



Fruit ripening and physiological changes associated with ripening.


INTRODUCTION



- Ripening is the process by which fruits attain their desirable flavor, quality, color, palatable nature and other textural properties.
- Ripening is associated with change in composition *i.e.*
 - conversion of starch to sugar.
 - Change in colour
 - Change in firmness
 - Shape and size
 - Odour /smell



Changes occurs During Ripening

- 
- Dev. Of wax on screen
 - Flavour volatiles
 - Proteins
 - Organic acid
 - Carbohydrate composition
 - Pectic substance
 - Tissue rigidity
 - Ethylene
 - Denaturation of chlorophyll



- Increases in biosynthesis
- Evolution of ripening hormone
- Increase in respiration mediated
- Alternation of cell structure
- Hydration of cell wall
- Decrease in structural integrity
- Increase in intercellular space



Metabolic Changes

In fruit ripening



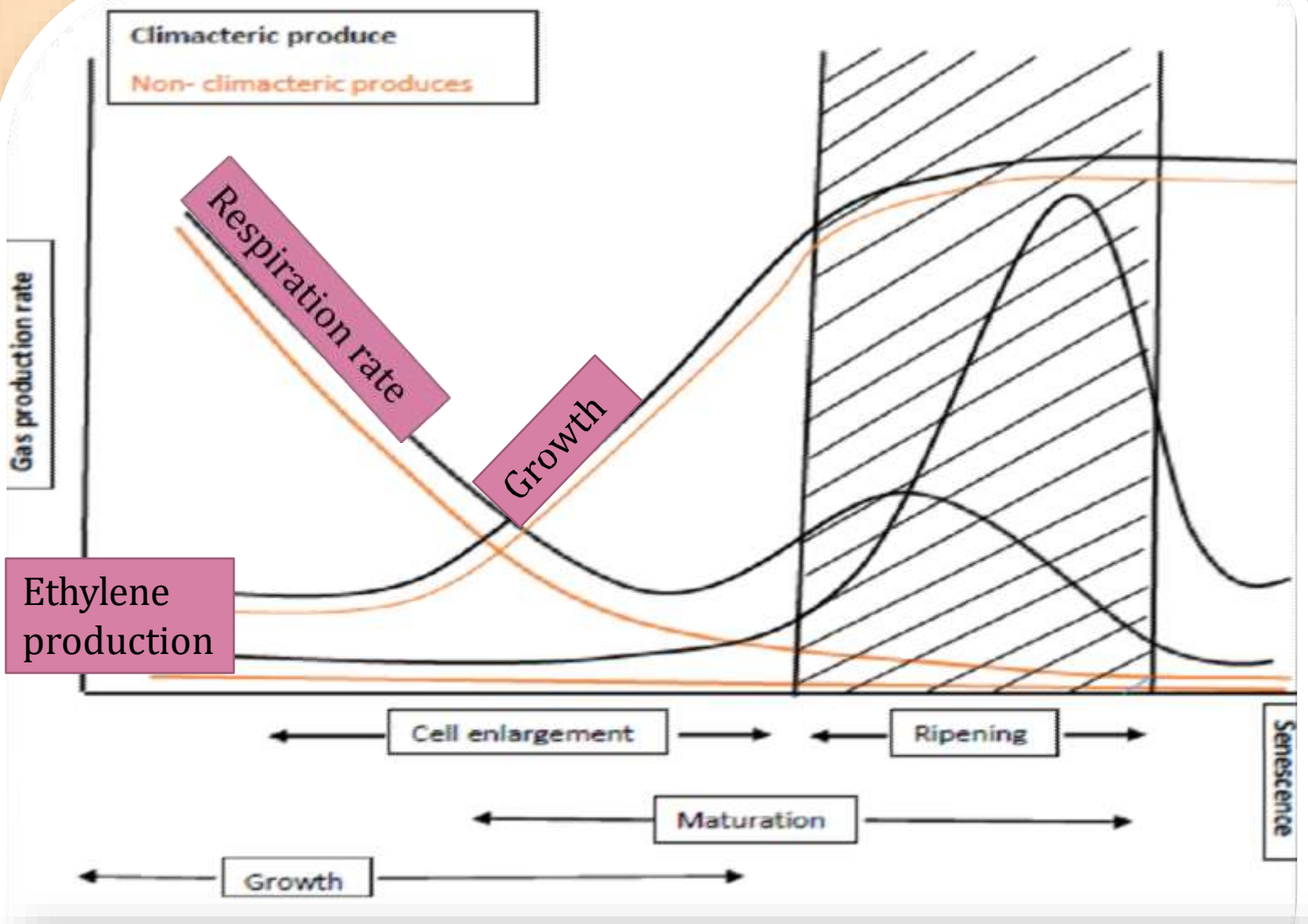
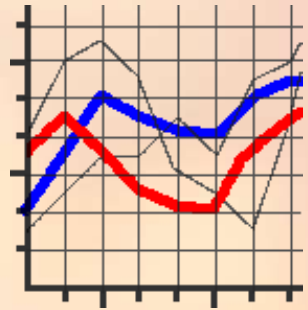
Respiratory Pattern



- Climacteric
- Non climacteric

| | Climacteric | Non climacteric |
|---------------------|--|--|
| Respiration | Increase | Not shows respiratory climacteric |
| Ethylene | More production ↑ | Less amount ↓ |
| Detachment ripening | occurs | On tree only |
| Fruits | Apple, Apricot, Banana, Guava, Kiwifruit | Cherry, Cucumber, Grape, Grapefruit, Lemon |





Ripening Graph

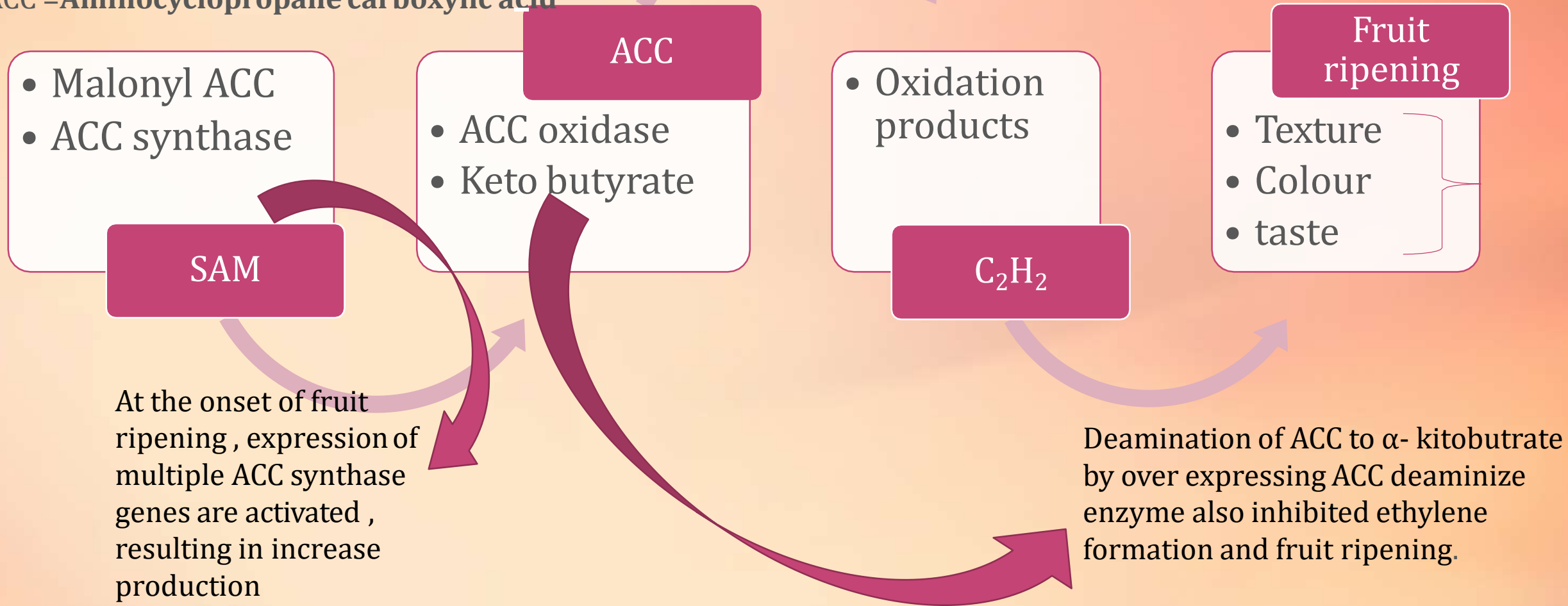
Growth, respiration and ethylene production in climacteric and non climacteric fruits



SAM = S- Adenosylmethionine

ACC = Aminocyclopropane carboxylic acid

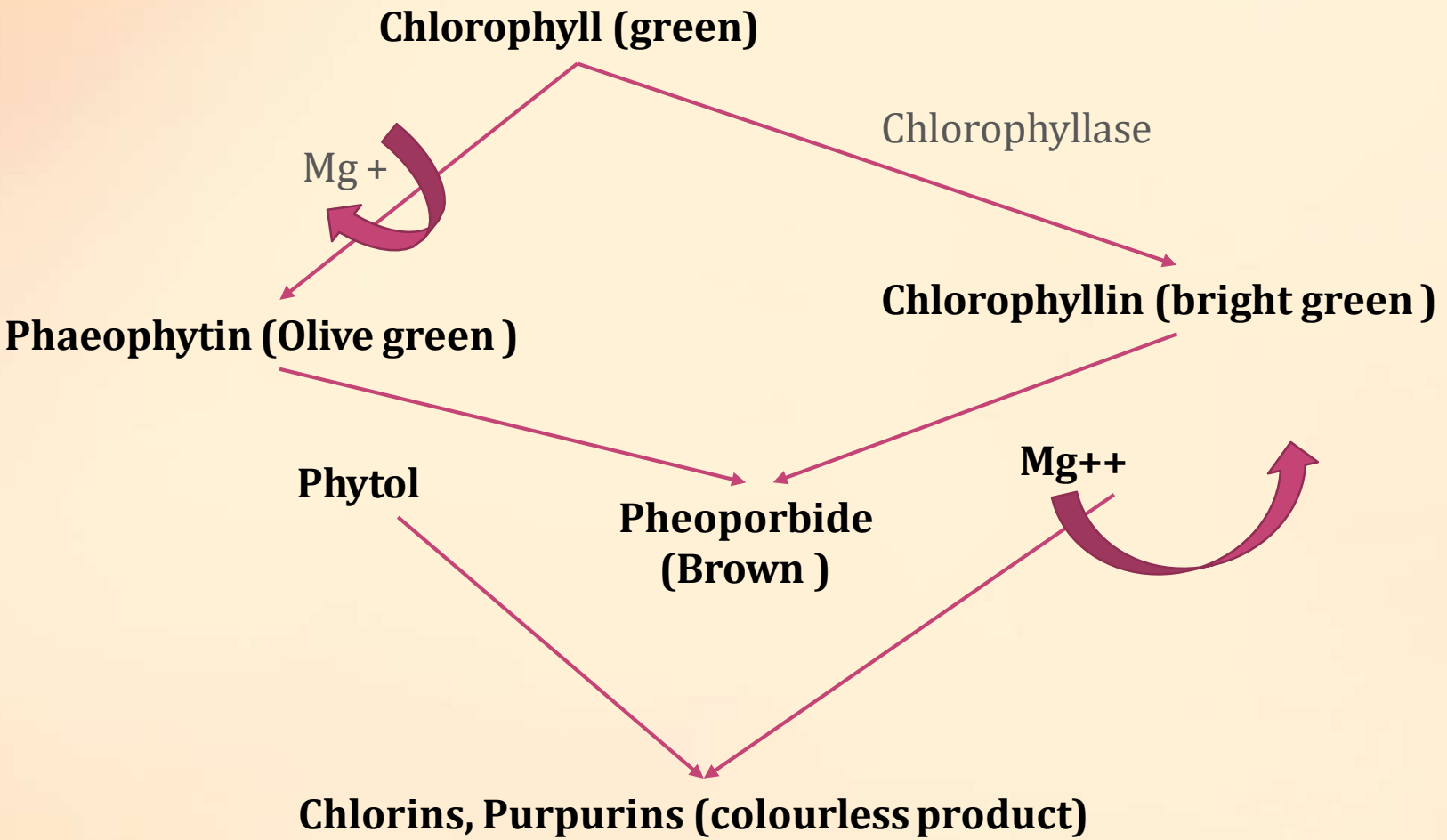
Yang and Hoffman 1993



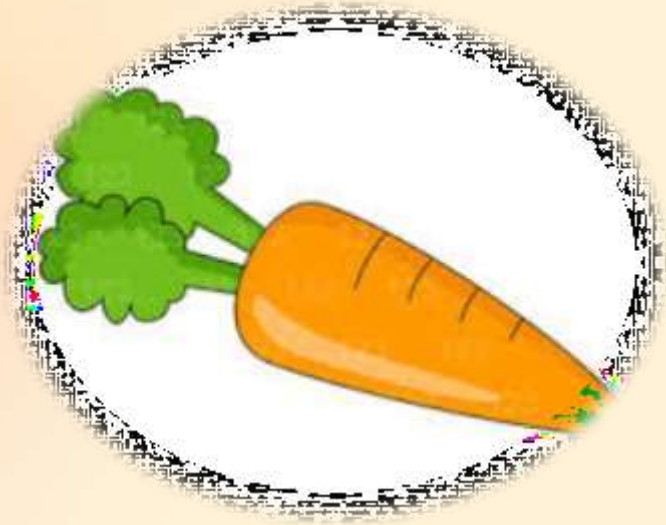
Mechanism of Ripening

Pathway of ethylene Biosynthesis and Metabolism

Degradation of Chlorophyll and Pigment Synthesis

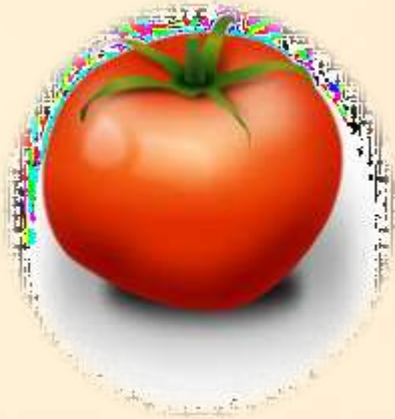


- ❖ Degradation of **chlorophyll** due to **Chlorophyllase** enzyme.
- ❖ Splitting of **chlorophyll** into **Phytol chain** and **porphyrin**.
- ❖ Loss of **Mg⁺⁺** ion and conversion of **porphyrin** into **Phaeophytin**.
- ❖ Change in **tetrapyrrolic** chain and it becomes **bilviridin**.
- ❖ **Oxidation** or saturation of double bonds.



| Enzyme | Mode of action |
|----------------------------|--------------------------------|
| α Amylase | Mixture of glucose and maltose |
| Starch phosphorylase | Glucose 6-phosphate |
| α (1-6) glucosidase | Amylopectin |

| Product | Compound |
|---------|----------------------------|
| Apple | Ethyle 2- methyle butyrate |
| Banana | 2 hexanol |
| Lemon | Citral |



Hydrolysis and Aroma

Starch to sugars

Aroma volatile after ripening



Textural changes

Enzyme degradation of polysaccharides

Different rates i.e. Degree

Breakdown of starch

Pectic substance

Hydrolysis starch- firmness

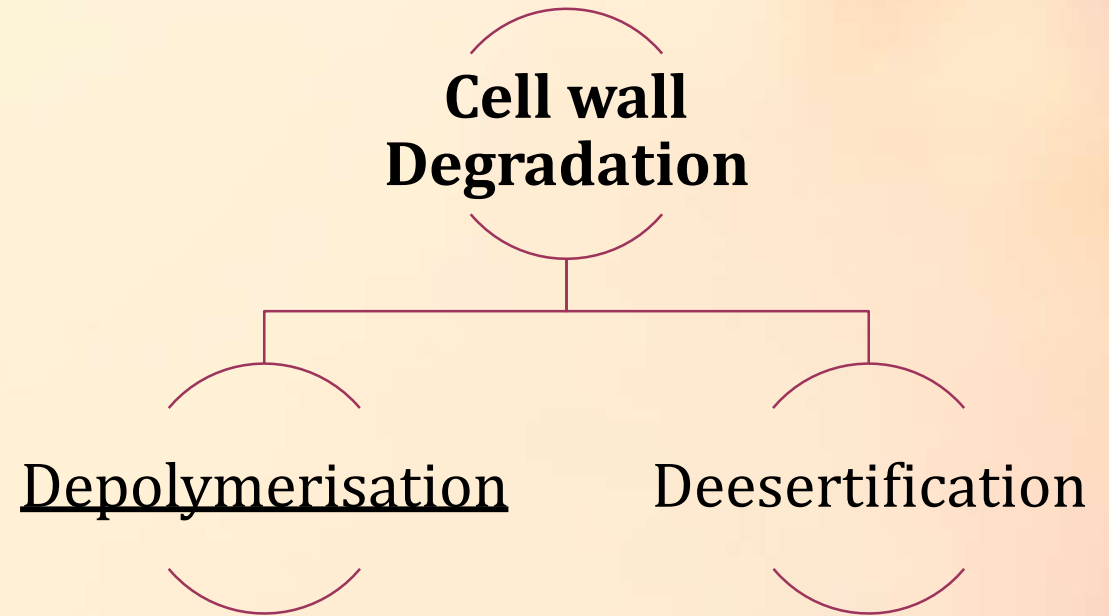


Cell wall breakdown

PG (Polygalacturonase)

PME (Pectin methylesterase)

Other hydrolases



Textural changes

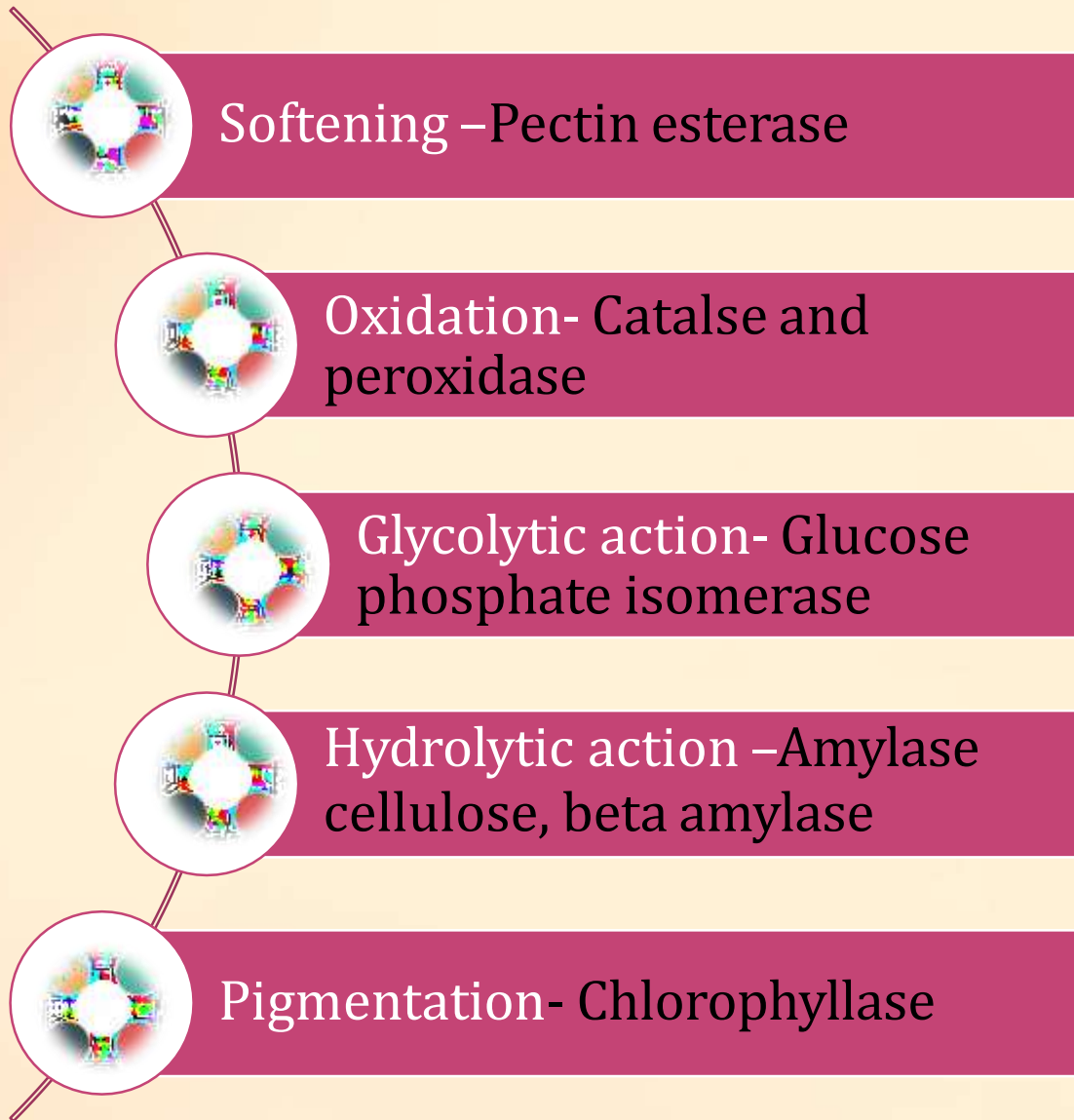
| S NO | Crop | Phenol | Status |
|------|--------|----------------------|-----------|
| 01. | Grapes | Flavon-3-ol monomers | Decreases |
| 02. | Loquat | Hydrobenzoic acid | Decreases |
| 03. | Citrus | Limonoids | Decreases |



Phenolic Compound

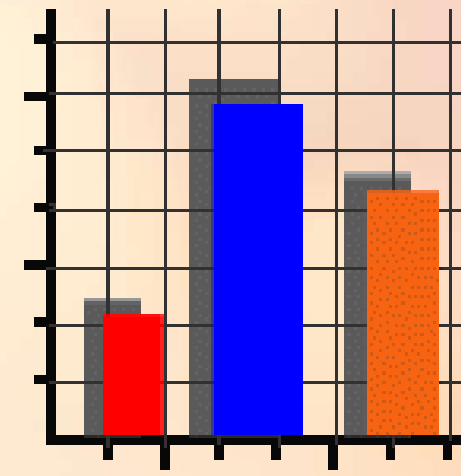
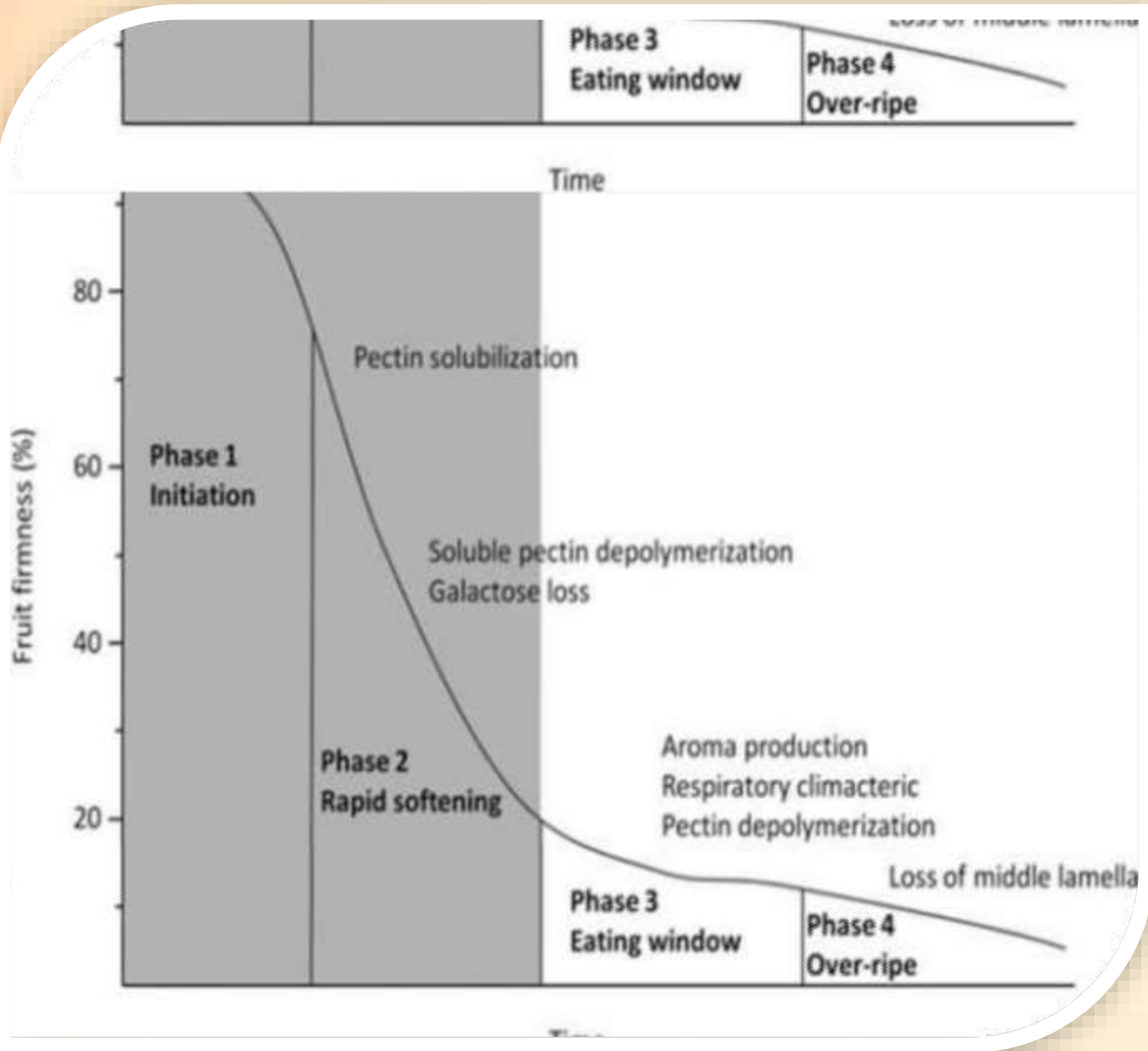
Astringency to fruit e.g. **Tannins.**

Involve in **oxidative browning**
due to **Polyphenoloxidase**



Enzyme Activity

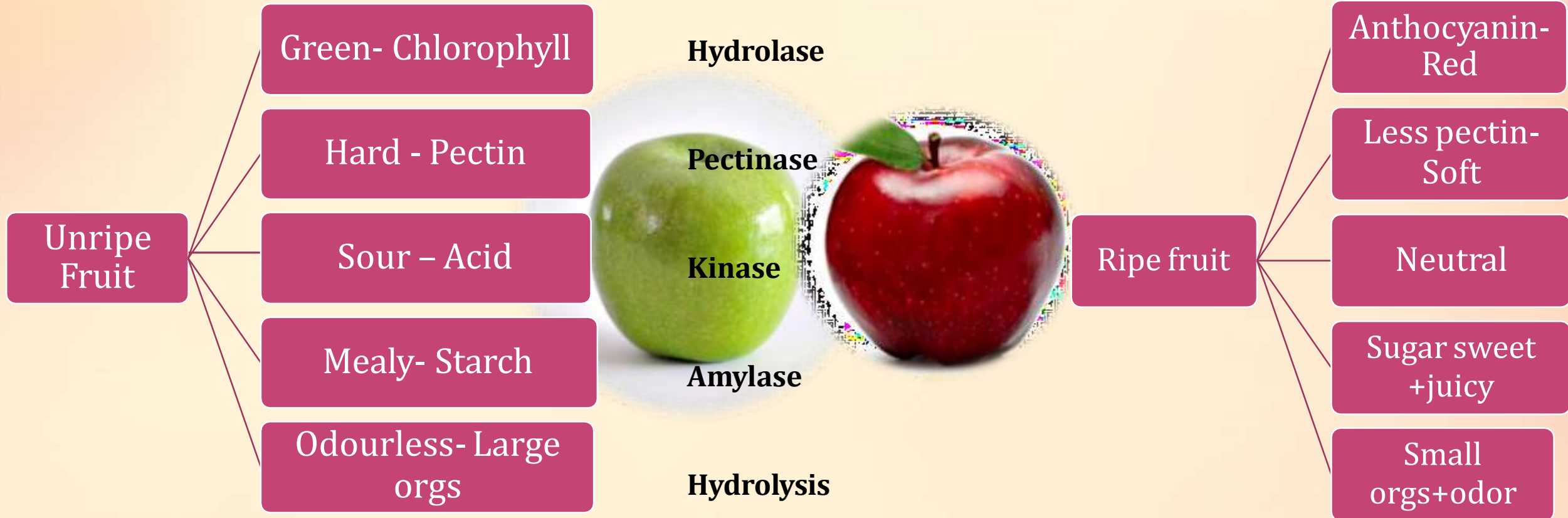
Many of the chemical and physical affects during ripening and after ripening processes are attributed to the enzyme action.



Fruit Firmness

Physical condition – Chemical cause

Chemical cause-Physical condition



Enzymatic action

Regulation of Ripening

Ethylene regulation

Regulation of O_2 and CO_2

- MAS
- CAS

Chemical treatment

- Calcium
- 1MCP methylcyclopropane

Bioregulators

- Auxin GA,CK
- Ethylene, ABA

Ionized radiation

- Gamma





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Thanking You