



THE MIRACLE OF SEEDS

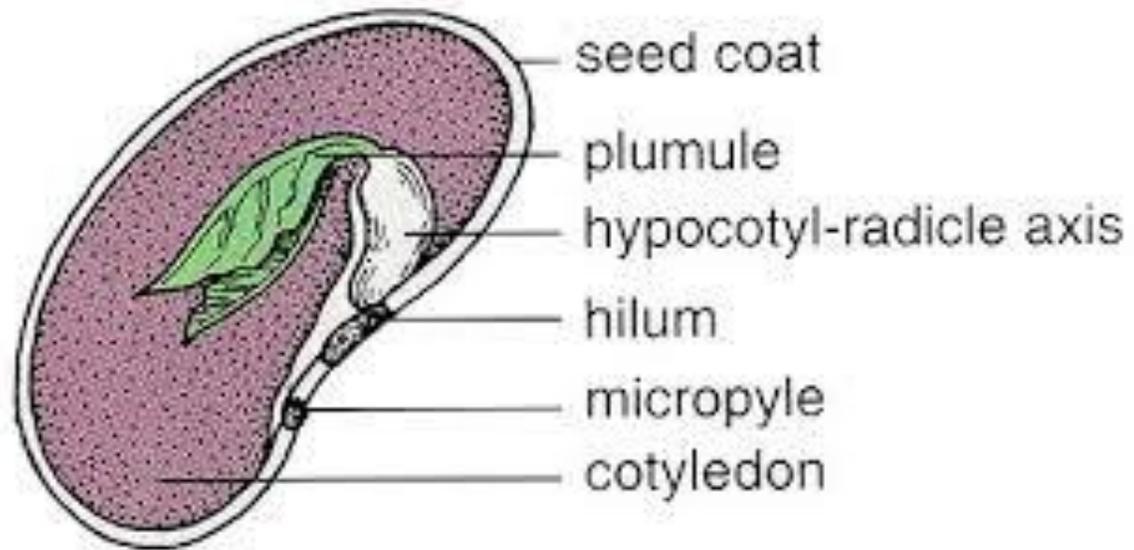
AND HOW TO GROW THE HEALTHIEST ONES

Connie Kuramoto - Gardens on the Go Horticultural Training and Services

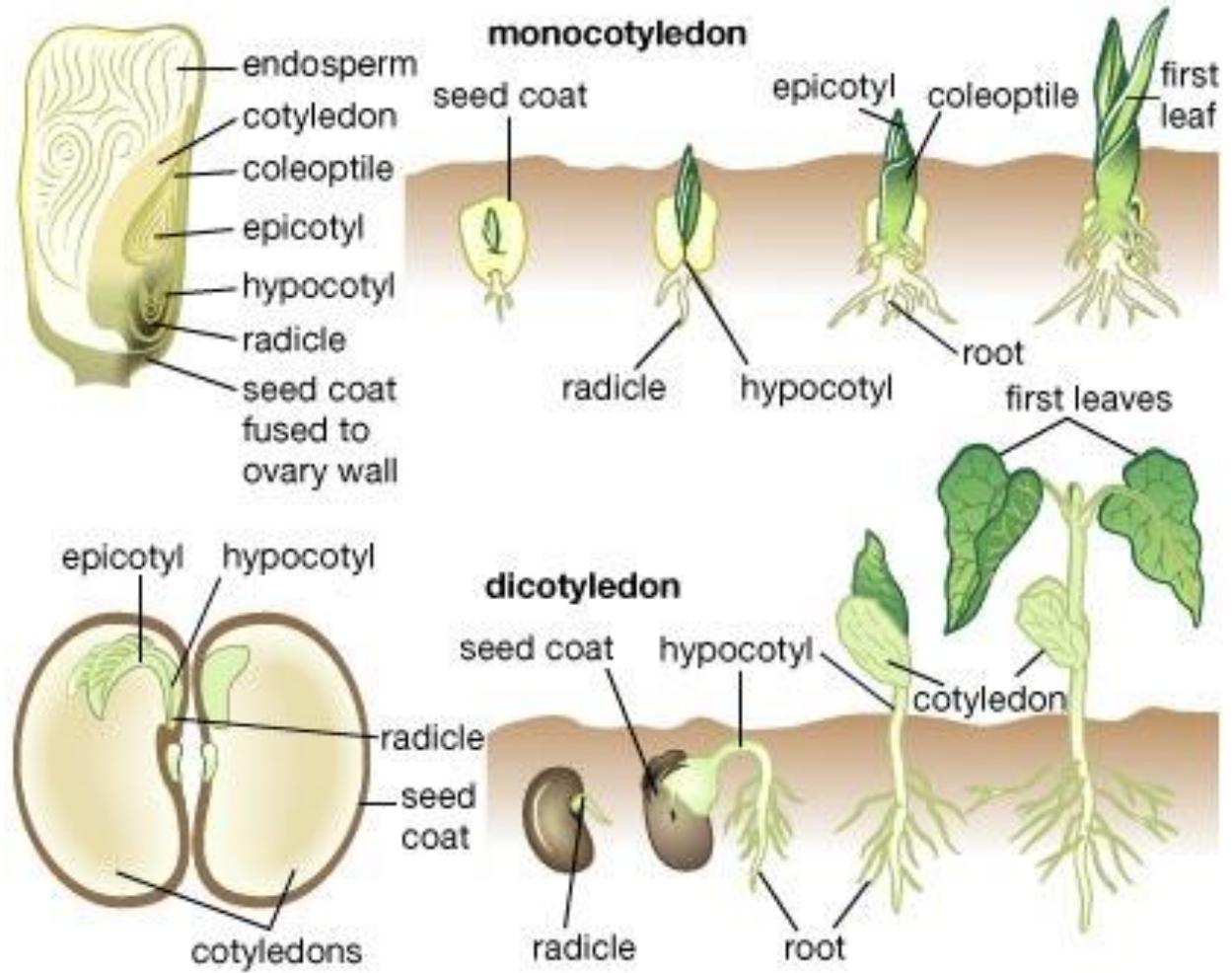


Topics Covered

- Importance of healthy seed.
- Importance of healthy soil.
- Three types of fertility and the most important factor in soil fertility.
- BRIX and how it relates to soil fertility and healthy seeds.
- Methods to healthy soil that will yield healthy plants and seeds with a higher BRIX.



THE SEED

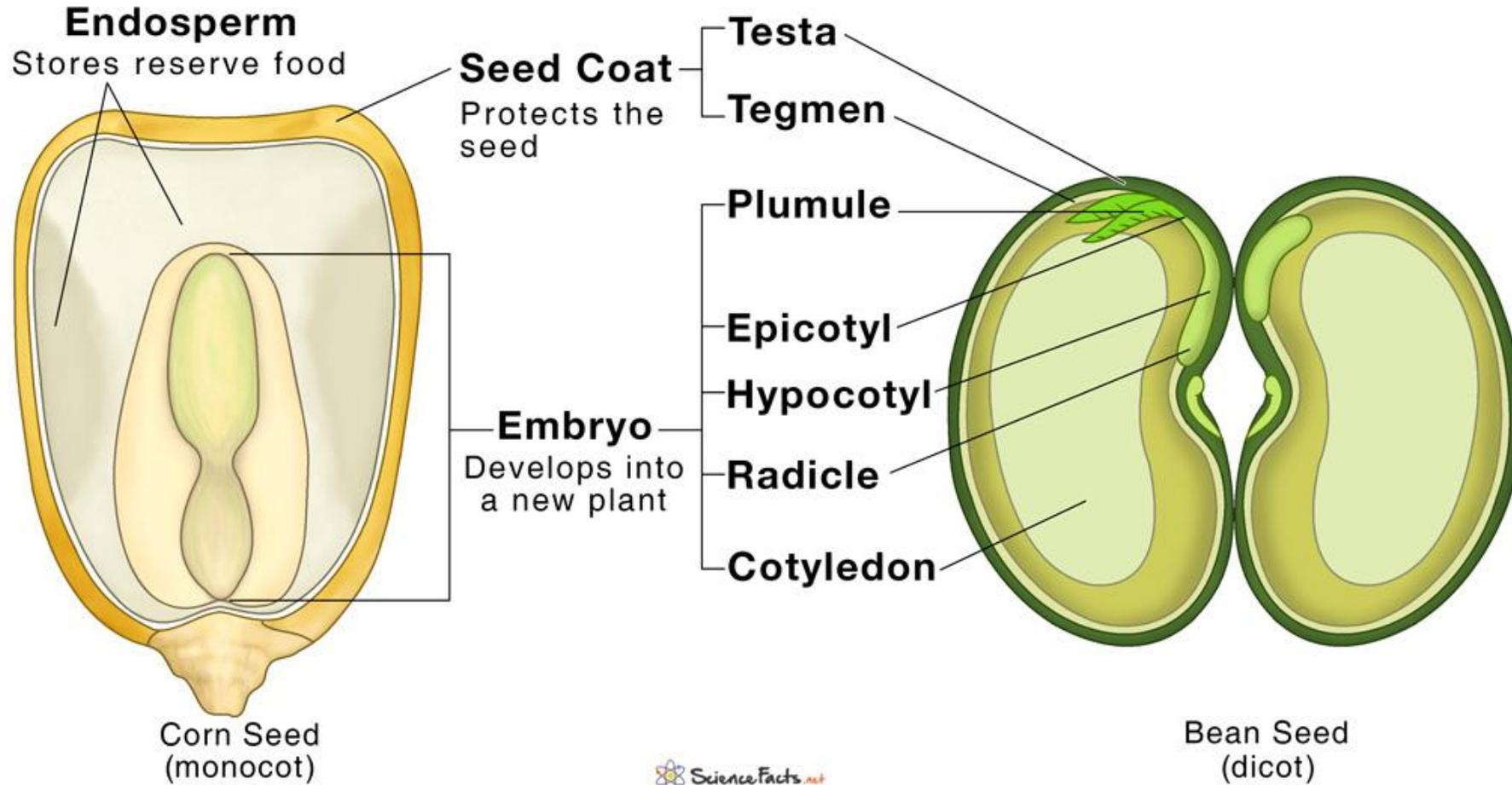


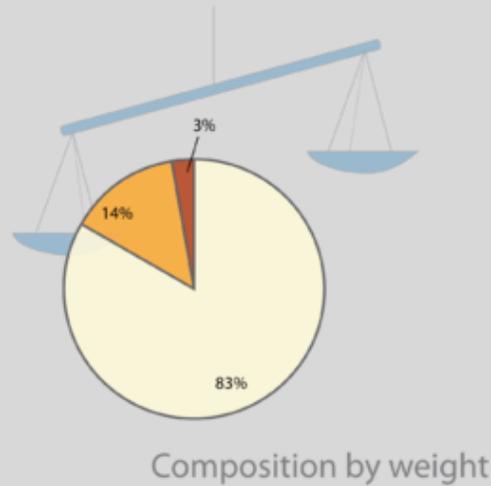
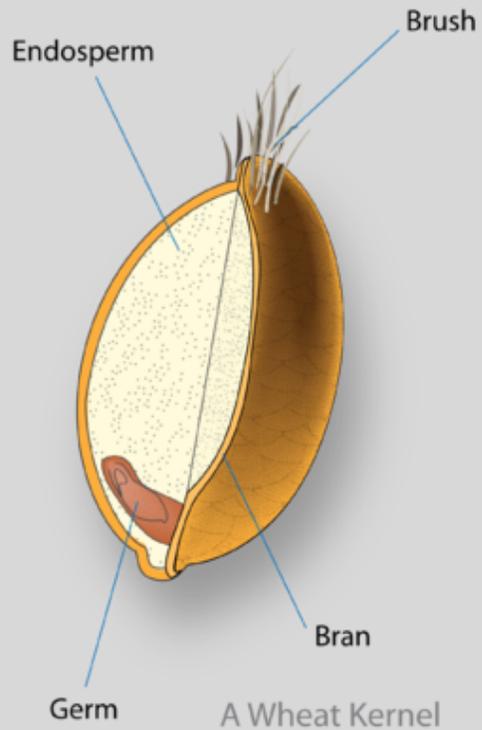
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Dicot, Monocot

- Monocot seeds have 1 seed leaf. They store food for the embryo in the endosperm of the seed.
- Examples are corn, wheat, rye, grass.
- Dicot seeds have 2 seed leaves. They store food in their cotyledons.
- Examples are beans, peas, cabbages, beets.

Parts of a Seed with Functions





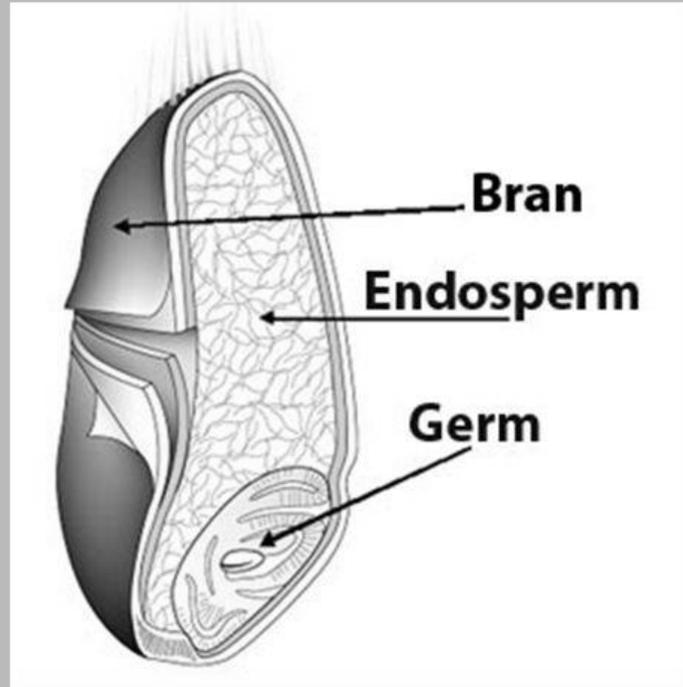
Endosperm

- Endosperm is a structure of a seed that stores nutrients.
- Nutrients may be stored in the form of starch, proteins or oils.
- These nutrients are used by the seed during germination to develop and grow the embryo.
- The starch, proteins, and oils of the endosperm is also food for humans and animals.

	Carb./g	Protein/g	Fat/g	Fiber/g	Iron (% daily req.)	Others
Bran	63	16	3	43	59	vitamin Bs
Endosperm	79	7	0	4	7	
Germ	52	23	10	14	35	vitamin Bs omega-3/6 lipids

Nutritional Value (per 100g)

GRAIN KERNEL



WHOLE GRAINS HAVE ALL 3 ELEMENTS

- **Bran** – *B Vitamins, Minerals, Protein, Fiber*
- **Endosperm** – *Starchy Complex Carbohydrates, Protein*
- **Germ** – *Vitamins B and E, Proteins, Unsaturated Fat, Iron, Zinc*

A close-up photograph of a white ceramic bowl filled with bright green, round peas. The peas are densely packed and fill most of the frame. A dark grey rectangular box with a thin white border is overlaid on the left side of the image, containing text.

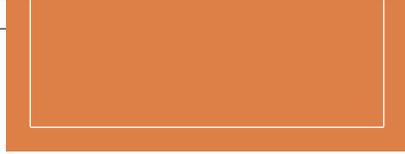
Endosperm is Important Human Food

- Endosperm is the most important plant product on Earth for humans
- Two thirds of all human calories come from consuming Endosperm.

Examples of Endosperm as Human Food

- Popcorn
- Corn
- Quinoa
- Rice
- Wheat
- Beans
- Peas
- Lentils
- Rye
- Oats





HEALTHY SEEDS

Characteristics of Healthy Seeds

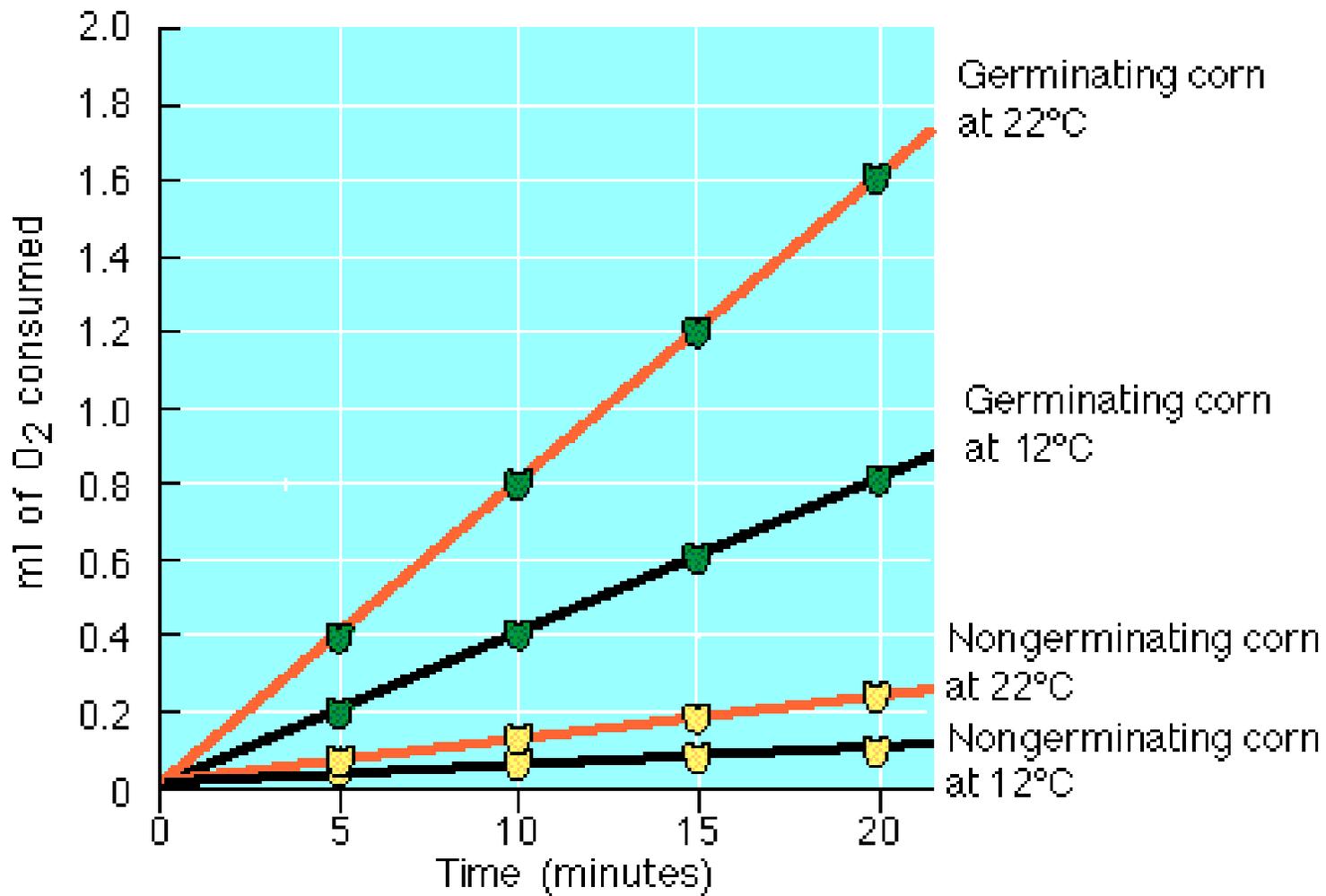
- **Viability**—what percentage of a batch of seeds will germinate?
- **Vigor**—how vigorous are the seedlings produced?
- **Size**—are the seeds large and fully formed?
- **Maturity**—did the seeds have what they needed to mature fully?





Seeds Store Food Energy

- Seeds have stored energy in the form of starch which feeds them until the leaves can begin the process of photosynthesis.
- Seed size, seed storage methods, and seed planting depth impact the process of germination because they affect the seeds energy stores.
- If a seed does not have enough stored food to push through to the light after germination it will not be able to begin photosynthesis before the food supply in the seed is exhausted.



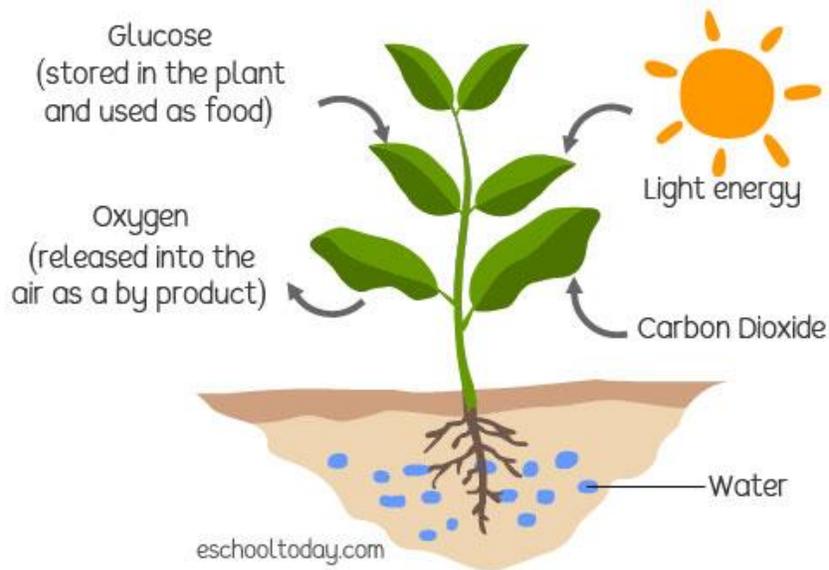
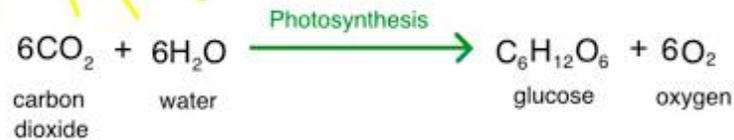
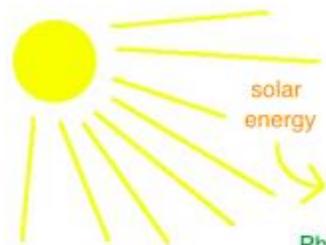
Seeds are Alive!

- The endosperm is food for the embryo of the seed.
- This food is used up by the embryo during seed storage.
- Keeping seeds cool during storage preserves more food for the seed at germination time.

A close-up photograph of a sunflower head, focusing on the central disk. The image shows the dense arrangement of small, yellowish-brown florets and the emerging seeds. The background is a soft, out-of-focus blue. A dark grey rectangular box with a thin white border is overlaid on the left side of the image, containing white text.

Healthy Mother, Healthy Offspring

To grow the healthiest,
most vigorous plants, you
must start with healthy,
robust seeds that have an
abundance of stored food
in their endosperm and
cotyledons.



Optimized Photosynthesis

- Plants manufacture glucose during photosynthesis, and then use it in a variety of life processes, including the manufacture of seeds and seed endosperm.
- The more conditions are optimized, the healthier the plant, and the more the plant can take advantage of the sunlight it receives to store more food in its tissue and ultimately in its seeds.

The glucose is very useful for the plant

Can be converted into **fats and oils** for the seeds

Can be converted to **fructose** for the fruit

Can be used in **respiration** to release **energy**

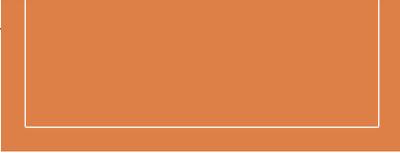
glucose

Can be joined together to make **cellulose** for the cell walls

Can be combined with nutrients from the soil to make **proteins** for the new growth

can be joined together to make **starch** for storage

Plants use and store food in different forms of glucose and use it in a variety of ways.



THE IMPORTANCE OF GOOD SOIL

Optimal soil conditions will grow plants that are most able to thrive and produce healthy seeds.



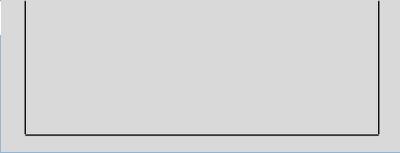
Healthy Soil
Healthy Plants
Healthy Seeds

No matter how you slice it , healthy soil is important.



Much of modern Agriculture is stuck in this spiral



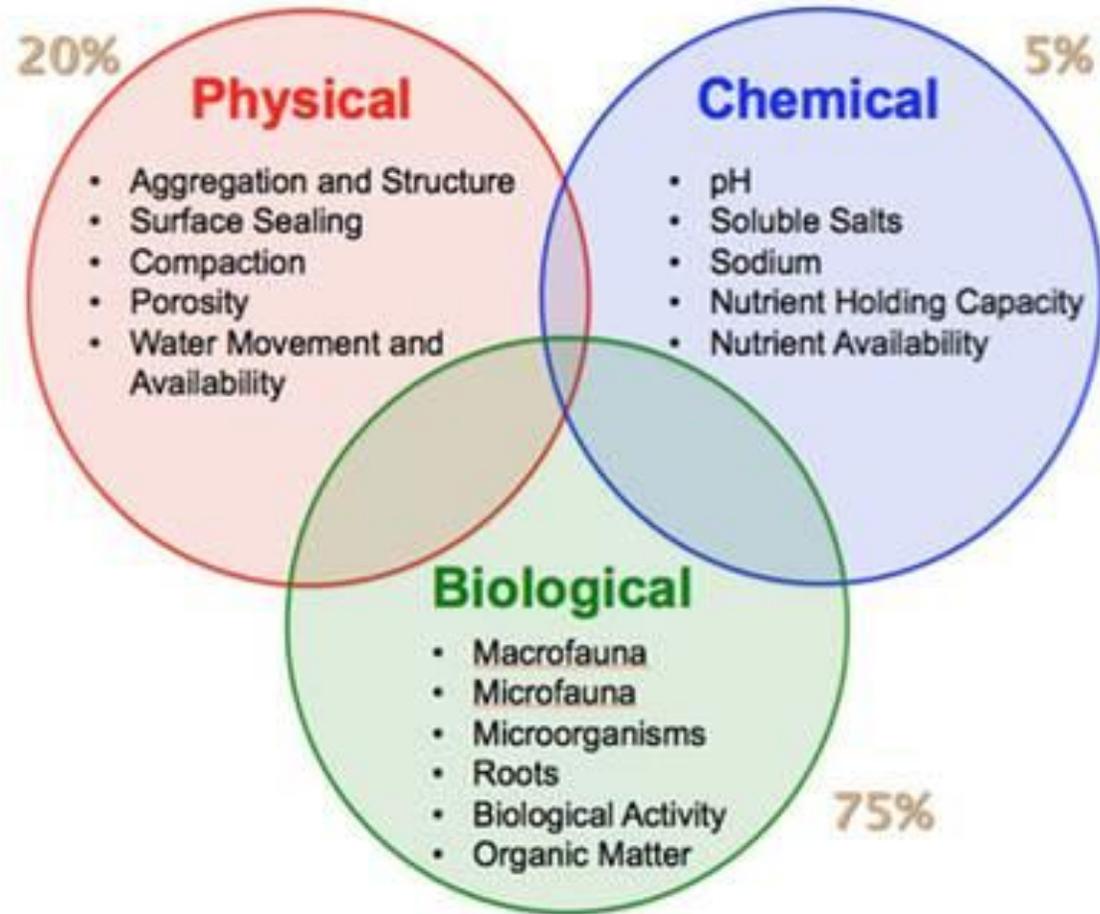


BREAKING THE UNHEALTHY SOIL CYCLE

WHERE DO WE START?

Healthy Soil - Soil Fertility

Soil fertility comprises three interrelated components: physical fertility, chemical fertility and biological fertility.





GOOD CONDITION VS = 2
Soil dominated by friable, fine aggregates with no significant clodding. Aggregates are generally sub-rounded (nutty) and often quite porous



MODERATE CONDITION VS = 1
Soil contains significant proportions (50%) of both coarse clods and friable fine aggregates. The coarse clods are firm, sub-angular or angular in shape and have few or no pores



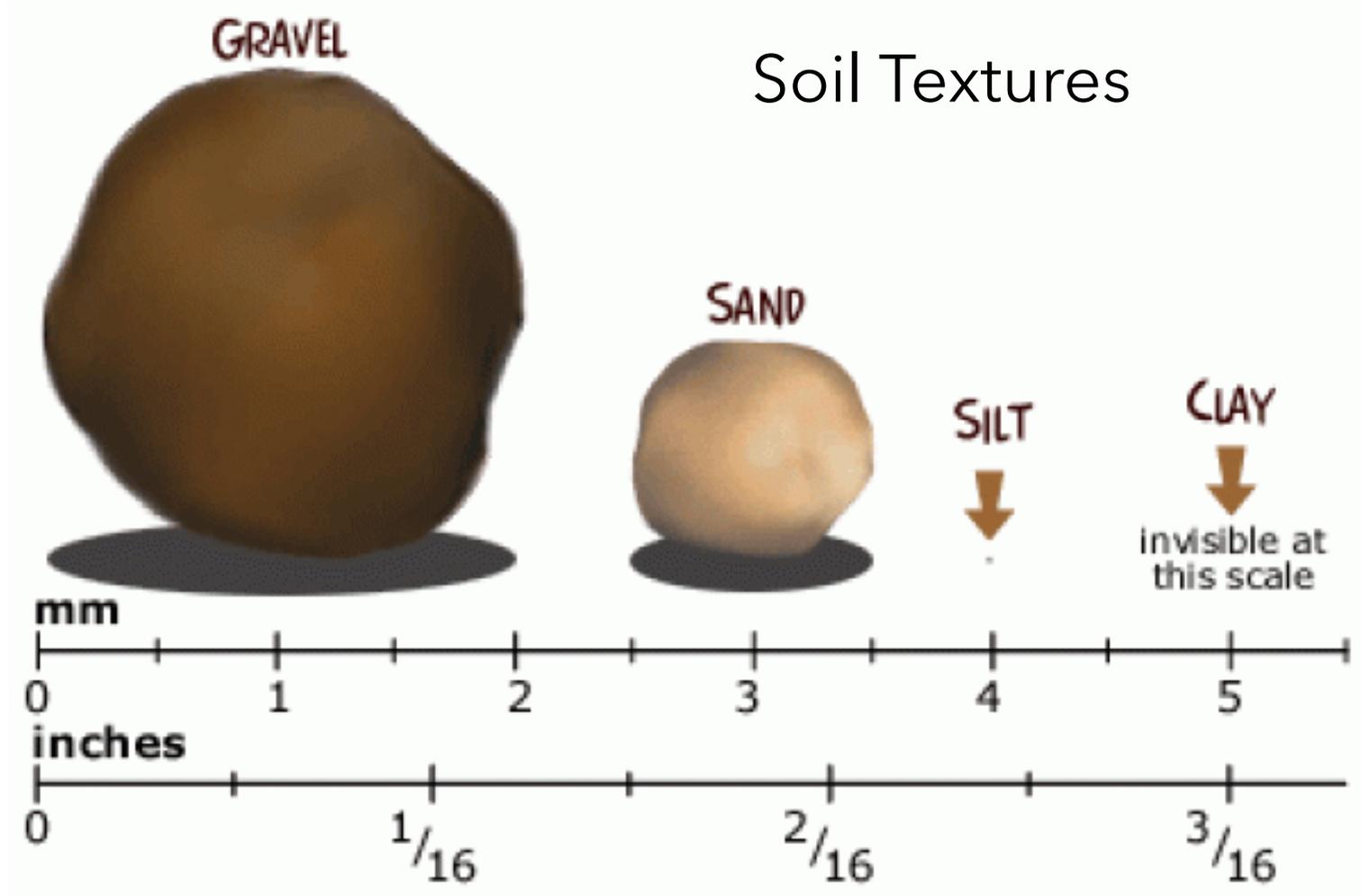
POOR CONDITION VS = 0
Soil dominated by coarse clods with very few finer aggregates. The coarse clods are very firm, angular or sub-angular in shape and have very few or no pores

PLATE 6. Visual scoring (VS) of soil structure under pasture

Physical Soil Fertility Considers

- Texture
- Structure
- Aggregation
- Surface Sealing
- Porosity
- Water Movement
- Water Availability

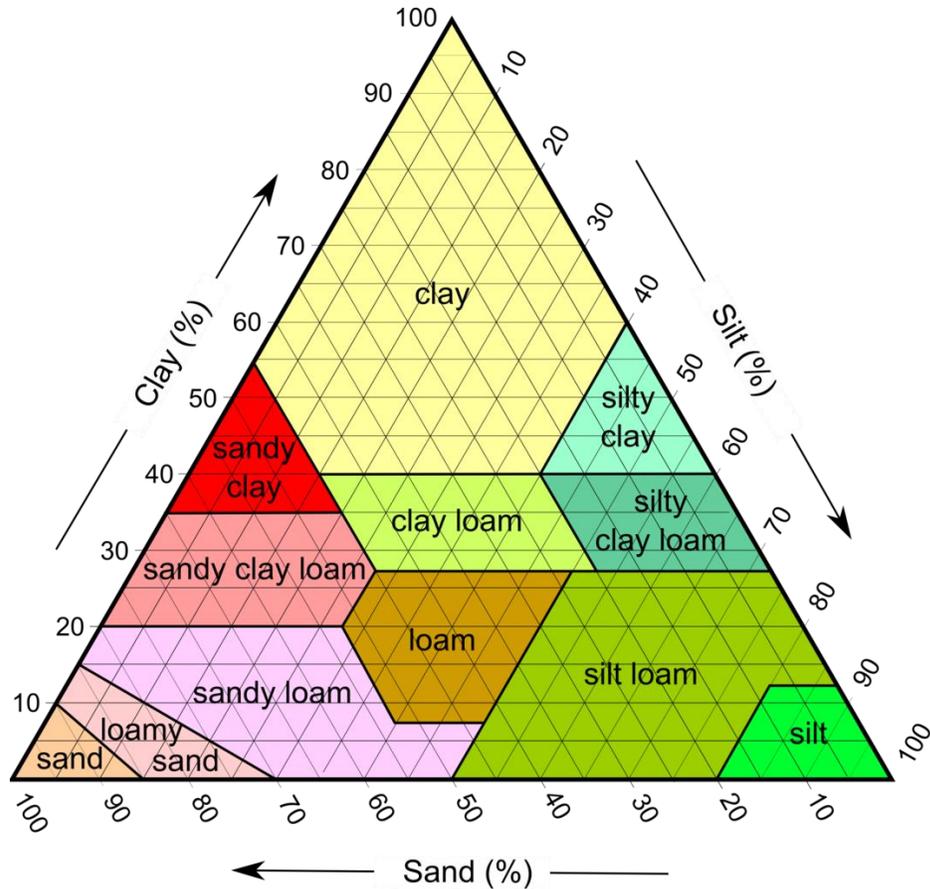
Soil Textures



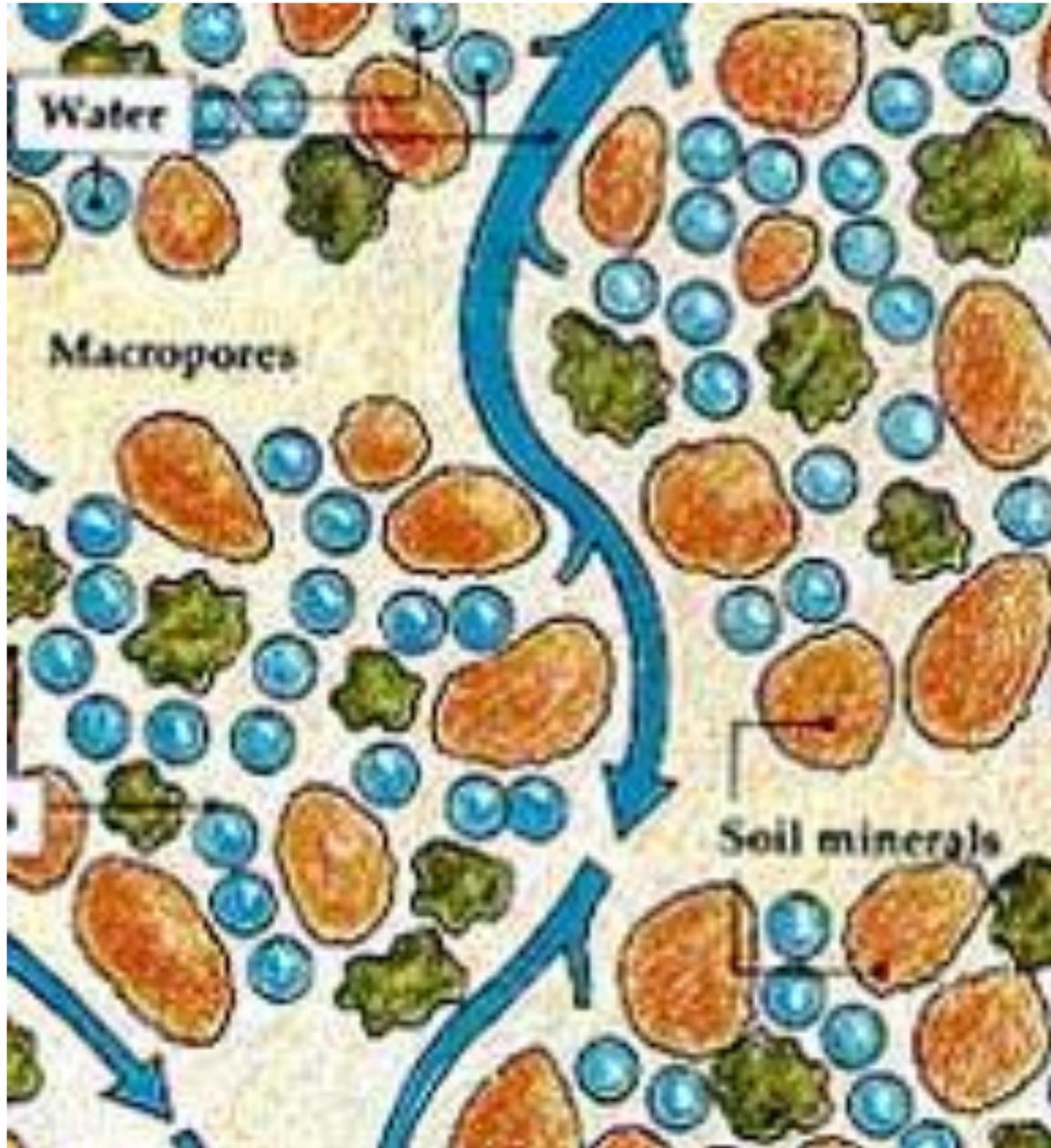
Physical Fertility

The first factor of physical fertility is soil texture.

Soil Texture



- Soil texture (such as loam, sandy loam or clay) refers to the proportion of sand, silt and clay sized particles that make up the mineral fraction of the soil.
- This is the underlying conditions of the soil and cannot be dramatically changed.
- <https://www.qld.gov.au/environment/land/management/soil/soil-properties/texture>

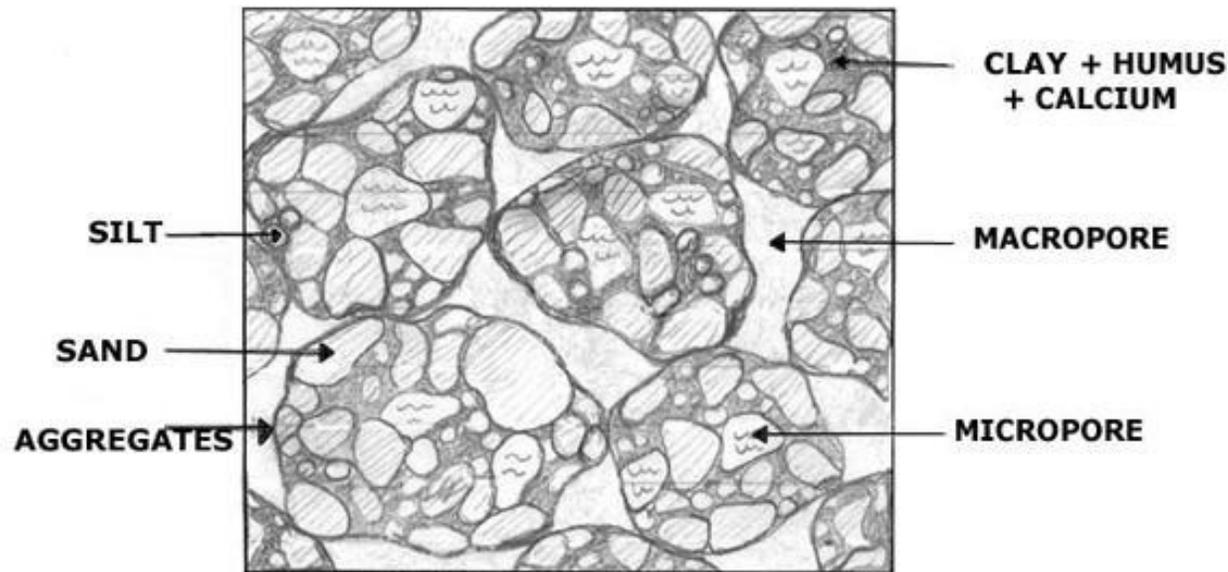


Soil Structure

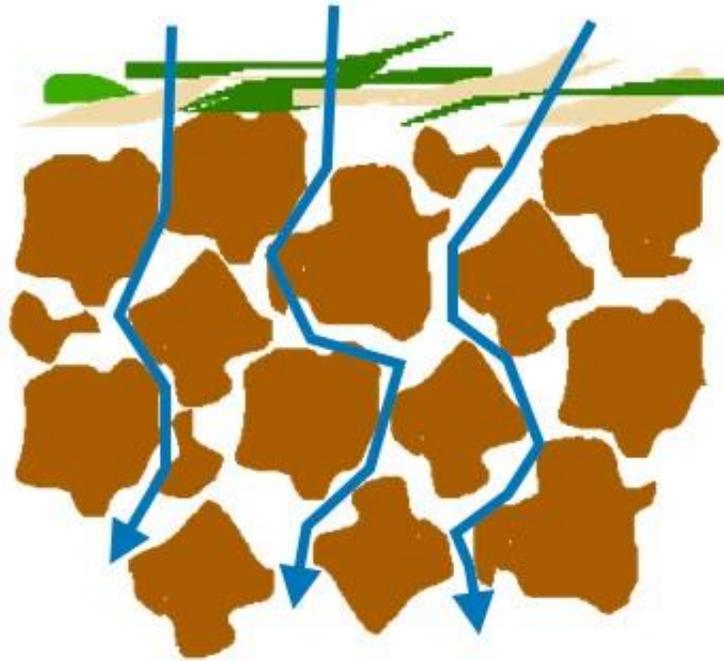
Soil structure refers to the proportions of solids and voids in a soil, which influence its density, porosity, drainage, aeration, water-holding capacity and resistance to erosion Barto et al.

- From: Developments in Soil Science, 2019
- <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/soil-structure>

Soil Structure

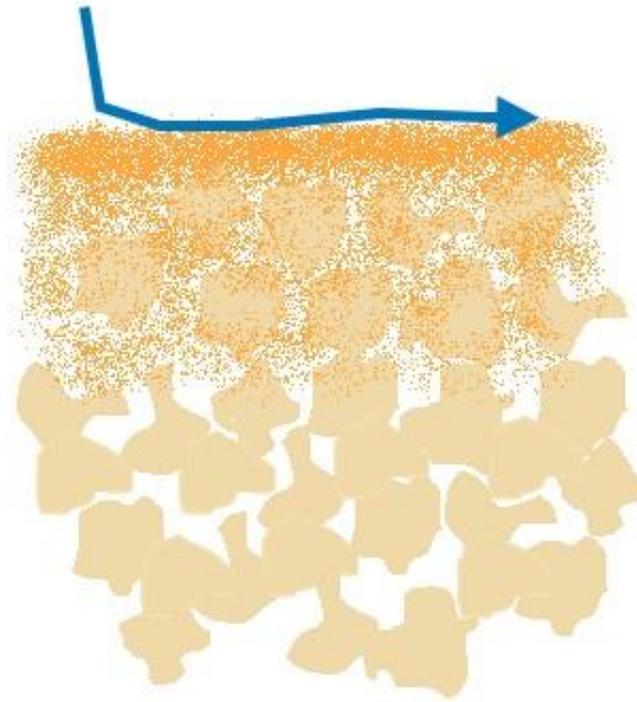


- Soil Structure is how the aggregates of soil texture are combined.
- It determines things like air porosity, and water infiltration in the soil, which also determines the ability of soils to support life.
- Good soil must have the capacity for air and water movement.



Healthy Soil

- Good structure
- Water infiltration into soil pores
- Slows water velocity
- Dark color
- High organic matter
- Soil surface is covered with dead vegetation



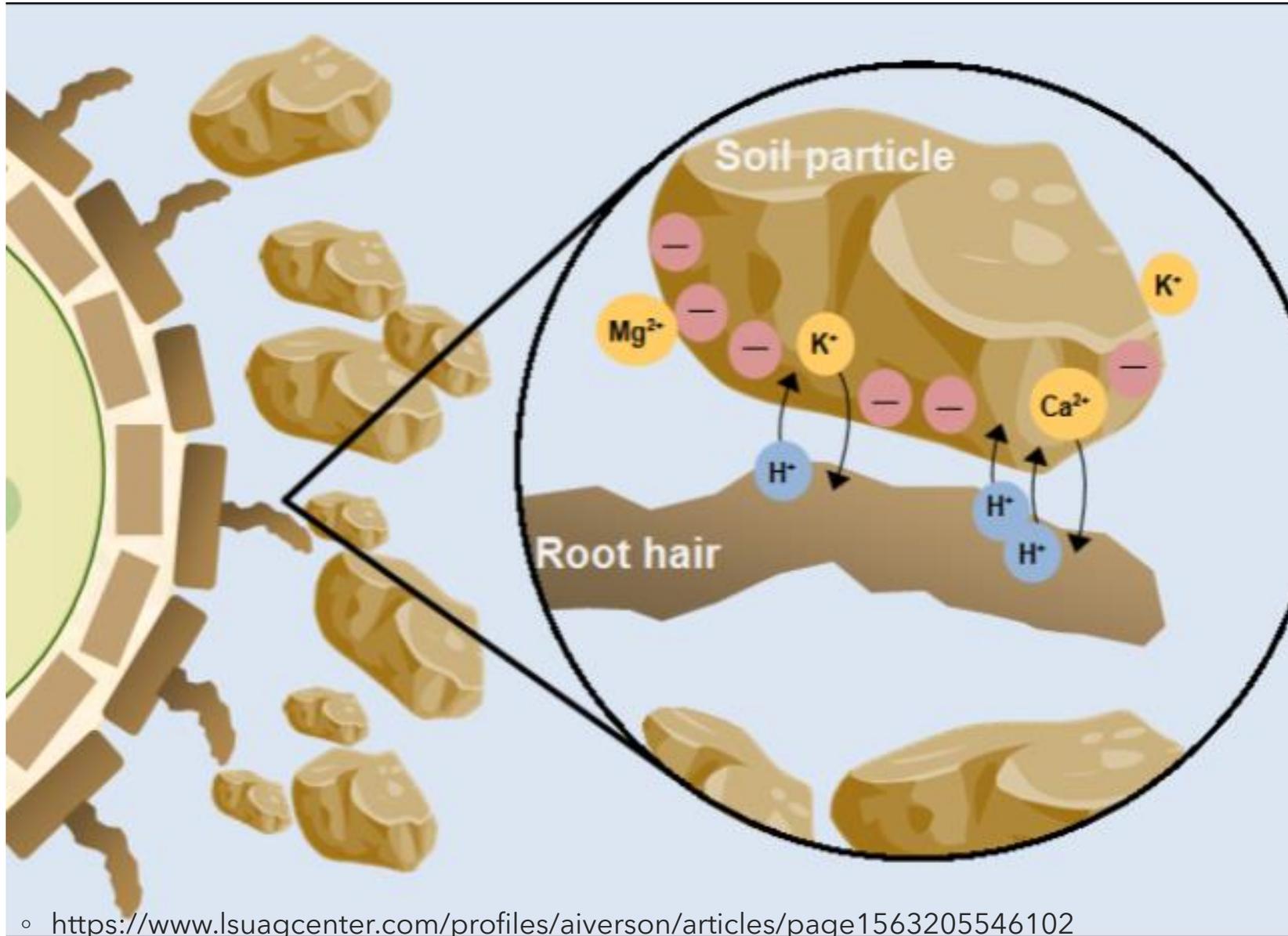
Degraded Soil

- Weak structure
- No water infiltration soil pores clogged
- Water runs off quickly
- Light color
- Low organic matter
- Soil surface is covered with a soil crust



CHEMICAL FERTILITY

Chemical fertility depends on cation exchange capacity as well as plant activity



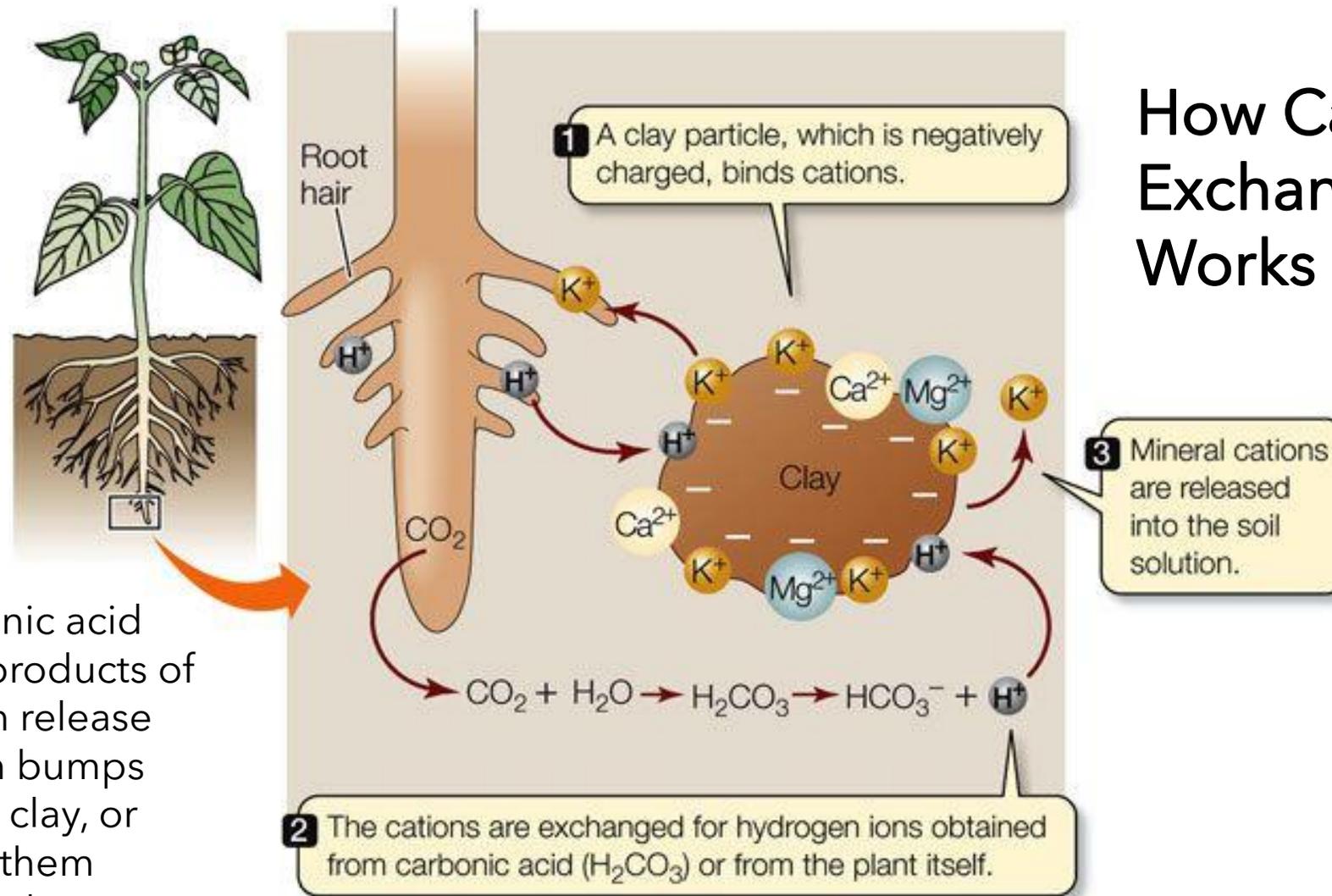
◦ <https://www.lsuagcenter.com/profiles/aiverson/articles/page1563205546102>

Chemical Fertility
relies on Cation Exchange Capacity (CEC)

How many attachment sites are there for nutrients to attach to?

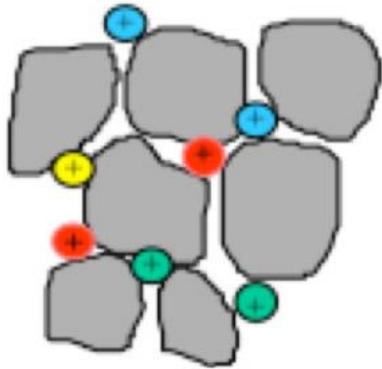
How big is your soil pantry?

How Cation Exchange Works

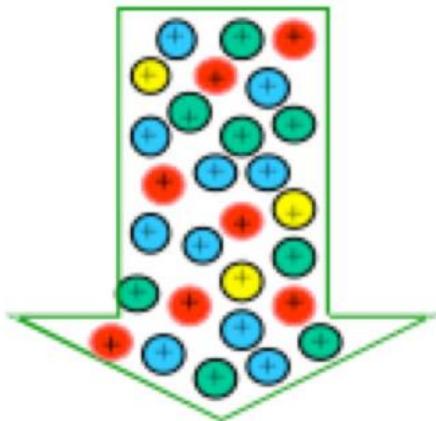


Acids like carbonic acid that are the by products of plant respiration release hydrogen which bumps nutrients off the clay, or humus, making them available to the plant

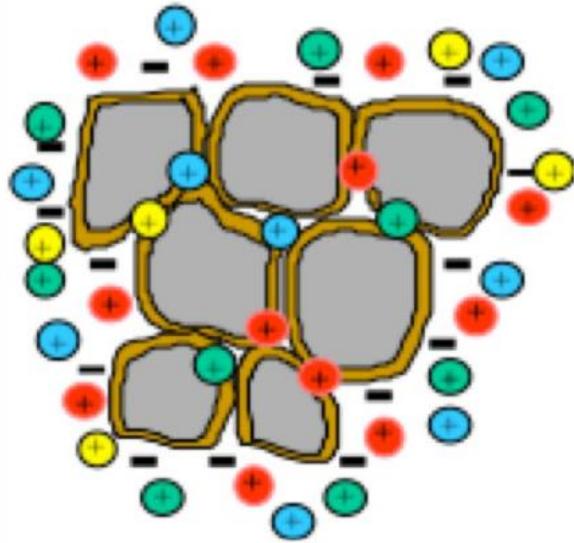
LIFE 8e, Figure 36.6



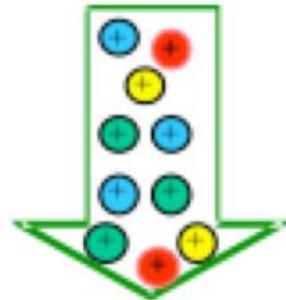
Soil with low humus content can not bind the nutrients



Large part of applied nutrients leach out



The soil has many negative charges that attract and bind the nutrients



Less nutrients leach out



Ca, Mg, K, Zn, Cu, Mn, Fe, B

Chemical Fertility

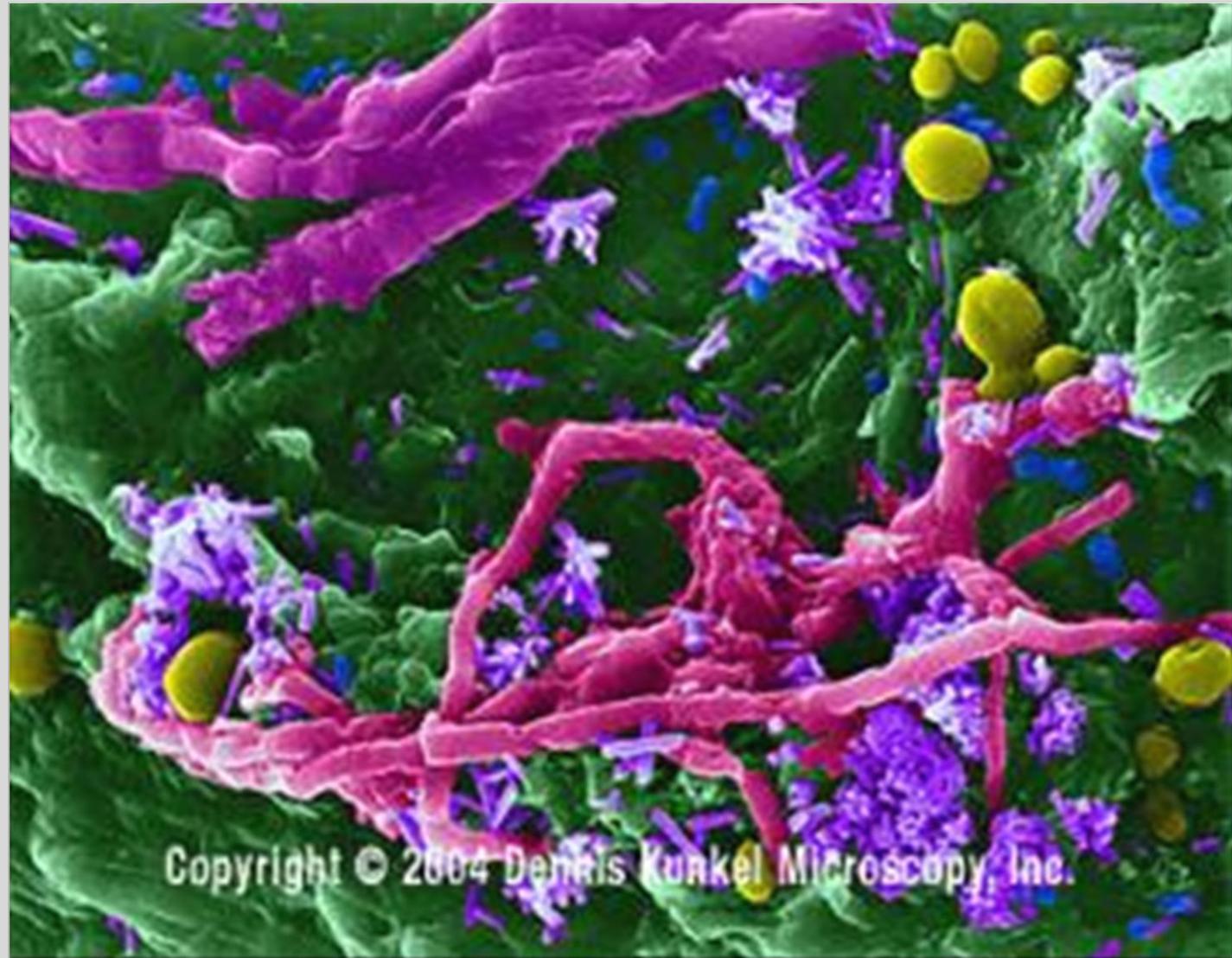
How many nutrients can your soil hold?

- Clay has the most cation exchange sites and has the highest CEC rating (fertility potential) of any soil texture.
- Organic matter has a higher CEC and has the advantage of holding both positive and negative charged nutrient ions.



BIOLOGICAL FERTILITY

A better understanding of soil microbiology is essential if agricultural production is to meet the needs of a growing world population. In many regions, the healthy microbe population is still being threatened, and not promoted, by agricultural practices.

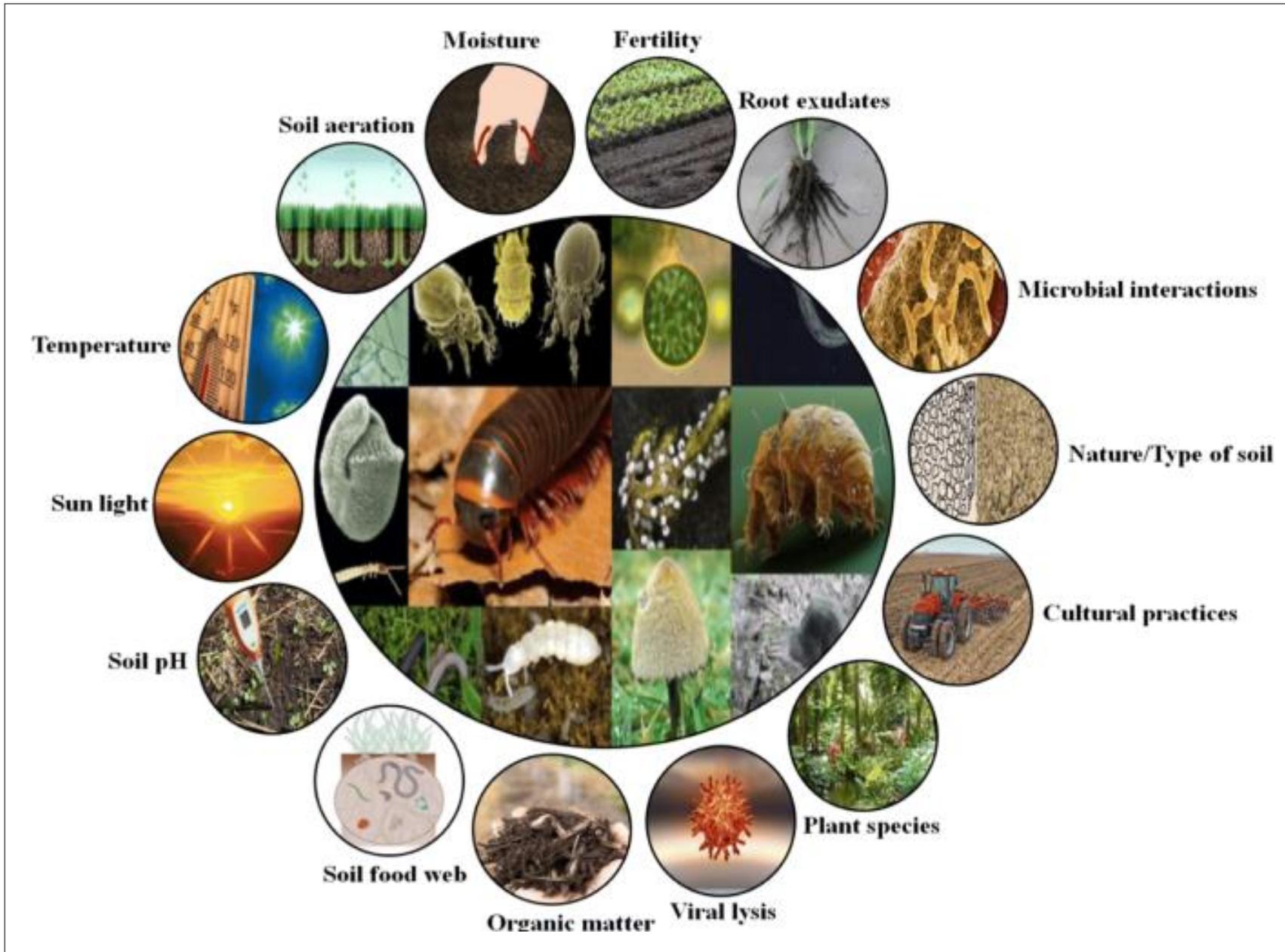




Biological Fertility

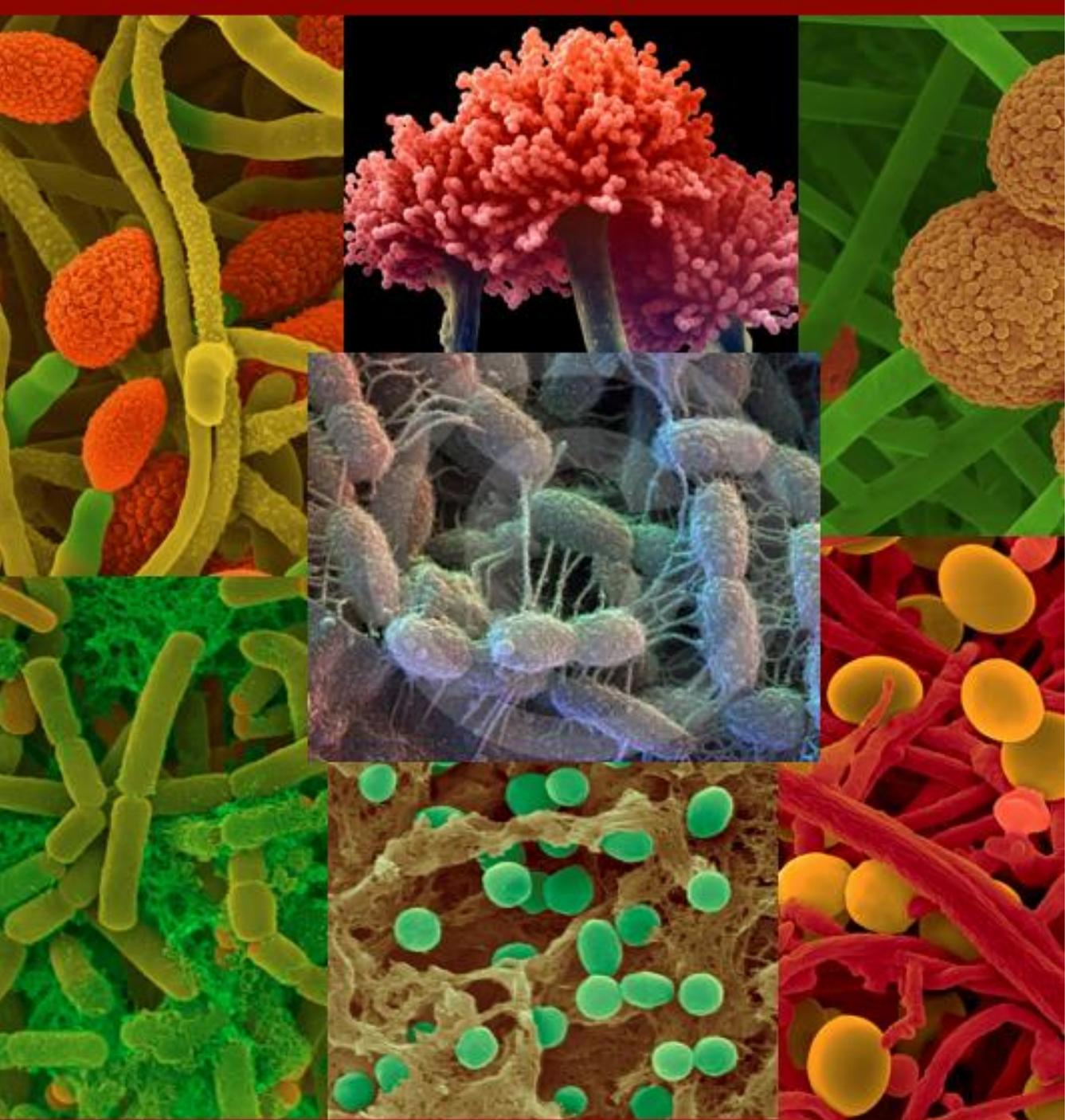
- Biological Fertility is the least well-understood fertility component.
- In addition to soil fertility, soil microorganisms play essential roles in the nutrient cycles that are fundamental to life on the planet.

◦ Picture: Microbes in the soil (Source: Eye of Science / Science Photo Library, via [Science Museum](#))



Biological Fertility

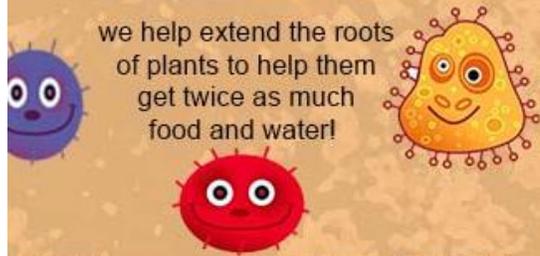
- Biological fertility, depends on the interaction of many different factors.
- Cultural practices, sun, temperature, water, aeration, root exudates, and amount of organic matter are just a few of the factors.
- This creates an intensely dynamic situation in the soil.



Fertile Soil is Teeming with Microbes

- There may be hundreds of millions to billions of microbes in a single gram of soil.
- The most numerous microbes in soil are the bacteria, followed in decreasing numerical order by the actinomycetes, the fungi, soil algae and soil protozoa

Soil microbes are scientifically proven to improve the health of plants



Microbes are Essential for Healthy Soil

A healthy population of beneficial microbes is absolutely essential to a good soil, healthy plants, and healthy seeds in an organic system.

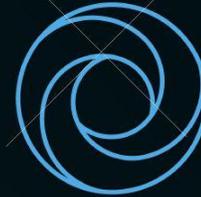
WHAT SOIL MICROBES NEED TO THRIVE

4 ELEMENTS



EARTH

LOREM IPSUM DOLOR SIT AMET,
CONSEC TETUR ADIPISCING ELIT,
SED DO EIUSMOD TEMPOR INCIDIDUNT
UT LABORE ET DOLORE MAGNA
ALIQUA, UT ENIM AD MINIM VENIAM,
QUIS NOSTRUD EXERCITATION
ULLAMCO LABORIS NISI UT ALIQUIP
EX EA COMMODO CONSEQUAT.



WATER

LOREM IPSUM DOLOR SIT AMET,
CONSEC TETUR ADIPISCING ELIT,
SED DO EIUSMOD TEMPOR INCIDIDUNT
UT LABORE ET DOLORE MAGNA
ALIQUA, UT ENIM AD MINIM VENIAM,
QUIS NOSTRUD EXERCITATION
ULLAMCO LABORIS NISI UT ALIQUIP
EX EA COMMODO CONSEQUAT.



AIR

LOREM IPSUM DOLOR SIT AMET,
CONSEC TETUR ADIPISCING ELIT,
SED DO EIUSMOD TEMPOR INCIDIDUNT
UT LABORE ET DOLORE MAGNA
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QUIS NOSTRUD EXERCITATION
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EX EA COMMODO CONSEQUAT.



FIRE

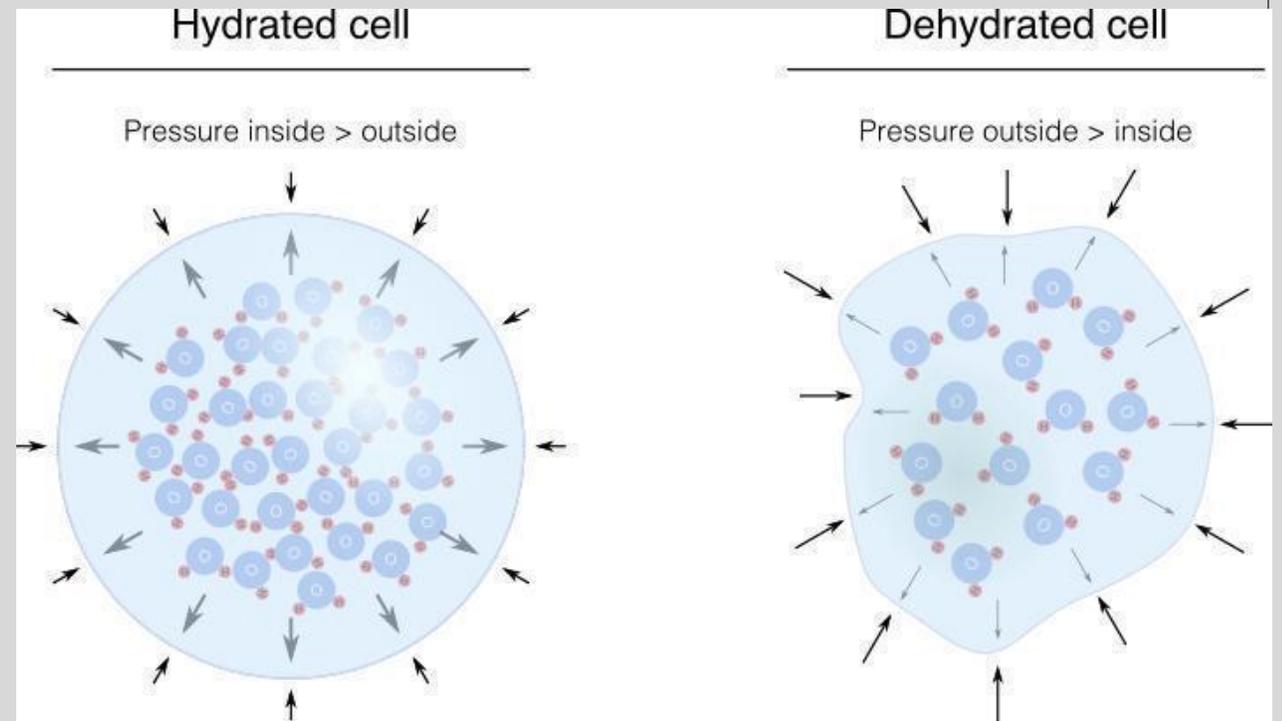
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QUIS NOSTRUD EXERCITATION
ULLAMCO LABORIS NISI UT ALIQUIP
EX EA COMMODO CONSEQUAT.

A close-up photograph of a hand holding several layers of a yellow onion peel, about to drop them into a blue plastic bin. The bin is filled with dark brown soil and various organic materials, including a whole brown egg, a piece of a banana, green leafy vegetables, and other vegetable scraps. The background shows a wooden fence. A white text box is overlaid at the bottom of the image.

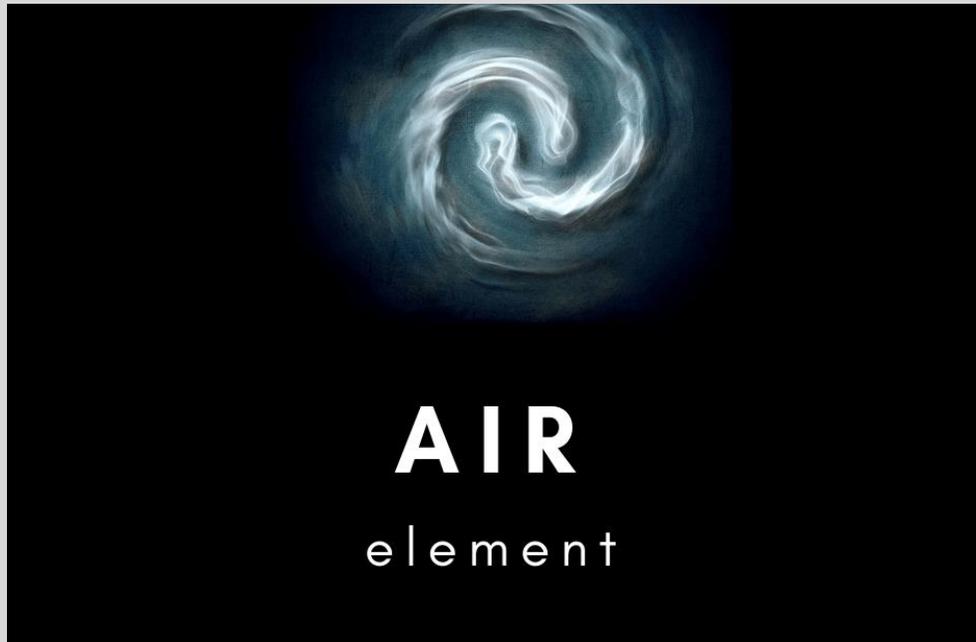
**MICROBES NEED EARTH
DECAYING ORGANIC MATTER**

Microbes Need Water

All living things need water



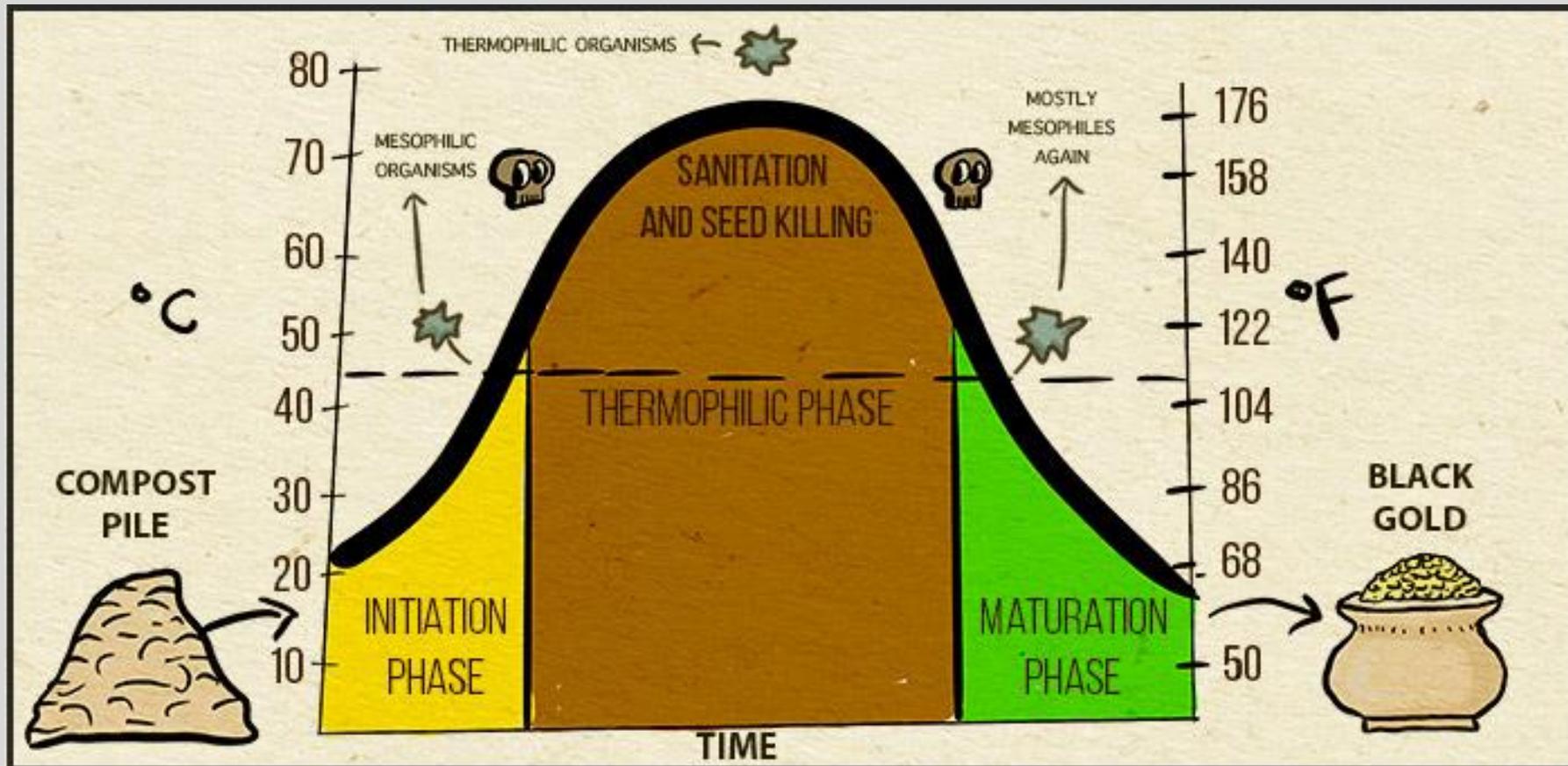
Microbes Need Air



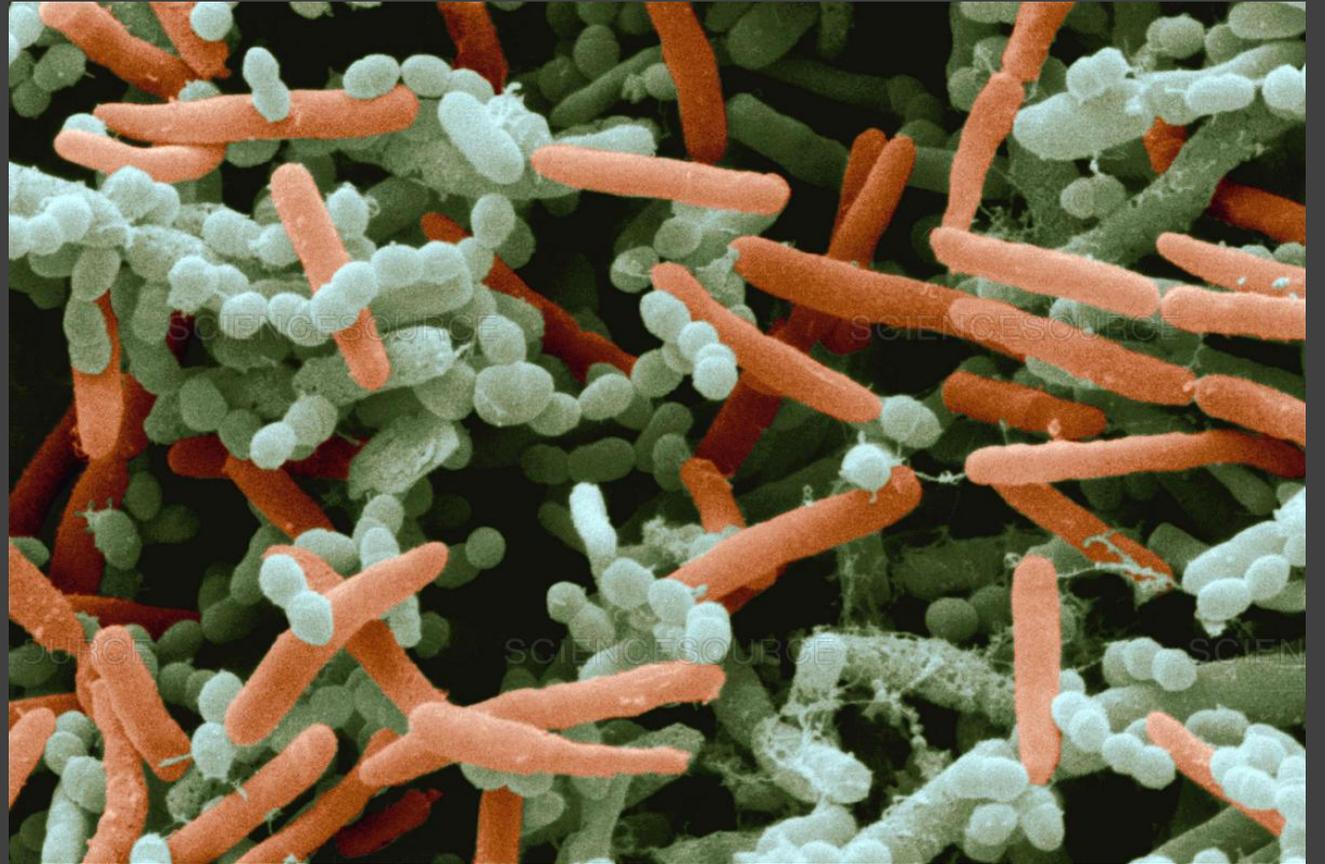
- Different soil microbes need differing amounts of air.
- Aerobic microbes need air – they are generally the more beneficial organisms in soil
- Anerobic microbes – Some dangerous microbes in this class, such as e coli.
- Facultative Anerobic microbes – Mostly beneficial and can live either with or without air.

Microbes Need "Fire" - Heat

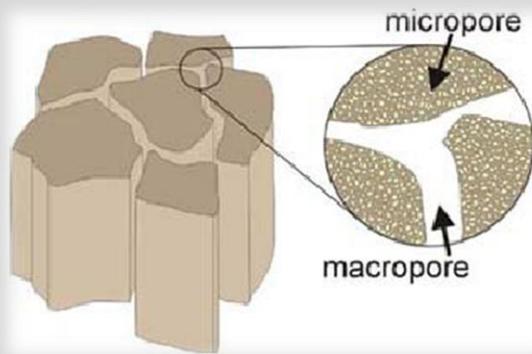
Different microbes thrive at different temperatures.



GARDENERS ROLE IN NURTURING MICROBES



Soil Microbe Care Checklist



- Provide sufficient food in the form of organic matter.
- Insure sufficient water by adding organic matter and using irrigation wisely.
- Build your soil with organic matter so that it has the texture suitable for good microbe habitat, with equal amounts of water and air holding capacity.
- Protect your microbes from temperature excesses by using organic matter as mulches and protective coverings.



PLANTS GROWN IN
FERTILE SOIL HAVE A
HIGHER BRIX



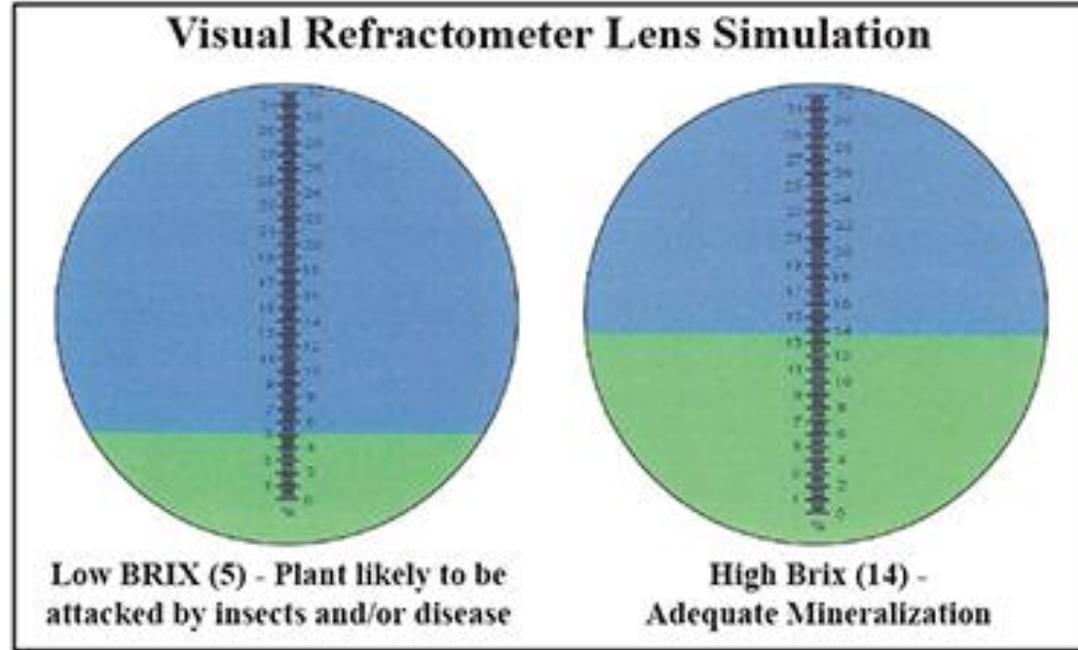
WHAT IS BRIX?

What does it have to do with soil fertility?

And what does it have to do with seeds?



Visual Refractometer*



Refractometer

Measures Brix

What is brix?

Brix - measures the *dissolved solids* in plant juice, including sucrose, fructose, vitamins, minerals, protein, and amino acids.

A higher brix is associated with higher nutrition, better disease resistance in plants, and more food stored in the plant tissues, including seeds.

Refractive Index of Crop Juices -- Calibrated In % Sucrose Or °Brix

	Poor	Average	Good	Excellent
FRUITS				
Apples	6	10	14	18
Avocados	4	6	8	10
Bananas	8	10	12	14
Blueberries	8	12	14	18
Cantaloupe	8	12	14	16
Casaba	8	10	12	14
Cherries	6	8	14	16
Coconut	8	10	12	14
Grapes	8	12	16	20
Grapefruit	6	10	14	18
Honeydew	8	10	12	14
Kumquat	4	6	8	10
Lemons	4	6	8	12
Limes	4	6	10	12
Mangos	4	6	10	14
Oranges	6	10	16	20
Papayas	6	10	18	22
Peaches	6	10	14	18
Pears	6	10	12	14
Pineapple	12	14	20	22
Raisins	60	70	75	80
Raspberries	6	8	12	14
Strawberries	6	8	12	14
Tomatoes	4	6	8	12
Watermelons	8	12	14	16
GRASSES				
Alfalfa	4	8	16	22
Grains	6	10	14	18
Sorghum	6	10	22	30

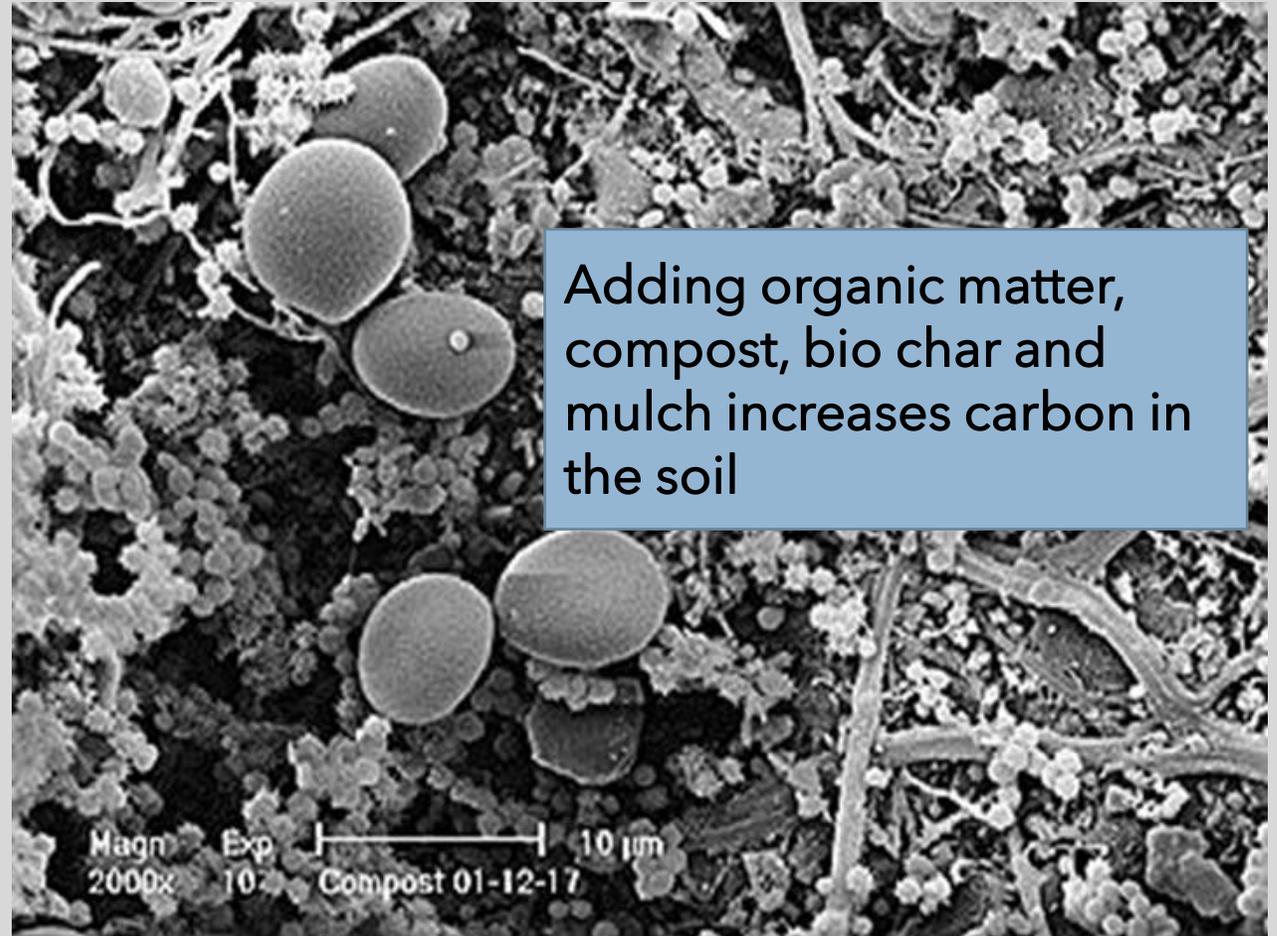
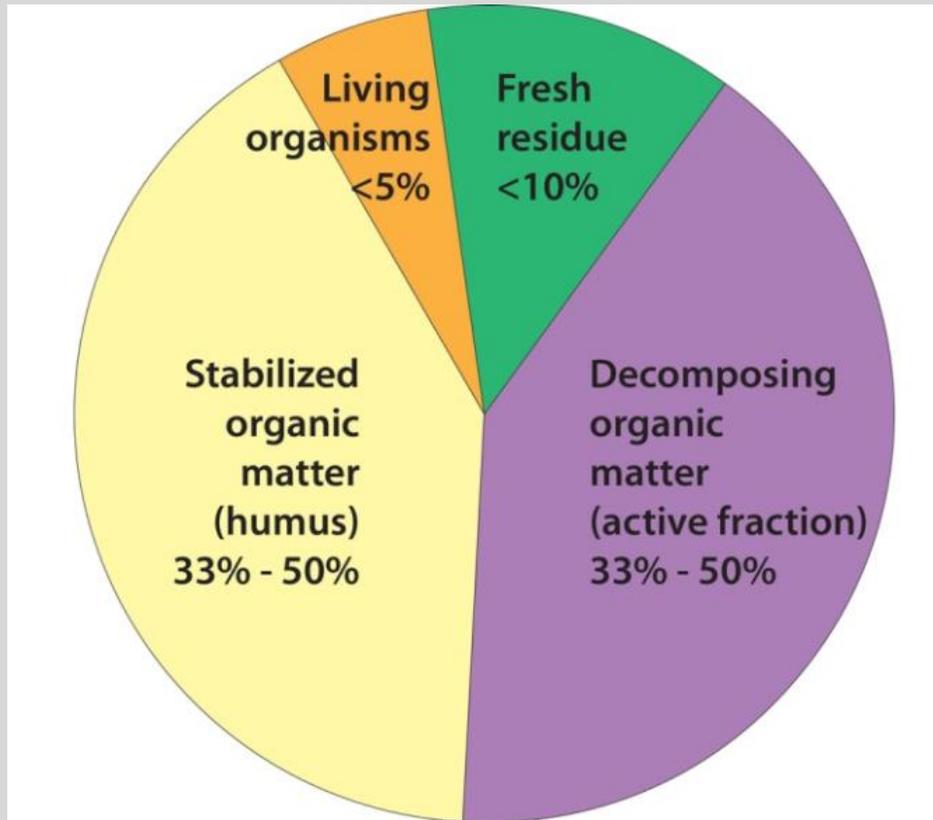
Within a given species of plant, the crop with the higher refractive index will have a higher sugar content, higher mineral content, higher protein content and a greater specific gravity or density. This adds up to a sweeter tasting, more mineral/nutritious food with lower nitrate and

	Poor	Average	Good	Excellent
VEGETABLES				
Asparagus	2	4	6	8
Beets	6	8	10	12
Bell Peppers	4	6	8	12
Broccoli	6	8	10	12
Cabbage	6	8	10	12
Carrots	4	6	12	18
Cauliflower	4	6	8	10
Celery	4	6	10	12
Corn Stalks	4	8	14	20
Corn (Young)	6	10	18	24
Cow Peas	4	6	10	12
Cucumbers	4	6	8	12
Endives	4	6	8	10
English Peas	8	10	12	14
Escarole	4	6	8	10
Field Peas	4	6	10	12
Garlic, Cured	28	32	36	40
Green Beans	4	6	8	10
Hot Peppers	4	6	8	10
Kale	8	10	12	16
Kohlrabi	6	8	10	12
Lettuce	4	6	8	10
Onions	4	6	8	10
Parsley	4	6	8	10
Peanuts	4	6	8	10
Potatoes	3	5	7	8
Potatoes, Sweet	6	8	10	14
Romaine	4	6	8	10
Rutabagas	4	6	10	12
Squash	6	8	12	14
Sweet Corn	6	10	18	24
Turnips	4	6	8	10

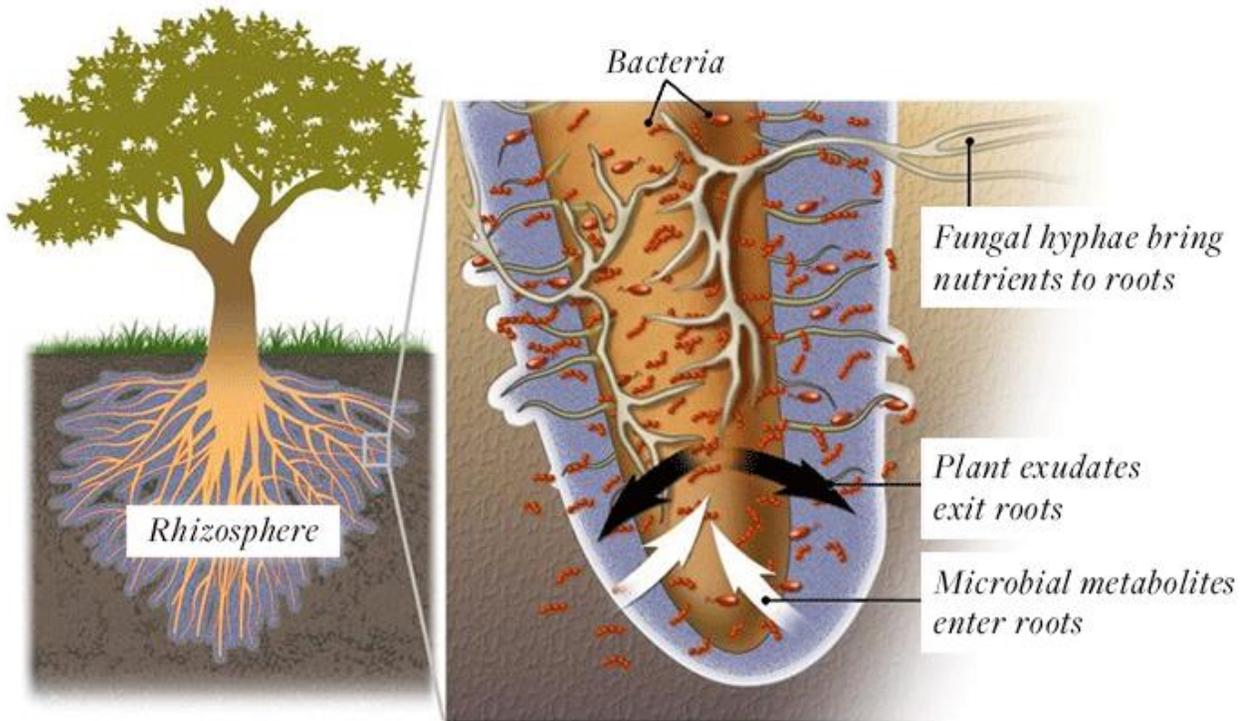


HOW DO WE INCREASE BRUX IN
PLANTS AND SEEDS?

Brix Levels in Plants and Seeds can be raised by Increasing Carbon in the Soil

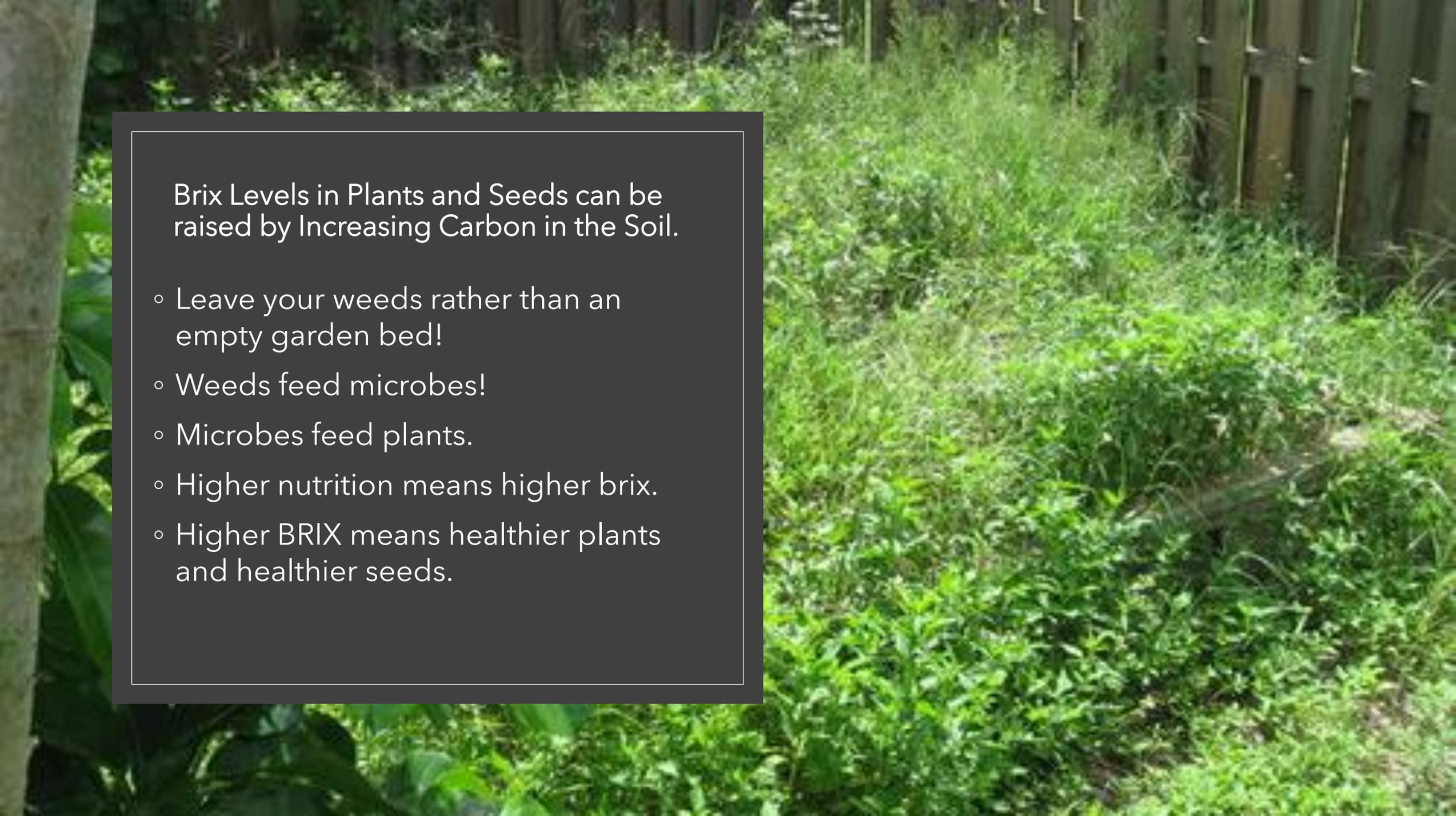


Brix Levels in Plants and Seeds can be raised by Increasing Carbon in the Soil



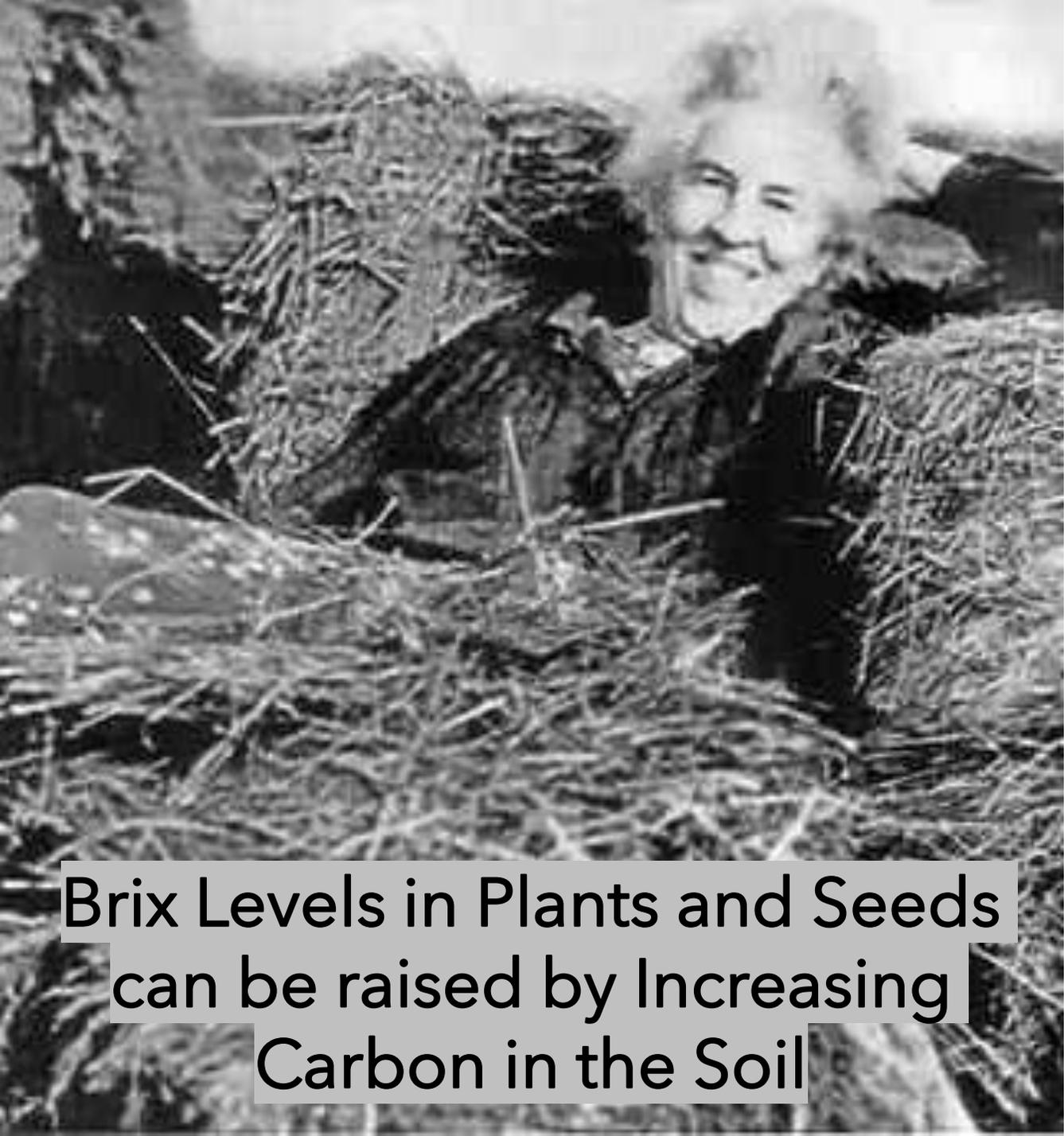
Increase Carbon in the Soil by Using Cover Crops

- Cover crop plants make and secrete large amounts of sugars (carbon) down into the soil through the roots to feed the microbes in the soil which in turn feed plants and raise the BRIX.
- Cover crops continually add carbon to the soil.



Brix Levels in Plants and Seeds can be raised by Increasing Carbon in the Soil.

- Leave your weeds rather than an empty garden bed!
- Weeds feed microbes!
- Microbes feed plants.
- Higher nutrition means higher brix.
- Higher BRIX means healthier plants and healthier seeds.



**Brix Levels in Plants and Seeds
can be raised by Increasing
Carbon in the Soil**

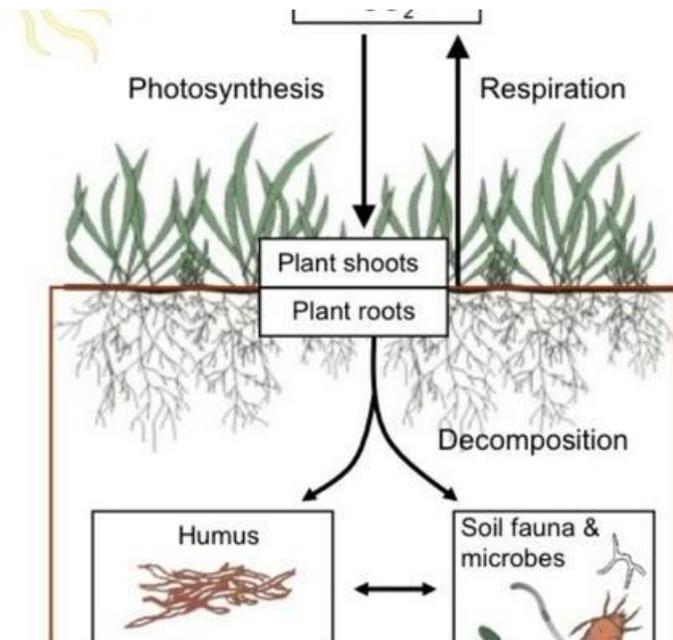
Increase Carbon in the Soil by applying Mulch

- Mulching provides good habitat for microbes.
- Decaying mulch provides an ongoing source of carbon for the soil and soil microbes.
- This is Ruth Stout. She wrote "How to have a Green Thumb without an Aching Back". It was the first book on the benefits of mulching.

Brix Levels in Plants and Seeds can be raised by Increasing Carbon in the Soil



- Mulch protects water resources keeping the soil and microbes hydrated.
- Mulch provides a slow-release source of food for microbes.
- Mulch moderates the soil temperatures for microbes, protecting them from temperature extremes.



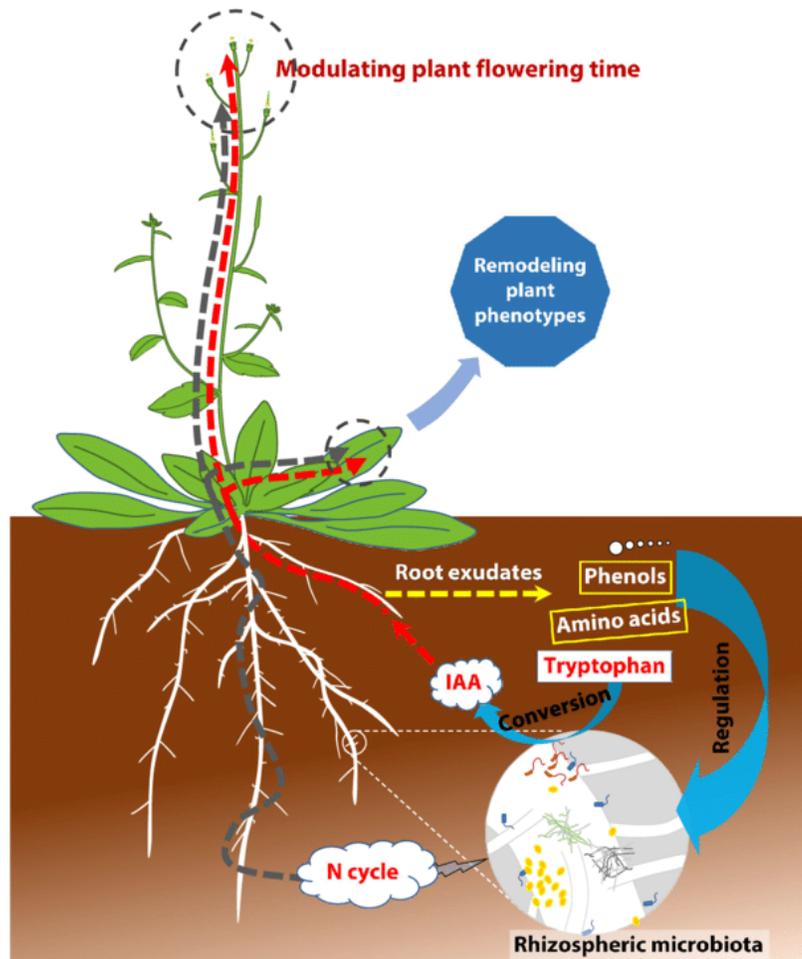
BRIX LEVELS IN PLANTS AND SEEDS CAN BE RAISED BY INCREASING CARBON IN THE SOIL



MICROBES HELP ADD CARBON TO THE SOIL

Encouraging healthy microbial populations help to add carbon to the soil.

Decomposers break down organic matter, releasing the carbon in it. Mychorrizal fungus grows and fixes carbon in the soil.

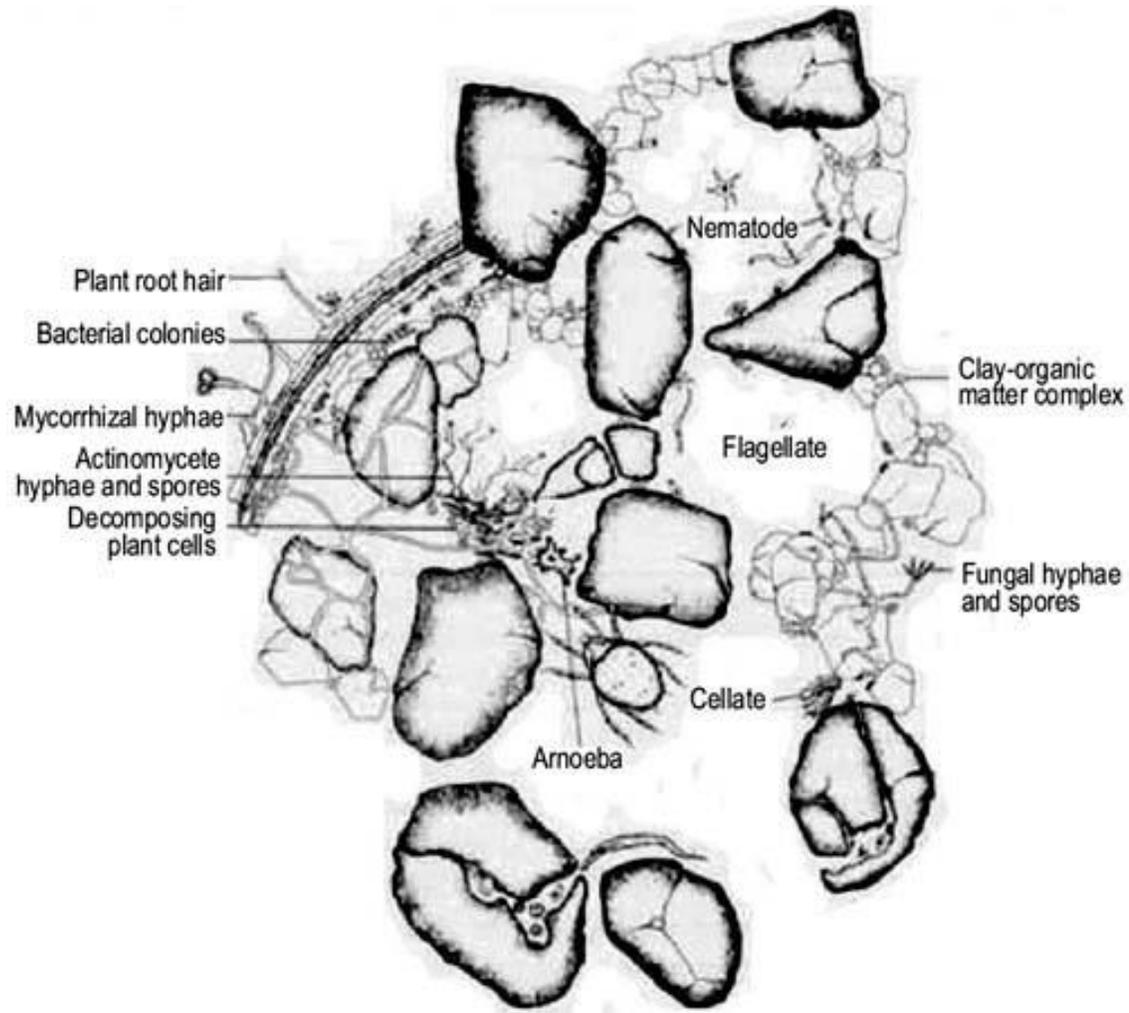


Bonus! Microbes Deliver Nutrients

- Microbes feed on the sugars in the root exudates for energy and exchange them for nutrients the plant needs.
- They consume and convert unavailable nutrients in organic matter and even rocks, into available nutrients and deliver them to the plant.

Bonus!

Microbes help build soil structure



- Aerobic microbes use sugars as glues to structure the soil, making a nice living environment for themselves with sufficient water and air infiltration.
- This cement makes aggregates less likely to crumble when exposed to water



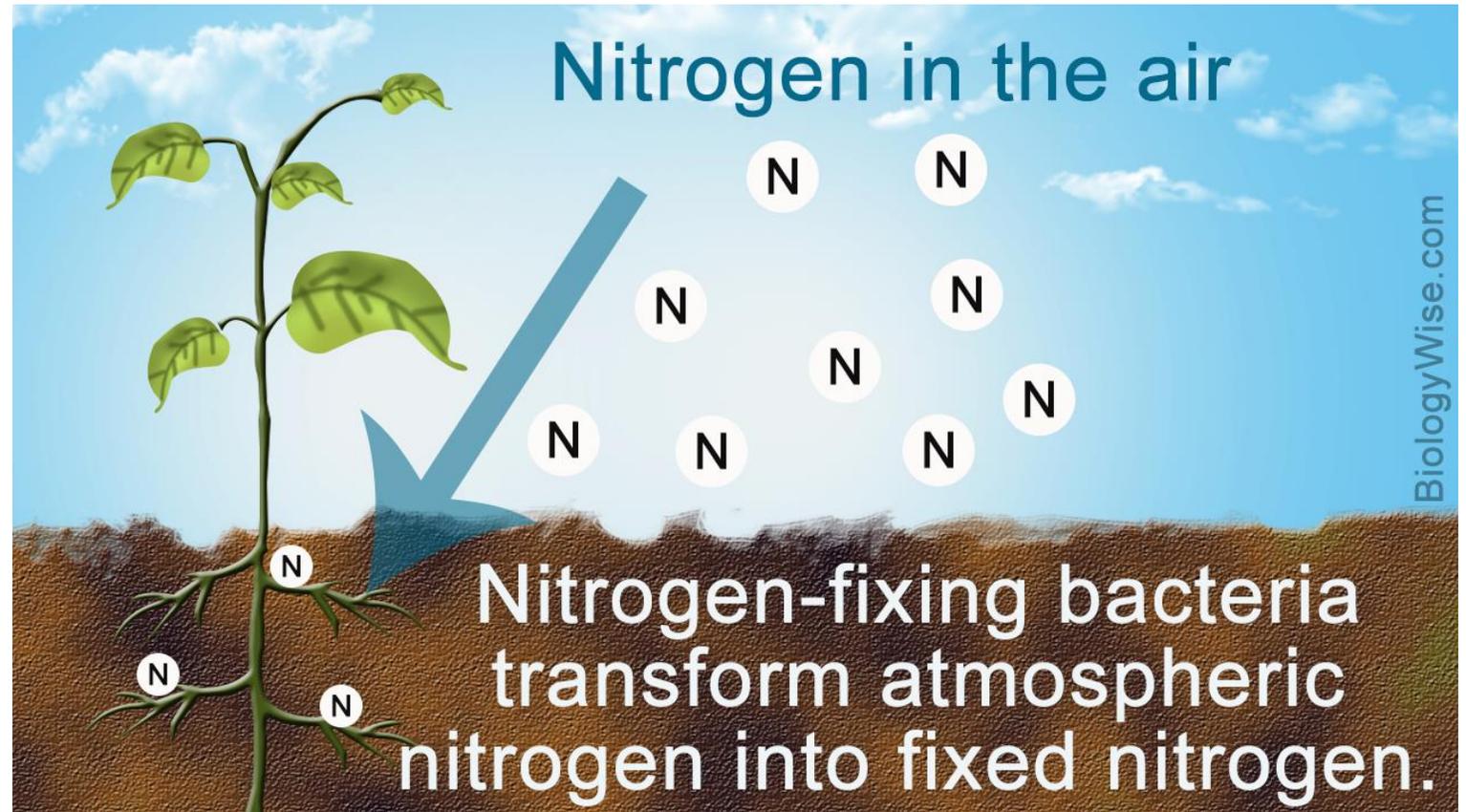
Bonus! - Microbes Stabilize Soil Structure

- Threadlike fungal structures branch out throughout the soil surrounding particles and aggregates like a hairnet.
- The fungi can be thought of as the “threads” of the soil fabric.
- By adding woody organic matter to your garden, you increase the populations of beneficial fungi because it is one of their favorite foods.

Bonus! Microbes Grab Nitrogen from the Air

In good soil, air circulates down into the soil, and nitrogen fixing bacteria in the soil pull nitrogen from the air and hold it in the soil.

They also convert it to a form that the plant can use to help manufacture proteins.



Organic matter
protects soil life,
and provides
food and water
for microbes
which in turn
feed our plants.

Additions of Organic Matter

= Increased Carbon in the Soil

= Healthy Microbes

= Increased Brix

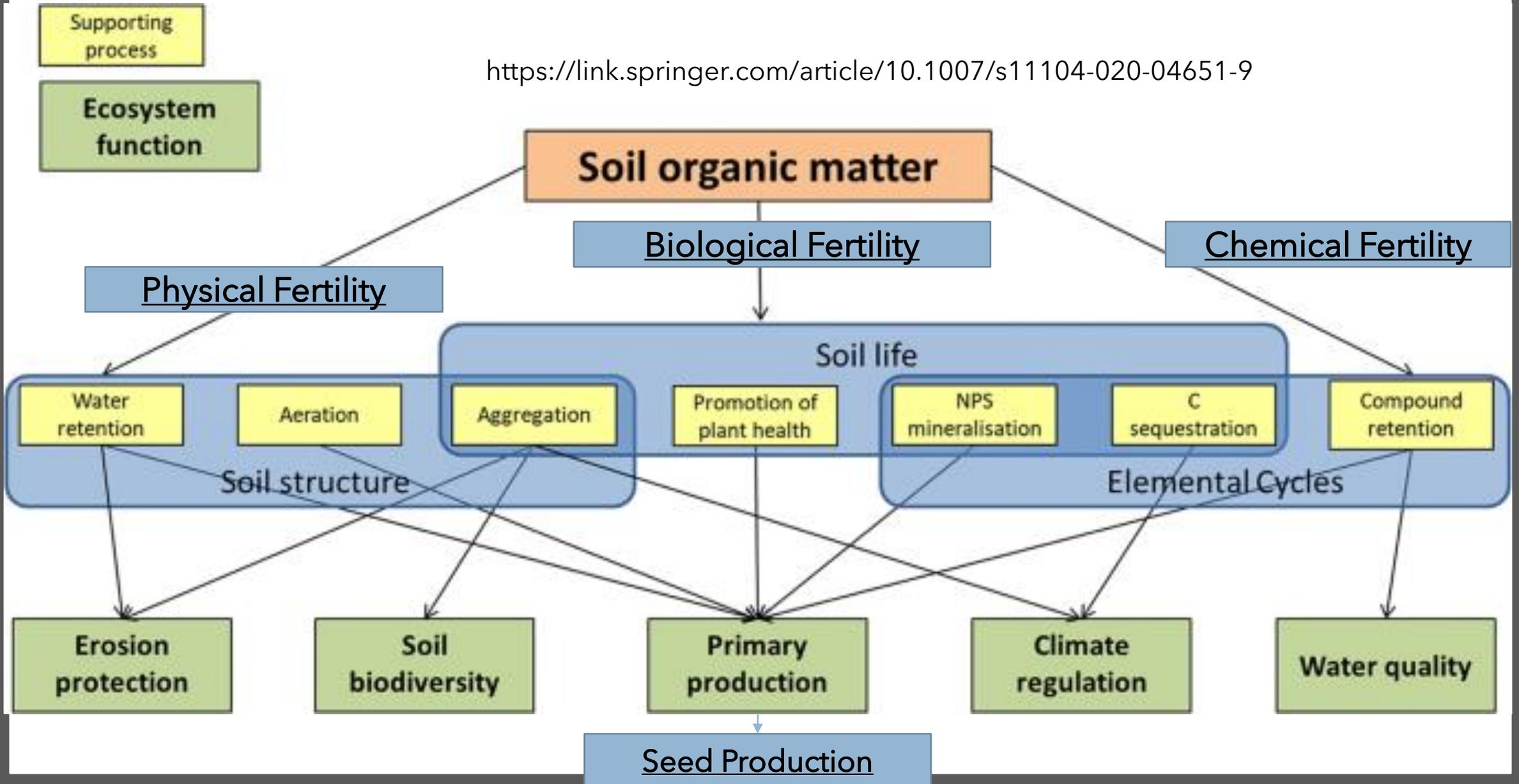
= Healthy Soil

= Healthy Plants

= Healthy Plants

= Healthy Seeds

<https://link.springer.com/article/10.1007/s11104-020-04651-9>



HAPPY HEALTHY SEEDS

HAPPY HEALTHY GARDENS

HAPPY HEALTHY HUMANS





THE EARTH THANKS YOU

Grow more plants, grow more trees, grow more veggies, grow more flowers,
grow more
SEEDS