Topic Page: Water

Definition: **water** from *Dictionary of Energy*

Chemistry. H_2O, a colorless, odorless, tasteless liquid having a melting point of 0°C and a boiling point of 100°C at standard atmospheric pressure, and having the allotropic forms of ice (solid) and steam (vapor). The most commonly found substance on earth and present in many other substances, including all organic tissues.

Image from: **For drinking water to be secure and useable,...** in *Encyclopedia of Environment and Society*

Summary Article: **water**
From *The Hutchinson Unabridged Encyclopedia with Atlas and Weather Guide*

Chemical compound of hydrogen and oxygen elements – H_2O. It can exist as a solid (ice), liquid (water), or gas (water vapour). Water is the most common compound on Earth and vital to all living organisms. It covers 70% of the Earth's surface, and provides a habitat for large numbers of aquatic organisms. It is the largest constituent of all living organisms – the human body consists of about 65% water. It is found in all cells and many chemicals involved in processes such as respiration and photosynthesis need to be in solution in water in order to react. Pure water is a colourless, odourless, tasteless liquid which freezes at 0°C/32°F, and boils at 100°C/212°F. Natural water in the environment is never pure and always contains a variety of dissolved substances. Some 97% of the Earth's water is in the oceans; a further 2% is in the form of snow or ice, leaving only 1% available as freshwater for plants and animals. The recycling and circulation of water through the biosphere is termed the **water cycle**, or 'hydrological cycle'; regulation of the water balance in organisms is termed osmoregulation. Water becomes more dense when it cools but reaches maximum density at 4°C/39°F. When cooled below this temperature the cooler water floats on the surface, as does ice formed from it. Animals and plants can survive under the ice.

The recycling and circulation of water on Earth is called the water cycle. Water occurs on the Earth's surface as standing water in oceans and lakes, as running water in rivers and streams, as rain, and as water vapour in the atmosphere. Together these sources comprise the hydrosphere which is in a constant state of flux – water vapour condenses as it cools to form clouds, droplets of water in the clouds merge to form raindrops that fall to earth (precipitation), and after flowing through rivers and streams into lakes and oceans water is returned to the atmosphere by evaporation; and so the cycle continues. Since the hydrological cycle is a closed system, the amount of water in the Earth's hydrosphere is constant. The cycle is powered by solar radiation which provides the energy to maintain the flow through the processes of evaporation, transpiration, precipitation, and run-off.

A family of two adults and two children uses approximately 200 l/350 pt per day (UK figures). The British water industry was privatized in 1989, and in 1991 the UK was taken to court for failing to meet EC drinking-water standards on nitrate and pesticide levels.

Organisms living on land tend to lose water and most need to take in water to replace what is lost. Animals drink and the water is absorbed from the gut. Plants absorb water from the soil by roots. In both cases the mechanism of uptake is osmosis.

Osmoregulation Water is very important to living organisms. It helps cells to maintain their form; as a solvent, it dissolves salts, sugars, proteins, and many other substances that are involved in metabolism and the digestion of food; and it enables the transportation of bodily wastes, and the maintenance of a stable body temperature through perspiration and evaporation. However too much water can be dangerous. The process that maintains an equable balance of water content in an organism is osmoregulation. Organisms gain water in a number of ways – by osmosis, in food, and by respiration. They lose water by evaporation, in urine, and by osmosis. In humans, the kidneys play a very important role in the regulation of water balance.

Water and plants Inside the plant, water is transported in the xylem tissue to the leaves. Here it evaporates and is lost to the atmosphere during transpiration. Transpiration keeps water moving in the xylem and this transports minerals up to the cells that need them. Water is needed in a plant cell for the cell's chemical processes, but is also needed to fill the cell tightly. Tightly-filled cells are rigid (a condition known as turgor) and this supports parts of plants such as the leaves. Photosynthesis in plants uses water by combining it with carbon dioxide to make glucose and other carbohydrates.

Water and humans Water makes up 60–70% of the human body, or about 40 l/70 pt, of which 25 l/53 pt are inside the cells and 15 l/26 pt outside (12 l/21 pt in tissue fluid, and 3 l/5 pt in blood plasma). A loss of 4 l/7 pt may cause hallucinations; a loss of 8–10 l/14–18 pt may cause death. About 1.5 l/2.6 pt a day are lost through breathing, sweating, and in faeces, and the additional amount lost in urine is the amount needed to keep the balance between input and output. In temperate climates, people cannot survive more than five or six days without water; this is reduced to two or three days in a hot environment.

In the human body, water is needed inside cells, but water is also needed for transport. The blood carries many chemicals around the body in solution, for example glucose. The balance between the water in cells and in the blood has to be kept and the kidneys help to maintain the balance. Water can absorb quite a lot of heat before its temperature rises, so the blood is also used to transport heat from inside the body to the skin surface, where it is lost to the environment. If the human body needs to cool, water is itself lost as sweat. When the water in the sweat evaporates, it cools the skin.

Pollution of water Pesticides and fertilizers used in agriculture and weedkillers from road verges are washed off when it rains. They may go into ground-water used for public water supplies, polluting them. They may go into lakes and rivers and harm living organisms there

Properties of water With a relative molecular mass of 18, water has unusual properties for a molecule of its size, and many of these properties have biological significance. It is a polar molecule with a slight positive charge at one end and a slight negative charge at the other. The oxygen molecule has a negative charge and attracts the positively-charged hydrogen atoms of other water molecules, with the result that hydrogen bonds are formed between the water molecules holding them together. This makes water a very good solvent for other polar molecules and ionic substances, which become more reactive in solution. Thus it provides the medium for metabolic reactions in organic cells and is vital in the transport of substances around the bodies of organisms. For example, food substances, hormones, and urea are dissolved and transported in blood plasma which consists of over 90% water.

Water has a high heat capacity, which means that it requires large amounts of heat energy to produce small rises in temperature. Consequently, temperature changes in water are usually quite small, and this is important in cells where metabolic reactions are controlled by enzymes; externally, it also provides a fairly constant environment for aquatic organisms. A great deal of heat is required to change water from its liquid state to vapour and this is important in temperature control in mammals. When the body becomes overheated, the animal sweats; thus the heat used for the vaporization of the water in sweat is lost from the body, thereby cooling it.

In liquid form, water cannot be compressed; when frozen, it expands by 1/11 of its volume. It has its maximum density at 4°C/39°F (one cubic centimetre of water has a mass of one gram forming the unit of specific gravity). When cooled below this temperature, the density of water decreases so that ice floats on the surface. This has been an important factor for the evolution of life on Earth, particularly in Arctic and temperate regions.

The individual molecules of water have great attraction for one another, producing high surface tension, and this is important in the conduction of water through the xylem tissue of plants. Plants require water to carry nutrients from the root zone into the body of the plant, to enable photosynthesis to take place, and to aid transpiration.

Human impact Water is not evenly distributed across the planet's surface – in some places there is too little, in others too much. Expanding populations are making greater and greater demands on supplies, although human impact on the water cycle is mainly in the run-off sector, with water being diverted for domestic, industrial, and agricultural uses. However, modern society interferes with almost all aspects of the cycle: agricultural and forestry practices disrupt evaporation and transpiration; boreholes and wells allow access to the ground-water system; and the construction of dams and reservoirs creates additional storage. Since the cycle is a closed system, human activities cannot deplete the overall supply, but excess withdrawal from the run-off or groundwater sectors can create localized shortages of water. Most human uses involve only short-term withdrawal from the system, but often the water is returned with its quality greatly impaired by pollutants. Pesticides and fertilizers used in agriculture and weedkillers from road verges are washed into ground water used for public water supplies; industrial chemicals get into drinking water from rivers.

Human consumption The major demand is for fresh water, but the proportion of fresh water to saline is very small – only 3% of the total volume of the hydrosphere. According to two UN reports in January 1997, large areas of the globe will start running critically short of water in the next 30 years. Total worldwide water consumption has been growing at 2.5% a year, roughly twice as fast as the population, and by 1997 it had reached 4,200 cubic kilometres annually. During the 20th century, water consumption rose sixfold and, as many rivers cross national boundaries, there is a danger that growing demands for this resource in the future could lead to conflict.

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