CHAPTER TWENTY-FOUR

HYDRATION AND CELLULAR RESPIRATION

הַשּׁוֹתֶה מַיִם לִצְמָאוֹ אוֹמֵר שֶׁהַכֹּל נִהְיֶה בִּדְבָרוֹ. רַבִּי טַרְפוֹן אוֹמֵר בּוֹרֵא נְפָשׁוֹת רַבּוֹת.

One who drinks water to [quench] his thirst says, "[Blessed are You, Hashem, our G-d, King of the Universe] for everything exists by His word." Rabbi Tarfon says [one should say, "Blessed are You, Hashem, our G-d, King of the Universe] Who creates numerous living things [and what they lack…]."

Berachos 6:8

ACCORDING TO RABBI TARFON, before drinking water one does not say the "שֶׁהַכֹּל" blessing that one recites before drinking or eating other foods that didn't grow from the ground. Instead, Rabbi Tarfon holds that one should say the "בּוֹרֵא נְפָשׁוֹת" blessing *before* drinking water[1] and afterward one should not say any blessing at all.[2]

There are two primary explanations for why Rabbi Tarfon prescribes this special treatment for water. When taken together, the two seem almost contradictory. On the one hand, the "שֶׁהַכֹּל" blessing is specifically for foods that provide at least

1 *Rashi*, *Eiruvin* 14b, s.v. רבי טרפון; *Tosafos*, *Berachos* 45a, s.v. רבי; cf. *Meiri*.

2 *Ritva*, *Berachos* 44b, s.v. השותה מים; cf. *Rashba*.

some nutritional benefit,[3] and since water does not provide us with any **nutrition**, that blessing isn't appropriate.[4] On the other hand, the "בּוֹרֵא נְפָשׁוֹת" blessing refers to Hashem's having created חֶסְרוֹנָן—the things that we simply cannot live without—and there is nothing more essential to our survival than water, so that blessing is appropriate.[5]

This leads us to two questions: First, what does it mean that water doesn't provide us with any nutrition? And second, if that is the case, why is water critical to life? Let's explore the second question first, and then we can return to the first one.

WHY IS WATER CRITICAL TO LIFE?

Hydration is the term that refers to ensuring the body has the water it needs. You might be more familiar with the term *dehydration*, which refers to the body *not* having enough water. Proper hydration is absolutely essential to good health and wellbeing. You may be surprised to learn that in fact, *most* of your body is water! Overall, the body is about 60% water, though certain **organs**, such as the brain and heart, can be more than 75% water. Even bones are about 22% water. Water is so critically important that it would not be an exaggeration to say that nothing in our bodies would work properly without it.

Here are just ten of the many vital roles water plays within you.

1. *Temperature regulation*. The water in sweat is what prevents your body from overheating.
2. *Joint lubrication*. Water cushions your joints and tissues, so you can enjoy pain-free physical activity.
3. *Waste removal*. Water is used to carry away bodily waste through sweat, urine, and bowel movements.
4. *Blood cleaning*. Proper hydration is essential for your kidneys to effectively filter waste products from your blood.

---

3 See *Berachos* 35a.

4 *Ritva* and *Shitah Mekubetzes*, *Berachos* 44b, s.v. השותה מים.

5 *Sefer Hamichtam*, *Berachos* 45a; *Tosafos*, *Berachos* 37a, s.v. בורא נפשות רבות; *Bartenura*, *Berachos* 6:8, s.v. אפי' אכל שלק.

5. *Efficient digestion*. Water makes it easier for your body to break down the food you eat and absorb its **nutrients**.
6. *Oxygen circulation*. Water is the main component of blood, which carries vital materials around the body. One of these vital materials is the **oxygen** that blood delivers to every cell in your body, every minute of your life.
7. *Saliva production*. Drinking enough water ensures your mouth is clean and produces sufficient saliva to properly chew your food and prevent tooth decay.
8. *Skin health and beauty*. Without sufficient hydration, your skin is susceptible to various disorders and premature wrinkling.
9. *Brain health*. Water is essential for proper brain and nervous system function. It cushions the spine and allows for the proper production and distribution of essential **chemicals** triggered by the brain, such as **hormones** and neurotransmitters.
10. *Easy breathing*. When the body lacks sufficient water, airways become restricted to prevent further water loss, so breathing can become strained and inefficient.

All these wonderful benefits provided by water are thanks to its ability to keep things moist. However, the body's need for water goes far beyond just needing something wet.

Hashem created water as a chemical with extraordinary molecular properties. These special properties are what make all of life possible and are necessary for the inner workings of your body. Explaining exactly what makes the water **molecule** so unique is best saved for another discussion, but, for now, we can explore certain things these properties enable water to do.

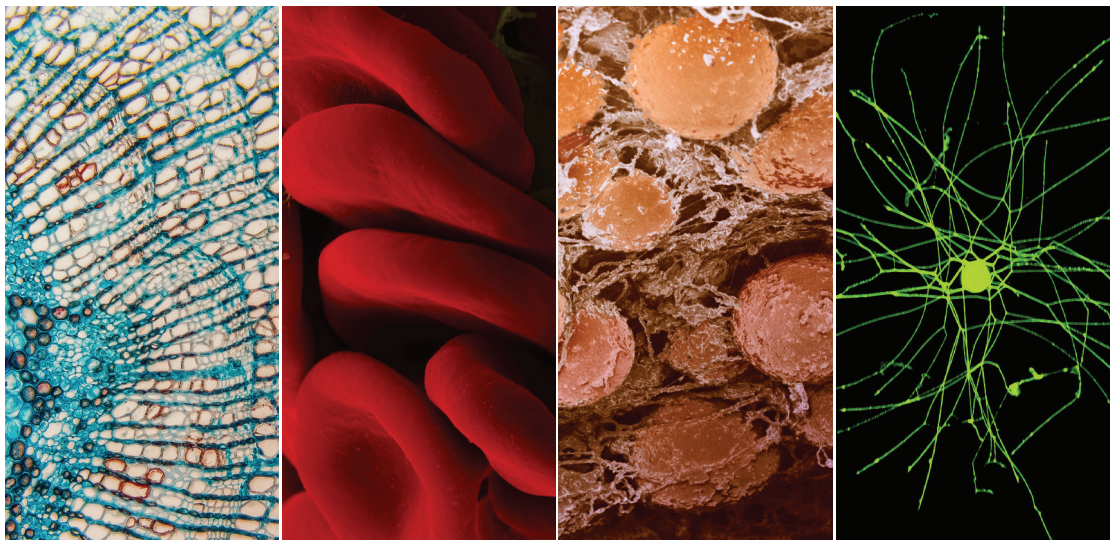
The basic building blocks of all living **organisms** are **cells**. There are hundreds of different types of cells in nature (see Figure 24.1), but all of them—without exception—depend on water. Here are a couple of the vital cellular processes that are only possible thanks to water's special properties:

1. Water's unique chemical structure enables it to **dissolve** many different types of chemicals. Your cells contain a variety of chemicals that need to react with each other but can only do so when dissolved in a **liquid**. The water within

each of your cells is what dissolves these chemicals and enables them to react with each other.

2. Water molecules themselves are essential ingredients in many important cellular reactions, such as the reactions needed for **photosynthesis** (making **energy** from sunlight in plants), for building **proteins**, and for supplying the energy every cell needs to power its activities.

In truth, there are many, many more essential roles that water plays in our bodies. So, it should not be surprising that water is a large portion of every cell in your body and that it is an essential ingredient all organisms need to survive.



Wood cells | Red blood cells | Fat cells | Nerve cells

FIGURE 24.1. These are pictures of four of the many different types of cells found in various types of organisms. Each is magnified between 100 and 1,000 times. Water molecules are much, much smaller than any of these: Each of the cells above might contain something like a trillion (1,000,000,000,000) water molecules!

WHERE DO ORGANISMS GET THEIR WATER?

Every organism needs water, but different organisms hydrate in different ways. Animals hydrate by drinking water directly and also by eating foods that contain water. Plants absorb water from soil through their roots. **Fungi** can even get their water from **water vapor** in the air. (See chapter 16, "Mushrooms and Truffles," for more on this.)

In some **environments**, water can be difficult to find. This is especially the case in the **Earth**'s deserts. Deserts are regions that get little rain or other **precipitation**, so they typically provide limited access to fresh water for their inhabitants. Plants and animals that make the desert their home must employ creative methods to collect and store water if they are to survive. Consider just one remarkable example: the darkling beetle (see Figure 24.2).

Darkling beetles live in the Namib Desert of Southern Africa. On most days of the year, there is not one drop of drinkable water to be found anywhere in the Namib. So, what are the darkling beetles to do? Every morning, each beetle climbs up a tall sand dune to meet the morning fog that blows in from over the sea. The insect then positions itself with its head down and its thorax (the rear third of an insect) up, facing the breeze. Tiny water droplets from the fog stick to the bumps on the darkling's wing cases and begin to accumulate. When the gathering droplets grow, merge, and become sufficiently heavy, they roll down channels within the beetle's wing cases and into its mouth. Quite a creative solution indeed!

We have established water's central importance for all living things, including for ourselves. But if water is such a critical element for our survival, how could anyone say it doesn't provide nutrition?

FIGURE 24.2. The darkling beetle. Droplets **condense** on its shell because of alternating **microscopic** waxy and non-waxy regions.

FIGURE 24.3. A darkling beetle collecting water in the desert from fog

WHY DOESN'T WATER PROVIDE NUTRITION?

Foods that provide us with the materials needed for our bodies to grow or to get energy are said to give us nutrition. While it might sound strange at first, we humans get essentially all of our nutrition by eating parts of other organisms, such as meat, vegetables, and mushrooms. Our bodies break those things down into their molecular building blocks (see chapter 27, "Digestion," for more on this process). Since the food we eat was originally part of other organisms, it is all made of cells. These cells are made of proteins, **sugars**, **fats**, and many other types of molecules, with water molecules surrounding all these other molecules and filling the spaces between them in the cell. All these molecules—except for water—are made from carbon atoms (along with other atoms such as **hydrogen**, oxygen, and **nitrogen**). (See chapter 15, "Bread and Nutrition," for more about these large carbon-based molecules.)

Carbon atoms can build up to make larger and larger structures that ultimately make cells. Look at Figures 24.4–24.7 and their captions to learn how this happens.

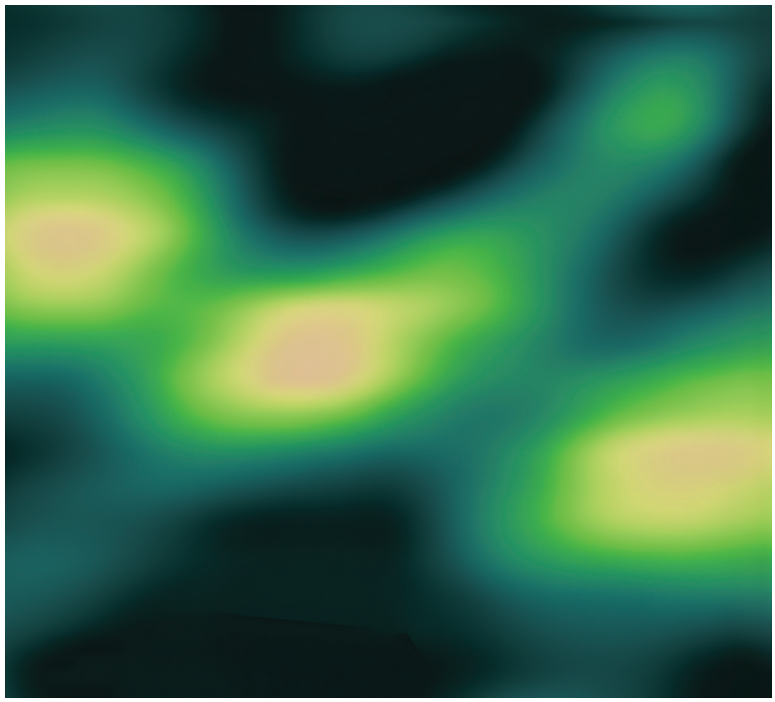


FIGURE 24.4. A real picture of a carbon **atom** (though the color is added). These are unimaginably small: a carbon atom is 0.00000007 mm across, meaning more than 100 million (100,000,000) lined up end-to-end could fit in one centimeter! This picture was made using an advanced microscopy technique called "electron cloud densitometry." This method can directly visualize the **electrons** on the outside of the atom (see chapter 30, "Lightning and Electricity," to learn more about electrons). ▶