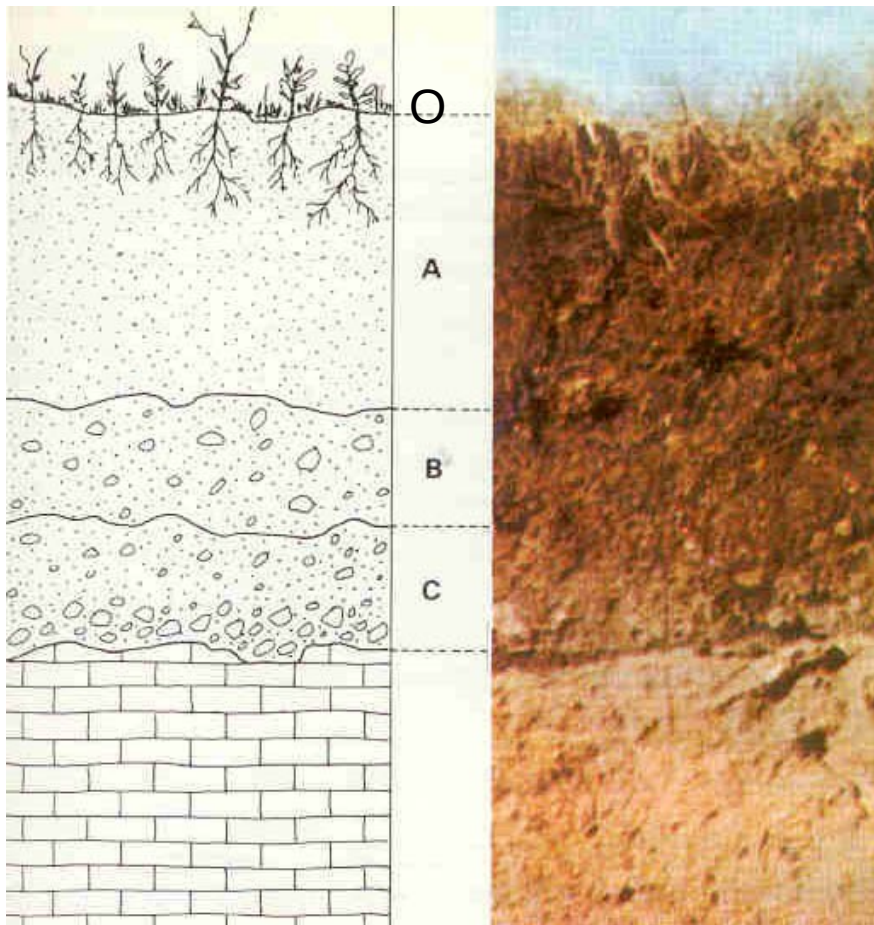




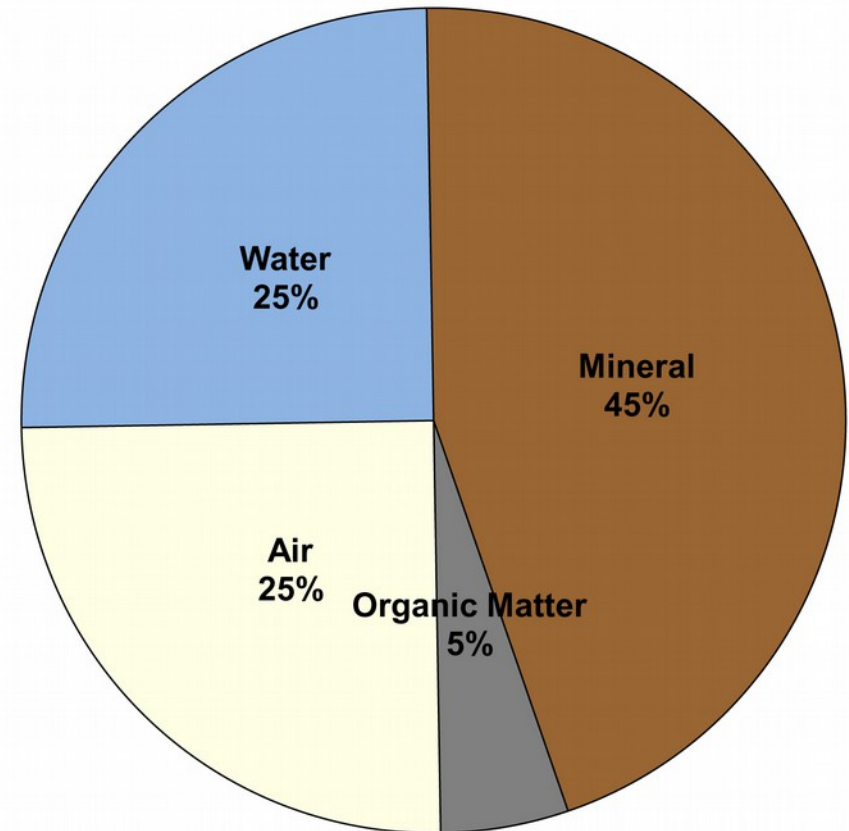
on Composting

Jardin Communautaire de Shediac Community Garden 2016/02/22

Soil



Soil Composition



“Essentially, all life depends upon the soil ... There can be no life without soil and no soil without life; they have evolved together.”

Charles E. Kellogg, USDA Yearbook of Agriculture, 1938

What is humus?

The result of advanced decomposition of organic matter. Contains the micro-remnants of animals, plants and, dead and living micro-organisms. Forms the organic portion of soil.

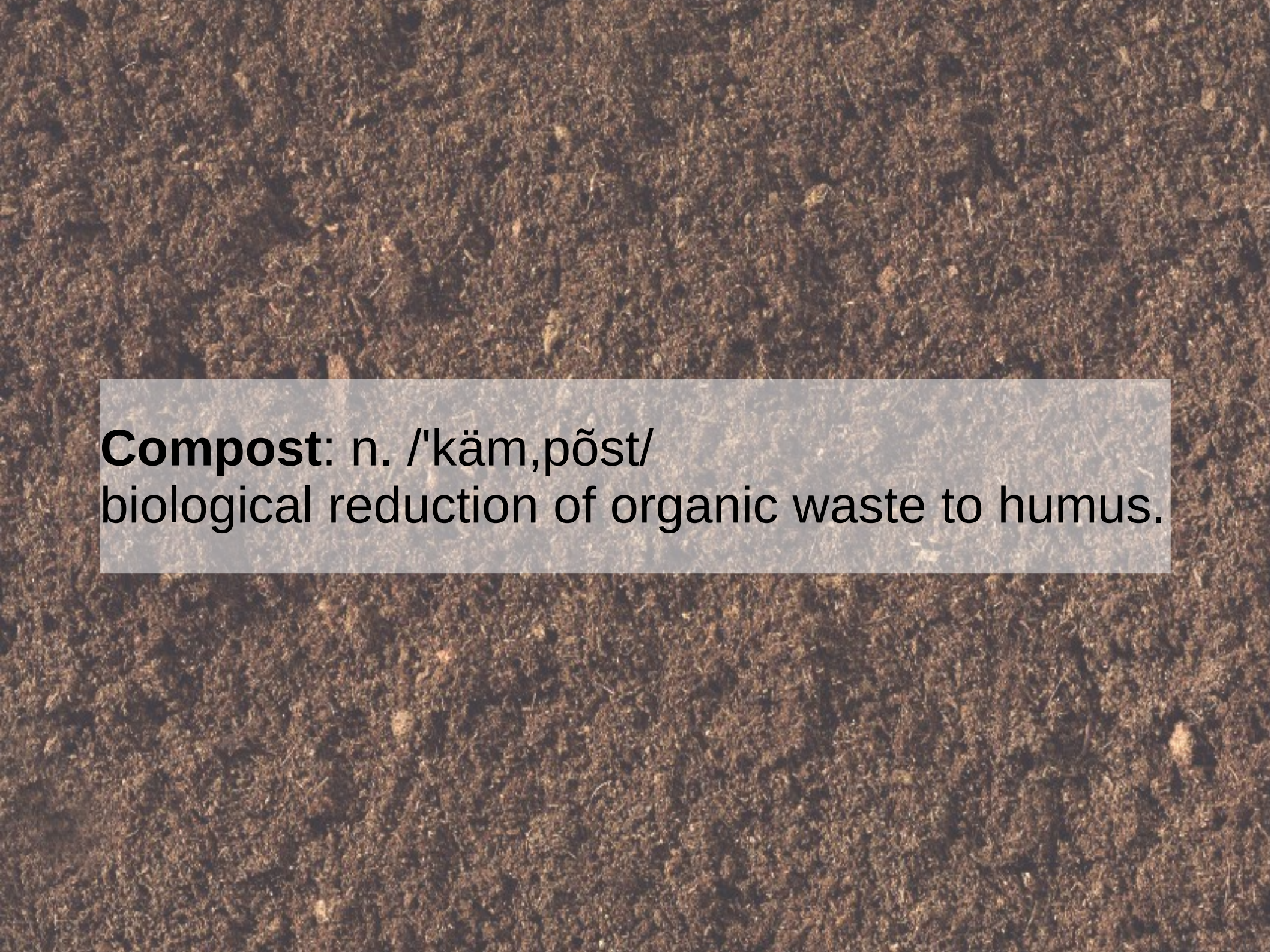
Unstable humus is continuously broken down by microbial and enzyme action, reducing its volume through CO₂ release to atmosphere. Life of ~10 years.

Stable humus is hidden inside small aggregates of soil particles. It contributes little to plant available nutrients but plays a role in maintaining soil physical structure. Life of 100+ years.

What is humus good for?



- source of (slow release) fertilization;
- holds on to minerals (prevents leaching);
- neutralizes toxins – fixes heavy metals;
- retains moisture – 1kg of humus can hold ~2kg of water;
- improves soil structure by forming aggregates;
- stops erosion;
- improves aeration;
- better buffer – plants are less specific to pH needs;
- feeds earthworms – which in turn neutralizes soil;
- stimulates growth;
- helps in suppression of diseases;



Compost: n. /'käm,põst/
biological reduction of organic waste to humus.

Why compost?

- turn non-useful waste into a valuable product;
- reduce waste hauled from home to landfill;
- Stores well (no odour or flies as manure);
- Can be applied at convenient time of year;
- Can be used as bedding substitute;
- Get all the benefits that humus provides

Organic Standard definition of compost:

The product of a carefully managed aerobic process by which non-synthetic materials are digested by micro-organisms. Organic materials for compost shall be managed appropriately to reach temperatures for the duration necessary to effectively stabilize nutrients and kill human pathogens.

55°C for 4 consecutive days;

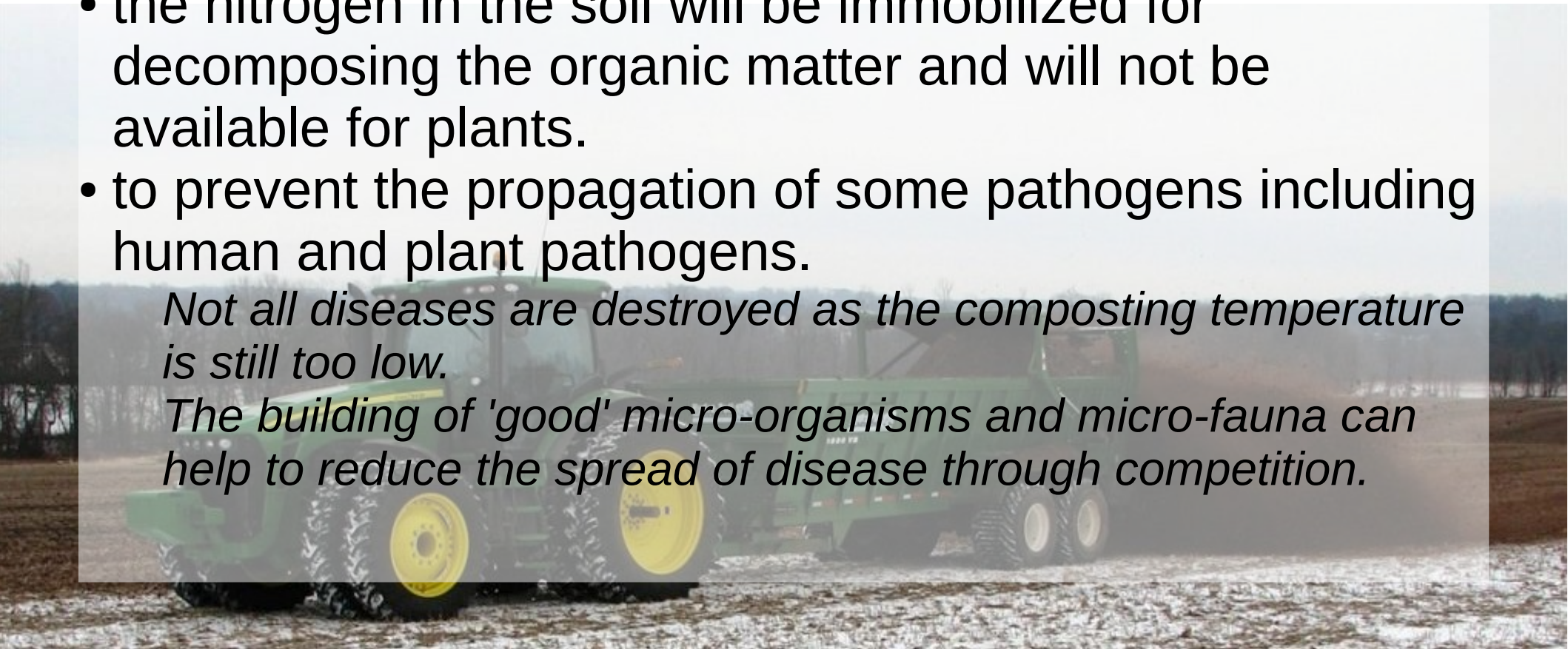
Free of specified risk materials of cattle (mad cow)

Why use compost and not apply organic matter directly to fields?

- to avoid sowing garden with weed seeds.
Most seed will survive the digestive track.
Leaf litter will contain tree seeds (maples)
- the nitrogen in the soil will be immobilized for decomposing the organic matter and will not be available for plants.
- to prevent the propagation of some pathogens including human and plant pathogens.

Not all diseases are destroyed as the composting temperature is still too low.

The building of 'good' micro-organisms and micro-fauna can help to reduce the spread of disease through competition.



And application of manure to fields raise the following additional challenges:

- timing for soil to be sufficiently warm and moist to ensure active bio-oxidation;
- avoiding contributing to the contamination of crops by pathogenic bacteria;
The organic standard specifies that manure must be incorporated into the soil at least 90 days before the harvesting of crops for human consumption that do not come into contact with soil, or 120 days for crops having an edible part that is directly in contact with the surface of the soil or with soil particles.
- minimizing potential for run-off into ponds, rivers and streams;
- avoiding significant contribution to ground and surface water contamination.
- nitrogen overloading

What is carbon?

1	IA	1.0079			
2		6	12.0107		
3		Li	C	Be	
4			CARBON		



- 4th most abundant element in the universe by mass
- 2nd most abundant element in the human body after oxygen
- Naturally occurring forms:
 - amorphous (carbon black, ~coal)
 - graphite - soft!
 - Diamond - hard!
- Approx. 10,000,000 known carbon compounds of which many are essential to all known life on Earth

CO₂ – carbon dioxide

CO – carbon monoxide

CH₄ – methane

CH₃COOH – acetic acid (vinegar)



What is nitrogen?

• 78% of Earth's atmosphere as N_2
 • Nitrogen is required to biosynthesize basic building blocks of plants, animals and other life forms.
 • Occurs primarily as nitrates (NO_3^-) and nitrites (NO_2^-) in soil
 • Bacteria 'fix' the nitrogen from air

LANTHANIDE

57 138.91	58 140.12	59 140.91	60 144.24	61 (145)	62 150.36	63 151.96	64 157.25	65 158.93	66 162.50	67 164.93	68 167.26	69 168.93	70 173.04	71 174.97
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
LANTHANUM	CERIUM	PRASEODYMIUM	NEODYMIUM	PROMETHIUM	SAMARIUM	EUROPIUM	GADOLINIUM	TERBIUM	DYSPROSIUM	HOLMIUM	ERBIUM	THULIUM	YTTTERBIUM	LUTETIUM

ACTINIDE

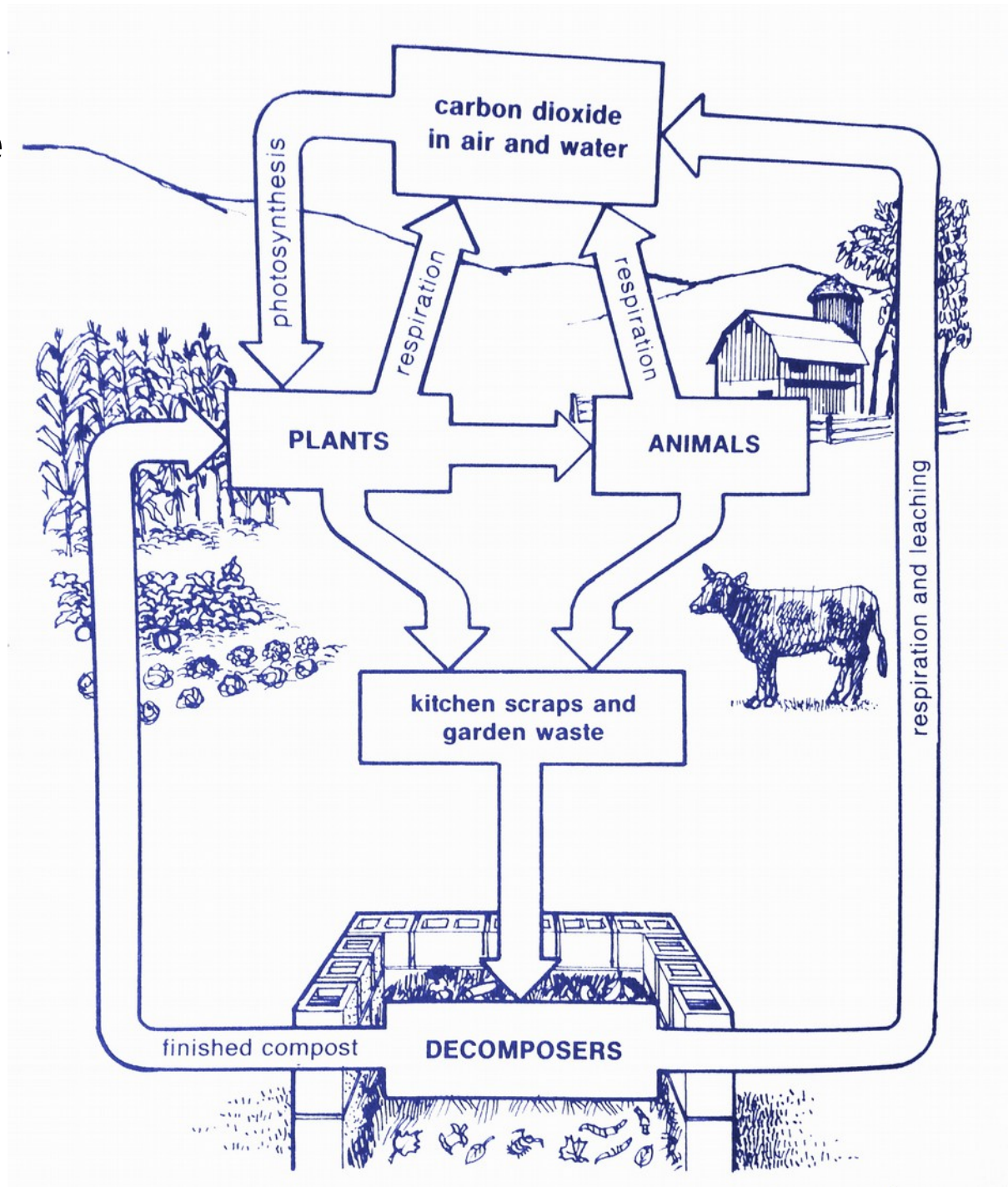
89 (227)	90 232.04	91 231.04	92 238.03	93 (237)	94 (244)	95 (243)	96 (247)	97 (247)	98 (251)	99 (252)	100 (257)	101 (258)	102 (259)	103 (262)
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
ACTINIUM	THORIUM	PROTACTINIUM	URANIUM	NEPTUNIUM	PLUTONIUM	AMERICIUM	CURIUM	BERKELIUM	CALIFORNIUM	EINSTEINIUM	FERMIUM	MENDELEVIUM	NOBELIUM	LAWRENCIUM

Compost is not something new, in history...

- References to composting made in the Bible
- Practised by North-American farmers, 18th & 19th century
- Composting perceived as unnecessary with the advent of mechanization and chemical fertilizers
- Renewed interest as space for waste disposal is diminishing – Municipal solid waste and sewage.

Cutting 62 bu. Wheat
1880 - Wray Colo.

The Carbon Cycle relative to composting



The workforce

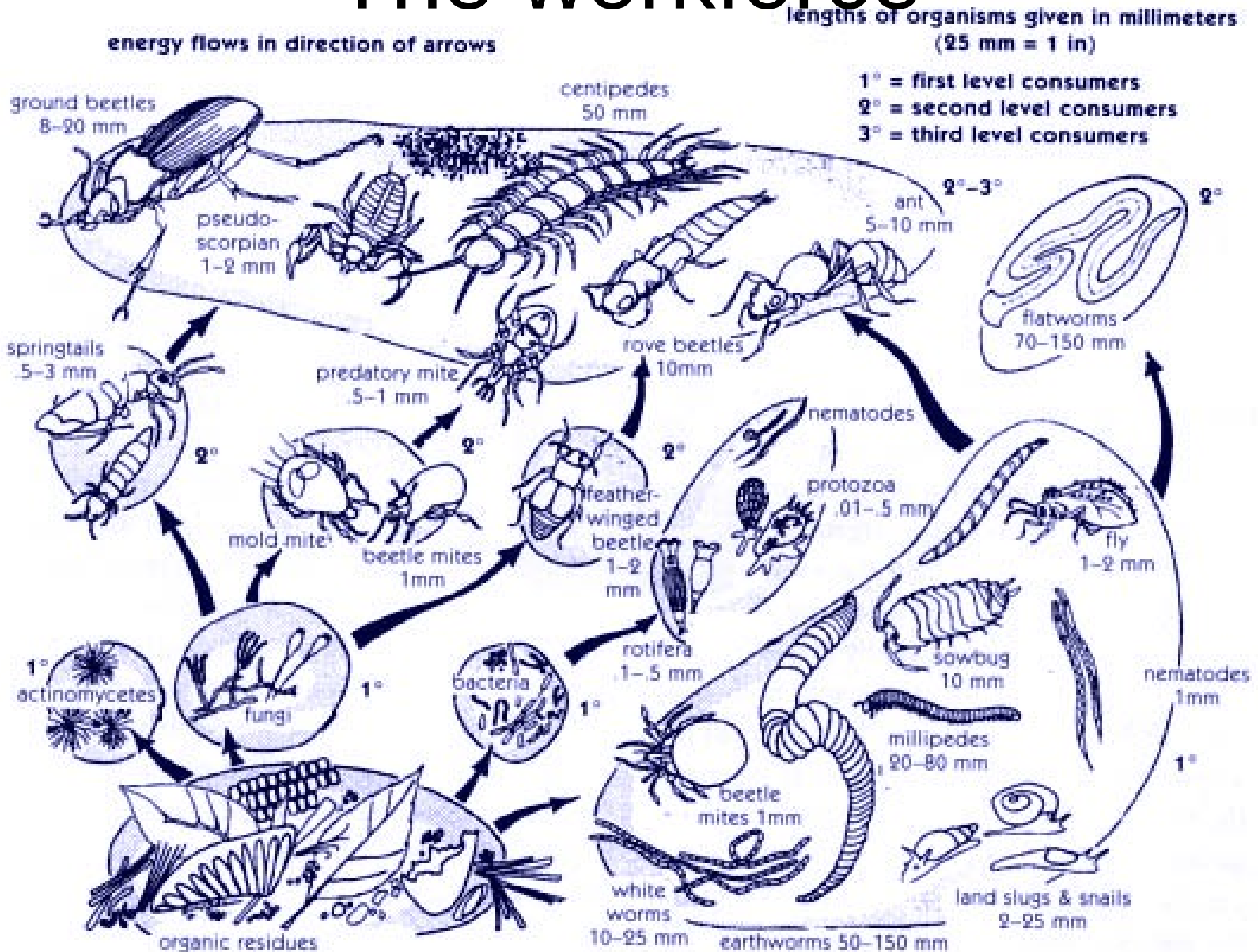
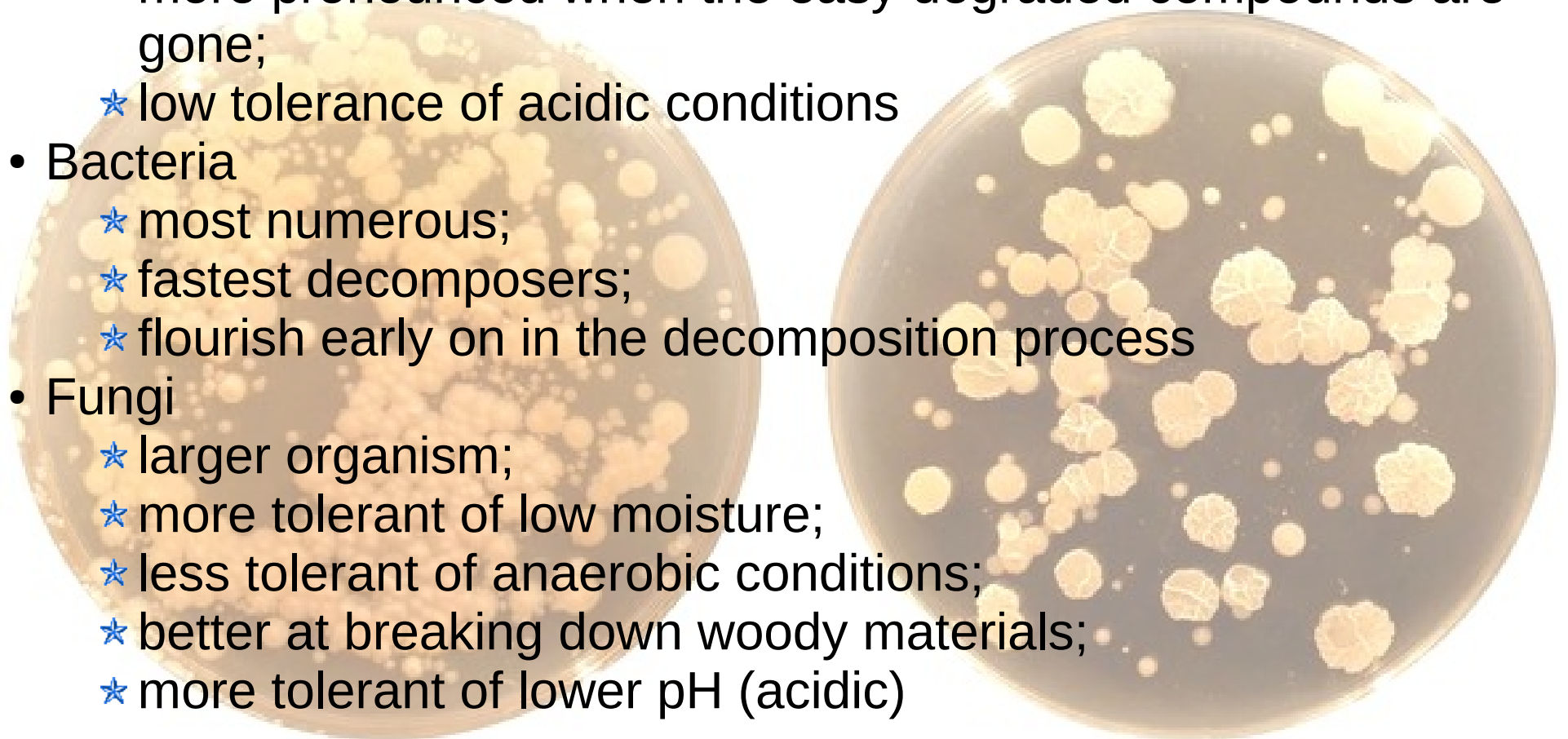


Figure 3.1 Soil organisms and their role in decomposing residues. Modified from D.L.Dindal, 1978.

Primary Consumers

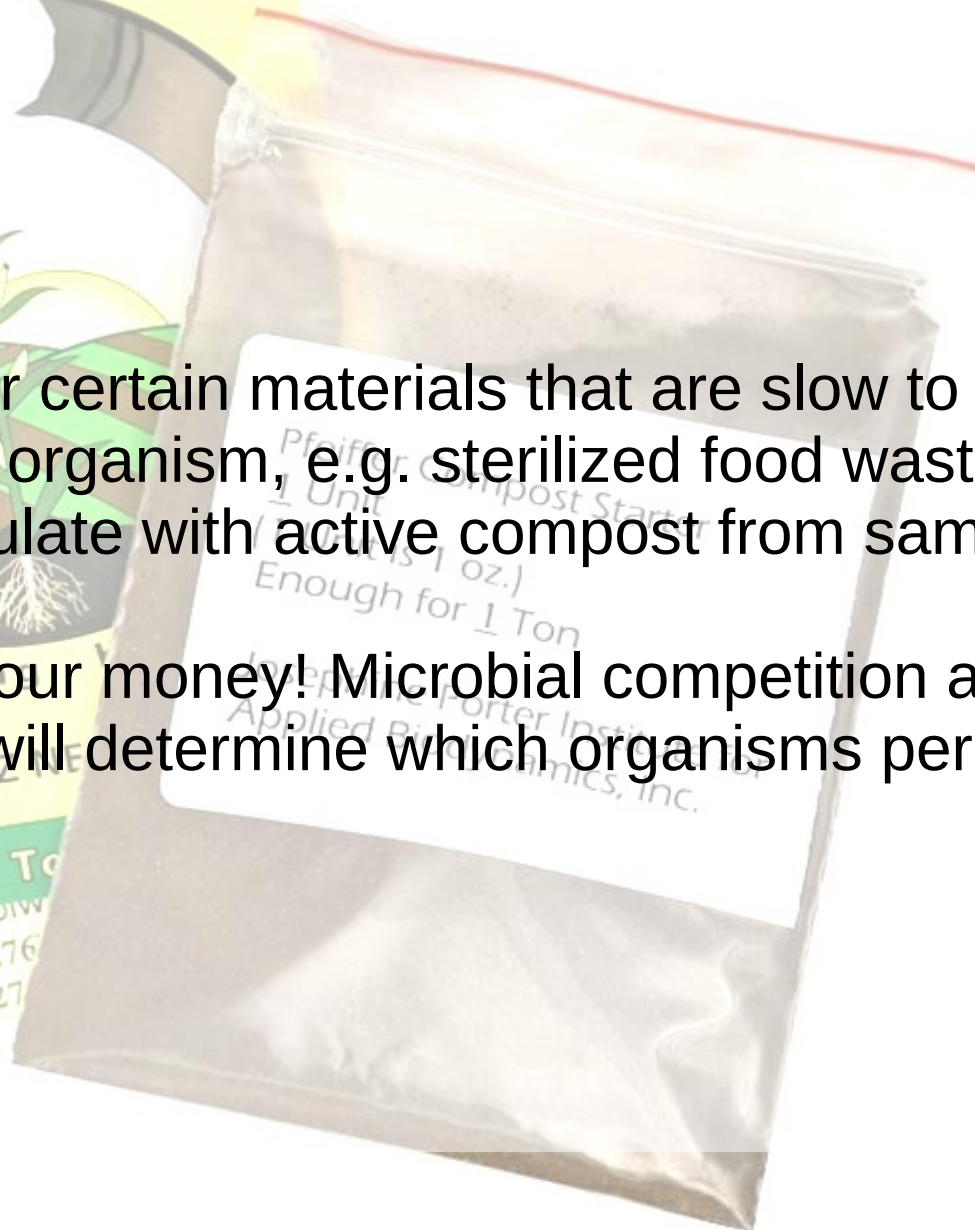
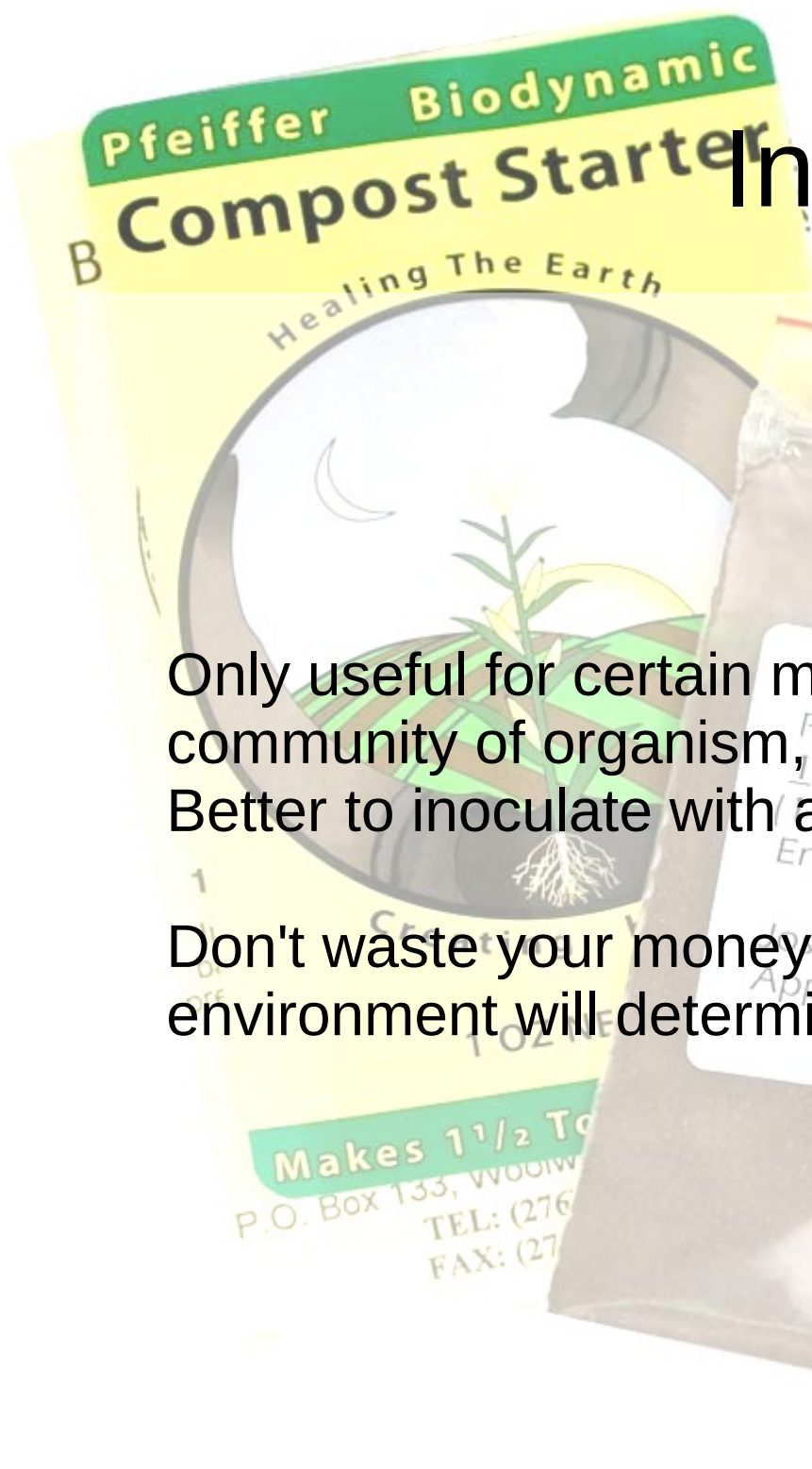
- Actinomycetes
 - ★ form filaments like fungi but are small like bacteria;
 - ★ more pronounced when the easy degraded compounds are gone;
 - ★ low tolerance of acidic conditions
- Bacteria
 - ★ most numerous;
 - ★ fastest decomposers;
 - ★ flourish early on in the decomposition process
- Fungi
 - ★ larger organism;
 - ★ more tolerant of low moisture;
 - ★ less tolerant of anaerobic conditions;
 - ★ better at breaking down woody materials;
 - ★ more tolerant of lower pH (acidic)



Inoculants

Only useful for certain materials that are slow to develop a large community of organism, e.g. sterilized food waste. Better to inoculate with active compost from same material.

Don't waste your money! Microbial competition and environment will determine which organisms persist.



Decomposition

Anaerobic

(absence of air)

- ✓ Less work
- ✗ Slow
- ✓ Fewer nutrients loss
- ✗ Smelly
- ✗ Pathogens and weed seeds can remain intact
- ✗ Risk of phytotoxicity

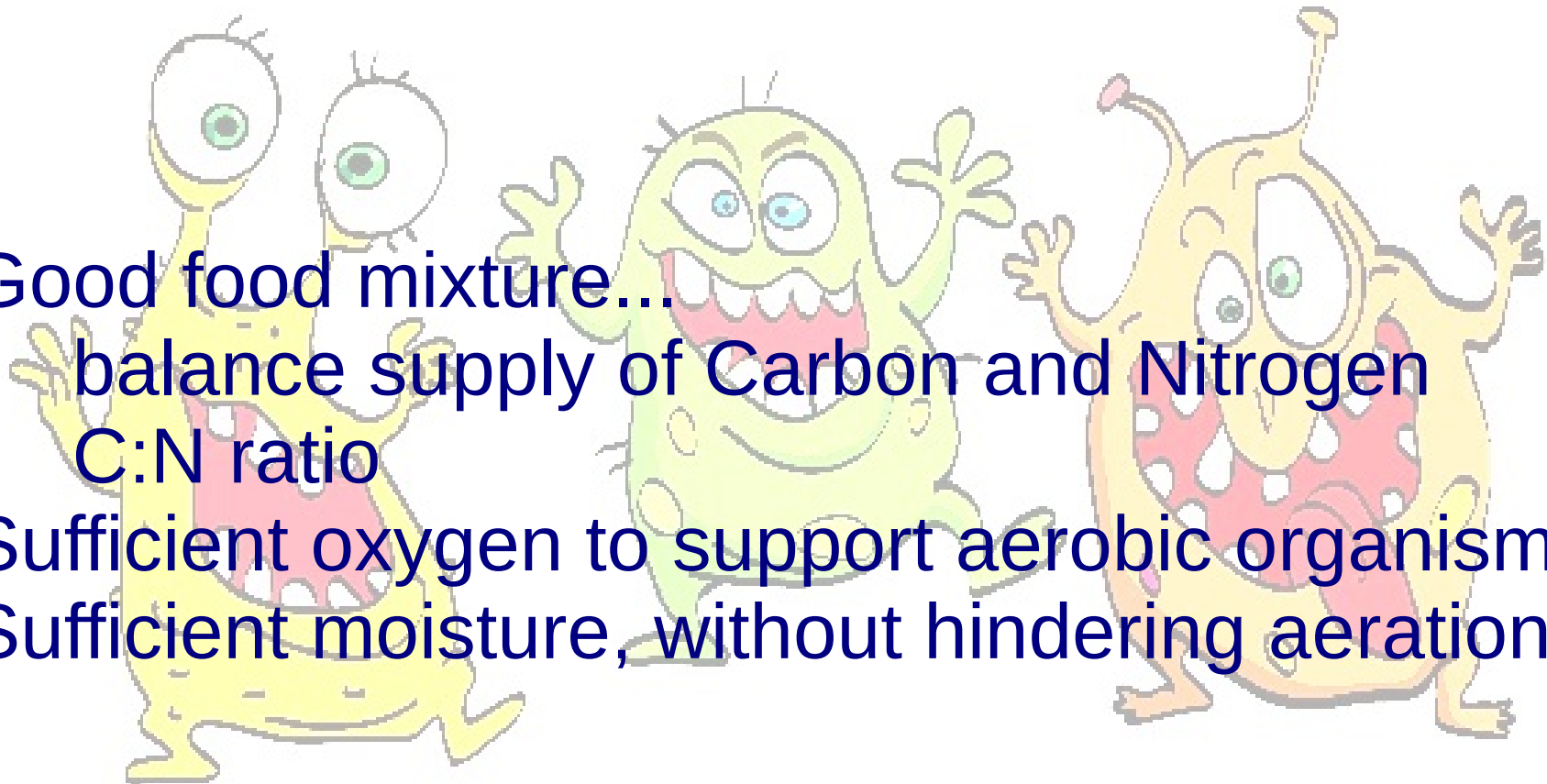
Aerobic

(presence of air)

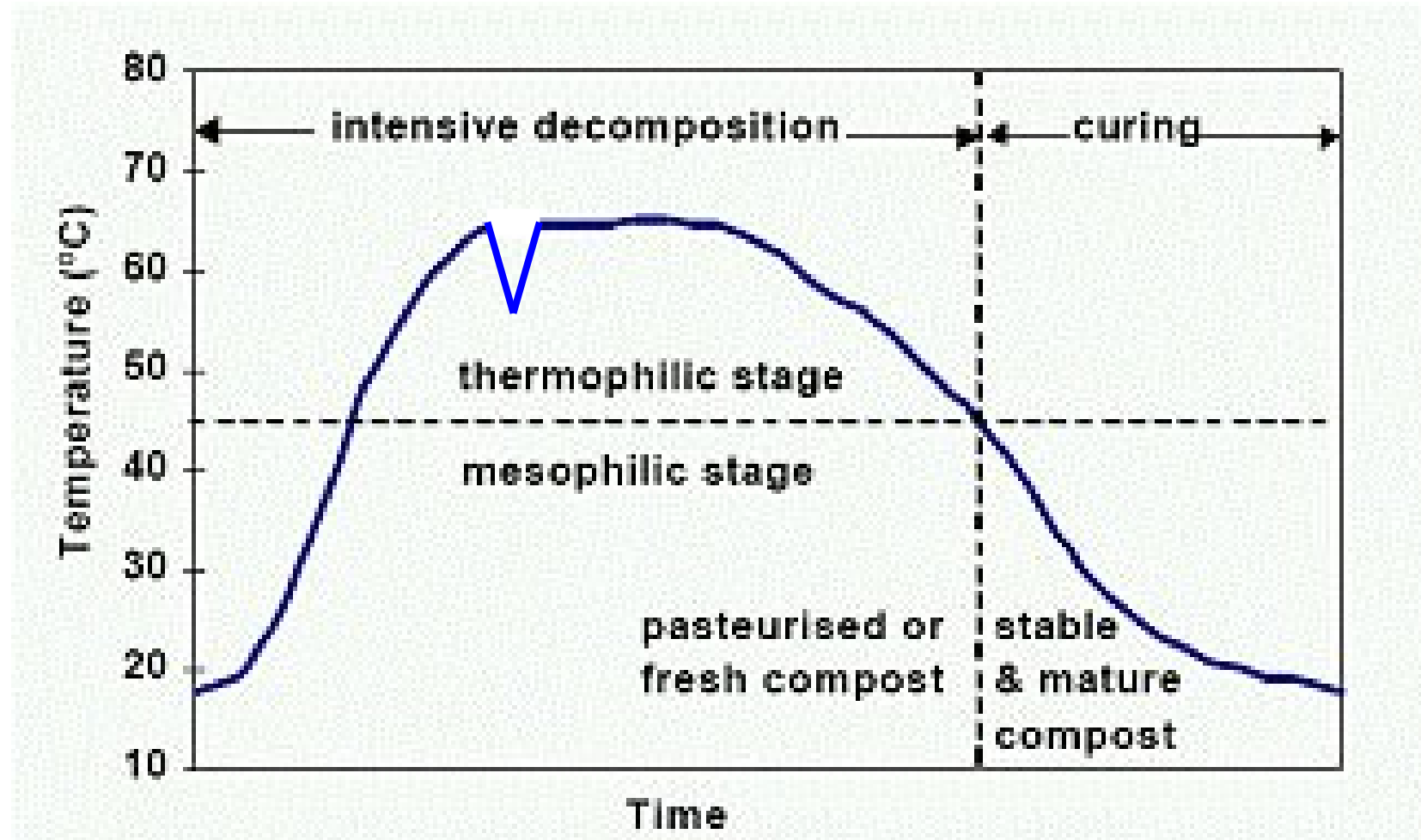
- ✗ More effort required to keep material oxygenated
- ✓ Fast
- ✗ Higher loss of nutrients
- ✓ Final product has an agreeable odor
- ✓ Many pathogens and weed seeds destroyed
- ✓ Generally a safe product

Keep the Workforce Happy!

- Good food mixture...
balance supply of Carbon and Nitrogen
C:N ratio
- Sufficient oxygen to support aerobic organisms
- Sufficient moisture, without hindering aeration



The Process



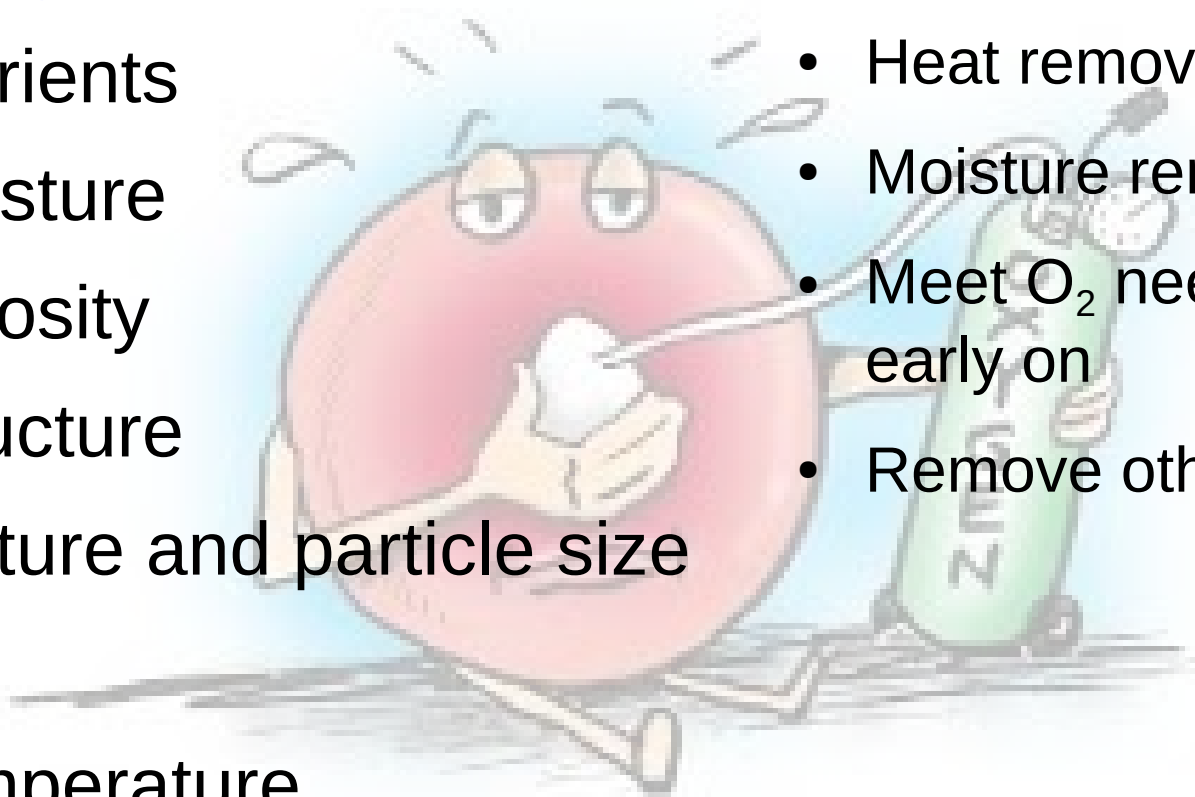
Factors Affecting Composting

★ Oxygen and aeration

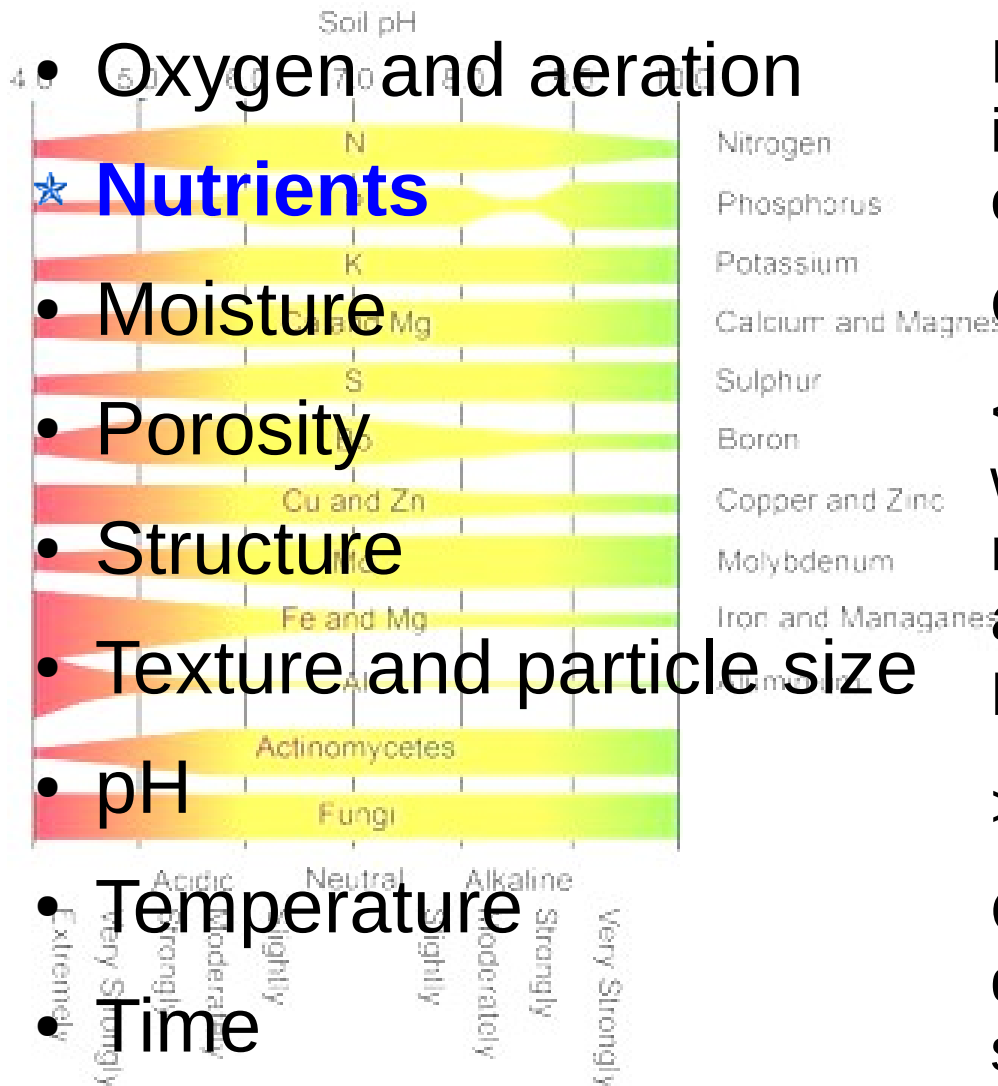
- Nutrients
- Moisture
- Porosity
- Structure
- Texture and particle size
- pH
- Temperature
- Time

Aeration is required for:

- Heat removal
- Moisture removal
- Meet O₂ needs – greater early on
- Remove other trapped gases



Factors Affecting Composting



Excess or insufficiency of Carbon is more likely to affect the composting process.

Optimal: 25 carbon to 1 nitrogen

< 20:1 - all the carbon is used up without stabilizing all the nitrogen... N loss to atmosphere as ammonia NH_3 or nitrous oxide N_2O (smelly)

> 40:1 - longer composting

C availability: woody materials don't release carbon as fast as straw.

Factors Affecting Composting

- Oxygen and aeration
- Nutrients
- ★ **Moisture**
- Porosity
- Structure
- Texture and particle size
- pH
- Temperature
- Time

Biological activity is optimal when materials are saturated.

Ceases when moisture content is below 15%

Ideal between 40% & 65%

Rule of thumb:

Material is too wet if water can be squeezed out of a handful.

Factors Affecting Composting

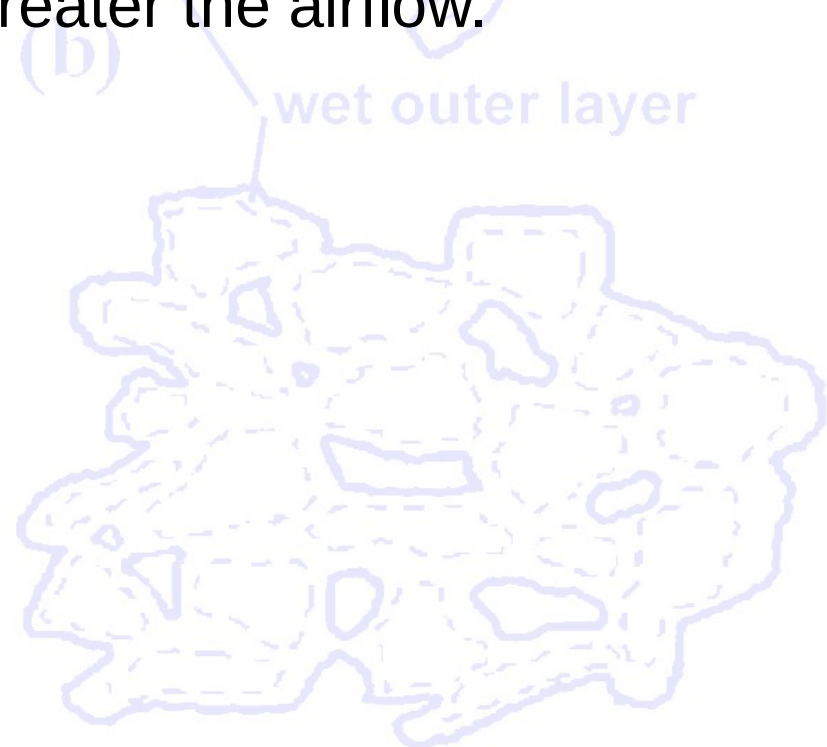
- Oxygen and aeration
- Nutrients
- Moisture

★ Porosity

- Structure
- Texture and particle size
- pH
- Temperature
- Time

Larger particles, and more uniform particles increase porosity...

The greater the porosity, the greater the airflow.



(c)

(d)

Factors Affecting Composting

- Oxygen and aeration
- Nutrients
- Moisture
- Porosity

Ability to resist setting and compaction in moist environment.

★ **Structure**

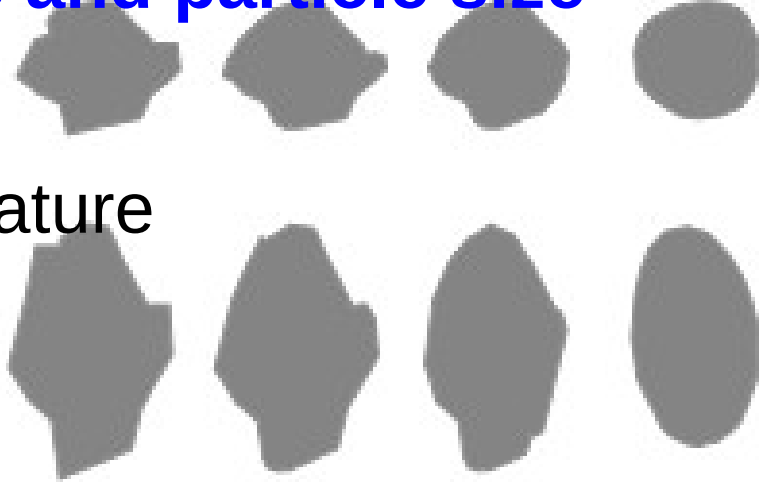
- Texture and particle size
- pH
- Temperature
- Time

Factors Affecting Composting

- Oxygen and aeration
- Nutrients
- Moisture
- Porosity
- Structure

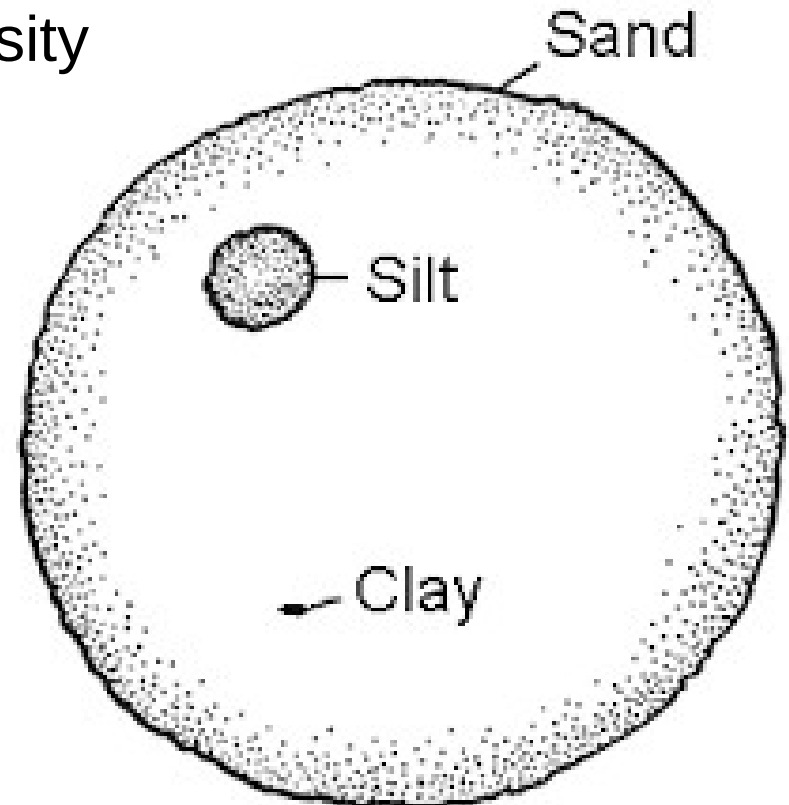
★ Texture and particle size

- pH
- Temperature
- Time



Available surface area for microbial activity.

Smaller particles --> increase of total surface but with lower porosity



Factors Affecting Composting

- Oxygen and aeration
- Nutrients
- Moisture
- Porosity
- Structure
- Texture and particle size
- ★ **pH**
- Temperature
- Time

Due to broad spectrum of microorganisms, composting is relatively insensitive to pH.

Effective between 5.5 and 9 but optimal between 6.5 and 8.

Material with high concentration of N and pH >8.5 encourages conversion of N to ammonia which increases the pH more.

Adding lime or ashes not advisable.

Early: pH is low, raises later on for a near neutral end product.

Factors Affecting Composting

- Oxygen and aeration
- Nutrients
- Moisture
- Porosity
- Structure
- Texture and particle size
- pH
- ★ **Temperature**
- Time

10°C-40°C : mesophilic

>40°C: thermophilic

55°C kills human pathogens

63°C kills most weed seeds

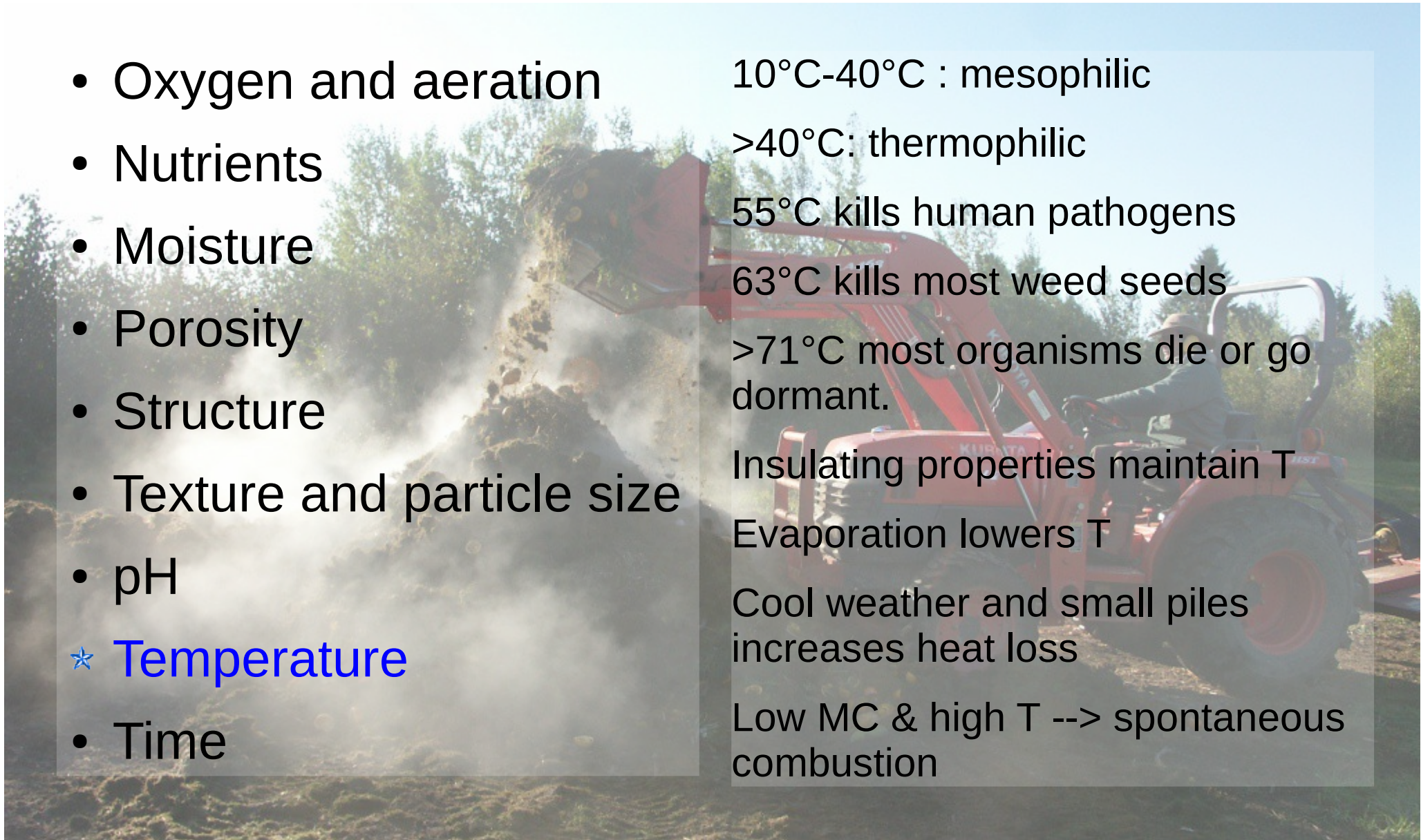
>71°C most organisms die or go dormant.

Insulating properties maintain T

Evaporation lowers T

Cool weather and small piles increases heat loss

Low MC & high T --> spontaneous combustion



Factors Affecting Composting

- Oxygen and aeration
- Nutrients
- Moisture
- Porosity
- Structure
- Texture and particle size
- pH
- Temperature

★ Time

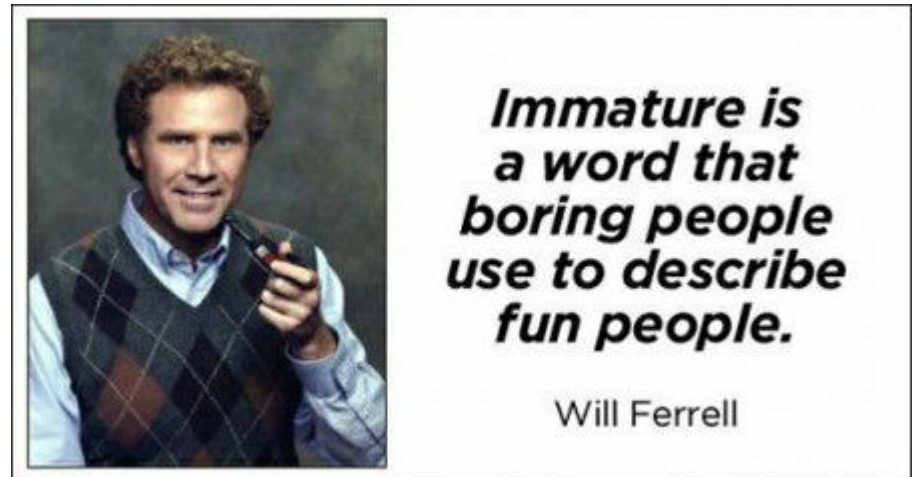
The pre mentioned factors affect the time.

Times can vary from a few days to one year plus curing time

Immature compost

- Immature compost ('hot compost') is still consuming O₂
- Using a hot compost:
 - 1) reduce availability of O₂ to plant roots
 - 2) high level of organic acids
 - 3) high C:N ratioall of which can be damaging to certain applications

Active composting is over when temperature no longer increases after turning.



Curing

- Reduced micro-organism activity
 - ↳ O₂ consumption ↓
 - ↳ Heat generation ↓
 - ↳ Moisture evaporation ↓
- A long curing period provides a safety net to overcome shortcomings of composting process.
- Further decomposition of resistant compounds, organic acids, large particles, and clumps of material.
- PH shifts towards 7 (neutral)
- Exchange capacity ↑
- Humus concentration ↑

Curing, con't

Some decomposition changes only occur at lower temperatures:

- formation of nitrate-nitrogen NO_3^- (available to plant, but soluble and leach-able)
- recolonization of the pile by soil micro-organisms which are responsible for disease-suppressing qualities
- Humus development occurs more readily

Curing is complete...

- when Temperature falls near ambient without the pile being anaerobic or overly dry.
- it smells good like the forest floor
- passes through a 1/2" sieve
- It's brown and crumbly

One month or longer

Extra curing with minimal turning to favour fungi

Home Compost Ingredients



Home Compost Ingredients

Go!

Vegetable scraps
Fruit scraps
Grass clippings
Hair
Twigs, wood chips, sawdust
Fallen leaves
Eggs
Urine
Coffee grinds & filters
Tea bags
Straw
Hay
Old compost

With caution...

Weeds
Meat and bones
Shellfish
Wood ash
Newspaper
Manure
Fat, oil

Naahh.

Diseased plants
Pet poop
Dryer lint
Inoculant
Soil



Method: Layering

COMPOST PILE LAYERING YOU CAN ADD AS MANY LAYERS AS YOU WANT

**DECOMPOSING
MATERIAL LAYERS.
REPEAT THESE AS MUCH AS YOU
WANT:**

THIN LAYER OF SOIL



**LAYER OF GREEN MATERIAL -
SAME AMOUNT AS PREVIOUS LAYER OF
BROWN**



LAYER OF BROWN MATERIAL



**DRAINAGE AND AERATION LAYER
DO NOT REPEAT:
STICKS ON TOP OF LOOSENED SOIL**

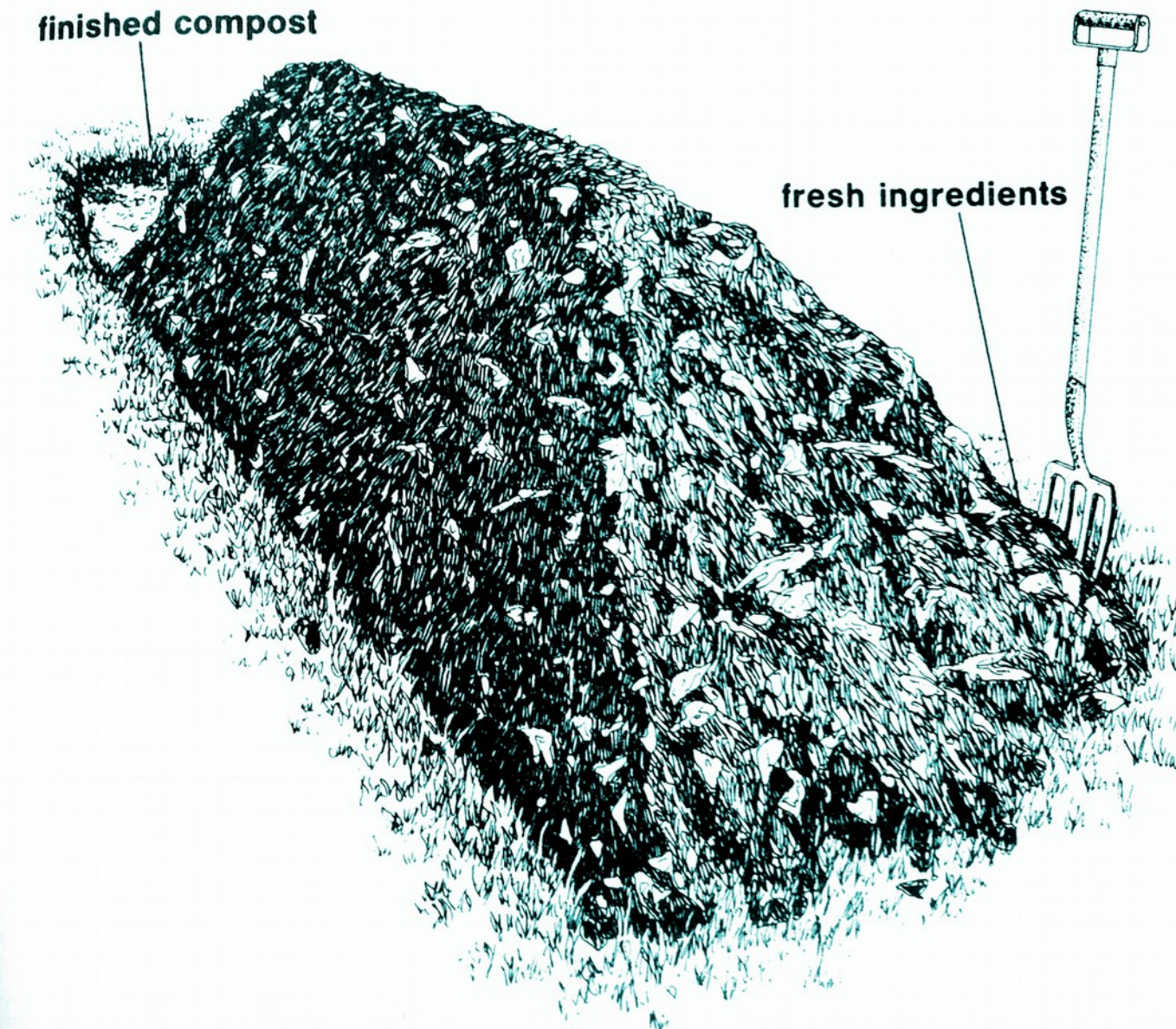


Aerating

- with a pitchfork;
- burying drainpipe at intervals within the pile;
- compost aerating tool;
- layered poles, withdrawn every few days
- sunflower stalks have soft centres that rot out quickly to make organic pipes
- turning whole pile over
- chickens



Method: never ending windrow



Method: rolling bin



- Less work
- Limited to kitchen scraps and small amounts of yard waste

Location, Location, Location

Do...

- Locate close to main source of material
- Locate in sunlight in winter
- Locate in shade in summer
- Shelter from wind
- Have easy access to water

Avoid...

- poorly drained spots that may gather water
- Contact with trees, wooden structures
- Away from combustibles due to risk of self-combustion
- Away from neighbours that may object to smells and sight



Troubleshooting

Problem	Possible Causes
Rotten odor	Anaerobic conditions due to excess moisture or food scraps Anaerobic conditions due to poor porosity and compaction
Ammonia odor	Too much nitrogen (greens); not enough carbon.
Slow decomposition	Not enough moisture Not enough nitrogen; OR slowly degradable materials Not enough oxygen (anaerobic conditions) Pile is cold; small volume Pile is totally frozen Compost is mature
Pile does not reach high temperatures (over 120°F)	Small volume Not enough nitrogen Cold weather
Pile is too hot (over 140°F)	Pile is too large Not enough air flow (poor ventilation) Pile is becoming too dry. Not enough evaporative cooling
Pile attracts pests (flies, bees, dogs, cats, rodents, skunks, etc.)	Exposed food scraps Meat, fish, or oily foods in the pile

Alternates to aerobic composting

Trench composting



Digester



Bokashi Systems



- Great for apartments, condos, students and home owner's assoc. (HOA)
- Quickest return on nutritious food scraps through the nutrient tea
- Broadest compost range: meat scraps, pet wastes, milk, cheeses, citrus
- Least amount of total work for the broadest range of food scraps/benefits
- Works with Biochar



Worm Systems



- Great for apartments, condos, students and home owner's associations (HOA)
- Restrictions on eligible foods, such as citrus, low pH foods
- Does not require soil to bury compost
- Worms can be sensitive to temperature
- Worms and towers available
- Castings are great for the soil



Black Soldier Fly



- Quick return on nutritious food scraps via nutrient tea: 10%
- Composts meat scraps, pet wastes, milk, cheeses
- Produces a compost for worms
- Produces larvae for chickens/fish/reptile feed
- Works well in moist, humid conditions, poorer results in hot dry conditions



Photo Credit: Emily Fitzgerald



STOP: Don't Add

*Pile is Ready for Garden!!

TURN: Don't Add

*Please Turn

GO: Add to
• Pile

Compost bins



















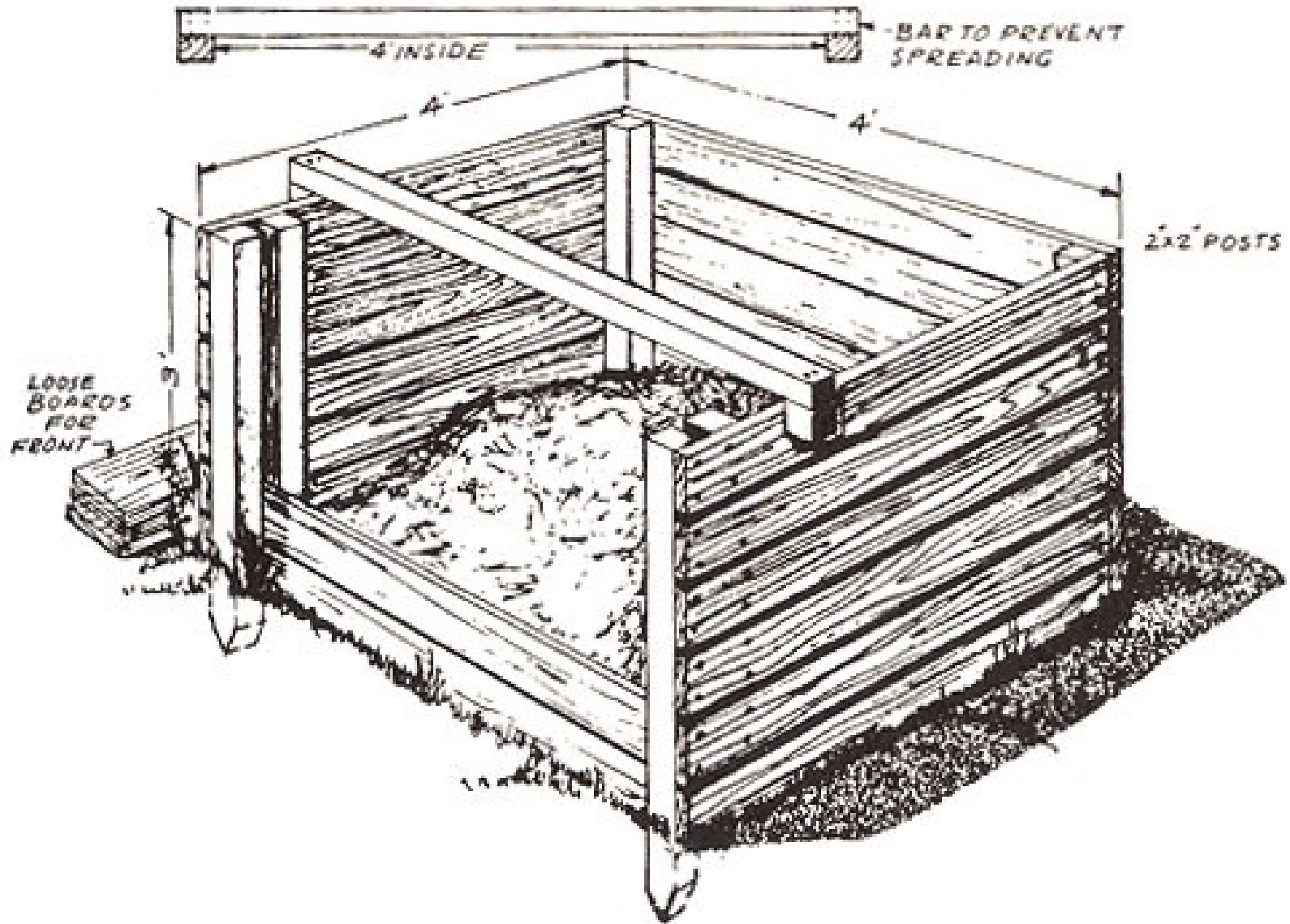
Traditional three-bin system using three of our economical wire bins.









































add food waste and wood chip here

lid controls airflow and removes water

Ridan Composter

Microbes turn waste into fertile compost

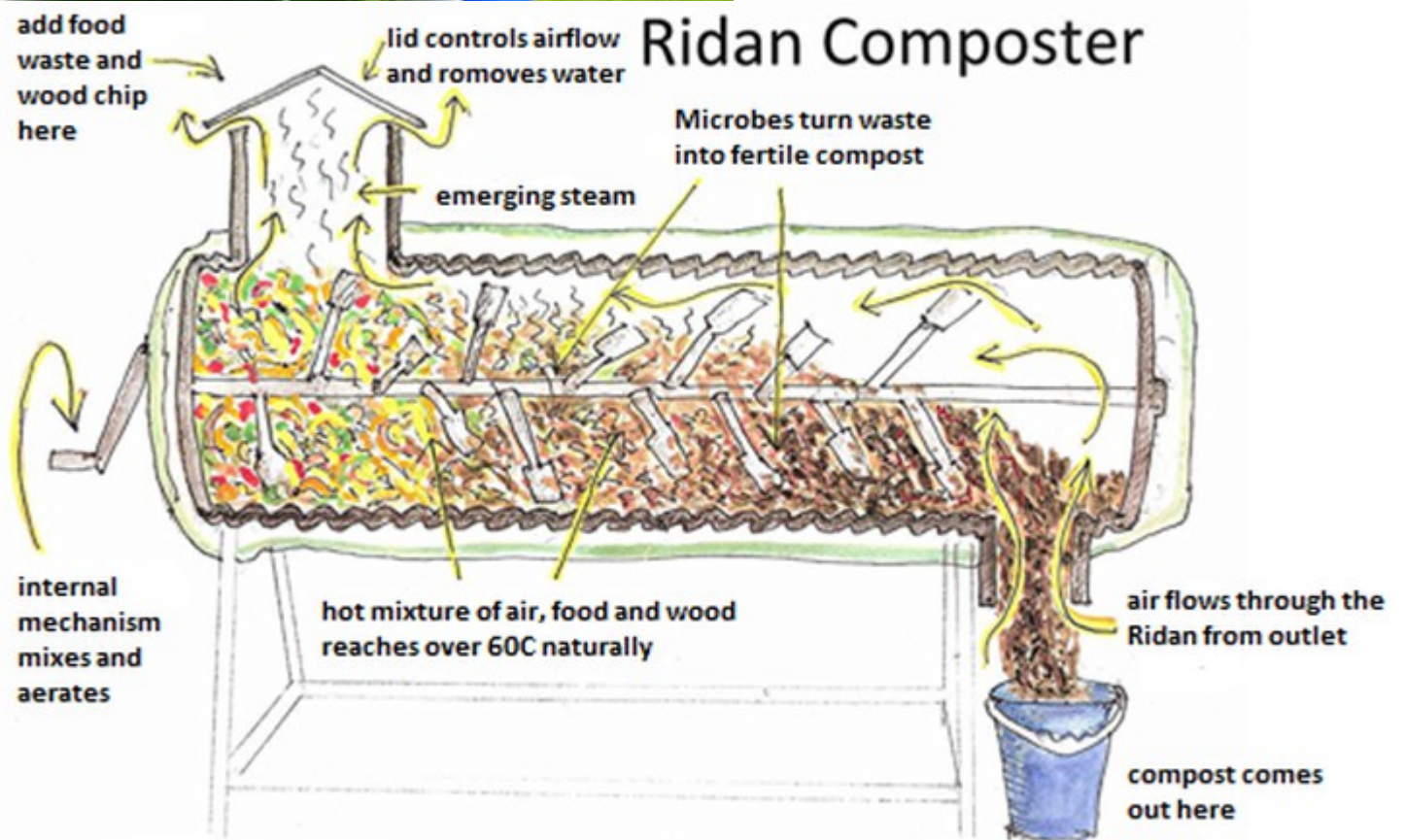
emerging steam

internal mechanism mixes and aerates

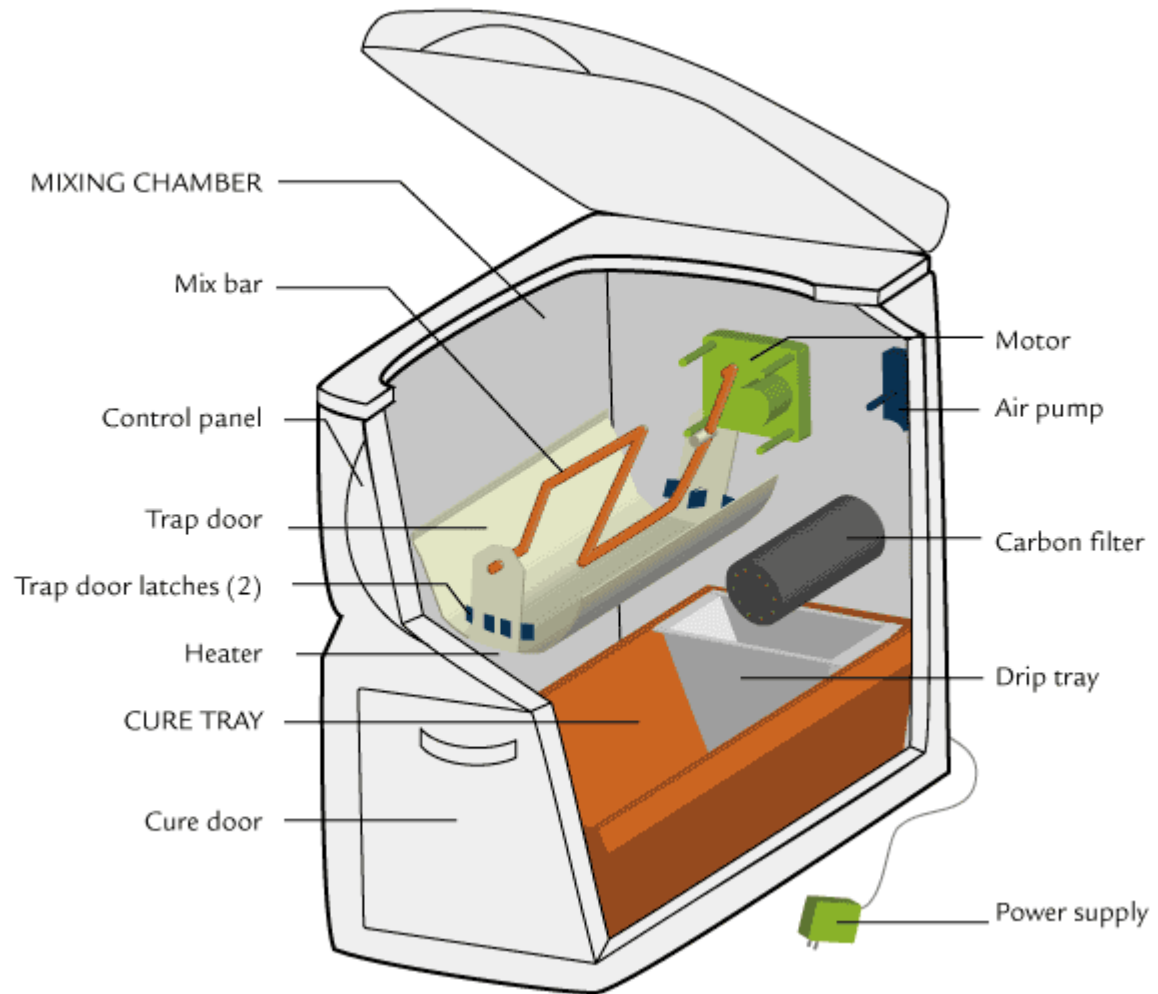
hot mixture of air, food and wood reaches over 60C naturally

air flows through the Ridan from outlet

compost comes out here



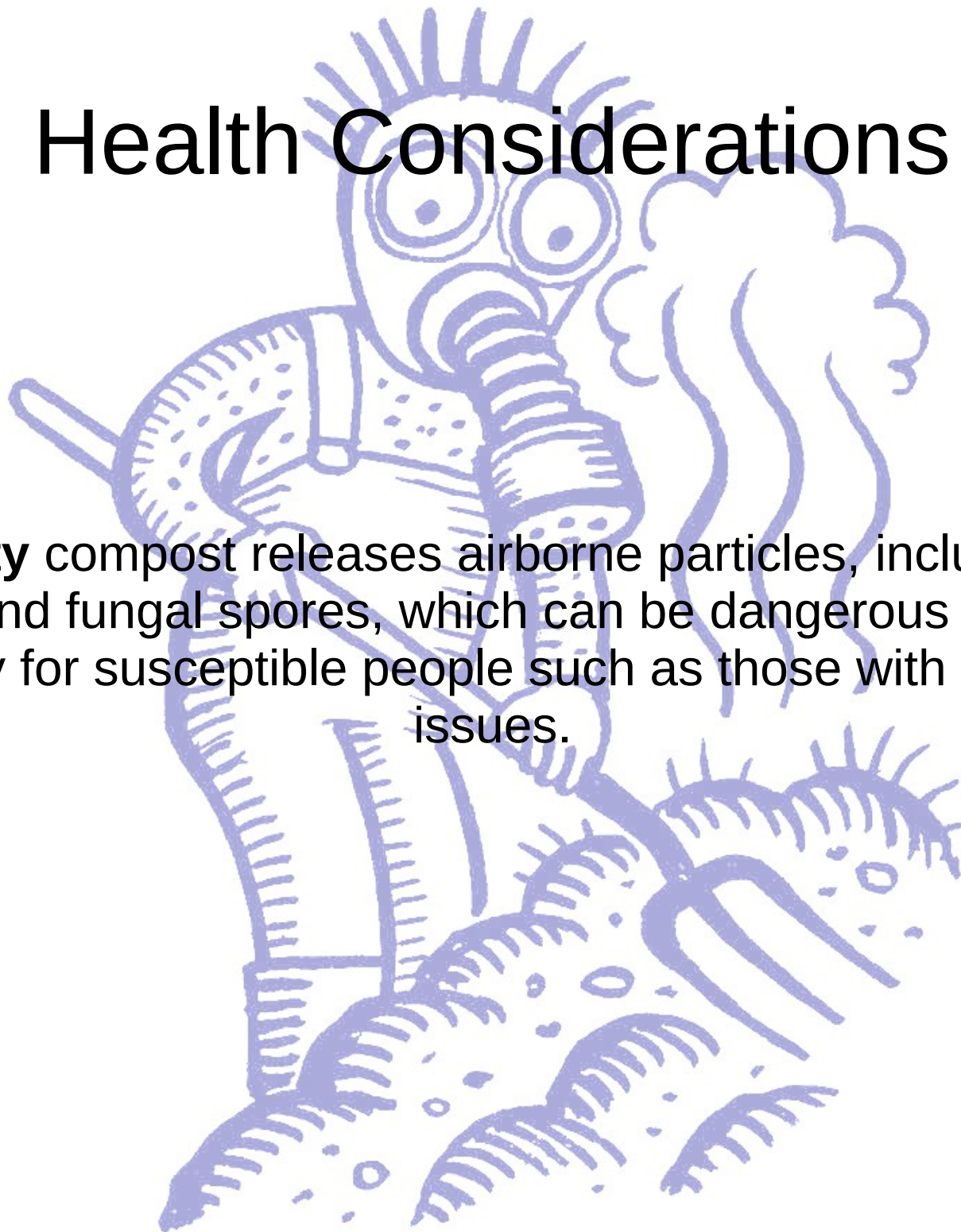






Health Considerations

Dry, musty compost releases airborne particles, including some mould and fungal spores, which can be dangerous to inhale, especially for susceptible people such as those with respiratory issues.



jardin biologique



Amarosia

organic garden

Self-pick /U-pick
Follow me on **facebook**.
to find out which produce
is ready for harvest

Vegetable transplants including ~40 varieties of tomatoes
www.amarosia.com

Compost library

Some of the following can be found on the net for free

Backyard Magic - The Composting Handbook, NB Dept. of Environment, 32pp

Basic On-Farm Composting Manual, The Clean Washington Center, 1997, 48pp

Composting on the Organic Farm, K. R. Baldwin & J. T. Greenfield, North Carolina State University

Compost-the organic farmer's gold!, Chapter 10 of COG's Organic Field Crop Handbook

On-Farm Composting Handbook, NRAES-54, 1992, 186pp

Field Guide to On-Farm Composting, NRAES-114, 1999, 128p, companion book to 'On-Farm Composting Handbook'

The Humanure Handbook : A Guide to Composting Human Manure, 3rd ed., Joseph C. Jenkins, 2005

The Practical Handbook of Compost Engineering, 1993. By R. T. Haug. Lewis Publishers, Boca Raton, FL. 717 p. \$200+

The Rodale Book of Composting: Easy Methods for Every Gardener, by Deborah L. Martin and Grace Gershuny, 1992, Rodale Press

USDA National Engineering Handbook - Chap2 Composting

The Composting Council of Canada - Le Conseil canadien du compostage <http://www.compost.org/>

Science and Engineering of Composting, The, Cornell Waste Management Institute, 1996

<http://compost.css.cornell.edu/science.html>