PLS 597-006
Lecture 10

Flowering and Fruiting

Regulation of Flowering in the Grapevine

- To review
  - 3 step process
    - Formation of uncommitted Anlagen (primordia)
    - Anlagen develop either as inflorescence or tendril primordia shortly after entering into dormancy
    - Formation of flowers from the inflorescence occur at the time of bud burst

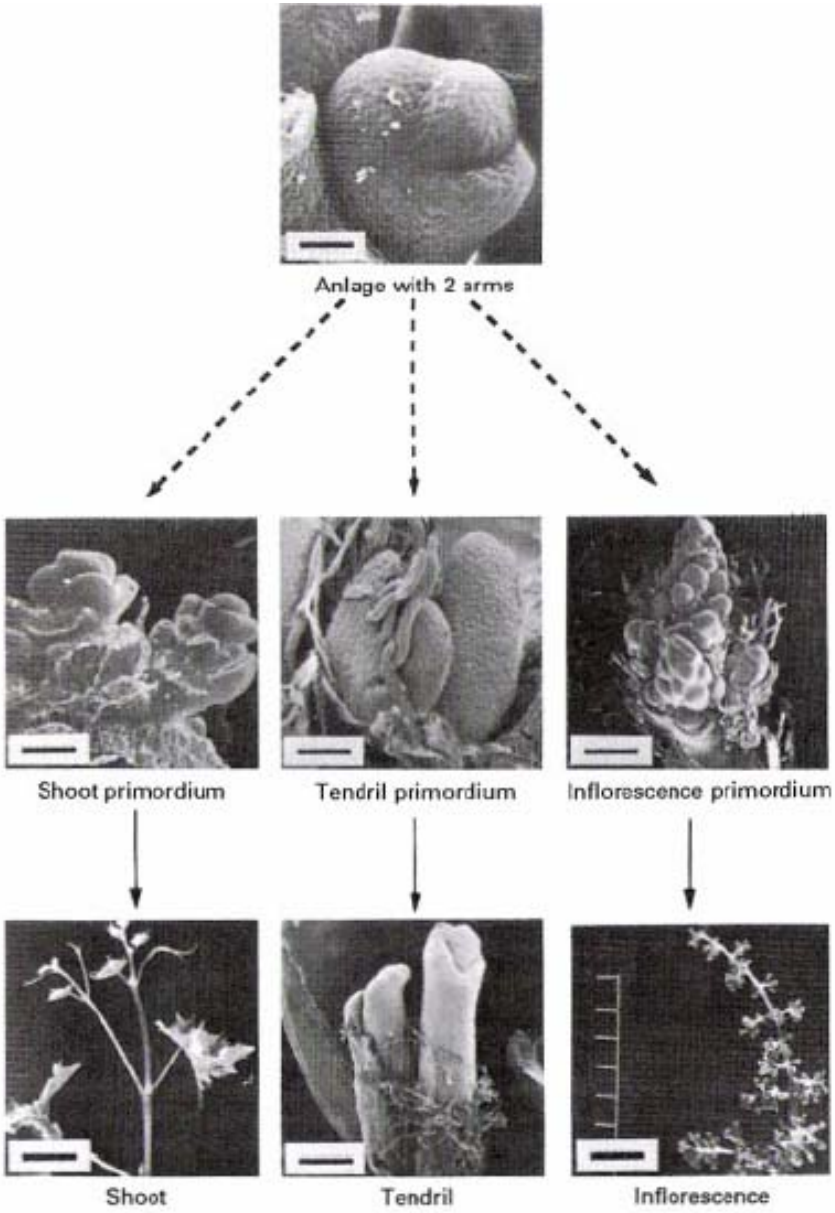
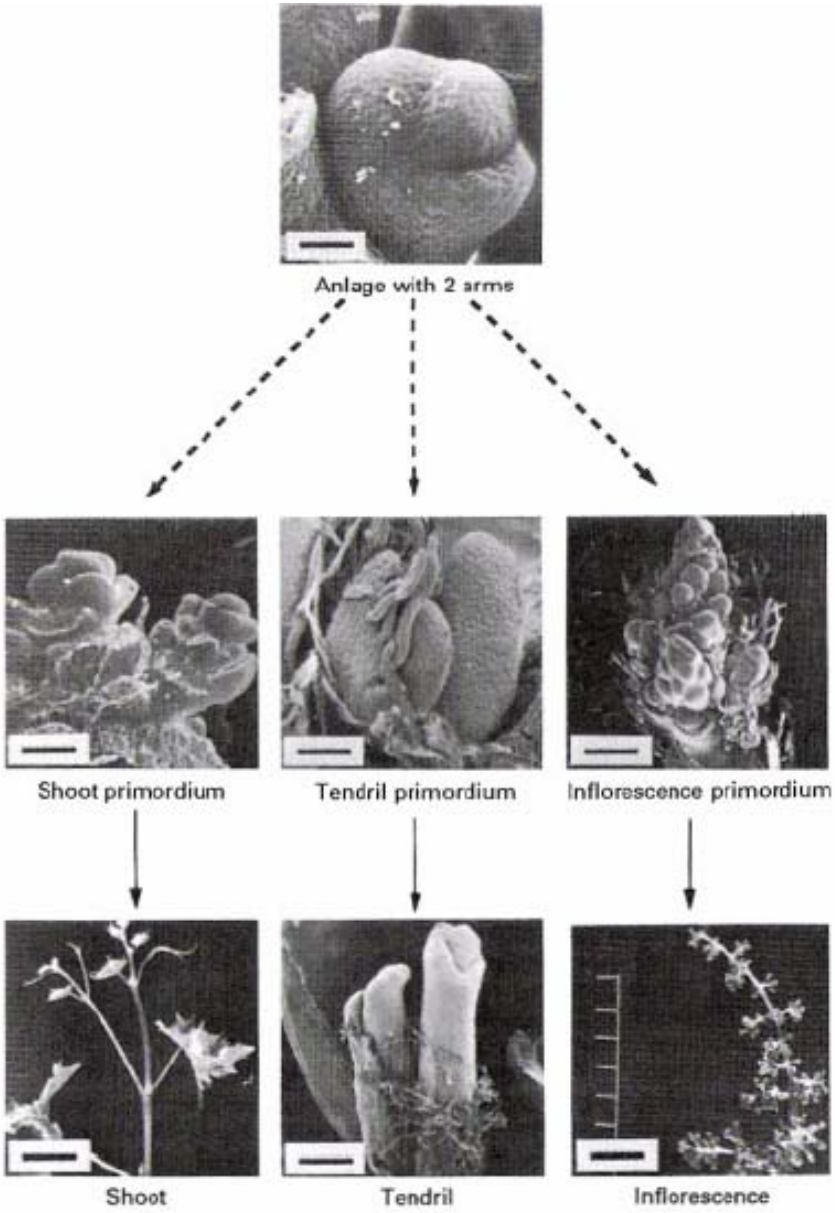


Fig. 5.1. Pathways of Anlage development. Anlage with two arms (bar = 64 µm); shoot primordium (bar = 230 µm); tendril primordium (bar = 105 µm); inflorescence primordium (bar = 400 µm); shoot (bar = 53 mm); tendril (bar = 800 µm); inflorescence (bar = 32 mm). Dotted lines refer to potential to switch from one pathway to another under influence of phytohormones. From Mullins (1980). Reproduced with permission

Hormonal Aspects of Flowering

- Regulation of Anlagen and Tendril formation
  - Anlagen divides into 2 branches
  - These two branches have the potential to form either tendril primordia, inflorescence primordia or shoot primordia



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- Shoot formation from Anlagen is rare
- Flowering is controlled at two levels
  - Coarse: The formation of the Anlagen
  - Finer: Switching of the two-branched Anlagen into either tendril or inflorescence pathway

Finer Level of Control

- The Case for Tendril formation
  - GA
  - Involved both in the formation of the Anlagen and the determination of its development
  - 3-30 uM of GA application to Sultana whole plants
    - Premature sprouting
    - Elongation of latent buds
    - Anlagen formation precociously

- 3-30 uM GA application to the Anlagen
  - Tendril primordia formation
  - Inflorescence formation inhibited
- GA is the phytohormone required for Anlagen formation
  - Chlormequat application (GA biosynthesis inhibitor) inhibits
    - Anlagen formation

Differentiation of Inflorescence

- Tendrils and Inflorescence are homologous organs
- Anlagen that goes thru repeated branching
  - Inflorescence
- Anlagen that DOES NOT go thru repeated branching
  - Tendril

- Phytohormonally controlled
- [Cytokinin] favors repeated branching of the Anlagen
- [Cytokinin] Anlagen grows into inflorescence
- Benzyladanine, PBA, and zeatin (cytokinins) cause Anlagen to repeatedly branch and form inflorescence

Induction of Precocious Flowering in Seedlings

- In seedlings
  - Treatment of Tendrils
  - 250uM of chlormequat + 500 uM of PBA
  - Prolific flower formation
- Ease of conversion and size of clusters
  - Varies with cultivar
  - Age of seedling

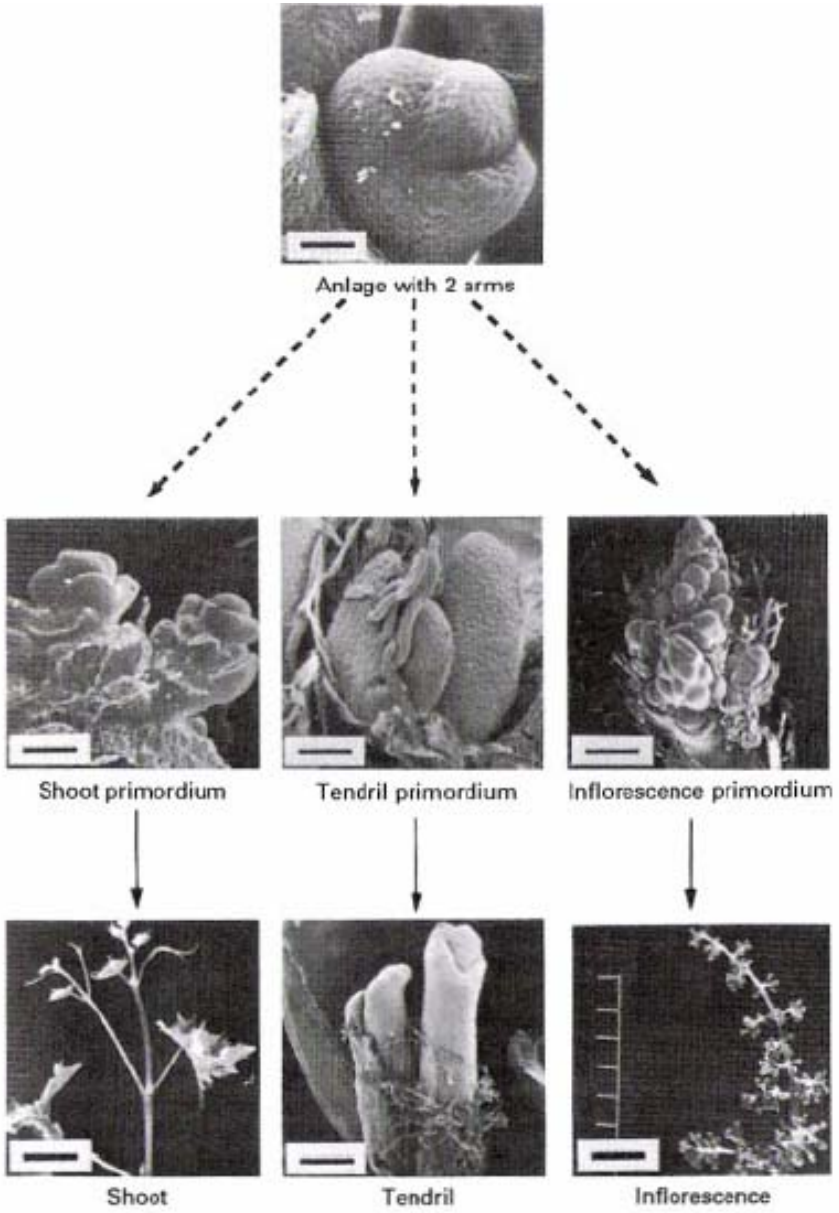
Effects of Cytokinins on Differentiation of Flowers

- Dormant latent buds
  - Activated in the spring
  - Inflorescence primordia formed summer undergo rapid development to form the flower primordia

- Flower formation is a cytokinin controlled process
- Xylem sap contains high [cytokinin] in spring during bud break
- Moves acropetally to the buds from the roots

Summary of Hormonal Control of Flowering

- Regulated at two leves
  - Anlagen formation
  - Differentiation of Anlagen
- At an earlier stage GA is a promoter of flowering
- Later stage GA is an inhibitor of flowering
- Cytokinins are involved in the differentiation of inflorescence



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Environmental Factors in Flowering

- Temperature
  - Requirement for high temperatures for inflorescence formation in grapes
  - Positive relationship between temperature from mid-June to mid-July and the # of inflorescence appearing on shoots
  - Higher temps. During stages 5-7 of latent bud development are correlated to fruitfulness of latent buds

- Critical period for temperature
  - Three weeks before the formation of Anlagen in the latent bud
  - A pulse of only 4h of day or night temperature of 30C is sufficient to induce maximum number of inflorescence primordia during stage 7.

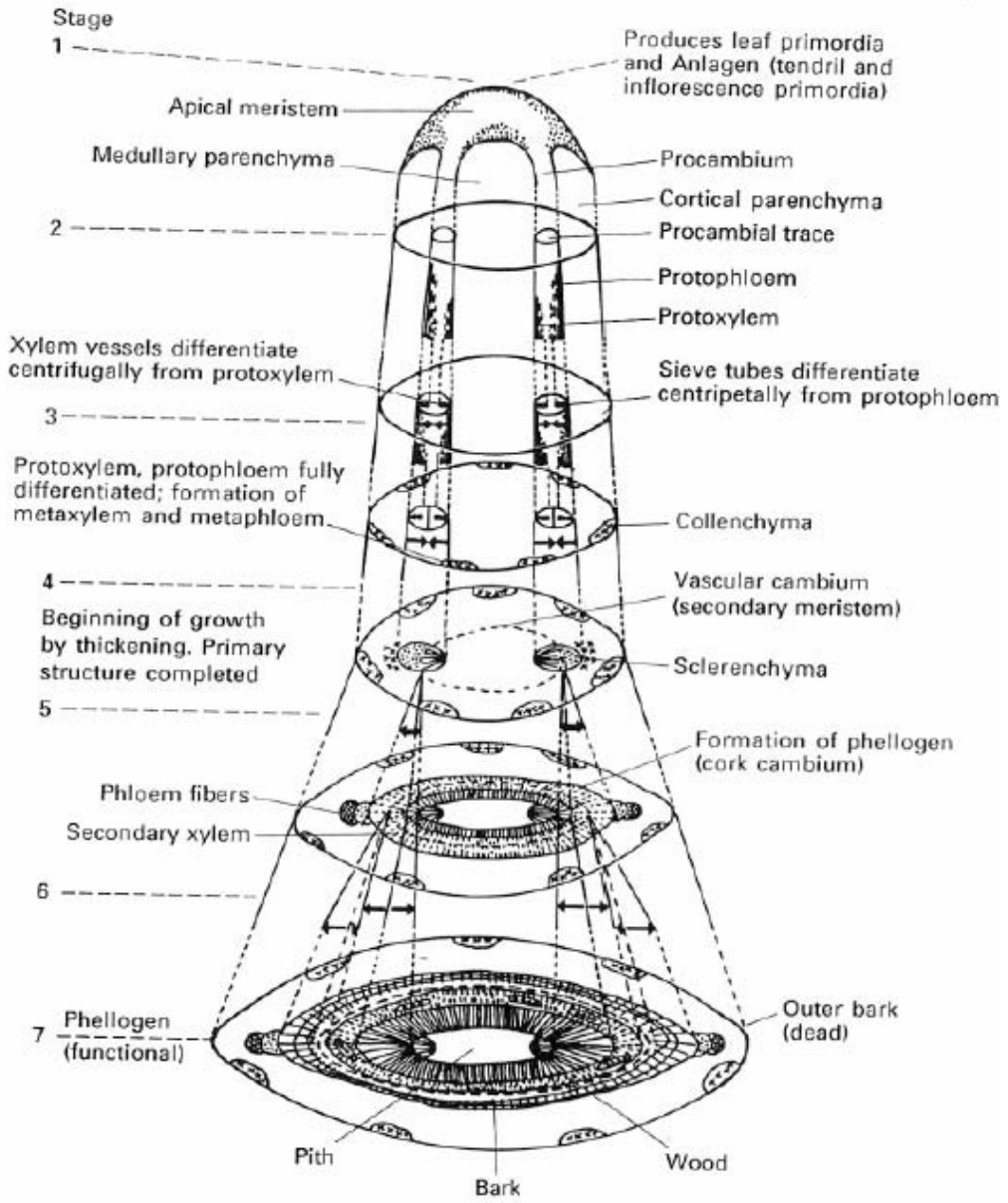

Fig. 3.13. Developmental anatomy of the grapevine cane. From an original drawing by Dr. J.C. Fournioux, Universite de Dijon. Reproduced with permission

- Cultivar dependent
  - Riesling and Shiraz
    - 20C
  - Muscat types
    - 25-28C
  - Hybrids
    - 21C
  - Shy-bearing cultivars
    - 30C

- Light intensity
  - Independent of temperature
- Shading reduces fruitfulness
  - A mean of 10h sunshine per day during inflorescence formation is needed
  - Less than 26% of sunlight during summer and autumn will decrease inflorescence formation in the latent bud
- Vertically trained shoots (VSP, SH, GDC etc)
  - More fruitful than horizontally trained shoots (Pergola)

- Buds inside the canopy
  - Less fruitful than exterior buds
  - GDC improved fruitfulness of buds
    - Increase by 50%-90%
- Response is cultivar dependent
  - Sultana, Shiraz only fruitful at light intensity >1950 uE
  - Riesling, Cab Sauvignon become fruitful at light intensities >1600uE

Photoperiod

- Does not affect induction of inflorescence in grapes
  - Some cultivars have > number of inflorescence primordia per bud under longer days than shorter days

- American species and hybrids are more sensitive to day length than vinifera
- Concord, Norton, Delaware grown in long days
  - Formed 3 x more inflorescence compared to ones grown in shorter days

Summary of Temperature, Light Intensity, Photoperiod

- Temperature is the dominant factor
- Light is the limiting factor
- Combination of exposure to high temperatures and high light intensity is necessary for optimum fruitfulness of buds

Water Stress

- Persistent water stress depresses fruitfulness of latent buds
  - Rain-fed buds usually bear fewer fruitful buds than irrigated vines
- Soil moisture is one of the chief factors influencing flower development in grapevines

- Reduced foliage density (leaf layers) of water stressed vines
  - Improves exposure of latent buds to light intensity
    - Leads to increased fruitfulness of the vine

- Shoot growth: Sensitive to water stress
  - Reduction in both bud fruitfulness and dry mass of shoots
- Water stress affects fruitfulness indirectly
  - Reduction in photosynthesis
  - Decrease in cytokinins xylem sap
  - Increase in ABA in leaves and stems

Mineral Nutrition

- Nitrogen
  - An adequate supply of N is required
    - Inflorescence primordium formation
    - Differentiation of flowers
  - Size of primordia is not affected by N nutrition
    - In N deficient vineyard, N application increases primordia formation
  - Overapplication of N results in reduction of fruitfulness

- Phosphorus nutrition
  - Promotes bud fruitfulness
  - Phosphate deficiency is detrimental to inflorescence formation
- Cultivar dependent again

- Shy bearing cultivars
  - Sultana, Norton
    - Low N, high P and water stress = high bud fruitfulness
    - Petiole P content is positively correlated with yield of these varieties

- Potassium (K) nutrition
  - Soil applications of K
    - American and hybrid varieties
  - Increased fruitfulness of latent buds in NY, MI
  - Soil applications of K
    - Sultana
  - Increased fruitfulness of latent buds

Conclusions

- Flowering is regulated by gibberellin and cytokinin interaction
  - Xylem sap
    - Contains high [gibberellin]
    - Contains higher [cytokinin] during bud burst
- Specific effect of roots on inflorescence development
  - Source of phytohormones

- External factors
  - Short-term exposure to high temperatures
  - High light intensity
  - Optimum levels of soil moisture
  - Macronutrients
- All promote cytokinin production

- Low light intensity, low temperature, Water stress
  - Inhibitory effect on cytokinin formation endogenously

- Tuesday
  - Fruit growth and Regulation
  - Reading Assignment pp 408-412 in G&H
  - Exam the following Tuesday