Compost: Let it Rot

This packet supports the following Georgia and South Carolina Curriculum Standards

Georgia Curriculum Correlations

S6CS3. Students will use computation and estimation skills necessary for analyzing data and following scientific explanations.
S6CS10. Students will enhance reading in all curriculum areas by: c. Building vocabulary knowledge Demonstrate an understanding of contextual vocabulary in various subjects.
S7CS3. Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.
S7CS10. Students will enhance reading in all curriculum areas by: c. Building vocabulary knowledge
S7L4. Students will examine the dependence of organisms on one another and their environments.
a. Demonstrate in a food web that matter is transferred from one organism to another and can recycle between organisms and their environments. c. Recognize that changes in environmental conditions can affect the survival of both individuals and entire species.
S8CS3. Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.
S8CS10. Students will enhance reading in all curriculum areas by: c. Building vocabulary knowledge
S8P2. Students will be familiar with the forms and transformations of energy.

South Carolina Curriculum Correlations

6-1.2 Differentiate between observation and inference during the analysis and interpretation of data.
6-5.2 Explain how energy can be transformed from one form to another
7-1.5 Explain the relationships between independent and dependent variables in a controlled scientific investigation through the use of appropriate graphs, tables, and charts.
Standard 7-4: The student will demonstrate an understanding of how organisms interact with and respond to the biotic and abiotic components of their environment. (Earth Science, Life Science)
7-4.4 Explain the effects of soil quality on the characteristics of an ecosystem.
7-5.10 Compare physical changes (including changes in size, shape, and state) to chemical changes that are the result of chemical reactions (including changes in color or temperature and formation of a precipitate or gas).

http://en.wikipedia.org/wiki/File:Compost-dirt.jpg

Compost: Let it Rot

Compost: What is it?

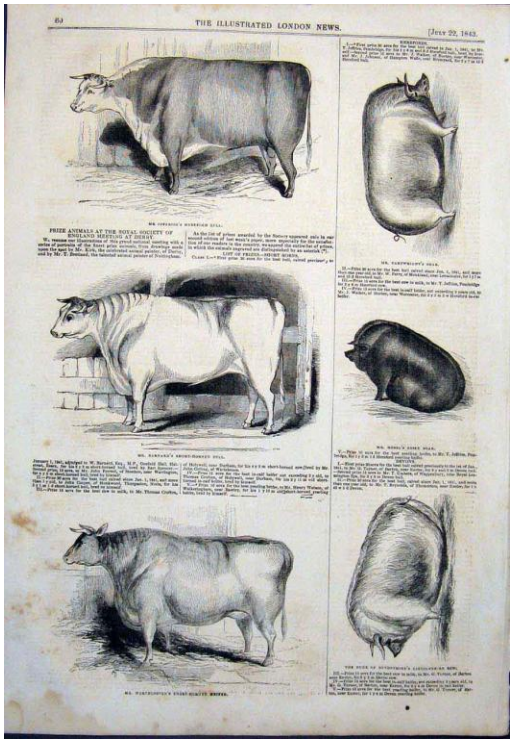
Compost is partially decomposed organic matter.

Compost: Where did it come from?

Composting as a recognized practice dates to at least the early Roman Empire. Traditionally, the most common method of composting was to pile leftover organic materials up and leave them until the next planting season, at which time the materials would have decayed enough to be ready for use in the soil.

The advantage of this method is that little working time or effort is required from the composter (the farmer) and it fits in naturally with agricultural practices in temperate climates. Disadvantages (from the modern perspective) are that space is used for a whole year, some nutrients might be leached due to exposure to rainfall, and disease producing organisms and insects are allowed to live on in the pile of decomposing materials.

Farmers knew from experience that the soil nourished their crops, and traditional farming methods included elements of composting and fertilization, but they were done without a scientific understanding of why they functioned as they did. Trained chemists began to study plant nutrition by 1750, but it wasn't until 1843 that the first official field experiments were conducted. By the 1850s, new scientific methods of farming were being called "book farming."



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In the American South, by the mid 19th century salt and lime were considered among the most valuable agents in composting and decomposing organic substances. Three bushels of slacked lime (also called calcium hydroxide, this white powder is made when lime is mixed (*slacked*) with water; it is used for a variety of tasks – from rising the ph of soil, to preserving food and tobacco products) and to one bushel of salt dissolved in as little water as possible has all sorts of applications! This mixture could be used to destroy the odor of putrefying animal matter, supply plants with chlorine, lime, and soda, decompose vegetable refuse, and absorb pig urine in pig pens.

Historically, farmers composted even items that we would **not** recommend you place in your compost today! These tricky substances included offal from slaughterhouses (the internal organs

and entrails of a butchered animal) as well as whole dead farm animals, buried in a deep pit layered top and bottom with mulch or loam and composted for a year. Night soil and chamber slop (human wastes) were even composted, using charcoal, black wood mould, and gypsum. Special care must be taken with these substances to prevent to the spread of pathogens and diseases.

Composting was somewhat modernized beginning in the 1920s in Europe as a tool for organic farming. The first industrial station for the transformation of urban organic materials into compost was set up in Wels/Austria in the year 1921. This modern composting was imported to America by various followers of these early European movements in the form of persons such as J.I. Rodale, E.E. Pfeiffer (who developed scientific practices in biodynamic farming), Paul Keene, and Scott and Helen Nearing (who inspired the back-to-land movement of the 1960s).

Compost is partially decomposed organic matter. Mature compost is defined as a thermophilic converted product with high humus content that can be used as a soil amendment and can prevent or remediate pollutants in soil, air, and storm water run-off.

Composting is the controlled decomposition of organic materials by microorganisms.

Humus is completely decomposed organic matter.

Thermophilic; is a descriptive term, meaning that it is something grown best in a warm environment; heat is used in the creation of compost.

Mulch is organic or inorganic materials spread in a layer on the soil surface.

Decomposition: How does it work?

Decomposition (or **rotting**) is the process by which organic material is broken down into simpler forms of matter.

To create compost, one must bring together the agents of decomposition (the decomposers, like Microorganisms, Macroorganisms *(organisms that can be seen by the naked eye)*, Bacteria, Fungi and Actinomycetes) with proper materials, conditions, moisture, and time. Compostable materials are all around you!

http://en.wikipedia.org/wiki/File:Composting_in_the_Escuela_Barreales.jpg

Why Compost?

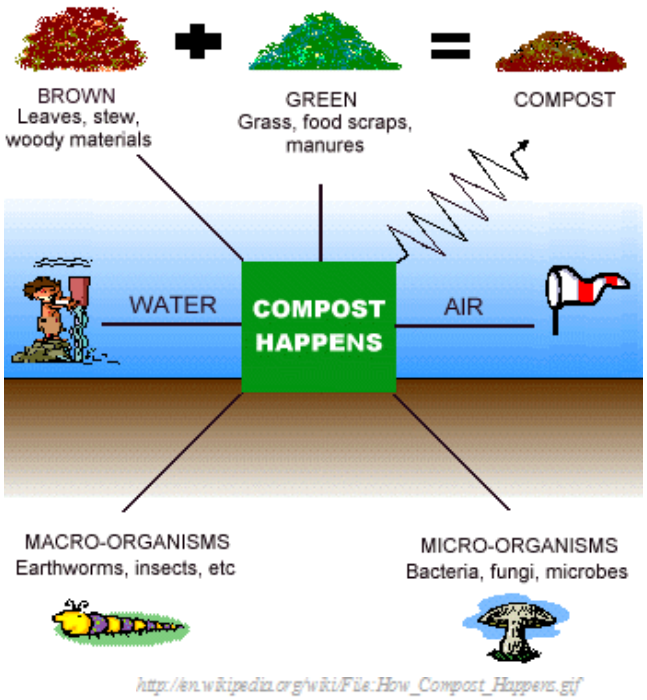
Compost offers many benefits to your landscape and garden!

- Mixing compost into your ground improves soil's health, condition, and structure.
- Compost increases the soil's ability to hold water and nutrients.
- Compost helps to support organisms living in your soil.
- It will help dissolve mineral forms of nutrients.
- Compost buffers soil from chemical imbalances.

- It helps provide biological control of certain soil pests.

Importantly, composting helps return organic materials to the soil, and keeps them out of landfills and waterways.

In your compost pile, your banana peels, egg shells, and shredded newspaper will transform relatively quickly (or return, depending on your point of view!) into viable nutritious soil amendments. These same organic materials, placed into a traditional landfill, without the proper agents of decomposition, will remain in a recognizable form for many years to come. In a landfill, or modern dump, these newspapers, eggs shells, and banana peels, will sit tightly packed, taking up valuable space on our planet. The nutrients inside these items will also be stuck – instead of decomposing and going back into the natural system.



http://en.wikipedia.org/wiki/File:How_Compost_Happens.gif

How to get started? Look around for Greens and Browns!

What Can Be Composted? The basic rule for backyard composting is that you can compost…

ANYTHING THAT WAS ONCE A PLANT

Backyard Composting is primarily a biological process, so you must feed your microorganisms to keep them happy. Microbes need both carbon (C), and nitrogen (N), food sources to function. All materials contain both C and N. The ratio of carbon to nitrogen within a material is called the carbon to nitrogen ratio (C:N).

Carbon to Nitrogen Ratio

Scientists speak of an ideal ratio of Carbon to Nitrogen of 30 to 1 (30:1), as measured on a dry weight basis. This is known as the C:N ratio. This equation is important to learn and understand, but in the actual production of compost, it is even MORE important is to understand how greens and browns affect the compost process and to use them to manage your compost system.

You can calculate the C:N ratio of your materials by using the chart below. For example, if you have two bags of grass clippings (C:N = 20:1) and one bag of leaves (C:N = 60:1) then combined you have a C:N ration of (20:1 + 20:1 + 60:1)/3 = (100:1)/3 = 33:1, which is pretty close to the ideal (C:N = 30:1).

Material	C:N Ratio
Coffee Grounds	20:1
Corn Stalks	60:1
Cow Manure	20:1
Fruit Wastes	35:1
Grass Clippings	20:1
Horse Manure w/ Litter	60:1
Leaves	60:1

Newspaper	50-200:1
Oak Leaves (Green)	26:1
Peat Moss	58:1
Pine Needles	60-110:1
Rotted Manure	20:1
Sawdust/ Wood	600:1
Sawdust Weathered for two months	325:1
Straw	80-100:1
Table Scraps	15:1
Vegetable Trimmings	12-20:1

Note that all plants have more carbon than nitrogen; that is why the C:N ratio is always above 1.0. Grass has a great deal more nitrogen than wood chips, thus it is called a "green" material. Wood chips are very high in carbon, but low in nitrogen. Thus they are called a "brown" material.

All plant material contains a mixture of Carbon and Nitrogen, and all plant material will compost over time.

Greens and Browns

Materials with favorable proportions of carbon and nitrogen (C:N) offer the decomposer microorganisms a "complete meal".

"Greens" - Nitrogen Sources - Materials that are a good source of nitrogen are called "Greens" and are characterized as having a low C:N ratio (C:N ratio less than 30:1) and are generally high in moisture and fast to decompose. Examples of "greens" include manure, inorganic fertilizer, vegetable kitchen scraps, green leaves, and grass clippings. Not all "greens" are green in color. For example, coffee grounds are a nitrogen source.

"Browns" - Carbon Source - Materials that are high in carbon relative to nitrogen (i.e., C:N greater than 30:1), are called "Browns", and are generally dry and slow to decompose. They are generally brownish or darker in color. Examples of "browns" include: straw, leaves, chipped branches and tree trimmings, paper, and sawdust. Browns decompose at low temperatures unless combined with a source of nitrogen.

Finding a mix of greens and browns that is in balance can be important. The optimum C:N ratio for rapid composting is about 30:1.

Compost = two parts vegetable matter (grass, leaves, straw) + one part animal matter (manure)

Green	Brown
High Nitrogen	**High Carbon**
Fast to decompose	**Slow to decompose**
Nitrogen provides microbes with the raw element of proteins to build their bodies and reproduce	Carbon is the energy source for the microbes that help break down the materials
Examples: manure, kitchen waste, grass clippings, inorganic nitrogen rich fertilizers	Examples: leaves, wood chips, straw, sawdust

Meet Your Decomposers!

Microorganisms	**Macroorganisms**
* Bacteria	*Earthworms
* Fungi	*Insects
* Actinomycetes	*Spiders
	*Nematodes

We'll start with the decomposers of "aerobic" composting, which uses oxygen loving microbes. Composting without oxygen is called "anaerobic". Both systems will break down organic matter, but aerobic composting is generally faster, hotter, and easier to manage. Most importantly, anaerobic (no oxygen) decomposition creates objectionable odors.

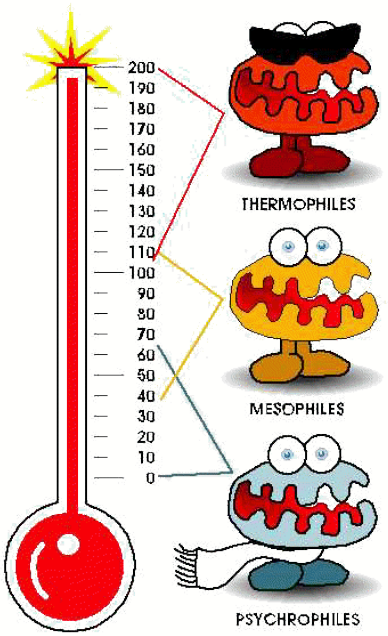
Generally speaking, three classes of bacteria will go to work for you in your aerobic pile:

Psychrophiles - the low temperature bacteria

Mesophiles - the medium temperature bacteria

Thermophiles - the high temperature bacteria.

Fun Fact! *Thermophiles, which are common in manure, were first identified in the hot springs of Yellowstone National Park.*



In tropical and subtropical climates, which are warm for much of the year, composting rarely utilizes the low temperature bacteria. Most garden compost begins at mesophilic temperatures, then increases into the thermophilic range . . . . These high temperatures are beneficial to the gardener, because they kill weed seed and diseases that could be detrimental to the planted garden.

Compost thermometers are available for measuring compost temperature.

To grow and multiply, microorganism need four things; (1) an energy source, or carbon; (2) a protein source, or nitrogen; (3) oxygen; and (4) moisture. It may be helpful to think of the carbon materials as the food and the nitrogen materials as the digestive enzymes. Most of the organic matter in your compost pile should be high-carbon food with just enough nitrogen to help the microorganisms break down the carbon. If there's too little nitrogen, decomposition slows down. Excess nitrogen will be released as smelly ammonia gas.

In later stages, other organisms will assist with pile decomposition, including: Actinomycetes (a medium temperature colonizer), Fungi, as well as Macroorganisms like Sowbugs, Millipedes, Centipedes, Spiders, and Earthworms. Macroorganisms dig, chew, digest, and mix compostable materials. Insects eat organic matter and increase the surface area for bacteria and fungi to get at by chewing it into smaller pieces. Their excrement also is digested by bacteria, causing more nutrients to be released.

Earthworms also ingest and digest organic matter. An earthworm eating its way through a compost pile passes organic matter through its body, grinding it with the help of tiny stones in its gizzard, and leaves dark, fertile, granular "castings" behind. A worm can produce its weight in casting each day. These granules are rich in nutrients plants need.

Microbes are not much different than people in terms of their basic needs.

Food	**Carbon and Nitrogen (Browns & Greens)**
Water	**Moist, not soggy**
Air	**Oxygen**
Volume	**An ideal compost pile should be at least 3 feet long by 3 feet high, and at least 3 feet deep**
Particle Size	**Less than 2 – 3 inches**

Compost Methods – Bins Barrels, and Tumblers, oh my!!

There are plenty of different ways to make a compost pile, but the most popular fall into the following list of methods

- Cold, or "Slow," Composting
- Sheet Composting
- Trench Composting
- Cold Bin Composting
- Heap Composting
- Hot, or "Fast" Composting
- Using Earthworms

Cold / Slow Composting

Cold / Slow Composting is for people who have more carbon (brown) material than nitrogen (green) material, and are not concerned about a slow composting rate, a desire for weed seed destruction, or a need for plant disease suppression.

The advantages of cold/slow composting include ease of implementation, lower level of management required.

The disadvantages of cold/slow composting include slow rate of decomposition and potential for pests to excavate buried wastes. Additionally, if the raw materials contain weed seed or plant pathogens, these will not be destroyed in the composting process.

You may also use this method to build up organic matter throughout the yard. You can build cold piles wherever you need compost, under trees, in washed out areas, in the space that will be next year's garden, etc. Over the course of a year or two, the material will decompose, adding valuable organic matter to the soil, without the need for a formalized bin or composting activity.

Sheet Composting

Sheet Composting involves top-dressing organic material on the soil surface and allowing the materials to decompose without further manipulation. As the materials decompose, compost filters slowly into the soil

below. Leaves, wood chips, and other mulches are examples of sheet composting.

The advantages of sheet composting include ease of implementation and the moisture retention qualities of mulch.

The disadvantages of sheet composting include slow rate of decomposition and it is not compatible with composting all materials, such as kitchen scraps. Additionally, if the raw materials contain weed seed or plant pathogens, these undesirables will not be destroyed in the sheet composting process.

Trench Composting

Trench Composting is a relatively straight-forward method of composting directly in the soil. This method does not require a bin. Simply dig a trench 8 inches deep in the garden area, fill with 4" of kitchen scraps and backfill with soil. After a few months, the material will have decomposed sufficiently for planting above the compost trench. For large amounts of material, consider roto-tilling the material into the soil, and waiting a season before planting.

The advantages of trench composting include ease of implementation and its ability to handle kitchen scraps without attracting pests as readily as in sheet composting. The disadvantages of trench composting include slow rate of decomposition and potential for pests to excavate trenches. Additionally, if the raw materials contain weed seed or plant pathogens, these undesirables will not be destroyed in the trench composting process.

A variant of trench composting was taught to the pilgrims by the Native Americans. You may have heard the story of how Squanto showed the pilgrims how to fertilize their corn crops by burying fish scraps underneath the corn. As the fish composted, nutrients were released for the crop.

Cold Bin Composting

http://web.extension.illinois.edu/homecompost/methods.html

Simply fill your compost bin halfway with browns and bury kitchen scraps in the bin. After a month or so, start layering kitchen scraps and thoroughly covering with browns and a little soil. Keep adding material throughout the year. As the bin fills up, start a second compost bin. After a year or so, the material in the first bin will have decomposed enough for most landscape uses. Start harvesting from the bottom of the pile.

With Cold Bin composting, bury or cover new material with browns. Exposed food, like these oranges, will attract pests.

Compost Bins come in all shapes and sizes; folks can pick their own bin depending on how they want to use it, how much material they wish to compost, and personal style!

There are straight forward wire compost bins, and fanciful kid-friendly options.

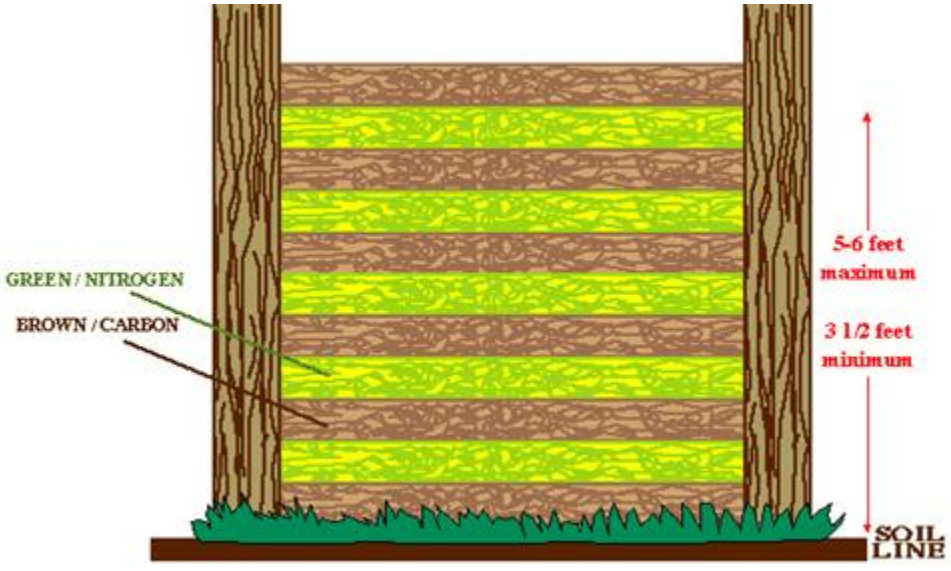
Image: http://www.motherearthnews.com/Nature-Community/2003-04-01/Compost-Tumblers.aspx

Tumblers: these compost containers are generally raised, and designed so you can crank, turn or roll the container to turn and aerate the compost without traditional turning tools like a pitchfork.

Although the decomposition time is not increased, compost tumblers do have advantages in addition to ease of turning. By and large, they are clean, neat, unobtrusive, pest-resistant and odor-free. Because of this, tumblers often can be used in urban and suburban areas, where local laws or restrictive covenants may prohibit open compost piles.

Adding Material to you Compost Pile for optimum results can follow a number of different Methods:

Sandwich Method Layer compost materials/ingredients into the composting system using a balance of Green and Brown materials.



CROSS SECTION OF LAYERING IN COMPOST BIN

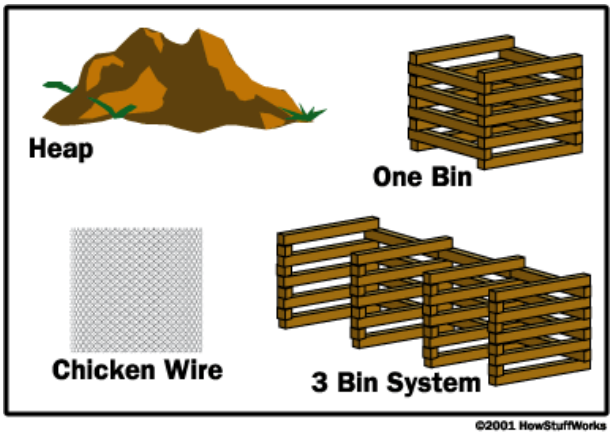
The general rules and reasons are:

Rule	Reason
3 – 4" layers alternating Green (high Nitrogen) and Brown (high Carbon) materials.	Thin layers help prevent anaerobic (smelly) pockets from developing and allows microbes access to both Green and Brown food sources.
Water each layer as you build it so material is moist not wet, like a wrung sponge.	Even distribution of moisture.
End with a Brown layer on top.	To filter odors, if any, before they leave the compost system.

Heap Composting

Heaps require the least amount of work to get started. Simply pile up your materials in an open area, preferably the future site of a garden so any nutrients leached from the pile will be put to use eventually.

You do not have to have a bin to have a compost system. A compost heap can be created anywhere in your yard, it's simply a collection of compostable materials placed in a designated area. However, bins help keep the compost neat and tidy, and may help you exclude pests if they are a problem.



A good size to aim for is 5 feet wide, 3 feet high, and as long as it needs to be. One good idea is to make at least two piles. When the first pile is big enough, make another. That way, you can have piles at different stages of decomposition going at the same time.

Hot / Fast Composting

Hot / Fast Composting will yield the fastest rate of composting and best control of weed seed and plant pathogens. Hot composting is also the most intensive method and requires several elements to succeed, including:

- A minimum of 1 cubic yard of material to start the pile
- A blend of greens and browns (C:N Ratio)
- Proper moisture content
- Frequent turning to provide aeration
- Particle size of less than 2" – 3"

Using Earthworms to create compost

Many people know the value of worms in their garden. Worms are great decomposers, especially red-wigglers and African night crawlers. Unfortunately, in an outdoor pile, you cannot rely on the earthworms and other maroorganisms to do much of the turning (*aeration) for you. Earthworms are great workers, as are ants, mites, and other insects, but because worms are weak "pushers," they must literally eat their way through the materials in the pile.

If you generate only kitchen and table scraps, or if you live in an apartment, composting with worms (called "vermicomposting") may be the way to go.

To contain your worms and their castings (their nutrient rich waste), you'll need a worm bin; a safe, moist, manageable container where worms can do their work.

Example Materials Needed:

1 - 18 gal. plastic or Styrofoam container with lid
window screen (can be old)
Duct tape
sections of newspaper, shredded paper, or paperboard (cereal boxes)
water
a couple of handfuls of sand or soil
Electric drill with 1 inch spade bit
½ to 1 pound of worms*

http://www.tipsofallsorts.com/quick-tips-on-vermicomposting/

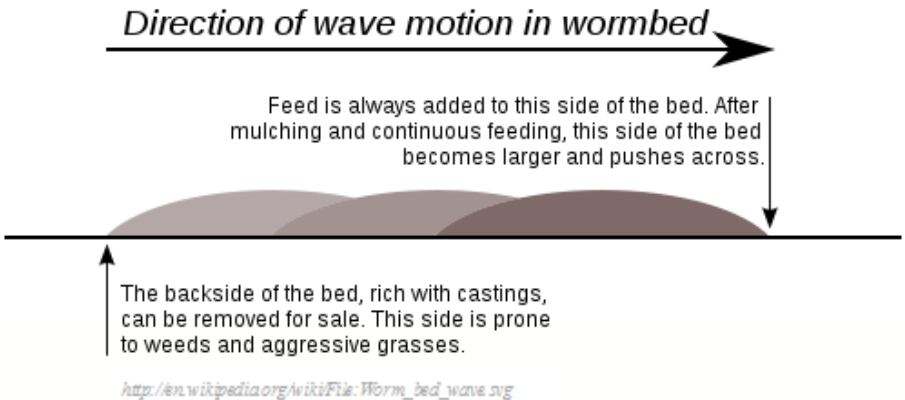
http://en.wikipedia.org/wiki/File:Worm.bin.jpg

* Just any worms won't do! Locate red wigglers or African Night crawlers. These worms are excellent composters and thrive in a worm bin environment. Red wigglers reproduce more quickly and are smaller than African Night crawlers; both are good fish bait. Local worm farms or bait stores can usually provide these types of worms.

http://www.vermiculturenorthwest.com/images/DSCF0010.JPG

Worm Bin Construction:

1. Drill 4 holes (2 holes per side) about 4 inches from the top of the bin.
2. Cut small pieces of screen large enough to cover the holes and tape them to the inside of the bin using duct tape.
3. Make a *bedding* by shredding paper lengthwise into 1 inch strips to fill the bin 1/3 full.
4. Spread sand or soil over the bedding.
5. Pour the water over the newspaper strips; stirring the bedding as you moisten it.
6. Dump worms out of containers onto surface of bedding. After 2 hours, remove any (dead) worms that have not wiggled down into bedding.



http://en.wikipedia.org/wiki/File:Worm_bed_wave.svg

Vermicomposting

(Composting with Worms)

Vermicomposting is the process of using worms to produce rich compost from kitchen wastes. One pound of worms can turn 65 pounds of garbage into garden compost in 100 days.

The best diet for your worms is food scraps that are of *plant origin*. This includes vegetable and fruit trimmings, coffee grounds, pasta, bread, cereal, tea bags and other paper products. Plate scrapings are also acceptable. Animal products such as meat, eggs cheese, etc. are best kept to a minimum to prevent odors.

How to care for Your Worms:

Feeding: One pound of worms can process ½ pound of kitchen scraps a day. Feed them daily, weekly or as desired. Cutting the scraps into small pieces allows the worms to consume them faster. Bury the scraps under the bedding; rotate where you bury them. You may add more bedding every once in a while.

Temperature: The ideal temperature for worms is between 60-80 F. So place an outdoor bin in a shady area, not in direct sun.

Moisture: Check the moisture when adding kitchen scraps. If too wet, add more bedding; if too dry, add water. Worms like more moisture than you might think.

Darkness: Keep the lid on your bin. Worms do not like light and the closed bin will not attract as many undesired insects.

Harvesting Compost and/or Worms:

After two or three months, the worms will have converted the bedding and food scraps into rich, dark compost. Here are two ways to harvest it:

1. Gently push the compost to one end of the bin and fill the empty side with moistened, shredded newspaper. Place kitchen scraps into bedding. The worms will eventually leave the compost and migrate towards the food. The compost can then be removed.
2. To harvest the worms and compost at the same time, dump the contents of the bin onto a piece of plastic. Allow the worms time to retreat to the middle of the pile away from the light, then scrape off the outer layer of compost. Repeat this procedure until all the compost is harvested and mostly worms are left.

Mix-It! Method

If you are using a "no-turn" method, or if you want to speed up the composting process, try the Mix It!

Method. Simply mix up the green and brown materials before adding them to the compost system. This prevents the moist greens (grass clippings, for example) from forming compact layers that may restrict the flow of water and oxygen through the pile.

Add the mixture to the compost system in 4" batches. Water each batch so that the moisture is evenly distributed. It's really difficult to get water into the whole pile after the pile has been built, so add water as you build the pile.

Mix materials in a wheelbarrow and then put them in the compost bin.

Creating the ideal environment for Composting

Rapid composting requires an environment in which microorganisms will thrive. To compost well, you must "think like a microbe" and create the best environment to support microbial activity.

Microbes have similar environmental needs as people: water, air, comfortable temperatures, and food. The elements of the compost environment that are important for rapid, efficient composting, include:

- Moisture
- Aeration
- Pile Temperature
- Particle size
- Carbon to nitrogen ratio

Moisture

Microbes need moisture to thrive. At the ideal moisture level, 40-60%, a handful of compost will feel wet but water cannot be squeezed out of it. Some people compare this to the feeling of a damp sponge.

It may be necessary to add water to the composting system to keep it moist. Add water when building and turning the compost pile.

Compost should be kept moist, but not soggy. If the materials are too wet, they will compact and restrict the airflow through the pile. This leads to anaerobic (no oxygen) conditions, which slow down the degradation process and causes foul

odors. A pile which becomes too wet should be turned. Turning the compost will dry it out and add oxygen.

Aeration

Aeration means adding oxygen to your compost system. Microbes need oxygen to break down organic materials efficiently. Because they reproduce so quickly under ideal conditions, microbes may deplete the available oxygen through their activity. Therefore, it is important to aerate your compost.

You can aerate your compost by turning it. This directly incorporates oxygen into the pile.

You can also aerate by adding bulky items. Bulky items provide air channels so that oxygen can flow into and through the compost. Bulky items also keep the pile from settling and compacting, which could restrict oxygen flow. Bulky items include oak leaves, pine needles, chipped twigs, and straw.

You can aerate by probing the pile with a piece of rebar or an aeration tool (or a pitchfork!). Simply probe the device in at several places in the pile. This will create passageways for air to enter the pile.

Pile Temperature

Compost pile temperature is a function of the biological activity within the composting system, and, to some extent, its exposure to the sun. When microbes flourish, they will raise the pile temperature through their metabolism, reproduction, and conversion of composting materials to energy.

<u>The main reason to be concerned about pile temperature is that maintaining a minimum pile temperature of 131°F for 3 days is desirable to destroy weed seeds or plant pathogens.</u>

To become a highly efficient biological system, a compost pile requires the proper food balance (a mixture of nitrogen and carbon rich materials), large enough pile size (approximately one cubic yard), oxygen and the right moisture content (moist but not soggy).

Your composting system may not reach higher temperatures during the composting process. If a pile does not heat up, all is not lost – compost happens at all temperature levels, it just a matter of process and timing.

Particle Size

Smaller materials have more surface area available for microbes to attack. Therefore, reducing the particle size of raw materials will increase the speed of the composting process. Size reduction also reduces the volume of the compost pile, thereby saving space.

It is a good idea to chip or mulch small limbs and twigs to a size of 2-3 inches before composting.

Particle size can be too small. For example, sawdust sized and wet materials can decrease aeration, reduce the rate of composting and perhaps cause anaerobic conditions leading to odor problems.

Composting Concerns?

Sometimes a compost pile builder needs to be concerned about problematic materials such as possible residues from pesticides, herbicides, weeds, and/or plant diseases. The most conservative response to these concerns is to avoid adding these materials to the composting system.

Can I Compost It?

Can I Compost?	Yes/No	Comments
Hair, human or animal	**Yes**	GREEN/NITROGEN but may be slow to degrade
Grass clippings	**Yes**	GREEN/NITROGEN may compact (counteract compaction by also adding bulky brown items when using a lot of grass)
Manure from herbivores (vegetarian)(e.g., horse or cow manure, rabbit droppings)	**Yes**	GREEN/NITROGEN, but do not use if animal is sick
Rotten fruit & vegetables	**Yes**	GREEN/NITROGEN may compact due to wetness, add with dry bulky brown/carbon items
Coffee grinds, including filter	**Yes**	GREEN/NITROGEN
Tea bags	**Yes**	GREEN/NITROGEN
Citrus, e.g. oranges, grapefruit, lemons, tangerines	**Yes**	GREEN/NITROGEN must cut in into pieces before composting. Mix with browns & add 6 inch layer of browns on top.
Leaves	**Yes**	BROWN/CARBON
Wood chips and pieces	**Yes**	BROWN/CARBON - a good source of bulky items.
Straw	**Yes**	BROWN/CARBON - a good source of bulky items.
Sawdust (from un-treated wood)	**Yes**	BROWN/CARBON very high in carbon.
Newspaper	**Yes**	BROWN/CARBON must shred it before composting
Landscape trimmings (cut to sizes less than 2")	**Yes**	BROWN/CARBON also a good source of bulky items.
Wet paper	**Yes**	BROWN/CARBON Break up into small pieces, or make a wet slurry and turn it (mix) into the compost
Paperboard, e.g. cereal boxes, paper plates, and napkins.	**Yes**	BROWN/CARBON Break up into small pieces, or make a wet slurry and turn it (mix) into the compost
Egg shells	**Yes**	Adds calcium
Banana Leaves	**No/Maybe**	Very tough to break down, must cut into small pieces to compost
Palm Fronds	**No/Maybe**	Very tough to break down, must cut into small pieces to compost, try drying first, then chipping.
Dog Waste	**No/Maybe**	Composting dog waste must be done with caution.
Animal by-products such as meat, chicken, lard, bones, cheese or milk products	**NO**	This type of kitchen waste can attract vermin.
Pet waste (not dog or bird), non-vegetarian animals	**NO**	Might contain diseases that could be transmitted to humans.
Mayonnaise, salad dressing or peanut butter	**NO**	Hard to degrade
Inorganic trash such as plastic, foil or metals.	**NO**	Will not break down in the compost process, instead recycle these materials

Chemicals such as pesticides, gasoline, diesel or oil.	**NO**	Potentially toxic to human health and the environment
Human waste	**NO**	Might contain diseases that could be transmitted to humans.

Yes! Compost It!

banana skins	leather	feathers
grains	flour	rice
stale bread	grass clippings	newsprint (b&w)
manures	egg shells	oatmeal
wood chips	old seed packets	flour
seaweed	fish scraps (buried)	straw and hay
powdered milk	tobacco	pine needles
stale cereal	hair (human, animal)	wood shavings
natural fibers (cotton, linen, wool)	rock powder (greensand, granite dust)	coffee grounds (with paper filter)
dead insects	tea bags	crop waste
cornmeal	paper/cardboard	flowers
bone meal	seashells (crushed)	peanut shells
cottonseed meal	kitchen scraps	yard waste
watermelon rind	vacuum bag wastes	potato peels
leaves	sawdust (not treated)	shredded hardwood
corncobs	ground bones	bird cage "stuff"
old potting soil/mix	weeds (most, but not all)	fruits & vegetables

Do Not Compost

meat	grease, fat, oil	dairy products
human waste	Un-ground bones	used kitty litter
treated wood	poultry	non-organics
colored newsprint	treated sawdust	cat feces
heavily colored paper	pressure treated wood	plywood
particle board		

Maybe Compost - Use best Judgment

weed seed heads	large woody brush	wood ash
diseased plants	fish waste (if buried deeply)	dog feces

Problematic Materials

There are certain materials that could potentially cause problems if they are added to the composting process. Some of the most common problematic elements are discussed below.

- Grass clippings
- Diseased plants
- Herbicides and pesticide residue

Grass Clippings
The easiest way to manage grass clippings is grasscycling, (just leave grass clippings on the lawn). However, if you prefer to remove grass after mowing, you can compost grass clippings, if you are willing to actively manage your composting process.

Freshly mowed grass has a high moisture content, and higher nitrogen content than many other materials. The moisture can cause the grass to mat down and clump up, resulting in anaerobic (no oxygen) pockets. This clumping effect, combined with the relatively high nitrogen content of fresh grass clippings and improper composting methods may result in odor problems. However, adding this material can help heat up your compost process and, therefore, adding grass to the compost bin may be desirable. Using proper management techniques can help you avoid odor problems.


http://en.wikipedia.org/wiki/File:Compost_pile.JPG

To compost grass clippings you will need to:

- Add bulky high carbon materials (browns),
- Oxygenate (aerate) the pile, or
- Manage two or more compost piles simultaneously.

Add Bulky Browns - Fresh grass clippings must be balanced with browns for the compost process to proceed without odor generation. Use browns that provide extra "bulk." Bulk keeps the compost from matting down and allows oxygen to enter the pile. Wood chips, leaves, cut up sticks, all provide bulk. You would probably want to avoid using paper as your primary brown if you are composting mostly grass clippings. While paper is a source of carbon, it has a tendency to mat down and could restrict airflow.

You can use either the "mix it" or "sandwich" methods of pile building. However, the mix it method tends to work better. If you use the sandwich method, make many thin layers, versus a few thick layers. For example, the green layer should be no more than 1-2 inches thick. This will help prevent the grass from matting down and creating anaerobic pockets. Always begin and end your pile with browns to help provide for air to enter the pile at the bottom and absorb odors before they are released from the top of your compost.

You may want to start with twice the volume of browns as grass. However, an actively managed bin can be constructed with less brown material.

NOTE: Bags or piles of grass clippings will go anaerobic very quickly, and whenever you open them up, you will release an "odor bomb" and then have a huge clump of grass to contend with. Therefore, do not store grass for later use. Instead, store browns.

Oxygenate the pile - A well oxygenated compost system does not create odors like an anaerobic (no oxygen) situation. Using a bulky brown material will help, but if you are composting grass clippings, you must be committed to turning the pile periodically. This mixes the materials, thoroughly oxygenates the pile, and prevents anaerobic pockets from forming. You may need to turn the compost system more frequently in the first few weeks than when composting other materials.

If you plan on composting grass clippings on a regular basis, you might consider making or purchasing a rotating drum composting unit. This kind of system is known for its ease of turning and oxygenating the compost. As a result, the composting process is accelerated and you may be able to stabilize the grass clippings in a week. After the material is stabilized, it is less likely to create odor problems. It must be cured for a period to complete the composting process, but will greatly reduce the composting time period and may allow you to keep up with the weekly mowing schedule common during the summer months.

http://www.thegardenerslist.com/Resources/compost-tips.html

Have multiple composting piles operating at the same time - After beginning composting grass clippings one week, the composting process will continue for several more weeks. What do you do during the summer months when clippings are created each week? You'll have to create a second, or even a third bin.

So you might have a schedule like this: Week 1, start compost bin 1; Week 2, turn compost bin 1, and start compost bin 2; Week 3, turn and consolidate compost bins 1 and 2 into bin 1, and then start composting again in bin 2. After a couple of consolidations, you will be able to set the compost to the side and let it finish the composting process without much more activity.

Diseased Plants

The concern with adding diseased plants is that the disease may survive the composting process and infect future crops that are treated with the compost. Most, but not all, plant diseases are destroyed when subjected to high temperatures (130-140 °F) for a period of 72 hours (3 days). These high temperatures may be reached in the pile during hot composting.

However it is usually difficult in a home composting system to mix a pile well enough to bring all material in contact with the high temperatures at the core of the pile and assure complete destruction of pathogens. This being the case, some horticultural experts suggest that it is not advisable to add large amounts of diseased plants to the compost pile if the resulting compost will be used in the garden.

Option 1 - You can use compost made with diseased plants in a quarantine area or with different kinds of plants. For example, if you have had problems with garden plant diseases, compost made from the diseased garden plants could be spread on the shrubbery with less chance of transmitting diseases that may have survived the composting process.

Option 2 - If you are making compost that absolutely must be free of diseases, you may want to keep diseased plants out of the compost.

Weeds and Weed Seed - The concern with adding weeds to the compost is that the weeds or their seeds will survive the composting process and result in new generations of weeds when compost is used in the landscape. Most seeds are destroyed by exposure to 72 hours (3 days) of high temperatures (over 131 °F). These high temperatures may be reached in the pile during proper composting. However, it may be difficult

A pointer about weeds: Tubers, corns, and rhizomes tend to survive the composting process, and therefore, these reprodutive parts are more difficult to compost than seed heads.

in a home composting system to mix a pile well enough to bring all material in contact with the high temperatures and assure complete destruction of weeds.

Herbicides & Pesticides
If you are composting materials from your own yard, then you have some measure of control over whether to use pesticides and herbicides in the first place. Once you have decided to use a pesticide or herbicide, be sure to follow the instructions on the label.

Most of the pesticides and herbicides currently on the market are not as persistent in the environment as pesticides and herbicides of decades ago. Therefore, much of the problematic elements in pesticides and herbicides dissipate over time, regardless of the composting methods employed. Furthermore, the heat and microbial activity of composting helps to break down pesticides and herbicides. So as a general guide, once a reasonable amount of time has passed since application the organic materials treated with pesticides and herbicides may be composted. Always check the label for proper handling of pesticides and herbicides.

Adding More
You can add fresh materials to an actively (or passively) composting pile. One way to add materials to an existing pile is to add them as you mix or turn the pile. Burying new materials in the pile also works well. Eventually, you will want to start a second batch of compost for adding fresh materials. This will give the first batch of compost time to stabilize and mature.

The materials you add will supplement the existing food base. If you add more greens, the effect will be adding nitrogen and potentially speeding up the composting process, increasing moisture, and/or heating up the pile. If you add more browns, the effect will be increasing carbon, and potentially slowing the composting process, drying out the pile, and/or reducing pile temperature.

Managing a Compost System
After you have built your compost pile, managing it involves four basic activities:

- Monitoring
- Mixing and Turning
- Finishing/Curing
- Screening

Monitoring

Monitor Smell
- Turn if there are any odors
- Add “browns” if odors persist
- Use a brown layer on top of compost pile. It will absorb odors and discourage flies.

Monitor Moisture
- Add moisture as you BUILD the pile
- Add moisture as you TURN the pile
- If too wet, turn (without adding more water)
- If still too wet, add dry “browns” to pile while turning

Why? Because microbes require moisture to survive, but too much moisture will create odor problems and slow the composting rate.

Monitor Temperature
If you are using a hot composting method:

- Turn if the pile is less than 100°F
- Turn if the pile is more than 150°F

Why? Because the Thermophilic bacteria prefer temperatures in the 105-140°F range, and these microbes are the fastest at converting raw materials to compost.

If the compost pile exceeds 155°F, or so, it may be too hot for the bacteria population to thrive. At higher temperatures the heat may actually kill off part of the population. If this happens, the temperatures will fall off and the populations will slowly rebuild.

Mixing & Turning Compost
The compost pile should be mixed and/or turned periodically, depending on how quickly and completely you want your compost to breakdown. Turning is also the first line of defense for any problems that may occur during the composting process. You can use a pitchfork, shovel or specialized tools for this purpose.

Turning has many benefits, including:

- Adding Oxygen
- Helping to Destroy Undesirables
- Reducing Odors
- Breaks up clumps and layers

Turning Adds Oxygen
Turning adds oxygen to the pile. Aerobic composting organisms need oxygen to survive. By building your compost pile with the right balance of greens/browns, providing moisture, and keeping oxygen available to your compost microbes, your pile's temperature will rise and your material will decompose rapidly. *(note that shortly after turning the pile temperature may drop, if the pile is getting "too" hot, you can turn it to help moderate temperature).*

Turning Helps Destroy Undesirables
Turning helps destroy undesirables such as weed seeds, insect larvae, and disease-causing organisms by exposing them to the lethal temperatures at the center of the pile. Turning also helps maintain the active population of beneficial microbes by providing more food at the active center of the compost system.

Turning Reduces Odor Problems
Bad odor is an indication that there is an imbalance in your compost system. Turn the pile at the first sign of offensive odor or ammonia smells.

Turning Breaks Up Clumps and Layers
Clumping or matting down can cause pockets in your compost system where oxygen cannot penetrate. These spots can go "anaerobic" which means that microbes that don't need oxygen are doing the work of composting. Anaerobic microbes produce smelly gasses as a by-product of decomposition. Turning breaks up clumps and matted layers in the compost and allows oxygen to penetrate. Therefore, to create a better end product, break up all the clumps of material when turning the compost.

Finishing/Curing
Many people wonder how to create finished compost if they are always adding materials to the compost bin. The secret is to make composting a batch process. After a while of composting in one bin, set the compost aside to finish the composting process for "curing" period.

Curing or "finishing" is the process of allowing materials in the compost system to finish the composting process at lower temperatures. Earthworms and other invertebrates will assist with this process. Make sure the compost is moist and aerated during the curing period, which can be as short as one month or as long as a year or more. While one batch of compost is curing, you can start a second composting bin for your active composting process. In this manner, you can make your compost and use it too!


http://compostguide.com/using-compost/

How to Use Compost
There are many ways to use compost. Some of the most common uses of compost include:

- Soil Amendment
- Mulch
- Potting Mix
- Compost Tea

Compost as Soil Amendment
Use compost as a soil amendment (*mix compost with your soil) to increase the organic matter in the soil. Organic matter is critical for plant development and growth. Tropical and subtropical soils are notorious for their lack of this material. Whereas temperate soils may have up to 50% organic matter, sub-tropical soils typically have 1% or less. Compost can help raise organic matter in soils.

Because tropical and subtropical soils never freeze, microbial activity continues year-round. As a result, organic material is used up quickly. Because of biological soil activity and year-round warm weather, gardeners are advised to apply compost annually, or as needed, to increase soil organic matter content.

For best results, use only finished compost as a soil amendment. Compost used as a soil amendment should be applied and incorporated into the soil before planting crops, grasses, plants, etc. Apply 1-3 inches of compost to the soil surface and work it in to the soil to a depth of about 3-4 inches.

Using unfinished compost as a soil amendment may stress plants, causing them to yellow or stalling their growth. This is because the decomposition process is continuing near the plant roots and the microorganisms in the compost are competing with the plants for nitrogen. You may want to compensate for this nitrogen imbalance by adding nitrogen fertilizer to soil applications of immature compost.

As an alternative, use compost as mulch, and you don't have to worry about whether the compost is "finished." This is because any additional decomposition is occurring above the root zone. The plants still benefit from the compost.

Compost as Mulch
The forest floor is a natural composting system in which leaves are mulch on the soil surface, and then gradually decompose, recycling nutrients and conditioning the soil. Likewise, yard debris such as leaves, grass

clippings, or shredded branches can be used as mulch in the landscape and allowed to compost on the soil surface. Over time, the mulch will compost in place.

Finished or unfinished compost can be applied as mulch 3-4 inches thick on the soil surface. Do not incorporate into the soil. Keep compost mulch 2-3" away from plant stems. Nutrients will filter into soil, without robbing nitrogen from the root zone. Similar benefits as regular mulch: soil moisture retention, insulates soil from extreme temperatures, breaks down to provide nutrients and organic matter for soil structure. One disadvantage to using compost as mulch is that it will not act as a barrier to weed growth, but, in fact, will promote weed growth if not covered with a standard mulch material. Compost or mulch should be reapplied yearly to replenish the decomposing layer.

Compost as Potting Mix
Compost can be used as an excellent potting soil for your container nursery. Compost offers good water retention qualities and some basic nutrients. However, gardeners should use only fully decomposed (called "finished") compost as a potting mix.

Container grown plants need a potting soil that retains moisture, but is well drained. Most gardening enthusiasts blend compost with coarse sand, perlite, or vermiculite to make optimal planting media.

If your compost still has large chunks in it, but is otherwise finished, you may want to screen compost through a 1/2" screen to remove un-decomposed material that could rob nitrogen from the plant roots. Leaving some coarse or bulky material in the mix will help maintain a well-drained planting media.

Caution: Remember, if the organic materials have not completely decomposed, plants growing in the compost media may turn yellow and appear stressed. This is because the decomposition process is continuing near the plant roots and the microorganisms in the compost are competing for nitrogen.

Compost as Tea
Compost tea is a method of using your compost nutrients for indoor plants, potted plants with no room for additional soil, and foliar applications (spraying on plant leaves).

To make compost tea, follow this procedure:

Step 1 - Fill a woven bag (example, burlap) with finished* compost.
Step 2 - Place the bag in a barrel or bucket of water.
Step 3 - Let sit an hour.
Step 4 - Remove the bag.
Step 5 - Use the resulting liquid, "compost tea" to water plants.
Step 6 - Empty the contents of the bag into the garden and use as compost mulch or soil amendment.

Benefits Compost Tea extracts nutrients and microorganisms from the compost and allows you to apply these beneficial components to plants. Therefore, compost tea acts as a weak liquid fertilizer, low in nitrogen but high in micronutrients.

If your plants are container grown, there may be no room to add compost to the pots. Additionally, soil should not be built up against the stems of many plants. Therefore, compost tea is a good option for applying the benefits of compost to container grown plants.

*Using unfinished compost is not recommended due to possible pathogens and compounds which could damage plants. Only finished compost should be used.

Websites for further research:

This packet is patterned after, and draws its information, images, and direction from many websites; the following is a selected bibliography; read on for further compost tips and facts!

Considering starting a compost pile? The following site has compiled resources to help with many projects, including ones for your school. http://www.compostinfo.com/tutorial/index.htm

Good basic info in 5 easy steps, plus your Nitrogen to Carbon table!
http://www.thegardenerslist.com/Resources/compost-tips.html

This article talks about the state of landfills overflowing with things that could have been composted or recycled – and what happens when they are not http://wc.arizona.edu/papers/94/141/01_2_m.html

Think that you won't have enough kitchen scraps to make a good home compost pile? Think again – most families waste more than they realize! http://uanews.org/node/10448

How long does trash last? http://coep.pharmacy.arizona.edu/curriculum/garbage/index.html

The science of Garbology http://www.treehugger.com/files/2005/04/the_garbage_pro.php

The historic creation and uses of compost and natural fertilizers in the American south
http://www.westville.org/documents/FertilizingAndCompostingIn1850.pdf

How to compost! http://www.howtocompost.org/

Let it Rot!: The Gardener's Guide to Composting, (1998), Stu Campbell; Storey Publishing, LLC; 3rd edition (1998) (http://www.amazon.com/Let-Rot-Composting-Down-Earth/dp/1580170234)