



Water in foods

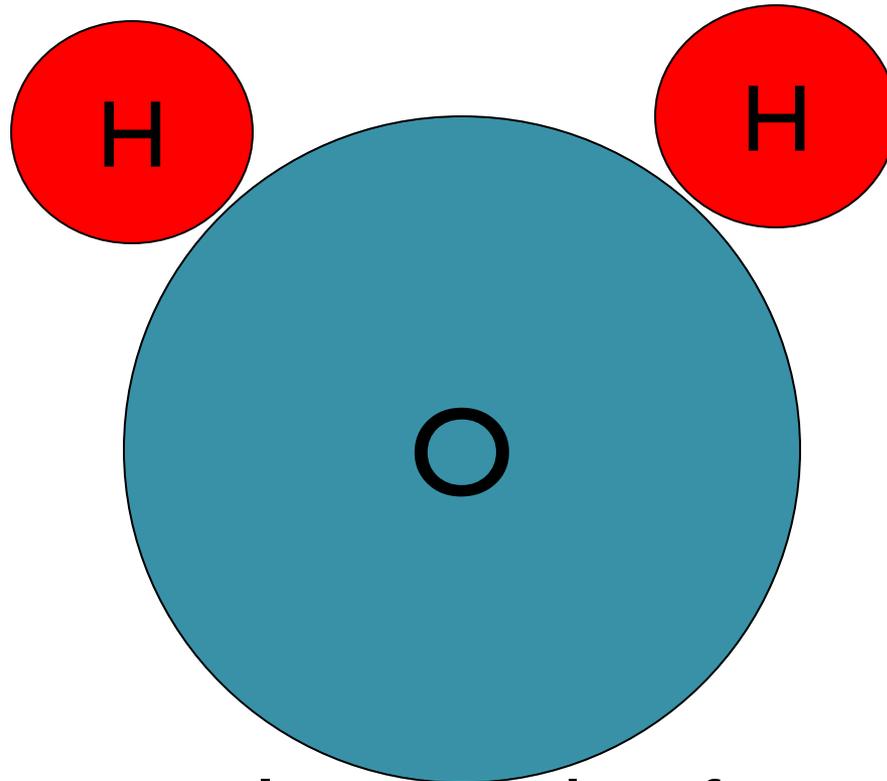
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Introduction

- Water is the most critical of all nutrients
- It is an essential constituent of all cell structures
- Water is the major component of all living organisms.
- It constitutes 60% or more of the weight of most living things, and it pervades all portions of every cell.
- Water is the universal solvent and dispersing agent, as well as a very reactive chemical compound.

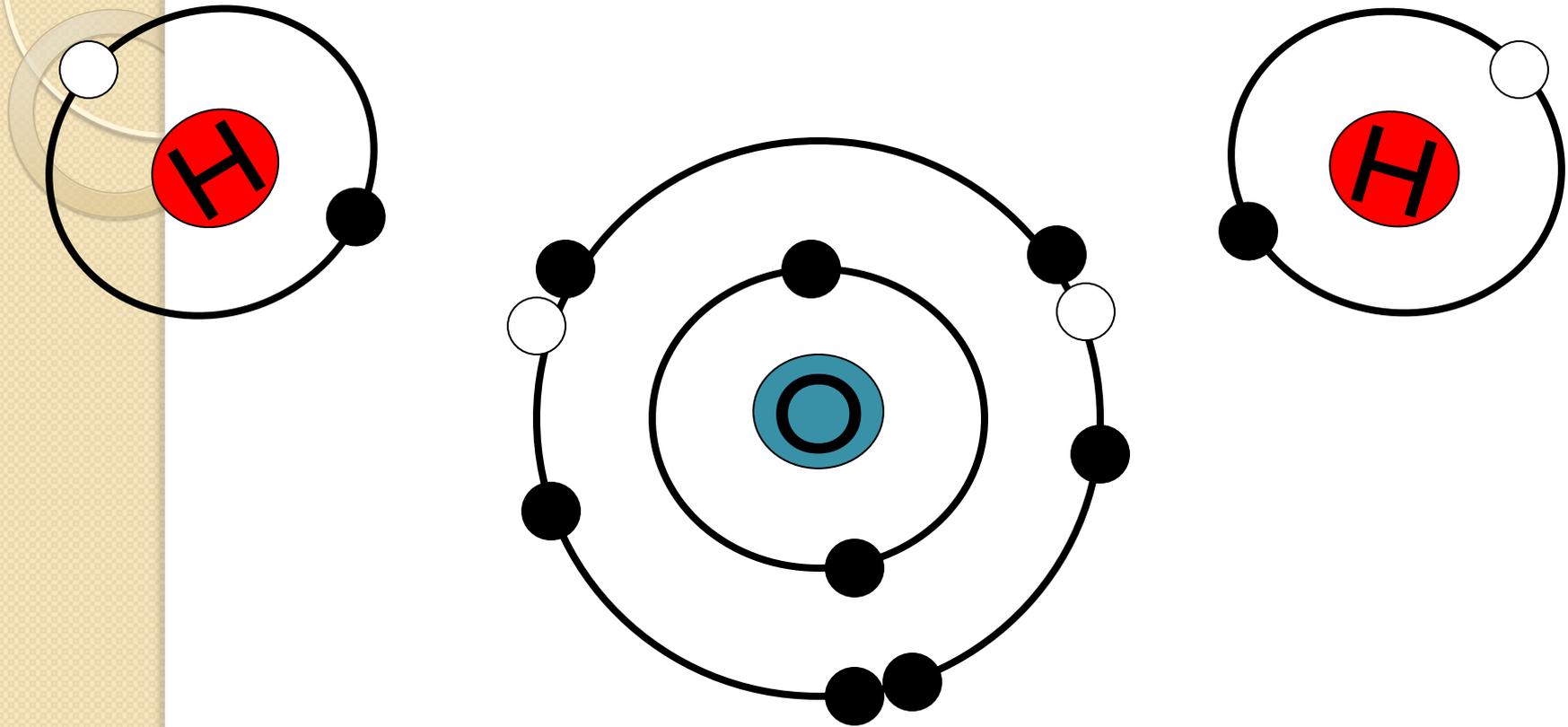
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- Regulation of water contents is important in the maintenance of homeostasis in all living systems.
 - Stability, shelf life are significant features of foods that are, to a large degree, influenced by the water content.
 - Dried foods were originally developed to overcome the constraints of time and distance before consumption.
 - Canned and frozen foods were developed next.
 - The physical properties, quantity, and quality of water within food have a strong impact on food effectiveness, quality attributes, shelf life, textural properties and processing.

Structure of water



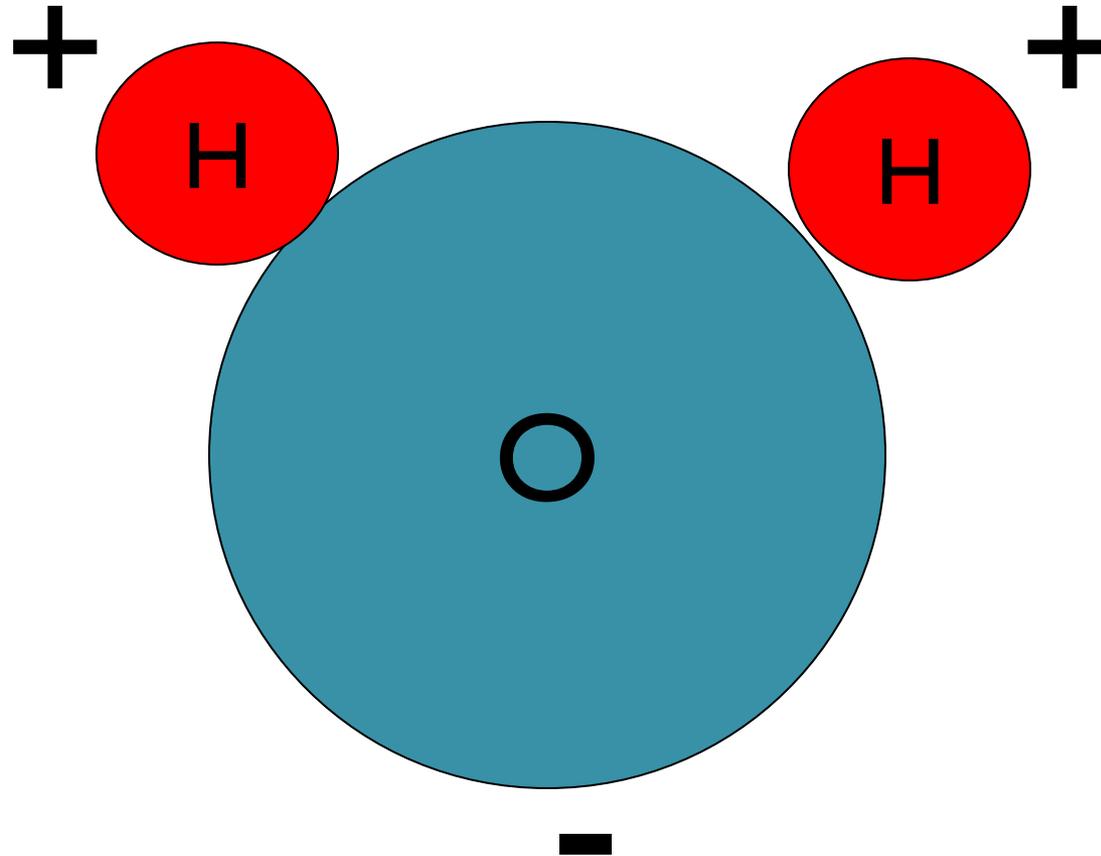
- 1 molecule of water is made up of 2 hydrogen atoms bonded with 1 oxygen atom

STRUCTURE OF WATER



Water is a **molecule** (H_2O) that contains two **hydrogen** atoms each sharing a pair of electrons with an **oxygen** atom. When atoms share electrons in this way, a **covalent bond** is created.

Polar molecule



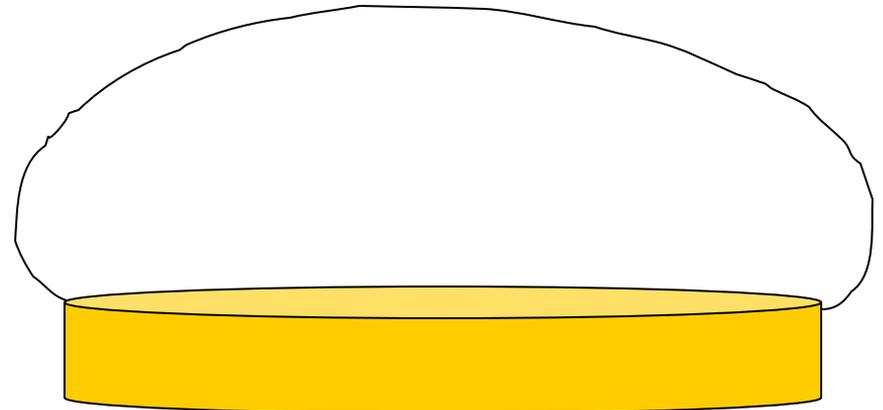
The positive hydrogen ends of 1 molecule are attracted to the negative end of the oxygen of another molecule.

Properties of water

- Cohesion
- Adhesion
- capillary action
- surface tension
- universal solvent
- specific heat

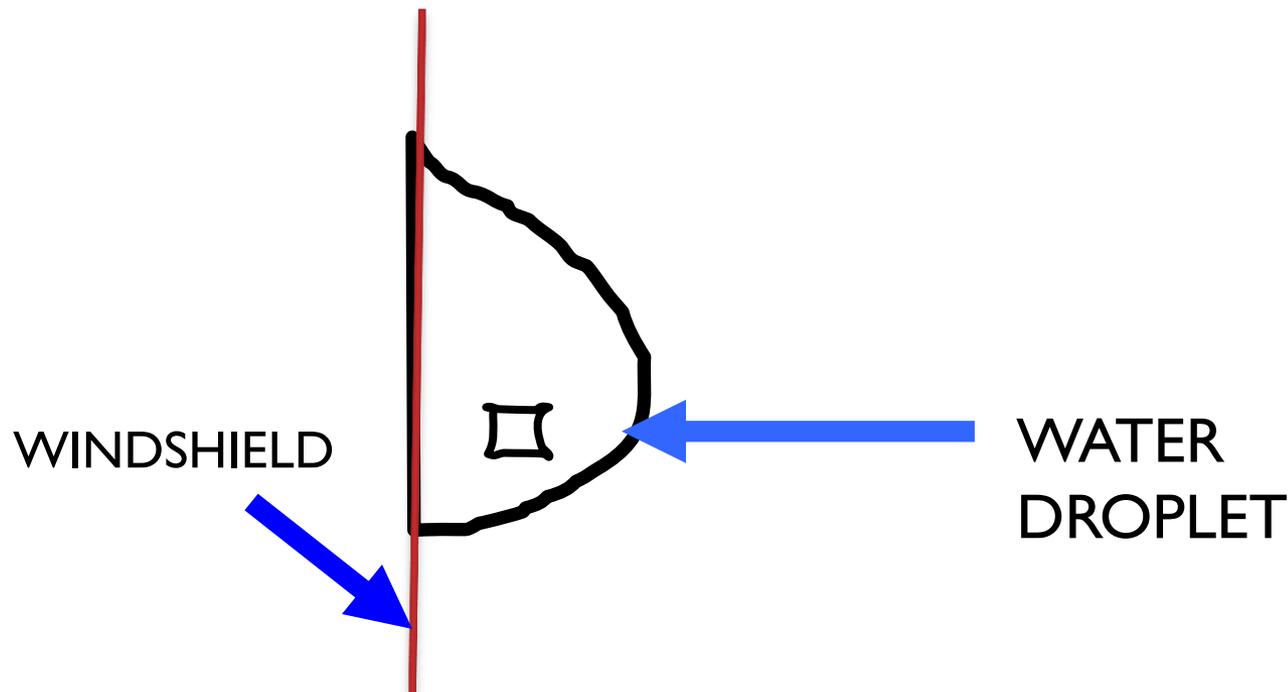
Cohesion

- **Cohesion** – is the attractive force **between water molecules**.
- A drop of water contains trillions of water molecules held together by weak hydrogen bonds. The tendency of water molecules to bind is called cohesion.
- Water molecules like to stick to each other.



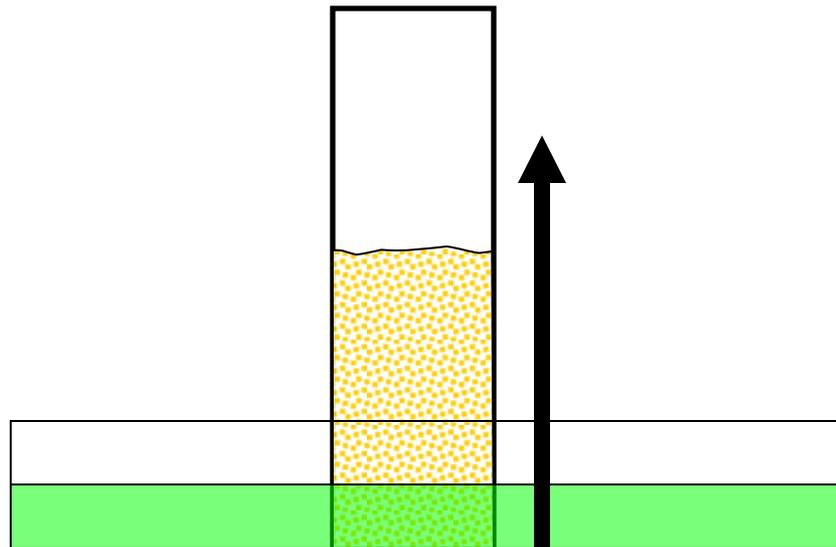
Adhesion

- Because water is a polar molecule, it is attracted to other substances.
- **Adhesion** – occurs when molecules of water are attracted to other substances.



capillary action

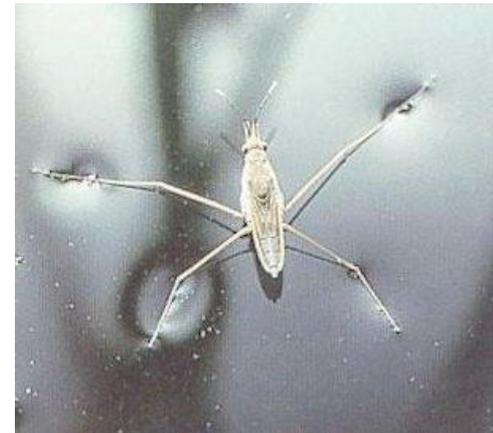
- The combined force of attraction among water molecules and with the molecules of the surrounding material.
- Cohesion + Adhesion



Surface tension

- Surface tension: The tendency of a liquid's surface to resist rupture when placed under tension or stress
- Water has a greater surface tension than most other liquids because hydrogen bonds among surface water molecules resist stretching or breaking the surface

Some animals can stand, walk, or run on water without breaking the surface



universal solvent

- Water dissolves LOTS of things
SOLVENT = the thing doing the dissolving
SOLUTE = the thing that dissolves away



specific heat

- Specific Heat = the amount of energy needed to increase the temperature of something 1 degree C.
- Water has a really HIGH specific heat
- That means it takes a lot of energy for water to increase its temperature.

Water in foods

- Most natural foods contain water up to 70% of their weight.
- Water in foods is classified in to two types: (a) bound water and (b) free water
- **Free water:** Water that can be extracted easily from foods by squeezing or cutting or pressing is called as free water
- **Bound water:** Water that is held so tightly by another molecule (usually a large molecule such as a protein) that it no longer has the properties of free water; water that is not easily removed from the food is called bound water.
- The water molecules are bound to polar groups or ions on molecules such as starches, pectin, and proteins.

Water activity

- Water activity is the amount of free or available water in a product as opposed to bound water
- Water activity is the measure of the energy status of the water in a system
- Water activity (a_w) is one of the most critical factors in determining quality and shelf life, safety, texture, flavour and smell of foods
- Water activity may be the most important factor in controlling spoilage
- Most bacteria, for example, don't grow at water activities below 0.91 and most molds cease to grow at water activities below 0.80.

Water activity of some foods

Substance	a_w
Distilled Water	1
Tap water	0.99
Raw meats	0.99 [†]
Milk	0.97
Juice	0.97
Dried fruits	0.60
Typical indoor air	0.5 - 0.7
Honey	0.5 - 0.7
Dried fruit	0.5 - 0.6

Water activity and Shelf life of Foods

- It is an important consideration for food product design and food safety.
- Food designers use water activity to formulate products that are shelf stable.

Microbial growth

- Many of the chemical and biological processes that cause deterioration of foods, and ultimately spoilage, are water dependent.
- Microbial growth is directly linked to water activity.
- No microbes can multiply at a water activity below 0.6.

Cont....

Dehydration

- Dehydration is possibly the oldest form of food preservation;
- The sun drying of meat and fish has been traces to the beginning of recorded history.
- Drying relies on removing water, thus making it unavailable for microbial growth.

Salting

- Salting has the same effect.
- A saturated solution of common salt has a water activity of close to 0.75.

Benefits of drying of food

- None of the dangerous pathogenic bacteria associated with food, such as *Clostridium* or *Vibrio* spp. which cause botulism and cholera, can multiply at water activity values below about 0.9.
- Drying is an effective method of preventing the growth of food-poisoning bacteria.
- Only osmophilic yeast and some molds can grow at water activities in the range 0.6 to 0.65.
- Thus, by reducing the water activity below these values, foods are microbial stable.

Chemical reactions and water activity

- Various chemical reactions that proceed, and may be accelerated, at low values of water activity.
- Maillard reactions leading to lysine loss and brown color development peaks at a_w around 0.5 to 0.8.
- Nonenzymatic lipid oxidation increases rapidly below $a_w = 0.4$.
- Enzymatic hydrolysis decreases with water activity down to $a_w = 0.3$ and is then negligible.
- Dry foods are much more stable than wet foods, because any water remaining to them has low activity, a_w .
- Freezing removes water from the food matrix by forming ice crystals.



Thank you