How Things Dissolve

In the winter, you might get a cold. The sore throat and cough are very unpleasant. To get relief, you can pop a cough drop in your mouth. The sweet cough drop contains medicine that makes your throat feel a little better and puts the cough on hold for a while.

But what happens to the cough drop? After a few minutes, it is a lot smaller than it was when you put it in your mouth. And not long after that, it is gone. Where did it go?

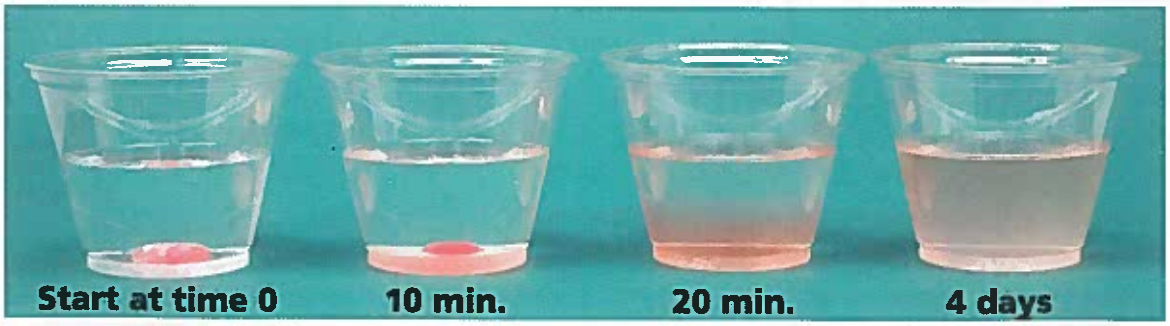
The cough drop, which is mostly sugar, dissolved. It dissolved in saliva, which is mostly water. As it dissolved, the medicine flowed down your throat, bit by bit, soothing the pain.

Dissolving in Water

You can observe the dissolving process more easily by putting a red cough drop in a cup of plain water. Within a minute or two, you can see a pool of red color forming around the cough drop. The red color is coming from the solid cough drop. Is the cough drop **melting**?

No, the cough drop is not melting. Melting is caused by heat. Heat is not transferring to the cough drop in the cup of water.

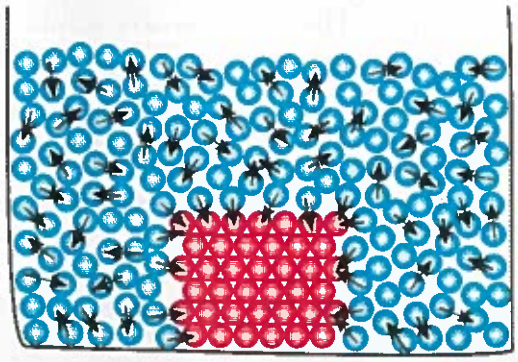
The cough drop is dissolving. It is breaking apart bit by bit, and the bits are moving into the water. In 10 minutes, the cough drop will



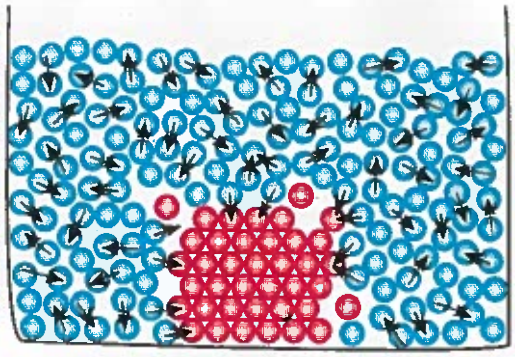
be very small, and there will be a thin layer of red water on the bottom of the cup. In 20 minutes, the solid cough drop will be gone, and the red layer at the bottom of the cup will be larger. A day later the red color will have moved higher in the cup, and in 4 days, the whole cup will be pink. The cough drop will be spread evenly throughout the water in the cup.

A Close Look at Dissolving

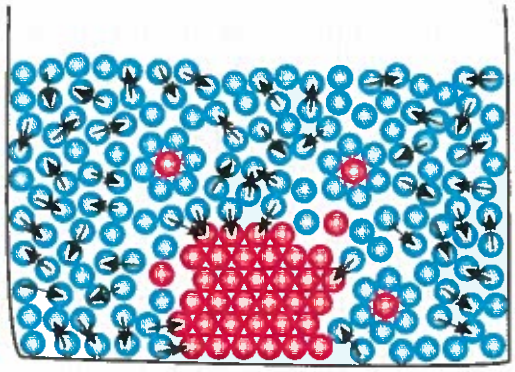
Water is made of water particles. They are in constant motion, bumping and banging around and over one another. But the water particles don't just bump into one another. They bump into everything that is in the water. If you put a cough drop in a cup of water, water particles will bang into it billions of times every second.



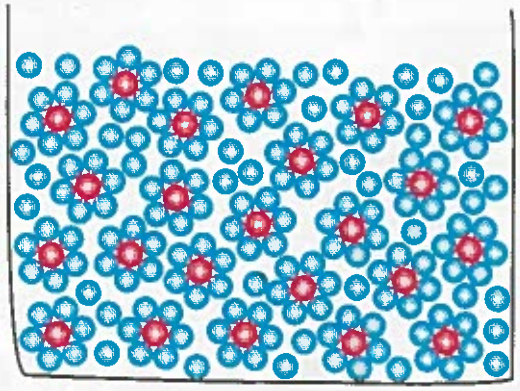
The cough drop is a solid, so its particles (shown in red) are held together by attractive forces called bonds. The bonds keep the cough drop from falling apart in the package before you use it. Then you drop the cough drop into water, a liquid. Water particles (shown in blue) hit the sugar particles on the edge of the cough drop and transfer enough energy to break those bonds.



The sugar particles leave the cough drop and form bonds with a few water particles. The tiny sugar-and-water groups move off into the mass of water.



After 20 minutes, the whole cough drop has been broken into individual particles and carried into the water. The cough drop is completely dissolved. And it happened one particle at a time.



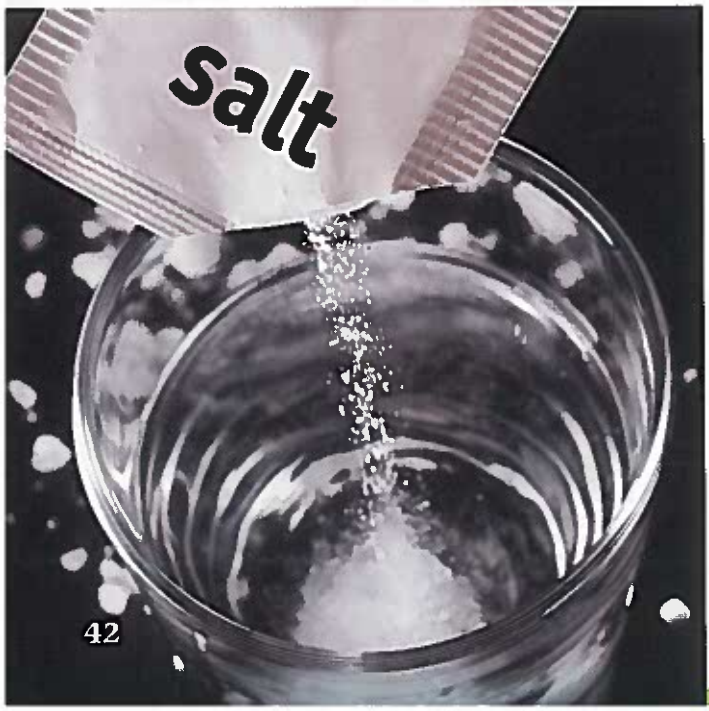
A mixture of nuts and raisins

Mixtures and Solutions

When two or more materials are put together, you have a mixture. Peanuts and raisins make a good mixture for snacking. Tomato sauce with herbs poured over pasta is a mixture. A mixture of oil and vinegar is a good start for salad dressing. Any combination of materials is a mixture.

You can make a mixture of salt and water. Salt dissolves in water, just like the cough drop. After the salt has dissolved, it is no longer visible. The mixture is **transparent**. When two substances are put together and one dissolves in the other, this kind of mixture is called a solution.

Salt dissolves in water to make a solution.



Solutions have two parts. There is the part that dissolves (salt) and the part that the salt dissolves in (water). The part of the solution that dissolves is the **solute**. The part that does the dissolving is the **solvent**.

Solutions on Earth

Remember the article called "Elements in the Universe"? In that article, we looked at the elements that make up the ocean and the atmosphere. We discovered that the ocean is mostly hydrogen and oxygen, and the atmosphere is mostly nitrogen and oxygen. As it turns out, the ocean and the atmosphere are both solutions.

Let's look at the ocean and atmosphere again, this time to see how those elements are organized in solutions.

What is the largest solution on Earth? That's a tough question. Largest in volume or largest in mass? The most massive solution has to be the ocean. The ocean's depth ranges from a few centimeters to over 10 kilometers (km). And the ocean covers more than 70 percent of Earth's surface. That's a lot of sea water.

The ocean is a solution.

Earth's atmosphere is the largest solution in volume.

Sea water is a solution. The solvent in sea water is pure water (H_2O). But sea water contains a lot of solutes. The main solute is the salt, sodium chloride, the same salt you sprinkle on food. There are thousands of other solutes in sea water, too, but in very small amounts. In fact, every element that occurs naturally on Earth can be found in sea water.

The solution that is largest in volume is Earth's atmosphere. The atmosphere covers Earth's entire surface, land and sea, and extends up about 600 km.

Earth's atmosphere is a mixture of gases called air. Air is pretty uniform in composition. It's about 78 percent nitrogen, 21 percent oxygen, 1 percent argon, and traces of hundreds of other substances. Does it seem a little odd to think of air as a solution? What is dissolved, and what did the dissolving? The substance that is present in greatest quantity is considered the solvent. So in air, nitrogen gas (N_2) is the solvent. Oxygen, argon, carbon dioxide, water vapor, and all the other gases are solutes.

Solutions for Life

You are full of solutions. Water is the solvent for most of them. Saliva is a solution.

Saliva is a solution.

So are sweat, urine, stomach acid, and tears. Each solution has an important function in the successful operation of a living human being.

Let's think about blood. If you spin a sample of blood in a device called a centrifuge, on top of the tube will be a clear, amber liquid called **blood plasma**. Plasma is a solution. The solvent is water, and the many solutes include proteins, vitamins, and minerals. There are solid parts of the blood at the bottom of the test tube. The solid portion of blood is mostly red and white blood cells. So blood is really a mixture. It's a solution with solids suspended in it.

You can separate the plasma (solution) from the cells (solid) in a sample of blood.

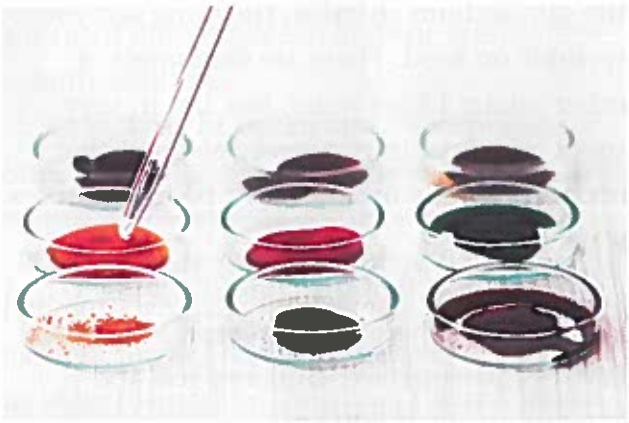
Nectar is a solution that attracts bees.

Plants contain a variety of solutions in their stems, leaves, and flowers. The sweet nectar that attracts bees and butterflies is a sugar solution. The sap flowing in plant stems and leaves is a solution of sugars and salts. The solution drawn up from the roots to all the plant's cells is a solution of minerals from the soil.

In every case, water is the solvent for life, and the solutes provide the raw materials that make life possible.

Solution Defined

- A solution is a kind of mixture of two (or more) substances, where one substance (solute) is dissolved in the second substance (solvent).
- In a solution, the solvent particles hit the particles of the solute and break the bonds holding the solute particles together. This is called dissolving.
- Substances that dissolve are **soluble**. Salt is soluble in water. Substances that don't dissolve are **insoluble**. Sand is insoluble in water.
- Individual solute particles are broken apart from the solid by the solvent particles. When the solute is all dissolved, the solute particles are uniformly distributed among the particles of the solvent.
- When one substance dissolves in another substance to make a solution, the particles of the two substances do not change. Solutions can be separated into their original substances. The most common way to separate a solution is by evaporating the solvent, which leaves the solute behind.



Think Questions

1. Magnesium sulfate (Epsom salts; $MgSO_4$) dissolves in water. Describe what happens at the particle level when magnesium sulfate is put into water.
2. How could a solution of magnesium sulfate and water be separated into its starting substances?
3. What are some of the solutions found in living organisms?