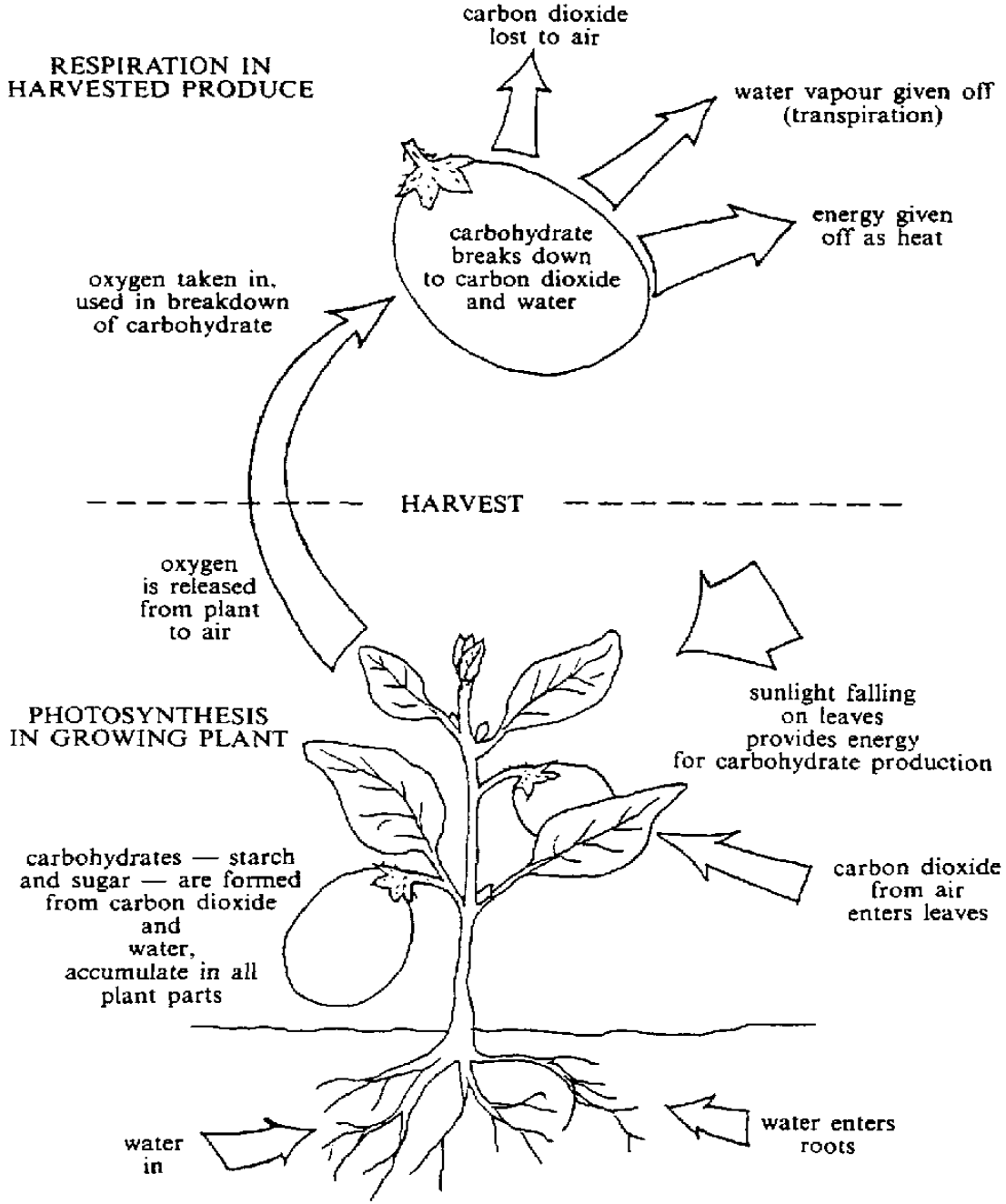
4th Lecture: Physiology
Physiology of ripening

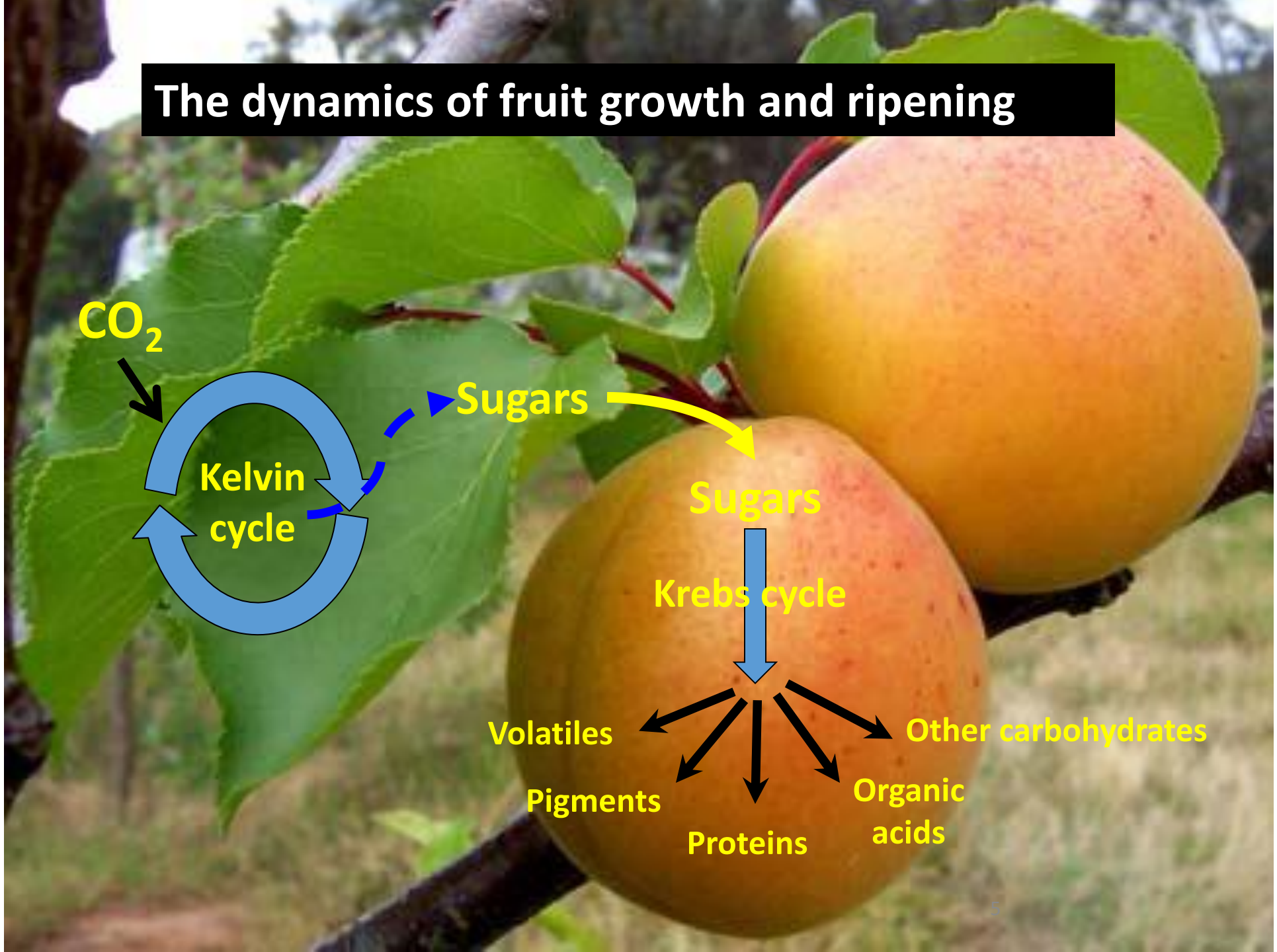
Process modulated during ripening:

Respiration and Climacteric response

Climacteric respiration- Found in fruits and vegetables and is defined as a rapid increase in respiration (increase in carbon dioxide) and the production of ethylene, in parallel with the ripening processes

Non-climacteric respiration- Is a fruit response showing not dramatic increase after harvest and does not show any production of ethylene


RESPIRATION IN HARVESTED PRODUCE
carbon dioxide lost to air
water vapour given off (transpiration)
energy given off as heat
carbohydrate breaks down to carbon dioxide and water
oxygen taken in, used in breakdown of carbohydrate
HARVEST
oxygen is released from plant to air
PHOTOSYNTHESIS IN GROWING PLANT
sunlight falling on leaves provides energy for carbohydrate production
carbohydrates — starch and sugar — are formed from carbon dioxide and water, accumulate in all plant parts
carbon dioxide from air enters leaves
water in
water enters roots


The dynamics of fruit growth and ripening
CO_2
Kelvin cycle
Sugars
Sugars
Krebs cycle
Volatiles
Pigments
Proteins
Organic acids
Other carbohydrates

What are the factors that enhance crop respiration

- Ripening of the fruit
- Physical damage (fall, injury, harvest)
- Decay development
- Increased temperature
- Stress (water, cold, heat, atmosphere)

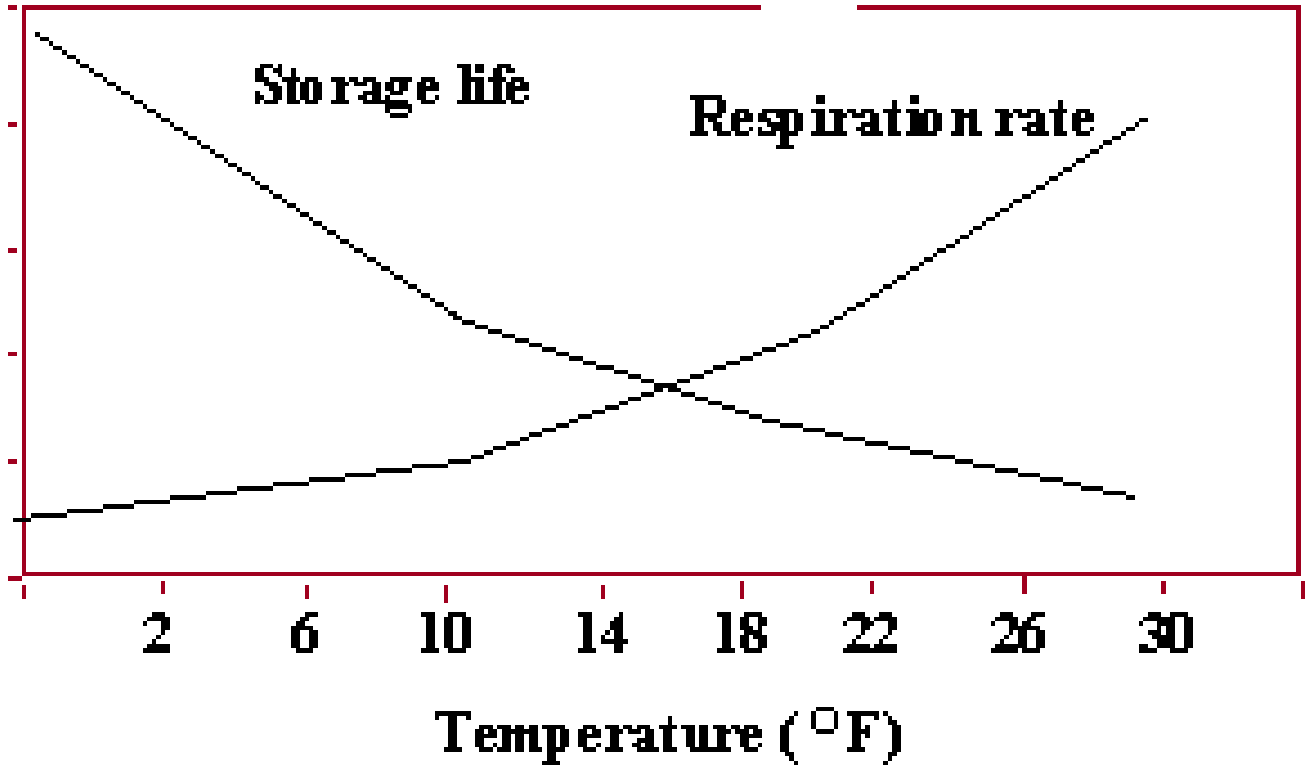
Events related to ripening and senescence showed a sharp increase in respiration

Factors modulating respiration

- Temperature – is the most important factor.
- The effect of temperature is modulated by Van't Hoff's law that indicate that the speed of biological reactions in fruit are increased by 2 to 3 times each increase of 10 C.

Temperature C	Relative biodegradation	Relative shelf life
0	1	100
10	3	33
20	7.5	13
30	15.0	7
40	22.5	4

The relative effect of temperature on the storage life and respiration



Respiration and Shelf Life

Respiration rate and shelf life are inversely related.

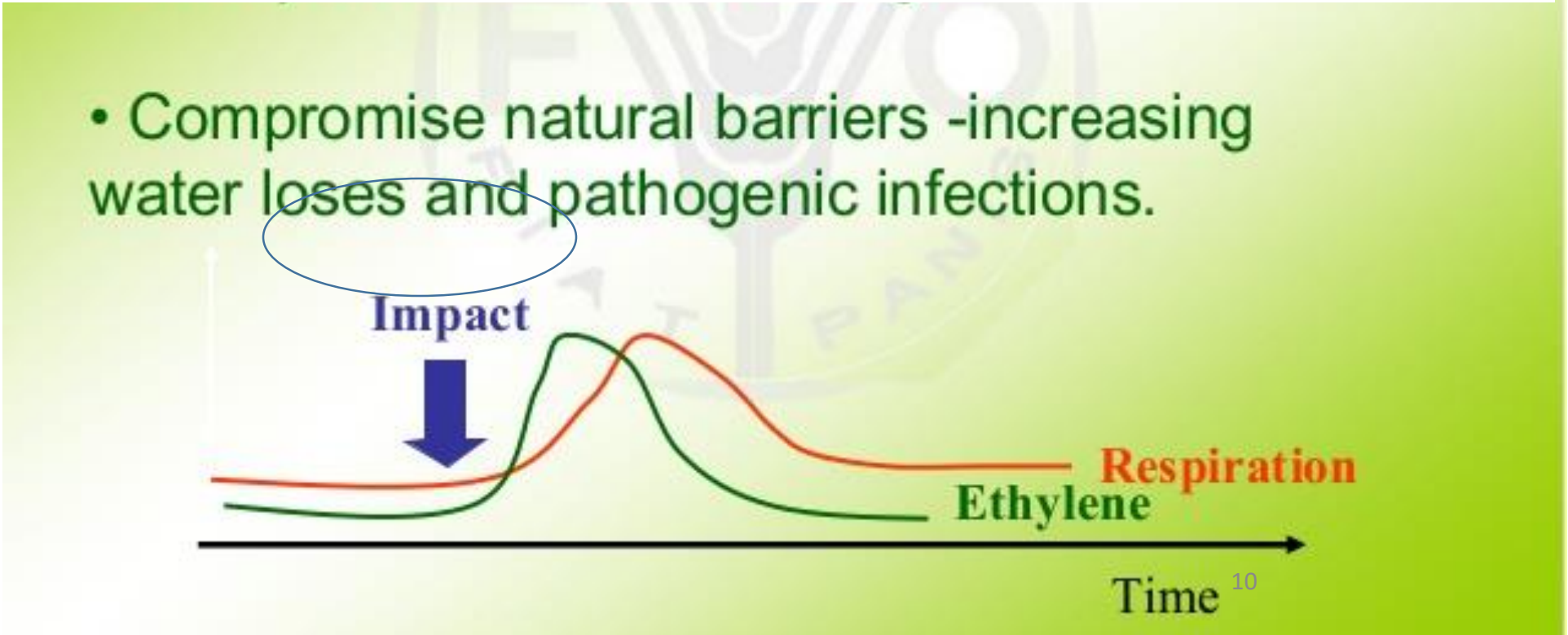
Higher respiration

↓

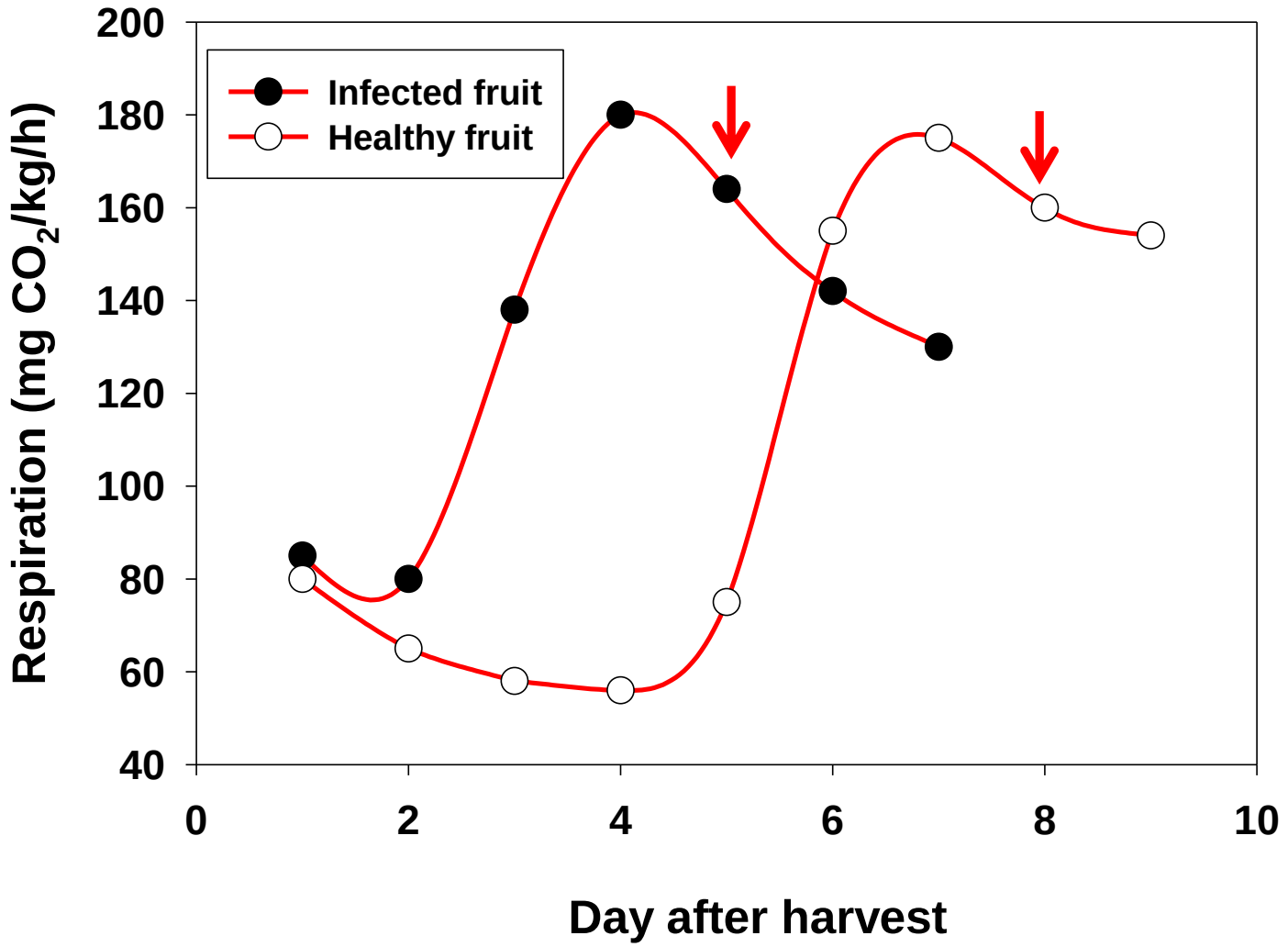
Shorter Shelf life

Mechanical damage during the postharvest chain

- Compromise natural barriers -increasing water loses and pathogenic infections.



Effect of decay on the respiration of the tomato fruit (red arrow – the beginning of the softening of the fruit)



Two ways of fruit ripening

Climacteric fruits – is the ripening by the expression of a regulatory system of transcription factors that modulate the respiration of the fruit and the production of ethylene.

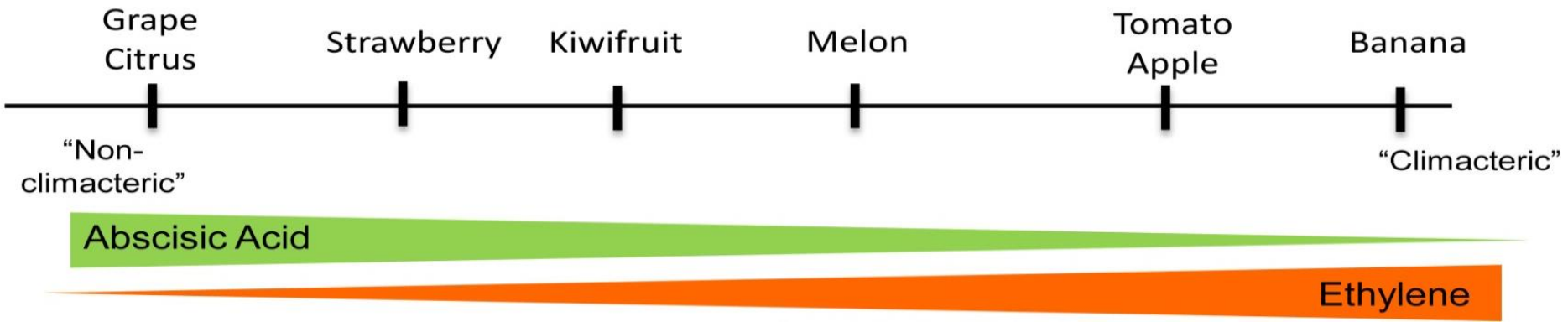
Non climacteric fruit- not known enough. Although the pathways of fruit development and ripening are different. These fruits show a similar ripening phenomenon that includes a change in the structure of the cell wall at the same time as softening, synthesis of pigments, turning starch into sugar and synthesis of aroma materials that affect taste and aroma.

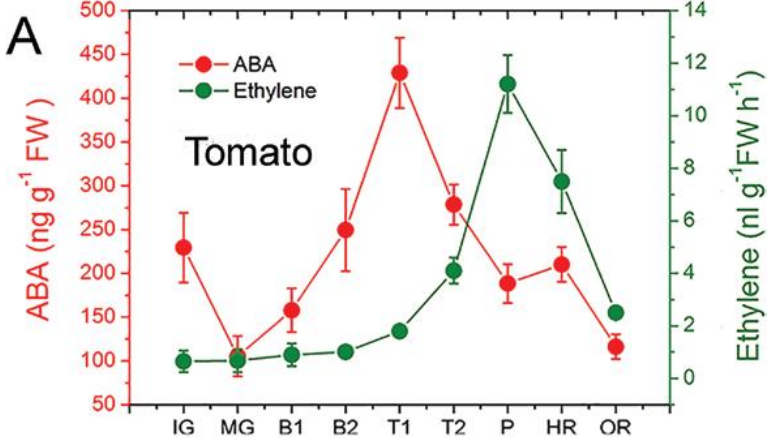
These results indicate that there are factors that are not ethylene-dependent and differentiate between the maturation of climacteric fruit from the non-climacteric ones.

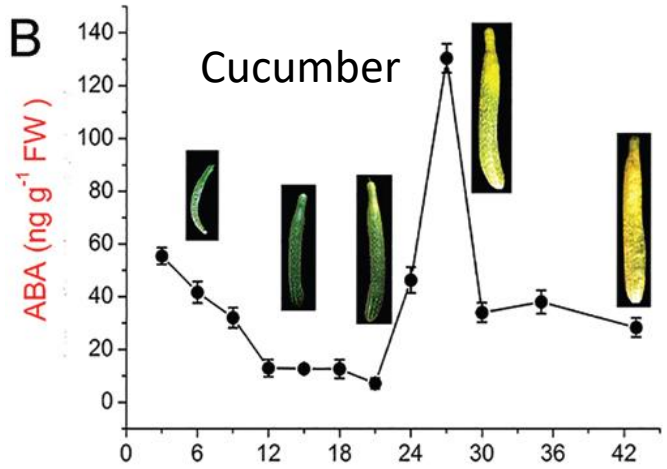
Abscisic acid (ABA) is another factor:

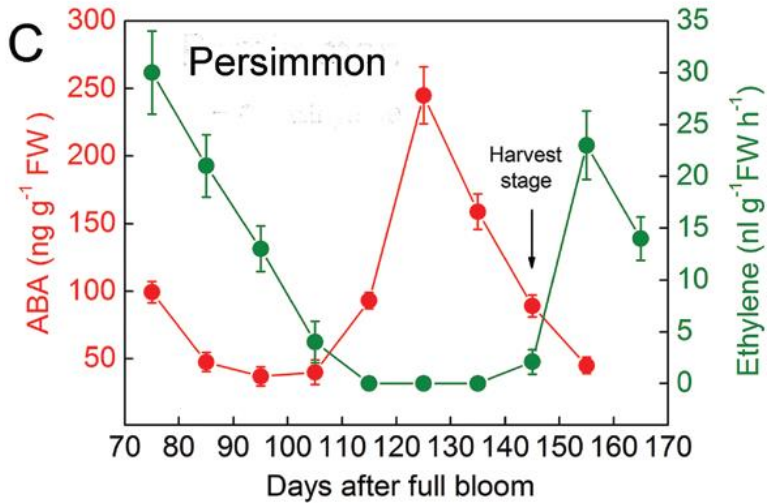
Why is Abscisic acid (ABA) another factor:

1. There was a sharp increase in ABA during the onset of ripening of the fruit, both in climacteric fruit and non climacteric ones.
2. The increase in ABA occurs before the increase in ethylene
3. Providing an external ABA speeds up the creation of metabolites involved in ripening the fruit and therefore speeds up ripening.
4. In mutants of tomatoes that lack ABA, the fruit has **NOT! shown** normal development.
5. Silencing the gene responsible for ABA formation in the strawberries delayed the development of the fruit.





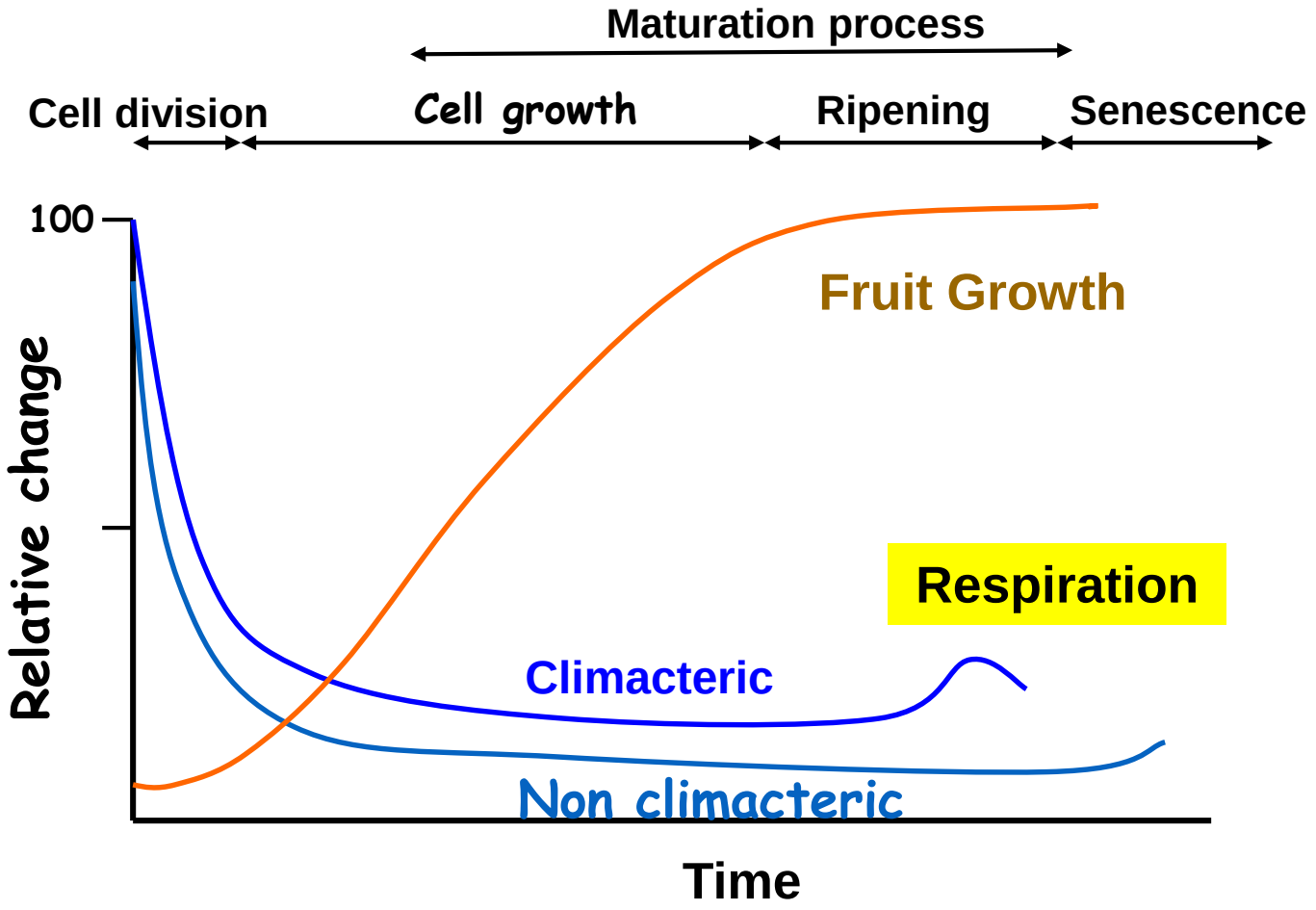


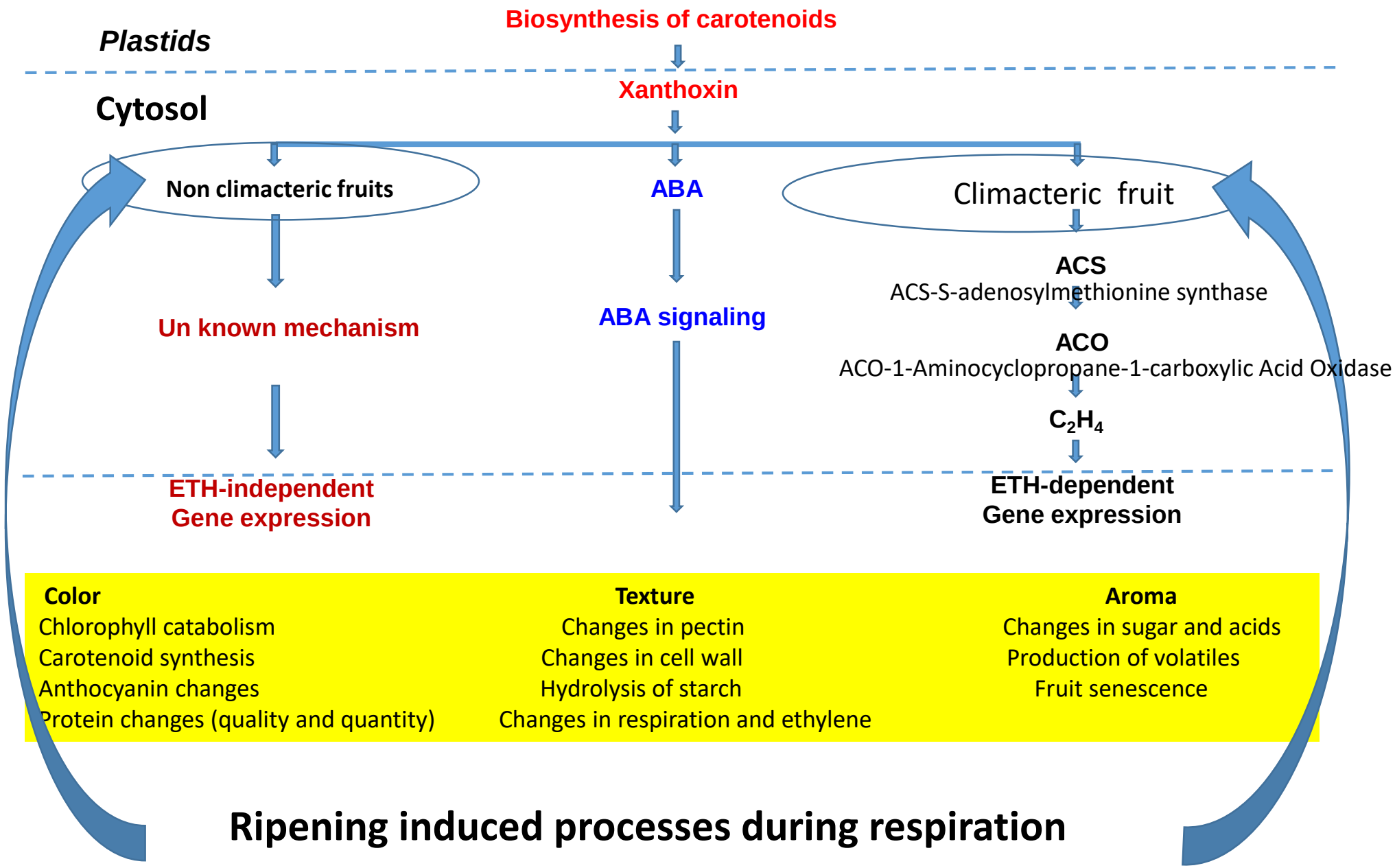


Changes in Abscisic acid (ABA) and ethylene during development and ripening

(ABA evolution in relation to ethylene production during ripening and senescence)

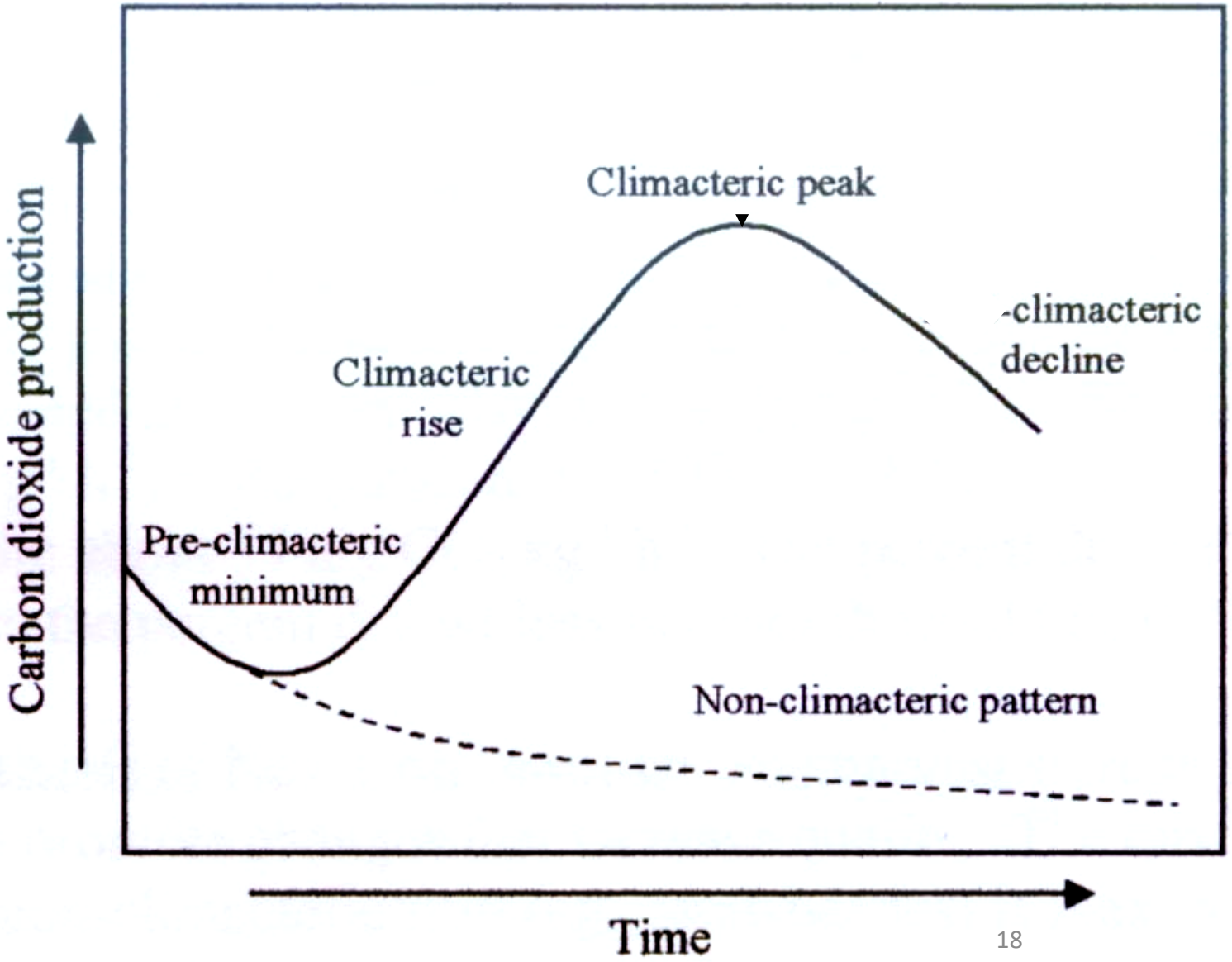
Climacteric ripening in relation to fruit growth

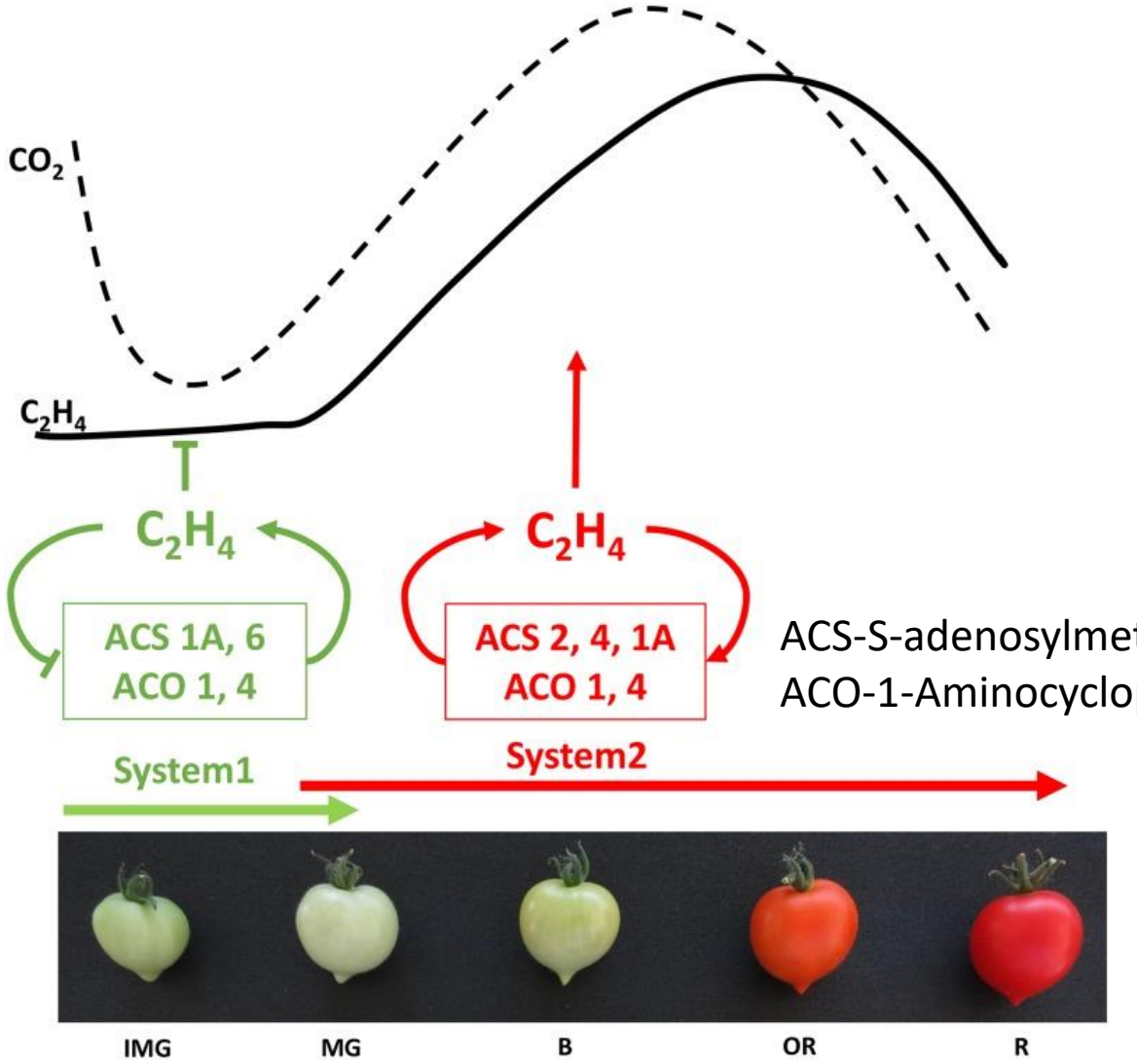




Ripening induced processes during respiration

Increase in respiration of climacteric fruit





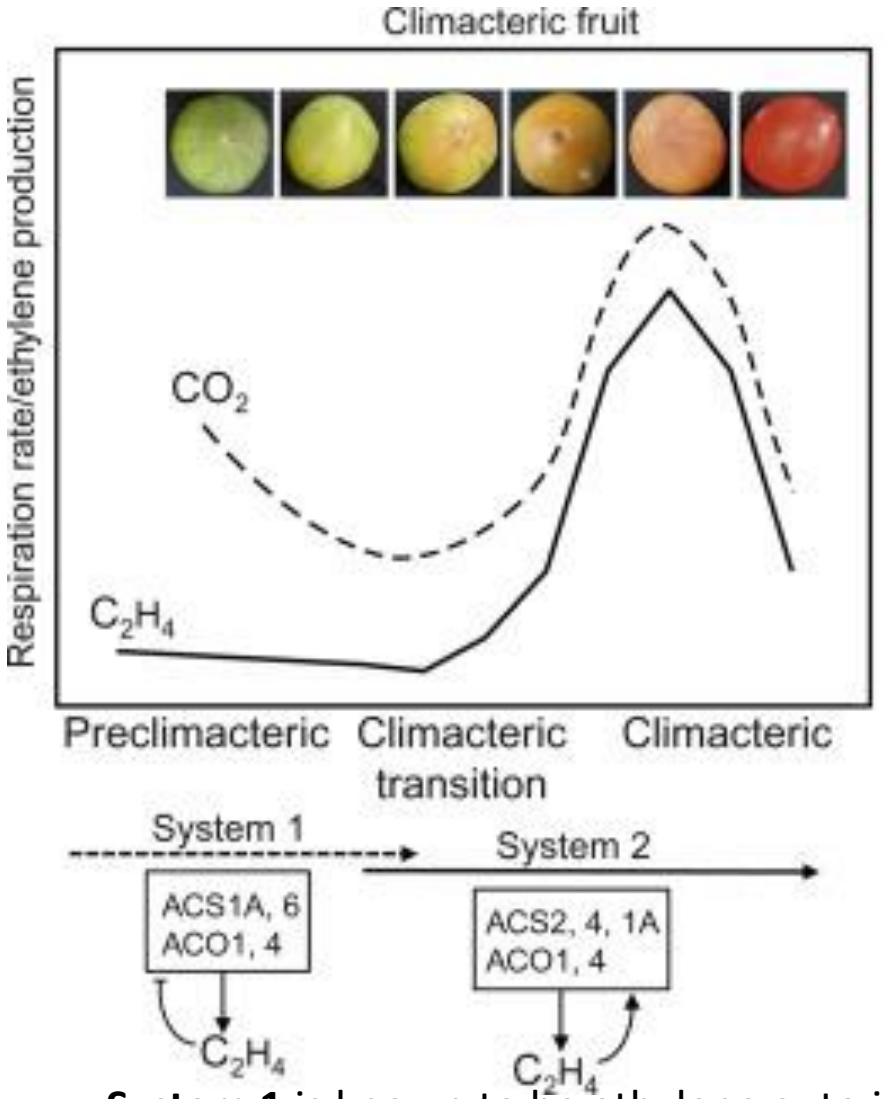
Still open subjects of research!!!

ACS-S-adenosylmethionine synthase
ACO-1-Aminocyclopropane-1-carboxylic Acid Oxidase

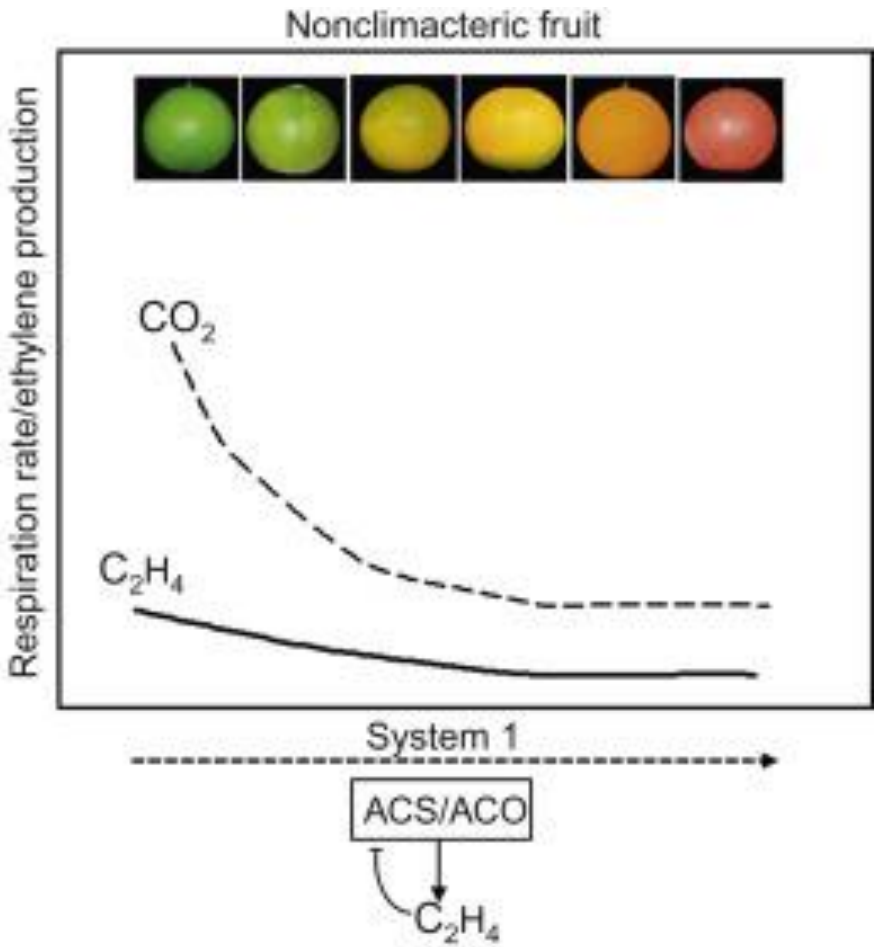
System 1 is known to be ethylene auto-inhibitory and is reported to function during fruit growth, where as

S**ystem 2** operates during the **climacteric** ripening and is autocatalytic

Tomato



Citrus



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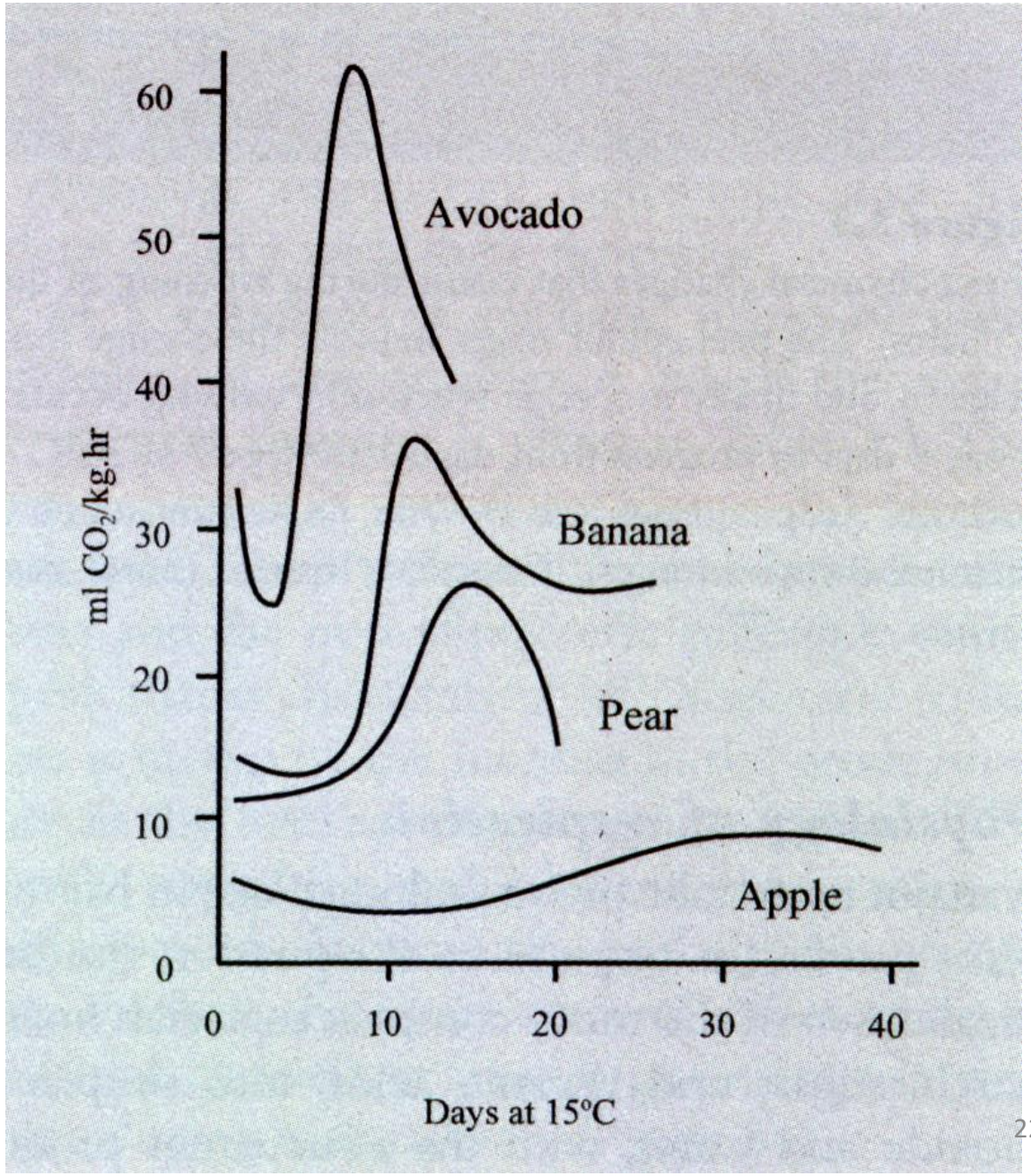
https://doi.org/10.1016/B978-0-12-813278-4.00007-5

Distribution of fresh produce over respiratory/ethylene behavior during ripening

Climacteric		Non climacteric	
Apple	Melon	Carambola	Pineapple
Apricot	Nectarine	Cherry	Pomegranate
Avocado	Papaya	Blueberries	Sweet melons
Blueberries	Passiflora	Dates	Sabras
Feiyoa	Peach	Grapes	Strawberries
Fig	Persimmon	Citrus	Raspberry
Guava	Plums	Loquat	Pepper
Kiwi	Quince	Lychee	Zucchini
Mango	Sapodilla	Olives	Cucumber
Mangosteen	Tomato	Okra	Lettuce
		peas	Fresh Herbs

The differential respiration different of climacteric fruits



WHAT INITIATES THE RIPENING TRANSITION?

Prior to Ripening, the Fruit Undergoes a Transition in Competence to Respond to Ethylene.

How is the competence for Ethylene occurs?