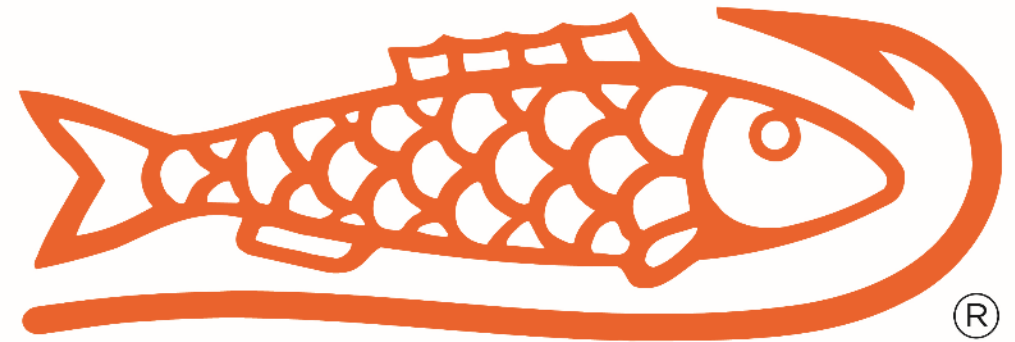


# Before We Begin

- Wi-Fi Access
  - Network: Oakville-Guest
  - Password: V&E@Oakville
- A Special Thanks to Bahco
  - Without a second thought, they donated the pruners we will be using tomorrow
  - (They are also very good at working with FFA and supporting our future viticulturists)



# BAHCO

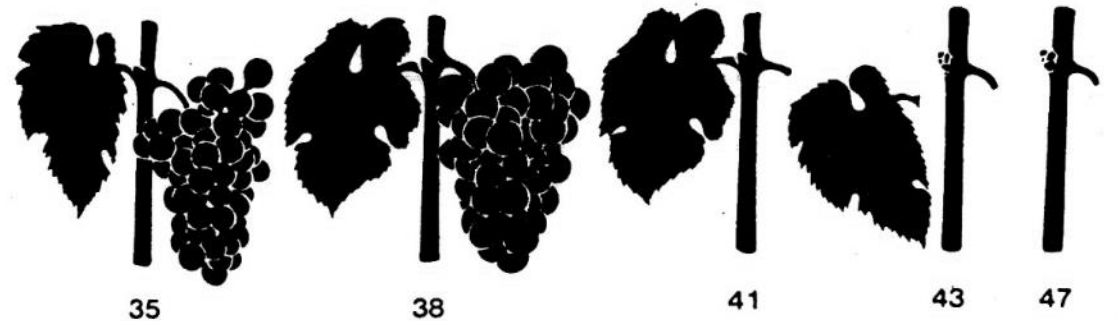
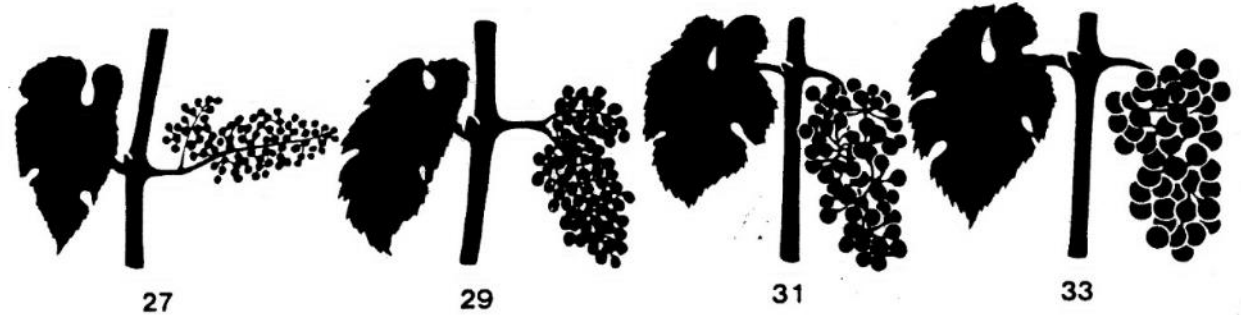
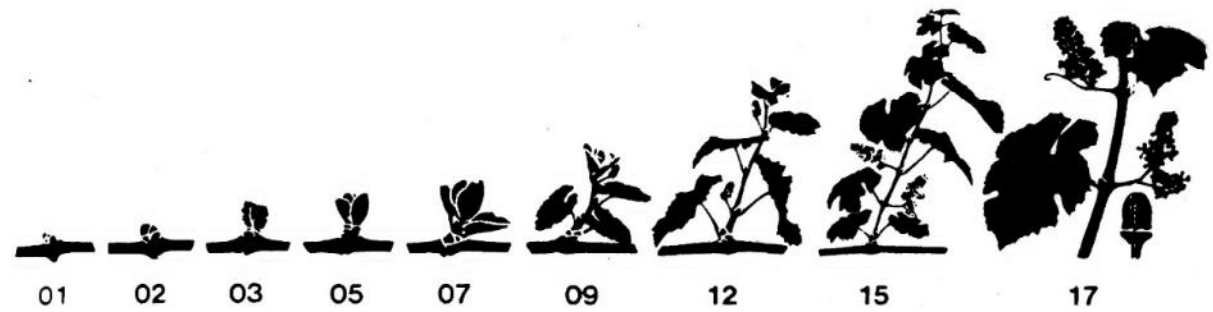
# Grape Growing Cycles

Karl T. Lund Ph.D.

Viticulture Advisor Madera,  
Merced, and Mariposa Counties

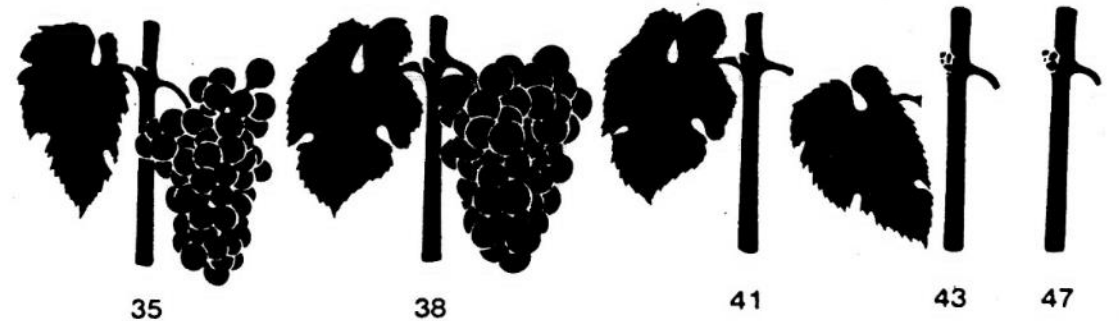
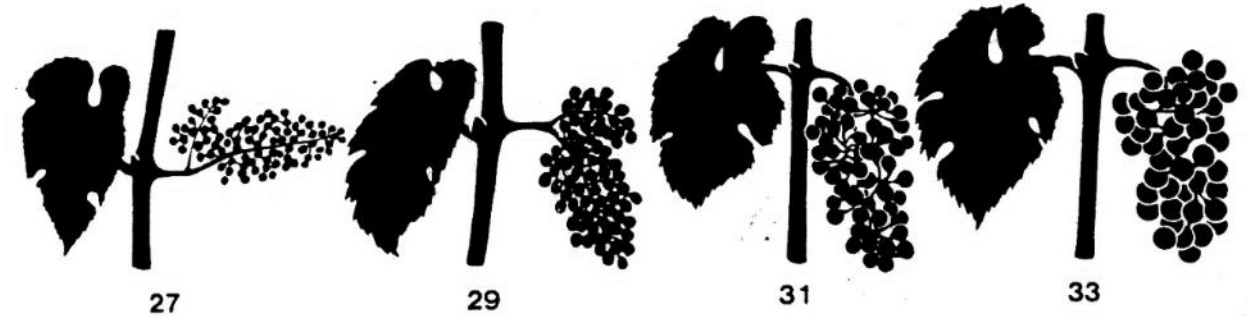
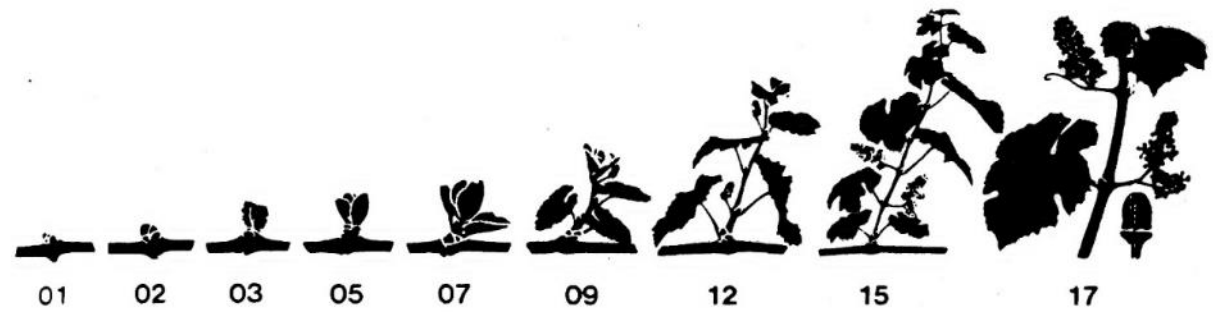
# Grape Life Cycle

- Grapes grow in a yearly cycle
  - Thanks to the dormant bud this is really a two-year cycle
    - More on that later
  - This cycle can be broken down into several steps
    - A 47-step cycle can be seen to the right



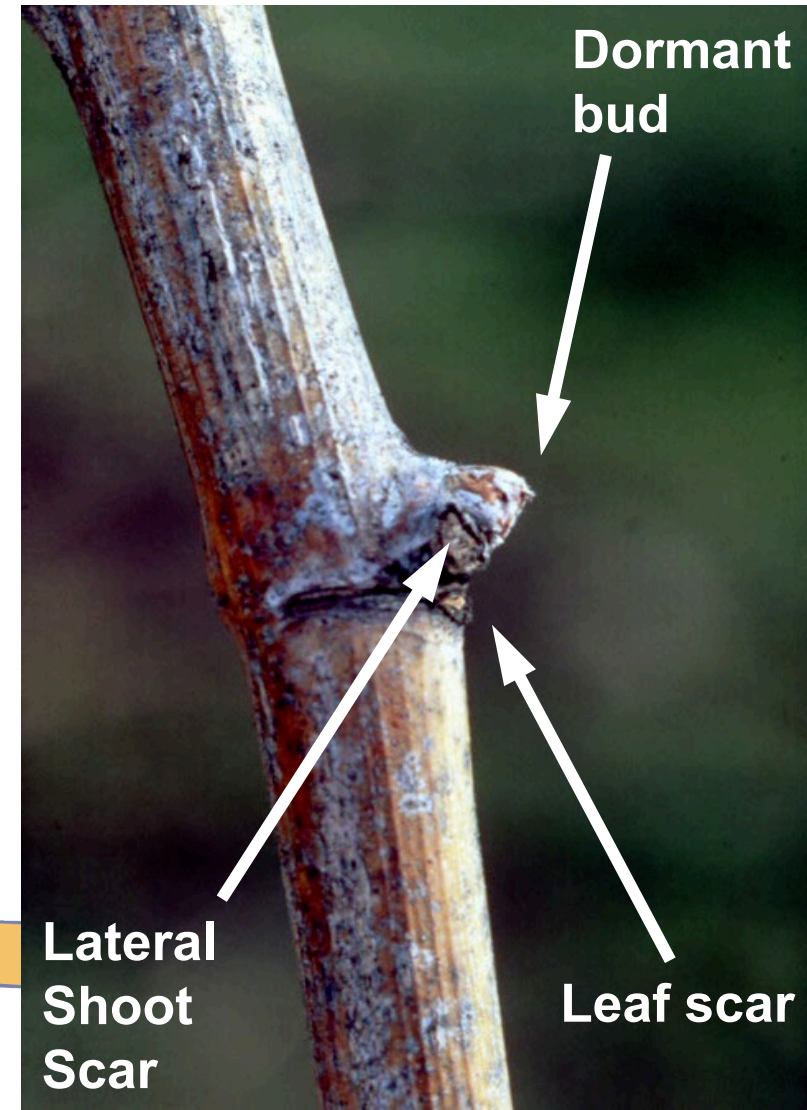
# Grape Life Cycle

- I prefer a simpler Cycle:
  - 1 – Budbreak (02-05)
  - 2 – Rapid Shoot Growth (05-17)
  - 3 – Bloom (19-25)
  - 4 – Berry Set (25-27)
  - 5 – Veraison (29-31)
  - 6 – Fruit Maturation (31-38)
    - 6.5 – Harvest (38-41)
  - 7 – Leaf Fall (41-43)
  - 8 – Vine Dormancy (47-01)



# Dormant Bud

- The star in the Grape Life Cycle is the Dormant Bud
- Dormant Buds form in every node next to lateral bud/shoot just above where the petiole attached to the stem
  - Dormant Bud: requires a dormancy period prior to activation.
    - 200 hours below 37° F, 3° C



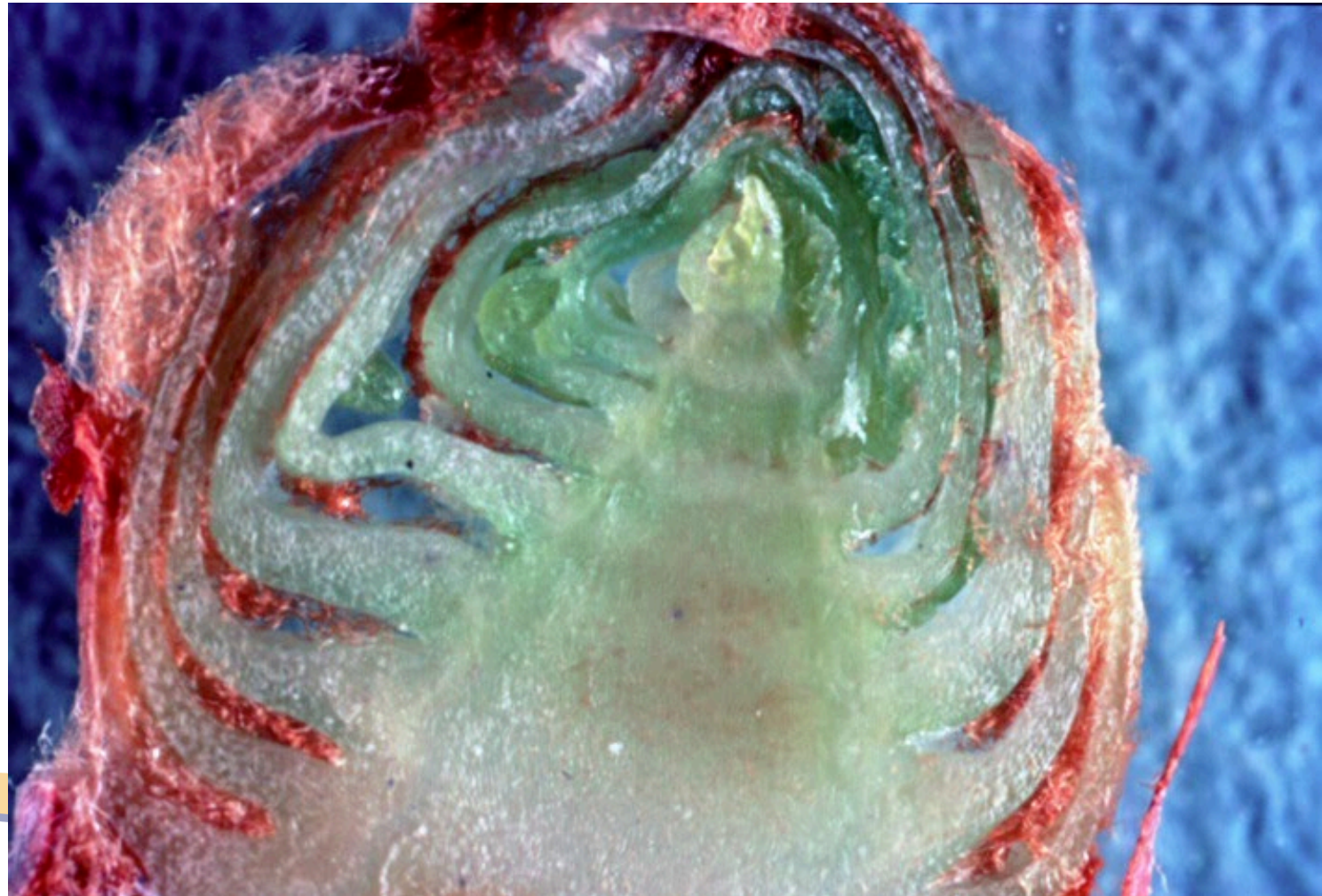
# Dormant Bud

- If we look even closer at the dormant bud we can see a hard outer layer of bud scales, and fuzzy tomentum (plant hair) leaking out from the cracks
- The bud scales and tomentum are there to protect the growing bud within



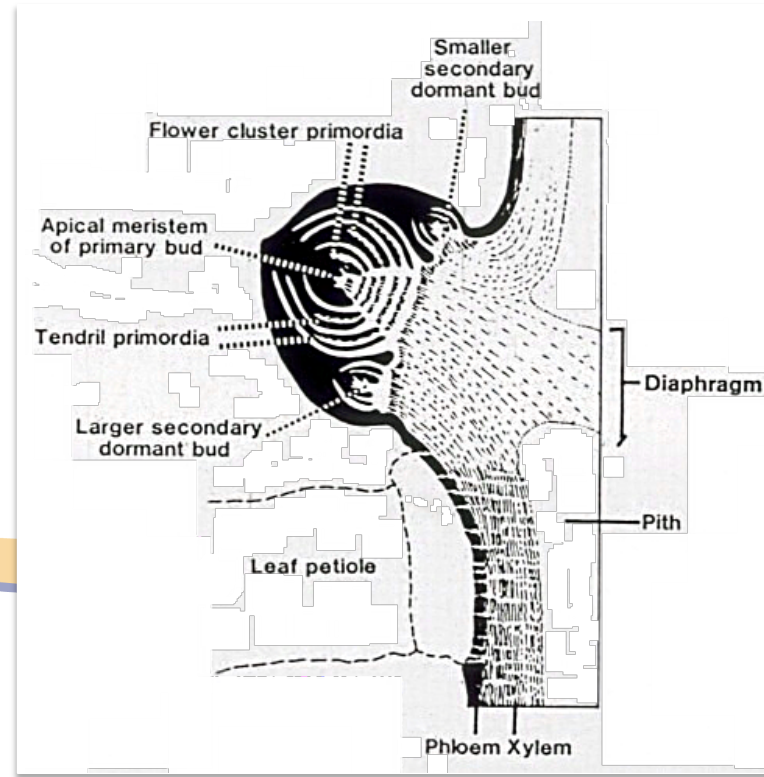
# Dormant Bud

- Dormant Buds are actually compressed shoots ready to expand



# Dormant Buds

- A dormant bud is actually 3 compressed shoots
  - A large primary bud in the middle
    - Houses “all” the fruit for next year
  - Two smaller secondary buds in case the primary is damaged
    - “Normally” fruitless



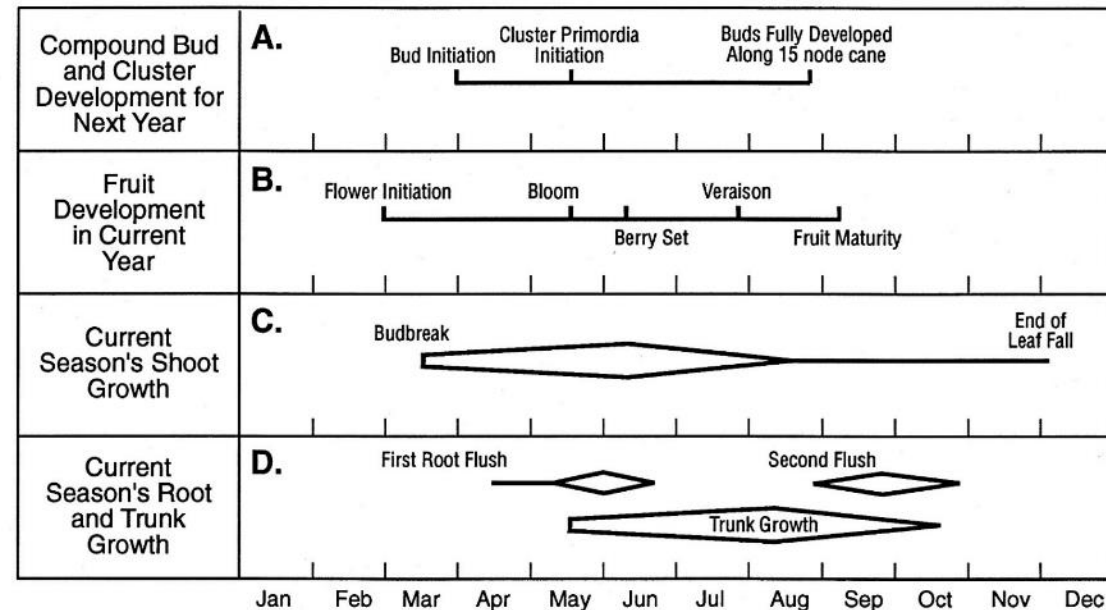
# Dormant Bud

- Following the development of a dormant bud and subsequent growth will allow us to see the full timeline of how your clusters develop every year



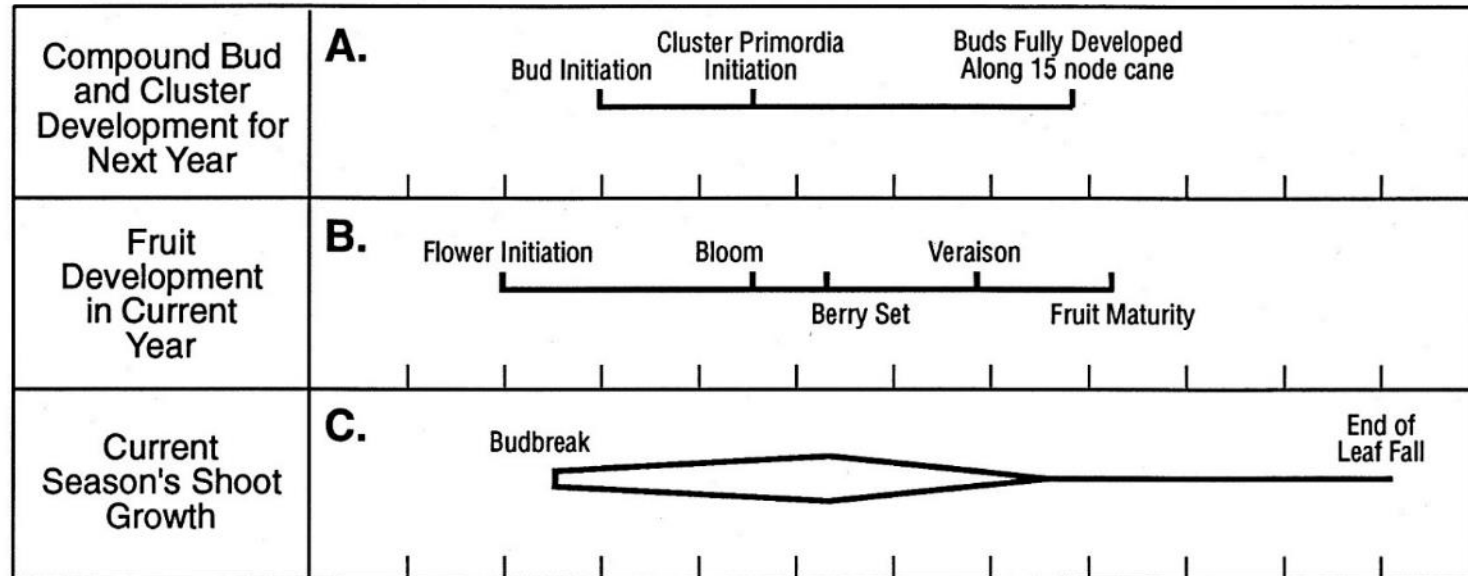
# Grape Life Cycle

- Below we can see a table looking at the development of various parts of the grapevine across a calendar year
- I'm going to cut off the root growth section as it we won't be talking about roots (yet)
- This will also cut off the calendar, as the development of your grapevines will be dependent on what part of the state you grow in



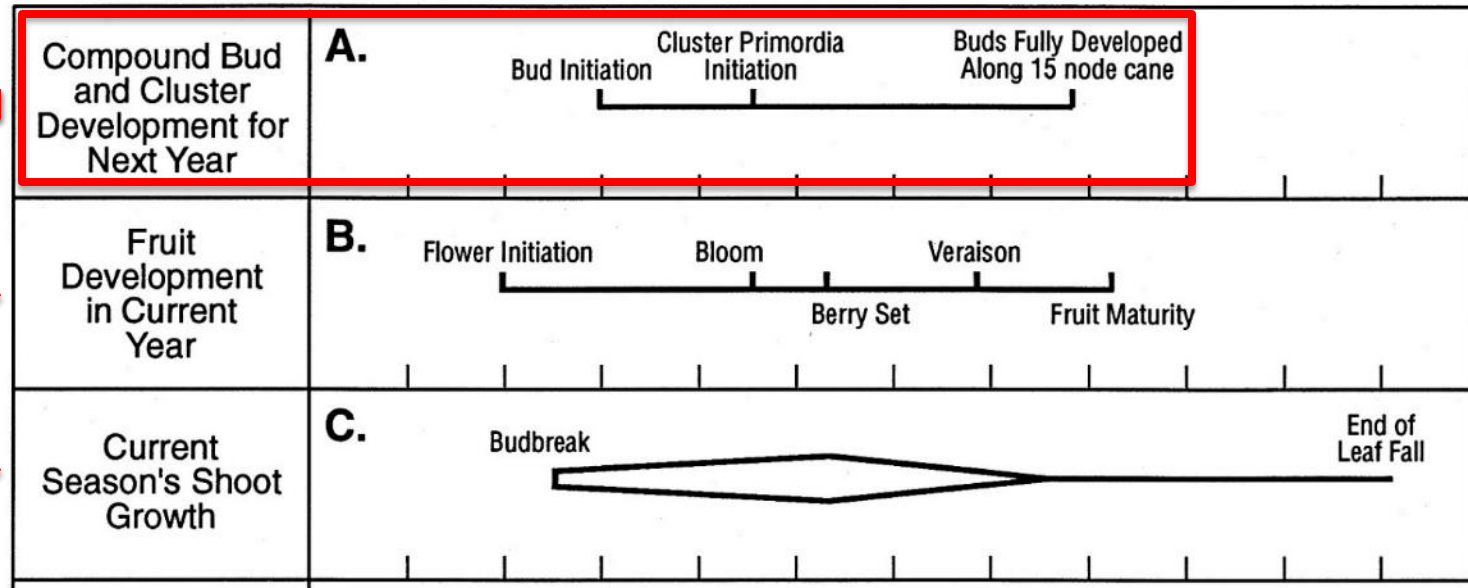
# Grape Life Cycle

- Here we can see the overlapping cycles between
  - A. Dormant Bud development (next years canopy and flowers/clusters)
  - B. This year's flowers/clusters
  - C. This year's canopy growth



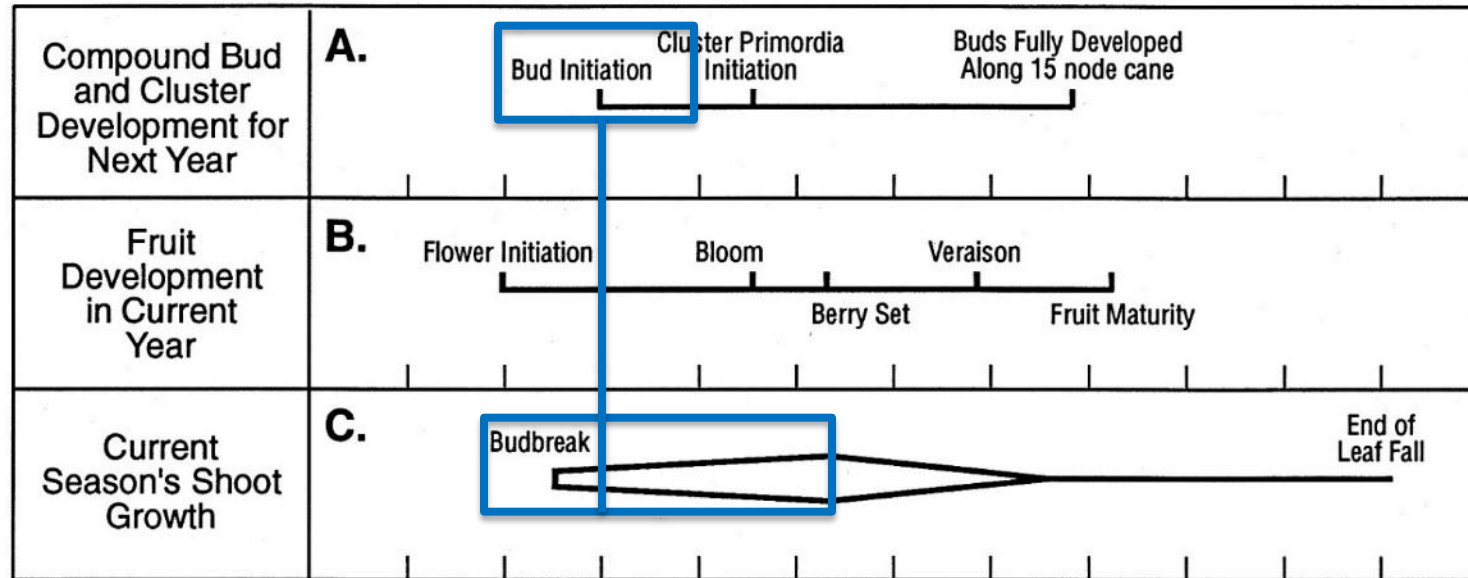
# Grape Life Cycle

- The overlap in development between the dormant buds that will make up next years crops and the development of this year's flowers/clusters and this year's canopy connects the years together



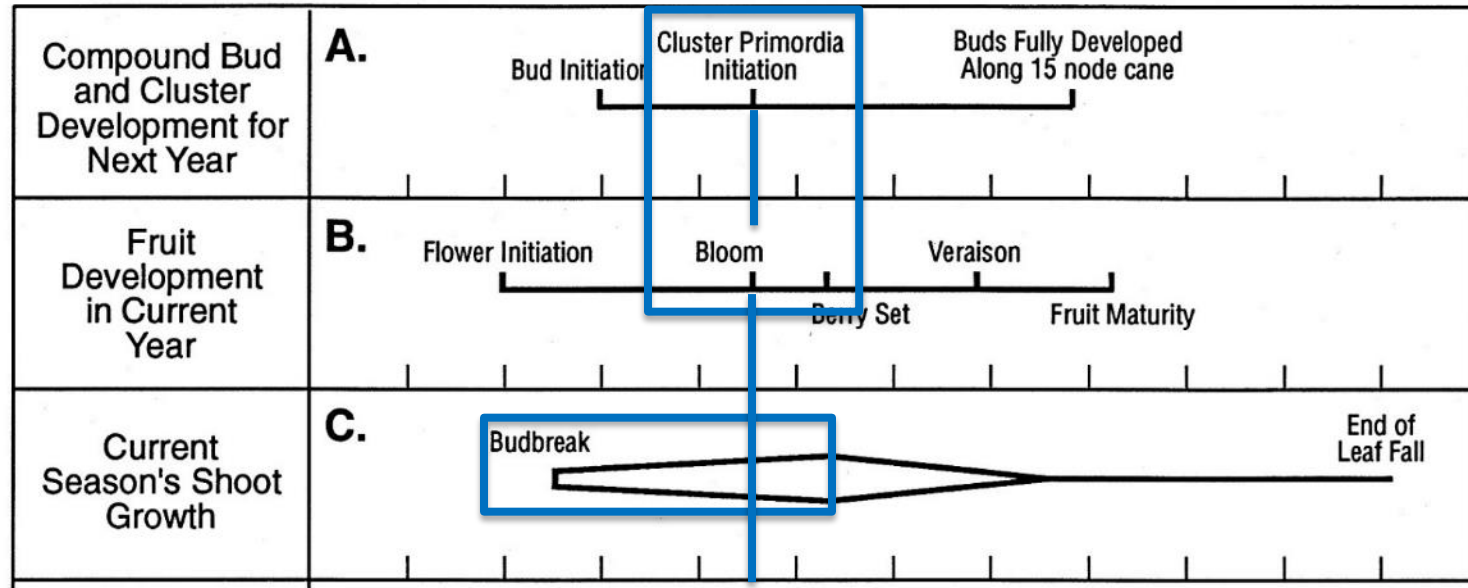
# Grape Life Cycle

- This means that the dormant buds from which your 2025 will sprout started in 2024
- Specifically, the dormant buds that will create your 2025 crop were initiated during the Rapid Growth phase of 2024



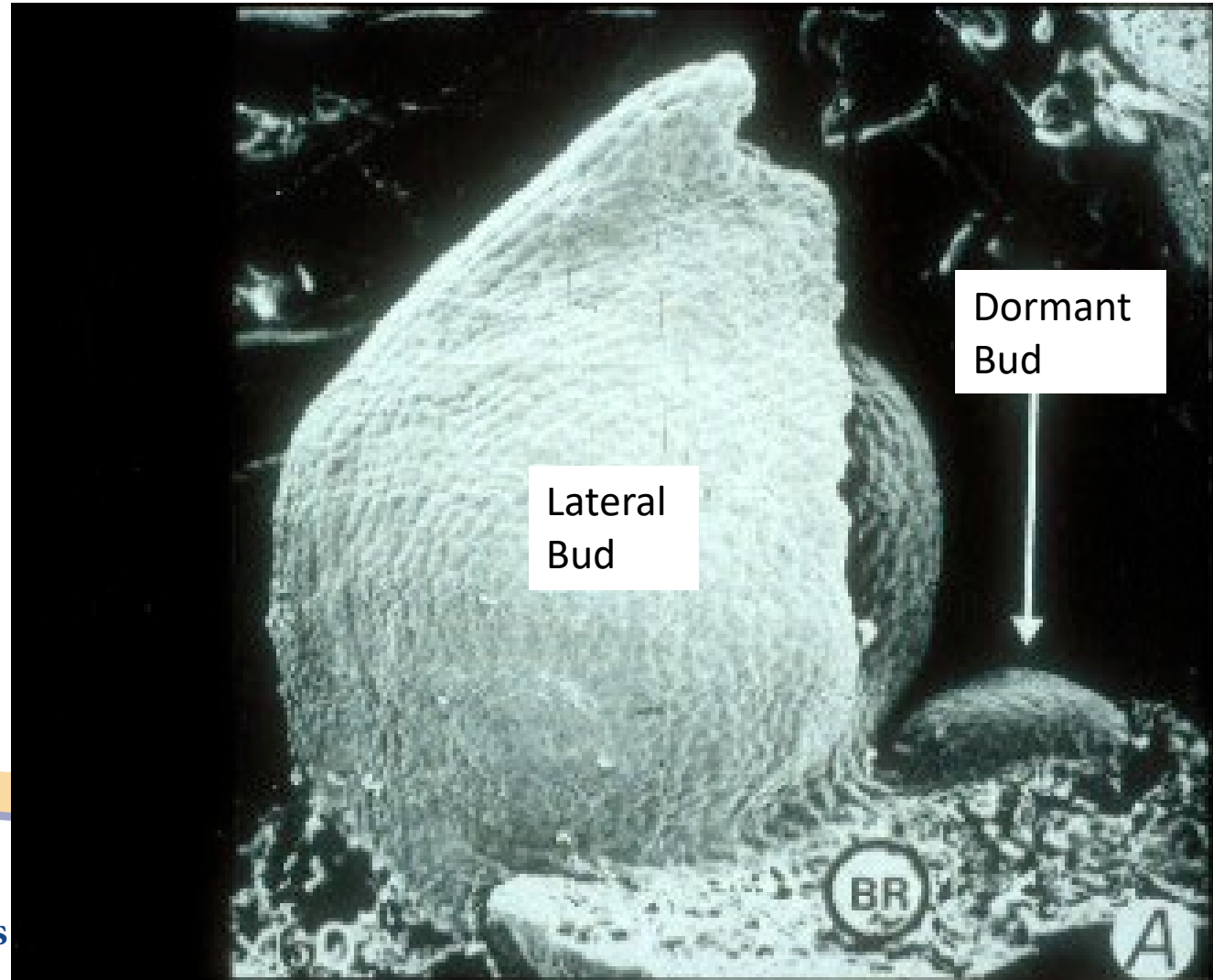
# Grape Life Cycle

- The flower clusters for 2025 were initiated during the 2024 bloom
  - During bloom of 2024, much of what will make up the 2025 harvest was already being determined



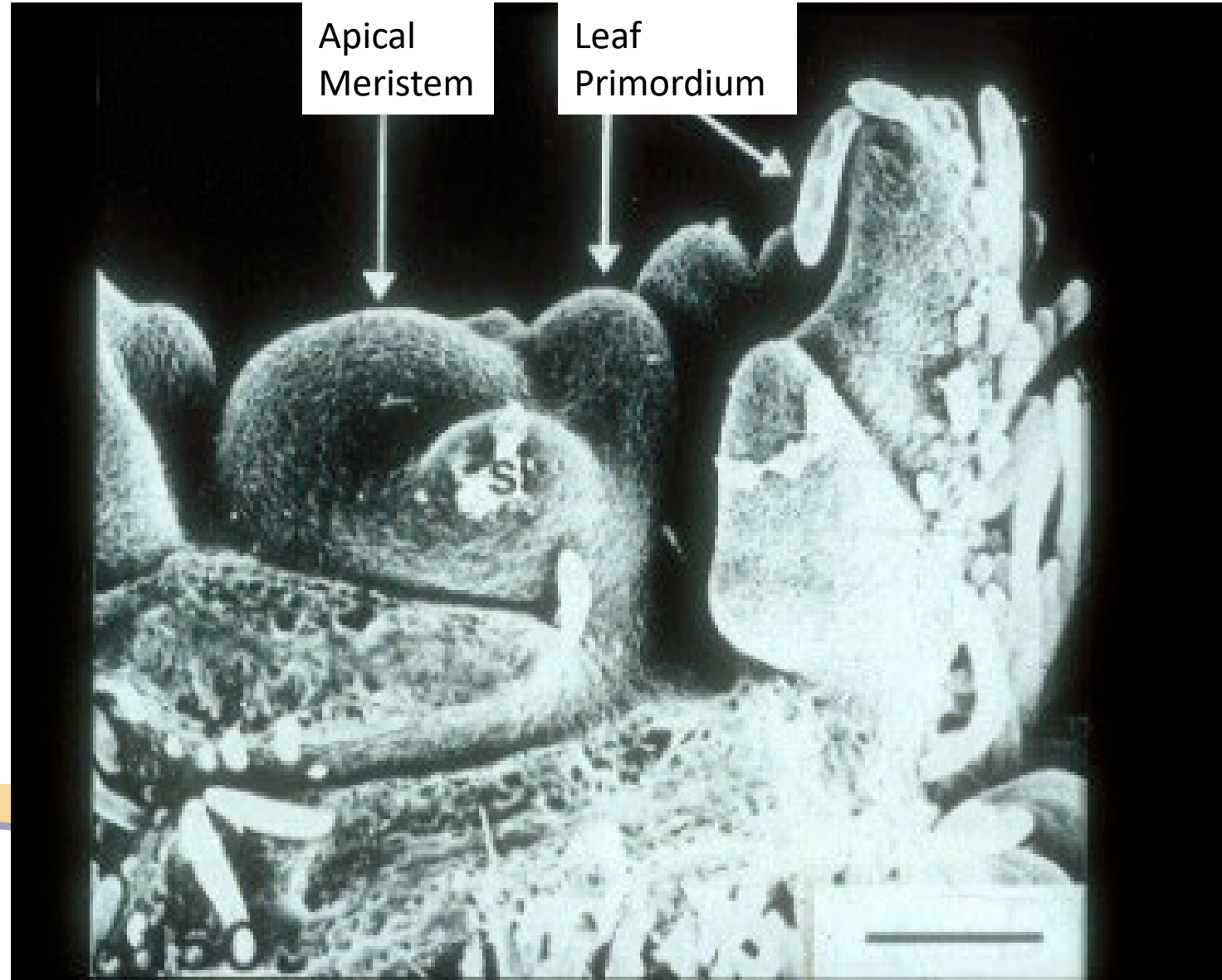
# Grape Life Cycle

- What does this look like
- The lateral bud is much bigger as it may grow during this growing season
- The dormant bud starts off much smaller, as it won't grow until next season



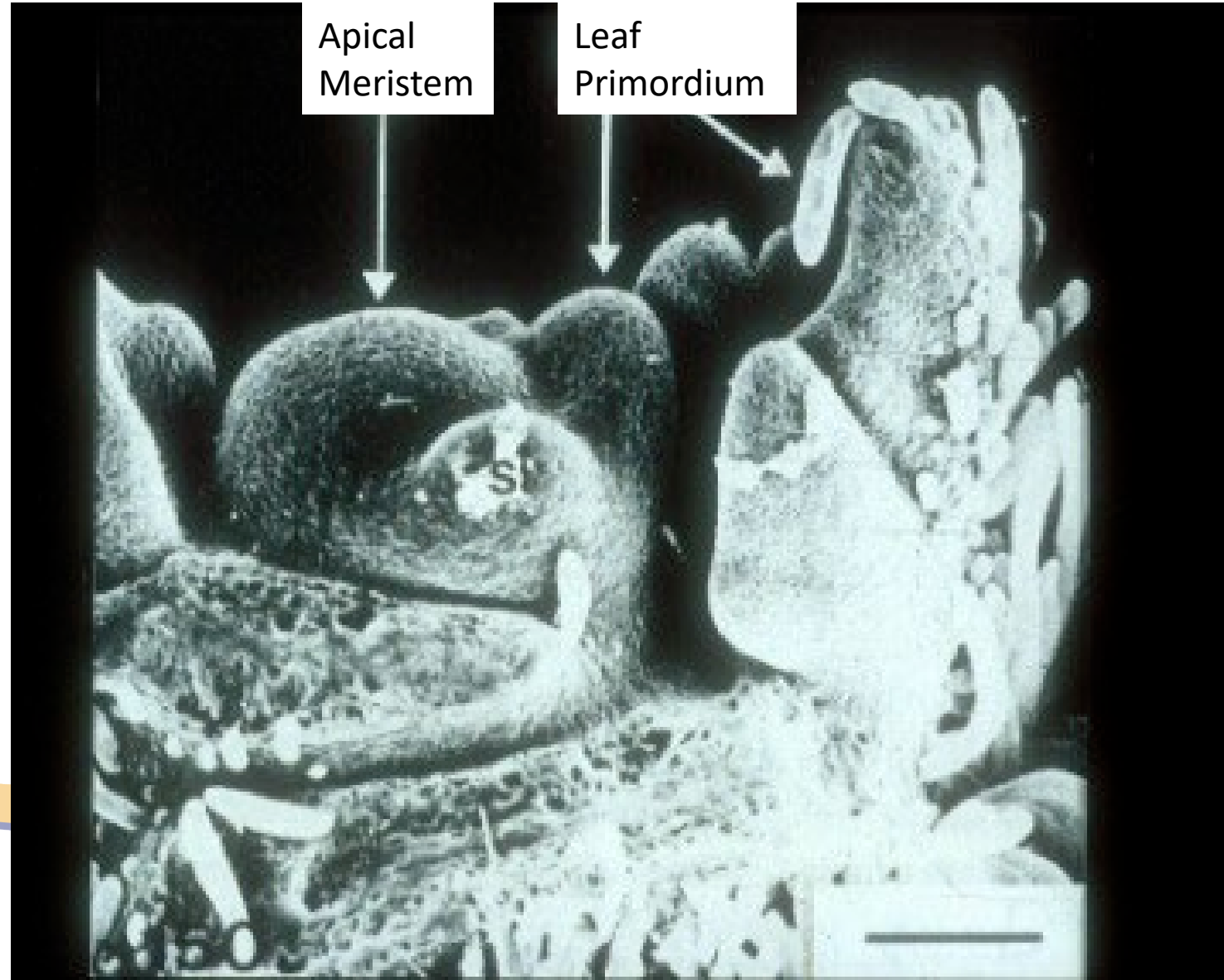
# Grape Life Cycle

- What does this look like
- The dormant bud grows from an Apical Meristem
- Cells in the Apical Meristem are totipotent
  - Totipotent = total potency
  - Totipotent = can become any type of cell



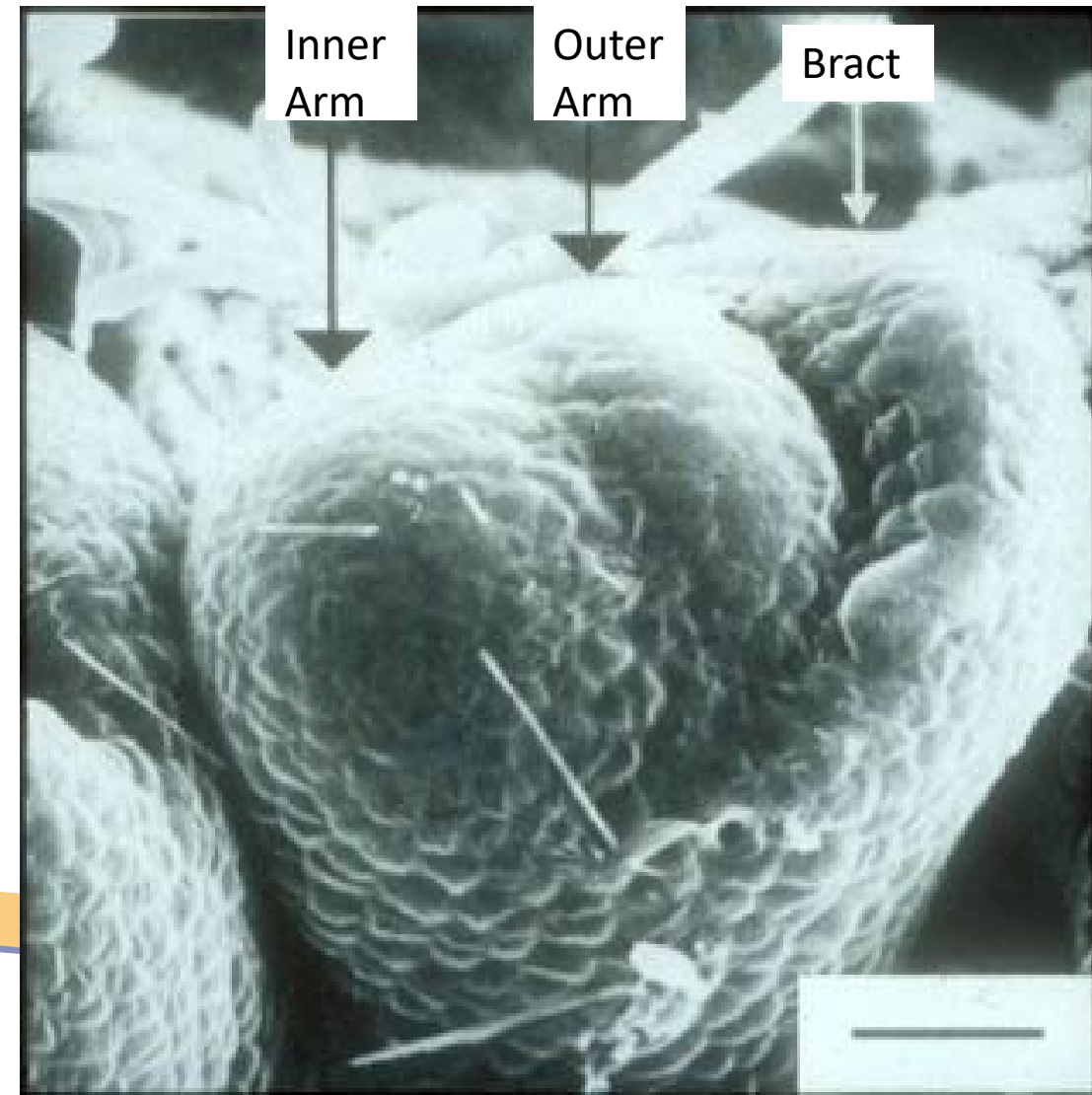
# Grape Life Cycle

- What does this look like
- We can see a couple leaf primordium forming
- These tissues will become leaves
- The cells within these tissues have already been programmed to become the different tissues within the leaf



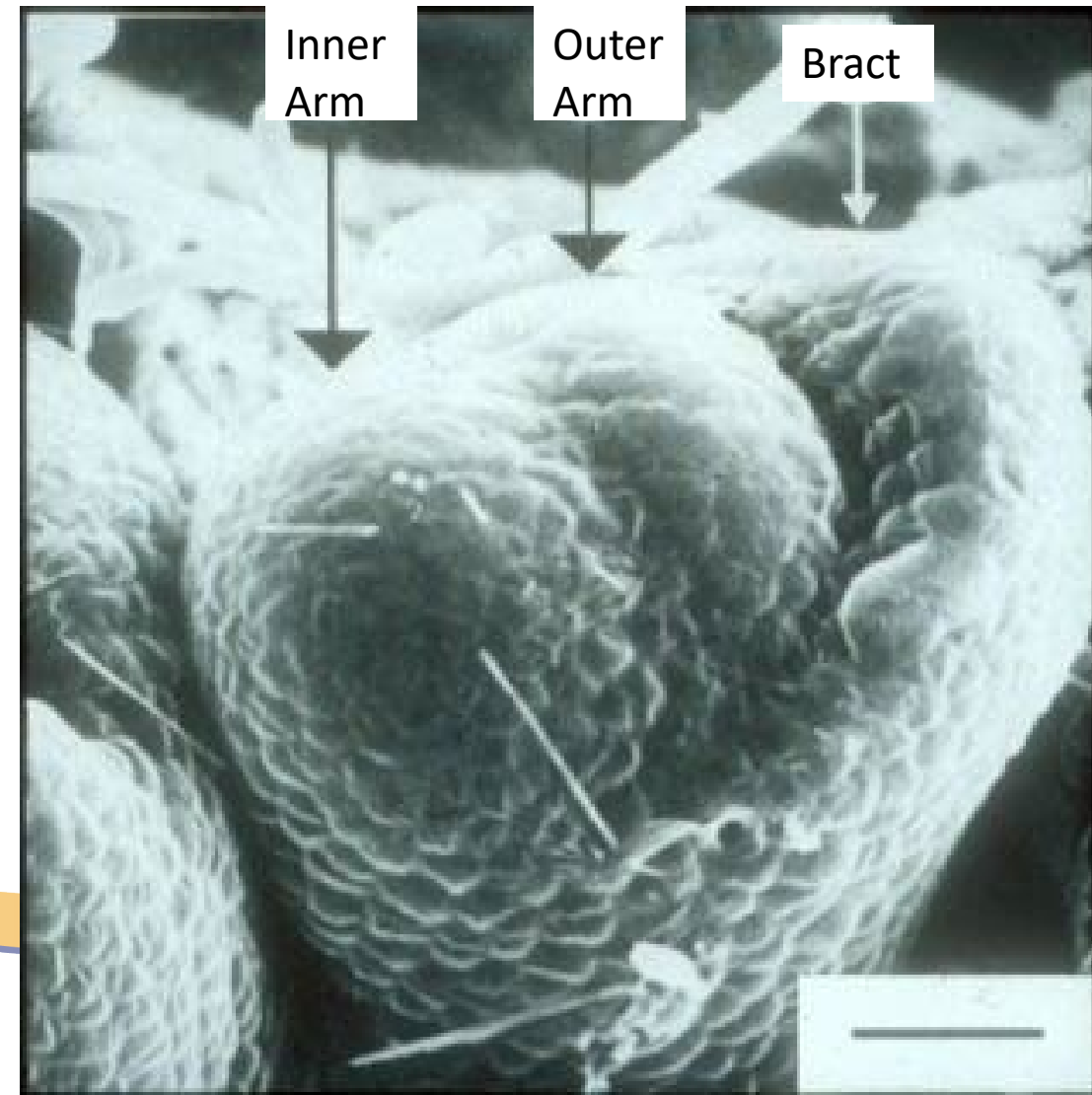
# Grape Life Cycle

- What does this look like
- Here we see another very important structure forming
- This structure can move in one of two directions
  - It can become a tendril, or
  - It can become a flower



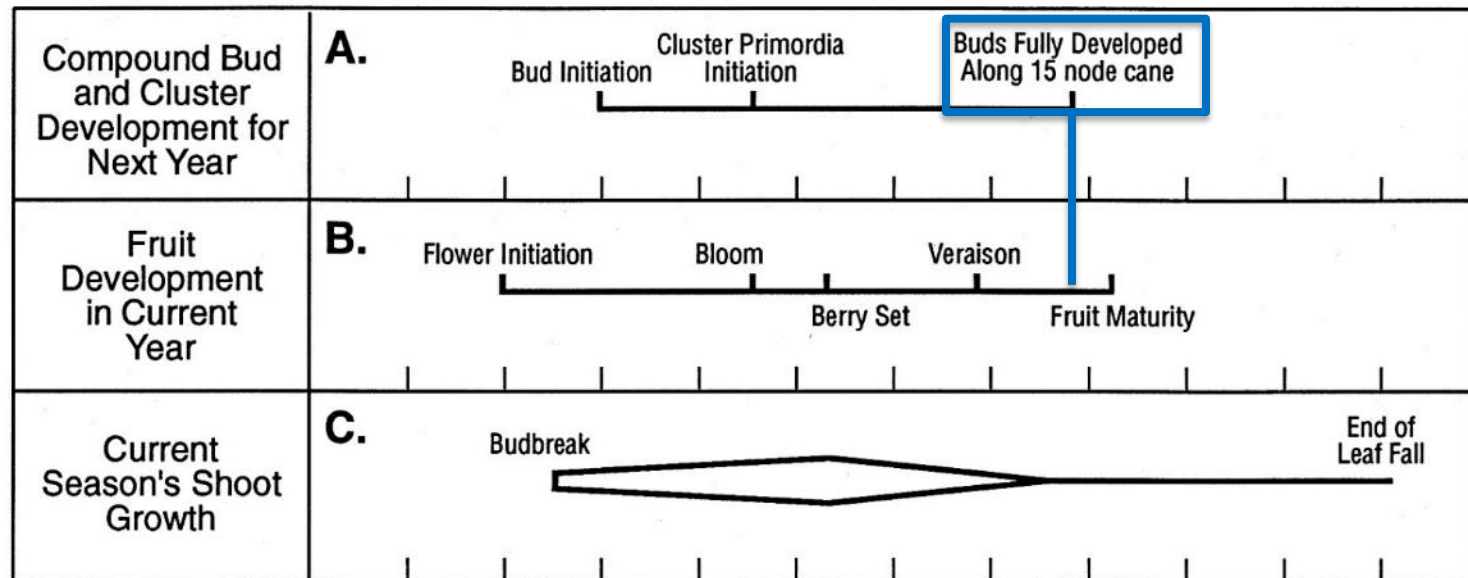
# Grape Life Cycle

- What does this look like
- This structure can move in one of two directions: Tendril or Clusters
- Two major environmental effects have been shown to affect this decision
  - Temperature: warmer temperatures favor cluster differentiation
  - Solar Radiation: higher light levels favor cluster differentiation



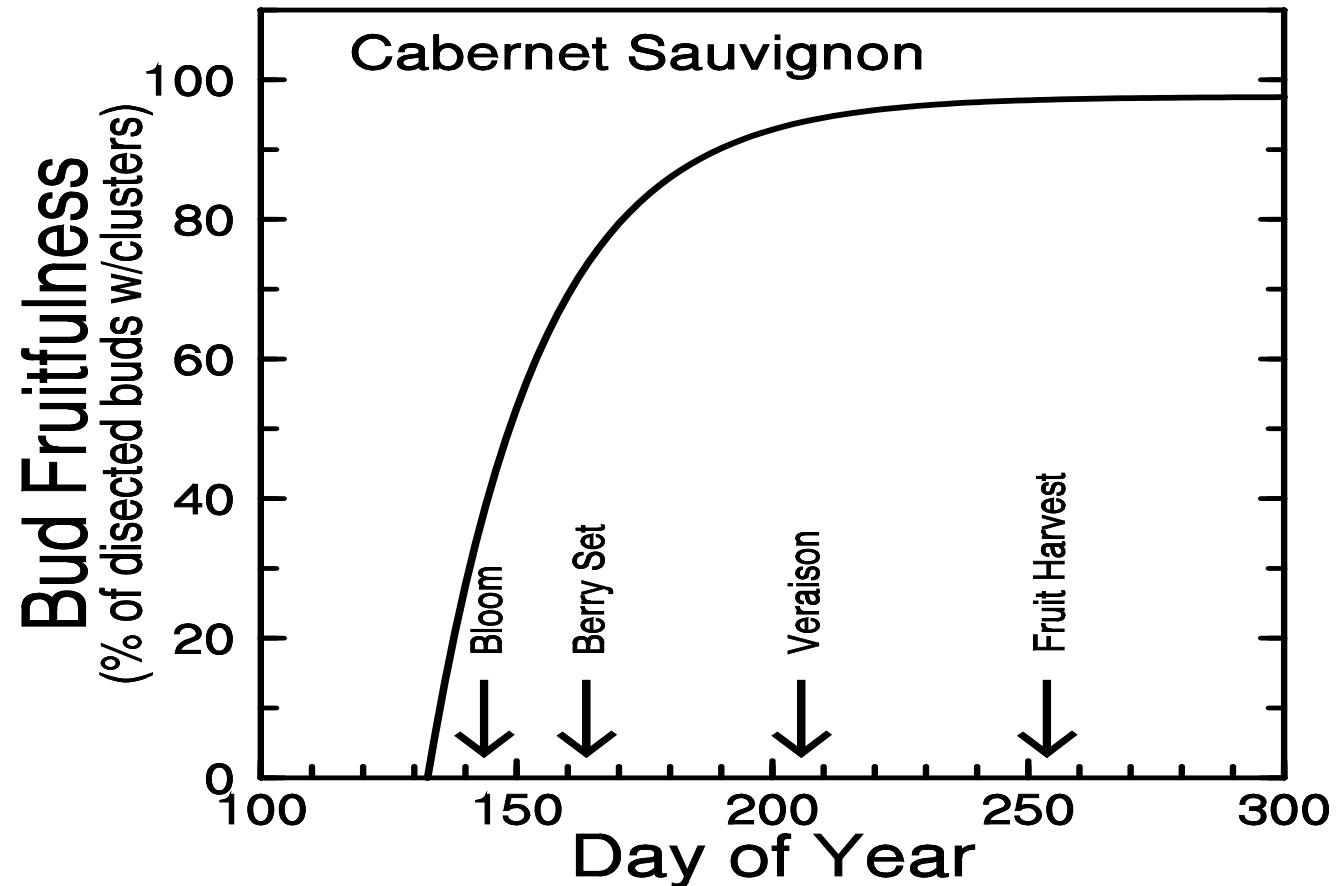
# Grape Life Cycle

- Buds farther along the cane do develop later into the season
- If you use a cane training system, all your buds won't be fully formed until closer to harvest



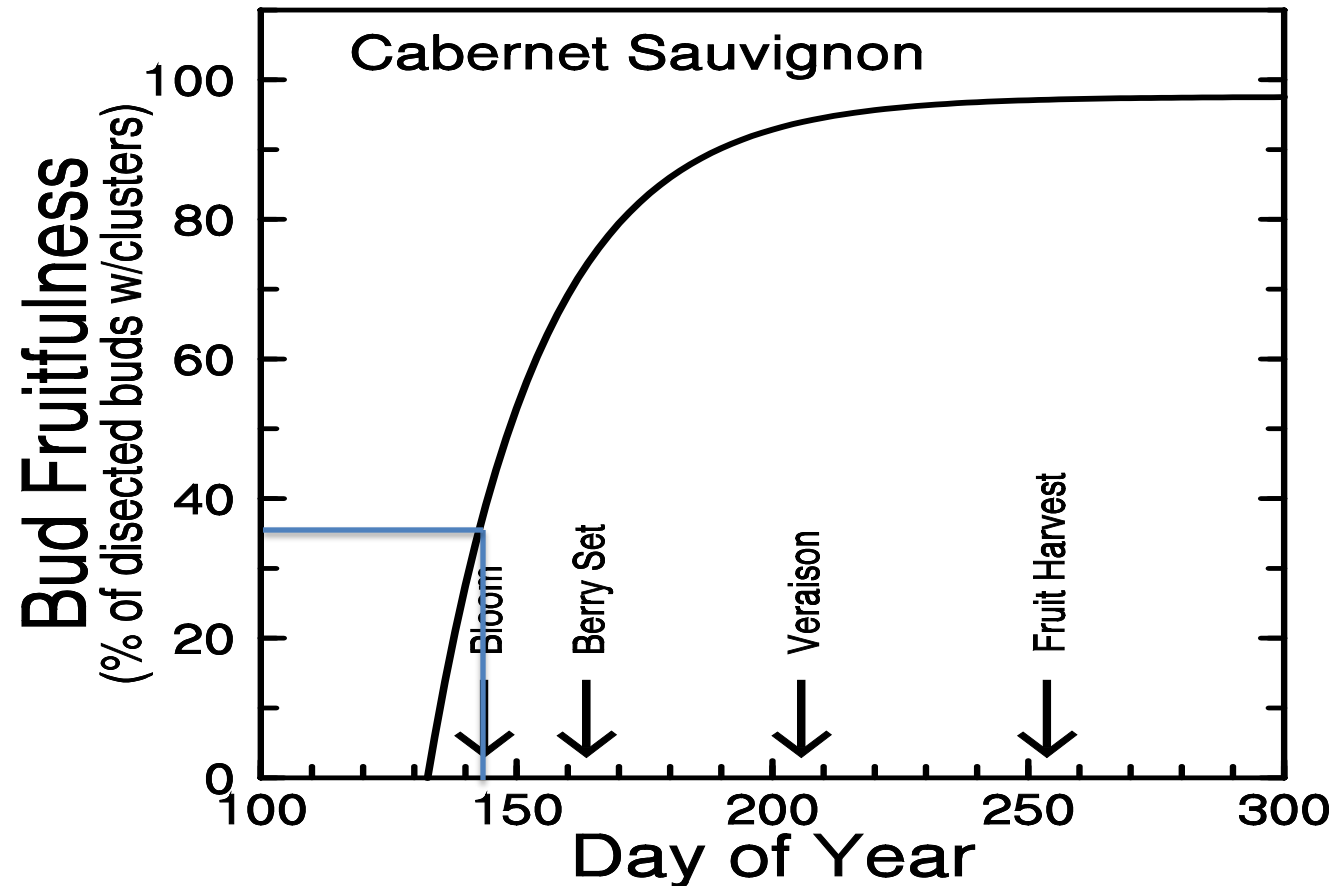
# Grape Growing Cycles

- How much of an overlap is there between this season's bloom and next seasons flower development?
  - Spur pruned system



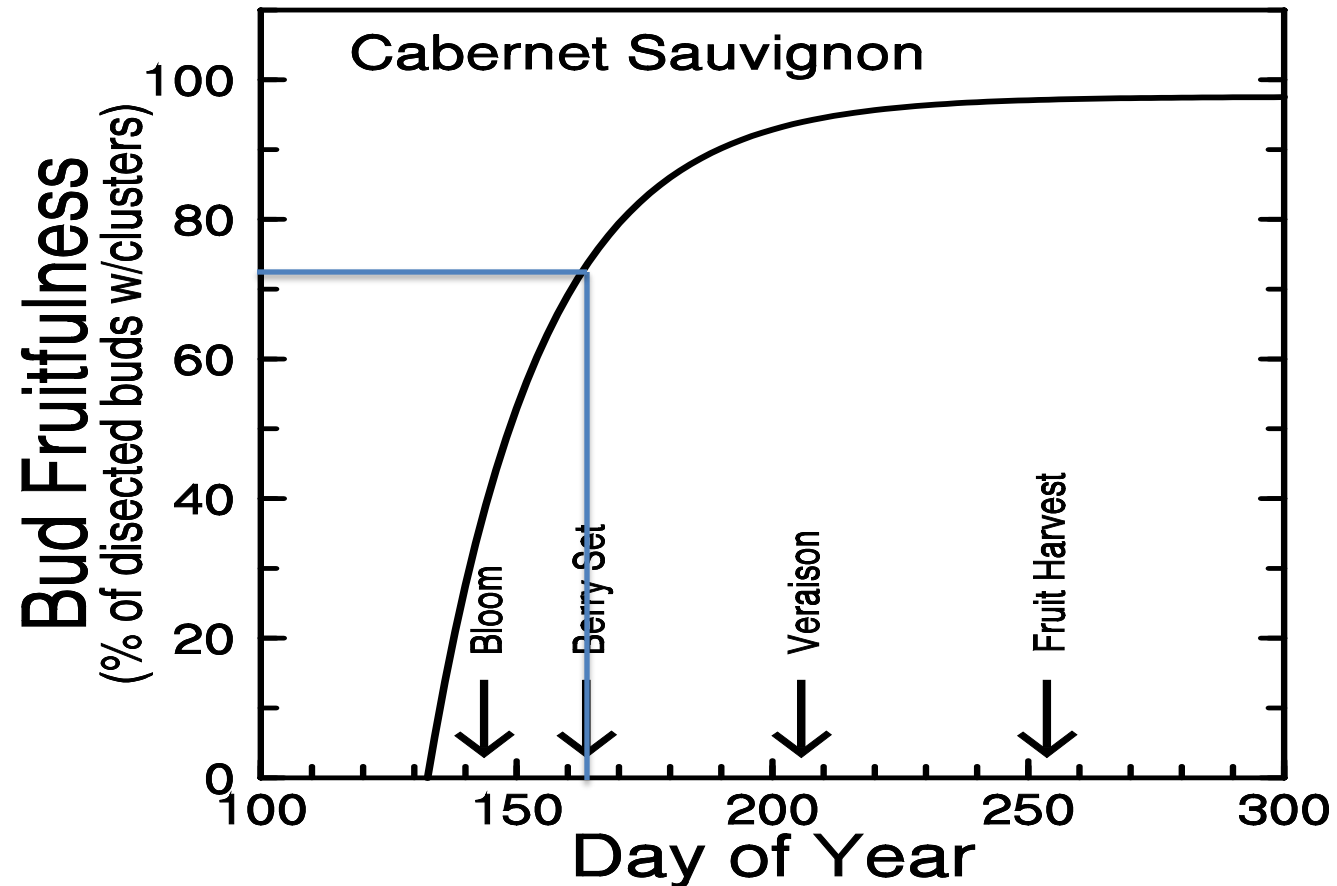
# Grape Growing Cycles

- How much of an overlap is there between this season's bloom and next seasons flower development?
  - Spur pruned system
- By bloom over 1/3 of clusters can already be detected during dissection



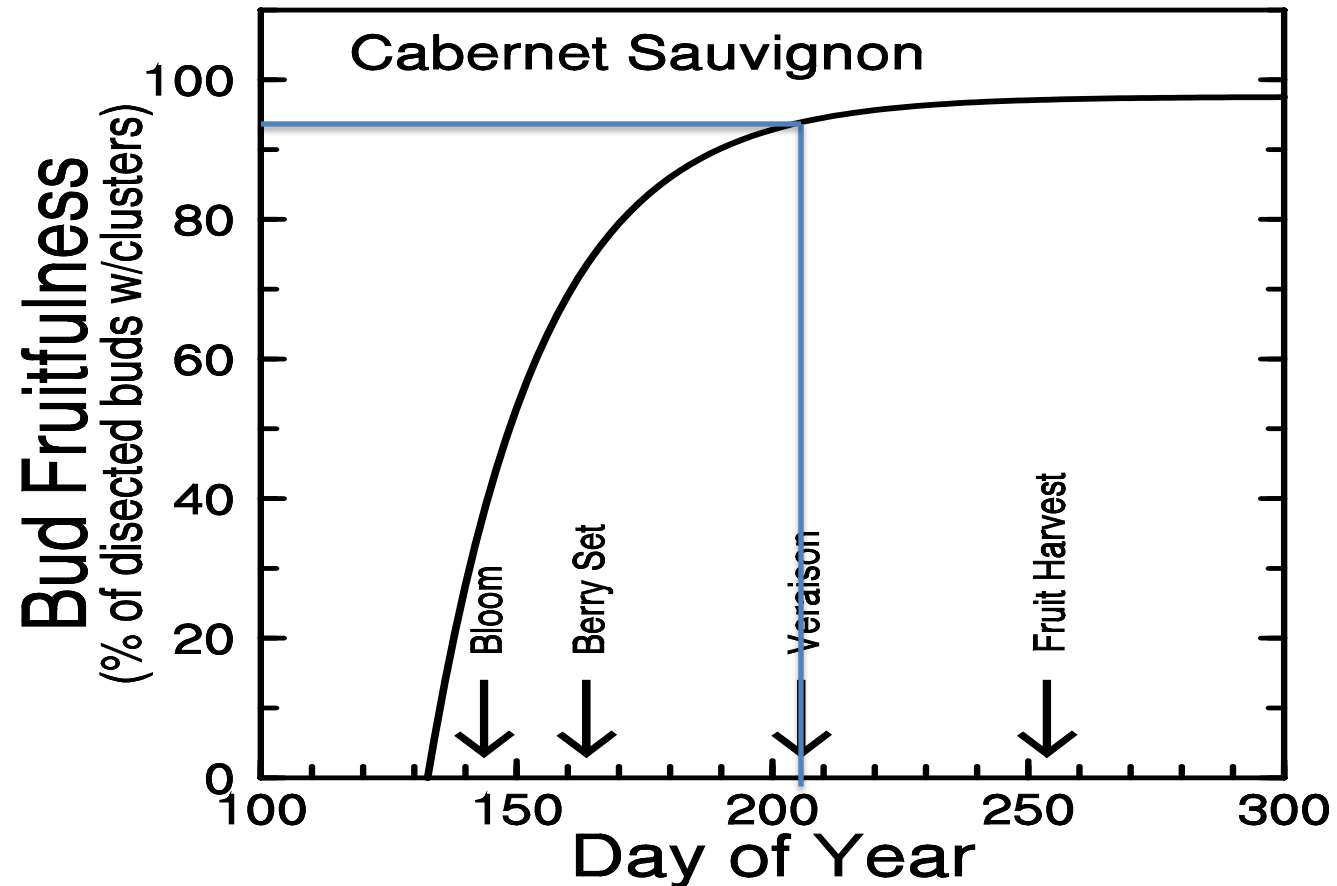
# Grape Growing Cycles

- How much of an overlap is there between this season's bloom and next seasons flower development?
  - Spur pruned system
- By berry set almost  $\frac{3}{4}$  of clusters can already be detected during dissection



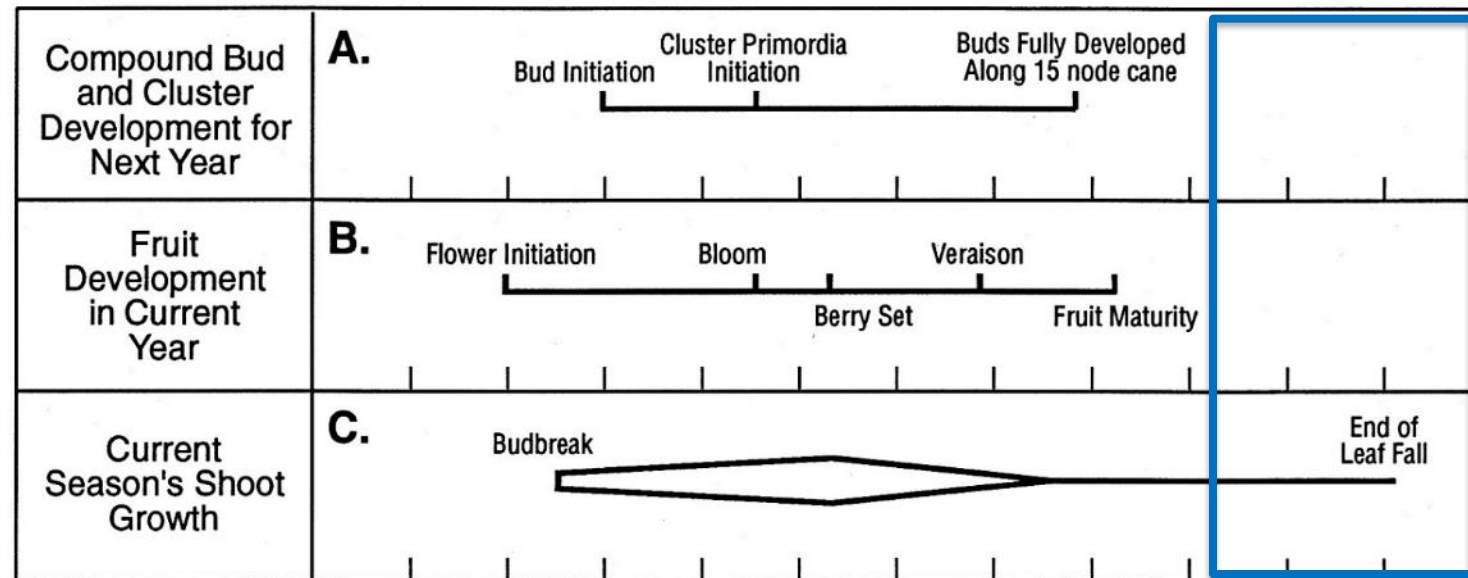
# Grape Growing Cycles

- How much of an overlap is there between this season's bloom and next seasons flower development?
  - Spur pruned system
- By veraison more than 90% of clusters can already be detected during dissection



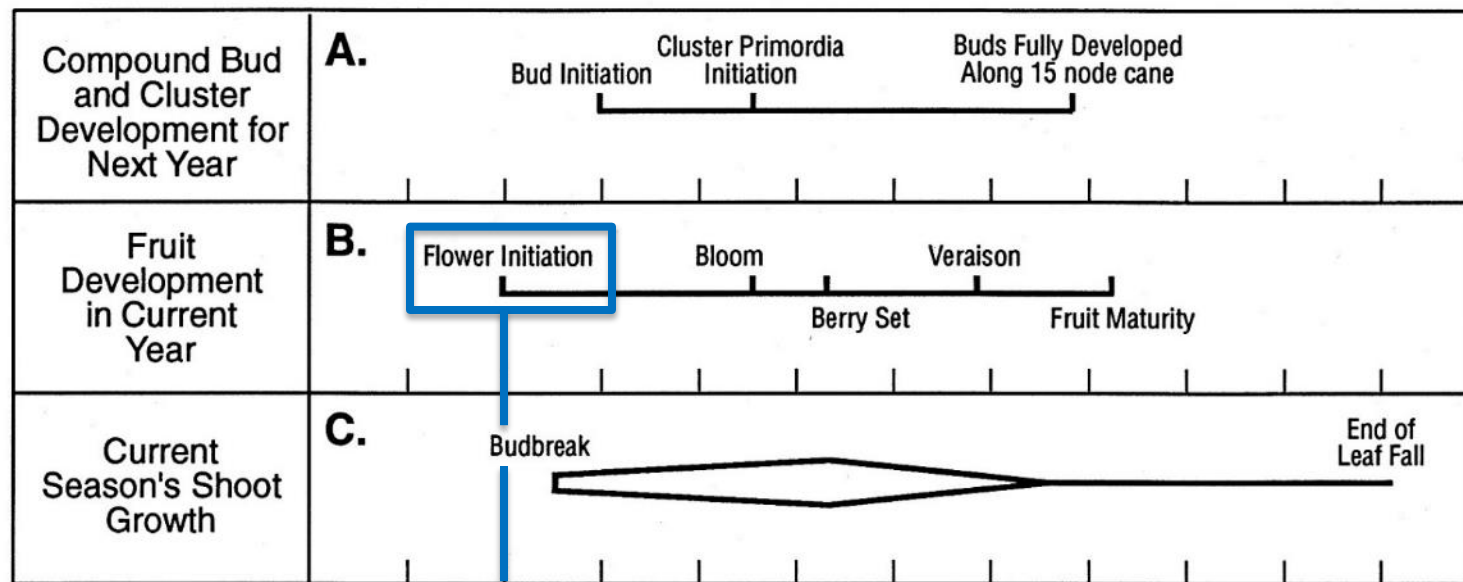
# Grape Life Cycle

- Now we come to the end of last season and enter dormancy



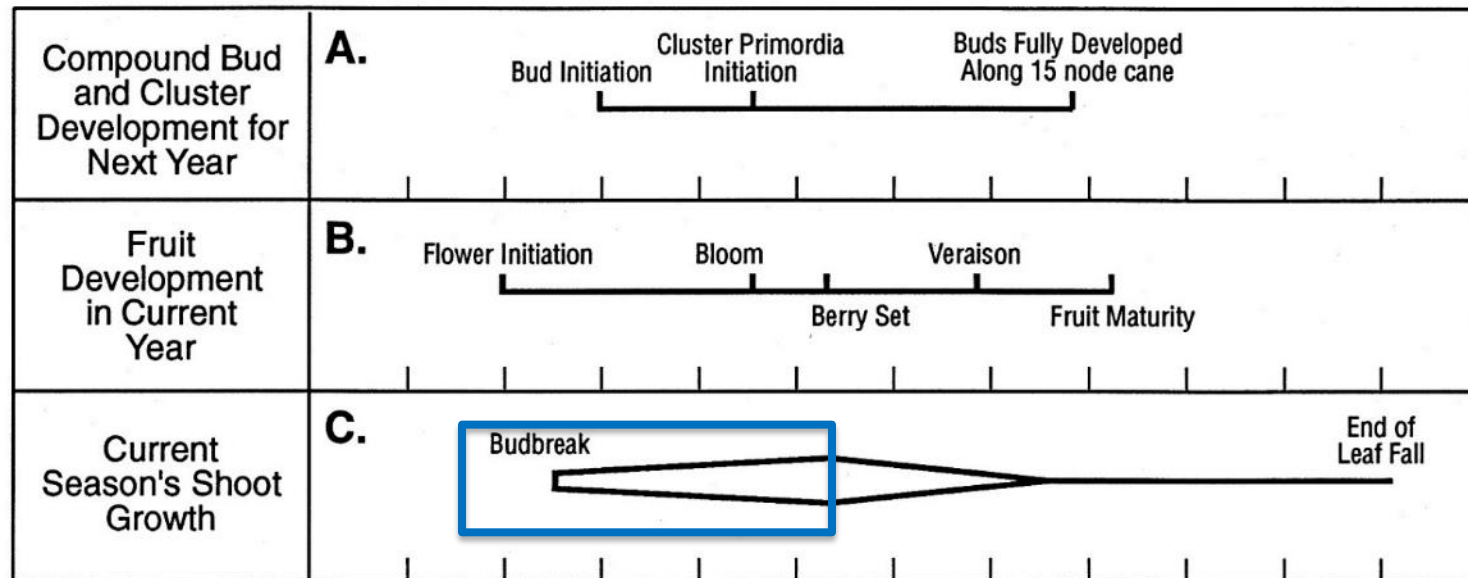
# Grape Life Cycle

- Now we start the 2025 growing season
- The first event to happen is flower initiation
  - Notice that flower initiation happens (a couple weeks) before budbreak



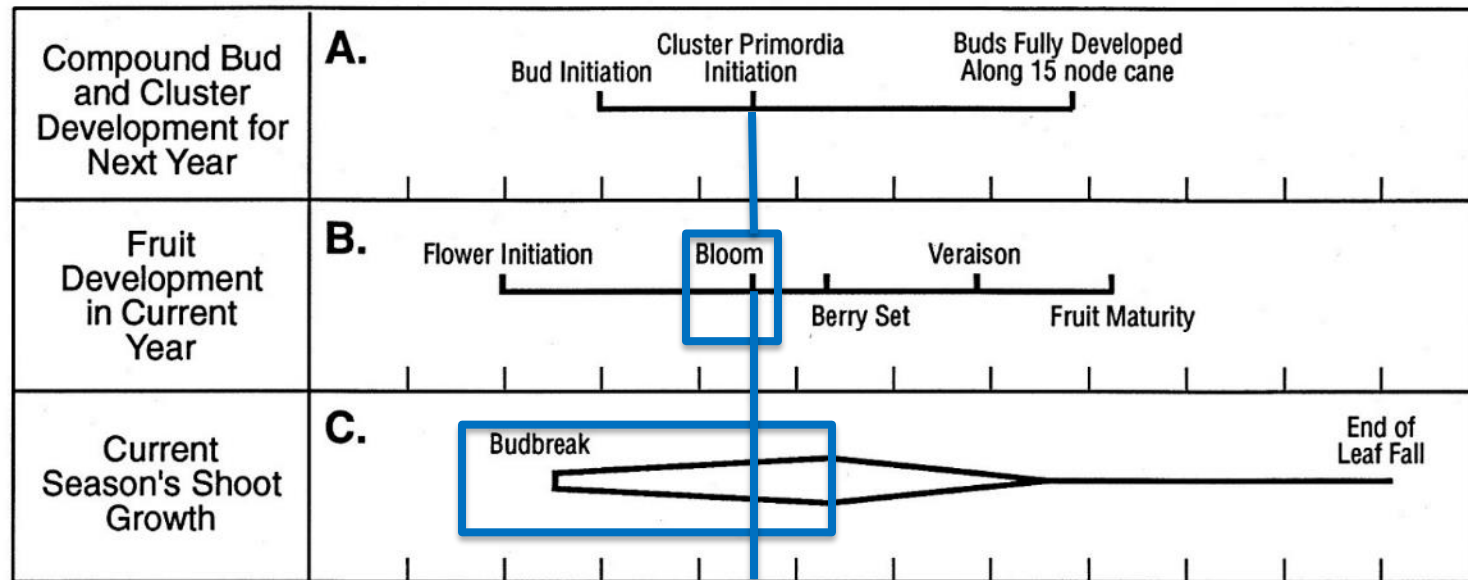
# Grape Life Cycle

- Then we hit budbreak, followed by rapid shoot growth
  - Remember that the dormant buds are compressed shoots so the first set of leaves, along with the flowers, were already partially formed
- All the activities that follow for the rest of the season require energy, and it is the canopy that will supply that energy
  - Remember Dormant Bud initiation for next season also start during rapid shoot growth



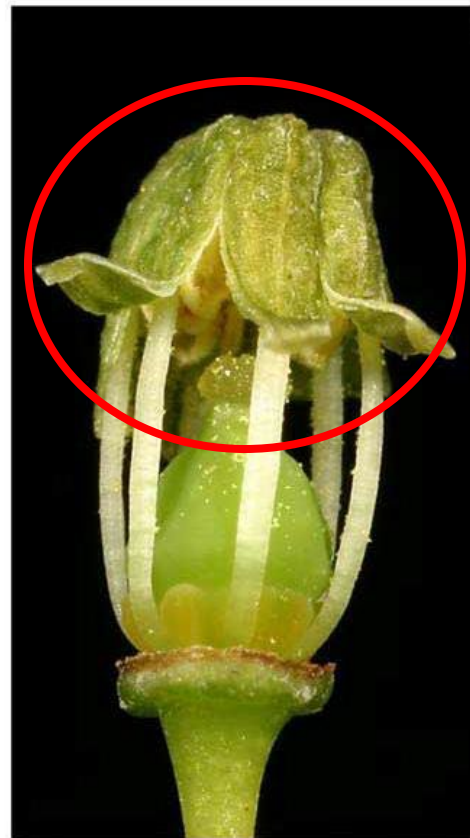
# Grape Life Cycle

- Next, we hit bloom
- Remember that during the bloom in 2025, the cluster primordia for 2026 will initiate



# Grape Life Cycle

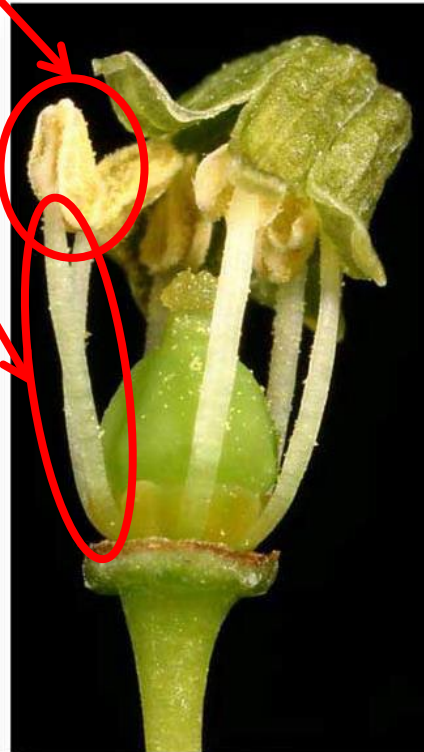
- Bloom is the moment that the calyptras/caps start to pop off the flower
  - Calyptra/Cap (red): a set of fused petals that enclose the reproductive organs



# Grape Life Cycle

- This exposes the male and female reproductive organs

- Anther: the top portion of the stamen, where pollen is produced
- Filament: the slender part of the stamen that supports the anther
- Stamen: the plants entire male organ (Filament + Anther)

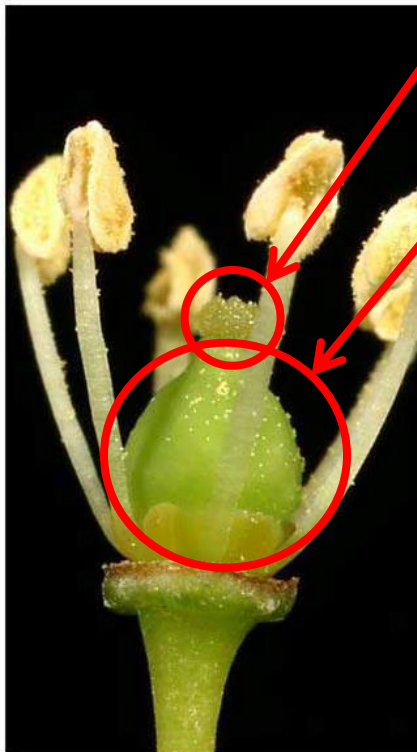


- Stigma: the top portion of the pistil where the pollen germinates

- Ovary: the enlarged bottom portion of the pistil where the seeds are produced

- Pistil: the entire female organ (Stigma + Ovary)

- Notice that even before the cap has been fully removed there is already pollen on the stigma



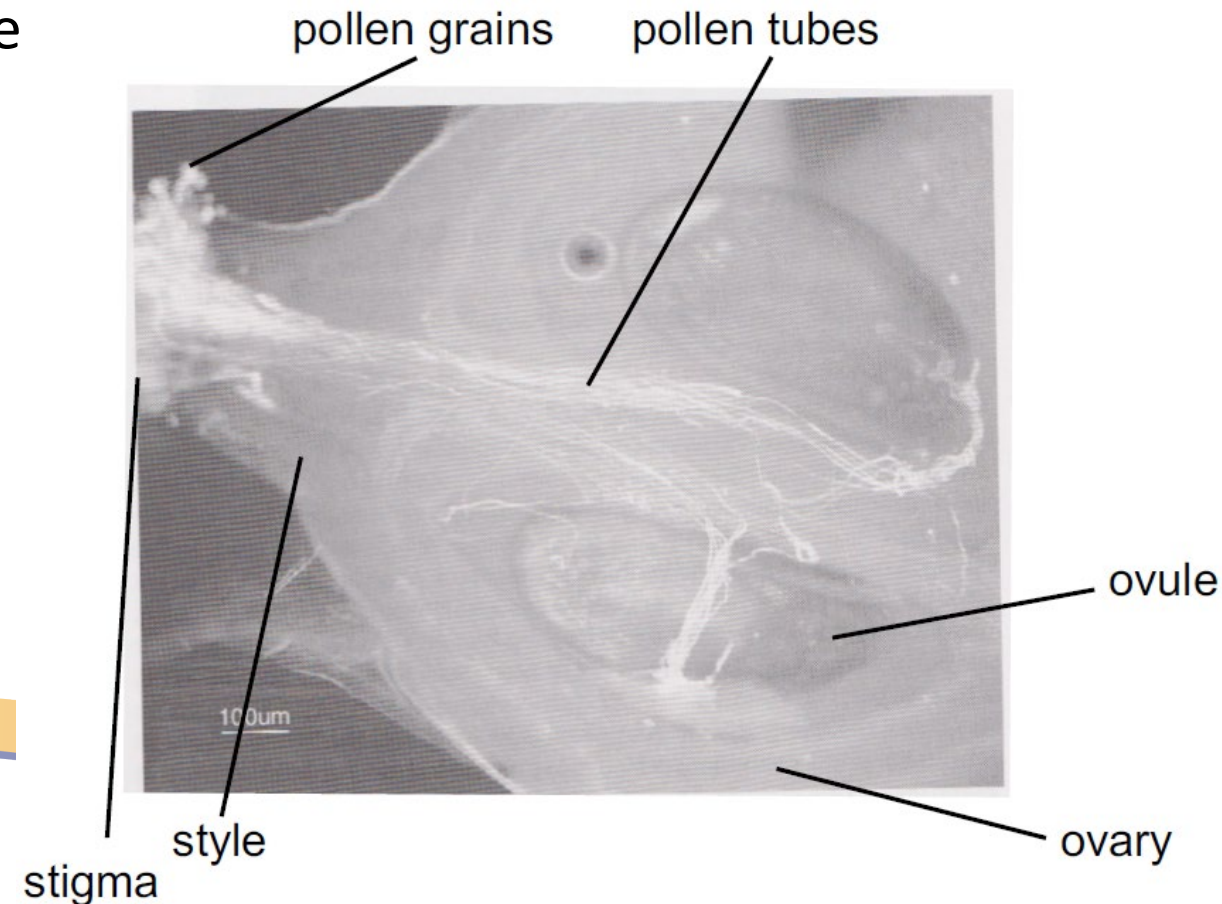
# Grape Life Cycle

- Optimal temperature for bloom are 68 F – 86 F
- Temperatures below 59 F and above 95 F hurt bloom
- Bloom can take 5 – 7 days for a single cluster
- Bloom can take 2 – 3 weeks for a vineyard



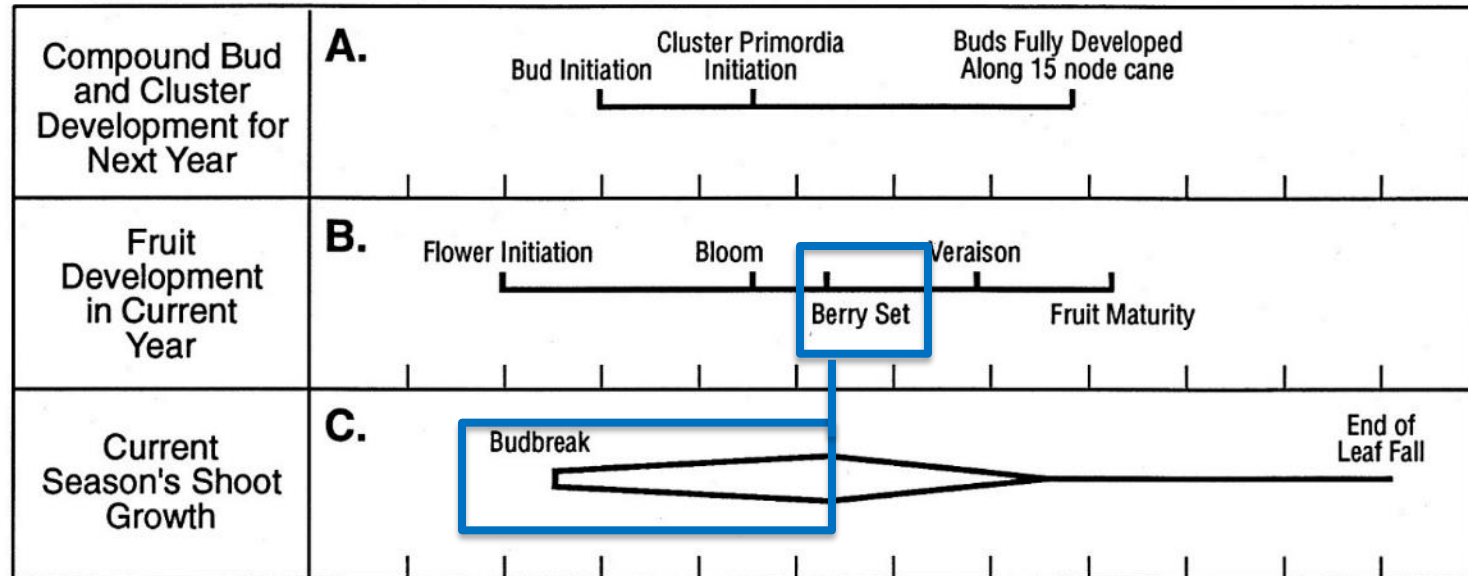
# Grape Life Cycle

- Once the pollen has landed on the stigma it must grow down to the ovaries for fertilization
- Ovaries only remain fertile for a limited time once bloom has started
- Rate of pollen tube growth is dependent on temperature
  - 77 – 86 F: 12-hour fertilization time
  - 68 F: 24-hour fertilization time
  - 59 F: 48-hour fertilization time



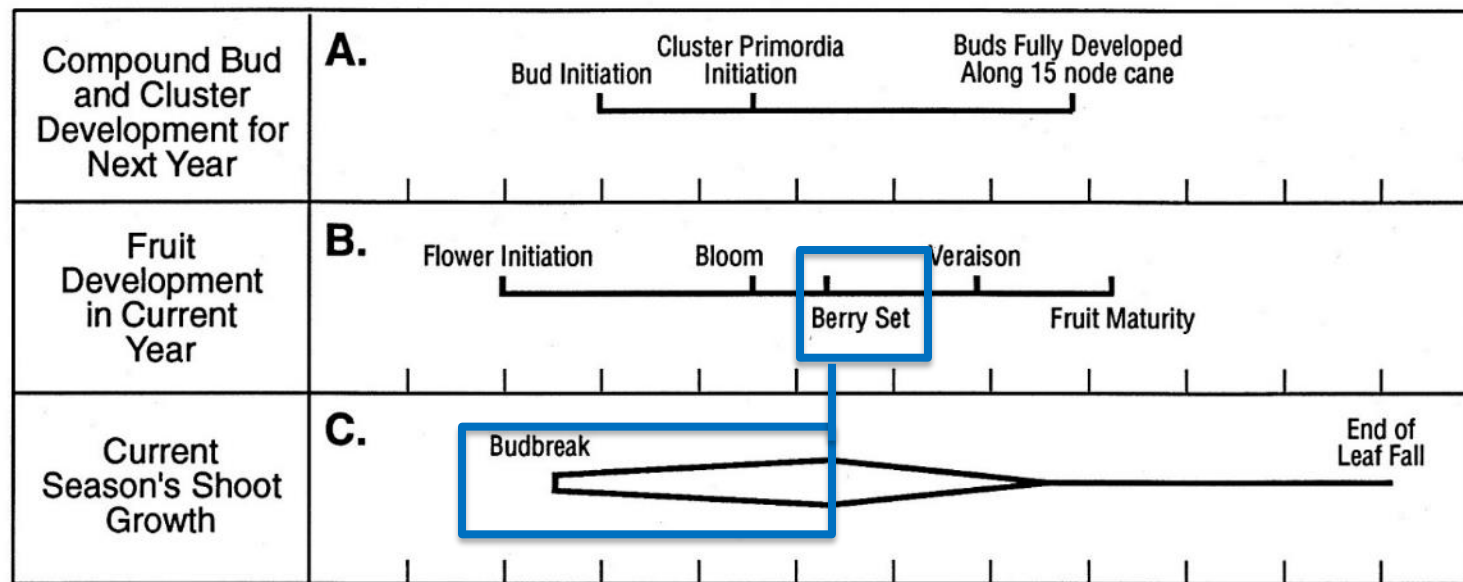
# Grape Life Cycle

- Next, we come to berry set
- Only 20% - 50% of flowers will develop into berries
- The energy required to start maturing the berries begins to slow down the rapid canopy growth



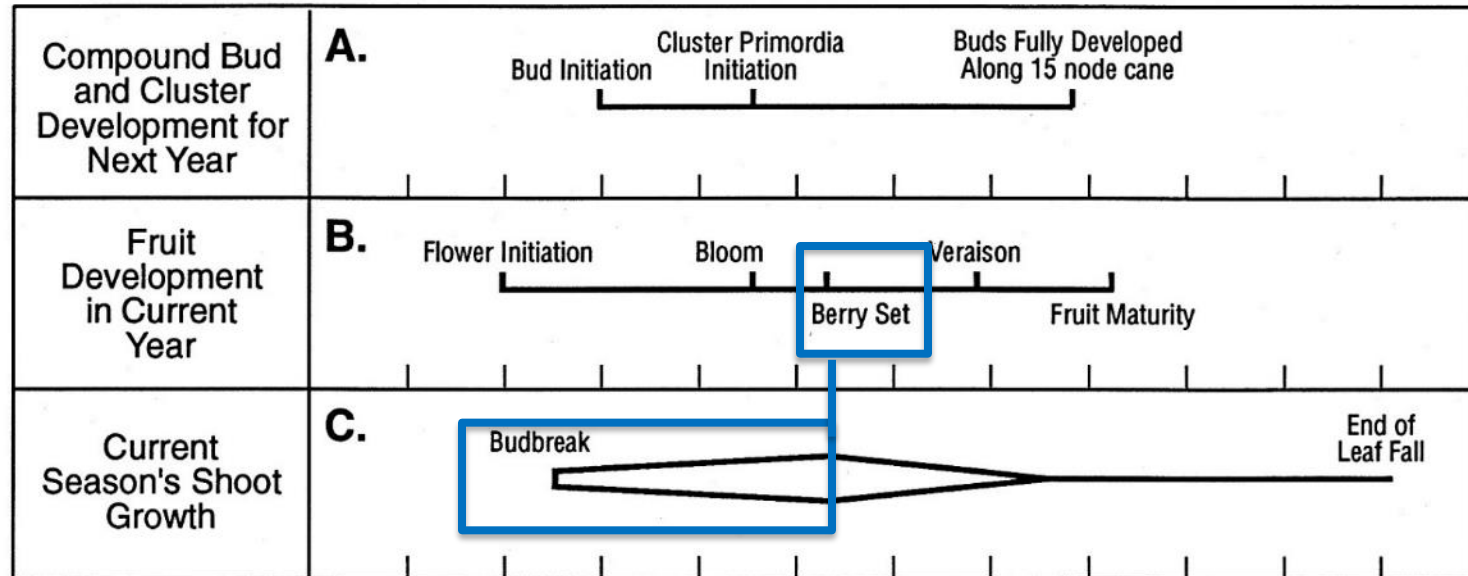
# Grape Life Cycle

- Optimum conditions for berry set:
  - Higher light intensity
  - Warm temperature
  - Adequate soil moisture and nutrient availability



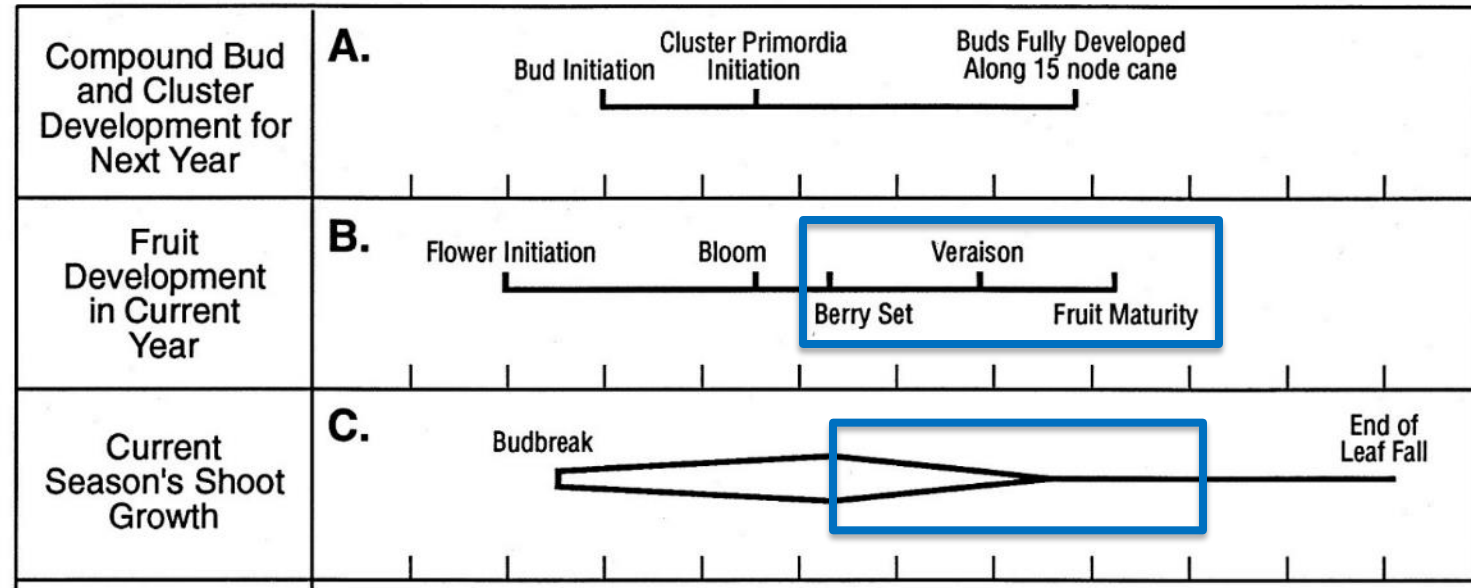
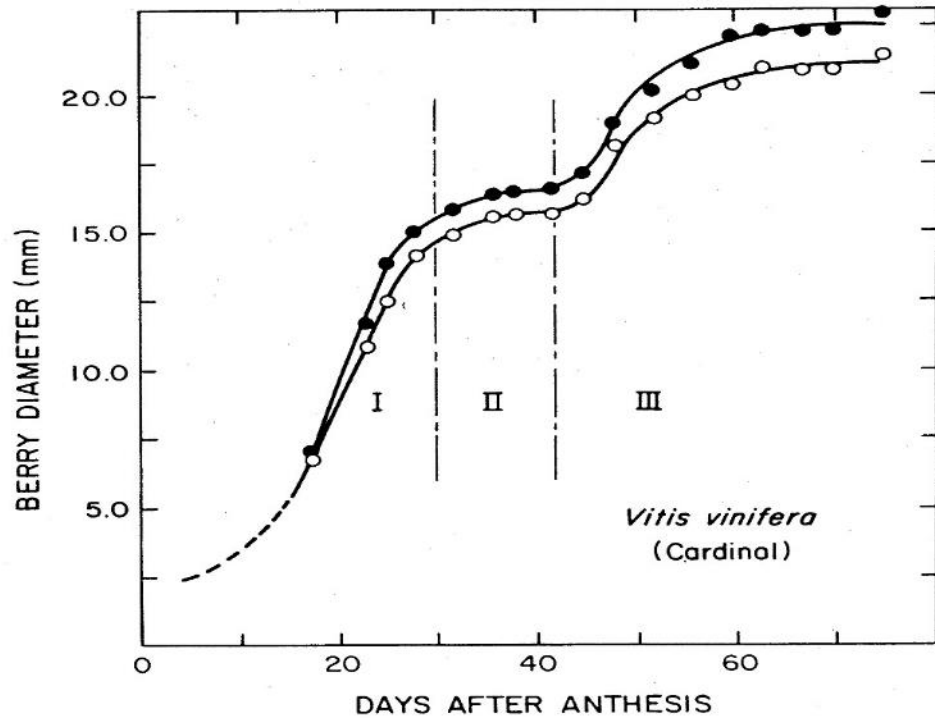
# Grape Life Cycle

- Adverse conditions:
  - cloudy, cool weather
  - too hot (>30-35°C)
  - water stress
  - nutrient stress
  - excessive vigor
  - insufficient leaf area
  - shaded dense canopy



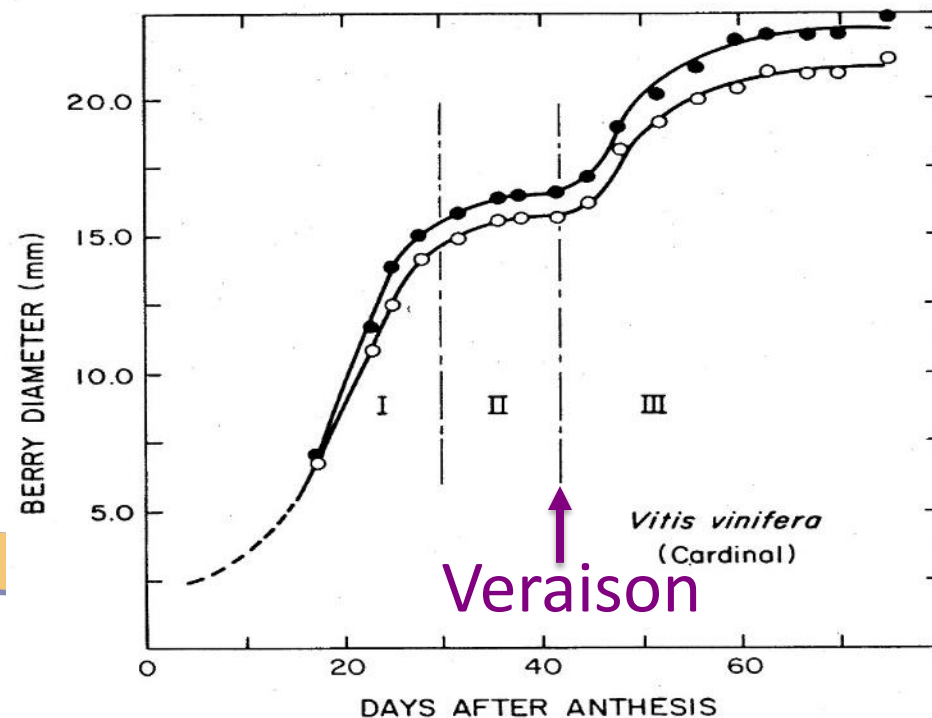
# Grape Life Cycle

- As berry development continues canopy growths slows and stops
- Berry growth comes in three phases



# Grape Life Cycle

- Berry growth comes in three phases
- Rapid berry growth is seen in Phase I and Phase III
- With a short pause in development during Phase II
- The transition between Phase II and Phase III is veraison



# Grape Life Cycle

- Veraison is an important milestone in the fruit's development
- It is when berries start to show color and soften
- It is also the point where the type of cell growth changes (next slide)
- And where the composition of the berries start to change (a few slides away)



# Grape Life Cycle

- Rapid berry growth is seen in Phase I and Phase III
- With a short pause in development during Phase II
- Why?
- During Phase I the number of cells increases rapidly, along with a small increase in the size of those cells
- During Phase III the size of cells increases rapidly
  - Phase I make more cell
  - Phase II catch our breath
  - Phase III make cells bigger

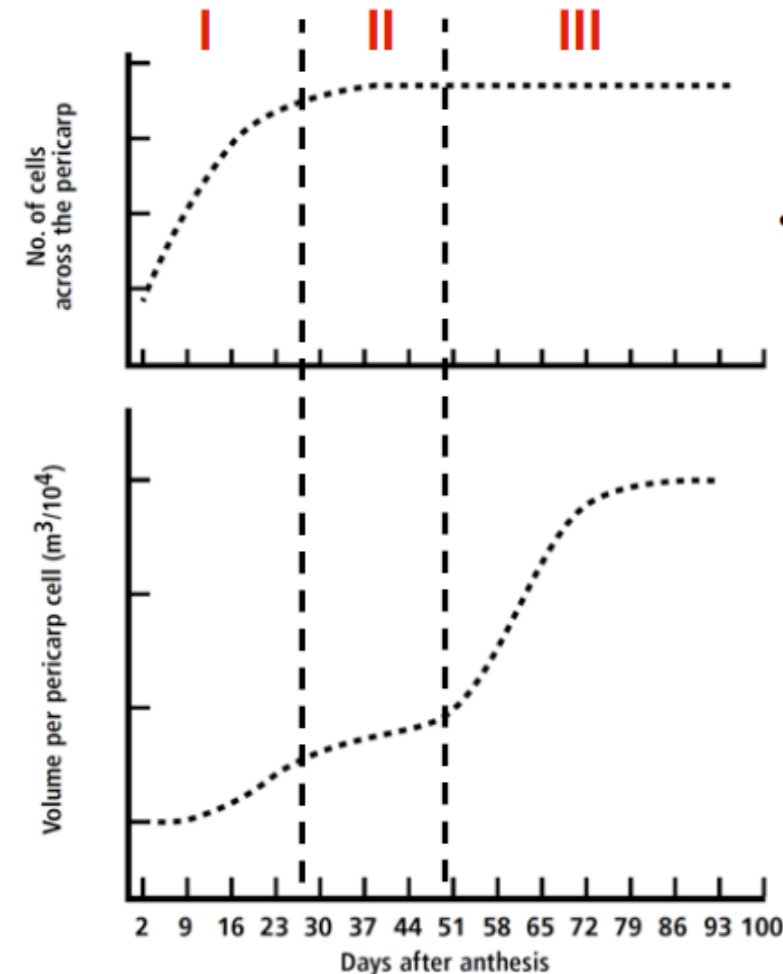
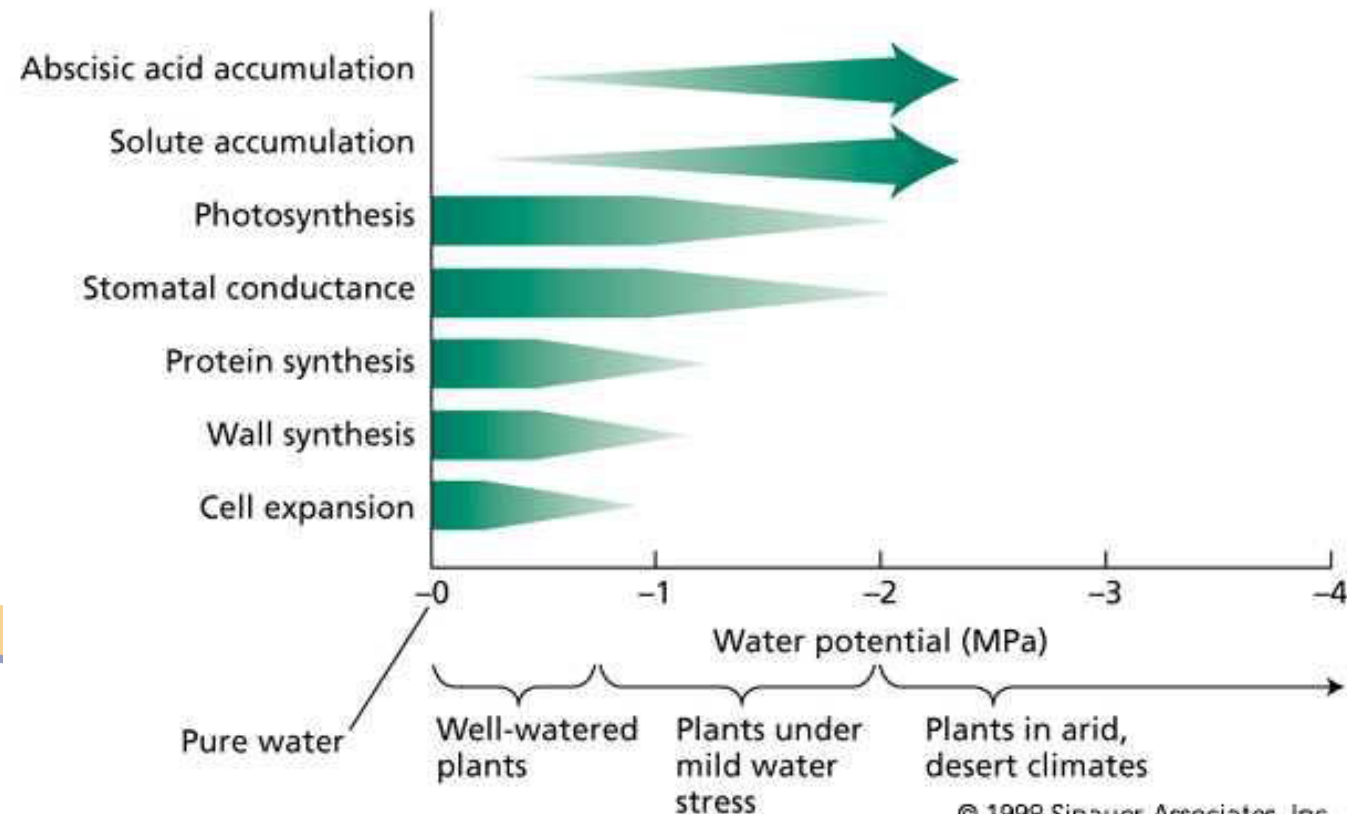


Figure 5.8 Changes in the number of cells per berry (*upper graph*) and berry cell volume (*lower graph*) in 'Thompson Seedless' during fruit development. Source: Harris et al., *Vitis* 7:106–9.

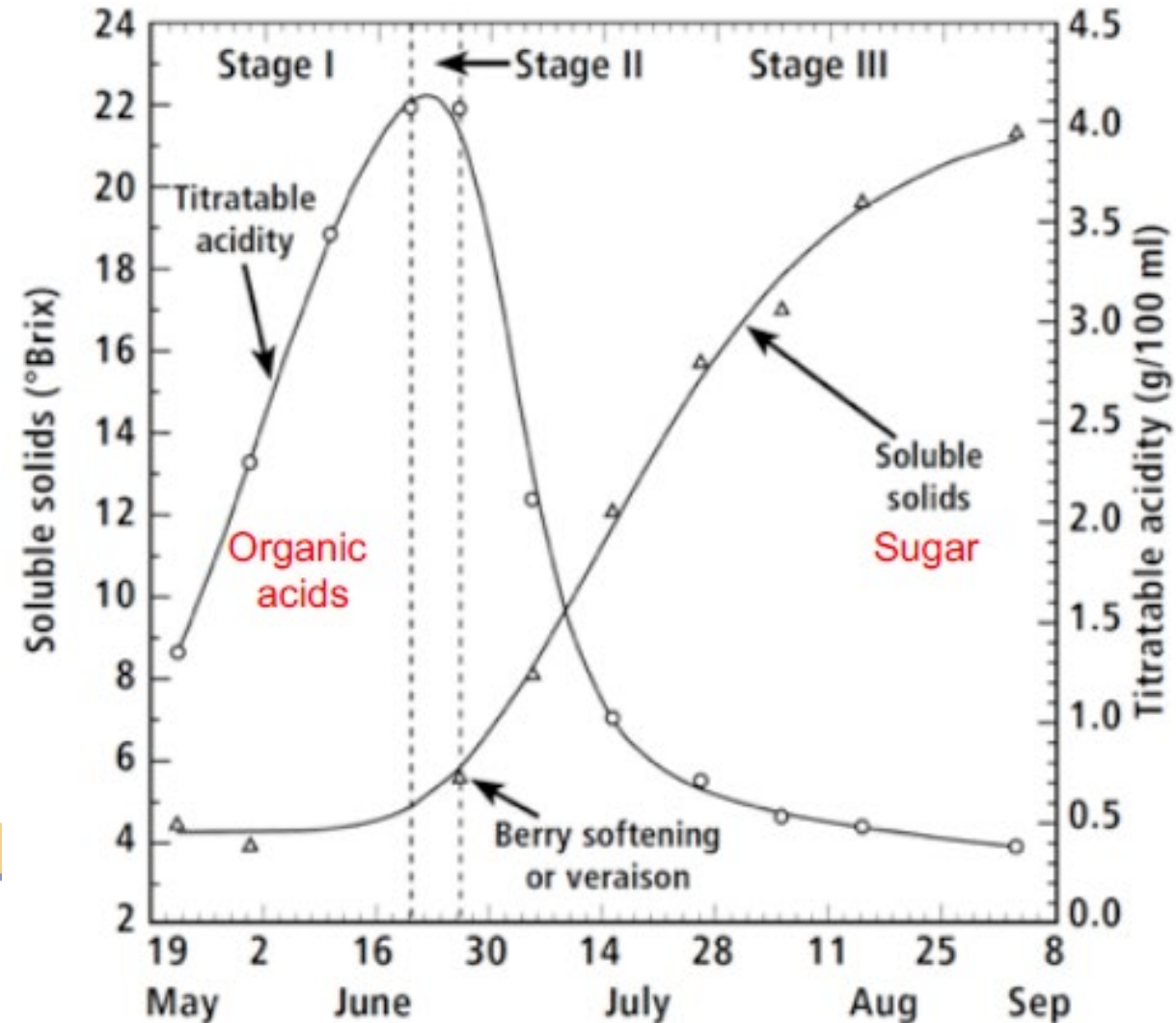
# Grape Life Cycle

- You can use how growth within the berries happen to help control the makeup of your clusters at the end of the season
- As vines go from well watered (left side) to water stressed (right side) different processes slow down and stop



# Grape Life Cycle

- Berry size is not the only item that changes with the phases
- During Phase I acid (TA) increases rapidly until it peaks during Phase II, then breaks down during Phase III
- Sugar stays low during Phase I then starts to accumulate during Phase II and especially during Phase III



# Grape Life Cycle

- Sugar accumulation doesn't continue forever
- As the season ends sugar production slows down
- Additional Brix increases at this point are due to dehydration not due to more sugar being added
- So, when do you harvest?

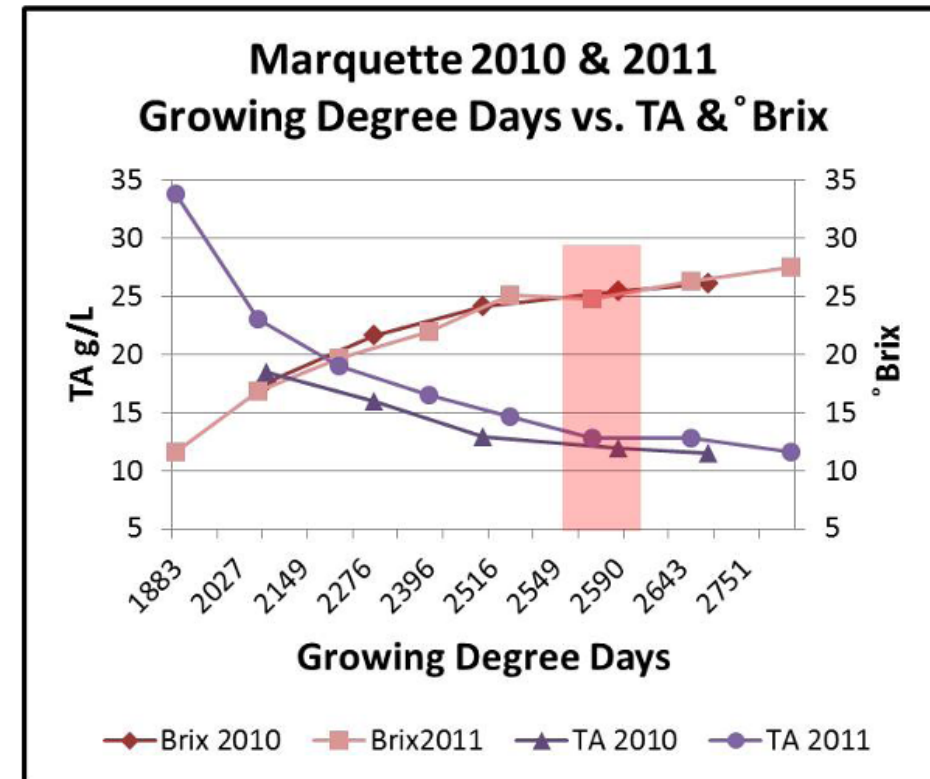


Figure 1. Changes in soluble solids ( $^{\circ}$ Brix) and TA show the variation of sugar and organic acid concentrations throughout 'Marquette' grape ripening in Chaska, MN. Harvest dates were converted to corresponding accumulated heat units expressed as growing degree days (GDD). The red shaded area indicates the range of peak maturity.

# Grape Life Cycle

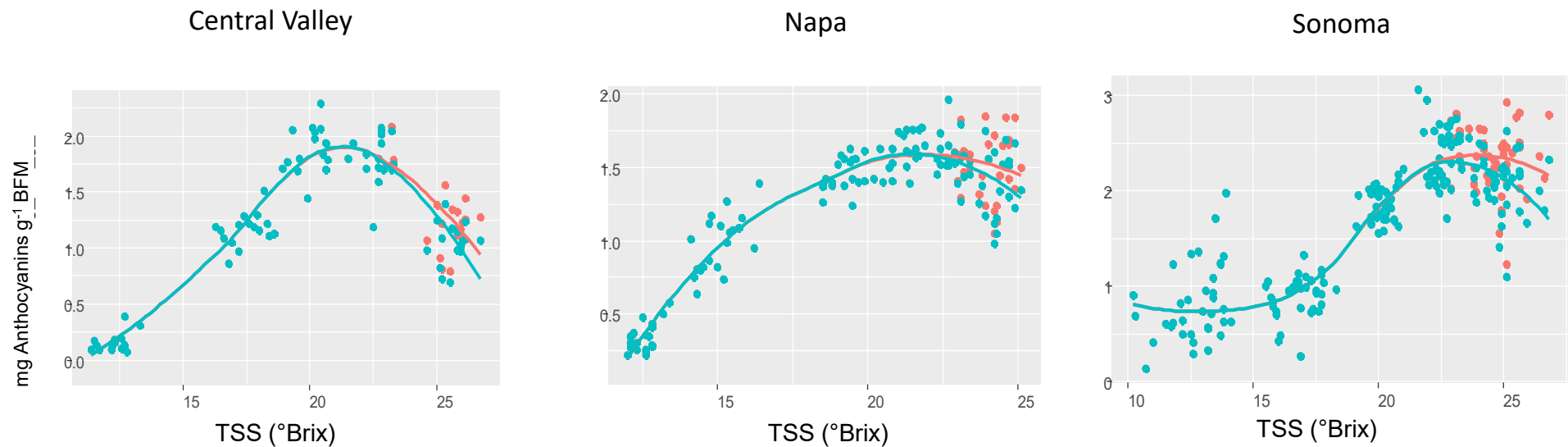
- Sugar makes alcohol during fermentation
- So... the more sugar, the more alcohol you can make
- But... how much is too much

Sugar to Potential Alcohol Chart

Brix	Baumé	°Oechsle	Specific Gravity	Potential Alcohol
14	7.8		1.0568	7.6
15	8.3		1.0611	8.2
16	8.9	65	1.0654	8.8
17	9.4	69.8	1.0698	9.5
18	10.0	74.1	1.0741	10.1
19	10.6	78.5	1.0785	10.8
20	11.1	83	1.0830	11.5
21	11.7	87.4	1.0875	12.2
22	12.2	91.9	1.0920	12.9
23	12.8	96.5	1.0965	13.6
24	13.3	101	1.1011	14.4
25	13.9	105.6	1.1057	15.1
26	14.4	110.3	1.1103	15.9
27	15	114.9	1.1150	16.7
28	15.6	119.6	1.1197	17.5

# Grape Life Cycle

- Anthocyanins also increase during maturation, but
- Once Brix gets into the low to mid 20s, anthocyanins begin to peak back down



# Grape Life Cycle

- When do you harvest?
- This is your decision... well the winemaker's decision
- You will need to balance
  - Sugar accumulation
  - TA loss
  - Anthocyanin gains, and then losses
  - Don't forget about flavor development

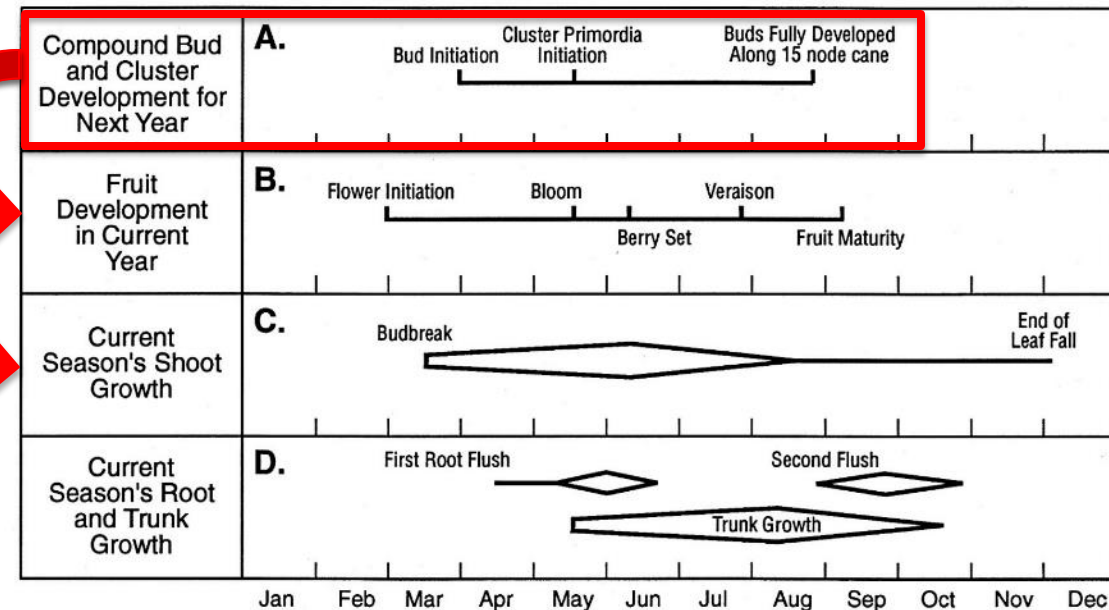
# Wrapping Up

- Grapevines go through a yearly cycle of growth
  - 1 - Budbreak, 2 - Rapid Shoot Growth, 3 – Bloom, 4 - Berry Set, 5 – Veraison, 6 - Fruit Maturation, 6.5 – Harvest, 7 - Leaf Fall, 8 - Vine Dormancy
- Thanks to the dormant bud this is really a two-year cycle



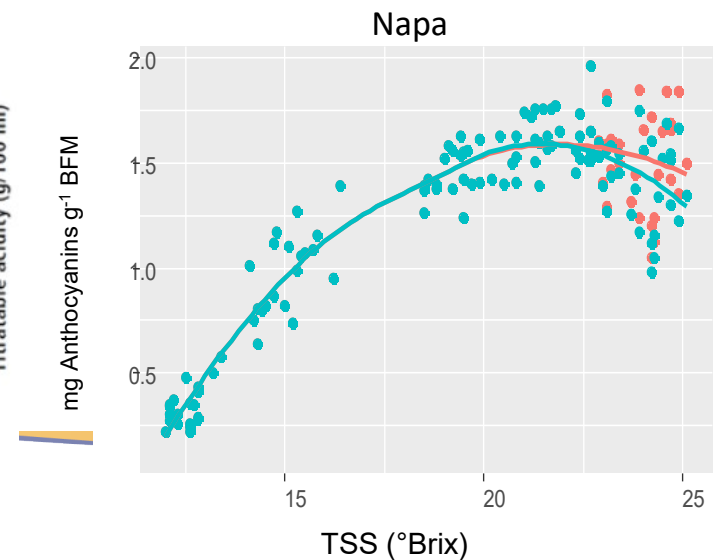
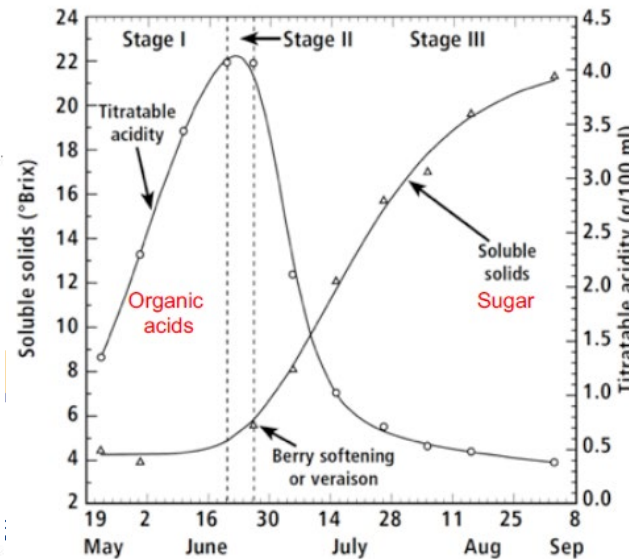
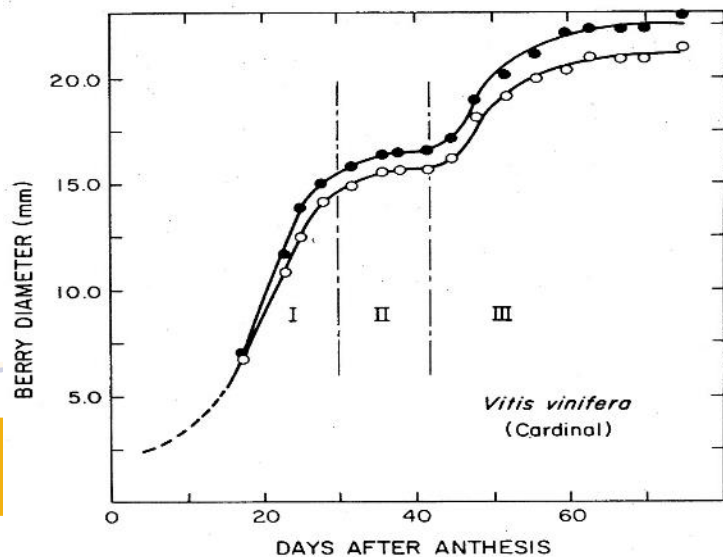
# Wrapping Up

- In the background of this season's growth and development, the seeds for next season are being laid
- Dormant bud initiation happens during rapid shoot growth
- Cluster initiation for next season's clusters happens during this season bloom
  - Last season affects this season, this season affects next season



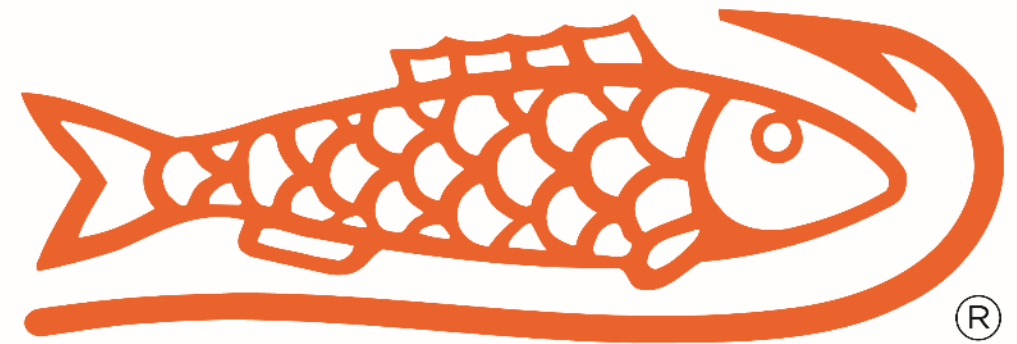
# Wrapping Up

- Berry growth is split into three phases
- Berry size, acid (TA), sugar, anthocyanin, and many other items shift across maturation
- There is no magic point at which you should harvest, that is up to what you need



# Questions?

- Thanks for listening
- Thanks to Bahco for their equipment donations



# BAHCO