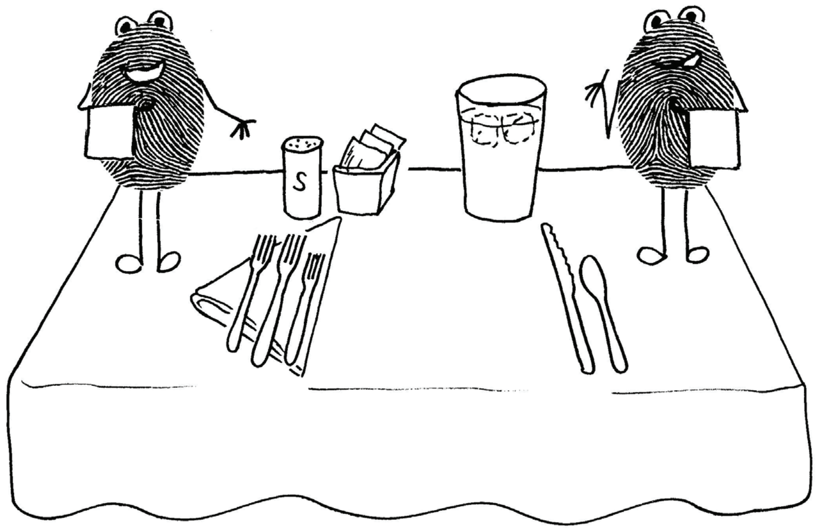
1: Before Dinner Begins

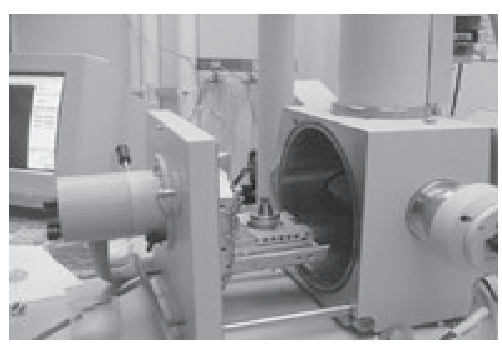
Good evening, and welcome to our restaurant! We offer a unique dining experience—not only do we serve the finest cuisine, we also assist you in dissecting your dinner all the way down to the molecular level! We just hired these waiters last week, so we might need to be patient as they learn their new job.



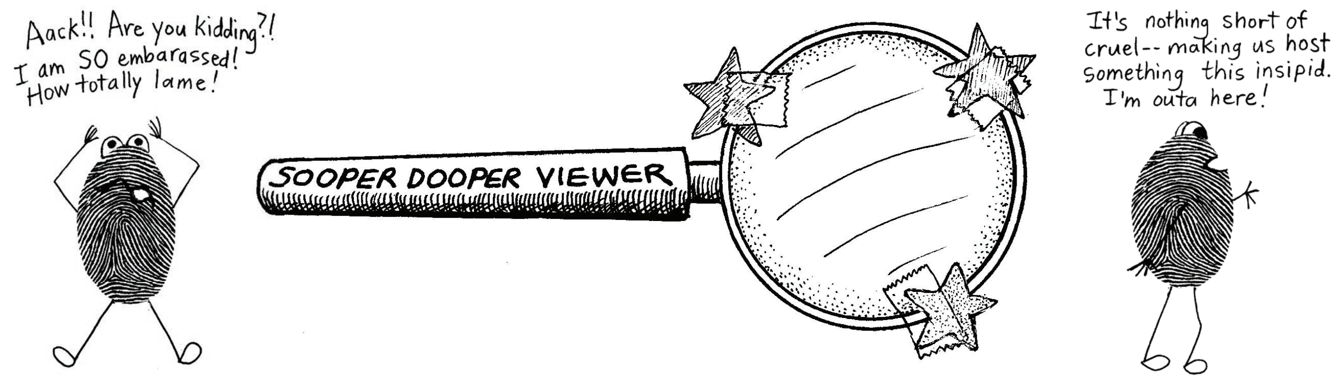
We will begin the dissection of your dinner even before the appetizers arrive. There are three edible things on your table already: water, salt and sugar. Let's start with your glass of water.

Yes, to dissect things down to the molecular level, we'll need some special equipment. Your ordinary scalpel and forceps won't be adequate. We'll need an amazing magnifying machine that will let us zoom in at ridiculously high levels of magnification, making things look up to one million times larger. In real life, we'd have to go to a lab that has an electron microscope worth tens of thousands of dollars. And even this machine might not even be good enough. We might have to use a machine that uses X-rays and needs super smart physicists to figure out what the pictures mean.

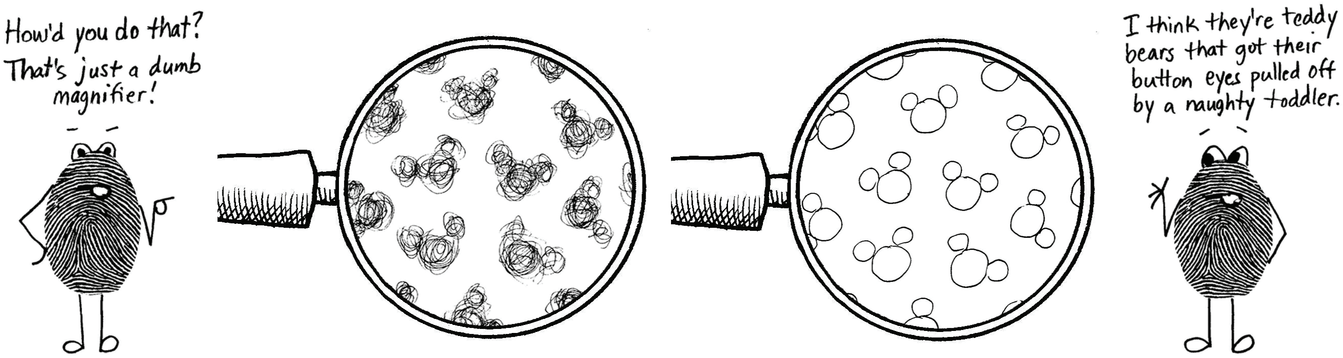
However, here on paper we can go cheap and just draw pictures. We can imagine that we have a super duper magnifier...



An expensive magnifier we can't afford



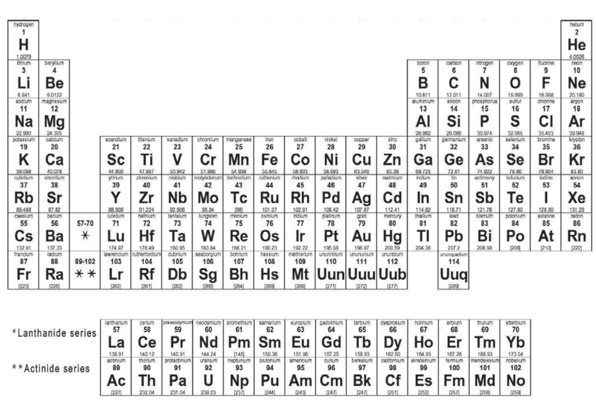
Hey—you haven't seen this little beauty in action yet! Please reserve your judgment for a moment. Let's use our magnifier to take a look at water. When seen with just our eyes, water doesn't appear to be made of anything. It's only when we magnify it several million times that we can actually see what it is.

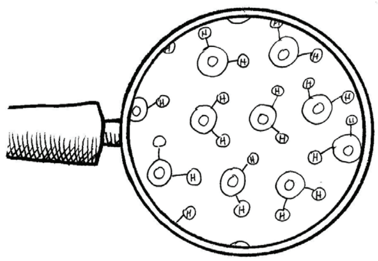


All those fuzzy blobby things are water molecules. As you can tell, water molecules are made of three parts—one large one and two little ones. The fuzzy view shows you that in reality, molecules are constant motion so it's impossible to get them in focus. The view on the right has an artificial focus imposed upon it. (And you thought our magnifier was wimpy. It's got artificial focus!) Those Mickey Mouse shapes (yes, we knew you were thinking that) are made of three atoms: one oxygen and two hydrogens.

Atoms are the most basic particles that exist. They're a little bit like building bricks ("Legos®"). Building bricks come in many different sizes and colors and can be used to make large structures. Structures can be taken apart and the pieces can be recycled. Atoms are like the individual bricks. When we speak of a type of atom in general, we call it an ***element***. Oxygen atoms can be referred to as "the element oxygen." In our building brick example, an element would be one type of brick, such as red 2x2 bricks, or white 2x6 bricks.

There are 118 different types of elements. Most of them are very useful, but some of the largest ones (numbers over 100) are very strange and only exist for a few seconds and are therefore practically useless. These 118 elements are usually written down not as a continuous list, but in a nice, neat rectangular chart called the Periodic Table of the Elements. The word "Periodic" means that there is a pattern to the way the elements are arranged, and "periodically" the pattern repeats itself. Some of these 118 elements are substances you've heard of, such as oxygen, nitrogen, hydrogen, helium, neon, carbon, calcium, magnesium, gold, silver, nickel, copper, iron and lead. Others are not so familiar and have names that look hard to pronounce. Fortunately, most of the atoms you meet in food chemistry are the easy and familiar ones, such as oxygen, hydrogen, carbon, nitrogen, sodium, and magnesium.



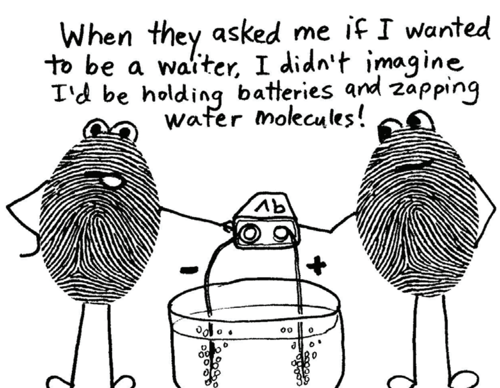


In this view, the molecules are shown as little balls stuck together with sticks. The balls are atoms. O stands for "oxygen" and H stands for "hydrogen." The sticks represent the bond that keeps the atoms together (in this case. by sharing electrons).

As you can see in our magnifier, atoms can stick together to make clumps. We call these clumps ***molecules***. Here we see clumps (molecules) that are made of two hydrogen atoms and one oxygen atom. Every molecule is exactly the same. The atoms stay together because the tiny hydrogen atoms are sharing their only electron with the oxygen atom.

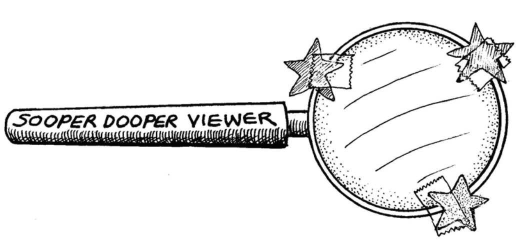
Just like an ***atom*** is a single particle of an ***element***, a ***molecule*** is a single unit of a ***compound***. ***A compound is a large amount of similar molecules, with each molecule being made of at least two different elements.*** Is water a compound? Yes, because all the molecules look the same, and each molecule is made of two different elements—oxygen and hydrogen. Would chicken soup be considered a compound? No, because there are so many different types of ingredients. Would pure oxygen be considered a compound? No, because even though the molecules are all the same, each molecule is made of just one element—oxygen.

So, how <u>do</u> you dissect, or tear apart, a water molecule? With a microscopic knife? Nope. Water molecules are so incredibly small that a knife would be useless. A knife blade is made of molecules that are much larger than the water molecules. It just wouldn't work. But there is a way to tear water molecules apart. We need... an electrical ZAPPER!

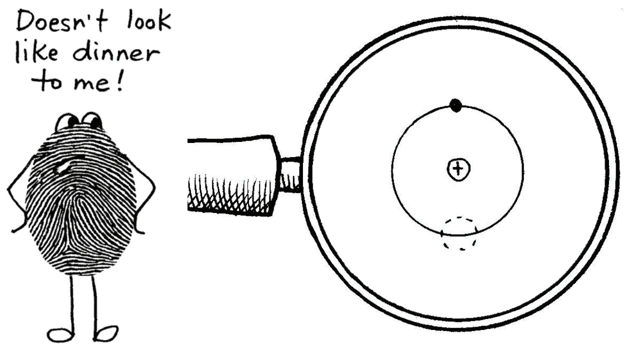


If we put electrodes from a battery into a glass of water and add a tiny pinch of salt or some other substance that conducts electricity, we will see bubbles forming on the electrodes. Bubbles of pure hydrogen gas will form on the negative electrode and bubbles of pure oxygen gas will form on the positive electrode. We have successfully dissected water molecules!

Does it work in reverse? If you put hydrogen and oxygen gases together would they form water molecules? Yes, they would. This is how a fuel cell works. Water molecules are split, then the gases are allowed to mix and form water again. Energy is released as the gas molecules form water molecules. The problem is that it takes energy to split the molecules in the first place, so a fuel cell can't actually create energy.



Now we're going to show you the full capabilites of our Sooper Dooper Viewer. We can zoom in using an even higher magnification and look at a single atom! Let's start with the smallest of all atoms—the hydrogen atom.

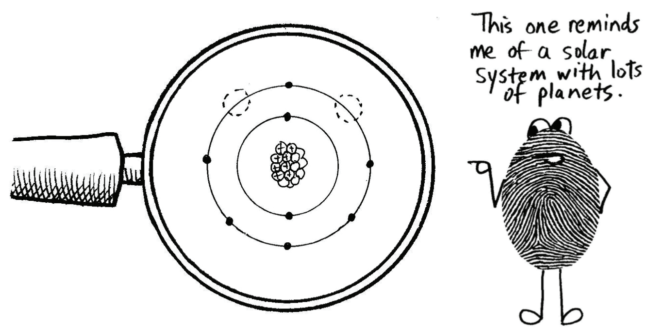


Here is a hydrogen atom. In reality, you can't actually see an atom. Atoms are just too small to see. Scientists figured out the structure of atoms using math and logic more than anything else. We draw diagrams like this one to represent atoms, but real atoms don't look like circles and dots. The dot in the center with the plus sign on it represents a ***proton***. What is a proton? It's a particle with a ***positive*** charge (thus the plus sign). What kind of particle? That's a question for a particle physicist, not a food scientist. If we understand that a proton is a particle with a positive charge, that's enough.

The dot represents an ***electron***. An electron is a particle with a ***negative*** charge. The circle around the proton represents an over-simplified "orbit" in which the electron travels. The electron actually whizzes around the proton in a three-dimensional way, being everywhere and nowhere all at once, looking more like a cloud than a circle. However, a circle will serve us much better as we try to understand how and why atoms stick together.

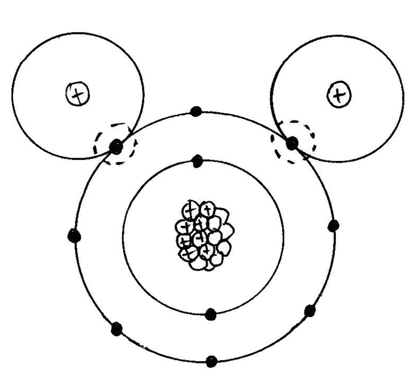
The small circle made dashes (opposite the dot) represents an empty place that another electron could fill. Electrons love to be paired up, and hydrogen's lonely electron would love to have a partner to fill that empty space. However, if the atom takes on another electron, it will create a new problem: the atom will no longer be electrically balanced. As it is right now, the atom has one positively charged proton and one negatively charged electron. With one of each, it's balanced. If it takes on a second electron, the score will be: protons: 1, electrons: 2. The atom will have an extra negative charge, giving it an overall charge of (-1).

What should hydrogen do? It has three options it doesn't like: 1) have a lonely electron, 2) be electrically unbalanced, or 3) give its electron away to another atom. It's a no-win situation for hydrogen. Yes. such a travesty. Let's find out what hydrogen does when an oxygen atom comes along.

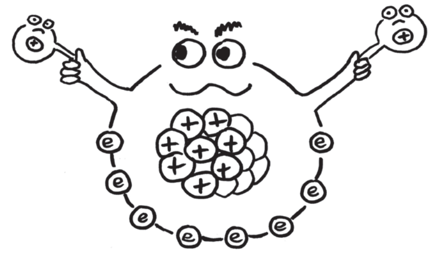


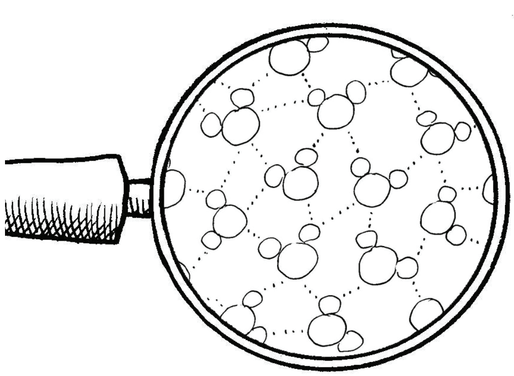
In this magnifier view, you see a representation of an oxygen atom. It's a bit more complicated than a hydrogen atom, but it's still similar. In the center, the oxygen has more than one proton; it has a whole clump of particles. There are 8 protons and also 8 ***neutrons***. Neutrons are electrically ***neutral***, neither positive nor negative. They just sit there. This little clump of protons and neutrons is called the ***nucleus*** of the atom. You'll notice that there are two rings around the nucleus, not just one. The inner ring has 2 electrons and the outer ring has 6. Those two electrons in the inner ring are very happy. They are paired up and their small ring is full with just the two of them. The outer ring is larger can hold up to 8 electrons. (Think of it as an 8-seat minivan.) Those two dotted circles are empty "seats" that the oxygen atom would really like to fill with electrons. However, just like the hydrogen atom, the oxygen atom is faced with the problem of being electrically unbalanced if it takes on more electrons. Right now it has 8 electrons and 8 protons. If it fills those circles with extra electrons, the score will then be 10 negative electrons to 8 positive protons. What will the oxygen do?

One solution that makes both hydrogen and oxygen atoms happy is to form a water molecule. When one oxygen and two hydrogens get together they have a total of 8 electrons in their outer rings. 6+1+1 Although in this picture it looks like the oxygen has gotten all of the electrons, this is not so. The electrons can move at lightning speed (literally) and are able to circle around the hydrogens often enough to make them reasonably happy. All three atoms get the electrons circling around them just often enough to convince them that this was a pretty good solution to their problem.



However, even though all three atoms are basically happy, this doesn't mean they are equal. The harsh reality for hydrogen is that it is puny in comparison to oxygen (or to any other atom, for that matter, since hydrogen is the smallest atom in the universe!). Hydrogen's one little proton is no match for oxygen's clump of 8 protons. Oxygen becomes a bully and begins "hogging" the electrons. This means that the electrons end up spending more time circling around the oxygen atom than they do around the hydrogen atoms. This unequal time-share of the electrons creates an imbalance in the molecule. Because the negatively charged electrons spend more time around the oxygen atom, that side of the molecule becomes slightly more negative. The side where the hydrogen atoms are stuck on becomes slightly positive because of the two protons sitting there unguarded by any electrons. Molecules like this, with a slightly negative side and a slightly positive side, are called ***polar molecules***. This use of the word "polar" doesn't have anything to do with snow or bears. It simply means "having two opposite sides." The earth's poles are north and south, and function a bit like opposite ends of a magnet.



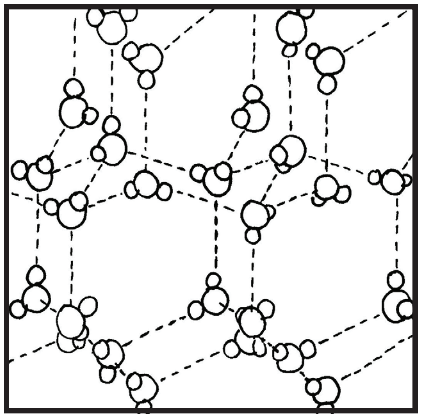


Being electrically lopsided, with a more positive side and a more negative side might seem like a bad thing, but actually it's a very good thing, and it's the reason you can take a bath or drink a glass of water. It's also the reason that plants can take up water through their roots. The negative side of one water molecule is attracted to the positive side of another water molecule. The end result is that water molecules stick together—in your bathtub, in your glass, in a raindrop, and inside plants.

This attraction between the water molecules is called ***hydrogen bonding***. (At least the poor hydrogens got the bond named after them. It's compensation for getting the short end of the deal when it comes to electrons!) Hydrogen bonds are much weaker than the bonds between the oxygen and hydrogen atoms, but they are strong enough that you can see them at work. Try putting a few drops of water on a penny. Then keep adding drops until the water finally spills over onto the table. You'll be amazed at how those water molecules stick together and form a really large droplet on top of the penny! That's hydrogen bonding at work.

Some "waiters" you turned out to be! You're not very good at waiting. Be patient. The rest of this dinner won't make sense if our guests don't understand their glass of water.

There's one more very important fact about water. You'll notice that there is ice floating in your glass. Your glass of ice water demonstrates a fundamental principle of chemistry. A substance can be altered, using temperature or pressure, to turn it into a solid, a liquid, or a gas. The chemistry of the substance doesn't change, just its physical properties. Water molecules are always made of one oxygen atom attached to two hydrogen atoms, no matter whether it is ice, liquid water, or steam. When you heat water so that it turns into steam, the



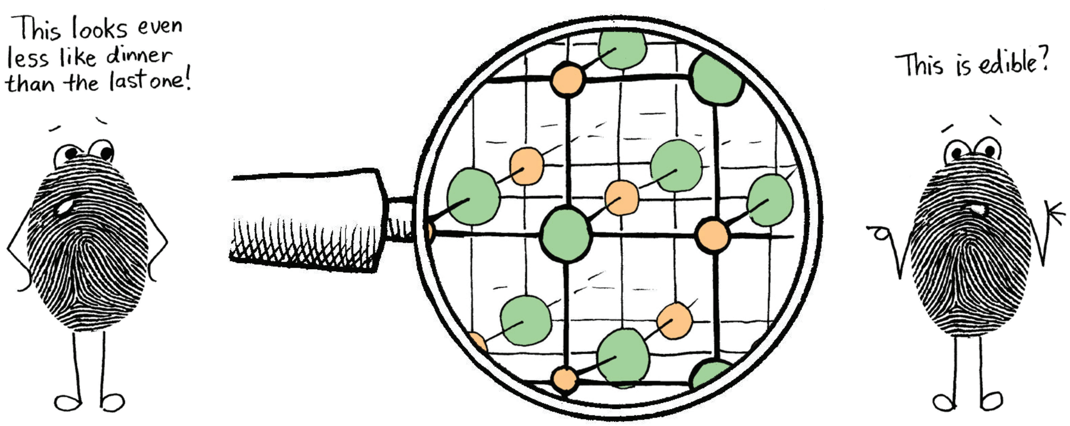
In this diagram, the dashed lines represent the electrical attraction (hydrogen bonds) holding the frozen water molecules together. These bonds (the lines) make a nice geometric pattern, and in the process they keep the water molecules farther apart than they would be if they were at room temperature and in liquid form.

water molecules themselves don't get torn apart. The heat weakens the hydrogen bonding between the molecules so that they can only form very small droplets. But the water molecules themselves remain unchanged. When water is cooled down to its freezing point, the bonds between the molecules get very strong, forming hard crystals. The water molecules actually move further apart in order to form this geometric crystal structure. When the crystals melt, the molecules move closer together again. In most other substances, it's the other way around. Usually solids are more dense (packed tightly together) than liquids. Water is backwards. It's this unusual property of water that allows ice to float instead of sink.

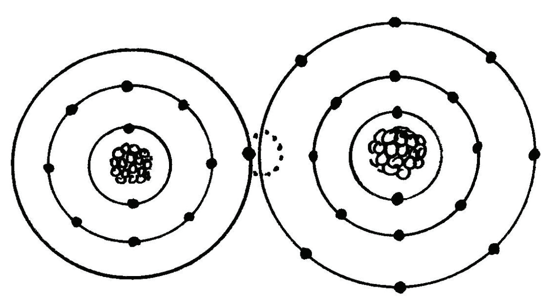
The scientific term for molecules being more or less tightly packed together is ***density***. Ice is less dense than liquid water because the molecules are more spread out, making fewer molecules per cubic measure. The densities of substances affect how they interact with other substances.

There's a lot more we could learn about water molecules, but we are going to move on now and look at what is in the salt shaker. If you look at salt under a magnifier, you'll see that the crystals look like little cubes. There is a reason for this, as we shall see.

Let's zoom in on the salt until we can see the molecules. Remember, this is something you can't see under a regular microscope. Our little Sooper Dooper Magnifier is much more powerful than any microscope you'd find in a biology classroom or even a medical lab.



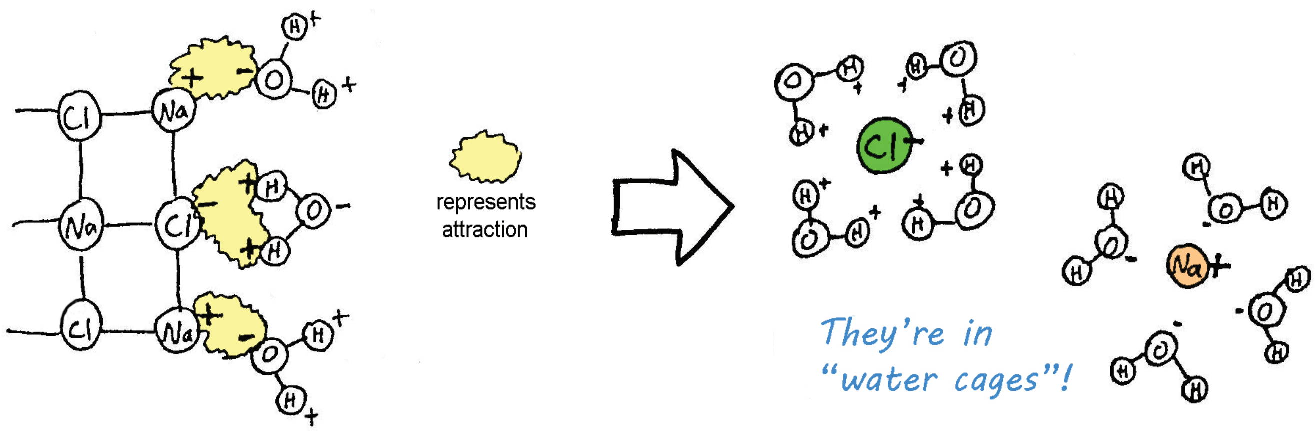
Wow—how different salt is from water! What structure! We've set our magnifier on "Ball and Stick View" so that's why you see all the circles and lines. Those circles are the atoms. The lines are the invisible bonds between the atoms (the electrical attraction). It's an endless framework of atoms all lined up in a perfectly cubic form. The atoms here aren't oxygen or hydrogen; they are ***sodium*** and ***chlorine***. The circles that represent chlorine atoms are larger than the ones that represent sodium because chlorine atoms have more pull, or "electronegativity" than sodium atoms do, and thus they are often drawn a bit larger.



Sodium and chlorine atoms stick together because sodium has an "extra" electron it would like to get rid of, and chlorine has one empty electron space it would like to fill. Atoms don't like it when their outermost ring has either an empty spot or one lonely electron. Sodium and chlorine put their two problems together to make a solution. Sodium gives its extra electron to chlorine and then they are both happy. Except that... in the process of doing this, sodium and chlorine have unbalanced themselves electrically. Sodium becomes more positive and chlorine becomes more negative. But this works out okay, because opposites attract and as long as chlorine and sodium stay next to each other everyone is (reasonably) happy.

Now... how can we dissect salt crystals? This turns out to be very easy, and you can do it without any special equipment. Just put the salt crystals into water, and presto—dissected! You won't be able to see the little atoms, though, so we'll show you an extremely zoomed-in view of dissected salt.

Remember that water molecules are "polar" and have a positively charged side and a negatively charged side. This "polarity" of water is what enables it to tear apart salt molecules. The water molecules have a stronger pull on the sodium and chlorine atoms than the sodium and chlorine do on each other. A sodium atom will leave the crystal to stick to the negative side of a water molecule. A chlorine atom will leave the crystal to stick to the positive side of a water molecule. It takes a little time for all the sodium and chlorine atoms to leave the crystal, but eventually they will all leave and the crystal will be gone. Once this has happend, we say that the salt has ***dissolved*** into the water. (NOTE: Sodium used to be called "natrium" so its symbol is **Na**.)



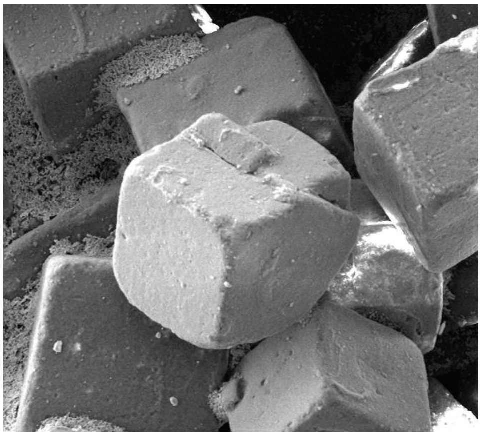
Look at the diagram on the right and notice how the water molecules surround the sodium and chlorine atoms. It almost looks like they have them imprisoned in little cages. The water molecules turn their positive sides inward to trap chlorine atoms, and they turn their negative sides inward to imprison sodium atoms. When sodium and chlorine atoms are floating around like this, unattached to anything, they are called ***ions***. An ***ion*** is an atom that has an electrical charge. Chlorine has a negative charge because it kept that electron that it borrowed from sodium. Sodium is positive because chlorine kept its electron, leaving it with 11 protons and 10 electrons.

Atoms on the Periodic Table, are listed in their "pure" form, with an equal number of electrons and protons, before they have interacted with any other atoms. In real life, you rarely find them in this state. Atoms like sodium and chlorine are almost always found as ions, having an unequal number of electrons and protons. This can be very confusing for young chemists. You help you out, if an atom has an electrical charge, it will be written in superscript, with the plus or minus symbol to the right of the number: Na^{1+} Cl^{1-}

When an ionic substance like salt breaks down into individual atoms, or ions, we say that it has been ***dissolved***. The water is called the ***solvent*** and the salt is called the ***solute***. The salt water is called a ***solution***. We'll meet some more solutions as dinner progresses.

Is the salt permanently damaged, or could the molecules be put back together again? The salt molecules can indeed be restored to their crystaline form, and this can be accomplished simply by doing nothing at all. Just let the water sit there. The water molecules will evaporate into the air and the sodium and chlorine atoms will go right back into their neat and tidy crystal lattice. (Go ahead, try it!)

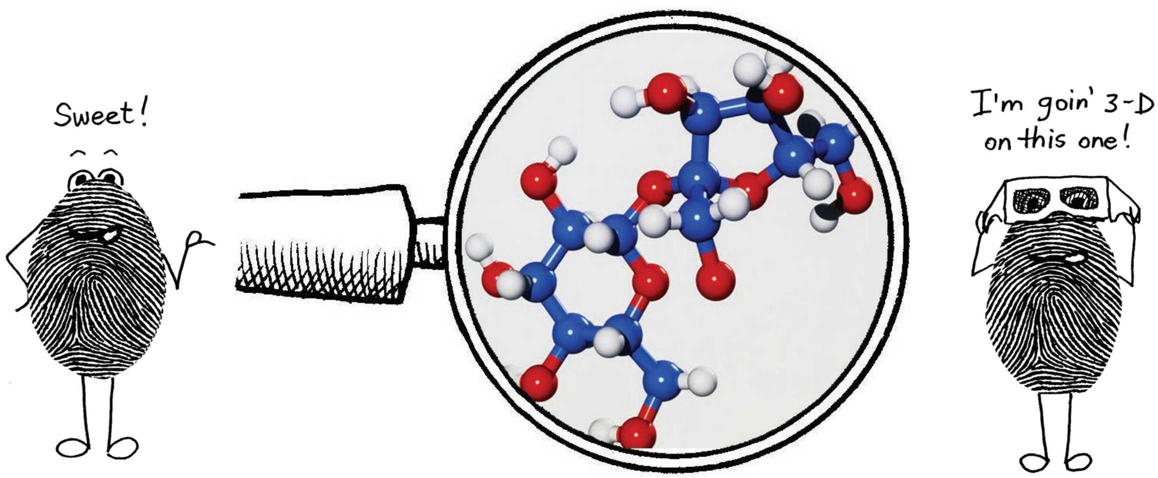
So what's left to dissect before the appetizers arrive? Let's open a packet of sugar. At first glance, it might look a lot like salt—little white crystals. But if we look at them under a magnifier (just an ordinary one this time, not our Sooper Dooper one) we can see a difference right away. The salt crystals look like little cubes, but the sugar crystals don't look cubic at all. They look more hexagonal (6-sided).



salt crystals

sugar (sucrose) crystals

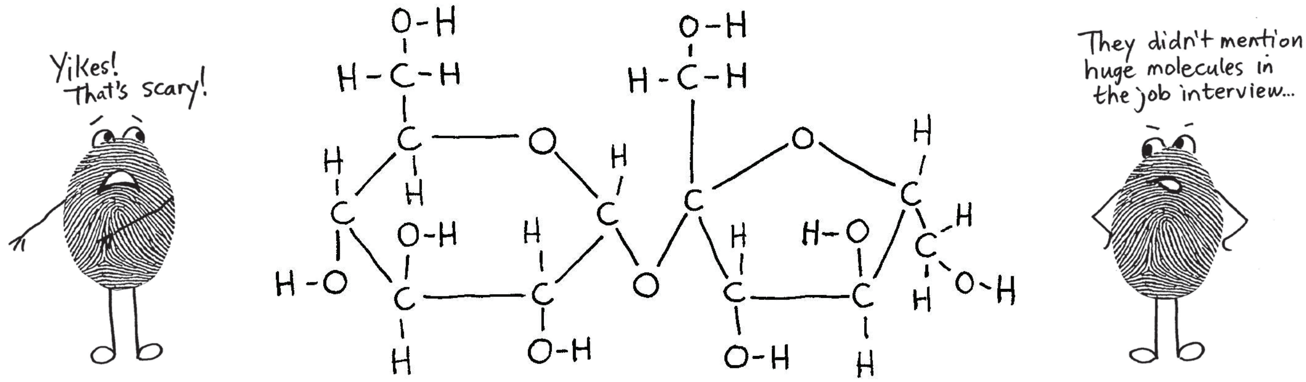
Now we'll switch to our amazing Sooper Dooper Magnifier and see what sugar molecules look like. But first, we'll toss the sugar crystals into our glass of water. Water has the same effect on sugar that it does on salt. (In fact, water has this effect in many substances. Water is sometimes called "the universal solvent" because of how many substances it can dissolve.) The polar water molecules pull on the sugar molecules, enticing them to leave their lovely crystal lattice and float around by themselves. So if we want so see just one sugar molecule by itself, the best way to do that is to dissolve the sugar into the water.



Here is just one molecule of sugar. The atoms are not lined up neatly like salt. It also looks like it should be viewed in 3D to see it properly. Some of the atoms look like they are in front or back of other atoms. To see this molecule in 3D, go to: **http://www.3dchem.com/Sucrose.asp#** Click on the molecule and it will open in a new window. If you have a touchscreen, you can interact with the molecule and rotate it. Or, you can use the commands at the bottom of this window. Look for the word "rotate," and click on the word "on." The molecule will begin to spin. There are many other options, too, listed at the bottom of the window. You can change from ball and stick model to other types of models. There are many ways to represent molecules. You can see a "stickless" (space-filling) model.

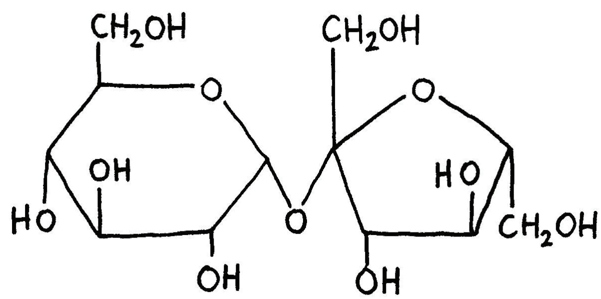
The picture in our magnifier shows the atoms as round balls. This kind of picture looks really nice, but you don't have a clue what those balls are, do you? For this reason, scientists have another way of representing molecules. They use letters, instead of circles or balls, to represent atoms. They keep the sticks, though. The letters they use to represent the atoms are the letter symbols found on the Periodic Table. The letters we will see most often in this book are: H for hydrogen, O for oxygen, C for carbon, N for nitrogen, Cl for chlorine, and Na for sodium.

These letter drawings don't look as artistic as the ball-and-stick ones, and they tend to look scary to non-scientists. This is the way that sugar molecule looks when drawn with letters:



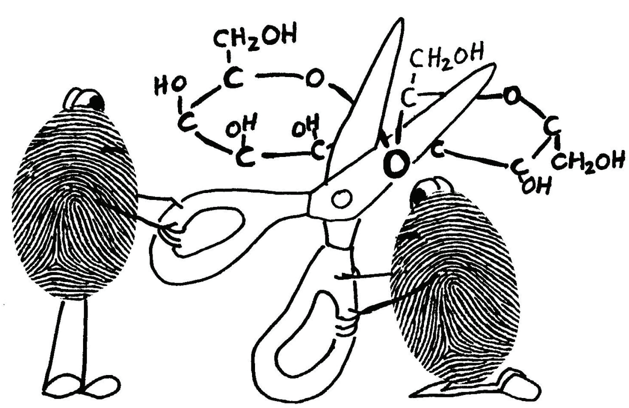
The biggest "plus" about this type of drawing is that you know exactly what type of atoms you are seeing. C is for carbon, O is for oxygen, and H is for hydrogen. These three elements are the main ingredients of most of what we eat. Another big "plus" is that it's much easier to draw or print a diagram that is nothing but letters and sticks. You lose the 3D aspect of the molecule, but this downside isn't down enough, and chemistry books almost always use these letter diagrams.

Chemists get so used to seeing these types of molecules that they don't even need all the letters in their diagrams. When they see a pentagon or a hexagon, they assume that the ***vertices*** ("corners") are carbon atoms. Compare this diagram with the one above. Where are C's missing? Can you find a few more missing letters? There are some H's missing, also. Chemists just automatically know the C's and H's are supposed to be there.



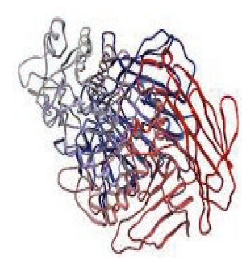
The correct name for this molecule is ***sucrose***. When we talk about putting "sugar" in a recipe, we are talking about "sucrose." In the world of science, the word "sugar" doesn't mean the stuff you bake with. "Sugar" is a more general word for a whole category of molecules that taste sweet. Sucrose is a sugar, but so are glucose, fructose, galactose, lactose, maltose, amylose and other "-ose's."

Notice that the basic structure of sucrose is a hexagon attached to a pentagon. Let's dissect sucrose by separating the hexagon and the pentagon. What is joining them? Look at the diagram and you will see that there is an oxygen atom between them. We'll have to snip off that oxygen.

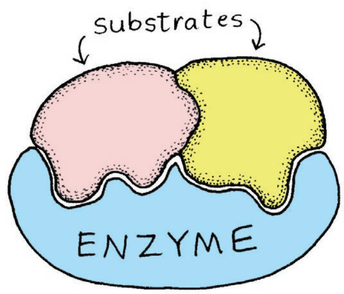


Wait a minute—SCISSORS?! Okay, okay, it works nicely in this picture and gets the point across. In real life, you need something called an ***enzyme*** to cut this molecule. An enzyme is a specialized protein molecule. Some enzymes act like scissors, but other enzymes act like staplers and fasten things together.

The enzyme represented here by our pair of scissors is called ***sucrase***. Enzymes don't have sharp blades, of course. Enzymes are able to do their job because of their special shape. On the right is a computer-generated image of sucrase. It's a long ribbon-like molecule all twisted up into just the right shape. It doesn't look like it would be able to cut apart sucrose, does it? Yet it does, and very quickly, too.

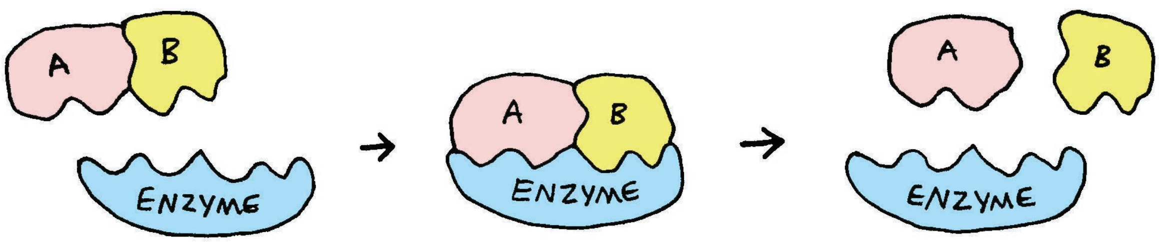


sucrase

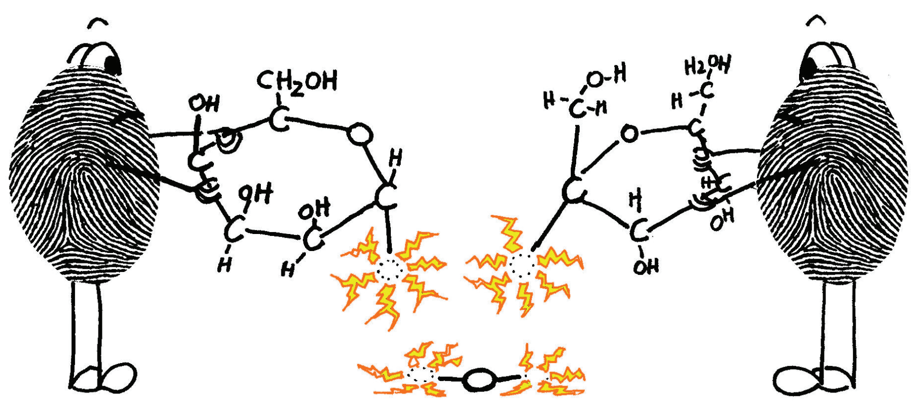


Here is the way enzymes are often look when you meet them in books. The artist makes the enzyme look like a large puzzle piece that attaches to two smaller puzzle pieces. The large piece is the enzyme and the smaller pieces are the things that the enzyme is putting together or taking apart. There's a good reason to make them look like puzzle pieces. They really do have matching shapes that fit together. The smaller pieces are called ***substrates***. (Now there's a really boring science word for you. Dull, dull, dull. You'll probably forget what a substrate is by the end of this chapter.)

This is a very typical drawing of an enzyme in action. It shows an enzyme acting like a pair of scissors, cutting apart two substrates. They almost always look like oddly shaped blobs, though occasionally you'll see them as rectangles. Blobs are closer to the truth, since they actually look like a random tangle of ribbons.



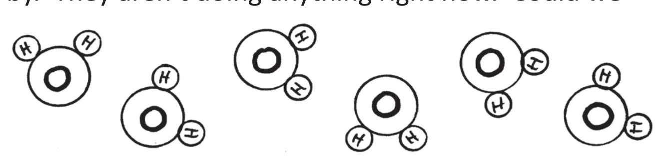
An enzyme is able to disassemble hundreds or thousands, or perhaps even millions, of substrates in its lifetime. You have sucrase enzymes in your intestines that work day and night to tear apart all the sucrose molecules you eat. Your digestive system contains many different kinds of enzymes, each one capable of tearing apart a different type of molecule.



Hmmm... it looks like your new molecules aren't very happy. Neither does that snipped off oxygen down there. In fact, those broken bonds look downright dangerous with all those zappy lines coming out.

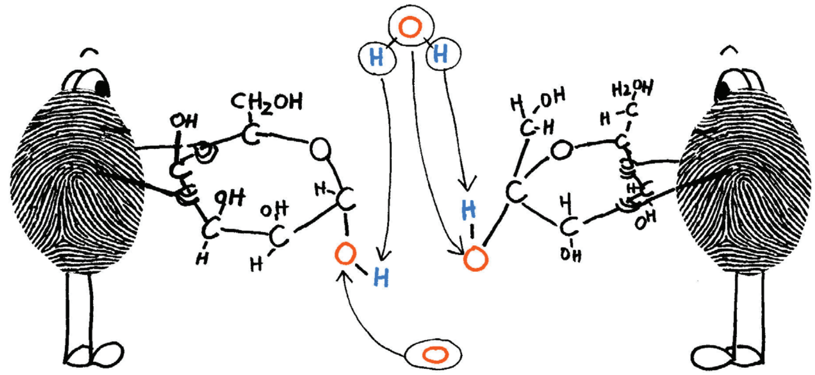
Here's what happening. Those sticks represent bonds between the atoms, right? But do you remember what a bond is? We looked at how hydrogens stick to an oxygen to make a water molecule. The "bond" was actually a place where the atoms shared an electron. It's the same with this molecule. That oxygen (O) was sharing electrons with the carbons (C) until you snipped it off. Now the oxygen is unhappy because it has two empty "holes" that are no longer filled. The carbon atoms are upset because they need to bond in four places and now they have only three of those slots filled. You've created a mess! If you walked away right now, those atoms would jump right back to where they were. If you want the molecule to stay dissected, you must patch up those broken bonds somehow. You need some spare atoms to stick onto those ragged ends. What's available?

Look! Here come some water molecules floating by. They aren't doing anything right now. Could we grab one and use it? Could hydrogens and oxygens be made into patches?



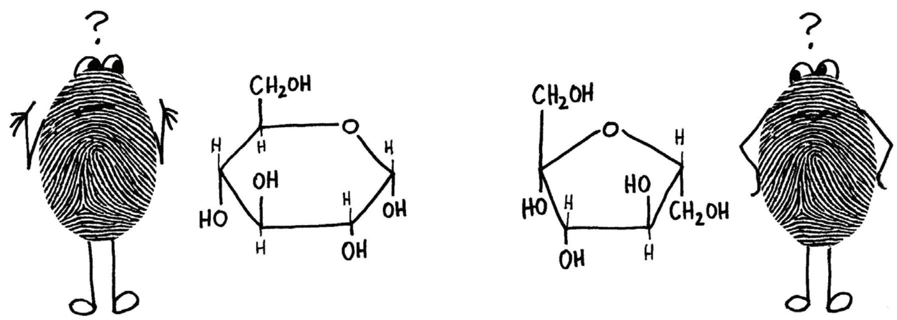
(Have you forgotten the word "substrate" yet?)

First, let's stick that snipped-off oxygen back onto one of the carbons. Now that carbon is happy again. But the oxygen is still unhappy because it is able to make two bonds and is only making one. We need an atom that only wants one bond. How about... hydrogen? Let's take a hydrogen off that water molecule and pop it onto the oxygen. There, now that molecule on the left is all patched up.

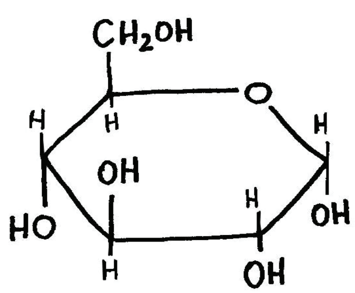


Let's try the same thing on the other side. Let's take the oxygen from water and put it onto the carbon. Then we'll patch the oxygen with the remaining hydrogen.

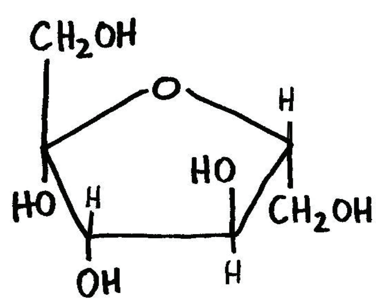
It looks like we've done it! We've separated the two rings and patched up all the bonds so that all the atoms are happy. What have we made? What are these rings?



We've turned sugar into... more sugar! All we've done is to turn a "two-ring" sugar into two "one-ring" sugars. These one-ring sugars are called ***simple sugars*** or ***monosaccharides*** *(mon-o-sack-a-rides)*. "Mono" means "one" and "saccharide" is a fancy word for "sugar." Sucrose is called a ***disaccharide*** *(di-sack-a-ride)*. "Di" means "two." (If the prefix "poly" means "many," then what would a polysaccharide look like?)



This molecule is called ***glucose***. The word glucose comes from the Greek word "glukos" meaning "sugar." Not too hard. Glucose is sometimes called "blood sugar" because it's the type of sugar that floats around in your blood. It's the sugar your cells use to harvest the energy they need to stay alive. Glucose has 6 carbons, 12 hydrogens and 6 oxygens. Can you find them all? (Remember, those "corners" have invisible carbons on them!) Chemists sometimes write glucose as $C_6H_{12}O_6$, giving the numbers of each type of atom right below its symbol.



This molecule is called ***fructose***. It's the kind of sugar found in fruit. Ripe fruit is sweet because it contains lots of fructose. That's easy to remember because "fruct" looks and sounds similar to "fruit." Fructose is the sweetest of all the sugars. Ounce for ounce it's sweeter than the sucrose in your sugar bowl. Fructose has the same number of each type of atom, and could also be written as $C_6H_{12}O_6$. Can you find all the atoms? Fructose is hard to find in crystal form. Most people are content to put sucrose in their dessert recipes.

Well, it looks like we've successfully dissected everything on the table. Before the beverages arrive, see if you can answer these questions. If you can, you've learned what you'll need to know to dissect the next stage of your dinner. If you can't remember, go back into the chapter and re-read until you find the answers.

1) What is an atom made of?

2) Which particles are in the center (the nucleus)?

3) What holds atoms together in a water moleclue?

4) How many bonds does oxygen want to make? (Look back at the picture where we patched up the molecules.)

5) Water is called a "polar" substance. Why?

6) What is the attraction between water molecules called?

7) Why do salt crystals come apart when you put them into water?

8) In salt water, which is the "solute," the water or the salt?

9) What do you call the things that attach to an enzyme? (Bet you forgot it already!)

10) What do enzymes do? (You are allowed to use the word you forgot in your answer to #9.)

11) What is the correct name for table sugar?

12) What is the name of the enzyme that tears apart sucrose?

13) Name the two simple sugars that link together to make sucrose.

14) What molecule can be used to patch up the ragged edges when you tear apart sucrose?

15) Did you ever notice that when you eat a lot of candy or sugar, you get thirsty? Can you think of a possible reason this might be so?

SUPPLEMENTAL VIDEOS FOR THIS CHAPTER

This curriculum has its own playlist on YouTube. Go to YouTube.com/TheBasementWorkshop and find the "Dissect Your Dinner" playlist. The videos are approximately in order, so the first ones on the list should correspond to topics from this first chapter. Come back to the playlist after you finish each chapter to watch the videos that go with those topics.

ACTIVITY 1.1 First installment of "Chew It Over," a group game to be played during a meal

This activity is designed to be something you do with family and/or friends during a meal. The questions are designed to be one of the following: informative, funny, challenging, or thought-provoking. Everyone will learn something either about science or about each other. You can use the questions in many ways. If you want to be the quiz master, you can simply read the questions out loud and see who knows the answer. Or, you could use scissors to cut them apart and then put them into a bag or bowl and go around the table letting each person draw out a question to answer. (If a question has a right answer, it is printed on the back of this page.)

CHAPTER 1: WATER, SALT, SUGAR 1) Can you name a natural substance other than water that is seen in all three states (solid, liquid, gas)?	CHAPTER 1: WATER, SALT, SUGAR 2) Which do you think uses less water, a bath or a shower?
CHAPTER 1: WATER, SALT, SUGAR 3) 90% of the world's fresh water is located on which continent?	CHAPTER 1: WATER, SALT, SUGAR 4) What % of your body weight is water? a) 1% b) 10% c) 60% d) 90%
CHAPTER 1: WATER, SALT, SUGAR 5) Plants release water vapor from their leaves. How much water does an acre of corn release in one day? (one gallon is about 4 liters) a) 4 gallons b) 40 gallons c) 400 gallons d) 4,000 gallons	CHAPTER 1: WATER, SALT, SUGAR 6) Can you guess which of these countries is NOT one of the top five producers of salt? USA, Russia, China, India, Germany, Canada
CHAPTER 1: WATER, SALT, SUGAR 7) Can you guess which one of these foods doesn't rely on salt as a key ingredient? cheese, yogurt, ketchup, mustard, soy sauce, olives, pickles	CHAPTER 1: WATER, SALT, SUGAR 8) Salt is often found underground in formations called salt domes. What other substance is usually found around or under the salt dome? a) oil b) water c) iron d) magma
CHAPTER 1: WATER, SALT, SUGAR 9) Which type of outdoor water do you like best? Ocean, lake, river, stream, puddles	CHAPTER 1: WATER, SALT, SUGAR 10) If you were required to give up either sugar or salt for one month, which would you choose?
CHAPTER 1: WATER, SALT, SUGAR 11) What is your favorite sweet food?	CHAPTER 1: WATER, SALT, SUGAR 12) What is your favorite salty food?

1) Probably not. Water is the only common substance found in all three states.
2) On average, a shower requires half as much water as a bath. 3) Antarctica
4) About 60% of your weight is water. On average, males have 60-65%, females 50-55%.
5) 4,000 gallons of water per day! 6) Russia
7) yogurt 8) oil (meaning crude oil, or petroleum)