

Quiz Questions—Week 4

Forests Through Time and Space

1. *“Create your own reality” was a common phrase during the 70’s and 80’s. After reviewing soil-forming processes, it is evident that plants were hip to this scene a long time ago and are continually creating better conditions for themselves. Explain how they do this, be sure to cover processes that capture or retain nutrients as well as those that release, increase availability of and/or form nutrients.*

Plants modify their environments in many different ways. In order to receive full credit for your answer, you need to have included at least five of the following.

Plants deposit organic matter on both the soil surface and in the upper layers of the soil (roots and exudates). As this organic matter is broken down, nutrients are released into the soil which the plant can then take up. In addition, as the organic matter decomposes it forms organic acids which are involved in chemical weathering thereby increasing the overall nutrient supply. Organic matter in the soil in temperate zones increases the CEC of the soil which will increase nutrient retention within the soil profile. Plants also act as “nutrient pumps” bringing nutrients from deep within the soil profile and depositing them in the upper soil where they are more readily available for recycling. Plant respiration in roots releases CO₂ that then dissolves to form carbonic acid. Carbonic acid can act directly as a chemical weathering agent, dissolving nutrients from parent material into the soil solution where the plant can get them. The H⁺ from the carbonic acid can displace cationic nutrients from CEC sites, making these exchangeable nutrients available to the plant. Plants release H⁺ directly from their roots to maintain charge balance as they take up cations. These H⁺ act the same way to release nutrients from CEC sites. Plants also can speed physical weathering by breaking parent material down with roots. Plants improve soil structure by binding soil into aggregates that provide more pore space which increases gas exchange and drainage, thereby improving plant growth. Many plants form symbiotic relationships with nitrogen-fixing bacteria. Plants also release root exudates that can promote the growth of free-living nitrogen-fixing bacteria. These represent new inputs of nitrogen into the ecosystem, making more available for the plants. Mycorrhizal associations also improve conditions for the plants. By feeding the mycorrhizal fungus with sugar, the plant gets phosphorous and other nutrients that are difficult for the plant to obtain on its own.

2. *Tropical rainforests contain significantly more biomass than temperate forests. When temperate forests are cleared and converted to agricultural uses, it usually results in productive farms with fertile soils. However, when tropical forests are cleared and converted to agricultural uses, the soils are not very productive. Explain.*

Both temperate and tropical forest ecosystems rely heavily on recycling of nutrients from biomass to support NPP. Due to a variety of factors, nutrients in temperate forests are stored both in the biomass and in the soil whereas the majority of nutrients in tropical forests are stored in the living biomass. Clearing temperate forests leaves behind a soil that contains a great deal of nutrients stored as living microbial biomass, stored on CEC sites, and stored as undecomposed or partially decomposed organic matter within the soil. These rich soils contain lots of nutrients that are available for crops. In tropical forests, the living biomass contains the vast majority of the nutrients. When organic matter falls to the soil surface, it is rapidly decomposed and the released nutrients are rapidly taken up by living plants. Due to the high rate of decomposition and chemical weathering, the heavily weathered tropical soils don’t hold or contain many nutrients. Removing the trees and other biomass effectively removes the nutrients from the system. Thus, there aren’t many nutrient for use by agricultural crops in areas where the forest has been cleared.