# Viticulture

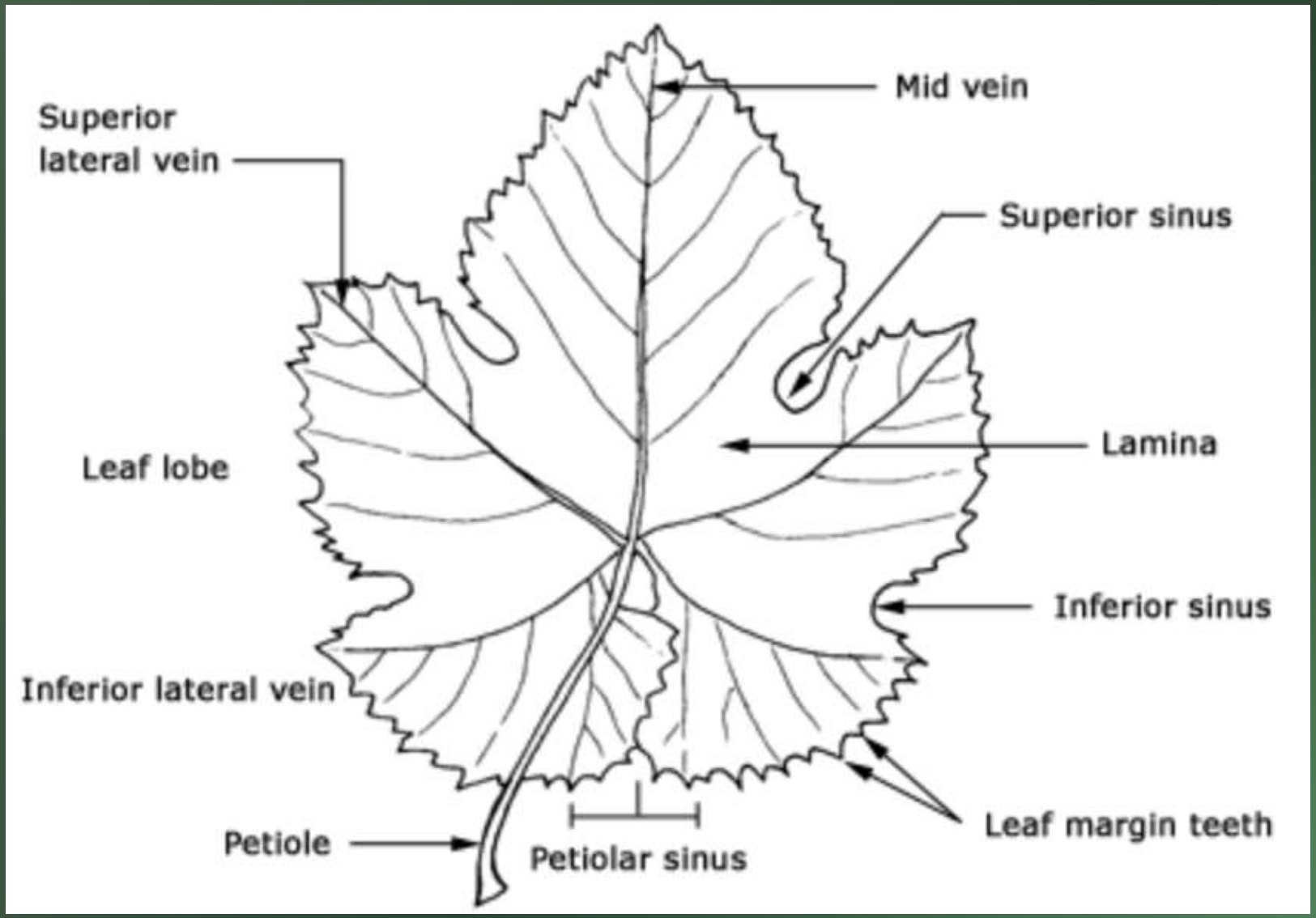
## Biology of the vine_2

**ARGYRO BEKATOROU**
**Associate Professor of Food Chemistry & Technology**

**Patras 2022**

# Viticulture - Biology of the vine_2

## Grapevine Leaf

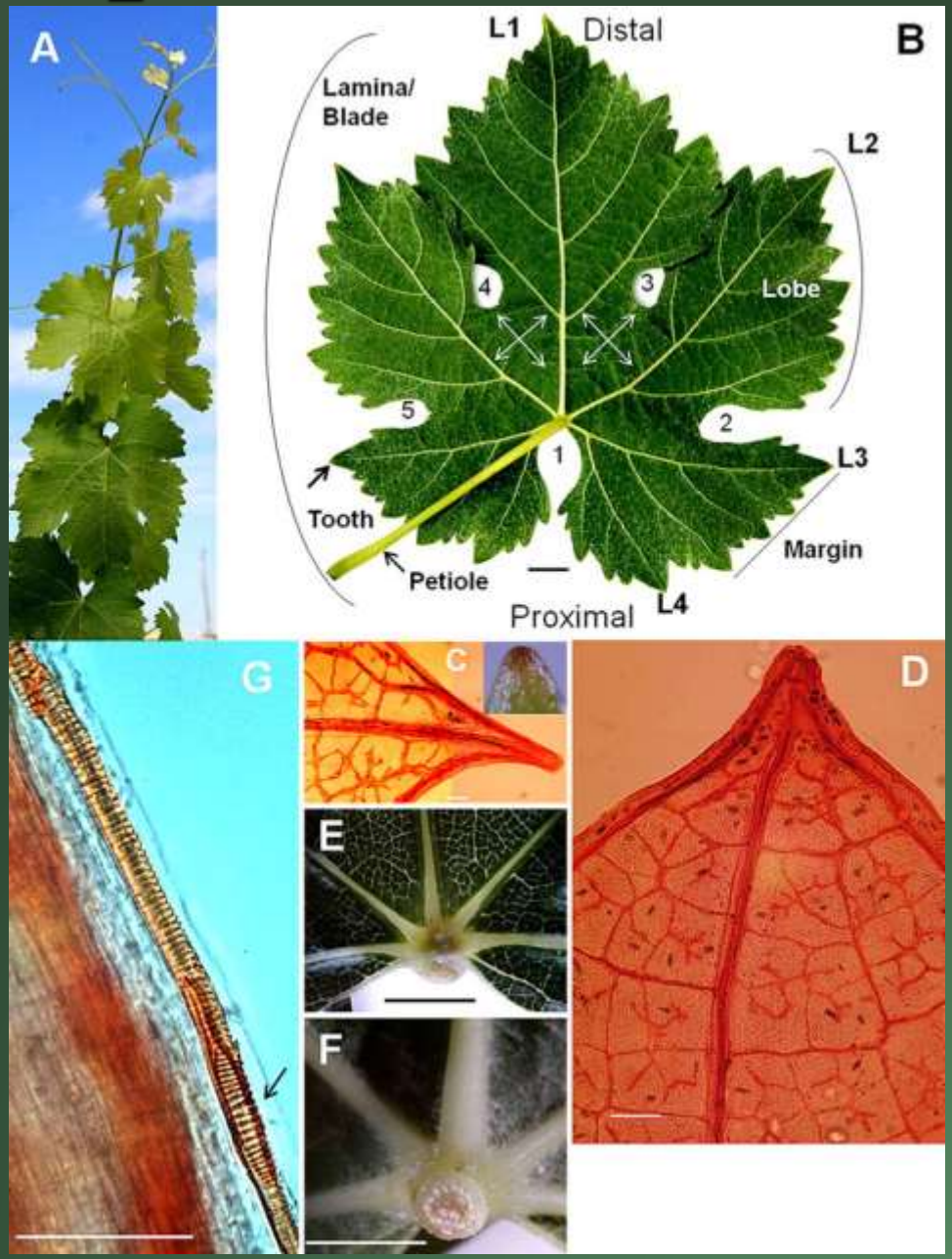



*https://enoviti-hanumangirl.blogspot.com/2018/07/ampelography-what-leaves-can-tell-us.html*

# Viticulture - Biology of the vine_2

## Grapevine Leaf

(**A**) healthy ‘Merlot’ grapevine **shoot**; (**B**) abaxial side of a ‘Merlot’ grapevine leaf from **A** showing the reticulate venation pattern, proximal and distal poles, which define the **proximodistal polarity** (**plane**), and the midvein and margin, which define the **mediolateral polarity**. The proximal region of the leaf forms a **petiole**, and the lamina or leaf blade develops more distally. The blade is traversed by 5 major veins arising from a petiole: **midvein** (**L1**), **superior lateral veins** (**L2/L′2**), and **inferior lateral veins** (**L3/L′3**) corresponding to 5 sinuses that separate the lamina into 5 **lobes**; **L4/L′4** are **petiolar veins** diverging closely from the insertion point (X arrows indicate lateral expansion); (**C**) Light micrograph (LM) of the apical lobe tip of a leaf from **A**; (**D**) LM of the tip of one of the lateral lobes of a leaf from **A**; (**E**) Stereomicrograph (SM) of the adaxial (ventral) surface of the insertion point where the lamina joins the petiole in a leaf from **A**; (**F**) SM of the abaxial (dorsal) surface showing the ribs of the 5 major veins originating from the insertion point of the same leaf as in **E**; (**G**) xylem vessel elements with annular thickening and a scalariform perforation plate in a healthy leaf vein from **A**. Scale bars: 10 mm (**B**), 200 µm (**C–D**), 500 µm (**E–F**), 50 µm (**G**).



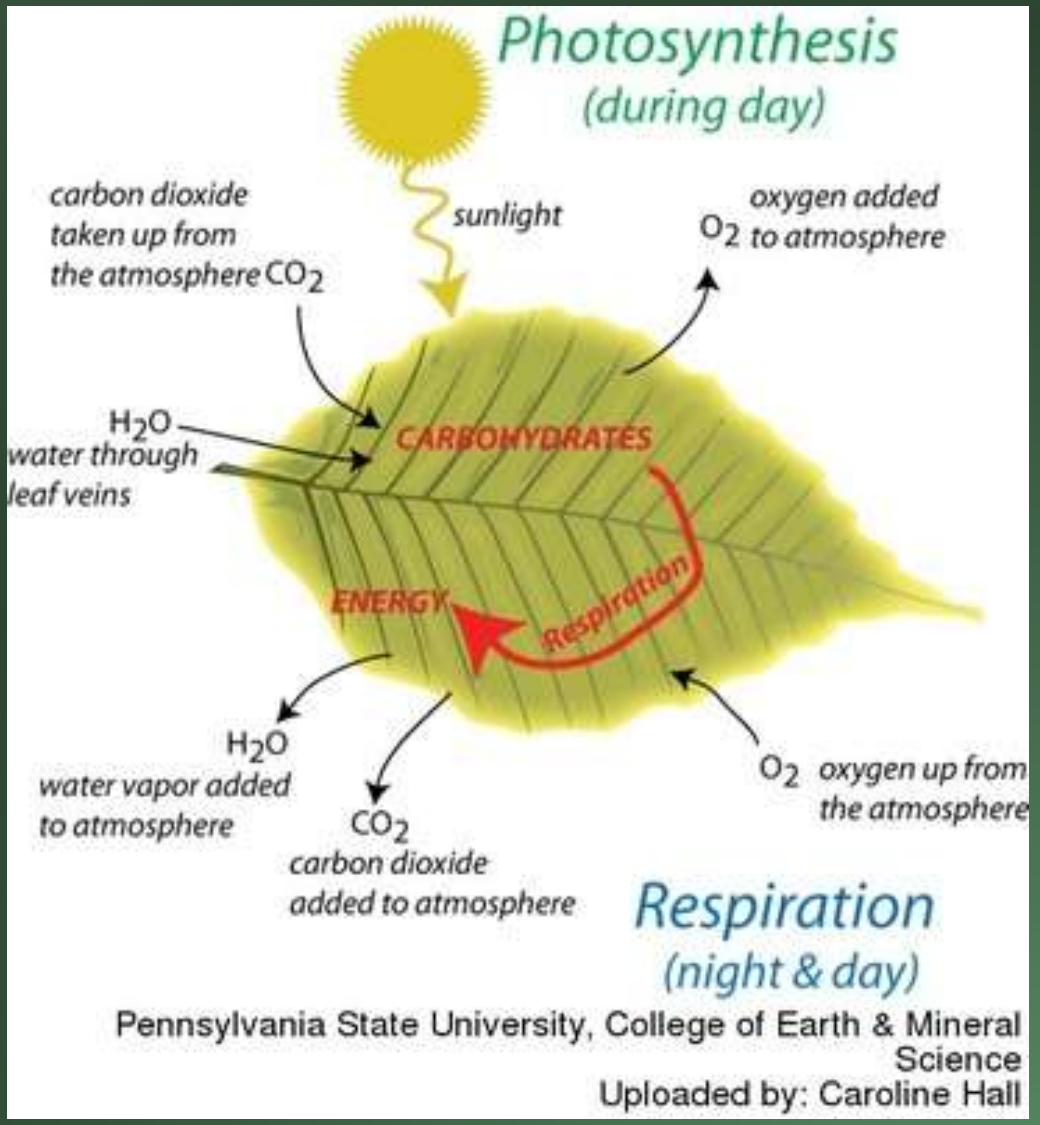

*Citation: Journal of the American Society for Horticultural Science J. Amer. Soc. Hort. Sci. 136, 3*

# Viticulture - Biology of the vine_2

## Grapevine Leaf

### Leaf Functions

- Transpiration of water (water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers)
- Guttation (the appearance of drops of xylem sap on the tips or edges of leaves)
- $CO_2$ fixation - photosynthesis
- Biosynthesis of organic compounds

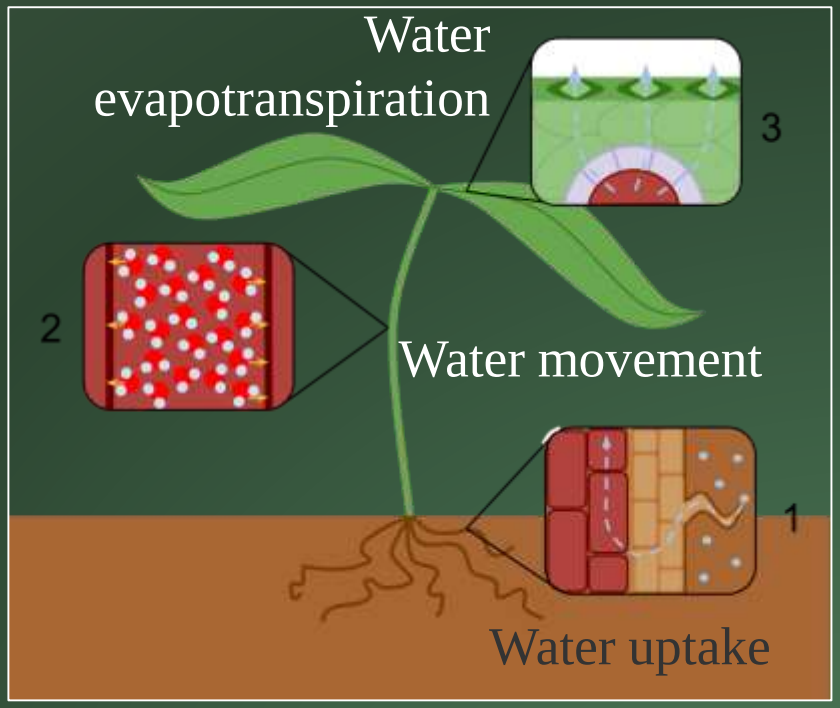


# Viticulture - Biology of the vine_2

## Grapevine Leaf

**Leaf Guttation**

*https://grapes.extension.org/guttation/*

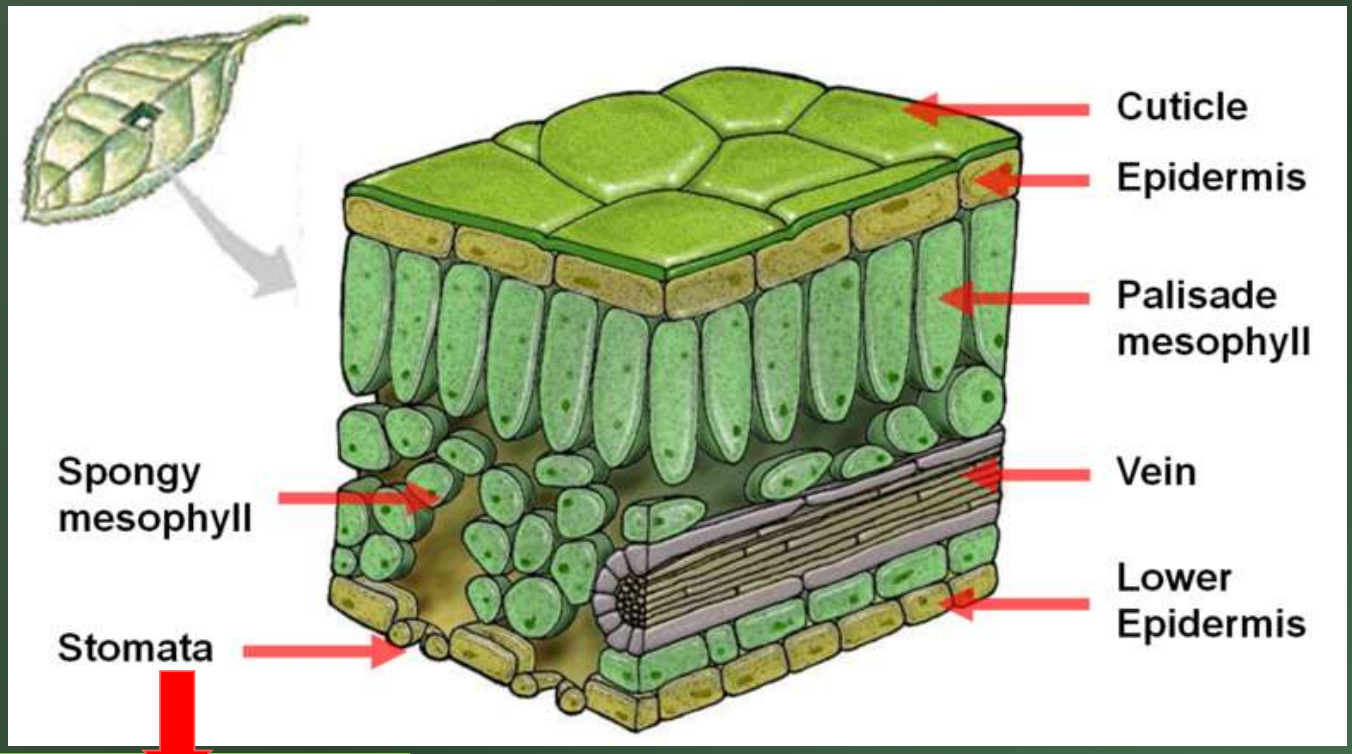


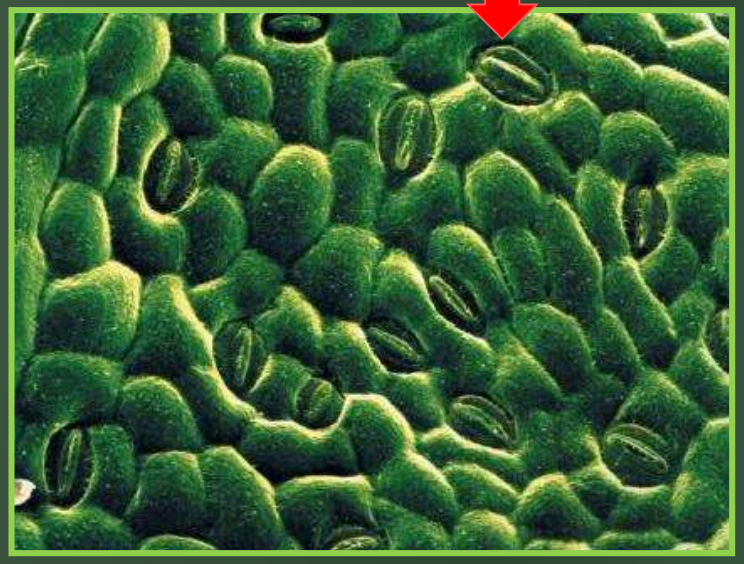

**Leaf transpiration**

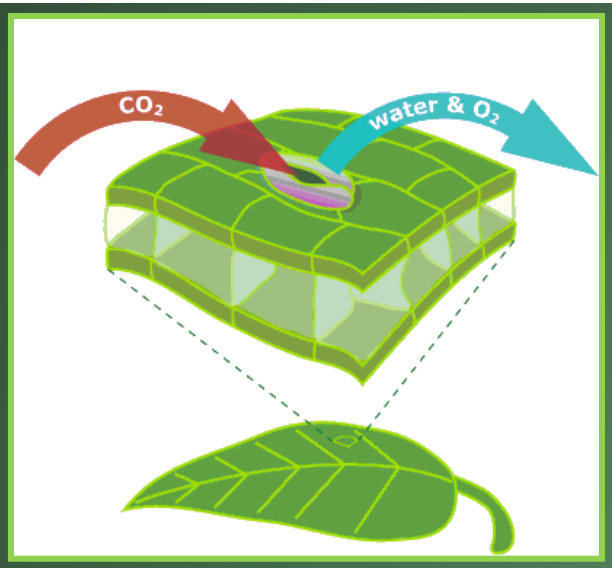
*https://en.wikipedia.org/wiki/Transpiration*

# Viticulture - Biology of the vine_2

## Grapevine Leaf



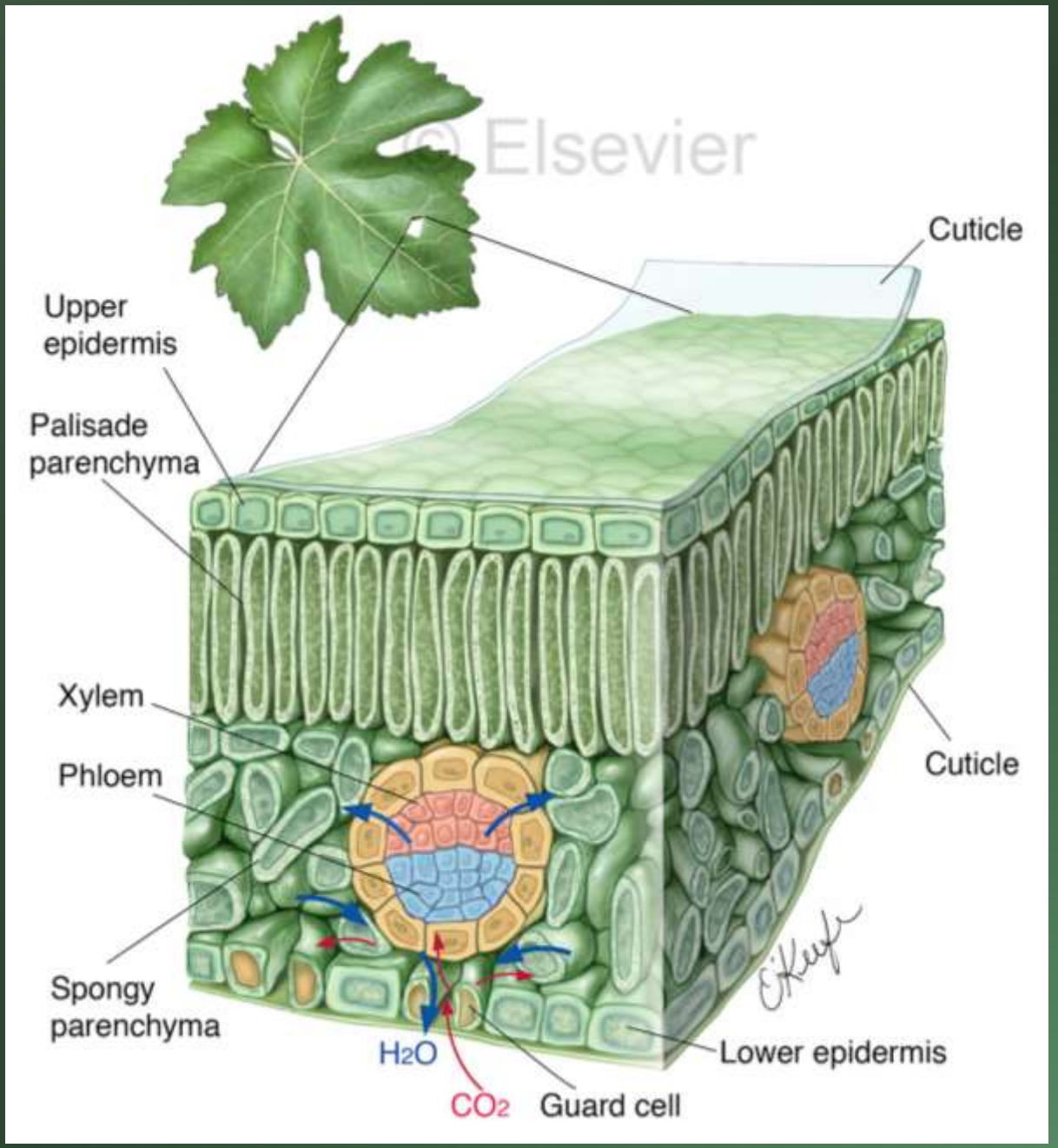





# Viticulture - Biology of the vine_2

## Grapevine Leaf

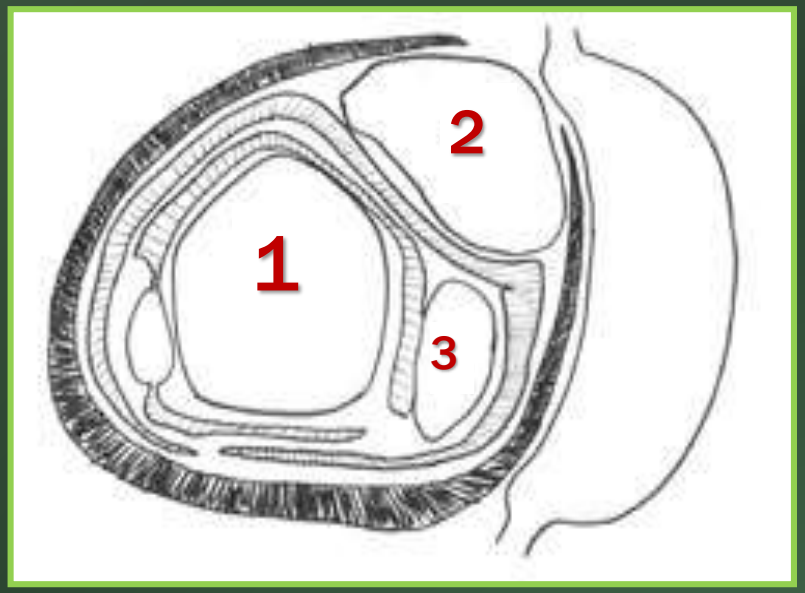
## Anatomy




*https://laurieokeefe.com/ngg_tag/leaf-anatomy/#gallery/leaf-anatomy/127*

# Viticulture - Biology of the vine_2

## Grapevine buds

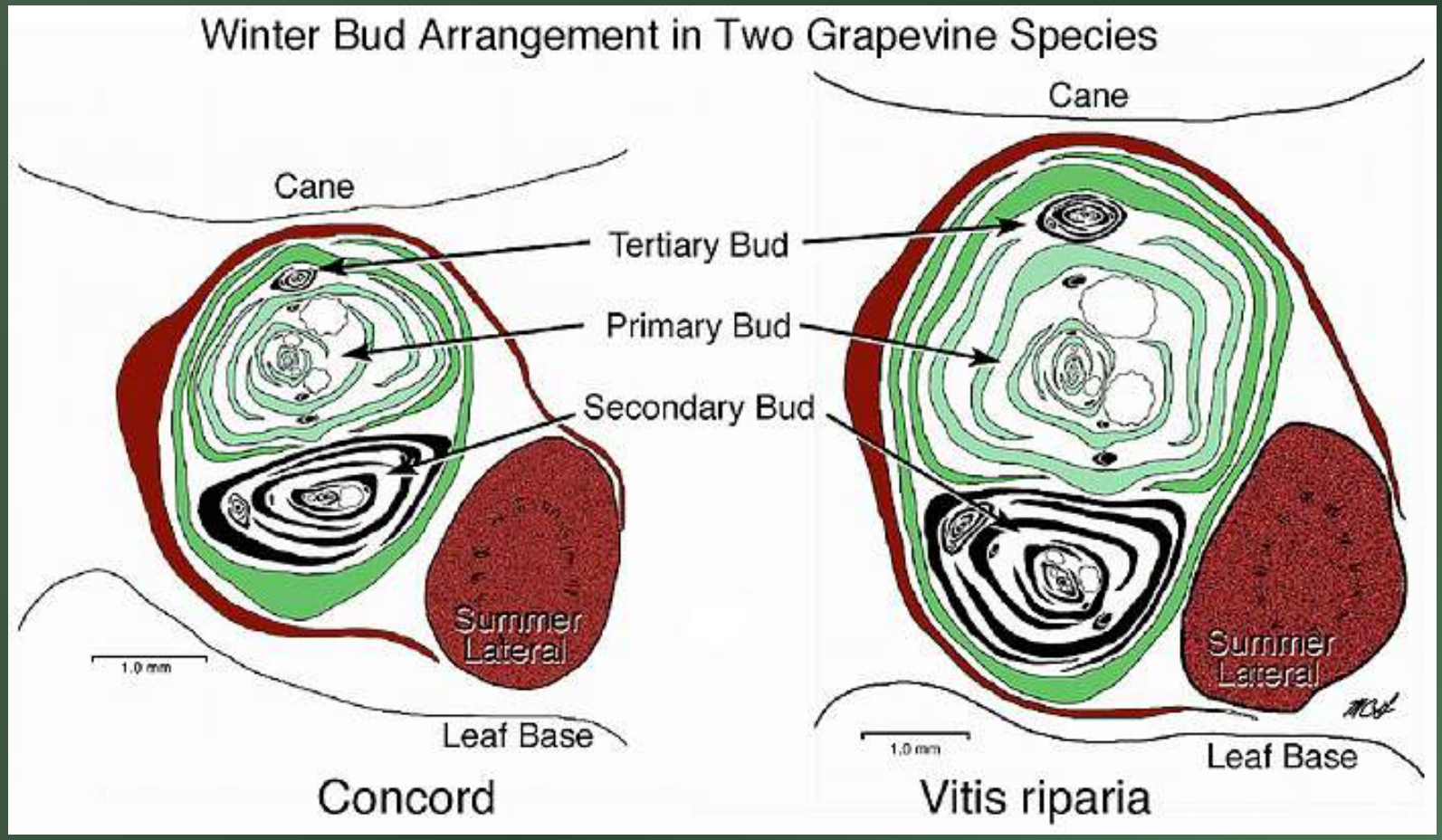





They are found exclusively in the axils of the leaves at the level of the nodes, the area just above the point of connection between the petiole and shoot. Although the dormant bud (sometimes called an “eye”) looks like a simple structure, it is actually a compound bud consisting of 3 growing points, sometimes referred to as the primary, secondary, and tertiary buds within one bud.

# Viticulture - Biology of the vine_2

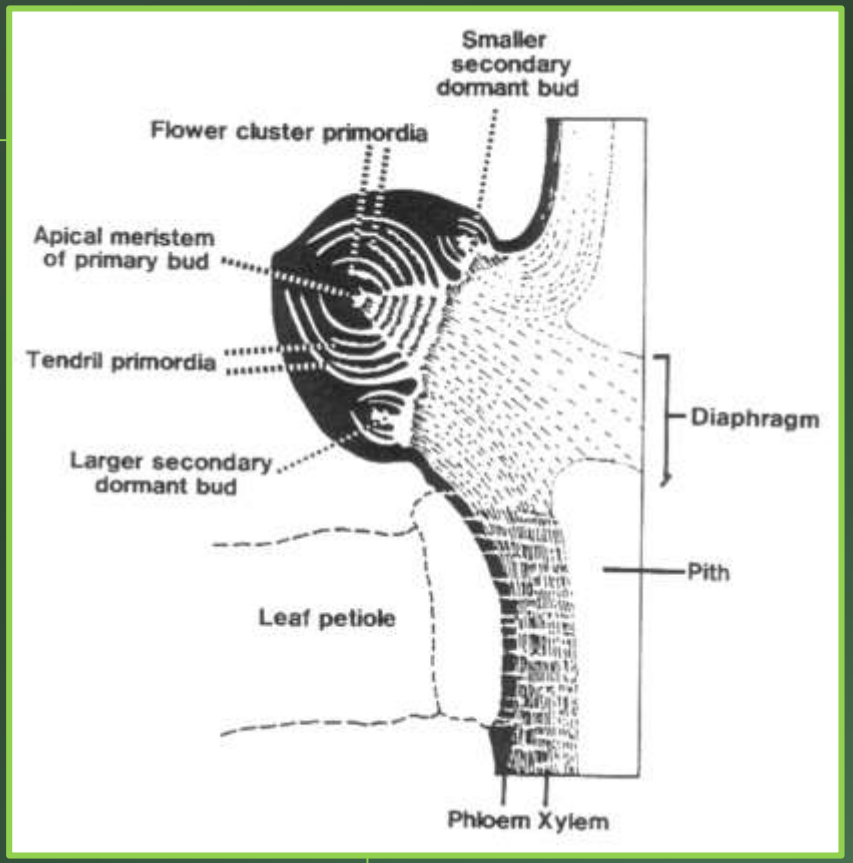
## Grapevine buds




*Martin C. Goffinet. Anatomy of Grapevine Winter Injury and Recovery. 2004*

# Viticulture - Biology of the vine_2

## Grapevine buds




- Buds may be classified into either a '**prompt**' bud or a '**compound**' bud.

### The compound bud

- The compound bud comprises of the primary, secondary and tertiary latent buds. Each bud contains 3 partially developed shoots enclosed in small leaf like structures called bracts which develop in the leaf axil.

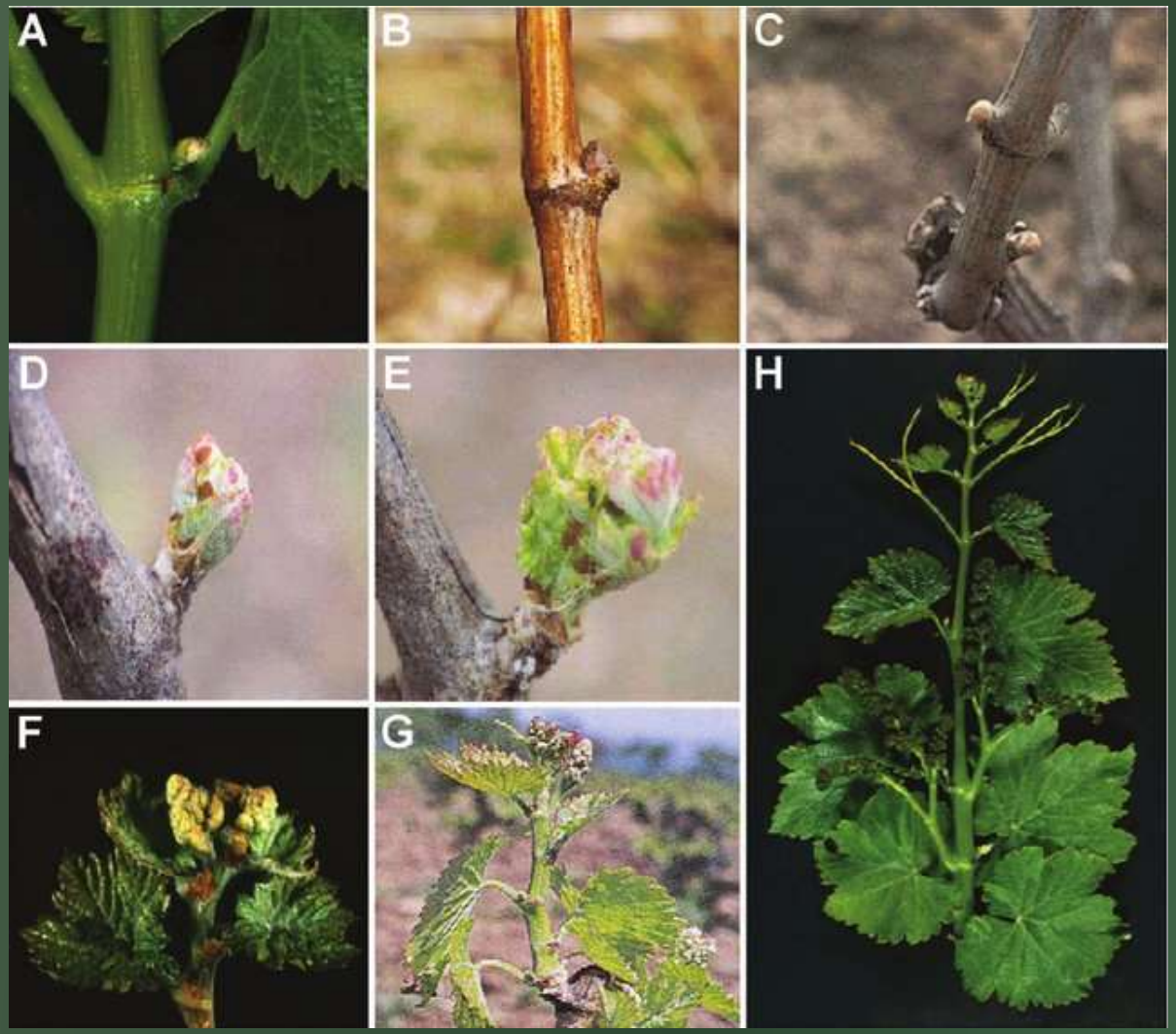
### The Lateral Shoot and Prompt Bud

- The summer lateral grows from a prompt bud in the leaf axil. It produces shoots and leaves in the current growing season and is usually not fruitful. Compound buds produce shoots, leaves and fruit after the completion of winter dormancy.

*https://www.viti.com.au/pdf/MVWGG%20Fact%20Sheet%20-%20Grapevine%20Biology.pdf*

# Viticulture - Biology of the vine_2

## Grapevine buds




*https://www.researchgate.net/profile/Pilar-Cubas/publication/11162232*

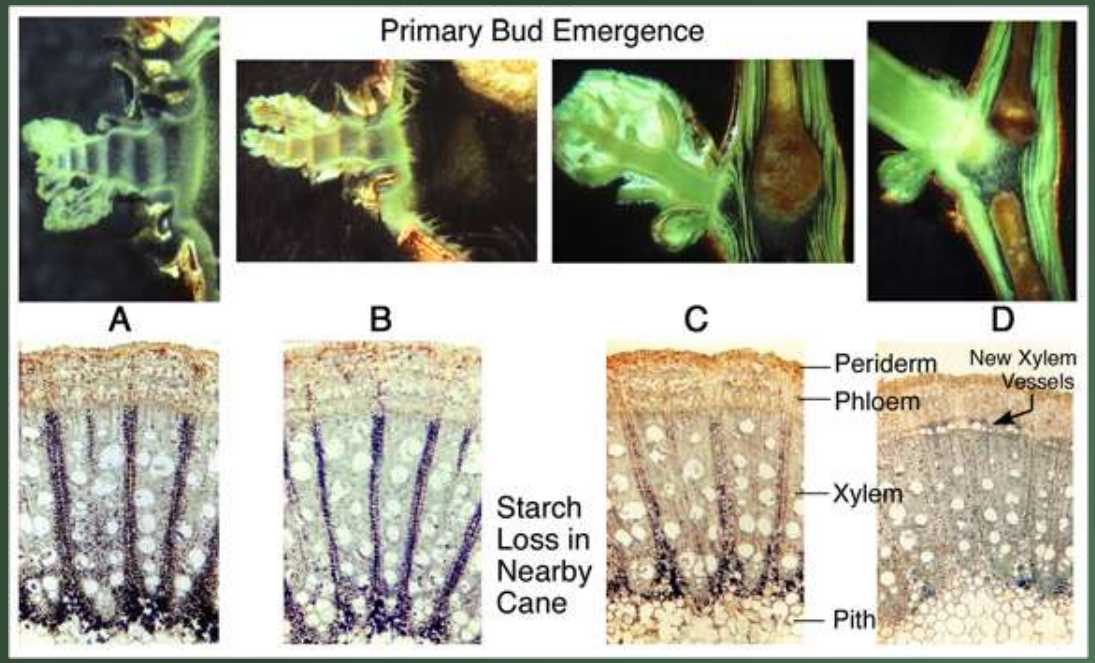
## Stages of grapevine development

A. Newly formed latent bud in the axil of a young leaf.
B. Winter bud; phenological stage A.
C. Swelling bud; phenological stage B.
D. Sprouting bud; phenological stage C.
E. Phenological stage D.
F. Outgrowing shoot; phenological stage E.
G. The inflorescences are clearly visible and separated; phenological stage G.
H. General view of a growing cane bearing inflorescences with developing flowers at phenological stage H.

# Viticulture - Biology of the vine_2

## Grapevine buds

Progression of grapevine bud burst at 0, 1, 3, 7 & 9 days (left to right) at 23 °C . (Meitha et al. 2015).




*http://www.hort.cornell.edu/goffinet/Anatomy_of_Winter_Injury_hi_res.pdf*

# Viticulture - Biology of the vine_2

## Grapevine Flowers

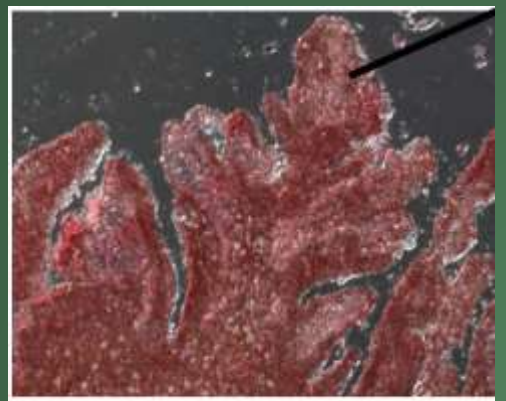
1. ***Anlagen*; First anlagen** form as club-shaped **meristematic protuberances** from the apices of latent buds. At this stage, the anlagen are uncommitted primordia; they may develop into **inflorescence primordia**, **tendril primordia** or **shoot primordia**.

2. ***Inflorescence primordia*;** The formation of inflorescence primordia takes place if the anlage undergoes repeated branching to develop many rounded branch primordia. This process is controlled by both environmental (temperature, light) and endogenous (growth regulator) factors.

3. ***Flower formation*; Grapevine flowers** are small (4-5 mm) and grouped together in a flower cluster or inflorescence. The inflorescences occur **opposite a leaf in the same position as a tendril** (there are several hundred flowers per inflorescence). 6-10 weeks after bud burst, flowering takes place.

Inflorescence primordia sampled in May 2006

Inflorescence primordia sampled in August 2006

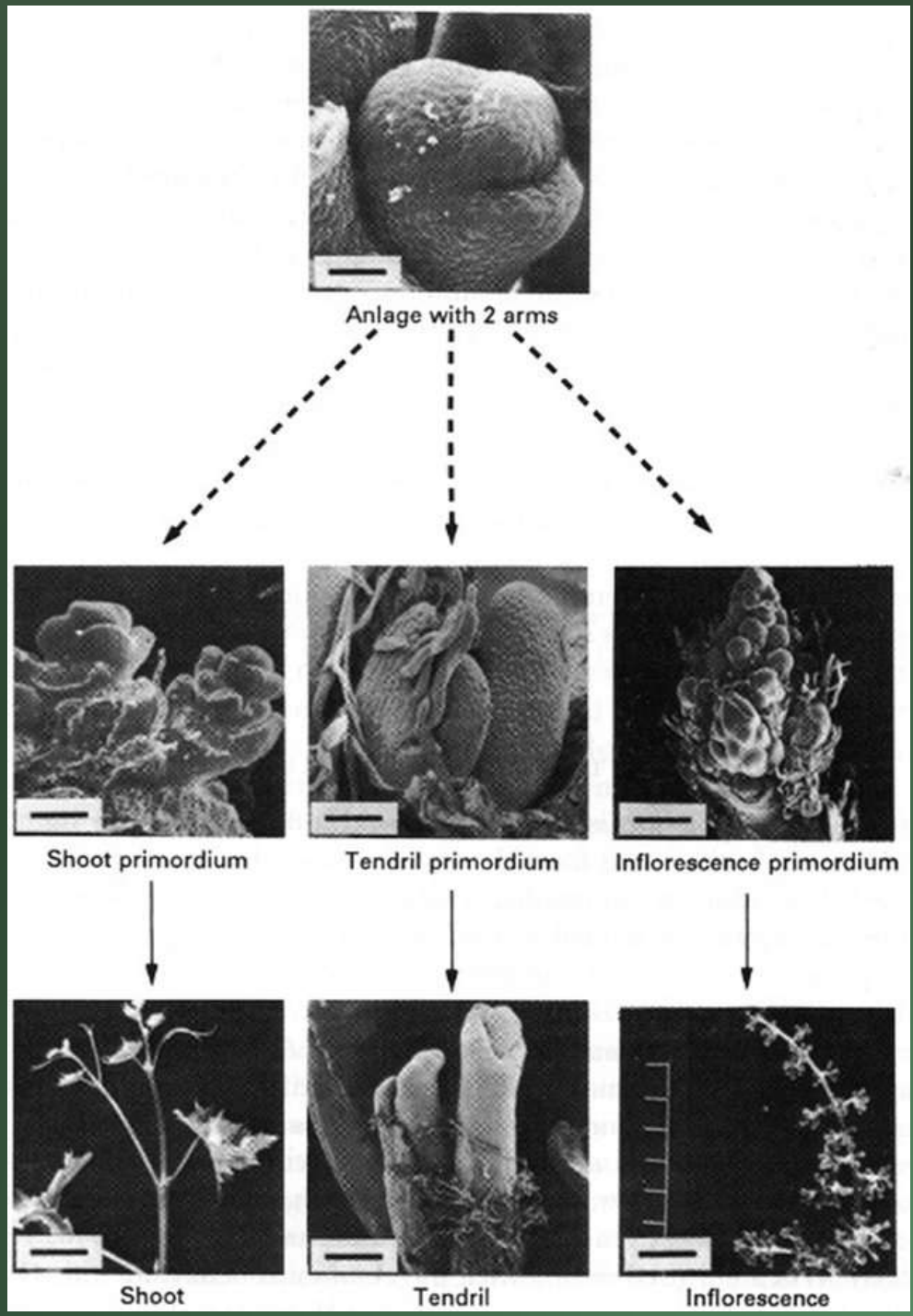


Inflorescence primordia

https://www.viti.com.au/pdf/MVWGG%20Fact%20Sheet%20-%20Grapevine%20Biology.pdf

# Grapevine Flowers

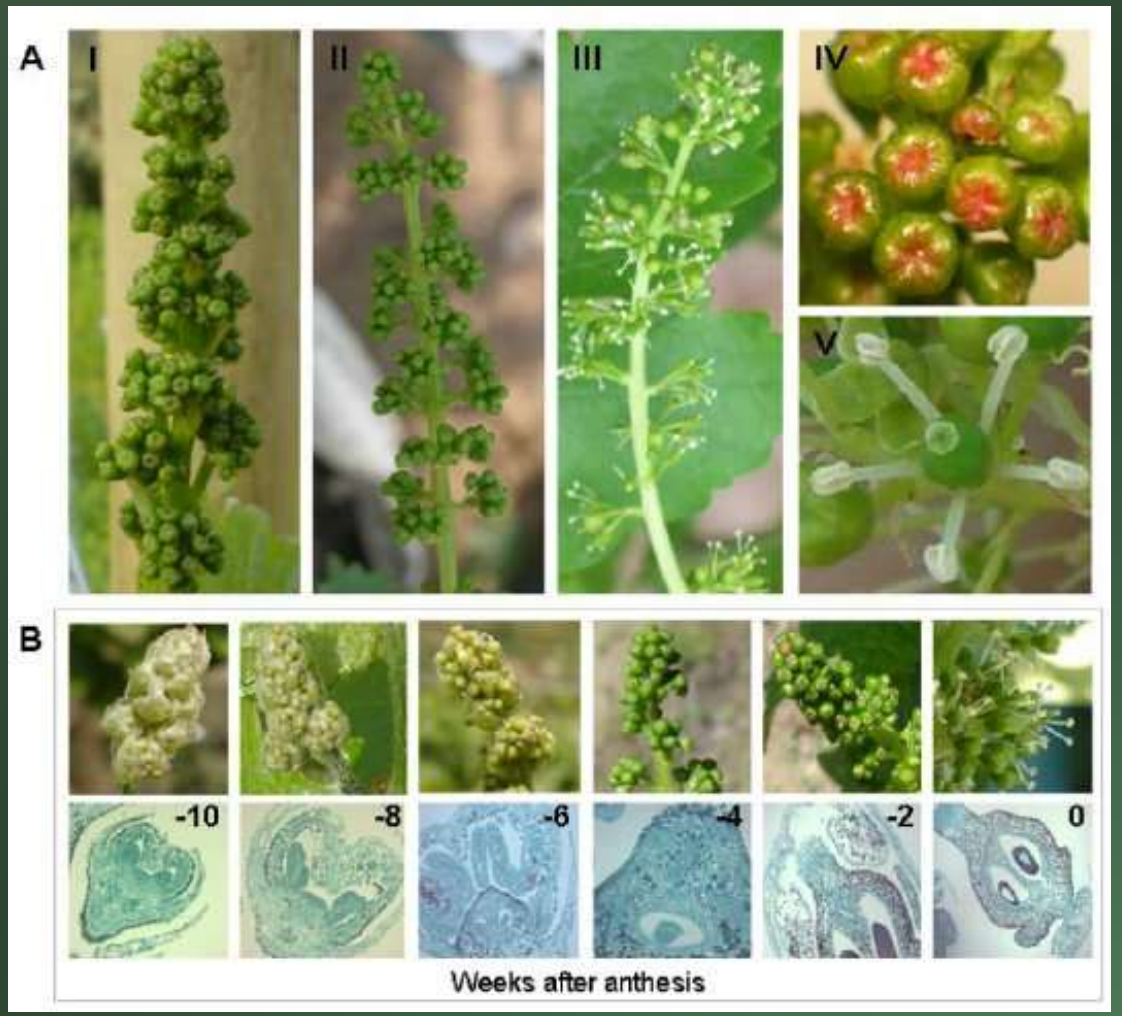
**Pathways of anlage development**
(Mullins et al. 1992).




*https://www.researchgate.net/publication/286865090_Factors_Controlling_Inflorescence_Primordia_Formation_of_Grapevine_What_Role_in_Latent_Bud_Fruitfulness_-_A_Review/figures?lo=1*

# Viticulture - Biology of the vine_2

## Grapevine Flowers



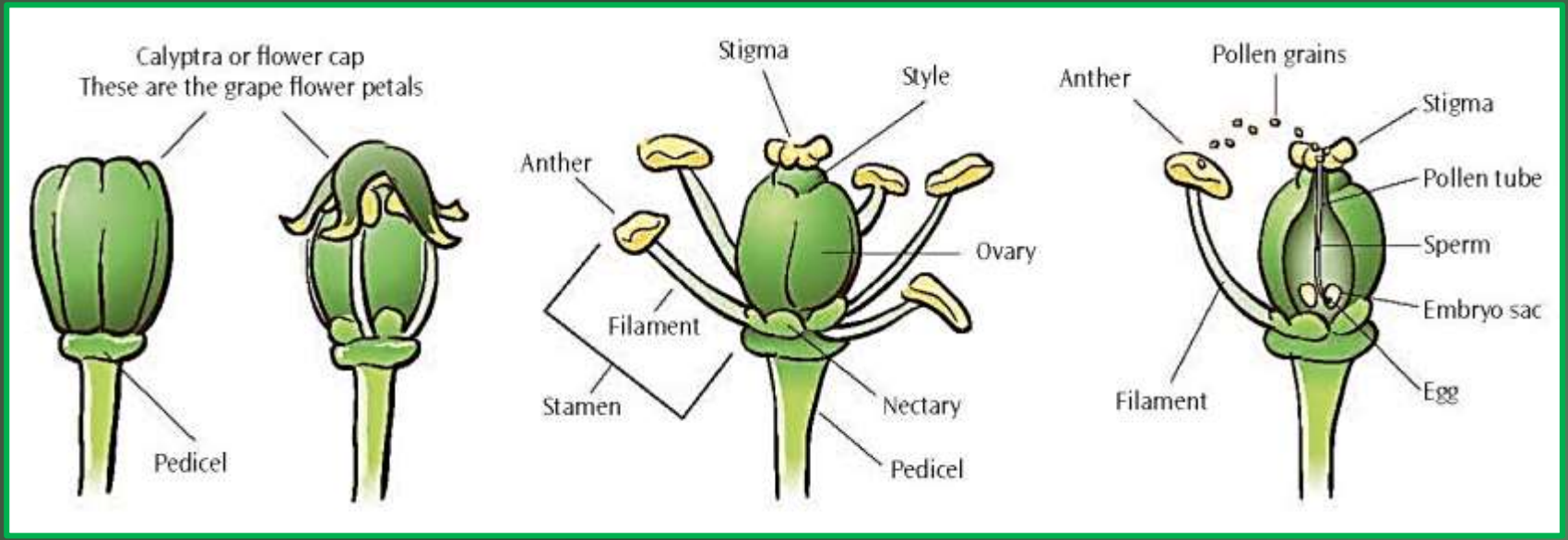

**A.** Different stages of inflorescences, from a very compacted inflorescence (**A, I**), to an elongated raquis (**A, II**). **A, III** shows the beginning of anthesis, where the closed calyptras later fall away (**A, V**).

**B.** Upper panel: Inflorescences at different growth stages until anthesis (Time 0). Lower panel: Microscopy sections stained with Safranin & Fast Green at 20X zoom; at -10 weeks after anthesis small sepals have developed, petals have formed the cap structure, and stamen primordia have also developed. At -8 weeks, stamens are distinguishable and the carpel primordium is observed. At -6 weeks, stamen filaments begin to elongate and developed carpels are observed, in which ovules are formed. At -2 weeks, anther membranes are degraded and mature pollen grains are released, while the cap is still attached to the flower. At this stage an early seed structure has begun to develop. At 0 weeks the development of the seed is observed and the cap has detached from the flower and fallen apart (Poupin et al., 2011).

*https://www.researchgate.net/publication/258868063_Flower_development_in_grapevine_A_tale_of_two_seasons*

# Viticulture - Biology of the vine_2

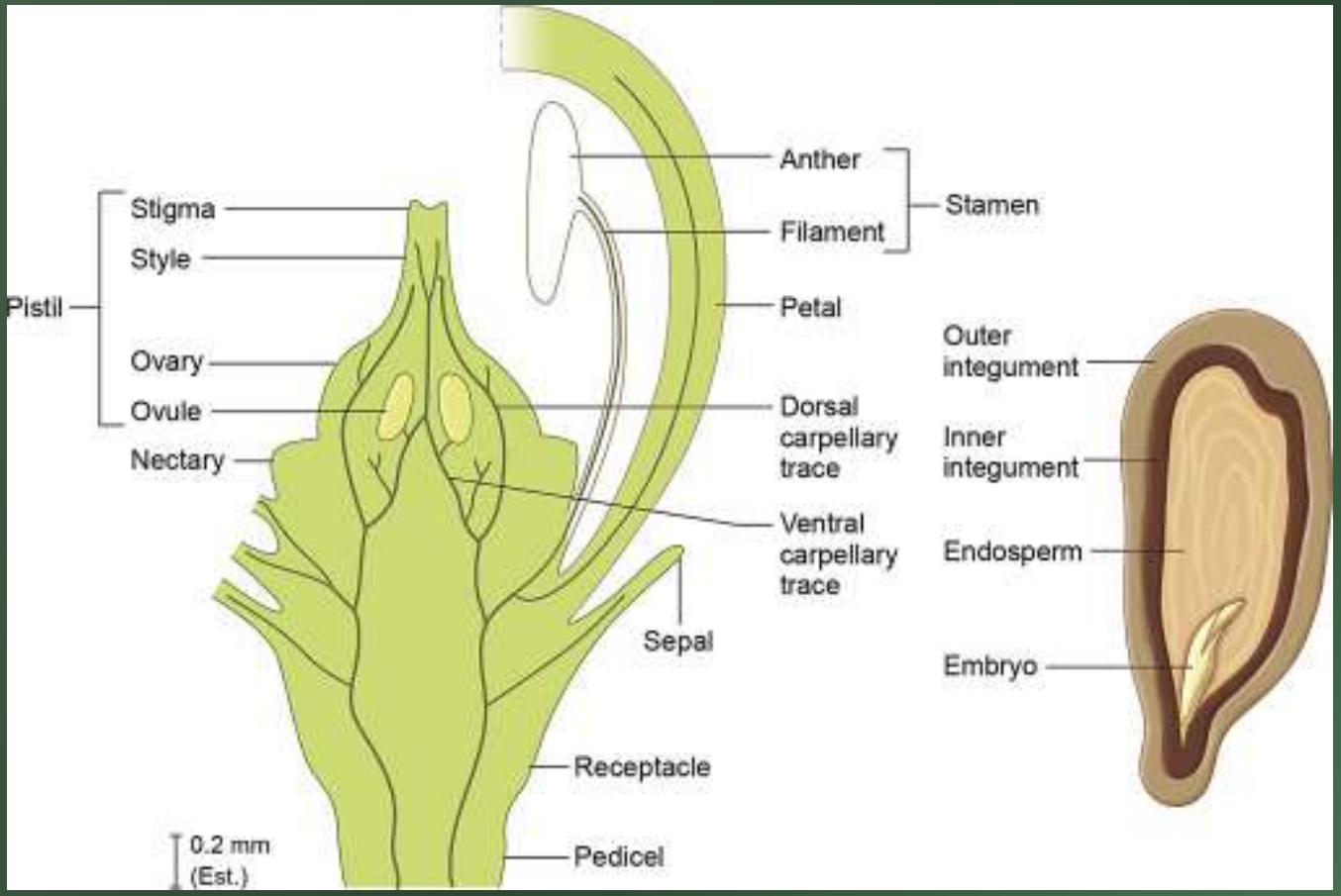
## Grapevine Flowers


*https://www.lodigrowers.com/wp-content/uploads/2014/05/Capture3.jpg*
*https://grapes.extension.org/parts-of-the-grape-vine-flowers-and-fruit/*

# Viticulture - Biology of the vine_2

## Grapevine Flowers




Diagrammatic longitudinal section of a Vitis flower (left), longitudinal section of a Vitis seed (top right).

*Left: © Elsevier Inc., illustration after Rafei, M.S., 1941. Anatomical studies in Vitis and allied genera. I. Development of the fruit. II. Floral anatomy. PhD thesis, Oregon State College; right: © Elsevier Inc.*
*https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/tendril*

# Viticulture - Biology of the vine_2

## Bud fertility – factors that affect it

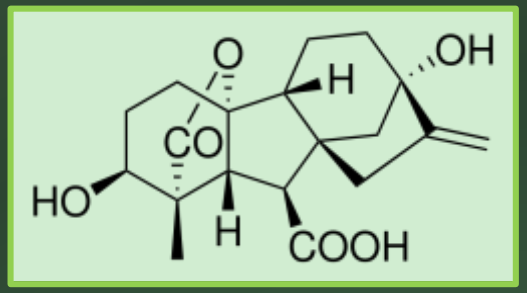
- Balanced production, good relationship between leaf area and fruits, balanced nutrient fertilization, canopy control, and good health condition of the leaves, increase bud fertility
- Light: shading reduces bud fertility
- Photoperiod: does not have much effect
- Temperature: has a positive effect during the period of inflorescence differentiation
- Lack of water: reduces inflorescence differentiation by reducing photosynthesis intensity
- Position of the buds on the vine: at the base and the tip of the shoots they have less fertility – higher towards the middle of the shoot - the inflorescences of the base also have fewer flowers

# Viticulture - Biology of the vine_2

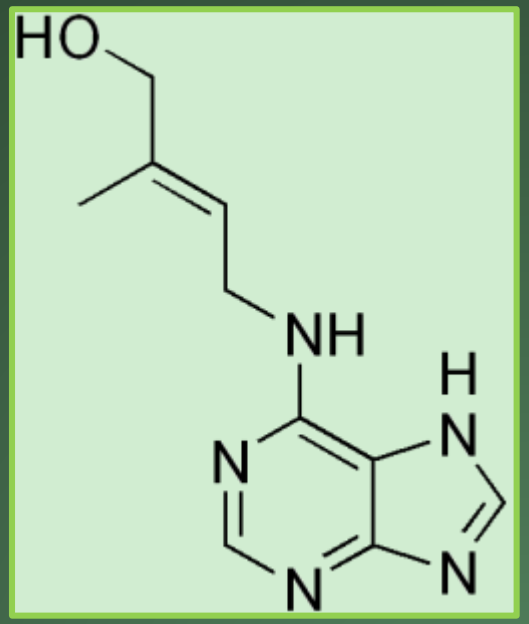
## Bud fertility - factors

**Intrinsic factors (growth regulators & inhibitors):**

- **Gibberellins** (plant hormones – diterpenoid acids): they have an inhibitory role in inflorescence differentiation - conversion of lateral meristems into tendrils
- **Cytokinins** (**Zeatin**): they have a decisive effect on the differentiation of inflorescences - conversion of tendrils into inflorescences - conversion of male flowers to females
- **Growth inhibitors**: they have a positive effect on inflorescence differentiation by inhibiting vegetation, inhibiting gibberellin biosynthesis and promoting cytokine synthesis




*Gibberellin A1*




*Zeatin*

*(E)-2-methyl-4-(7H-purin-6-ylamino)but-2-en-1-ol*

# Viticulture - Biology of the vine_2

## Grapevine tendrils

- They are shoot supporting organs
- They are located at the nodes (after the 3rd or 4th node) and are always found opposite to the leaf
- They have similar anatomy to the shoot
- They have fortified epidermis, hair, and some stomata
- When they come in contact with an object, they stop growing and continue to grow on the opposite side of the tendril. This induces twining of the tendril around the object touched, so that they eventually rotate around it

*Vitis* shoot tip showing tendrils with 2 and 3 tips (left) and tips of a tendril coiling around a trellis wire (right).
Photos by M. Keller.
*https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/tendril*

- With the development of collenchyma cells in the cortex and xylem, and lignification of the ray cells, the tendril becomes woody and rigid at maturity.
- They usually have 2 tips, but vigorous vines often form tendrils with 3 or more tips

# Viticulture - Biology of the vine_2

## Grapevine tendrils

Intermediary forms of Syrah inflorescence/tendril/shoot and structure of a grape cluster with berries removed (left; inset: inflorescence that would rather be a tendril; photos by M. Keller) (right; illustration by A. Mills; inset reproduced from Viala and Vermorel, 1909).

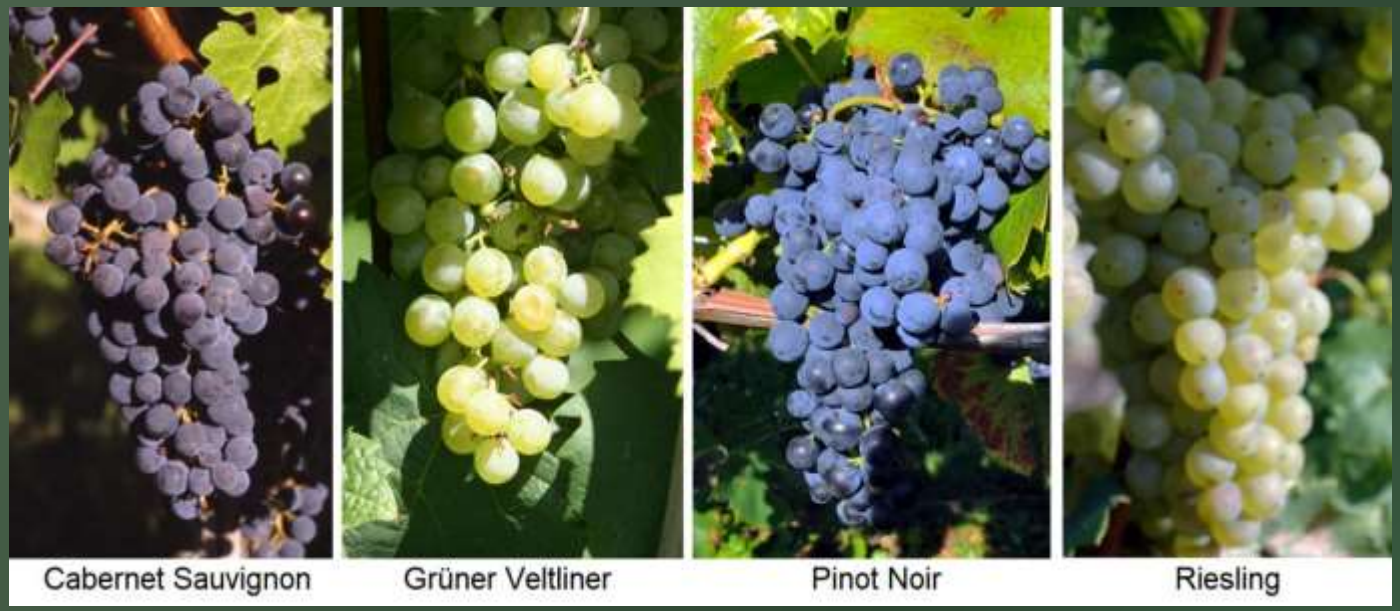
*https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/tendril*

# Viticulture - Biology of the vine_2

## Grapevine berries

- The berries are an evolution of the ovary after fertilization
- Their number is smaller than the flowers due to losses (non-fertilization, fall, drying) and varies depending on the conditions
- Their shape, size and other characteristics serve to differentiate the varieties
- They make up 90-98% of the weight of the grapes

# Viticulture - Biology of the vine_2 Grapevine berries




***Wine grape varieties***

*https://glossary.wein.plus/quality-wine-grape-varieties*


***Table grape varieties***

*https://glossary.wein.plus/table-grape*

# Viticulture - Biology of the vine_2 Grapevine berries

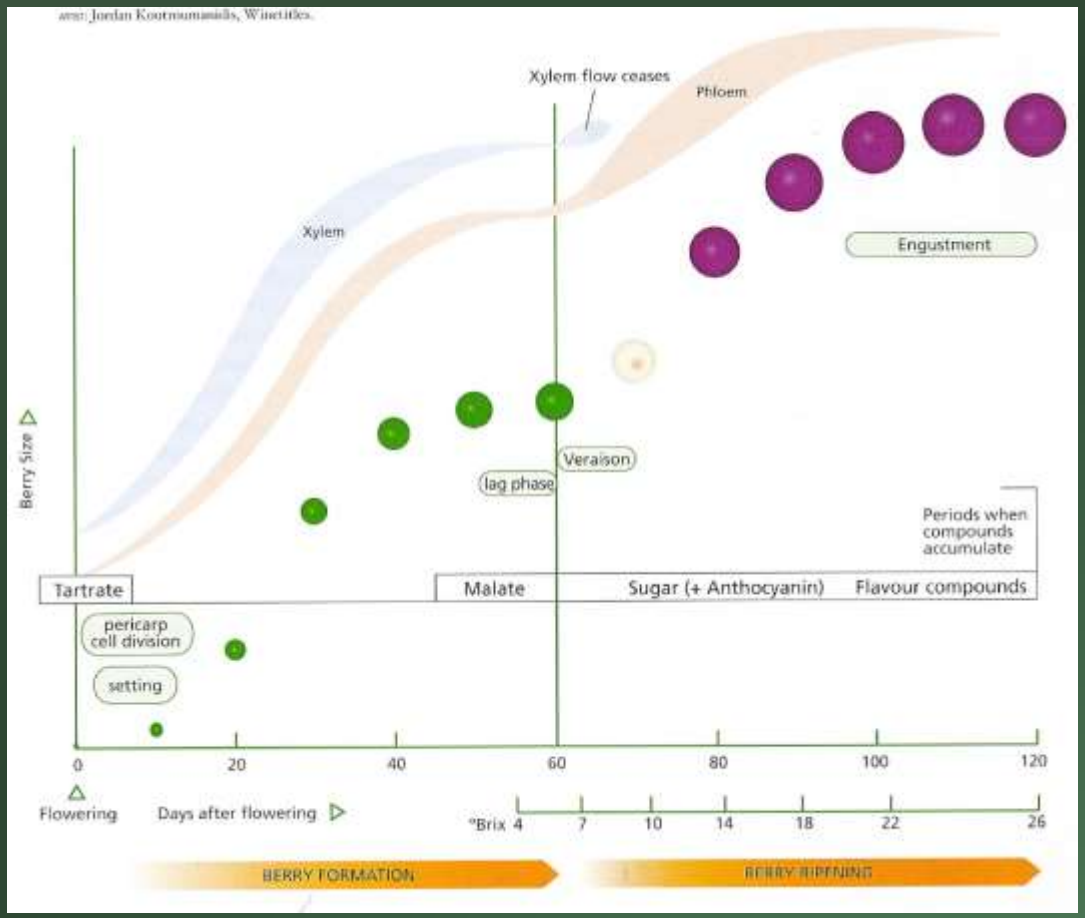
## Berry growth stages

### *Stage 1: Rapid Growth (40 - 60 days)*

The seed increases in size. There is a rapid increase in berry size due to cell division in the first 2 weeks. The berry remains hard, acid is high and sugar levels almost constant.

### *Stage 2: A lag stage of nil or slow growth (7 - 40 days)*

The 'lag phase' is a period when either less growth or no growth in volume occurs. The boundary between stage 2 & 3 is often unclear.




### *Stage 3: Growth resumes and maturation begins (~ 35 - 55 days)*

The onset of Stage 3 is signalled by **veraison**, the point of sudden change in colour. During this stage, the berry softens, acid levels decrease, sugar accumulates, varietal flavours and aromas develop. The rapid increase in berry volume is due to cell enlargement.

*https://www.viti.com.au/pdf/MVWGG%20Fact%20Sheet%20-%20Grapevine%20Biology.pdf*

# Viticulture

## Biology of the vine_2

ARGYRO BEKATOROU
Associate Professor of Food Chemistry & Technology

Patras 2022