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

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

<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</td>
<td>- carrot, turnip secondary</td>
</tr>
<tr>
<td>Stem</td>
<td>- asparagus, leek, leek, leek, leek, leek, leek, leek, leek, leek, leek</td>
</tr>
<tr>
<td>Tuber</td>
<td>- potato, yam, several ornamentals</td>
</tr>
<tr>
<td>Leaf</td>
<td>- leaf lettuce, spinach, leaf lettuce</td>
</tr>
<tr>
<td></td>
<td>- celery, rhubarb</td>
</tr>
<tr>
<td></td>
<td>- cabbage, beet</td>
</tr>
<tr>
<td></td>
<td>- cauliflower, cauliflower, cauliflower</td>
</tr>
<tr>
<td>Floral parts</td>
<td>- cut flowers, artichokes, cauliflower, cauliflower</td>
</tr>
<tr>
<td>Bulb</td>
<td>- onion, several ornamentals</td>
</tr>
</tbody>
</table>
| Fruits            | - apples, pears, peaches, berries, grapes, citrus, melons, tomatoes, winer (hard-rind) squash
|        | - cucumbers, summer (soft-rind) squash                                   |
|        | - green beans, okra, sweetcorn, sweetcorn                                |
|        | - seeds and nuts                                                         |
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.

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>Rapidly growing vegetative and immature fruit structures</td>
<td>- Highly perishable&lt;br&gt;- Usually high respiration rate&lt;br&gt;- Rapid chemical changes&lt;br&gt;- Weight loss is a major cause of deterioration&lt;br&gt;- Continued growth can be a problem</td>
</tr>
<tr>
<td>Mature fruits</td>
<td>- Vary in perishability from very high (strawberry) to low (apple)&lt;br&gt;- Undergo many physiological and compositional changes associated with ripening&lt;br&gt;- Decay can be an important deterioration factor&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.<br>- Cell = cell wall + protoplasm<br>  - Protoplasm = cytoplasm + nucleus<br>     - Nucleus<br>     - Information center<br>     - Cytoplasm = everything within the cell except the nucleus or the cell wall<br>     - Cytosol - watery matrix<br>     - organelles - membrane-bound, specialized function

Plasma Membrane

- Boundary between the living and non-living world<br>- Selectively permeable<br>  - Physically limits the cell<br>  - Controls exchange of "stuff"
  - Maintains differences between cell & environment<br>- Hormone perception<br>- 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
  - 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
- 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)

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

[Image: http://homepage.smc.edu/hodson_kent/Cells/Energetics/chloroplast2.jpg]

**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

[Buchanan et al., 2000.]

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

[Taiz & Zeiger, 2002]

**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.

Asparagus epidermis and parenchyma tissue

1. A stomate
2. Cuticle
3. Epidermis
4. Parenchyma with chloroplasts
5. Unspecialized parenchyma

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.)
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., \( \text{O}_2 \)) 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.

<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>- small</td>
<td>2</td>
<td>30.3</td>
<td>35.5</td>
<td>1.10</td>
</tr>
<tr>
<td></td>
<td>- large</td>
<td>4</td>
<td>120.1</td>
<td>258.4</td>
<td>0.47</td>
</tr>
<tr>
<td>Cucumber</td>
<td>- small</td>
<td>8</td>
<td>800.5</td>
<td>83.6</td>
<td>1.20</td>
</tr>
<tr>
<td></td>
<td>- large</td>
<td>16</td>
<td>401.0</td>
<td>690.4</td>
<td>0.60</td>
</tr>
<tr>
<td>Carrot</td>
<td>- small</td>
<td>8</td>
<td>64.9</td>
<td>41.9</td>
<td>1.55</td>
</tr>
<tr>
<td></td>
<td>- large</td>
<td>16</td>
<td>359.5</td>
<td>355.1</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, grape, olive

Slow growth phase varies in length among species and among cultivars within a 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

- **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.

- **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