Trees!

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I realize that many years may have passed since you completed biology or chemistry but let's do a science experiment! If this experiment is successful it could be published in one of the premier scientific journals (e.g., *Science* or *Nature*). Even though the materials and methods seem quite simple (household items, no special equipment, not even a lab coat) a successful outcome (making sugar), once authenticated, could win a Nobel Prize in Biology or Chemistry.

Materials and Experimental Conditions

You will need an 8-ounce glass containing exactly 3.8 ounces of water, a 1 cup measure (ultimately, it will hold 6.35 ounces of sugar), a stool, and a sunny day. A partly cloudy day would be acceptable, but the experiment will take substantially more time to run. A bright sunny day with pleasantly warm, dry air and a steady breeze would be ideal. Follow the instructions carefully.

Methods and Experimental Set-up

1. Place the stool in an open area and carefully place the glass of water on it.
2. Stand next to the stool and place your feet shoulder width apart. Be sure this is a comfortable stance since you will not be able to move your feet once the experiment begins.
3. Hold the empty one cup measure straight above your head in the full sunlight.

[Note I: Steps 4a through 4d need to be done simultaneously.]

4a. Place the fingers of your free hand in the glass and absorb the 3.8 ounces of water.
4b. Slowly extract 4.75 cubic feet of carbon dioxide gas from the atmosphere.
4c. Slowly release 4.75 cubic feet of pure oxygen gas back into the atmosphere.
4d. Carefully monitor the rate at which the 1 cup measure spontaneously fills with organic sugar.

[Note II: Steps 4a through 4d may take several hours, so please be patient. You will not be able to switch hands nor move your feet during the experiment. You may sway from side-to-side if you get really bored or a bird lands on your head.

5. When all parts of step 4 are completed (you should feel the weight of the cup change), very carefully move one finger from the side of the cup and bring it in contact with the organic sugar. Absorb some of the sugar through your fingertip to meet your short-term energy needs and build muscle. As you absorb the rest of the sugar cause it to flow through your arm, your torso and both legs for storage in your feet. You will be glad to have this food reserve when you really need it to cope with stressful conditions and lean times in the days, months, or years to come.

Expected Results

If the experiment is going as planned, you will see the water level in the glass slowly and steadily decrease. At the same time (at approximately the same rate), nearly 5 cubic feet of carbon dioxide gas will be absorbed through some of the pores in your skin, while an equal volume of pure oxygen gas is released through other pores. This silent, invisible process is very difficult to feel unless you really concentrate. It's helpful to wear a loosely woven organic cotton shirt in a tasteful shade of green (no synthetics, garish colors, or crazy prints, please). This permeable covering will allow carbon dioxide to flow in and oxygen to flow out, while protecting your skin from long-term damage by the sun. The rate at which the 1 cup measure fills with organic sugar will be directly proportional to the intensity of the sunlight, the rate of water absorption through your fingertips, and the rate of gas exchange through your skin.

If nothing is happening (i.e., no sugar is spontaneously forming in the cup) …your arm is cramping from holding the cup above your head …you're getting hot and uncomfortable standing in the bright sun …and your feet are bothering you, try drinking the water in a last ditch effort to complete the experiment. Still no sugar in the cup? Science experiments are so darn frustrating. You followed the instructions exactly. You came to lab early and stayed late. When you asked questions, all Professor Barten could do was to repeat the instructions and try to be encouraging. It really wasn't helpful when he said "Well, that's just how this biochemical and physiological process works" while strolling casually around the stationary group.

It's too bad you're not a tree. If you were, you could extract water and nutrients from the soil (where you landed years ago as a windblown seed or were buried by an absent-minded squirrel). You could readily absorb carbon dioxide from the atmosphere, then use sunlight as the catalyst for this miraculous biochemical reaction. (Please note its beautiful symmetry …all those 6's.)

Photosynthesis: $6CO_2 + 6H_2O + \text{sunlight} \rightarrow C_6H_{12}O_6 + 6O_2$

That's right, as a tree you stand in the sun and make your own food …to meet your daily energy needs, to grow, and to providently store for future needs. You thank the Creator by storing tons of carbon for the common good …carbon that other organisms [*ahem*] carelessly released into the atmosphere. And, as if this carbon storage wasn't enough, you altruistically release tons of purified oxygen back into the atmosphere. This second contribution to common good is necessary for all life on Earth. As a tree you might live for 200, 500, even 5,000 years old. What a wonderful life! *Well* …not exactly.

You can sway in the wind but you can never move off the exact spot where you germinated or were planted, come what may: pounding rainstorms, prolonged droughts, ice and snow loads, searing heat, bitter cold, powerful winds, lightning [yikes], fires, insects, diseases, fungi, vines, toxins in the air and in the dust on your leaves, damaging birds (e.g., woodpeckers) and animals (e.g., porcupines, beaver, deer, and others), and people—especially indifferent, uncaring people who do not understand all that trees do for them. A tree, any tree—in a vast forest, an apple orchard, an evergreen plantation, a walnut grove, or along a busy street—must have *Sisu* (the Finnish term for strength, patience, stoic determination, and perseverance). And all trees do.

With luck, and perhaps some divine intervention, trees may come into association with caring, nurturing people who understand and honor their unique and essential place in Creation. John Burroughs (1837-1921)[1] was such a person.

> "To me, nothing else about a tree is so remarkable as the extreme delicacy of the mechanisms by which it grows and lives, the fine hairlike rootlets at the bottom and the microscopic cells of the leaves at the top. The rootlets absorb the water charged with mineral salts from the soil, and the leaves absorb sunbeams from the air. So it looks as if the tree is almost made of matter and spirit, like man." (*Under the Maples*, 1921)

We all can emulate John Burroughs, Wangari Maathai, and countless other conservationists. It happens that April is the perfect time of year to begin this new (hopefully lifelong and intergenerational) avocation. In the northeastern U.S., the time period from Arbor Day (April 22) to Mother's Day (the 2nd Sunday in May), plus or minus a few weeks, is an excellent time to plant a tree. An addendum to this essay will provide some practical information and web resources about different types, sizes and sources of trees, planting methods, watering and fertilizing, and other considerations to help them grow and thrive. The starting point is simply asking "how can I add ecological value and beauty to our world by planting and caring for trees?"

Evergreen trees — Commonly planted in Canadian and northern European cities, evergreens are relatively rare in northeastern U.S. cities and suburbs. After two or three years of establishment, many pine, spruce and fir species will thrive and provide year-round interest and habitat value (especially for birds who need a place to escape from the wind, rain and snow or to rest in the sun on bright winter days). Evergreen trees are also the most effective species at reducing urban runoff.

Flowering trees — Most commercial nurseries and garden centers offer a wide range of flowering trees. Flowering crabapple, dogwoods, hawthorns, and many other species tend to be moderate in size at maturity. Their spring display grows lovelier year by year. They also add ecological value as excellent nesting sites and prized food sources for many fruit-eating birds.

Fruit trees — Nurseries and old-school mail order [now internet] sources offer a wide range of disease- and pest-resistant, and frost hardy varieties of apple, peach, and pear trees that will thrive in the Northeast. Dwarf varieties mature to stepladder height; semi-dwarf varieties require a larger ladder or a pole with a picking basket. These trees require some pruning and care, but this work is rewarded with tree-ripened fruit that exceeds all but the best Farmer's Market or off-the-beaten track roadside stand for flavor, wholesomeness, and color. With the exception of years with a severe late frost, you will have enough fruit to eat, freeze for smoothies and baking, use for jam or preserves, *and* give to grateful friends and neighbors. You can do it! Web resources, a short guidebook or two, simple tools and a little quiet work are all that's needed.

2% Per Year List

1. Reusable shopping bags
2. Drive rationally
3. Don't "burn" electricity
4. Be frugal
5. Active Hope
6. Diligent recycling
7. Abhor food waste
8. Trees!
9. *…the list is growing!*

Deciduous/shade trees — The oaks, maples, birches, gums, sycamores, and other less common "hardwood" species will quickly grow to impressive sizes (when reasonably well matched to the site and soil where they are planted). They cast shade during the summer, keeping your house, deck or patio cooler, then allow the sun to stream through during the late-fall, winter, and early-spring. Most of these species also provide valuable food and habitat for wildlife. Also consider willows, hickories and walnuts, larch (a deciduous conifer) and alpine evergreens …just a tiny fraction of the more than 60,000 tree species on Earth.

"So, I said to the women, why not plant trees? Let's plant trees!" Wangari Maathai, 1977

[1] http://www.catskillarchive.com/jb/index.htm and http://www.johnburroughsassociation.org/