

Master Gardener Association of San Diego County

Healthy Soil The Key to Growing Great Plants

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Master Gardener



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What is Healthy Soil?

and what is not



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Soil is ...

“a naturally occurring mixture of inorganic and organic ingredients with a definite form, structure, and composition that varies from one location to another.”



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Soil is Living



Video credit:
Soil Science Society of America, 2015



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Healthy soil has ...

“The continued capacity ... to function as a vital living ecosystem that sustains plants, animals, and humans”

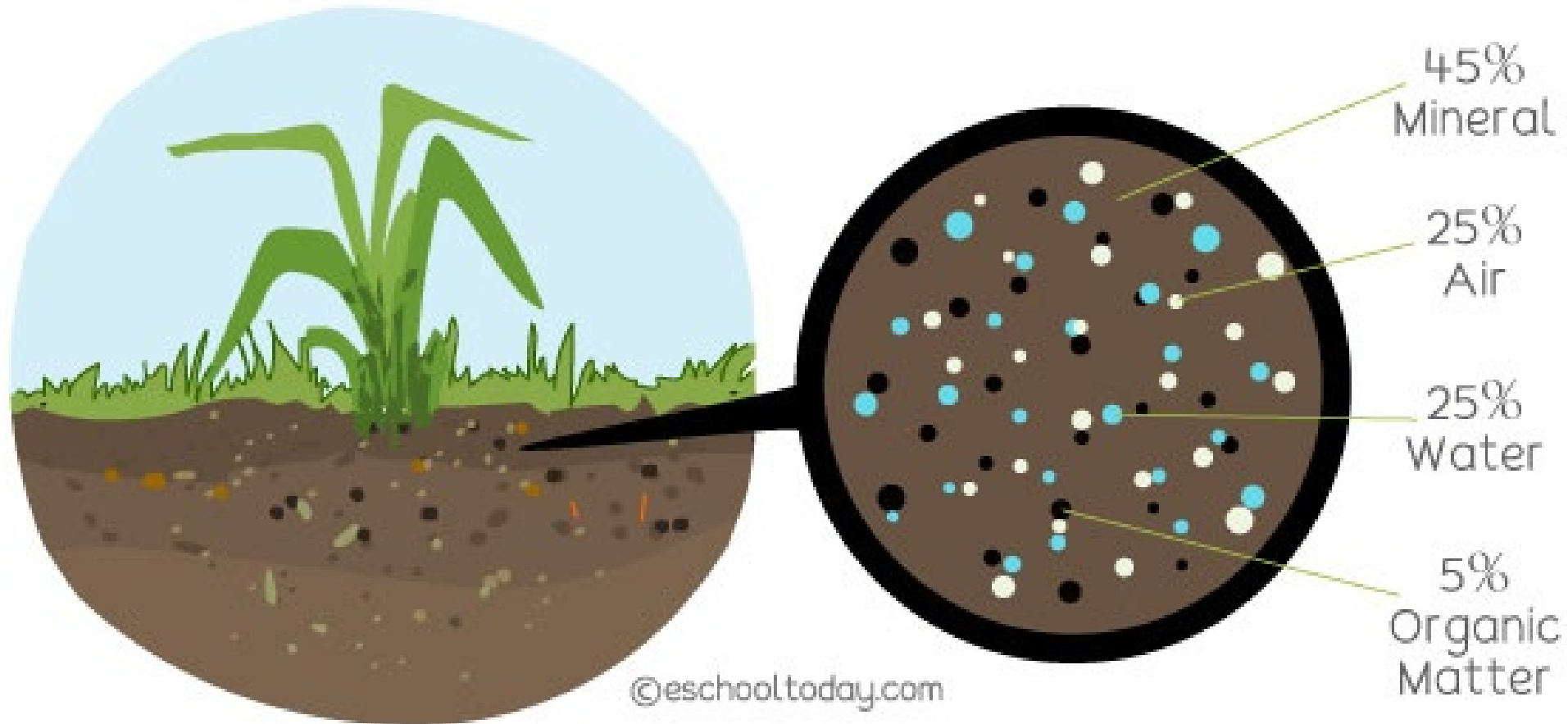


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Healthy soil is ...



(ds_03_particles-and-pores.gif (260x204), n.d.)



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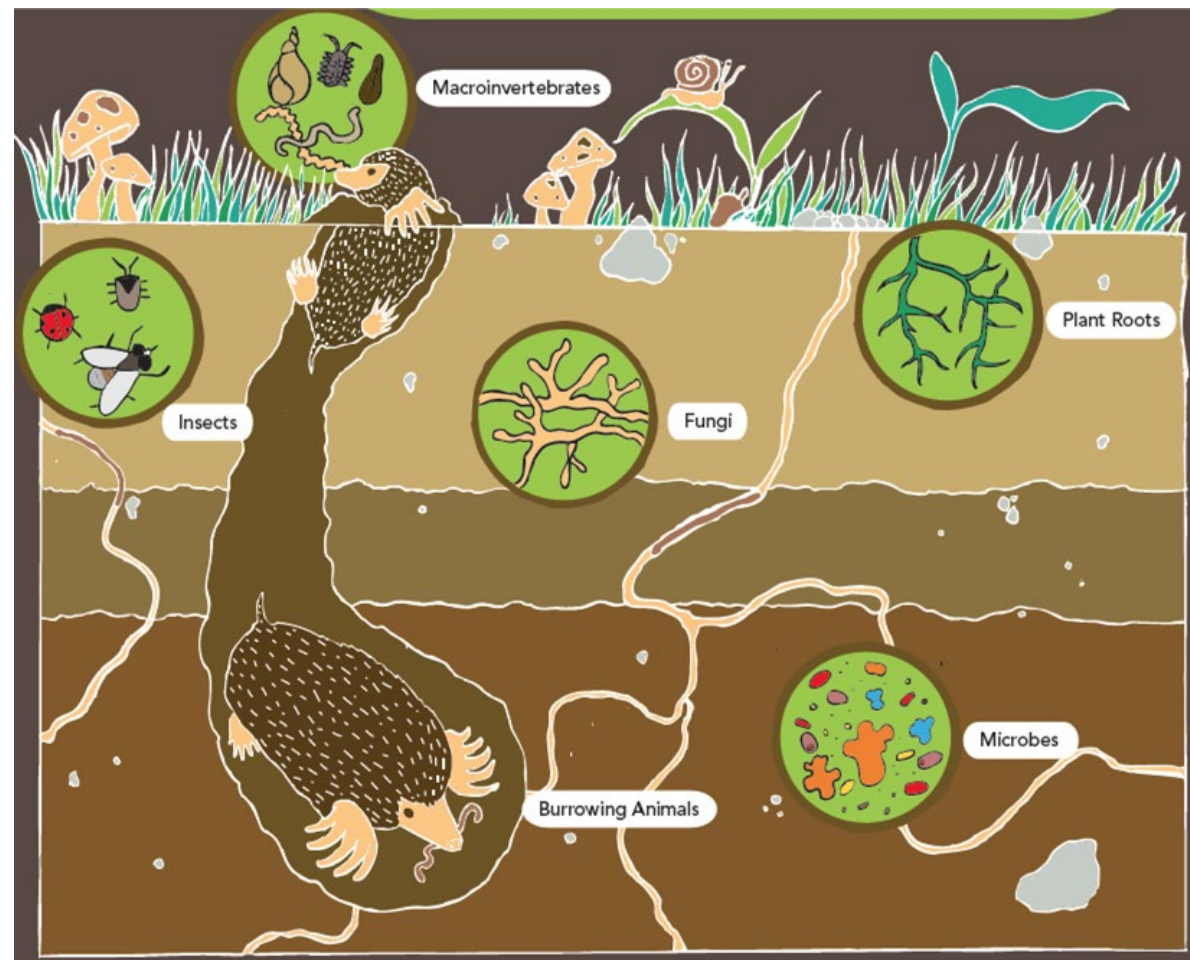
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Soil Composition

Soil Organic Matter

Consists of:

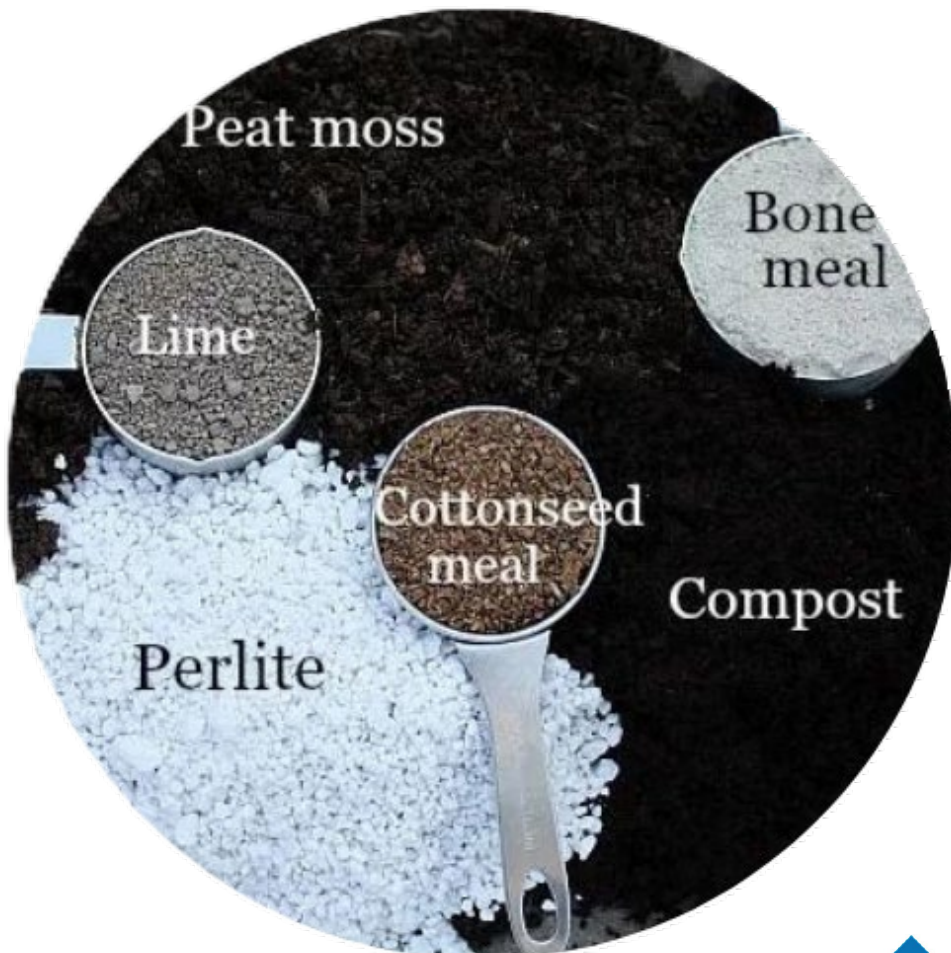
- Microbes
- Fungi
- Plant roots
- Insects - ants, beetles
- Macroinvertebrates - Snails, slugs, worms, pillbugs, etc
- Burrowing animals - moles, gophers



(Captain Planet Foundation – Engaging & Empowering Young People to Be Problem Solvers for the Planet, n.d.)



What about potting soil?



(potting_soil_ingredients.jpg (600x400), n.d.)

- Manufactured product
- Contains variable amounts of different materials
- May be pH adjusted
- May contain fertilizers
- Little or no actual soil
- Great for containers





Factors impacting soil health:

- Structure
- Texture
- pH & nutrient content

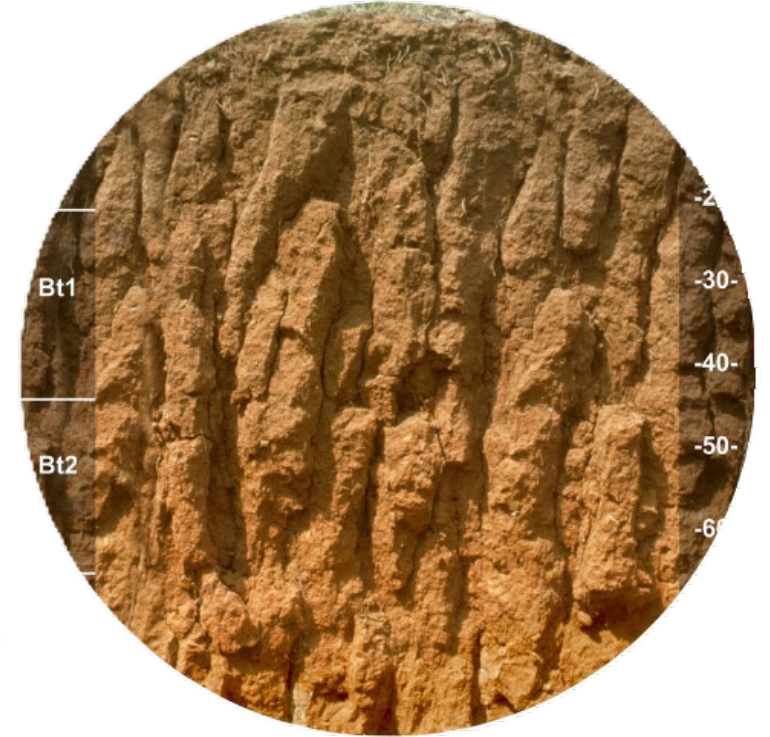


Structure



Granular

Blocky

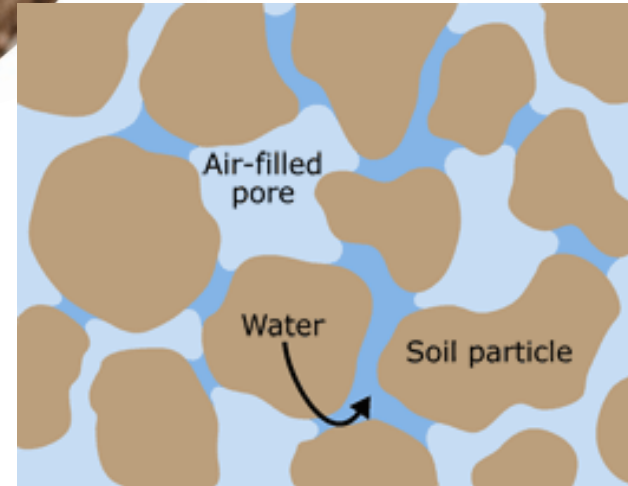


Prismatic

Images:
Granular structure (File:Douglas County, SD, Soil Structure on April 27, 2015 (17207379368).Jpg - Wikimedia Commons, 2015)
Blocky structure (Kelley & Kelley, n.d.)
Prismatic structure (Kelley & Kelley, n.d.)



Texture

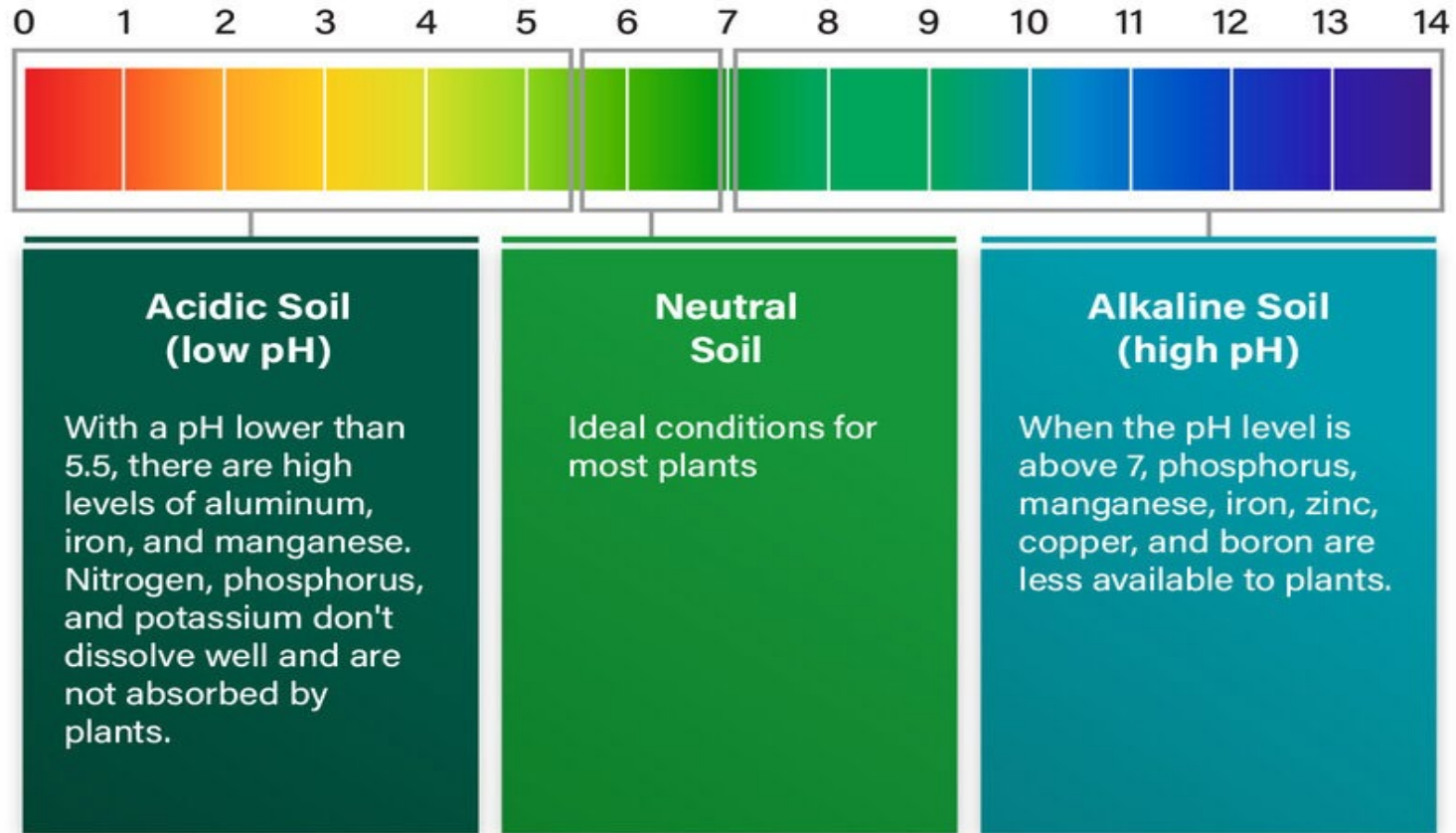


Pore space

Image credit:
Sand: (File:BeachSand.jpg - Soil Ecology Wiki, n.d.)
Pore space: (ds_03_particles-and-pores.gif (260x204), n.d.))



Soil pH



(RSZ_1Soil-Ph.jpg (800×566), n.d.)

LAWN LOVE | lawnlove.com

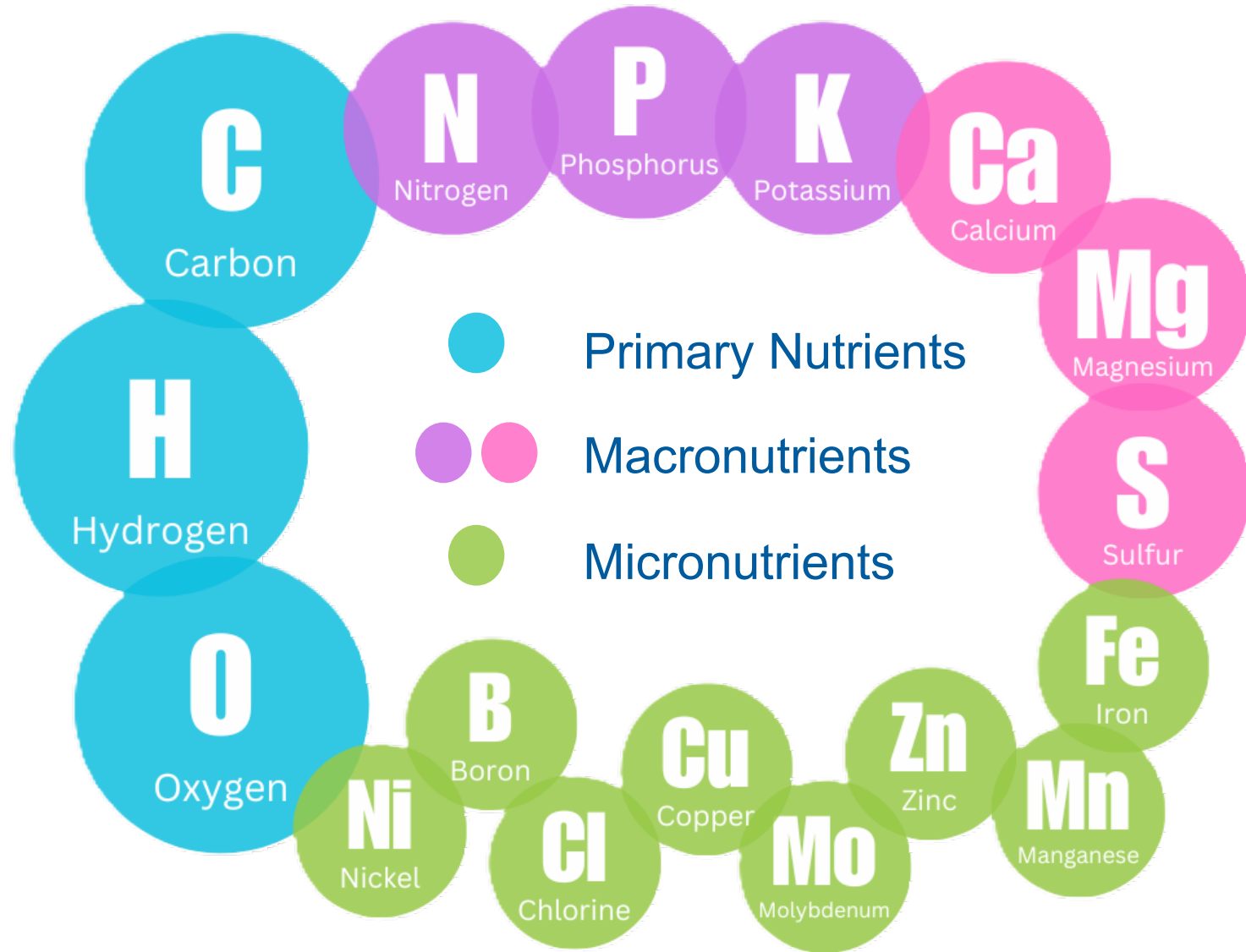


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Essential Nutrients for Plant Growth



5 Essential Functions of Soil

Regulating water



Providing physical stability and support



Cycling nutrients



Sustaining plant and animal life



Filtering and buffering potential pollutants



5 Essential Functions

Regulating water



Healthy soil:

- Absorbs rainfall, snowmelt and irrigation water
- Mitigates flooding
- Supplies water and air to plant roots
- Stores water for plants, wildlife and people





5 Essential Functions

Sustaining plant and animal life



Image: (Schaeffer, 2021)

Healthy soil:

- Provides habitat for organisms such as microscopic bacteria and earthworms
- Creates habitat for diverse plants, animals, and microbes living in and above the soil



5 Essential Functions

Filtering and buffering potential pollutants



Healthy soil:

- Removes pollutants and cleanses water
- Absorbs and filters excess nutrients, and pollutants so water does not carry contaminants to groundwater or surface water

Image courtesy of Canva



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5 Essential Functions

Cycling nutrients



Image courtesy of Canva

Healthy soil:

- Stores & transforms plant nutrients
- Makes nutrients available to plants
- Stores atmospheric carbon
- Minimizes leaching of nutrients to ground and surface water



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5 Essential Functions

Providing physical stability and support



Image courtesy of Canva

Healthy soils:

- Anchor plant roots
- Provide a healthy rooting environment
- Provide a stable foundation for structures
- Protect cultural resources



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Do you have healthy soil?



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Indicators of soil health



Productive plants



Plenty of earthworms



Soil is easy to work



Water easily soaks the surface

Images:
vegetables: courtesy of Canva
gardening hands: courtesy of Canva
earthworms: (File:Earthworm on Earth - heart.jpg - Wikimedia Commons, 2006)
water: (Markus-Spiske-SFYDXGRT5OA-Unsplash-200x300.jpg (200x300), n.d.)



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Getting to know your soil



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Dig a hole



(Screenshot 2018-02-23 AT105742am.png (551×312), 2018)

- One or more holes for each sampling area
- Use a hand auger, shovel or trowel
- Dig when soil is moist
- Look for changes in:
 - texture
 - structure
 - density
 - roots
 - color
 - odor
 - moisture



Check the Texture



Video: (Stark Bro's, 2021)

Simple Soil Ribbon Test



STARK Bro's



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Check the stability



Video: TheUSDANRCS, 2012



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Check the moisture

Fine sand and loamy fine sand soils at various soil moisture



Slightly moist

- Very weak ball
- Well-defined finger mark



Moist

- Weak ball
- Loose sand grains
- Darkened color
- Moderate staining on fingers
- Will not ribbon



Wet

- Weak ball
- Loose sand grains
- Darkened color
- Heavy water staining on fingers
- Will not ribbon

All images: (Estimating Soil Moisture by Feel and Appearance, 1998)



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Check the moisture

Sandy clay loam, loam, and silt loam soils at various soil moisture conditions



Slightly moist

- Weak ball with rough surfaces
- No water staining on fingers
- A few soil grains break away



Moist

- Forms a ball
- Darkened color
- Very light staining on fingers
- Forms a weak ribbon



Wet

- Forms a ball
- Well-defined finger marks
- Light to heavy soil/water coating on fingers
- Ribbons between thumb and forefinger



Check the drainage

- Dig a hole about 1 foot deep
- Fill with water and allow it to drain completely
- Immediately refill the pit and measure the depth of the water with a ruler
- 15 minutes later, measure the drop in water in inches, and multiply by 4 to calculate how much water drains in an hour

< 1" per hour	POOR
1" - 6" per hour	IDEAL
> 6" per hour	EXCESSIVE



Check the color and odor



Black	High in organic matter (4% or more)
Brown	Good organic matter content and well-drained
Red	Low in organic matter, well drained; color is due to the presence of iron
Gray	Low in organic matter, poorly-drained
Yellow	Low in organic matter, well-drained
Mottled	Mottling effects in subsoil indicates both well and poorly drained conditions during the year due to fluctuations in water table

(File:Park Archaeologist Beth Horton Examine Soil Color (43002388321).jpg - Wikimedia Commons, 2018)

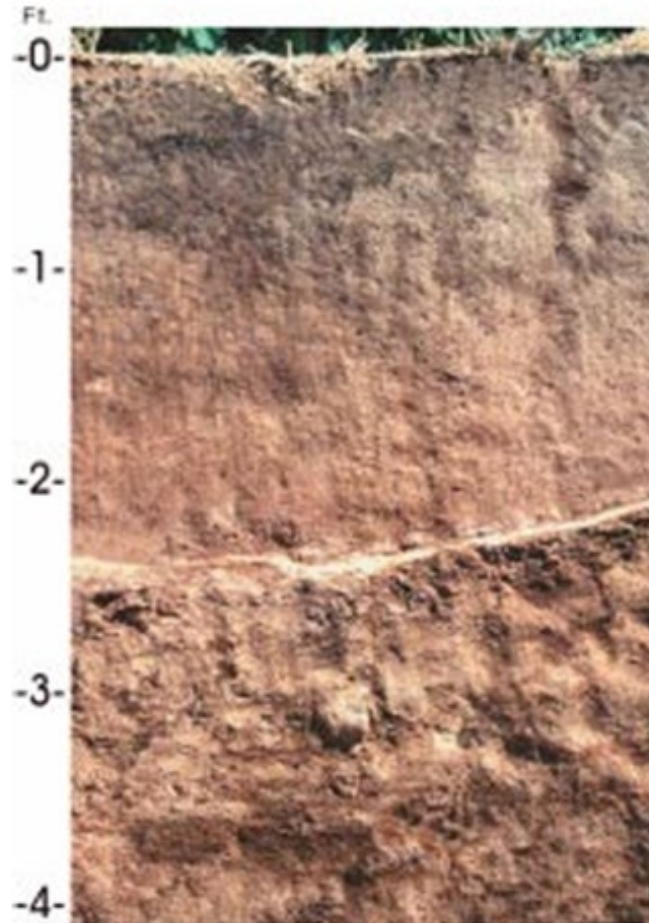


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Check the depth & uniformity



("San Joaquin - California State Soil," n.d.)

Look for:

- compact clay
- bedrock
- hardpan
- layer of sand or gravel

San Joaquin Soil Series

- *Surface layer: brown loam*
- *Subsoil - upper: brown loam*
- *Subsoil - lower: brown clay*
- *Substratum: light brown and brown, indurated hardpan*



Check the pH and nutrients



(81LMIYOIRFL_AC_SX425_.jpg (425x755), n.d.)



(The Celtic Farm, n.d.)



Should I test my soil?



Ask yourself ...

- Do my plants look healthy?
- What am I growing?
- Why am I growing it?
- How much does testing cost?
- What will I do with the results?





Keep Your Soil Healthy



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Manage Common Soil Problems

- Compaction
- Drainage
- Too much water, too little air
- Too little water, too much air
- pH
- Erosion



Compaction

To manage compaction:

- Design your planting area so that you do not walk over bare soil in your garden
- Soil should not be dug until it is sufficiently dry enough to crumble when worked on



Image: (3-Pathway_Sam_Saunders_CCBYSA20.jpg (563x600), n.d.)



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Drainage



(Columbus KFeehan Soil Erosion, resized.jpg (600x400), n.d.)

To improve drainage:

ADD ORGANIC MATTER!

- Compost
- Organic mulches
- Living plants
- Cover crops



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Too much water, too little air

To prevent aeration deficit:

- Avoid compaction
- Improve soil structure
- Select plant species that are more tolerant of wet soils, especially if periodic soil saturation is unavoidable



(File:Gley.JPG - Wikimedia Commons, n.d.)



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Too little water, too much air

To prevent overwatering or underwatering:

- Use appropriate and efficient irrigation systems
- Consider the depth, structure and texture of the soil
- Consider the microclimate
- Understand your landscape's moisture demands



Images:
sprinklerhead: (FEMP_Sprinklerhead.jpg (820×410), n.d.)
Smart water controller: (Rainbird-st.jpg (580×326), n.d.)
Soaker timer: (E3b91cf0-2a5f-4afe-89bf-f82a44af5faa.jpg (800×800), n.d.)
Soaker hose: (04fb5271-5f64-471a-820c-05afc30aa9f7.jpg (800×800), n.d.)

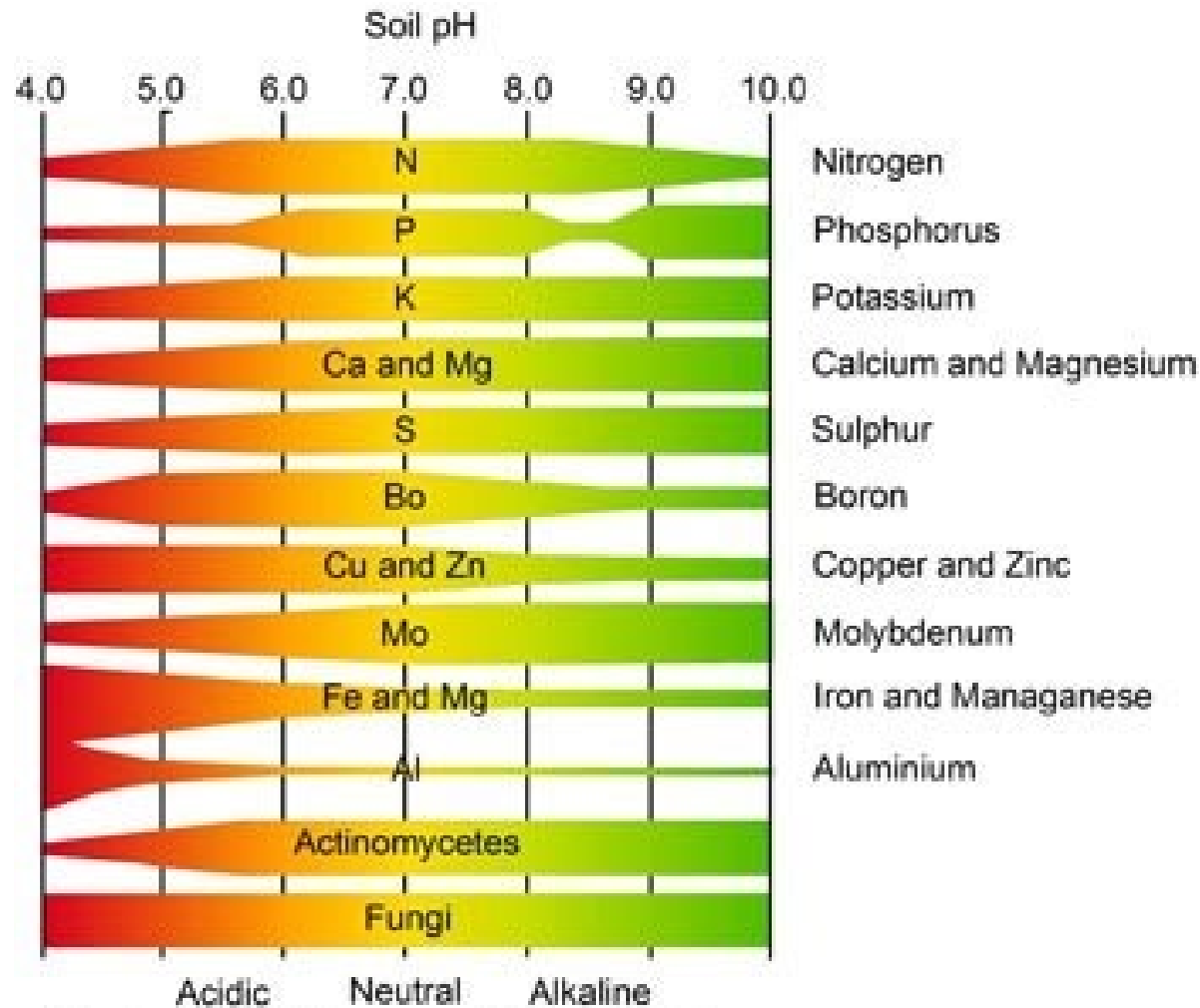


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Soil pH



To adjust pH:

- Replenish the soil each gardening season by amending it with organic matter, e.g., compost and mulch
- Amend soil to adjust soil pH up or down

(316193.jpg (350×363), n.d.)



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Erosion

To reduce erosion:

- Replace lost nutrients by adding compost
- Add three inches of organic **mulch** each year.
- Plant a cover crop
- Use an inorganic mulch (stone, gravel, DG) where appropriate
- Keep soil covered



(Erosion-400x320.jpg (400x320), n.d.)



Optimize Soil Health

5 Principles



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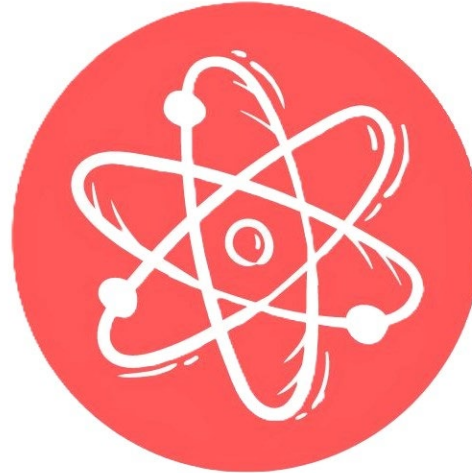
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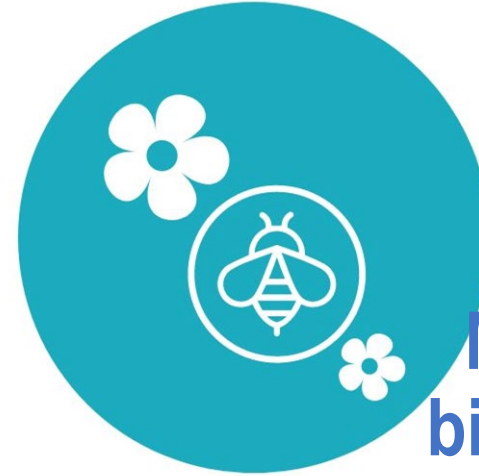
Minimize disturbance



Minimize chemicals



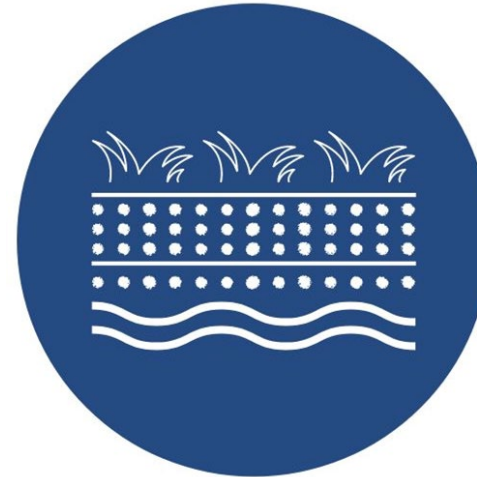
Maximize biodiversity



Maximize living roots



Maximize soil cover



5 Principles



Minimize Disturbance

Why?

- Soil disturbance can create a hostile environment for microorganisms
- Protects against water ponding or erosion.

How?

- Tread lightly
- Don't work in wet soil!
- Lay organic matter on the surface
- Push aside the mulch layer when you plant
- Cut your plants at the soil line



Image: (Boley, 2022)



5 Principles



Maximize biodiversity



Why?

- A wide mixture of plants supports the diversity of soil microorganisms

How:

- Include different plant types (perennial, annual, woody, grassy, broadleaf, legume, etc.)
- Use plants with different root structures (tap, fibrous, etc.).
- Rotate crops



5 Principles



Maximize soil cover

Why?

- Moderates soil temperature
- Conserves moisture
- Provides food and habitat for soil organisms
- Prevents erosion

How:

- Keep soil covered
- Plant cover crops
- Use organic mulch
- Leave plant residue in place



Images:
Wood chips: (Hou, 2019)
Fallen leaves: Jones (2020)
Straw mulch: (343777display.png (1440x502), n.d.)



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5 Principles



Maximize presence of living roots



Why?

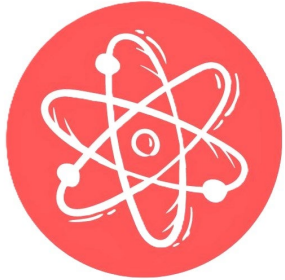
- Slow and steady supply of plant nutrients
- Improves soil structure
- Promotes movement of air and water
- Improved environment for plant roots and soil organisms

How:

- Let it be!
- Leave grass clippings on the lawn.
- Use compost as a mulch.
- Keep plants growing throughout the year



5 Principles



Minimize the use of chemicals

Why?

- Possibly toxic to soil microorganisms
- Can disrupt the symbiotic relationships
- Some pesticides break down quickly while others may persist for long periods.

How:

- Choose organic over synthetic
- Choose the right plant in the right place
- Providing habitat for natural enemies
- Use Integrated Pest Management





Should I use compost from The Greenery?

It depends on your tolerance for risk

Potential benefits:

- Free or low cost organic matter
- Time spent outdoors
- Mental and emotional health

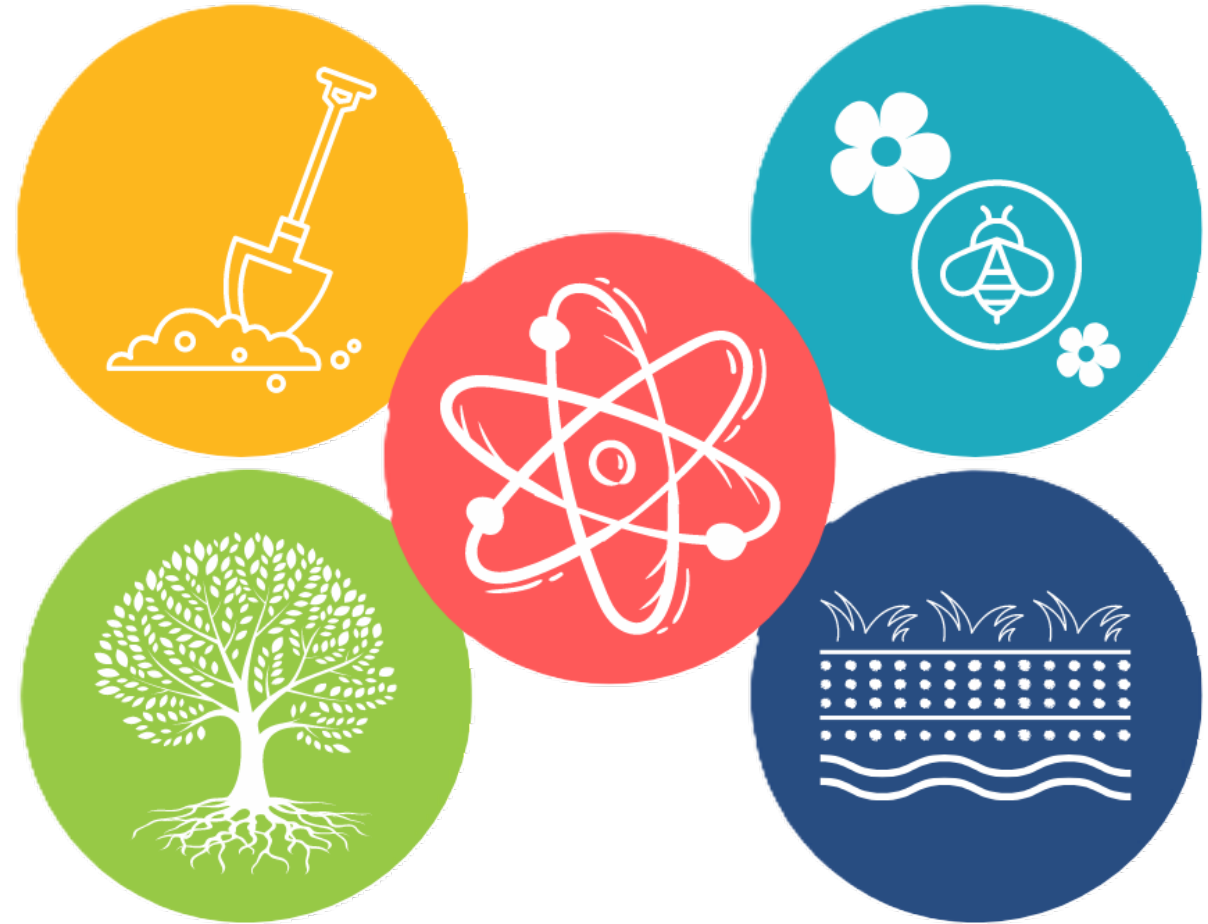
Potential costs & considerations:

- How much would I consume?
- Who would be consuming my produce?
- Other environmental hazards



Conclusions

- Soil is ALIVE!
- Get to know your soil
- Adopt the 5 principles
 - Minimize disturbance
 - Maximize biodiversity
 - Maximize soil cover
 - Maximize living roots
 - Minimize use of chemicals



When in doubt, ADD ORGANIC MATTER!



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