Te Hōnonga a Iwi
Restoring Rosedale Park

Education Resource
Matt Cummings

Engine of ecology:
How carbon drives the health of our natural environment

Brightstar

Soil is a living thing — it is a complete and self-sustaining ecosystem, alive with organisms such as worms and insects, and microorganisms such as fungi, bacteria and other organic matter.

Carbon is the main element present in soil organic matter — it's usually referred to as organic carbon. Organic carbon influences the characteristics of soil including, colour, its ability to hold water and nutrients, nutrient cycling and availability and water infiltration and aeration. It is a vital component of a productive natural environment.

The carbon cycle

How does carbon get into soil?

The organic carbon that is present in our soil has come out of the atmosphere. Hundreds of millions of years ago, our atmosphere was almost one per cent carbon dioxide – today it is only 0.042%.[1] Over time, the process of photosynthesis has sequestered that carbon into our soil and biomass (organic matter).

How is carbon released from soil?

There are two main processes that release carbon from the soil.

Cell respiration – this is essentially the process by which living organisms, including microorganisms such as bacteria or fungi, create energy in their cells. Part of this process is releasing – "breathing" or "exhaling" – carbon dioxide into the atmosphere. This is an organic living process – respiration is one of the requirements for an organism to be categorised as alive.

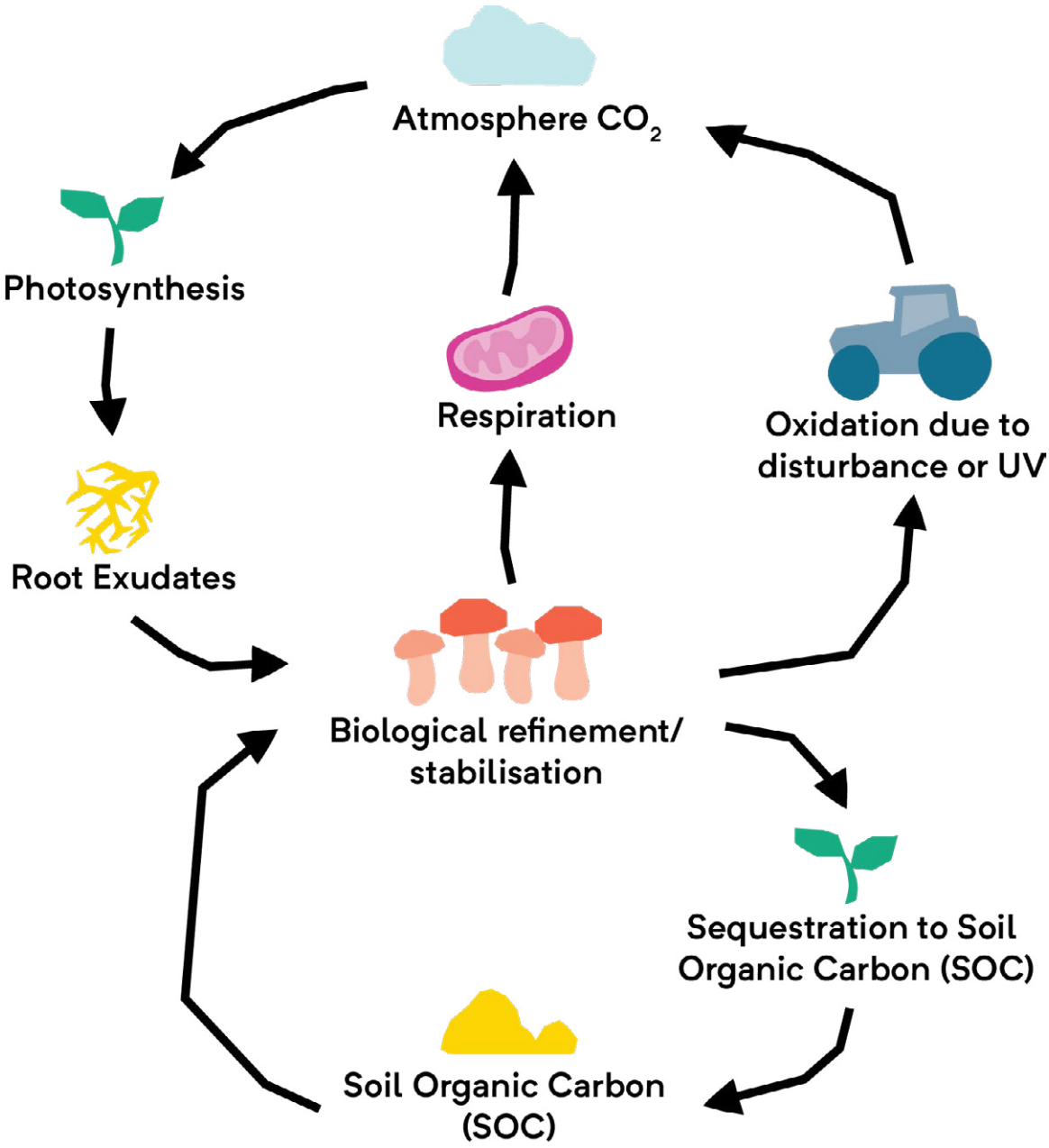
Oxidation – the inorganic process that releases carbon dioxide into the atmosphere happens when organic matter is burned, or when soil is exposed to light through natural events such as landslides, or by human activities such as agricultural practices.

1 earth.org/data_visualization/a-brief-history-of-co2/

More carbon in than out

Over time, given natural conditions, photosynthesis is more prevalent than respiration or carbon release from soil exposure so organic carbon builds up, "growing" healthy soil and sustaining the environment.[2]

2 www.ncbi.nlm.nih.gov/pmc/articles/PMC6524366/

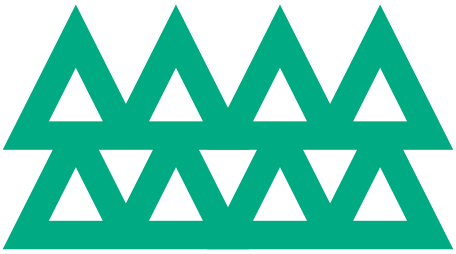


What's required for photosynthesis and how can it be promoted?

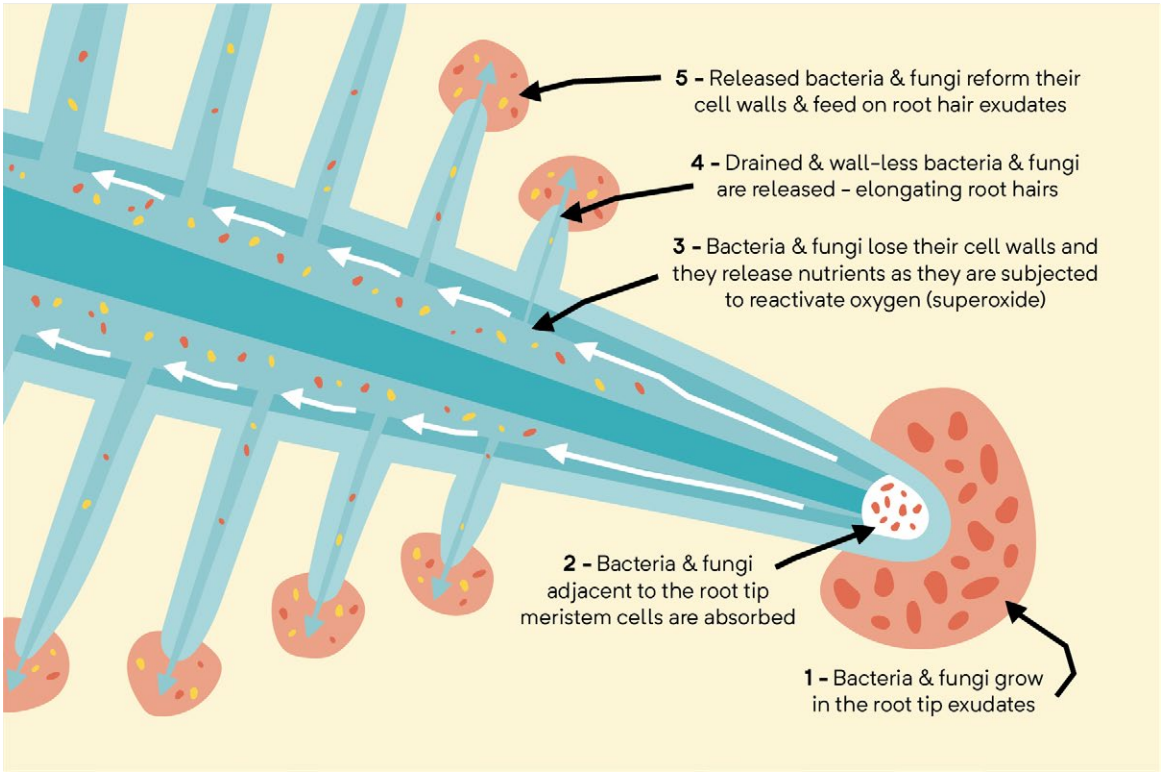
Photosynthesis is a complicated and only partially understood process, with many steps and conditions. But we do know it can only happen when there are sufficient materials and electrical charges accessible by the cell, and it can happen more and more efficiently when those supplies are in certain forms, compared to how they might otherwise be found. So if we're going to try to promote this process, we need to help plants get those supplies easily, and keep unhelpful things from interfering. Then we'll be able to make quick progress in siphoning carbon out of the atmosphere to build beautiful rich soil.

Plants take up nutrients in three main ways, depending on their species and function in the ecosystem:

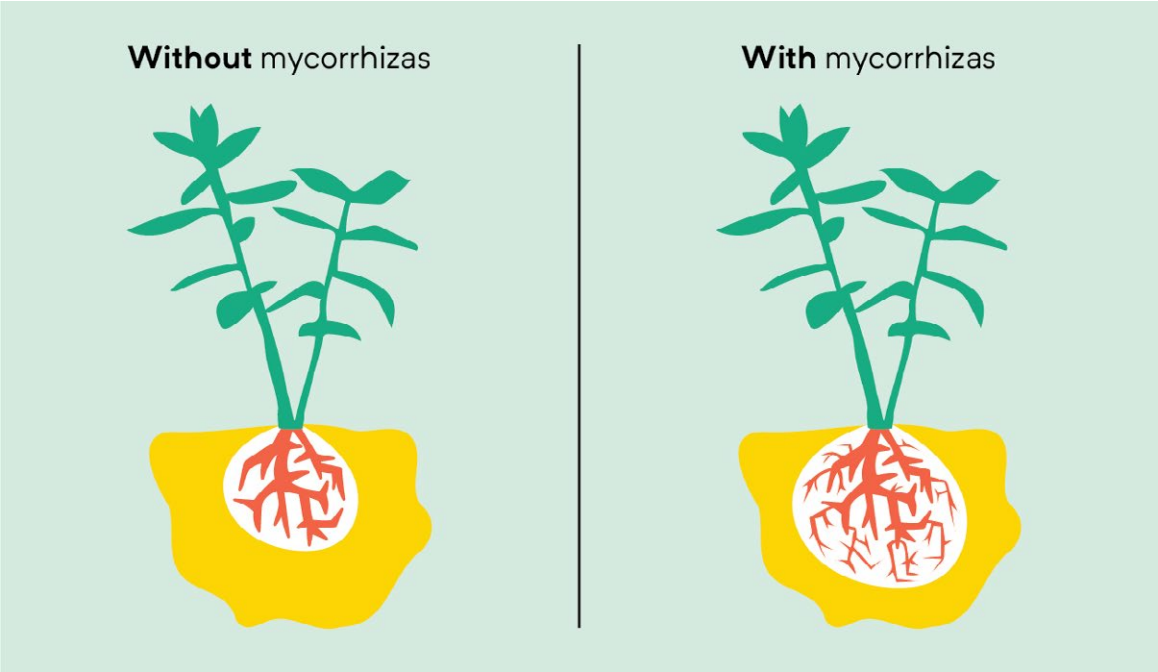
Absorption: Soluble nutrients (minerals) in rainwater or ground water can be absorbed by the root hairs that project from the surface of the root. Nutrients can also be absorbed through a plant's stomata (tiny openings on the leaves), without ever passing through the soil. We can take advantage of this process to directly feed a plant, avoiding negative side effects on the soil microbiome (many nutrient applications are harmful for soil). A successful strategy for moving from conventional land management to a regenerative approach has been to use carefully tailored "foliar sprays" of nutrients to promote high levels of photosynthesis – even in areas of degraded soil. The plants then set about repairing the soil with enthusiasm, pumping "photosynthates" (ie, food for microbes) down through their roots. This has resulted in remarkable turnarounds in soil carbon and ecosystem health, without disruptive applications of 'fertilisers' to soil.



Rhizophagy cycle: Scientists have only recently discovered this process that plants use to extract nutrients from microbes. From a farmer or gardener's perspective, it reduces work as the plant organises its "flock" of bacteria to provide exactly what it requires, without any help. This is a natural process and is the desirable long-term solution to supporting photosynthesis – but it only happens efficiently when soils are healthy and have enough carbon. Bacteria cluster in the plant's root zone and are then enveloped by the root. Once inside the root, the bacteria are stripped of their cell membranes (which contain proteins, carbs and fats — nutrients the plant needs that are already in organic form). The plant keeps the membranes and expels the bacteria. As part of that ejection process, the plant provides the bacteria with a chemical signal that makes them grow another membrane, and the process repeats. Incredible!



Fungi friends: Mycorrhizae (myco – fungi, rhizae – roots) are beneficial fungi that grow in association with a plant's roots. They exchange sugars from the plant for moisture and nutrients gathered from the soil by the fungal strands. Among other less understood functions, such as communication and networking between plants, the mycorrhizae greatly increase the absorptive area of a plant, acting as extensions to the root system and creating more 'pipelines' for nutrients to transfer from the soil to the plant.



How we worked with these natural cycles at Te Hōnonga a Iwi Restoring Rosedale Park

At our restoration, we haven't had the resources or inclination to use foliar sprays, as the project's been about more than just restoring the land. Community development and education have been key pieces, so we've opted for a slower, but more natural and accessible approach to repairing the soil:

We directly incorporated organic matter with lots of plant friendly microbial life (aerobic compost from Untangled, and from our bioreactors) into the planting area to improve the soil organic carbon percentage in the rhizosphere (root zones) of our plants. This promoted rhizophagy, meaning that our plants should be able to feed themselves forever.

We invested in mechanical clearance and didn't spray herbicides on the weeds or add any inorganic fertilisers that would have made those same root zones uncomfortable for fungi, in particular. This creates an opportunity for any mycorrhizal spores surviving dormant in the soil (spores can lie dormant for thousands of years) to respond to root signals, germinate and connect with our natives.

We amped up the diversity and density of plant life by sowing cover crops inoculated with compost. The cover plants are 'pioneer' species, adapted to photosynthesise reliably in poor soils. They pumped energy (carbohydrates and proteins) and carbon into the soil on a large scale, created a huge amount of biomass above ground and suppressed weeds on the site, which would have otherwise resprouted. We made sure to choose species which wouldn't stick around and present a new weed issue in future.

Now that you have a basic understanding of how the carbon cycle works and the pivotal role photosynthesis will play in our future, get some tips on how to harness the power of these natural processes in your home garden. Find out more on our Resources page.

This education resource was produced with generous support from

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