



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

- 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





Grouping by Plant Parts

Edible plant part

Entire plant - - - - - - - - beet, radish, potted plants Shoot - - - - - - - green onion, cut flowers Root primary ------carrot, turnip

secondary --- --- -- sweetpotato, cassava Stem - - - - - asparagus, kohlrabi

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

Examples

fleshy, immature - - - - - cucumbers, summer (soft-rind) non fleshy, immature - - -peas, green beans, okra, sweetcorn

non fleshy, mature - - - seeds and nuts



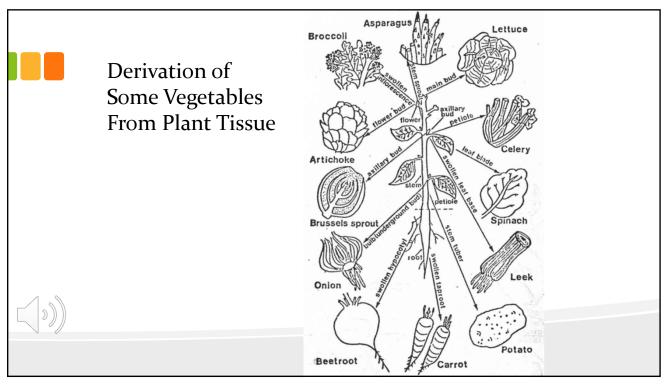


Morphological Structure of Horticultural Commodities

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



5



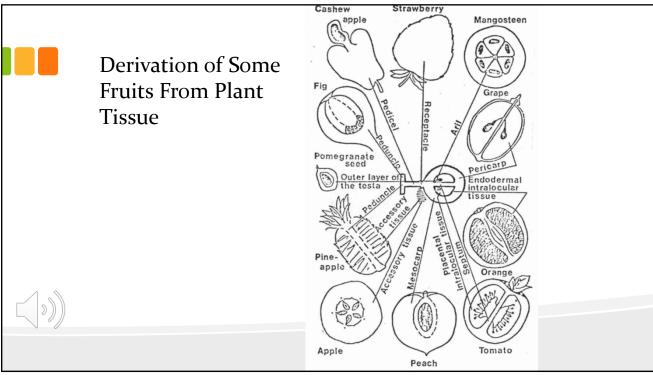


Morphological Structure of Horticultural Commodities

 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



7



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Relationship between structure of horticultural commodities and their postharvest behavior

| General postharvest characteristics |
|---|
| - Highly perishable |
| - Usually high respiration rate |
| - Rapid chemical changes |
| - Weight loss is a major cause of deterioration |
| - Continued growth can be a problem |
| - Vary in perishability from very high (strawberry) to low (apple |
| Undergo many physiological and compositional changes associated with ripening |
| - Decay can be an important deterioration factor |
| - Moisture content is important to storage-life |
| - Germination can be a factor |
| |

9



Relationship between structure of horticultural commodities and their postharvest behavior

(Cont.)

| Group | General postharvest characteristics |
|----------------|---|
| Fleshy storage | - Low perishability |
| organs and | - Low respiration rate |
| propagules | - Growth can accelerate deterioration |
| Mature seeds | - Very low perishability |
| and nuts | - Very low respiration rate |
| | - Moisture content is important to storage life |
| | - Germination can be a factor |



The Plant Cell

- A basic functional unit.
- Cell = cell wall + protoplasm
 - Protoplasm = cytoplasm + nucleus
 - Nucleus
 - Information center
 - Cytoplasm = everything within the cell except the nucleus or the cell wall
 - cytosol watery matrix
 - organelles membrane-bound, specialized function







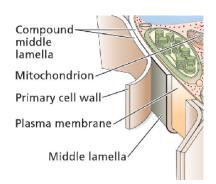






Plasma Membrane

- Boundary between the living and non-living world
- Selectively permeable
 - · Physically limits the cell
 - Controls exchange of "stuff"
 - Maintains differences between cell & environment



Taiz & Zeiger, 2002



- Hormone perception
- Direct synthesis of cellulose



Membrane Composition

- Lipid bilayer.
 - Phospholipids& Sterols
- Proteins (~50%)
 - Functional component
- Carbohydrates
- http://tiger.towson.edu/~cfaneli/istc301/cell-membrane.gif

 Exterior Oligosaccharide Glycoprotein Glycolipid Peripheral protein
 Integral protein

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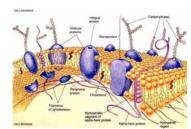


- Glycoprotenins & a few glycolipids
- Relative compositions of each vary

13



Properties of Bilayer



- Highly fluid
- http://bio.winona.edu/berg/ILLUST/memb-mod.jpg
- Impermeable to polar molecules
 - Exception: H₂O
 - CO₂ & O₂ (non-polar) can pass readily

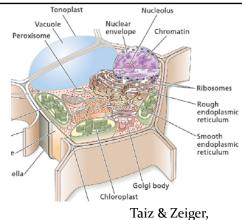


Contains unsaturated fatty acids (= "kinks" in their "tails")



Organelles

- Membrane limited compartments
- Each is involved with specific chemical processes



Taiz & Zeiger, 2002



 Cytosol - liquid, jellylike component, full of "raw" chemicals which surround the organelles

15



Nucleus -

Information central

- Surrounded by a double membrane.
- Contains DNA
 - encodes RNA (Transcription)
- Contains RNA
 - directs protein synthesis (Translation)





The Vacuole

- "Storage pool"
- Largest volume component of the cell
 - Often 80-90% of cell volume
- Vacuolar membrane = tonoplast.
- Allows uptake of water for cell enlargement (turgor pressure).
 - controls water potential of the cell
- Contains complex chemicals
 - Inorganic ions, organic acids, sugars, enzymes, pigments, secondary metabolites (e.g., phenolics)

http://micro.magnet.fsu.edu/cells/plants/images/plantvacuolesfigure1.jpg

17

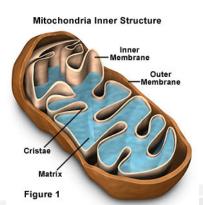


Mitochondria

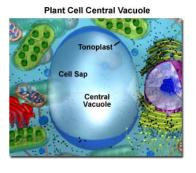
- Energy metabolism site of cellular respiration
- Double membrane
- Sugar oxidation drives synthesis and transport of ATP
- Contain DNA
- Self replicating



100 to 1,000s per cell



http://www.biologyclass.net/mitochondria.jpe





Plastids

- Energy harvesting
- Double membrane bound
- Contain DNA and ribosomes
- Self-reproducing

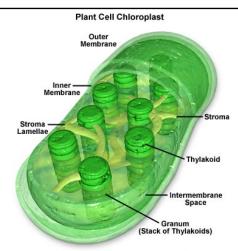


Figure 1

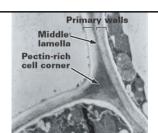


 $http://homepage.smc.edu/hodson_kent/Cells/Energetics/chloroplast2.jpg$

19



Extracellular Matrix



- A complex mixture [carbohydrates, phenolics & proteins (enzymes)]
- Cell Wall
 - Primary comes first
 - Secondary matures inside primary
 - Wall pits and plasmodesmata
- Middle Lamella cellular "glue"



Buchanan et al., 2000.



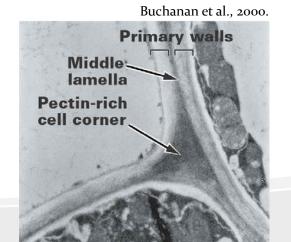
Cell Walls

Provide support (rigidity) to the cell and tissues

Permeable

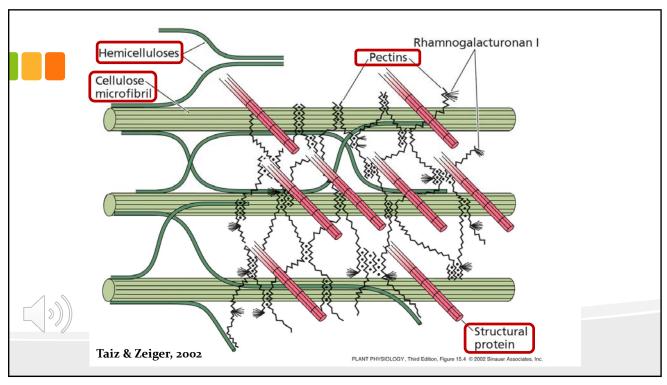
Composed of:

- Cellulose
- Hemicellulose
- Pectin
- Lignin
- Protein





21





Tissue systems and component cells

- The dermal system (protective tissues)
- The ground system
- Supporting tissues
- Vascular tissues



23



Tissue systems and component cells

The dermal system (protective tissues)

- Epidermal cells
- Cuticle (waxy coating)
- Stomates
- Lenticels
- Trichomes
- Periderm (cork)



Taiz & Zeiger, 2002





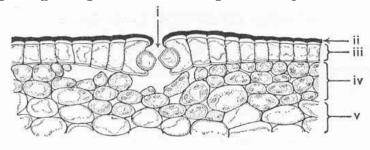
Tissue systems and component cells

- 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.



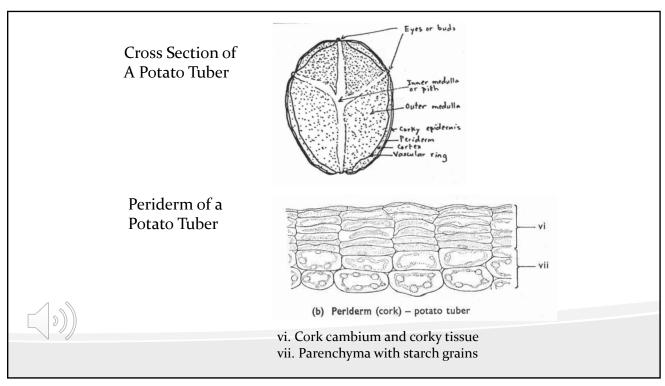
25

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







Tissue systems and component cells

- Supporting tissues
 - Collenchyma cells - largely responsible for stringiness in celery stalks
 - Sclerenchyma cells
 - Schlerenchyma fibers are major constituents of the "string" in green beans.
 - Sclereids (stone cells) in the flesh of certain fruits (*e.g.*, guava, pear, sapote) are responsible for their gritty or sandy texture.



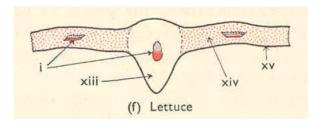


Tissue systems and component cells

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



A Lettuce Leaf



A PETIOLE

(e) Celery

A Celery Petiole

i. Vascular bundles

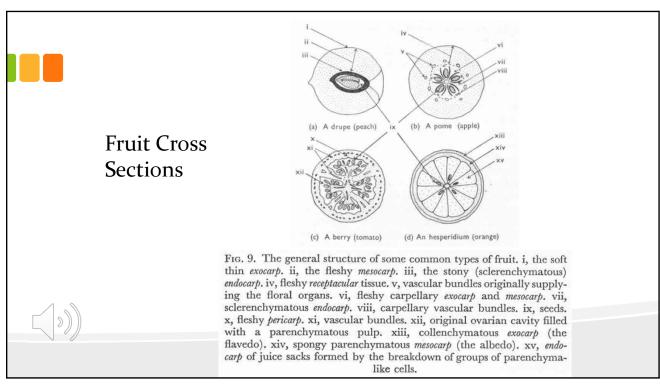
Collenchyma xii. xiii. Midrib of leaf

Spongy chlorenchyma

Blade of leaf









Surface to Volume Ratio

- Commodities with large surface to volume ratios (*i.e.*, leaf lettuce) experience much faster evaporative water loss.
- However, large, bulky commodities with low surface to volume ratios may not exchange gases (i.e., O₂) rapidly enough to satisfy aerobic respiratory demand.





Surface to Volume Ratio



- In general, doubling dimensions of an object
 - = 4x increase in surface area
 - = 8x increase in volume
- Therefore, larger bulky crops have smaller surface to volume ratios.

| Commodity | Length (in.) | Radius | Area | Volume | Area/Vol. |
|-----------|--------------|--------|-------|--------|-----------|
| Tomato | | | | | |
| - small | | 2 | 50.3 | 33.5 | 1.50 |
| - large | | 4 | 201.1 | 268.1 | 0.75 |
| Cucumber | | | | | |
| - small | 8 | 2 | 100.5 | 83.6 | 1.20 |
| - large | 16 | 4 | 402.0 | 670.2 | 0.60 |
| Carrot | | | | | |
| - small | 8 | 2 | 64.9 | 41.9 | 1.55 |
| - large | 16 | 4 | 259.5 | 335.1 | 0.77 |

33



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.
 - Changes in water loss/gas diffusion.





Image courtesy of Steve Sargent

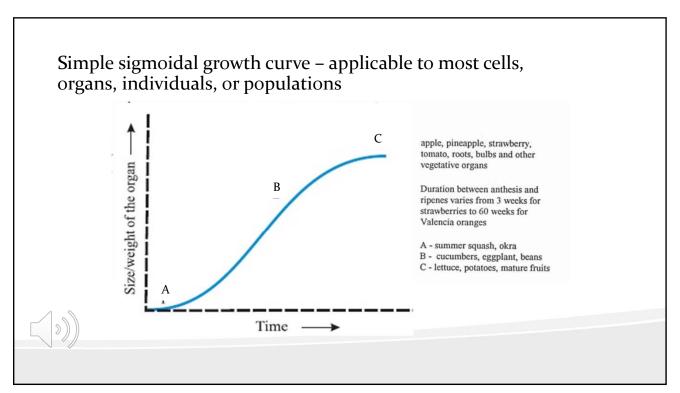


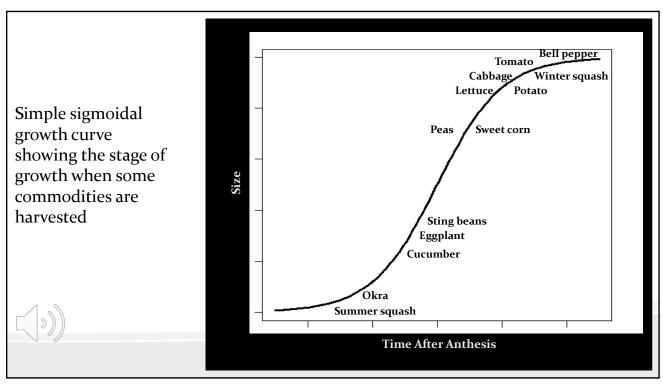
Growth and Development of Plant Parts

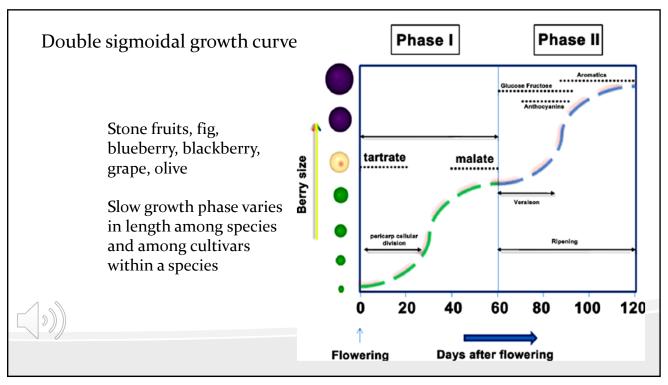
- **Growth**: The irreversible increase in physical attributes of a developing plant or plant part
- **Development**: The series of processes from the initiation of growth to death of a plant or plant part

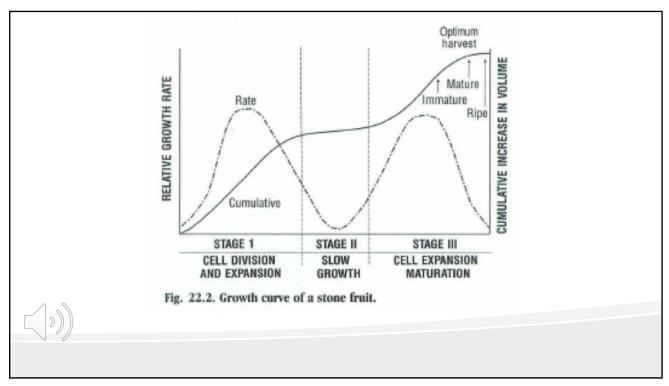


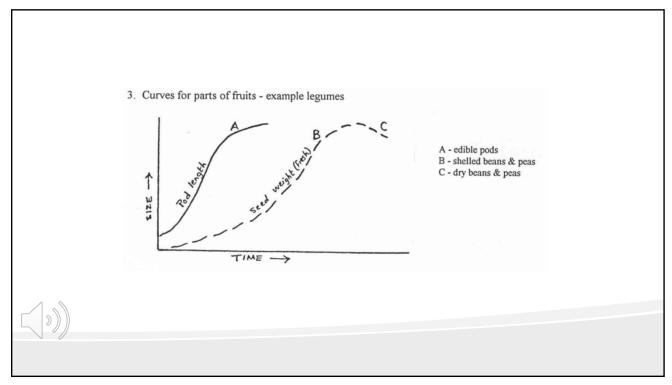
35













Developmental Changes

- **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



41



Developmental Changes

- **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





Developmental Changes

• 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



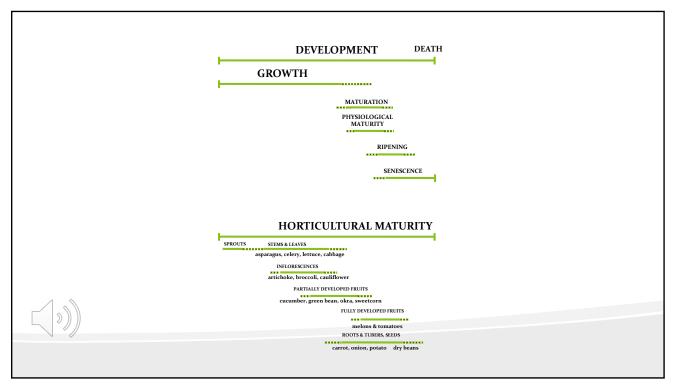
43

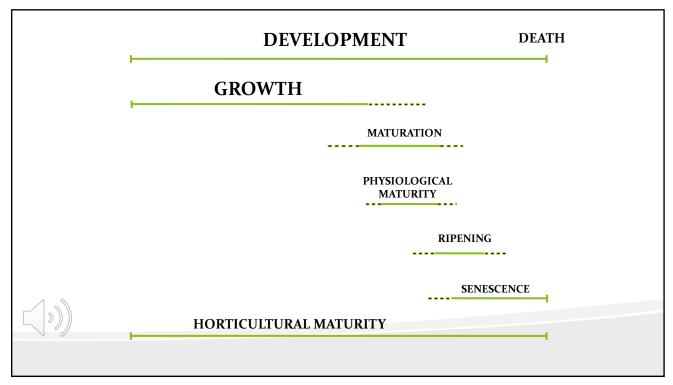


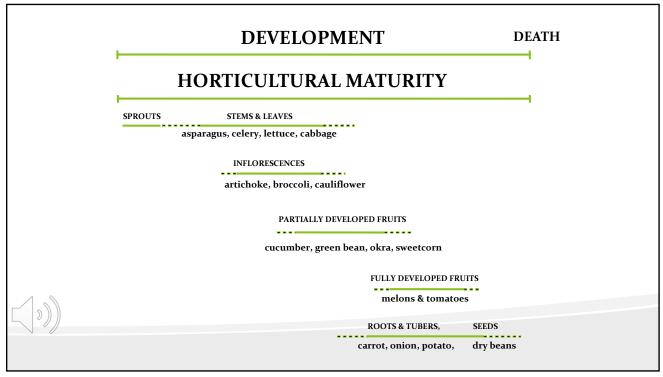
Developmental Changes

- **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











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

