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

<table>
<thead>
<tr>
<th>Edible plant part</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire plant</td>
<td>beet, radish, potted plants</td>
</tr>
<tr>
<td>Shoot</td>
<td>green onion, cut flowers</td>
</tr>
<tr>
<td>Root, primary</td>
<td>carrot, turnip</td>
</tr>
<tr>
<td>Stem</td>
<td>asparagus, kohlrabi</td>
</tr>
<tr>
<td>Tubers</td>
<td>potato, yam, several ornamentals</td>
</tr>
<tr>
<td>Leaf</td>
<td>mainly leaf blade – leaf lettuce, spinach</td>
</tr>
<tr>
<td></td>
<td>buds – cabbage, head lettuce</td>
</tr>
<tr>
<td>Floral parts</td>
<td>cut flowers, artichokes, cauliflower</td>
</tr>
<tr>
<td>Bulbs</td>
<td>– onion, several ornamentals</td>
</tr>
<tr>
<td>Fruits</td>
<td>fleshy, mature – apples, pears, peaches, berries, grapes, citrus, melons, tomatoes, winter (hard rind) squash</td>
</tr>
<tr>
<td></td>
<td>fleshy, immature – cucumbers, summer (soft rind)</td>
</tr>
<tr>
<td></td>
<td>non fleshy, immature – peas, green beans, okra, sweetcorn</td>
</tr>
<tr>
<td></td>
<td>non fleshy, mature – seeds and nuts</td>
</tr>
</tbody>
</table>

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### Morphological Structure of Horticultural Commodities

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

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### Derivation of Some Vegetables From Plant Tissue
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

<table>
<thead>
<tr>
<th>Group</th>
<th>General postharvest characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rapidly growing</td>
<td>- Highly perishable</td>
</tr>
<tr>
<td>Vegetative and</td>
<td>- Usually high respiration rate</td>
</tr>
<tr>
<td>Immature fruit</td>
<td>- Rapid chemical changes</td>
</tr>
<tr>
<td>Structures</td>
<td>- Weight loss is a major cause of deterioration</td>
</tr>
<tr>
<td></td>
<td>- Continued growth can be a problem</td>
</tr>
<tr>
<td>Mature fruits</td>
<td>- Vary in perishability from very high (strawberry) to low (apple)</td>
</tr>
<tr>
<td></td>
<td>- Undergo many physiological and compositional changes associated with ripening</td>
</tr>
<tr>
<td></td>
<td>- Decay can be an important deterioration factor</td>
</tr>
<tr>
<td></td>
<td>- Moisture content is important to storage-life</td>
</tr>
<tr>
<td></td>
<td>- Germination can be a factor</td>
</tr>
</tbody>
</table>
Relationship between structure of horticultural commodities and their postharvest behavior

<table>
<thead>
<tr>
<th>Group</th>
<th>General postharvest characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fleshy storage organs and propagules</td>
<td>- Low perishability&lt;br&gt;- Low respiration rate&lt;br&gt;- Growth can accelerate deterioration</td>
</tr>
<tr>
<td>Mature seeds and nuts</td>
<td>- Very low perishability&lt;br&gt;- Very low respiration rate&lt;br&gt;- Moisture content is important to storage life&lt;br&gt;- Germination can be a factor</td>
</tr>
</tbody>
</table>

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
- Hormone perception
- Direct synthesis of cellulose
Membrane Composition

- Lipid bilayer
  - Phospholipids & Sterols
- Proteins (~50%)
  - Functional component
- Carbohydrates
  - Glycoproteins & a few glycolipids
- Relative compositions of each vary

Properties of Bilayer

- Highly fluid
- Impermeable to polar molecules
  - Exceptions:
    - 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
- Cytosol - liquid, jellylike component, full of “raw” chemicals which surround the organelles
**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)

[Image: https://micro.magnet.fsu.edu/cells/plants/images/plantvacuolesfigure1.jpg]

**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

[Image: http://www.biologyclass.net/mitochondria.jpg]
**Plastids**

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

http://homepage.smc.edu/hodson_kent/Cells/Chloroplasts/chloroplast.jpg

**Extracellular Matrix**

- A complex mixture (CHO, phenolics & protein)
- 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

Buchanan et al., 2000.
Tissue systems and component cells

- The dermal system (protective tissues)
- The ground system
- Supporting tissues
- Vascular tissues
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 single epidermis - asparagus stem
  1. A stoma
  2. Cuticle
  3. Epidermis
  4. Parenchyma with chloroplasts
  5. Unspecialized parenchyma

Cross Section of A Potato Tuber

- Periderm of a Potato Tuber
  6. Cork cambium and corky tissue
  7. Parenchyma with starch grains
Tissue systems and component cells

• Supporting tissues
  - Collenchyma cells - largely responsible for stringiness in celery stalks
  - Sclerenchyma cells
    - 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) 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 Celery Petiole

i. Vascular bundles
xi. Collenchyma
xii. Midrib of leaf
xiv. Spongy chlorenchyma
xv. Blade of leaf
Fruit Cross Sections

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.

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.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Length (in.)</th>
<th>Radius</th>
<th>Area</th>
<th>Volume</th>
<th>Area/Vol.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tomato</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>small</td>
<td>2</td>
<td>3</td>
<td>50.3</td>
<td>33.5</td>
<td>1.50</td>
</tr>
<tr>
<td>large</td>
<td>4</td>
<td>6</td>
<td>201.1</td>
<td>268.1</td>
<td>0.75</td>
</tr>
<tr>
<td>Cucumber</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>small</td>
<td>8</td>
<td>2</td>
<td>100.5</td>
<td>85.6</td>
<td>1.20</td>
</tr>
<tr>
<td>large</td>
<td>16</td>
<td>4</td>
<td>641.0</td>
<td>670.2</td>
<td>0.60</td>
</tr>
<tr>
<td>Carrot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>small</td>
<td>8</td>
<td>2</td>
<td>64.0</td>
<td>40.9</td>
<td>1.55</td>
</tr>
<tr>
<td>large</td>
<td>16</td>
<td>4</td>
<td>530.5</td>
<td>335.5</td>
<td>0.77</td>
</tr>
</tbody>
</table>
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.

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.

Simple sigmoidal growth curve – applicable to most cells, organs, individuals, or populations
Simple sigmoidal growth curve showing the stage of growth when some commodities are harvested.

Double sigmoidal growth curve

Stone fruits, fig, blueberry, blackberry, gooseberry

Slow growth phase varies among species and among cultivars within species.
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.
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.

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.
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