The Garden Plot, September 2009
By Robin Mittenthal, University Apartments Community Gardens Committee

Possible garden tasks for September: This is mostly a harvest month, but there are still some crops you can plant, particularly radishes and small turnips, spinach, lettuce, and other salad greens. So far, this summer has been one of the coldest in 30 years in Wisconsin, but September can be warm, and you may need to keep watering if it does not rain. Even so, cold weather is not far away. If you take the time to make a cold frame (a simple miniature greenhouse), you can plant cold-tolerant greens such as spinach and tatsoi inside it this month. As the cold weather comes, your cold frame will keep these plants growing, possibly into December. The cold frame will also help them continue growing early next year, perhaps in March. See the garden manual available at http://www.eagleheightsgardens.org/tips/gardenmanual.shtml for more information about cold frames and other gardening basics.

News from the Eagle Heights Garden Committee July meeting: A geography graduate student named Emma is studying the gardens and wants to send a survey out to all gardeners. The committee approved the idea, and gardeners are encouraged to complete the survey when it arrives by e-mail.

There is now no waiting list for plots, and in fact there are some plots open – if you are interested, just complete and submit the application at http://www.eagleheightsgardens.org/plots/plot_info.shtml#applications.

I (Robin) was approved as the new Chair of the Garden Committee, and will try to serve the gardens well. Then, there was a discussion of the issue of using the herbicide glyphosate to manage weeds in some parts of the gardens. While we have decided not to do this, the non-chemical measures gardeners are taking to control the weeds are causing soil erosion, so some other solution(s) need to be found. If you are willing to join a subcommittee to help with this, please e-mail me at mittenth@gmail.com.

Last month's column talked about *which* nutrients plants take out of the soil. This month, I'd like to discuss exactly how plants get these elements from the soil into their roots.

For starters, it's important to understand what soil *is*. About 95 to 98 percent of the soil beneath our feet is basically tiny chunks of rock. These chunks of rock contain many different chemical elements, but the vast majority of the weight of the rock is made up of oxygen (which plants need but don't get from the soil) along with aluminum and silicon (neither of which plants need, though some plants do accumulate silicon). While some of the nutrients plants need *are* present in rock, those nutrients are present at higher concentrations in the organic matter (pieces of formerly living things, like plant stems and insect bodies) that makes up the other 2 to 5 percent of the weight of soil.

Unfortunately, none of the nutrients present in either rock or organic matter are directly available to plants. Jethro Tull (1674-1741), an early agricultural researcher, thought that plant roots had tiny mouths that they used to "eat" soil. This turned out not to be true, and plants have no way to take actual soil (rock or organic matter) into their tissue. Instead, they have to wait for nutrients to be released from the rock or organic matter in very small, chemically simple forms.

In the case of nitrogen, for example, nitrogen atoms that in a living animal are built into protein molecules containing hundreds or thousands of atoms must be broken off of these molecules (usually by the feeding of bacteria or fungi) such that they are present in the soil in very small, simple forms – most often the molecules NH_4^+ (ammonium) or NO_3^- (nitrate). With minor exceptions, these are the only forms in which plants can take up nitrogen. The story is pretty much the same for each of the other elements plants get from soil. That is, big molecules in rock or organic matter must get broken down by physical, chemical, or biological processes so that just the right small molecules or even atoms are present in the soil. For some elements like phosphorus, there's only a very narrow range of soil conditions under which this happens, so these elements are ones that are most likely to be in short supply for plants.

Unfortunately (again!) having the right small nutrient molecules present in the soil isn't enough. Just as a soccer ball must be moved by a soccer player to make a goal, a significant amount of water must be present in soil to carry nutrient molecules to (and then into) roots. Plants drink their nutrients – they don't eat them!

Even if nutrients are present in the right forms with plenty of water, I still haven't said exactly *how* those nutrients get into plants. At one level, that's really complicated – it involves elaborate protein "machines" built into the walls of the cells that make up plant roots. It also involves some chemistry and physics that I myself didn't cover until graduate school.

At another level, though, the way plants take up nutrients is simple, resembling the workings of a common children's toy. Many small children I know have boxes with different shapes cut into the sides. A box like this comes with a set of blocks whose shapes match the shapes cut in the box. The protein "machines" that transport nutrients through the surface of a root are like the specially shaped holes in the box, and the nutrients are like the blocks – all the child (or plant) has to do is find the right block (or molecule) to go through the right hole.

One difference between children and plants is that while a child might struggle for a minute to find the right hole for one block, plants can move thousands or even millions of nutrient atoms or molecules through a single transporter in seconds (they also have millions of transporters). Another difference I've already mentioned is that while a child uses its fingers to bring the block to the hole and push it through, plants rely on water to carry nutrient atoms or molecules up to and through nutrient transporters.

My analogy to the child's toy may make it sound like plants don't make mistakes (my son's box will only allow each block through a single hole), but some nutrient transporters are actually not all that specific. A few, like the one that moves the essential element zinc, also unintentionally pick up elements like cadmium, which is quite toxic to humans. This is one of many reasons to keep lead, cadmium, and other metals out of our gardens and farm fields.

Hopefully, I've now successfully explained the basics of how plants take up nutrients. Next month, in the last of four columns about how plants and soil interact, I'll talk about how plants get *enough* nutrients into their roots to grow well.