GROW FOR LIFE
Gardening Class

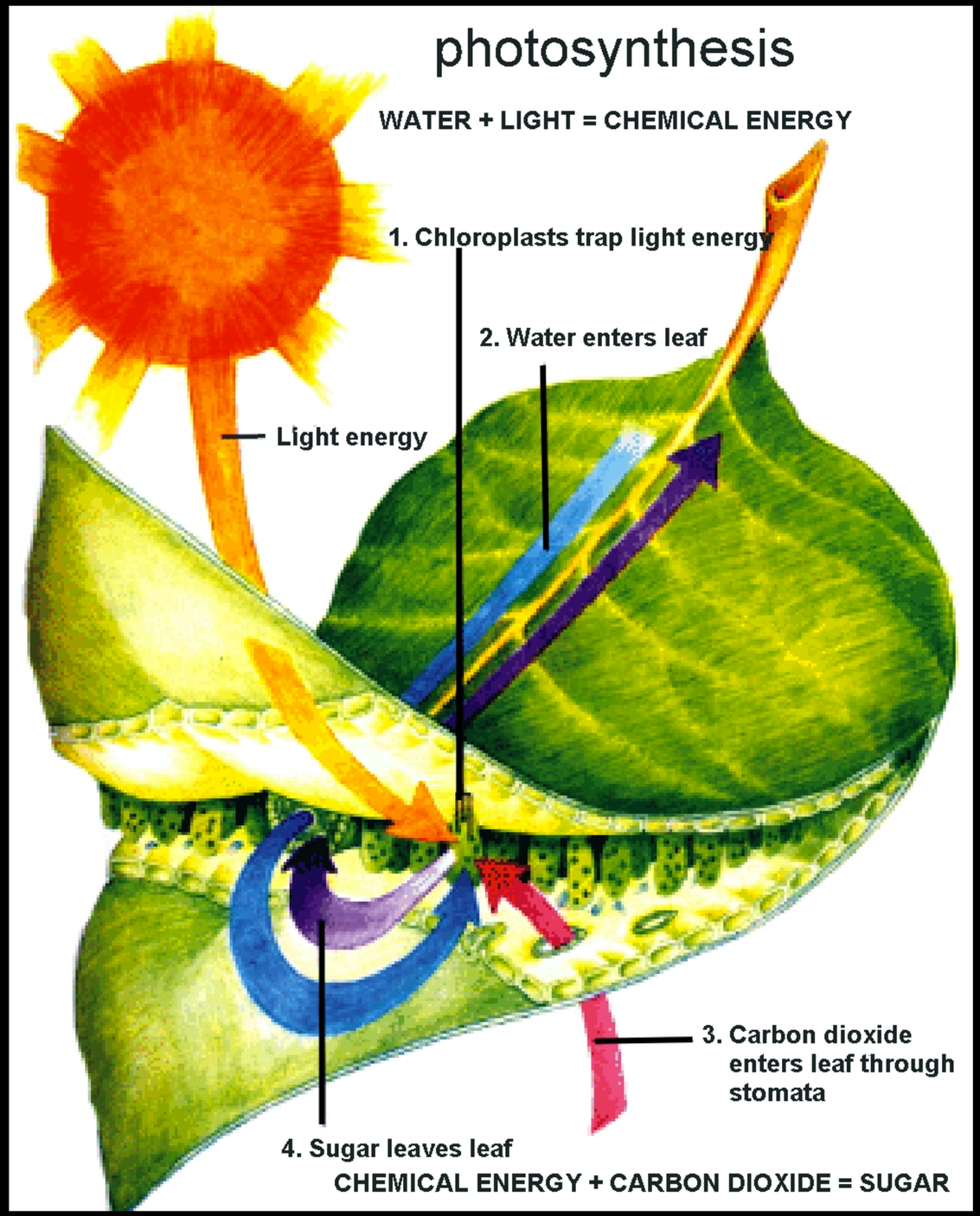
FUNDAMENTALS OF HOW PLANTS WORK AND SOIL WORKS

What plants need in order to grow

- Sun
- Water
- Minerals
- Soil

Sun

1. Process of photosynthesis
2. photosynthesis > water and co2 splitting into glucose
3. nitrogen in the plant is converted to a complete protein


photosynthesis
WATER + LIGHT = CHEMICAL ENERGY
1. Chloroplasts trap light energy
2. Water enters leaf
Light energy
3. Carbon dioxide enters leaf through stomata
4. Sugar leaves leaf
CHEMICAL ENERGY + CARBON DIOXIDE = SUGAR

Water

1. Needed for seeds to sprout
2. Plant tissue is up to 95% water
3. Carries nutrients throughout the plant

Minerals

- For photosynthesis, Plants require adequate levels of magnesium, iron, manganese, nitrogen, and phosphorus

Minerals

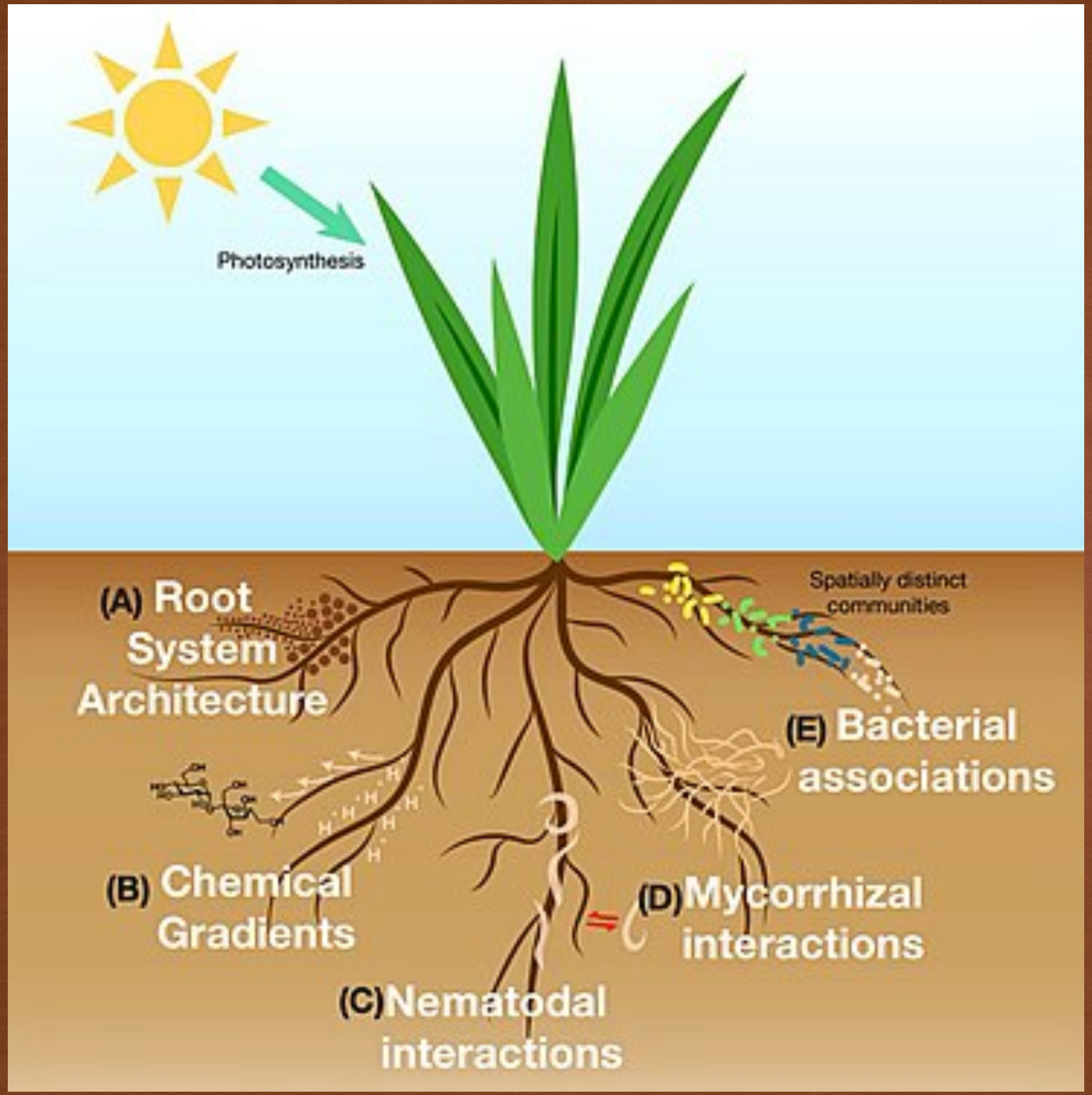
- Plants require adequate levels of magnesium, sulfur, and molybdenum to do protein synthesis which convert Nitrogen into proteins.

Minerals

- **Example: Photosynthesis makes glucose but plants upload sucrose to the sap. So, in a healthy plant, sap sugar is sucrose. An enzyme in the cell converts glucose to sucrose. That enzyme has a manganese in the center. You have a phosphorus and manganese deficiency. Take away the food of the insect and they go away.**

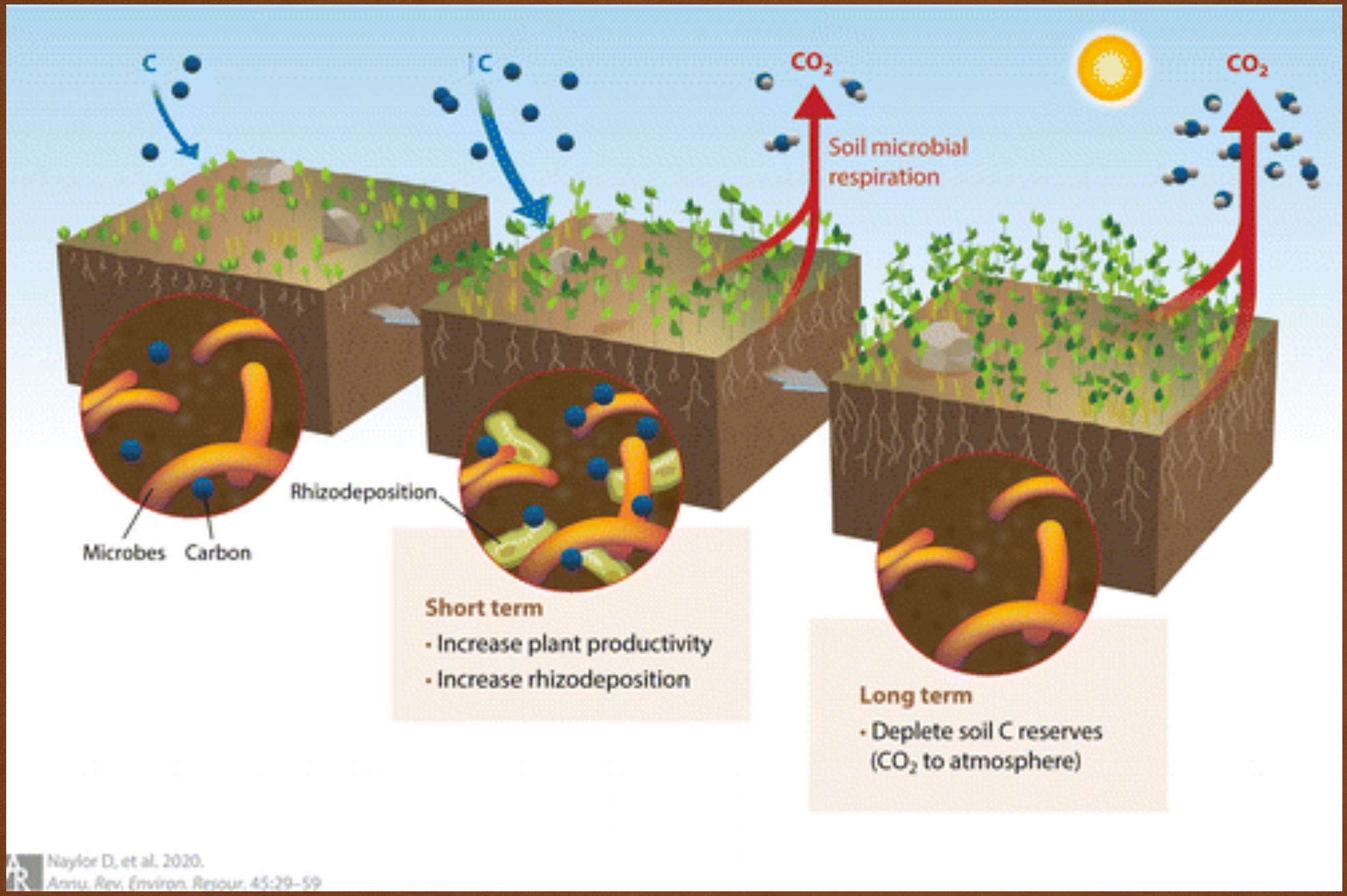
Soil

- **Soil is how plant primarily get minerals, water, and nutrition in the form of microbial metabolites which are amino acids.**


Photosynthesis
(A) Root System Architecture
Spatially distinct communities
(E) Bacterial associations
(B) Chemical Gradients
(D) Mycorrhizal interactions
(C) Nematodal interactions

Soil

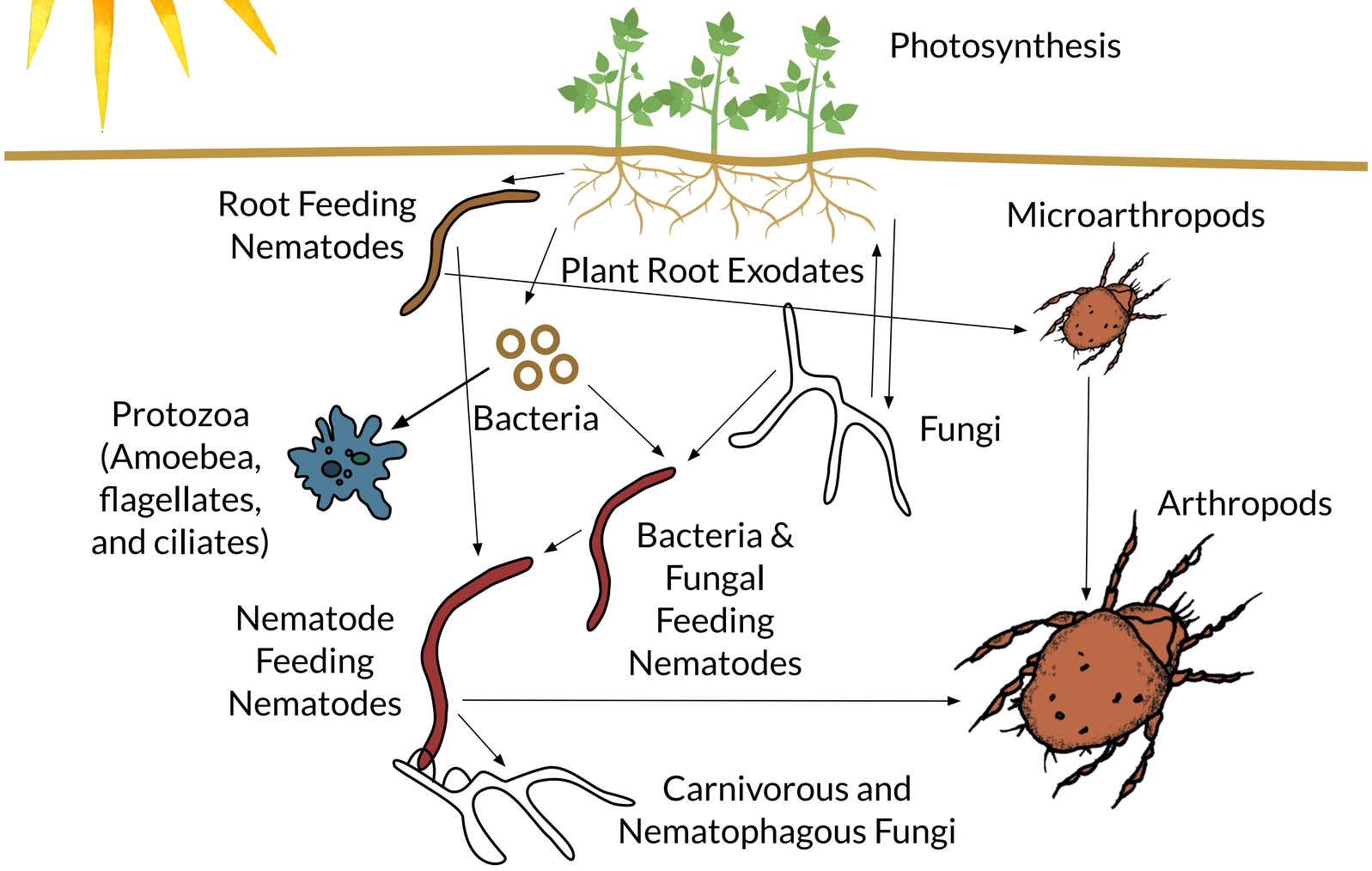
- In order for plants to get access to minerals in the soil that are not already water soluble, they exude sugars and proteins into the soil which are food for bacteria and fungus. This increases the population of bacteria in the soil which then go about eating organic mater in the soil breaking it down releasing CO2 and then nematodes come along and eat them and poop out minerals in a plant available form. This happens in the area right around the plant roots called the rysosphere.



Naylor D, et al. 2020.
Annu. Rev. Environ. Resour. 45:29–59

Biology

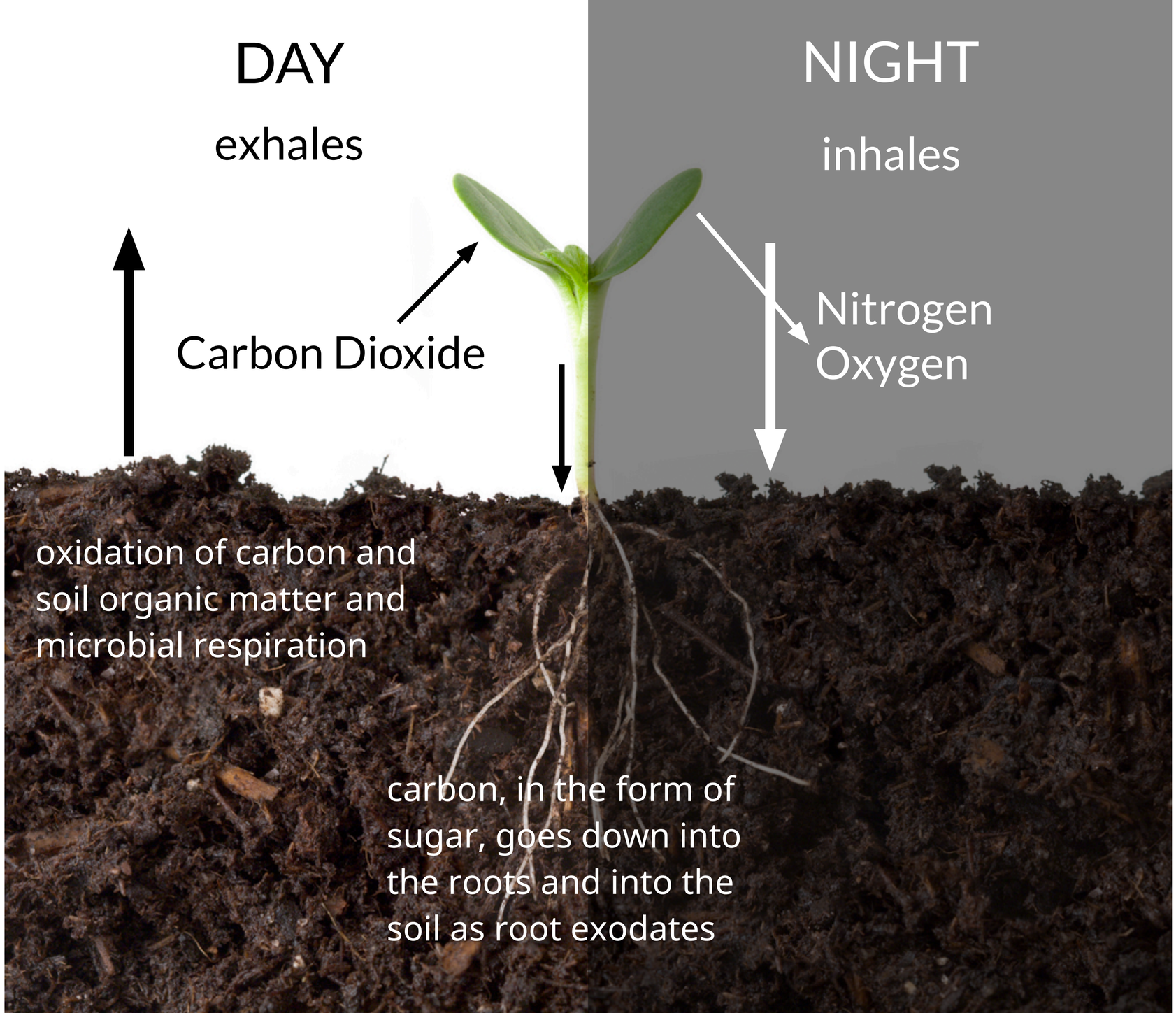
The Soil Food Web



Carbon Dioxide

The air we breathe has

Nitrogen, N_2	**78.08%**
Oxygen, O_2	**20.95%**
Argon, Ar	**0.93%**
Carbon dioxide, CO_2	**0.033%**
Neon, Ne	**0.0018%**
Helium, He	**0.00052%**
Methane, CH_4	**0.0002%**
Krypton, Kr	**0.00011%**
Dinitrogen oxide, N_2O	**0.00005%**
Hydrogen, H_2	**0.00005%**
Xenon, Xe	**0.0000087%**
Ozone, O_3	**0.000001%**


DAY
exhales
NIGHT
inhales
Carbon Dioxide
Nitrogen
Oxygen
oxidation of carbon and soil organic matter and microbial respiration
carbon, in the form of sugar, goes down into the roots and into the soil as root exodates

Carbon Dioxide

We want carbon in the soil
so we can loose it as CO2

Mineral Availability

To photosynthesize, plants require adequate levels of magnesium, iron, manganese, nitrogen, and phosphorus.

Soil Principles

We want to keep the soil moist

but not too much water.

Soil Principles

Remove garbage and large rocks from the soil.

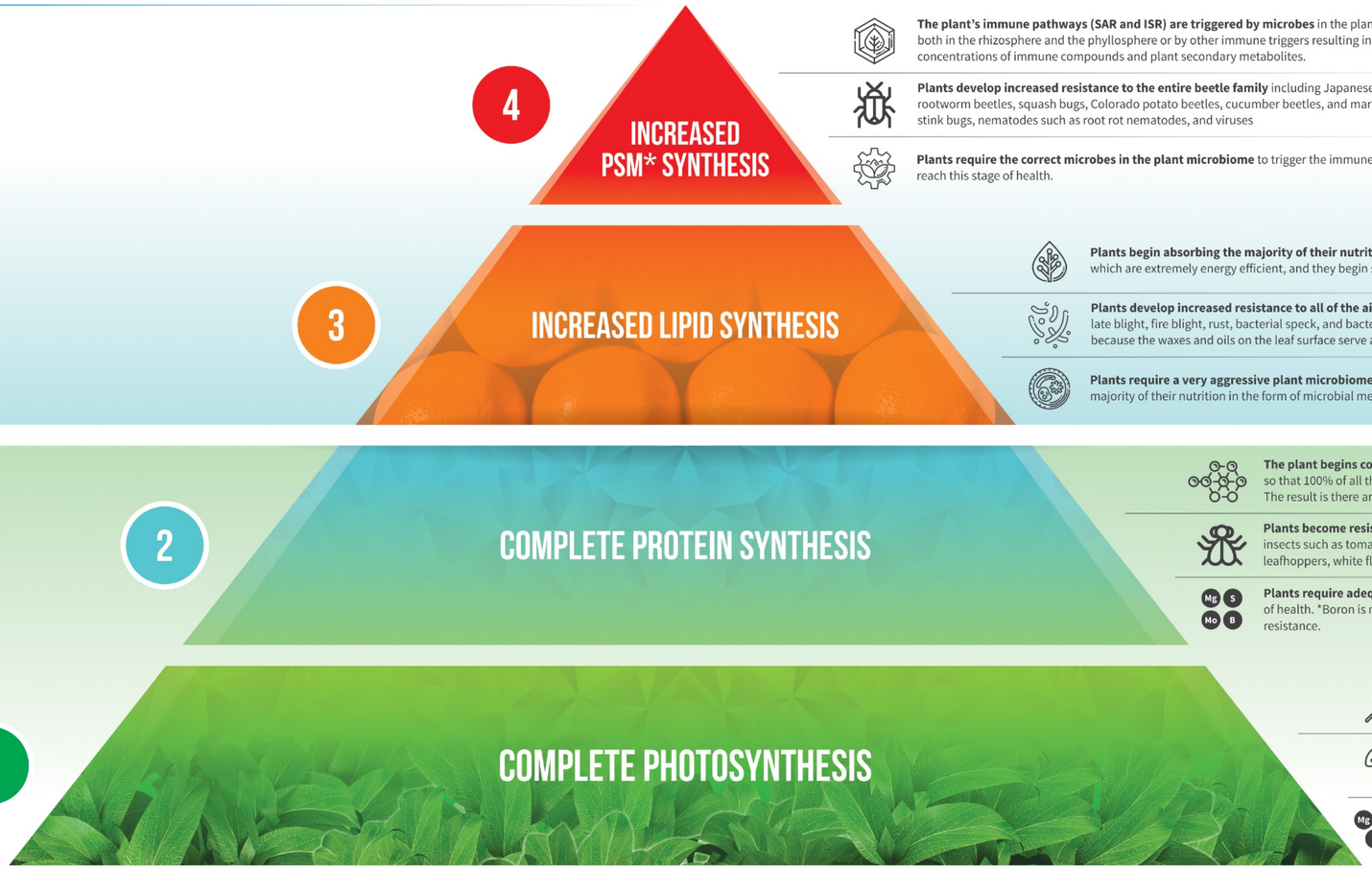
Soil Principles

The biology in the soil can provide 100% of the nutrient requirements of a plant as long as there is a healthy ecosystem of bacteria, nematodes, fungi, protozoa, worms, etc.

PLANT HEALTH PYRAMID

The upper 2 levels are **active immunity** and based on **vigorous biology**.

The lower 2 levels are **passive immunity** and based on **balanced chemistry**.



The plant's immune pathways (SAR and ISR) are triggered by microbes in the plant's microbiome, both in the rhizosphere and the phyllosphere or by other immune triggers resulting in increased concentrations of immune compounds and plant secondary metabolites.

Plants develop increased resistance to the entire beetle family including Japanese beetles, corn rootworm beetles, squash bugs, Colorado potato beetles, cucumber beetles, and marmorated stink bugs, nematodes such as root rot nematodes, and viruses

Plants require the correct microbes in the plant microbiome to trigger the immune response to reach this stage of health.

Plants begin absorbing the majority of their nutrition in the form of microbial metabolites which are extremely energy efficient, and they begin storing surplus energy in the form of lipids.

Plants develop increased resistance to all of the airborne fungal and bacterial pathogens such as downy mildew, powdery mildew, late blight, fire blight, rust, bacterial speck, and bacterial spot which land on the leaf surface and release peptolytic enzymes, because the waxes and oils on the leaf surface serve as a shield to prevent the enzymes from working.

Plants require a very aggressive plant microbiome in the rhizosphere to begin absorbing the majority of their nutrition in the form of microbial metabolites to reach this stage of health.

The plant begins converting all of the soluble nitrogen compounds to amino acids and complete proteins so that 100% of all the nitrogen in the plant is converted to a complete protein in every 24-hour photo cycle. The result is there are no nitrates and no ammonium remaining in plant sap in every 24 hour photo period.

Plants become resistant to insects with simple digestive systems, especially larval and sucking insects such as tomato horn worms, cabbage loopers, corn borers, corn ear-worms, aphids, leafhoppers, white flies, and thrips.

Plants require adequate levels of magnesium, sulfur, molybdenum, and boron* to reach this stage of health. *Boron is not directly involved in protein synthesis but contributes additional pest resistance.

The **volume of photosynthesis increases anywhere from 150-600%** and the carbohydrate profile changes to be composed of a high proportion of complex carbohydrates with low levels of nonreducing sugars in the plant sap.

Plants develop resistance to soil-borne fungal pathogens such as verticillium, fusarium, rhizoctonia, pythium, phytophthora, and others.

Plants require adequate levels of magnesium, iron, manganese, nitrogen, and phosphorus* to reach this stage of health. *Phosphorus is not directly involved in photosynthesis but is needed for photosynthate metabolism with the increased sugar production.

"Healthy plants can become completely resistant to diseases and insects."

- John Kempf -

AdvancingEcoAg.com