The Plant Vacuole
Vacuole

- For plant tissues, the vacuole plays a significant role in regulating the amount of water and solutions that come into the cell.
- The cell membrane, although semi-permeable, cannot always regulate solution flow.
- Sometimes solutions are added or taken away from the plant cell that need to be there for the cell remain healthy.
Vacuoles take up a lot of space!
Solutions and Growth

- These solutions are stored in the plant vacuole to be used immediately or can be stored to be used at a later time when the plant needs them.
- This is important during plant growth.
What do they store?

- Ions – essential for communication between cells
- Metabolites – used for energy
- Pigments – colouring
- Components for detoxification – prevent cell damage
- Proteins – structure
- Carbohydrates – used for energy
Diversity of Vacuoles

- Plant cell vacuoles range in variety in form, size and functionality.
- In fact a single plant cell can have more than 1 type of vacuole present depending on the environment its in.
Central Vacuole

- Takes up the most space in the cell.
- Used as storage of many materials but mostly ‘digest’ the components brought into the cell and transform them into liquid form for the cell to use.
- This digestion is a result of the central vacuole being acidic.
- Carbohydrates are the main storage material.
central vacuole
Seeds and Fruit Vacuoles

- Cells found in seeds and fruits also have a large central vacuole.
- However, their main storage component is proteins rather than carbohydrates.
- The reason for this is to repair any damaged tissues to ensure reproductive success.
Small Vacuoles - Vesicles

- When lots of nutrients are added into a plant cell, some cells will create small vacuoles that form around the large vacuole.
- These ‘baby’ vacuoles are used to help digest the additional material and are absorbed by the large vacuole once the material is gone.
Vesicle
Sap Vacuoles

- Found only in certain types of plants, sap vacuoles contain high amounts of carbohydrates.
- These are stored up in the plant over the warmer months and used up in the winter to nourish the plant.
- Example – maple tree
SAP Video

http://www.youtube.com/watch?v=vGelvneyl5E
How do vacuoles work?

- Vacuoles act like sponges in plants, taking up what is needed by the plant and storing them.
- They have membranes that allow many materials in but regulate what is added to the cell depending on what the cell needs.
Solutions and Vacuoles

- Solutions or the liquid environment that plants live in, can influence the behavior of vacuole in plants.

- Solutions are made of 2 parts:
  - Solvents: the liquid part (think water)
  - Solute: the dissolved part(s) (think Kool-Aid powder)
Movement of Solvents

- Since solvents are the only part of the solution that can move easily through a cell membrane and into a vacuoles they will always follow a certain pattern.
- Solutes will always move from an area of higher concentration to an area of lower concentration. This is called DIFFUSION.
- Move from more to less every time.
A hypotonic solution has more solvent (water) than solute (dissolved parts).

This means that if a plant was put in a hypotonic solution, water would move into the cell vacuoles.

This causes the cell vacuoles to grow and expand.
A hypertonic solution has less solvent (water) than solute (dissolved parts).

This means that if a plant was put in a hypertonic solution, water would move out of the cell vacuoles.

This causes the cell vacuoles to shrink and get smaller.
Isotonic

- A isotonic solution has equal solvent (water) and solute (dissolved parts).
- This means that if a plant was put in a isotonic solution, water would not move into the cell vacuoles.
- This causes the cell vacuoles to stay the same size.
<table>
<thead>
<tr>
<th>Type of Solution</th>
<th>Diagram</th>
<th>Solvent Movement</th>
<th>Fate of Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Isotonic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypotonic</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hypertonic</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Overwatering plants

- Based on what you know about solutions, what is happening when you overwater a plant and it dies?
Underwatering plants

- Based on what you know about solutions, what is happening when you underwater a plant and it dies?
Turgor Pressure

- When a plant cell is in a hypotonic solution, water is brought in and stored in the vacuole.
- This allows the plant to stay upright or become rigid.
- This is mostly found in the roots and stem of the plant to allow for structural support of the plant.
- If too much water is present the plant will take turgor pressure to the extreme and can even burst its own vacuole.
Plasmolysis

- When a plant cell is in a hypertonic solution, water is removed from the vacuole.
- This causes the plant to shrivel or wilt.
- This is mostly found in the leaves and flowers of the plant first, because they are made of thinner tissue than roots or stems.
- If too little water is present the plant eventually ‘lyse’ or loose all of it’s water and the plant cells with shrink.
Turgid Cell

- Water enters cell
- Vacuole swells and pushes against cell wall

Flaccid Cell

- Water lost from cell
- Vacuole shrinks and cell loses shape
(a) Turgid cell

(b) Cytoplasm shrinks away from cell wall

(water gain)

(water loss)