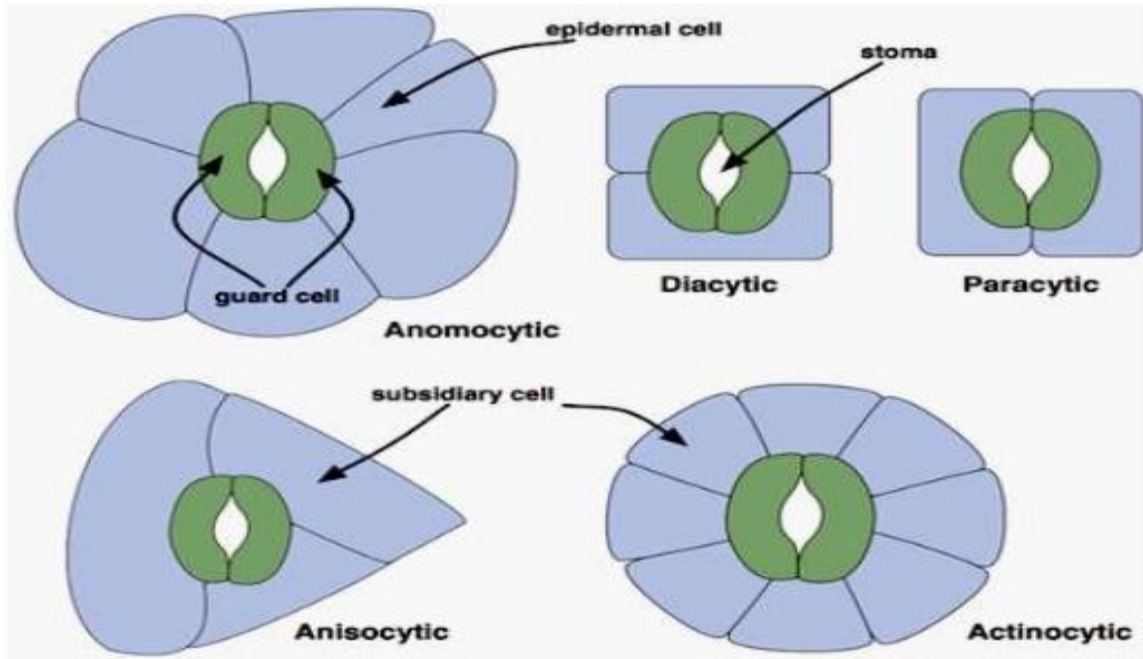
- ▶ Each stoma is surrounded by 2 or more subsidiary cells, 2 of them have their long axes parallel to the pore, which means that the axes of the subsidiary cells are parallel to the axes of the pore like the one in senna leaves, check the following picture.



## D) Diacytic type, Caryophyllaceae


- ▶ Each stomata is surrounded by 2 subsidiary cells having their long axes perpendicular to the pore like in peppermint, *Mentha piper*, check the following picture






# Types of stomata and Example of drugs

- ▶ **Paracytic or Rubiaceous or parallel- celled stomata: Cocca leaf, senna leaf**
- ▶ **Diacytic or caryophyllaceous or cross-celled stomata : Peppermint, Vasaka**
- ▶ **Anisocytic or cruciferous or Unequal celled stomata: Belladonna, Datura**
- ▶ **Anomocytic or ranunculaceous or irregular celled stomata: Digitalis, Lobelia**

- 
- \* The stomata consist of minute pores called stoma surrounded by a pair of guard cells. Stomata, open and close according to the turgidity of guard cells. The cell wall surrounding the pore is tough and flexible. The shape of guard cells usually differs in both monocots and dicots, though the mechanism continues to be the same. Guard cells are bean-shaped and contain chloroplasts. They contain chlorophyll and capture light energy.
  - \* The subsidiary cells surround the guard cells. They are the accessory cells to guard cells and are found in the epidermis of plants. They are present between guard cells and epidermal cells and protect epidermal cells when the guard cells expand during stomatal opening.
  - \* The average number of stomata is about 300 per square mm of the leaf surface.
  - \* Also, refer to Distribution of Stomata in the Lower and Upper Surfaces of the Leaves
  - \* The table given below explains the total number of stomata present on the upper and lower surfaces of leaves of different plants.

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- \* stomata are the microscopic pores on leaf surfaces that facilitate gas exchange with the atmosphere, namely, CO<sub>2</sub>, O<sub>2</sub>, and H<sub>2</sub>O. Approximately 200% and 16% of the total content of atmospheric water vapor and CO<sub>2</sub> are cycled through stomata each year



- \* Functions of Stomata

- \* The main functions of stomata are:

- \* Gaseous exchange- Stomatal opening and closure help in the gaseous exchange between the plant and surrounding.
- \* It helps in transpiration and removal of excess water in the form of water vapour.
- \* Stomatal closure at night prevents water from escaping through pores.
- \* It maintains the moisture balance according to weather by opening and closing.
- \* Stomata facilitate carbon dioxide uptake and release of oxygen during the process of photosynthesis.

- \* Anomocytic Stomata
- \* They are surrounded by epidermal cells, which have a fixed shape and size. The stomata appear to be embedded in epidermal cells. There is no definite number and arrangement of cells surrounding the stomata.
  
- \* Anisocytic Stomata
- \* Stomata are surrounded by three subsidiary cells having unequal sizes, one is smaller compared to the other two.
  
- \* Diacytic Stomata
- \* The stomata are surrounded by a pair of subsidiary cells that are perpendicular to the guard cell.
  
- \* Paracytic Stomata
- \* The stomata are continuously surrounded by two subsidiaries, which are arranged parallel to the stomatal pore and the guard cells.
  
- \* Gramineous Stomata
- \* Each stoma possesses two guard cells, which are shaped like dumbbells. The subsidiary cells are parallel to the guard cells. The guard cells are found narrow in the middle and wider at the ends.





Thank you