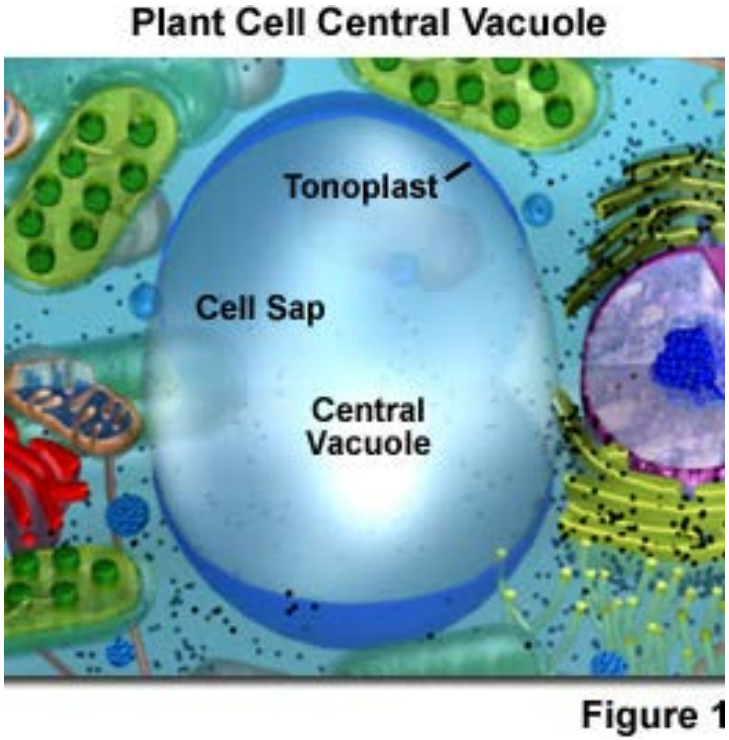
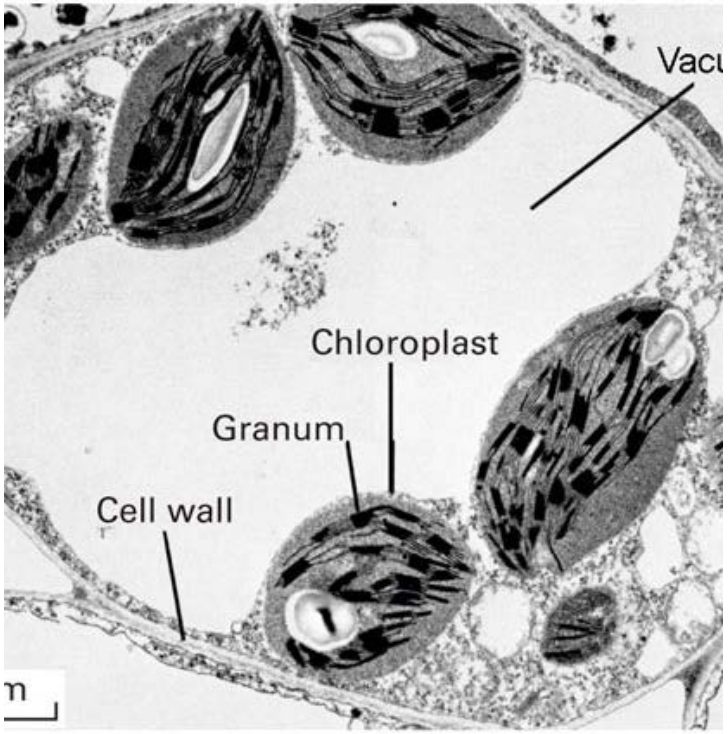
The Plant Vacuole

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.

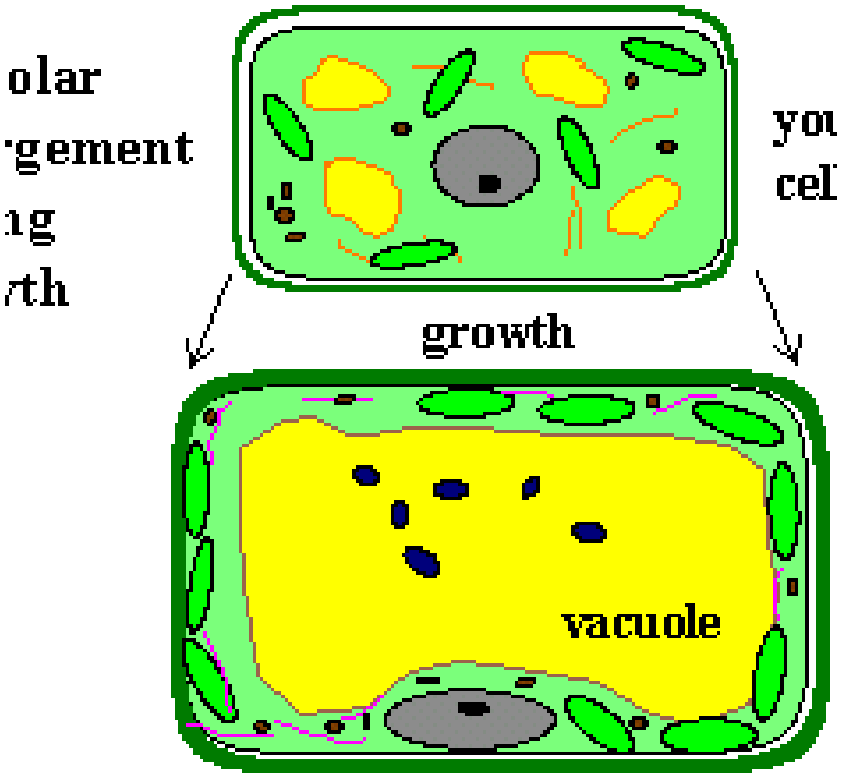
Vacuoles take up a lot of space!





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?

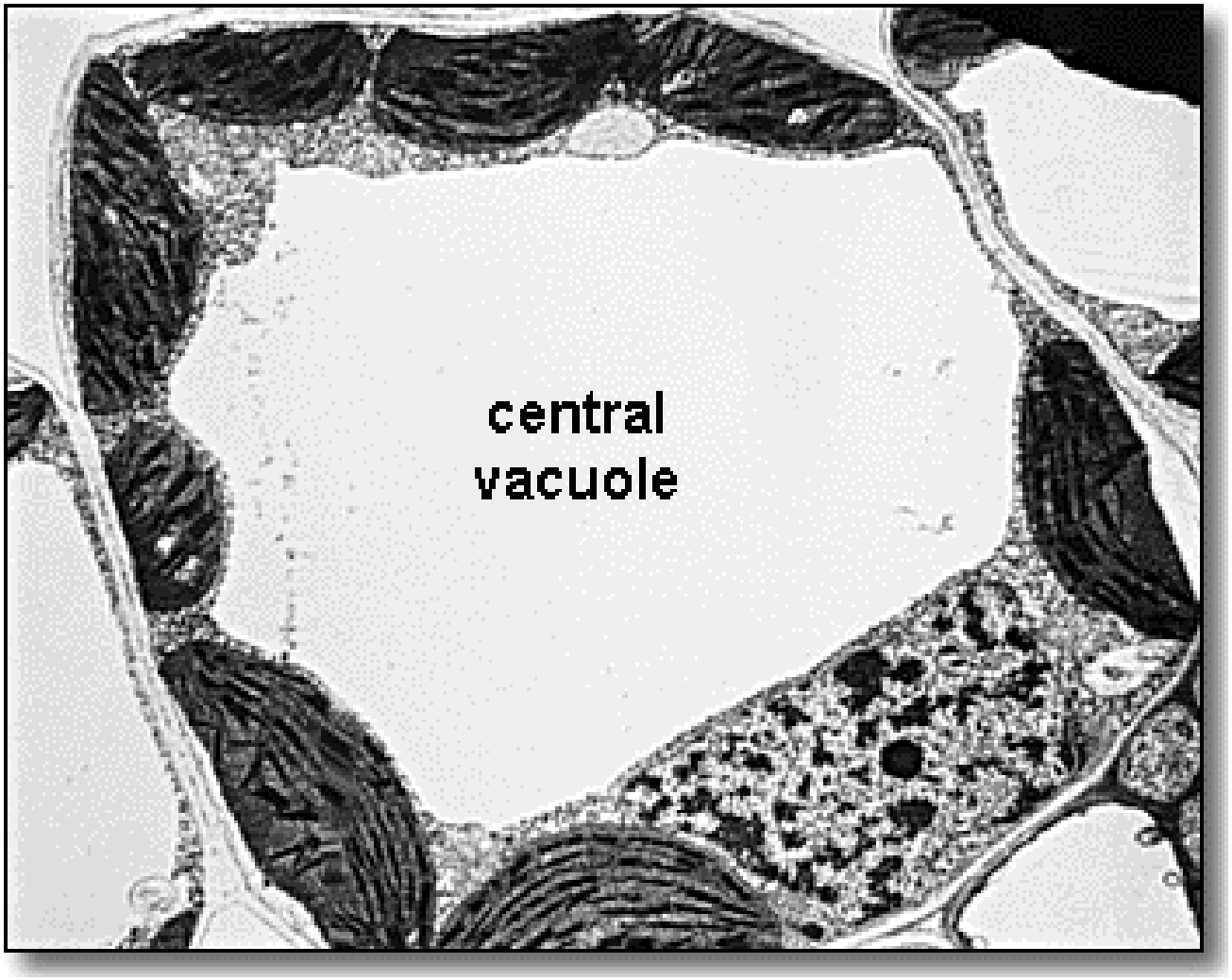
- Ions –essential for communication between cells
- Metabolites – used for energy
- Pigments - colouring
- Components for detoxification – prevent cell damage
- Proteins - structure
- Carbohydrates - used for energy

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

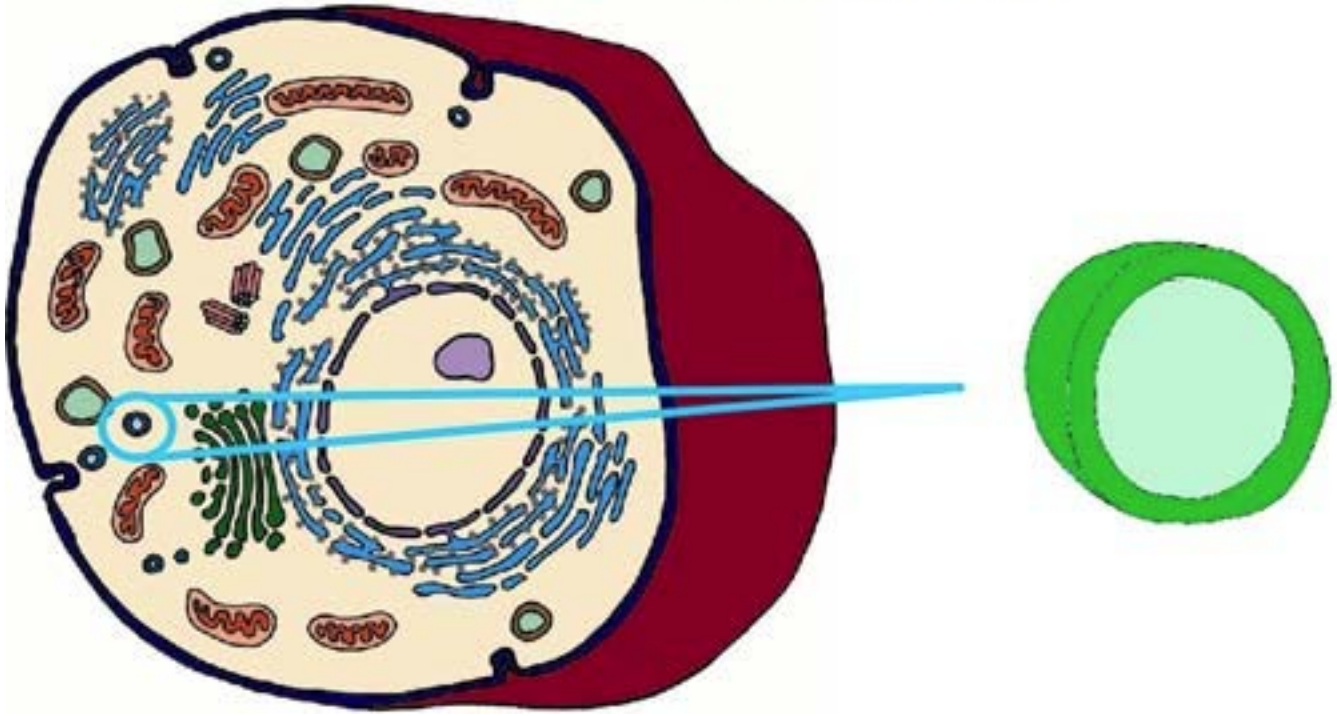
Seeds and Fruit Vacuoles

- Cells founds 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

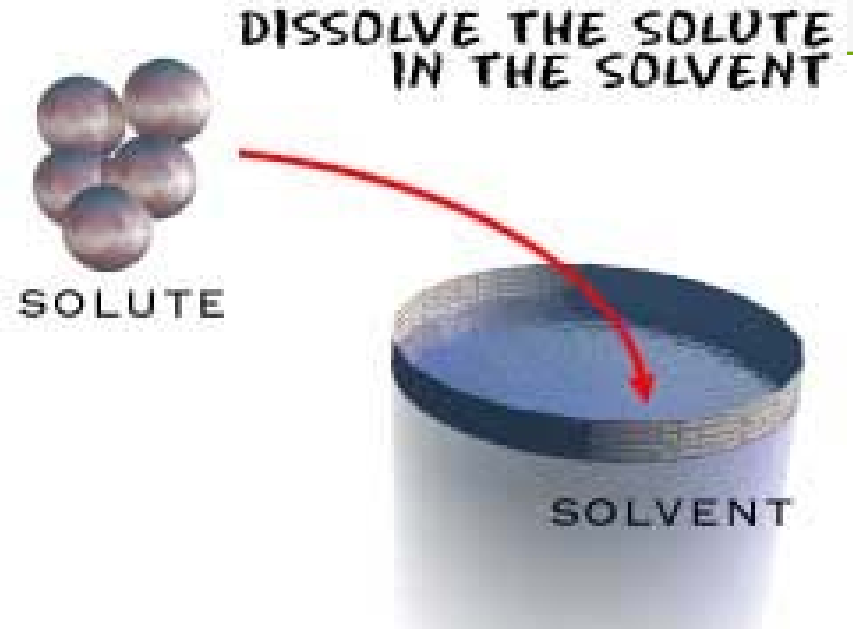
- http://www.youtube.com/watch?v=vGelvneyl5E

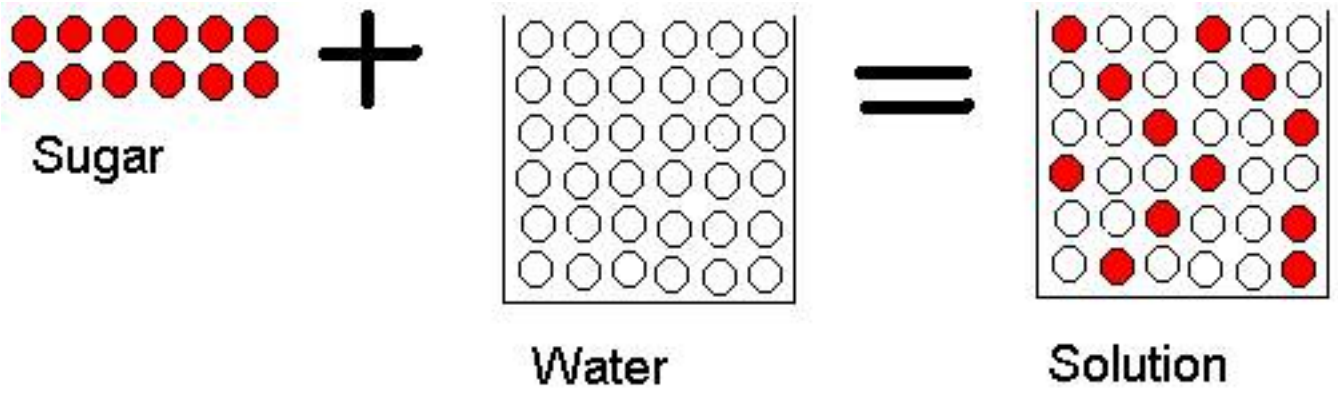
How do vacuoles work?

- 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)


DISSOLVE THE SOLUTE
IN THE SOLVENT
SOLUTE
SOLVENT


Sugar
Water
Solution

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.

Hypotonic

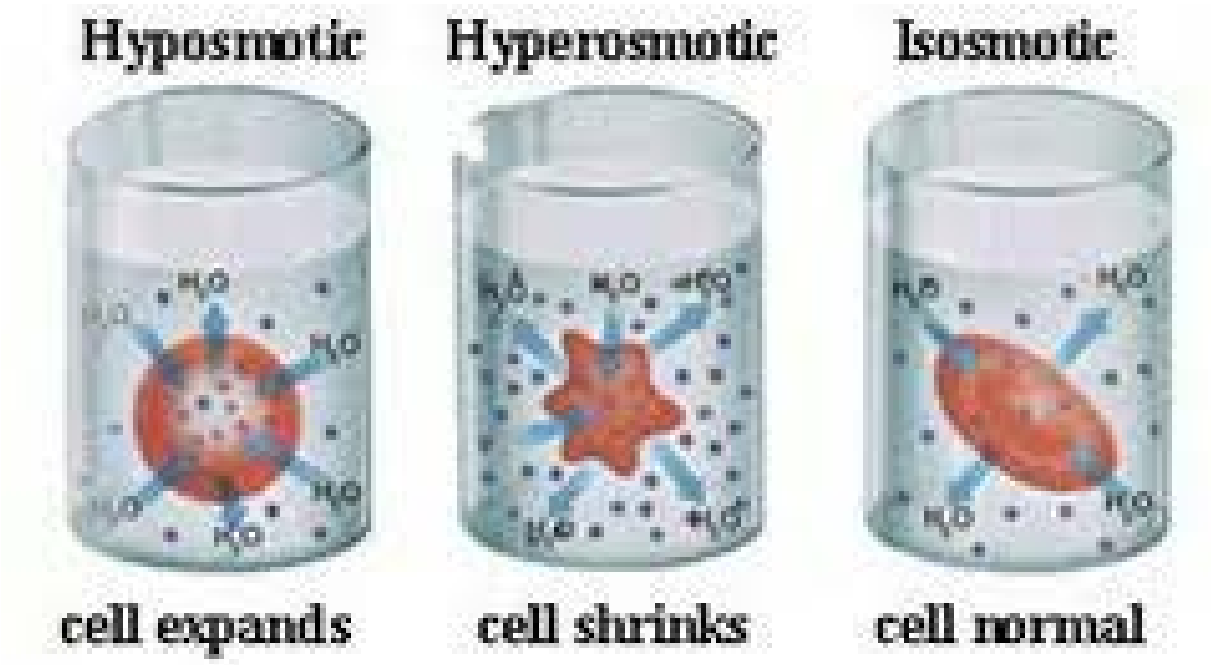
- A hypotonic solution has more solvent (water) than solute (dissolved parts).
- This means that if a plant was put in a hypotonic solution, water would move into the cell vacuoles.
- This causes the cell vacuoles to grow and expand.

Hypertonic

- 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


Hyposmotic
Hyperosmotic
Isosmotic
cell expands
cell shrinks
cell normal

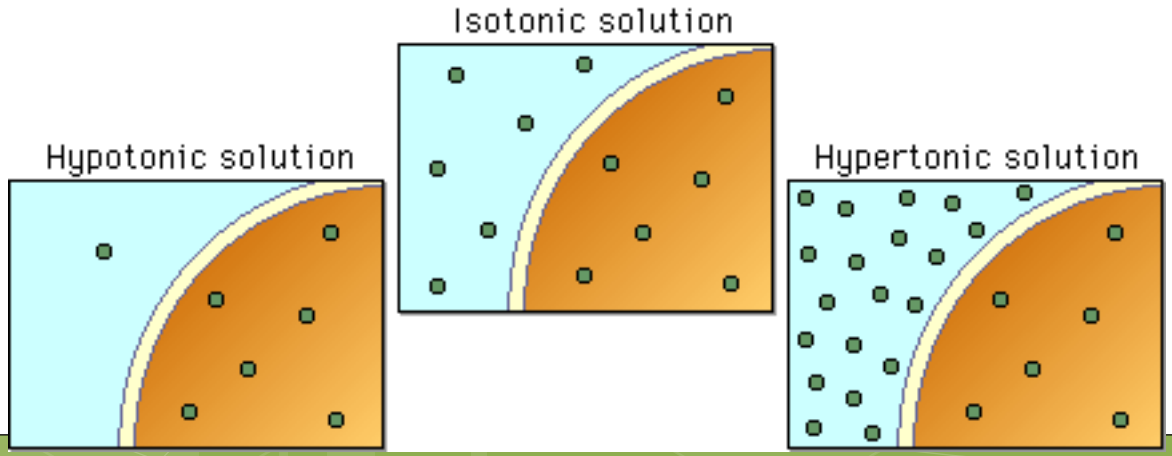

Isotonic solution
Hypotonic solution
Hypertonic solution

Chart of Solutions

Type of Solution	Diagram	Solvent Movement	Fate of Cell
Isotonic			
Hypotonic			
Hypertonic			

Overwatering plants

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

Under watering plants

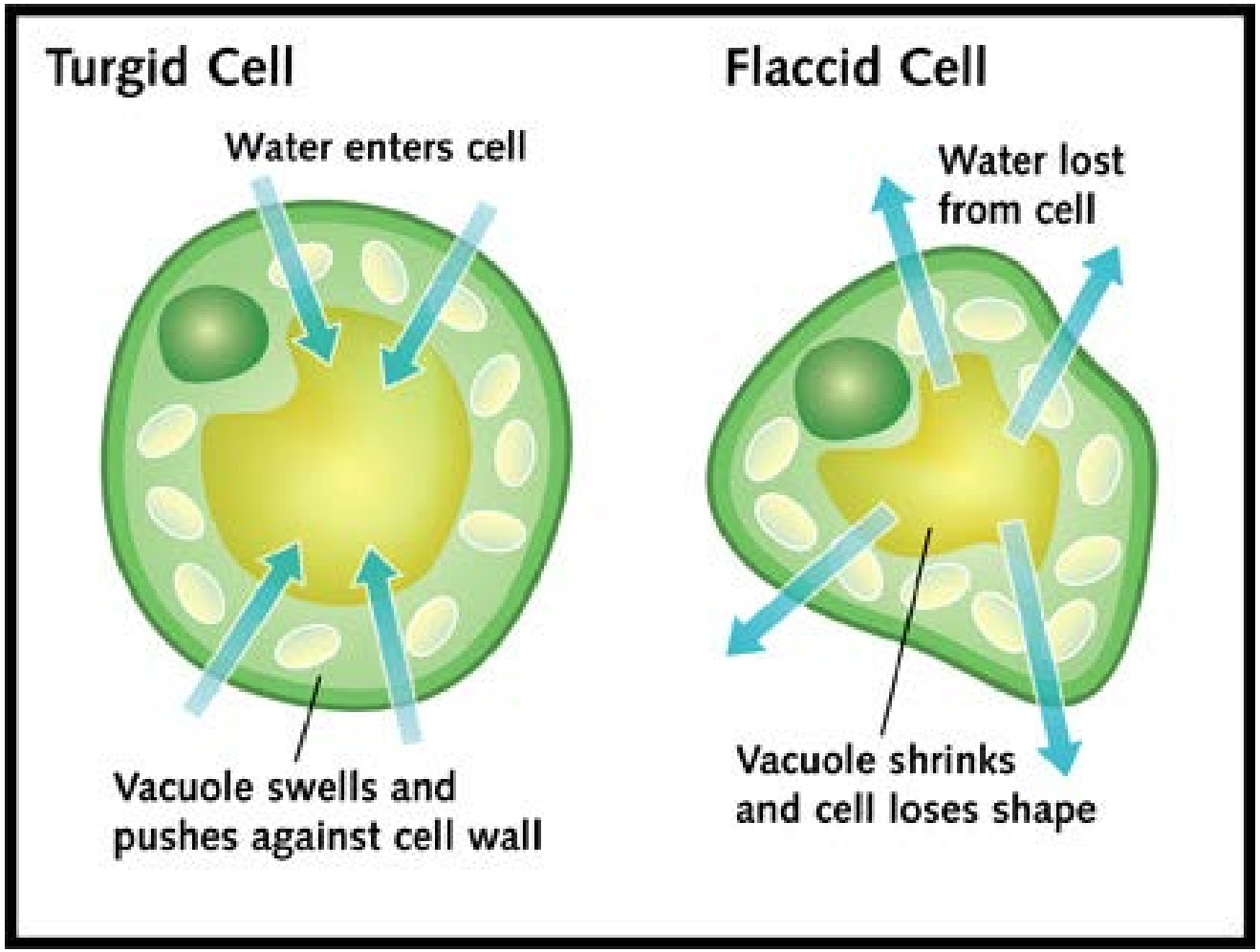
- Based on what you know about solutions, what is happening when you underwater a plant and it dies?

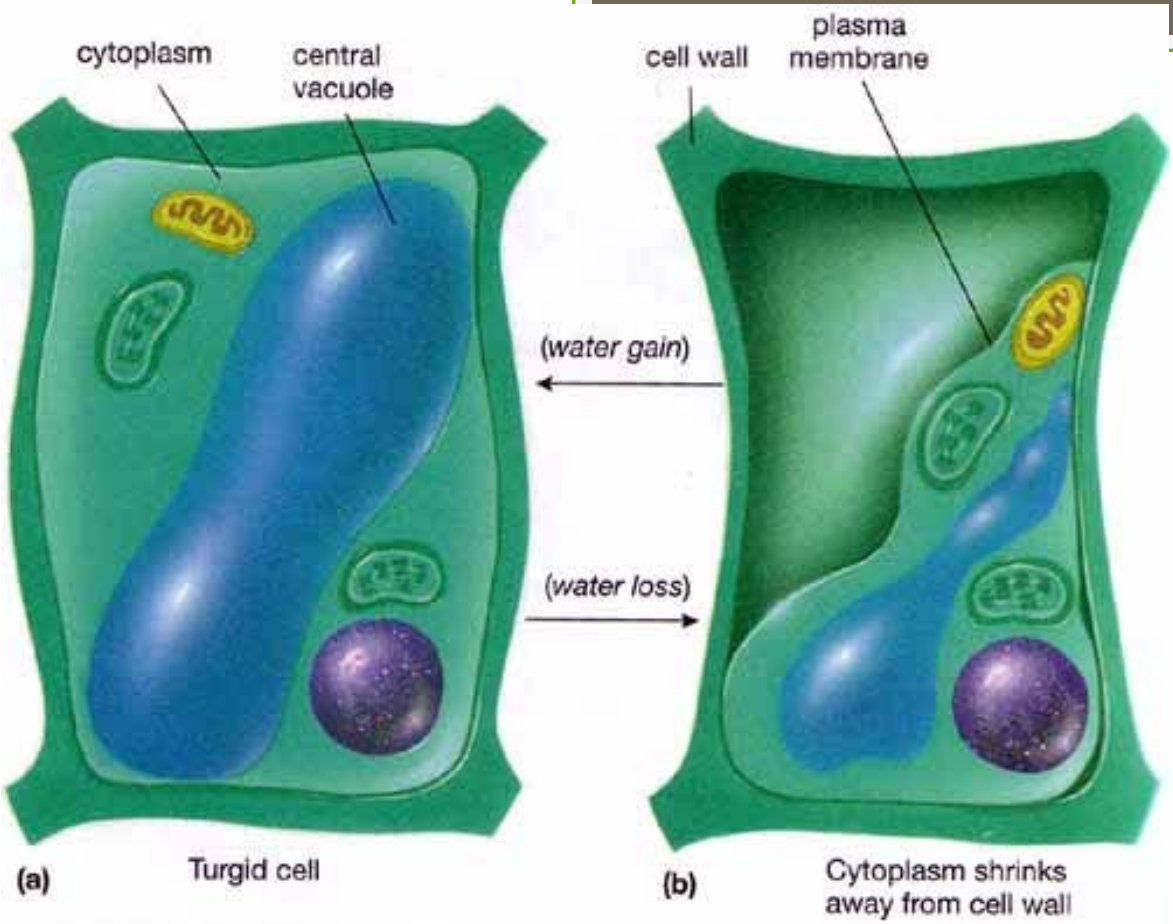
Turgor Pressure

- 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 it's 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


cytoplasm
central vacuole
cell wall
plasma membrane
(water gain)
(water loss)
(a)
Turgid cell
(b)
Cytoplasm shrinks away from cell wall