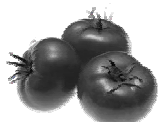


# 第一章 果蔬贮运保鲜的基本原理

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## Postharvest Physiology of Fruit & Vegetable



### Contents

- Morphology, Structure, Development
- Composition
- Respiration
- Transpiration
- Ethylene
- Dormancy
- Other

### MORPHOLOGY, STRUCTURE, GROWTH AND DEVELOPMENT



#### Classifications of Horticultural Crops and Their Usefulness in Relation to Postharvest Considerations

- Botanical classification
- Classification by geographical origin
- General groups of horticultural commodities
- Subgroups within general groups
- Grouping by plant parts

#### Grouping by Plant Parts

Edible plant part	Examples
Entire plant.....	Beet, radish, potted plants
Shoot.....	Green onion, cut flowers
Root primary.....	Carrot, turnip
secondary.....	Sweet potato, cassava
Stem.....	Asparagus, kohlrabi 大头菜
Tuber.....	Potato, yam, several ornamentals
Leaf mainly leaf blade.....	Leaf lettuce, spinach
mainly petiole.....	Celery, rhubarb
buds.....	Cabbage, head lettuce
Floral parts.....	Cut flowers, artichokes, cauliflower
Bulb.....	Onion, several ornamentals
Fruits fleshy, mature.....	Apples, pears, peaches, berries, grapes, citrus, melons, tomatoes, winter (hard-rind) squash
fleshy, immature.....	Cucumbers, summer (soft-rind)
non fleshy, immature.....	Peas, green beans, okra 黄秋葵, sweetcorn
non fleshy, mature.....	Seeds and nuts

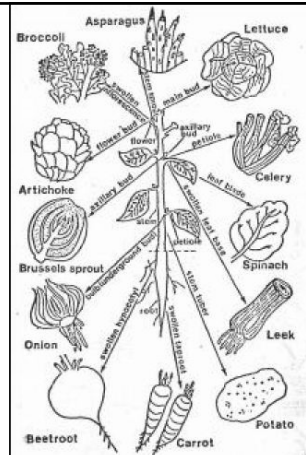
#### Grouping by Plant Parts

- This classification is the most useful in relation to postharvest considerations since, in most cases, commodities within a given group have similar postharvest requirements and recommendations.
- Couple with knowledge of geographical origin, which relates to chilling injury susceptibility

### Morphological Structure of Horticultural Commodities

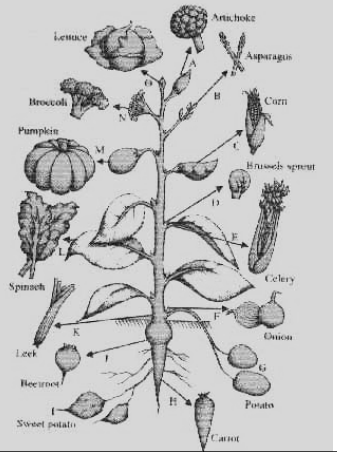
- A diversity of plant parts and their structures are represented by harvested fruits and vegetables

- Derivation of some vegetables from plant tissue



### Derivation of some vegetables from plant tissue

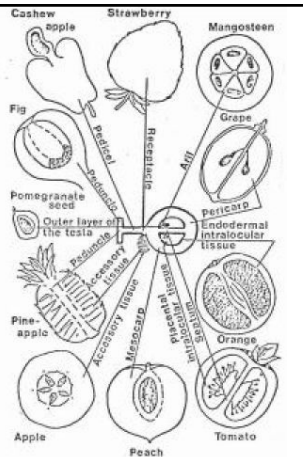
- A 朝鲜蓟——花蕾
- B 芦笋——嫩芽
- C 玉米——种子
- D 球芽甘蓝——辅芽
- E 芹菜——叶柄
- F 洋葱——鳞茎
- G 马铃薯——块茎
- H 胡萝卜——膨大根
- I 番薯——膨大根茎
- J 甜菜根——膨大胚轴
- K 韭菜——膨大叶基
- L 菠菜——叶片
- M 南瓜——果实
- N 青花菜——膨大花序
- O 莴苣——主芽



### Morphological Structure of Horticultural Commodities

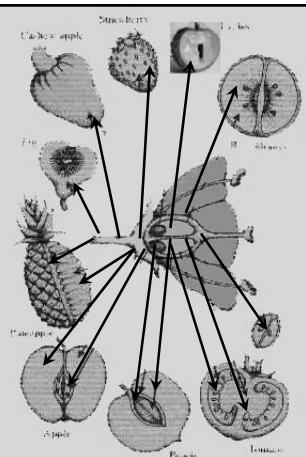
- Note also the diversity of tissues that can develop into fruit flesh. All parts of the total inflorescence structure are, in one species or another, developed into fruit flesh

- Derivation of Some Fruits from Plant Tissue



### Derivation of Some Fruits from Plant Tissue

- A 腰果——花梗
- B 草莓——花托
- C 荔枝——假种皮
- D 柑桔——内胚层
- E 葡萄——果皮
- F 番茄——隔膜和胎座
- G 桃——中果皮和内果皮
- H 苹果——心皮和附属组织
- I 菠萝——总花梗和附属组织
- J 无花果——总花梗



Relationship between structure of horticultural commodities and their postharvest behavior	
Group	General postharvest characteristics
<b>Rapidly growing vegetative and immature fruit structure</b>	<ul style="list-style-type: none"> <li>-Highly perishable</li> <li>-Usually high respiration rate</li> <li>-Rapid chemical changes</li> <li>-Weight loss is a major cause of deterioration</li> <li>-Continued growth can be a problem</li> </ul>
<b>Mature fruits</b>	<ul style="list-style-type: none"> <li>-Vary in perishability from very high (Strawberry) to low (apple)</li> <li>-Undergo many physiological and compositional changes associated with ripening</li> <li>-Decay can be an important deterioration factor</li> <li>-Moisture content is important to storage-life</li> <li>-Germination can be a factor</li> </ul>

Relationship between structure of horticultural commodities and their postharvest behavior	
(Cont.)	
Group	General postharvest characteristics
<b>Fleshy storage organs and propagules</b>	<ul style="list-style-type: none"> <li>-Low perishability</li> <li>-Low respiration rate</li> <li>-Growth can accelerate deterioration</li> </ul>
<b>Mature seeds and nuts</b>	<ul style="list-style-type: none"> <li>-Very low perishability</li> <li>-Very low respiration rate</li> <li>-Moisture content is important to storage life</li> <li>-Germination can be a factor</li> </ul>

- ### Tissue systems and component cells
- The dermal system (protective tissues) 表皮
  - The ground system
  - Supporting tissues
  - Vascular tissues

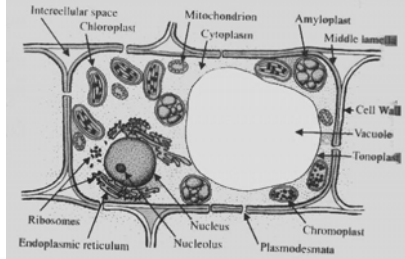


Diagram labels: Intercellular space, Chloroplast, Mitochondrion, Cytoplasm, Amyloplast, Middle lamella, Cell Wall, Vacuole, Tonoplast, Plasmodesmata, Chromoplast, Nucleolus, Nucleus, Endoplasmic reticulum, Ribosomes.

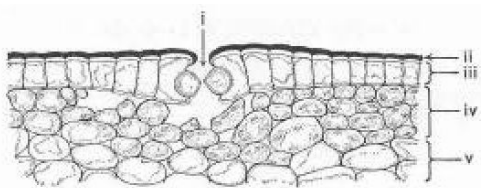
- 细胞壁 cell wall
- 细胞膜 cell membrane
- 细胞质 cytoplasm
- 液泡 vacuole
- 线粒体 mitochondrion
- 叶绿体 chloroplast
- 细胞核 nucleus
- 内质网 Endoplasmic reticulum
- 核糖体 Ribosomes
- 液泡膜 tonoplast

典型的果蔬细胞构造

- ### Tissue systems and component cells
- The dermal system (Protective tissues)
    - Epidermal cells
    - The cuticle
    - Stomates
    - Lenticels
    - Trichomes毛状体
    - Periderm (cork) (周皮)

- ### Tissue systems and component cells
- The ground system
    - Parenchyma cells - constitute most of the edible portion of an apple or a potato, etc.
    - Intercellular spaces - constitute about 20% in fruits and roots, >20% in leaves.

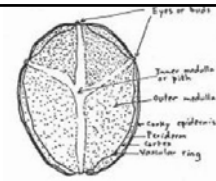
### Asparagus epidermis and parenchyma tissue



(a) A simple epidermis – asparagus stem

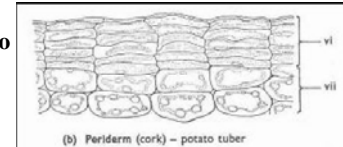
- i. A stomate
- ii. Cuticle
- iii. Epidermis
- iv. Parenchyma with chloroplasts
- v. Unspecialized parenchyma

### Cross Section of A potato Tuber



周皮

### Periderm of a potato tuber



- vi. Cork cambium and corky tissue
- vii. Parenchyma with starch grains

### Tissue systems and component cells

- Supporting tissues
  - Collenchyma cells – largely responsible for stringiness in celery stalks 厚角组织
  - Sclerenchyma cells 厚壁组织
    - Sclerenchyma fibers are major constituents of the “string” in green beans.
    - Sclereids (stone cells) in the flesh of certain fruits (e.g., guava, pear, sapote) 人心果 are responsible for their gritty or sandy texture.

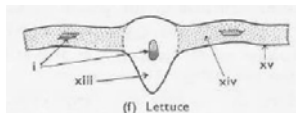
硬化细胞, 石细胞

### Tissue systems and component cells

- Vascular tissues
  - Xylem
  - Phloem
  - Laticifers (latex-producing cells in papaya, banana, etc.)

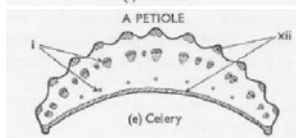
乳汁管

### A Lettuce Leaf



(f) Lettuce

### A Celery Petiole



(e) Celery

- i. Vascular bundles
- xii. Collenchyma 厚角组织
- xiii. Midrib of leaf (叶的中脉) 绿色组织
- xiv. Spongy chlorenchyma
- xv. Blade of leaf

### Fruit Cross Sections

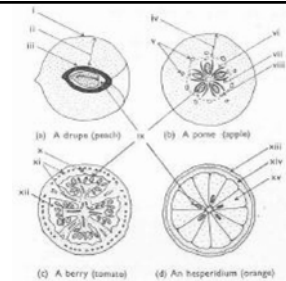


Fig The general structure of some common types of fruit. I, the soft thin *exocarp*. ii, the fleshy *mesocarp*. iii, the stony (sclerenchymatous) *endocarp*. Iv, fleshy *receptacular* tissue. v, vascular bundles originally supplying the floral organs. vi, Fleshy carpellary *exocarp* and *mesocarp*. vii, sclerenchymatous *endocarp*. viii, carpellary vascular bundles. ix, seeds, x, fleshy *pericarp*. xi, vascular bundles. xii, original ovarian cavity filled with a parenchymatous pulp. xiii, collenchymatous *exocarp* (the flavedo). xiv, spongy parenchymatous *mesocarp* (the albedo). xv, *endocarp* of juice sacks formed by the breakdown of groups of parenchyma-like cells.

### Significance of Morphological Structure and Growth in Postharvest Considerations

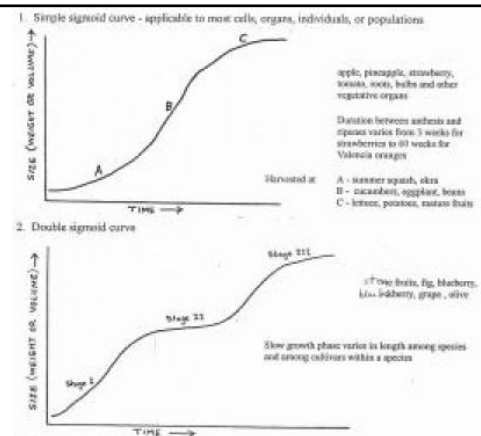
- **Relation to maturity and quality**
- **Changes after harvest**
  - Growth –sprouting, rooting, elongation, seed germination.
  - Toughening (due to increased lignification); fiber content.
  - Softening (due to changes in cell wall).
  - Wound periderm (formed in response to wounding).
  - Increased thickness of cuticle and wax deposits with fruit ripening.

### Significance of Morphological Structure and Growth in Postharvest Considerations

- Influence on susceptibility to mechanical damage
- Relation of the dermal system to physiology and deterioration
  - Gas exchange ( $O_2$ ,  $CO_2$ ,  $C_2H_4$ ).
  - Moisture loss
  - Entry of pathogens
  - Penetration of chemicals
  - Resistance to temperature and physical stress

### Growth and Development of Plant Parts

- **Growth:** The irreversible increase in physical attributes of a developing plant or plant part
- **Development:** The series of processes from the initiation of growth to death of a plant or plant part

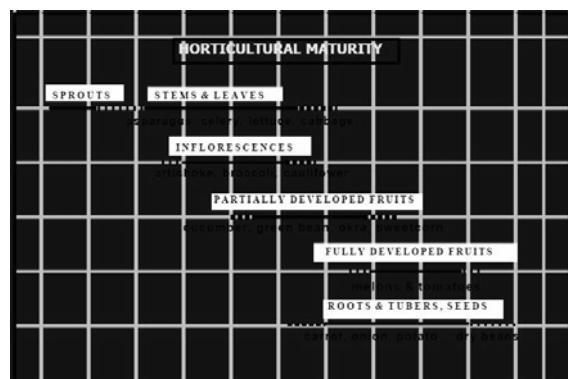
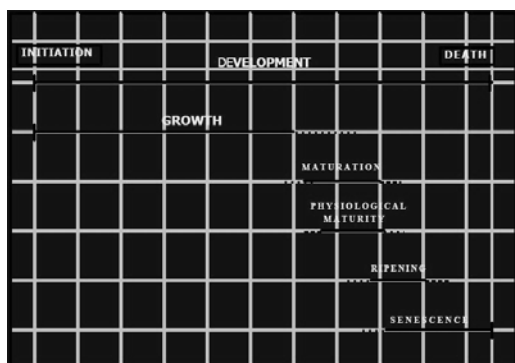


- **Maturation:** The stage of development leading to the attainment of physiological or horticultural maturity.
- **Ripening:** The composite of the processes that occur from the latter stages of growth and development through the early stages of senescence and that result in characteristic esthetic and/or food quality, as evidenced by changes in composition, color, texture, or other sensory attributes

- **Horticultural maturity:** The stage of development when a plant or plant part possesses the prerequisites for utilization by consumers for a particular purpose
- **Physiological maturity:** The stage of development when a plant or plant part will continue ontogeny even if detached

- Climacteric period: The period in the development of some plant organs involving a series of biochemical changes associated with the natural respiratory rise and autocatalytic production of ethylene

- Senescence: Those processes that follow physiological maturity or horticultural maturity and lead to death of tissue
- Aging: Any increment of time, which may or may not be accompanied by physiological change



### More on “Maturity “...

- “Horticultural maturity “ is based on a relative scheme
  - Can refer to any stage of organ development
- “Physiological maturity” means that the plant organ has fulfilled its biological purpose
  - e.g. a fully expanded leaf or a fruit that is able to ripen on or off the plant

### Importance of Stage of Development

- Time of harvest
- Quality when harvested
- Frequency of harvest (“harvest window”)
- Potential for mechanical harvest
- Intended use
- Behavior after harvest