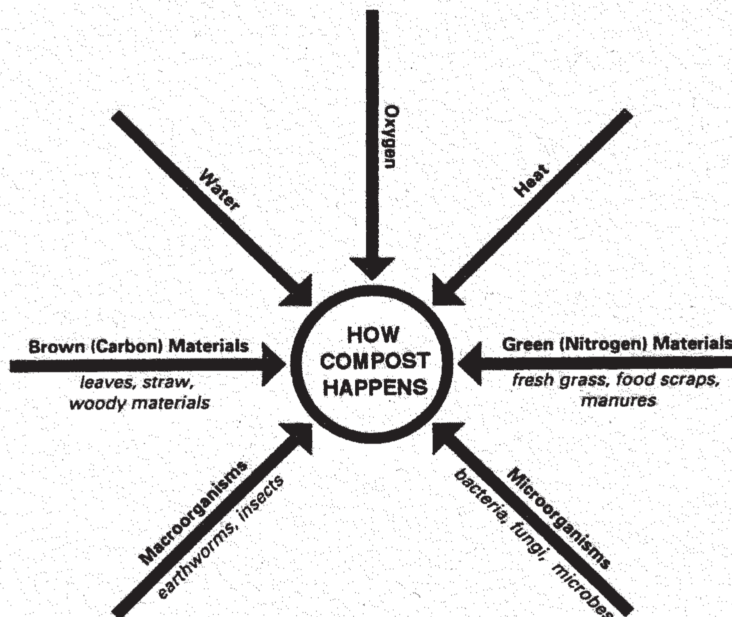
THINK COMPOSTING

ACTIVITY GUIDE



Dedicated to the memory of Clark Gregory, "Compost Man"

Originally published by Hall County Resource Recovery
with a GEFA Recycling and Source Reduction Grant, 1995
Developed and written by Richard Foote, Stephanie Reed, and Marianne Scott.
Illustrated by Stephanie Reed

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Think Composting

Activity Guide Contents

Composting Concept/Process

The most important message taught by composting is to value "nature's way" -- the interdependent ecology of our world. We learn that solid waste can be transformed by the process of decomposition, providing fertilizer to grow trees and gardens of flowers and vegetables for our families, schools and neighborhoods. Thus, the grand cycle of Nature comes full circle. Good citizens compost to be personally responsible for their own waste.

We can succeed at composting, invent new forms of composting technology, and learn to judge the relative merits of various solutions to the solid waste problem.

GOOD NEWS: Anyone can create and use beneficial compost!

A related key concept in environmental education is the mutual compatibility of ecology and economy-- the basic rationale for environmental legislation and public funding to protect the environment.

Curriculum Framework

THINK COMPOSTING across the curriculum . . .

Within the school's total plan, composting projects fit into ecology or "mini society" thematic units, which feature the diverse interconnected roles within our community. When ample time is allowed for full involvement, completion and mastery, high expectations will be met in student's participatory learning, satisfaction and environmental action. The activities are appropriate for grades 3-5 with benefits for lifelong learning.

Mathematics Concepts are needed to estimate, measure and calculate quantities of volume and time involved in composting and in creating composting technology. More mathematical exercises can explore macro-economics, and the symbolic logic and reasoning skills of stating "if-then" propositions about ecology themes.

Science Composting activities and the ecology theme fit well into the science curriculums strand, E.S.T.S (Environmental Science, Technology, and Society).

Social Studies Activities delve into the history and philosophy of ecology, Earth Day, and composting. You may want to look at the beginning of the ecology movement around the world and at inventions and leaders of environmental protection.

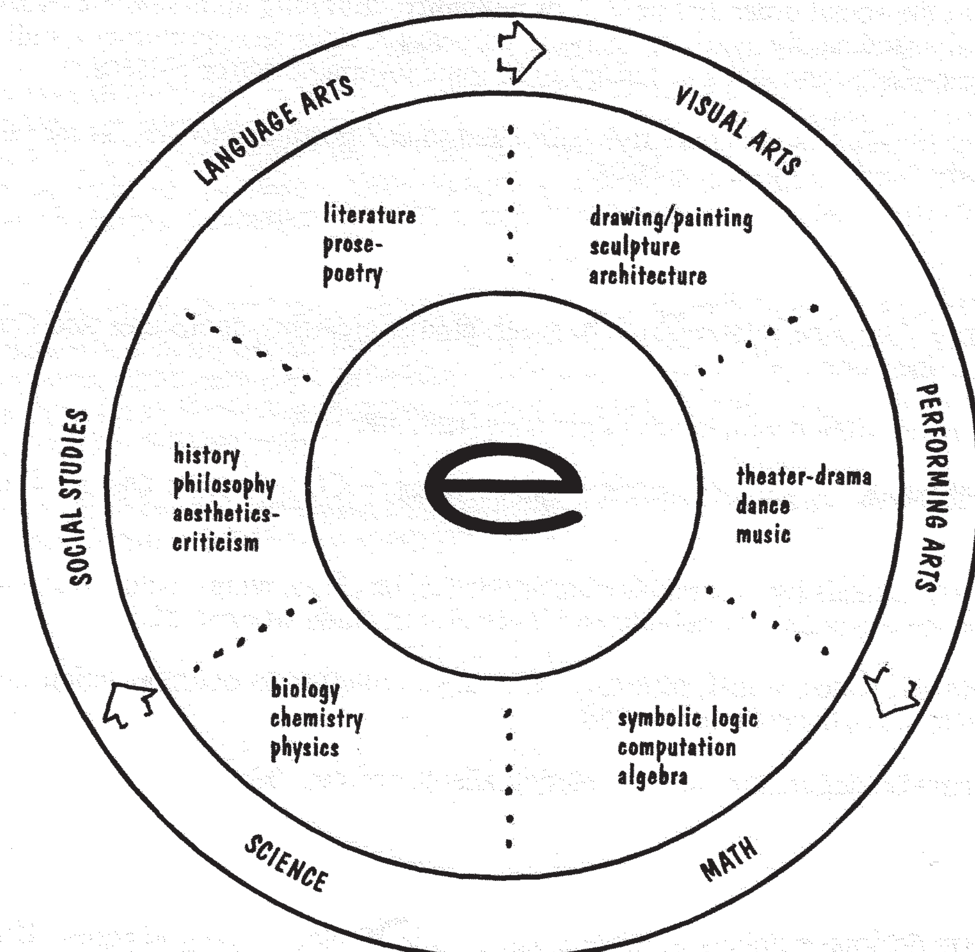
Health and Safety Composting activities involve learning about sharing family chores, nutrition and wellness, opportunities to do cooperative family projects and pastimes to enjoy while improving the environment.

Visual Arts The artistic concept of the *Think Composting* coloring book is characterized by a unified composition, beautifully detailed sketches, and overall book design continuity across the spread folds. Instructions for completing the coloring book should emphasize originality in color choices and crayoning techniques, and encourage color mixing and shading to create various expressive and illusionary effects. Some expansions are cartooning inspired by the talking bugs and worms, enlargements of flowers ala American modernist painter Georgia O'Keefe, dioramas, innovative book arts projects, study of graphic art careers, and three dimensional dioramas.

Language Arts Write poetry, prose, haiku, essays, letters to the editors, congresspersons, mayors, or county commissioners about nature's themes, ecology and composting. Creative writing activities may include writing for political activism to examine landfill issues or to alert the general public to the benefits of composting and solid waste reduction.

Music, Dance, Theater Listen to a symphony inspired by nature and sing and play Earth Day theme songs. Be inventive with sounds mimicking bugs in the compost bin. The dynamic process of decomposition may be shown by movement in interpretative dance. Dramatics may be skits, plays, puppet stage, pantomime, living history improvisation or scripted performance depicting the composting cast of characters.

ECOLOGY THEME MULTIDISCIPLINARY PLANNING WHEEL FOR
CO-RELATED CURRICULUM UNIT



e = ecology symbol, as the Greek letter "oikos" is the shared source for both words ecology and economy: ecology pays for itself !

Educational Objectives

COMPOSTING AND THE QUALITY CURRICULUM

Composting Activities as related to Georgia Quality Core Curriculum
Learning Objectives (QCC's)

By acts of the Legislature and the State Department of Education, 76 basic skill competencies are noted across 13 subject areas, all of which each student is expected to master by high school graduation. Above and beyond minimum levels of learning, enrichment opportunities shall be provided. The basic standards of the QCC provide a framework for each local community's school program of curriculum. The category fields or disciplines of learning are social studies, math, business ed., industrial arts, vocational subjects, foreign language, fine arts, science, health, physical education, driver's ed., safety ed., reading, humanities and English (spelling, handwriting, literature and use of dictionaries).

The general aims of education are to foster individual development, transmit our cultural heritage and contribute to the social order and benefit of humanity. Building upon real life events, needs and feelings of the student, the teaching/learning process provides an opportunity for all students to acquire the knowledge and skills necessary to become informed, active citizens.

Listed below are the QCC's for grade five correlated to composting activities, as an example of how they meet the needs of this grade level.

Science

Matter/Chemistry Describe relationships between atoms, elements, molecules and compounds (use models and diagrams): 47.

Energy/Heat Create friction with hands to generate heat: 48.

Plants In depth study of photosynthesis (light + water + CO_2 + sun's energy = sugar and Oxygen): 51.

Animals Classify animals by observable characteristics, i.e., legs, wings, color, size, etc. Know the two major animal groups -- vertebrate and invertebrate; study worms: 51.

Ecology Relate air, water, visual, olfactory, and noise pollution to overpopulation factors and formulate ideas to solve these problems: 50.

E.S.T.S. Compare biodegradable and non biodegradable objects: 50.

Math

Concepts Relate decimal numbers to models using basic 10 blocks and grid paper. Know place values to the millions, decimals through 100. Compare and order whole numbers, fractions and decimals. Determine which fractions are closer to zero, 1/2, or 1. Identify factors or multiples for a given number. Identify truisms in symbolic logic (if x, then y): 20.

Process Skills Do four digit addition and subtraction; add and subtract fractions with like and unlike denominators: 18. Measure perimeter, area and volume by experimenting with manipulatives using covering, filling and counting.

Problem Solving Refine estimation strategy (front end clustering, rounding and reference point) to predict computation, with whole numbers, fractions, and decimals: 22. Predict measurement by "walking off" and rough comparison; collect and organize data using charts, tables, tallies, scales, bar graphs, and pictographs: 25. Solve simple math problems: 23, 26, 27, and 28.

Social Studies

See scarcity as an imbalance of unlimited wants and limited resources: 54 and 56. Identify well known leaders: 57. Know the U.S. role in world affairs: 53, 54, and 57. Learn how inventions change lifestyles; recognize your own and others' value systems: 54. Know the democratic principles: 62. Evaluate the reliability of information: 61. Recognize the rights of others to hold different opinions: 55.

Health and Safety

Family Living Discuss roles and responsibilities of family members: 64.

Nutrition Identify protein, starch, sugar, fats, vitamins, and minerals: 64.

Personal Health Identify preventative health methods: 64.

Mental Health Demonstrate awareness and acceptance of self and others; use communication skills in interpersonal relationships: 64.

Substance Abuse Describe alternatives to drug and alcohol use, like hobbies, interests, and leisure activities: 64.

Language Arts

Oral Communication - Listening Know the difference between prose, poetry and drama literary forms: 12, 13, and 39. Record orally presented information (transcribe): 13, 43.

Speaking Adjust manner and style of speaking and writing to suit audience and situation: 17. Explain in organized fashion your purpose to audience: 13 and 16.

Written Communication -Writing Use standard conventions of American English. Use colloquialisms, slang, regional expressions, inflexions, and accents; write legibly: 9 and 36.

Reading Make generalizations and draw conclusions, balancing perception and judgment as a means of cultural literacy: 4.

Reference and Study Skills Use a thesaurus: cross reference information with several types of sources: 5 and 28. List personal sources in a Bibliography or reference list: use study techniques (e.g. PORST, SW3R, PQ4R, 4R): 28.

Literature Recognize that literature reflects human experience: 40 and 53.

Music

Listening Skills Be aware of music's historical origins and describe effects of personal musical experience: 14, 69, and 71.

Performance Skills Accompany singing with auto harp, ukulele or guitar. Play by ear and from simple notation using melody and percussion instruments: 71.

Creative Skills Create text and melodies of simple songs: 11, 44, 69, and 70.

Dance/Drama

Creative Skills Perform folk drama with creative movement; create movements for music dramatizations and interpretations; create "sound stories" using a variety of sound sources (munch, munch); create organized movements and portray the form of music; create simple pantomime improvisation: 70. Plan organized dance movements for music: 69.

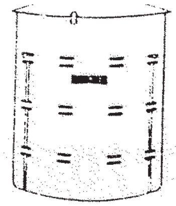
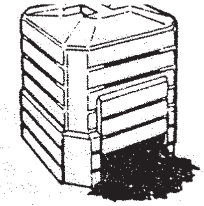
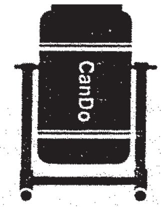
Visual Arts

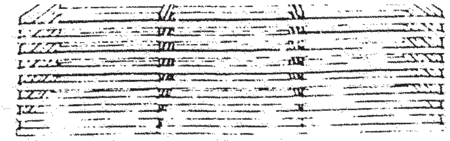
Perceptual Awareness Identify a range of values of a color or a neutral hue; make a grouping of related colors or "analogues" on the color wheel, like yellow-orange, yellow and yellow-green; see lines that suggest space and depth; recognize that forms can be open and hollow or closed and solid; identify how one and two point perspective show distance in artworks; notice how light and shadow (shading) reveal textures, shapes and form: 12, 13, 69, and 70.

Production of Artworks Create art works that express specific emotion: 12, 13, 26, 27, 69, and 70. Create art works using specific subject matter; use color analogues; create sculpture that is "open or closed"; communicate a visual message in a logo, symbol or sign: 12, 13, 26, 27, 69, and 71. Use perspective to make special illusion; emphasize proportion; portray an object under changing light and conditions: 12, 13, 69, and 70.

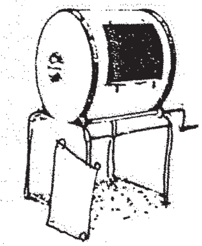
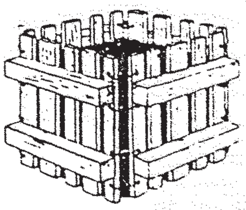
Artistic Heritage Learn about art careers -- architecture, graphic design, photography: 12, 13, 69, and 70.

Art Criticism and Aesthetic Judgment Identify specific media and techniques in art; analyze art based on the elements of art and design principles: 9, 16, 69, and 70. Support reasons for personal preference of art; Classify objects as "art", "not art", "may be art": 9, 16, 30, 69, and 70.

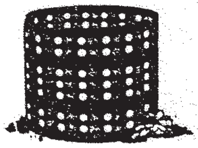
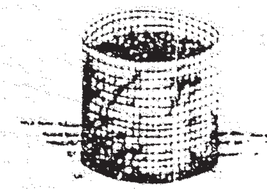


Compost Bin Art reproduced by permission of Harmonious Technologies

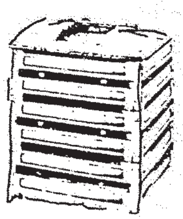
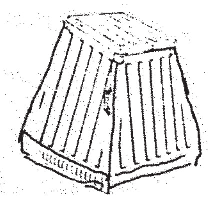



Activity 1

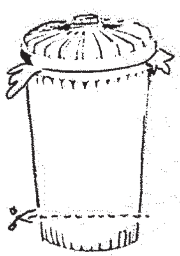
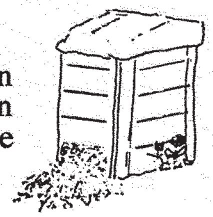
BUILD A BIN!

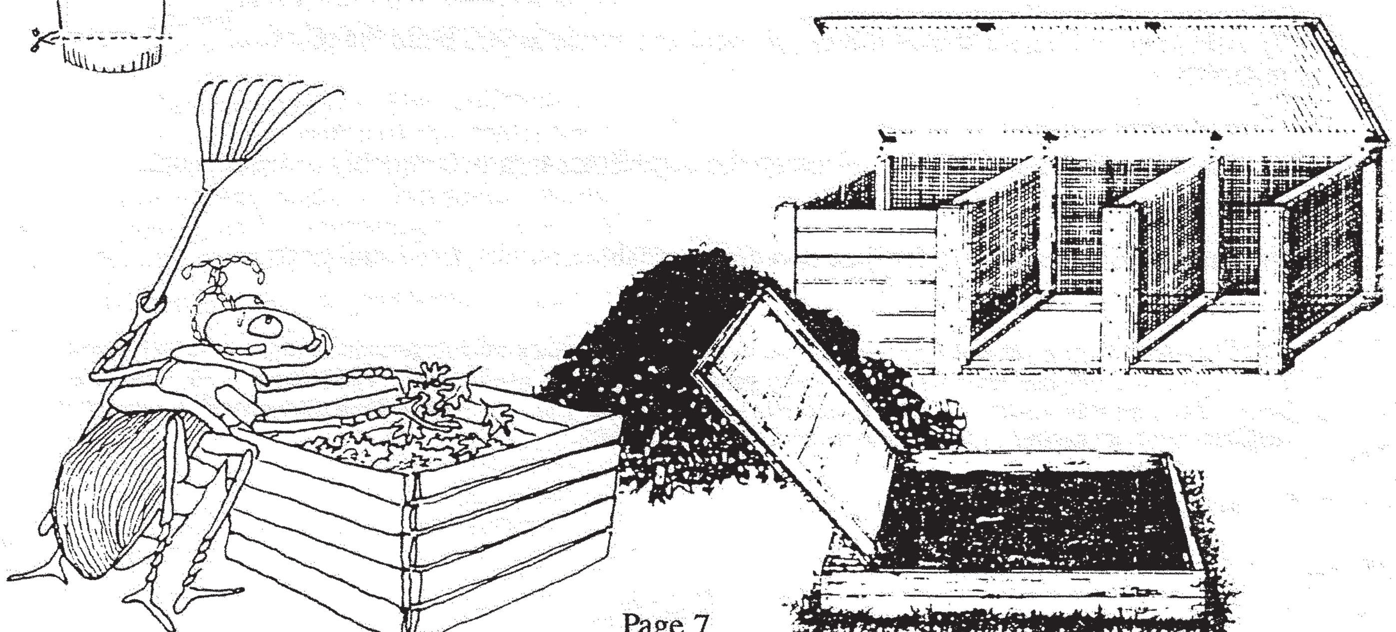
Construct a compost enclosure of any type.

Four wooden shipping pallets can be placed on edge and tied or wired together at the corners to form a square, or an eleven foot length of 36 inch wide welded fence wire can be tied or wired to form a hoop. Shipping pallets are often given away by businesses that use them. You can find fence wire pre-cut specifically for composting at some garden stores. If you know others who want to compost, you can purchase 25 to 100 foot rolls of the fence wire and cut it yourselves. A 100 foot roll of 2x4x36 inch welded fence wire at a farm supply costs approximately $30.00. Hardware and building supply stores often carry shorter rolls at a somewhat higher cost.

Compost bins can also be made of cement blocks or from a garbage can with holes drilled in it for air. Decomposition will take place in an open pile as well, but the enclosure keeps the mass together and speeds up the process. The optimum size is 3 x 3 x 3 feet (one cubic yard).



Activity 2

RECIPE FOR COMPOST

Step by Step…to success

1) Construct a compost enclosure (see activity number one).

2) Pick up sticks and put them in your compost bin - a base layer of loosely stacked twigs and branches allows for needed air circulation.

3) Make a layer of brown stuff (carbon materials) such as leaves, hay, straw, sawdust, wood chips (except from treated wood), paper products such as napkins, towels, and tubes, dryer lint, and wood ash.

4) Add a layer of green stuff (nitrogen materials) such as banana, apple, or potato peels, lettuce leaves, carrot tops, table scraps, and weeds that haven't gone to seed.

5) Continue to add layers, alternating brown and green stuff. Always end with a layer of brown stuff in order to hide the green stuff from flies and wildlife.

6) Moisten with water now and then.

7) Add to the mixture a shovel full of soil once in a while as you build the pile to provide needed microbes.

8) Stir with a pitchfork weekly and watch the ingredients turn into crumbly brown humus.

9) Harvest your compost to fertilize flowers, vegetables, shrubs, trees, and grass.

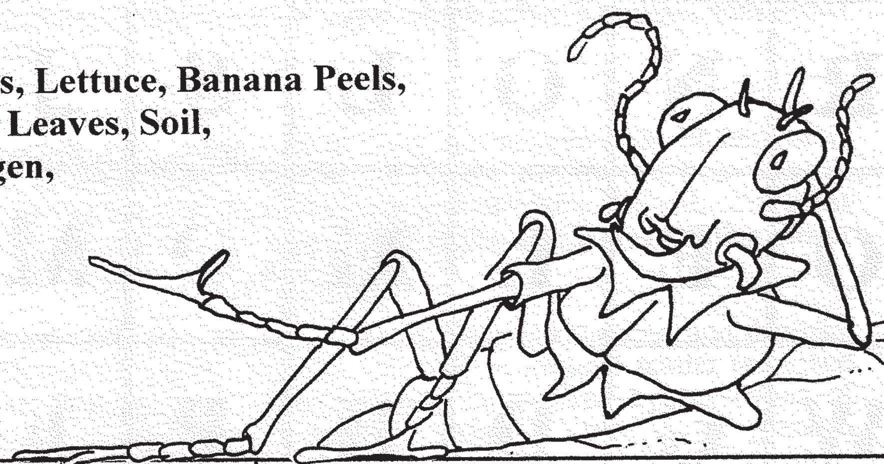
NOTE: Avoid using cat and dog feces (manure) because it contains microorganisms harmful to human health. Cow, horse, and chicken litter are great. Dairy products, eggshells, meat scraps, bones, fats and oils can attract pests. Also, an oily coating on the organic residue you put in your compost inhibits decomposition because it displaces moisture needed by the helpful microorganisms and bugs.

Activity 3

WORD SCRAMBLE

Each of the groups of letters here are scrambled words you've learned about composting. First, see how many you can solve without looking at the list provided. Then read the list and go back to see how many you recognize.

Water, Coffee Grounds, Lettuce, Banana Peels, Organics, Apple Core, Leaves, Soil, Microorganisms, Oxygen, Decomposers



RIGOSCAN	
PRODECOSSEM	
NEXOGY	
SCRIMORGSAMOIN	
TAWER	
PLAPE OCER	
VALEE S	
OSIL	
ANNBAA LEPES	
TELCUTE	
FOCEFE DROGUNS	

Now, write a paragraph using all the words you have unscrambled.

Activity 4 WORD FIND

Can you find these words? bacteria, carbon, compost, fungi, humus, mold, nitrogen, organic, earthworm, MSW

M	E	M	V	T	W	N	C
R	N	O	L	S	J	O	I
O	E	L	M	O	M	B	N
W	G	D	H	P	F	R	A
H	O	F	O	U	L	A	G
T	R	S	N	W	M	C	R
R	T	G	I	H	Q	E	O
A	I	R	E	T	C	A	B
E	N	H	U	M	U	S	Z

Activity 5 COMPOST MEASUREMENT ACTIVITY OR . . . ROT'N'REDUCE

When you have completed activities one and two, you will have a compost enclosure full of decomposing organic material. Now you can observe, measure and record the characteristics of decomposition. While you won't be able to see the microscopic activity at work, teachers can enhance your understanding by explaining the "unseen" world. Organic material decomposes when exposed to air, water, bacteria, and other microorganisms. Temperatures of about 150 degrees Fahrenheit (65 degrees Celsius), may be generated thereby "cooking" the material in the pile. You will also observe that the pile shrinks. Composting is a form of solid waste reduction because it keeps organic waste out of the landfill. Reduction also occurs naturally, because when something decomposes it gets smaller.

Procedure:

1) Take a guess! Write your hypothesis about the outcome of the activity in the space provided on the worksheet.

2) Use the worksheet to describe what the pile looks and smells like throughout it's decomposition.

3) Measure and record the temperatures of the pile using a long thermometer. You may find a compost thermometer at a lawn and garden shop or call Gardener's Supply, Burlington, VT at (802) 660-3500 to request a mail order catalog.

4) After logging data for several weeks, discuss your findings.

5) Summarize and write your conclusions.

6) Compare your conclusions with the hypotheses you made when you began this activity. Are you surprised by results of composting? Why are landfills not good places for the composting process to occur?

More about temperature:

Composting occurs at temperatures ranging from approximately 60° F to 160° F. Composting may be a little slower at lower temperatures within this range. At the higher temperatures, weed roots and seeds, some bacteria, and insect eggs are destroyed.

Checking the temperature of the compost pile with a compost thermometer is a good way to monitor the progress. The center of the compost pile will be warmer than the outside. Why?

The temperature will remain high during decomposition and then start to cool as the decomposing materials begin to "stabilize". One way to determine whether the compost is ready for use, is to check the temperature of the pile right after you have turned it. The temperature may drop slightly but will quickly rise again. If the temperature does not rise or is generally 100° F. or lower, and all other conditions in the pile are favorable, the compost should be ready. The materials should no longer be recognizable.

Discussing reduction:

How does composting reduce the amount of organic material you would have thrown out. What do you think happens to organics that end up in the landfill? Is the landfill a gigantic natural compost pile, or are there potential problems with placing large amounts of organic material in landfills?

Name________________________________ Date_________________

ROT 'N' REDUCE WORKSHEET

Hypothesis:

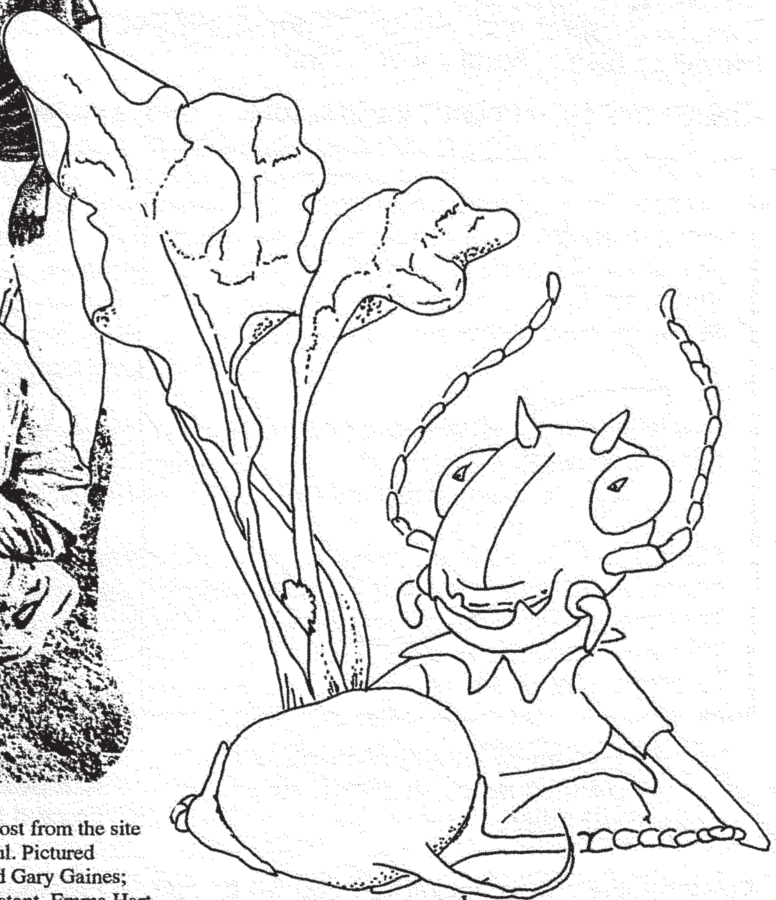
Day	Date	Temp.	Height	Smell	Appearance and Changes
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

Conclusion:

Activity 6

FROM ROT TO RADISH:
FULL CIRCLE COMPOSTING

Taking care of business
This group is preparing the soil for an herb garden with compost from the site established at CCES by Roberta/Crawford Clean and Beautiful. Pictured clockwise are fifth graders, Blake Obenauf, Joseph Daigle and Gary Gaines; CCI lunchroom manager, Donnelle Wright; and nutrition assistant, Emma Hart.



Here is a great activity from Roberta/Crawford Clean and Beautiful, Roberta, Georgia that shows the end results of composting-- fresh vegetables grown in your own garden! Here's how they do it. Using a three bin composter, three 5th grade students volunteer during the school year to be responsible for the composting of food preparation wastes from the school cafeteria. The school dietitian separates things such as outside leaves of lettuce and carrot peelings for the student volunteers to pick up and mix into the compost pile with stockpiled leaves. The stockpiled leaves come from parents, students and teachers for the project. The compost pile serves as an outdoor classroom throughout the school year. This is full circle composting!

To use the compost, a garden bed of topsoil was prepared and compost mixed in. Radishes were grown (since they grow very fast in the early spring), harvested, and used by the dietitian in the making of salads for school lunches.

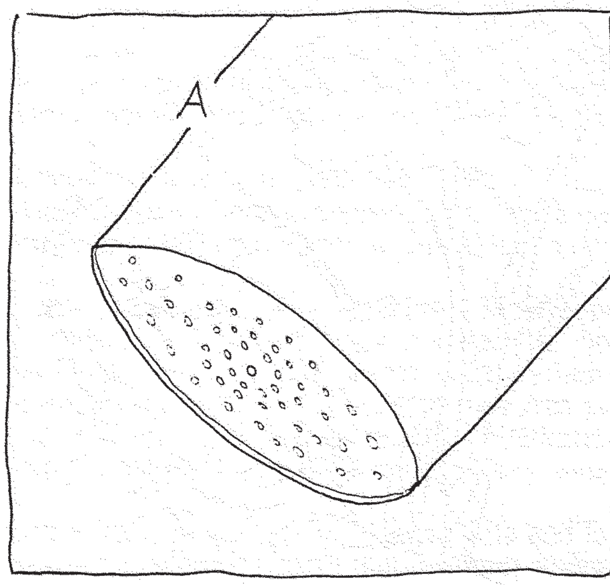
As an experiment, you may try growing radishes or other vegetables side by side-- one with compost and one without. Compare your results. How do they Look? How do they taste?

Activity 7 WORMS AT WORK . . .

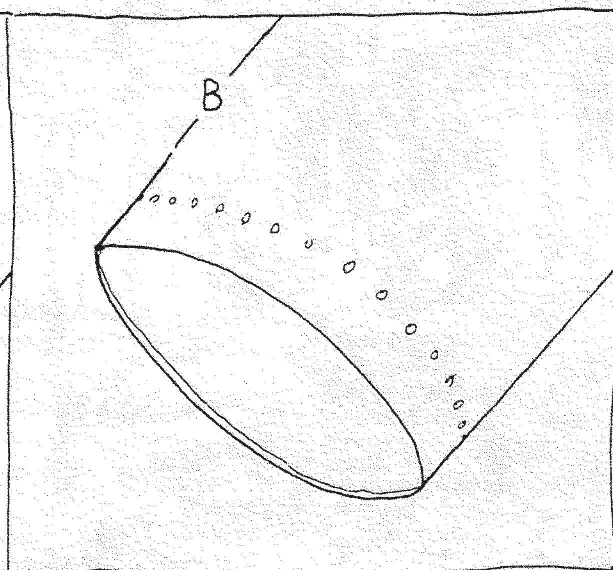
When you're done with your lunch, do you still have a little food left on your plate? What are you going to do with it? This may sound strange, but you don't have to throw it away. You can save it and turn it back into rich, fertile soil -- one of Earth's greatest treasures. You can then use it for growing plants. It's called composting. It's so simple that anyone can do it.

WHAT YOU CAN DO
You can compost with worms. Worms? Believe it or not, they're great composters. With your teacher or parent, build a worm farm.

Clean 2 five gallon plastic buckets (obtain from a restaurant, house painter, etc.).

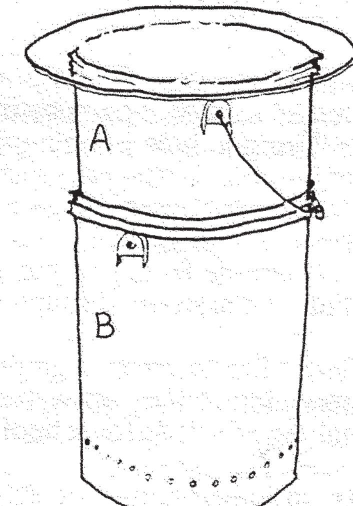


In the bottom of bucket (A) drill 20 or 30 1/4 inch holes, or punch 50 or more nail holes.



In the sides of bucket (B) drill or punch nail holes 2 inches up from the bottom around the entire circumference.

Stack bucket (A) in bucket (B) and fill bucket (A) to about half full with moist "bedding." Peat moss, shredded paper, leaves, hay and grass are all good choices. Collect Red Wiggler worms from your yard or garden area(especially after a rain), or buy some earth worms at a local nursery or bait shop and put them in. Add one pound of worms for every half pound of food to start. You will be surprised to see how fast they multiply! Put in a couple of handfuls of soil. You can put in food scraps (except for meat, bones, dairy products, and fatty food) Mix it all together, and watch the worms at work. Cover the worm bin with a bucket lid or cut a disk of plywood or Plexiglas.



When the worms have overpopulated their "mini-habitat", its time to release them into the soil to do their work there.

A 12' x 20' garden space needs a wheel barrow full of worms to ***aerate*** the soil by loosening the soil so that oxygen may enter and to ***fertilize*** by adding their castings (feces).

Activity 8

COLLECT AND OBSERVE LIVING COMPOST CRITTERS

Decomposition is the process by which bacteria, fungi, and other microscopic organisms break down organic matter into nutrients that can be used by plants and animals.

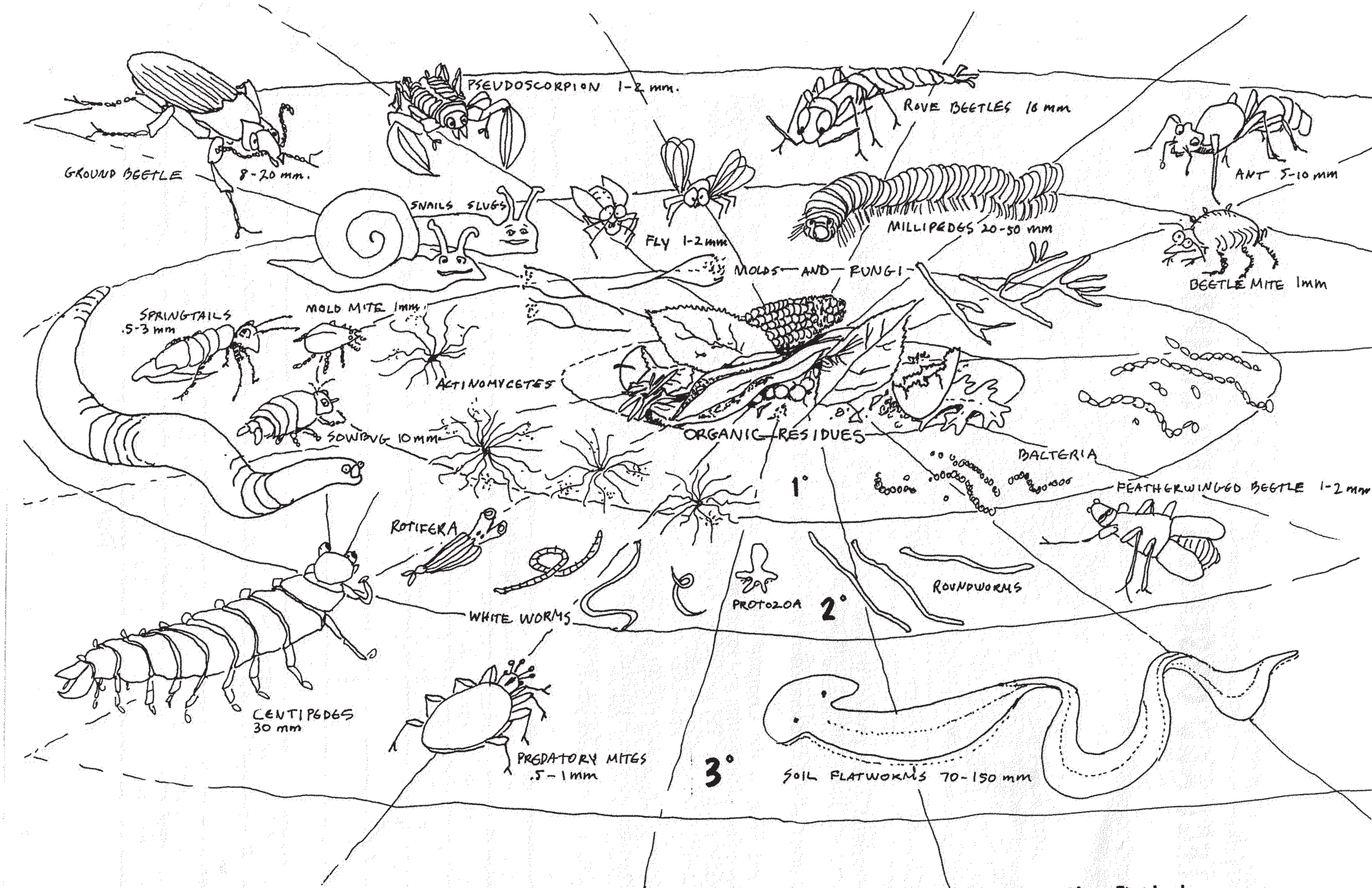
Visible organisms are decomposers too. Make a collection of living compost critters.

The Food Web of the Compost Pile will help you decide what creatures to collect. Use encyclopedias, field guides and information on pages 24 - 27 of the activity guide to identify and learn about each one. Try to find out such things as their favorite food, temperature preference, or occupation in the compost pile.

Keep the specimens long enough and take a good look with a magnifying glass, or make sketches for an outdoor classroom journal. Then set the creatures free to get back to their important work.

Make a list of the critters you find and give a compost pile job description for each one.

Name	Job Description



THE FOOD WEB OF THE COMPOST PILE

1° = First level consumers
2° = Second level consumers
3° = Third level consumers

Activity 9

THE CHALLENGE:
DESIGN THE ULTIMATE COMPOSTER

Now with the knowledge you have gained on home composting, design the ultimate compost bin (be imaginative). Use this page to draft your creation. Sculpture/models could also be fun!

Explain the features of your design and what makes it the ultimate composter. This activity provides an excellent opportunity for a demonstration speech and public speaking experience in explaining the workings of "the ultimate composter" to the class.

BACKGROUND

Today, solid waste management is one of the most prominent environmental issues facing Georgia and many other states throughout the nation. Something must be done to slow down the accumulation of waste materials. Georgians generate about 4 1/2 pounds of solid waste per person each day. Statewide this amounts to over 12 million tons each year. Recycling programs underway in many communities across the state are helping slow the flow of waste into landfills. While most of what we throw away is recyclable, less than 20% of our household waste is presently being recycled.

In 1990 the Georgia Legislature passed the ***Georgia Comprehensive Solid Waste Management Act.*** This Act requires local governments across the state to document a 25% reduction in landfill volume by July 1, 1996. It also gives local governments the right to refuse to accept organic landscape materials at landfills after July 1, 1990. Further amendments ban yard trimmings from lined landfills after July 1, 1996.

Stringent environmental regulations have made the cost of constructing landfills skyrocket. Costs range from $250,000 to $350,000 per acre to build a new landfill facility, or ten times more than they cost in the past.

Organic landscape materials, including leaves, woody trimmings and grass clippings typically account for between 15% and 20% of a community's annual solid waste. During peak leafdrop in fall when residents are bagging and placing leaves curbside, organic materials may account for as much as 50% of the incoming landfill volume.

The irony of this scenario is that, with the exception of large woody brush, residents can recycle all their organic materials right in their own yards through composting, mulching and grasscycling. By recycling these materials, we're not just saving our landfill space but also improving our home environment. Organic matter adds valuable nutrients back to the soil, improves the condition of our soils, and helps plants survive dry periods by holding moisture.

As concerned citizens and good stewards of the environment, it's time we take action and stop throwing out what we can recycle and reuse. It's time we stopped classifying organic materials as waste and see them as Mother Nature intended -- as an important link in the web of life, whose death and decay brings newness of life and beauty to our environment.

Compost is the controlled decomposition of organic matter through biological processes, with the end result being a nutrient-rich humus. The word 'compost' is derived from the Latin verb componere which means to put together. Composting involves the putting together of a mixture of vegetable residue, soil and water to form humus. Just as variety is the spice of life, a variety of different organic materials makes the best compost. While commercial fertilizers supply the three main ingredients required by plants for growth (nitrogen, phosphorus, potassium), many other nutrients and micro-nutrients are not available in these preparations. Adding compost to the soil provides the full spectrum of nutrients. It conditions the soil so that plant root systems are healthier. It produces a soil that resists erosion because it holds together better. It helps the soil retain moisture so that watering need not be done as often, and thus water is there when the plants need it. It attracts bacteria and worms, which further change the chemistry of the soil so that more nutrients are available to the plants.

As a natural process, "composting" has been taking place since the initiation of plant life on earth. Early man no doubt learned to use manures and planted in soil enriched by natural decay. Historians have traced composting and the use of compost in Europe to the Roman, Marcus Cato over 2000 years ago.

The first important advance in the practice of composting was made by Sir Albert Howard almost 75 years ago in India. He systemized the traditional procedure into a composting method he called the Indore process. This process involved stacking alternate layers of animal manure, sewage sludge, garbage, organic matter such as leaves, and municipal refuse. The material was stacked to a height of about 5 feet or was placed in specially constructed pits 2 or 3 feet deep. The original procedure called for turning the material only twice during the composting period of six months or longer. The liquor draining from the decomposing mass was recirculated to moisten the pile or was added to other drier piles. The Indore process, named after the locality in India, with modifications and improvements, has been used widely in many different countries. An important innovation has been more frequent turning to maintain aerobic conditions, thus providing more rapid decomposition and shortening the composting period.

During the period 1926-1941, Waksman and his associates carried out fundamental research on the aerobic decomposition of vegetable residues and stable manures. They made and reported important discoveries regarding the influence of temperature on the rate of decomposition, the role of individual groups of micro-organisms, and the effect of mixed cultures compared with pure cultures on organic breakdown.

From 1950 to 1952, Gotaas and his associates conducted research on some of the basic aspects of composting, mixed municipal refuse containing garbage and sewage sludge. Their investigation provided information on the effects of some of the different variables encountered in aerobic composting, namely: (1) temperature; (2) moisture; (3) aeration by turning and by other means; (4) the C:N (Carbon:Nitrogen) ratio of the organic materials; (5) the use of special biological inocula; and (6) grinding or shredding the material.

Their studies also yielded data on the types of organisms present in composting for judging the condition of the compost at various stages of decomposition.

While composting practices were being refined in India, China, and elsewhere, other investigators, notably in Europe, were devoting considerable effort to mechanizing the composting process, particularly for use as a method for treatment and sanitary disposal of the garbage and refuse from cities. These efforts resulted in various mechanical innovations, usually with the objective of improving the aesthetics of the process by enclosing the materials in some type of structure, of speeding it up, and making it more economical. The mechanized and enclosed processes are primarily designed for cities, but they are also valuable in rural composting.

Anything organic - leaves on the ground, a fallen tree, or a wood framed house - will decompose. The more resistant the material is to decay, however, the longer the process will take. Except in some special situations, decomposition is inevitable! In very dry places or in very cold climates decomposition may be slowed or stopped. But everything organic that's out in the weather will sooner or later be fueling the decomposition process.

A diversity of materials is the key to a really first-rate compost. The more diverse the materials composted, the more likely that these elements are returned to the plants.

Where are materials for composting found? Well, an avid recycler of organic wastes looks longingly at the contents of supermarket dumpsters and florist shop trash barrels. These are items that would otherwise be thrown away. The quote below from Vic Sussman's book Easy Composting (pp. 103-4), sums up the situation:

"..gardeners can serve an important role in collecting such 'waste' that might otherwise plague the community and the local environment by ending up as pollutants. But besides lifting a small part of the burden off your fellow taxpayers, you'll be functioning as an agent of change. People will express surprise and curiosity at your collection and composting of what they had previously considered useless stuff. Your recycling and humus making will act as a reminder that garbage and organic trash are really resources, not problems, if we use our collective imaginations and practice self-reliance".

The Decomposition Process

The process of decomposition -- the breakdown of raw organic materials to a finished compost -- is a gradual complex process, one in which both chemical and biological processes must occur in order for organic matter to change into compost.

The decomposition (stabilization) of organic matter by biological action has been taking place in nature since life first appeared on our planet. In recent times, man has attempted to control and directly utilize the process for recycling and reclamation of organic waste material. Such organic materials as vegetable matter, animal manure and other organic refuse can be converted from otherwise wasted materials to a more stable form for use as a soil amendment by this process. This process is called "composting" and the final product of composting is called "compost". Generally speaking there are two processes that yield compost:

1. AEROBIC (with oxygen) decomposition and stabilization.

2. ANAEROBIC (without oxygen) decomposition.

In these processes, bacteria, fungi, molds, protozoa, actinomycetes, and other saprophytic organisms feed upon decaying organic materials initially. While in the later stages of decomposition, mites, millipedes, centipedes, springtails, beetles and earthworms further breakdown and enrich the composting materials. The organisms will vary in the pile due to temperature conditions, but the goal in composting is to create the most favorable environment possible for the desired organisms.

Anaerobic Decomposition (Fermentation)
Anaerobic decomposition takes place in nature, as in the decomposition of the organic muds at the bottom of marshes and in buried organic materials to which oxygen does not have access. Intensive reduction of organic matter by anaerobic decomposition is usually accompanied by disagreeable odors of hydrogen sulfide and reduced organic compounds which contain sulfur, such as mercaptans (any sulfur-containing organic compound).

The lack of heat generated in the anaerobic destruction of organic matter is a definite disadvantage if contaminated materials are used for composting. High temperatures are needed for the destruction of pathogens and parasites. In anaerobic decomposition the pathogenic organisms do eventually disappear in the organic mass, as a result of the unfavorable environment and biological antagonisms.

However, organic material can be decomposed anaerobically to produce compost. For instance, a heavy plastic bag can be used to decompose grass clippings, shredded leaves, kitchen trimmings, small amounts of stable manure or other high nitrogen materials. However, as. anaerobic compost can have a strong odor (and may need to be aired prior to using it), it is not usually the first choice for homeowners.

Aerobic Decomposition
When organic materials decompose in the presence of oxygen, the process is called "aerobic." The aerobic process is most common in nature. For example, it takes place on ground surfaces such as the forest floor, where droppings from trees and animals are converted into a relatively stable humus. There is no accompanying bad smell when there is adequate oxygen present.

In aerobic decomposition, living organisms, which use oxygen, feed upon the organic matter. They use the nitrogen, phosphorus, some of the carbon, and other required nutrients. Much of the carbon serves as a source of energy for the organisms and is burned up and respired as carbon dioxide (CO_2). Since carbon serves both as a source of energy and as an element in the cell protoplasm, much more carbon than nitrogen is needed. Generally about two-thirds of carbon is respired as CO_2 while the other third is combined with nitrogen in the living cells. However, if the excess of carbon over nitrogen (C:N ratio) in organic materials being decomposed is too great, biological activity diminishes. Several cycles of organisms are then required to "burn" most of the carbon.

When some of the organisms die, their stored nitrogen and carbon becomes available to other organisms. As other organisms use the nitrogen from the dead cells to form new cell material, once more excess carbon is converted to CO_2. Thus, the amount of carbon is reduced and the limited amount of nitrogen is recycled. Finally, when the ratio of available carbon to available nitrogen is in sufficient balance, nitrogen is released as ammonia. Under favorable conditions, some ammonia may oxidize to nitrate. Phosphorus, potash, and various micro-nutrients are also essential for biological growth. These are normally present in more than adequate amounts in compostable materials and present no problem.

During composting, a great deal of energy is released in the form of heat in the oxidation of carbon to CO_2. If the organic material is in a pile or is otherwise arranged to provide some insulation, the temperature can exceed 160°F; however, the bacterial activity is decreased and stabilization is slowed.

Initially, mesophilic organisms, which live in temperatures of 50°F to 115°F, colonize in the materials. When the temperature exceeds about 120°F, the thermophilic organisms, which grow and thrive in the temperature range 115°F to 160°F, develop and replace the mesophilic bacteria in the decomposing material. Only a few groups of thermophiles carry on any activity above 160°F.

Oxidation at thermophilic temperatures takes place more rapidly than at mesophilic temperatures; hence, a shorter time is required for decomposition (stabilization). The high temperatures will destroy pathogenic bacteria, protozoa (microscopic one-celled animals), and weed seeds, which are detrimental to health or agriculture when the final compost is used.

Aerobic oxidation of organic matter produces no objectionable odor. If odors are noticeable, either the process is not entirely aerobic or there are some special conditions or materials present which are creating an odor. Aerobic decomposition or composting can be accomplished in pits, bins, stacks, or piles, if adequate oxygen is provided. Turning the material at intervals or other techniques for adding oxygen is useful in maintaining aerobic conditions.

Compost piles under aerobic conditions can attain a temperature of 140°F to 160°F in one to five days depending upon the material and the condition of the composting operation. This temperature can also be maintained for several days before further aeration. The heat necessary to produce and maintain this temperature must come from aerobic decomposition, which requires oxygen. After a period of time, the material will become anaerobic unless it is aerated.

Requirements for Efficient Decomposition
Decomposition of organic material in the compost pile depends on maintaining microbial activity. Any factor which slows or halts microbial growth also impedes the composting process. Efficient decomposition occurs if aeration, moisture, and a sufficient source of carbon and nitrogen are in evidence.

Aeration/Oxygen
Oxygen is required for microbes to decompose organic wastes efficiently. Some decomposition occurs in the absence of oxygen (anaerobic conditions); however, the process is slow, and foul odors may develop. Because of the odor problem, composting without oxygen is not recommended in a residential setting. Mixing the pile once or twice a month provides the necessary oxygen and significantly hastens the composting process. A pile that is not mixed may take three to four times longer to decompose. Raising the pile off the ground allows air to be drawn through the mass as the material decomposes. Coarse materials should be placed on the bottom as the pile is built or placed in the pile and removed after decomposition starts.

Moisture
Adequate moisture is essential for microbial activity. A dry compost will not decompose efficiently. Proper moisture encourages the growth of microorganisms that break down the organic matter into humus. If rainfall is limited, water the pile periodically to maintain a steady decomposition rate. Add enough water so the pile is damp but not soggy. It should feel like a damp sponge. Avoid over watering. Excess water can lead to anaerobic conditions which slow down the degradation process and cause foul odors. If the pile should become too wet, turn it to dry it out and restart the process.

Particle Size
Grinding the organic material before composting greatly reduces decomposition time. The smaller the size of the organic refuse particle, the more quickly it can be consumed by the microbes. A shredder is useful for chipping or shredding most landscape refuse and is essential if brush or sticks are to be composted. A low-cost method of reducing the size of fallen tree leaves is to mow the lawn before raking. Wind-rowing the leaves into long narrow piles one foot high will make the shredding process more efficient. If the mower has an appropriate bag attachment, the shredded leaves can be collected directly. However, grinding is entirely optional.

Temperature
Temperature of the compost pile is very important to the biological activity taking place. Low outside temperatures slow down the activity, while warmer temperatures speed up decomposition. The microbes that make up the bulk of the decomposition process fall into two categories: mesophilic, those that live and function in temperatures of 50 to 115°F, and thermophilic, those that thrive at temperatures between 115 to 158°F. A well-mixed, adequately working compost pile will heat to temperatures between 110°F and 160°F as the microbes actively feed on the organic materials. These high temperatures will help destroy weed seeds and disease organisms within the pile.

Organisms in Composting

There are many organisms that break down organic materials. Most are not seen by the human eye, but they are there throughout the process. Others that are large enough to see, are usually associated with the later stages.

The most important organisms in the breakdown process are bacteria. Bacteria present in any given pile are dependent upon the raw material present, amount of air in the pile, moisture conditions of the pile, pile temperature and numerous other factors. Compostable organic materials normally contain a large number and many different types of bacteria, fungi, molds, and other living organisms. Only very limited data are available regarding the variety of different organisms and their specific functions. It appears that more species of bacteria are involved in aerobic decomposition than in anaerobic decomposition.

Although many types of organisms are required for decomposition of the different materials, the necessary variety is usually present in the materials to be composted, and the organisms thrive when environmental conditions are satisfactory. During decomposition, marked changes take place in the nature and abundance of the biological population. Some of the many species will multiply rapidly at first but will dwindle as the environment changes and other organisms are able to thrive under more varied conditions. Temperature and changes in the available food supply probably exert the greatest influence in determining the species of organisms comprising the population at any one time. Aerobic composting is a dynamic process in which the work is done by the combined activities of a wide succession of mixed bacteria, actinomycetes, fungi, and other biological populations. Since each is suited to a particular environment of relatively limited duration and each is most active in decomposition of some particular type of organic matter, the activities of one group complement those of another. The mixed populations parallel the complex environments afforded by the heterogeneous nature of the compostable material. Except for short periods during turning, the temperature increases steadily in proportion to the amount of biological activity until equilibrium (state of balance) with subsequent heat losses is reached, or the material becomes well-stabilized (humus-like).

It should be noted that since the necessary organisms for composting are usually present and will carry on the process when the environment is suitable, an extensive knowledge of the characteristics of the various organisms is not necessary for understanding a compost pile.

Since decomposition is the crux of the composting process, let's take a look at the various organisms that play an essential role in the working compost heap. Most are microscopic, some are large enough to be observed with the unaided eye, but all are beneficial, each having a role in breaking down raw organic matter into finished compost. They are known as decomposers. By far the most important microscopic decomposers are bacteria, which do the lion's share of decomposition in the compost heap. But there are other microscopic creatures such as actinomycetes, fungi, and protozoa, that also play an important role. Together, these are chemical decomposers that change the chemistry of the organic wastes. The larger fauna in the heap include mites, millipedes, flatworms, centipedes, sowbugs, snails, slugs, spiders, springtails, beetles, ants, flies, nematodes and, most importantly, earthworms. Collectively, these are called the physical decomposers since they bite, grind, suck, tear and chew the materials into smaller pieces, making them more suitable for the chemical work of the microscopic decomposers.

All of the organisms, from the microscopic bacteria to the largest of the physical decomposers, are part of a complex food web in the compost pile. They can be categorized as first, second or third level consumers, depending upon what they eat. First level consumers attract and become the food of second level consumers, who in turn are consumed by third level consumers. The organisms comprising each level of the food web serve to keep the populations of the next lower level in check, so that a balance can be maintained throughout the compost. For example, according to Daniel L. Dindal, in <u>Ecology of Compost</u>,

> "...mites and springtails eat fungi. Tiny feather-winged beetles feed on fungal spores. Nematodes ingest bacteria. Protozoa and rotifers present in water films feed on bacteria and plant particles. Predaceous mites and pseudoscorpions prey upon nematodes, fly larvae, other mites and collembolans. Free-living flatworms ingest gastropods, earthworms, nematodes and rotifers. Third level consumers such as centipedes, rove beetles, ground beetles, and gnats prey on second level consumers. These creatures function best at medium or mesophilic temperatures, so they will not be in the pile at all times. "

Chemical Decomposers
These organisms are the initial inhabitants of the pile. Many of them are unseen and come in with the materials that make up the pile. These organisms are around all the time and only need to find the conditions right "to their liking" in order to start their normal functions of breaking down organic materials.

Bacteria
Bacteria likely to be found in a compost heap are aerobic bacteria that specialize in breaking down organic compounds and thrive in temperatures ranging up to 170°F. (77°C.) Bacterial populations differ from pile to pile, depending upon the raw materials of the compost, degree of heat, amount of air present, moisture level, geographic location of the pile, and other considerations. Bacteria are single-celled and can be shaped like a sphere, rod, or a spiral twist. They are so small that it would take 25,000 bacteria laid end to end to take up one inch on a ruler, and an amount of garden soil the size of a pea may contain up to a billion bacteria. Most bacteria are colorless and cannot make carbohydrates from sunshine, water, and carbon dioxide the way more complex green plants can. Some bacteria produce colonies; others are free living.

Under the best conditions, a colony of bacteria can multiply into billions in a very short time. The life span of one generation of bacteria is about 20 to 30 minutes, so that one cell may yield a progeny of billions of individuals in half a day.

Bacteria can eat nearly anything. Most compost bacteria are heterotrophic, meaning that they can use living or dead organic materials. Some are so adaptable that they can use more than a hundred different organic compounds as their source of carbon because of their ability to produce a variety of enzymes. Usually, they can produce the appropriate enzyme to digest whatever material they find themselves on. In addition, respiratory enzymes in the cell membrane make aerobic respiration possible as an energy source for compost bacteria.

Since bacteria are smaller, less mobile and less complex than most organisms, they are less able to escape an environment that becomes unfavorable. A decrease in the temperature of the pile or a sharp change in its acidity can render bacteria inactive or kill them. When the environment of a heap begins to change, bacteria that formerly dominated may be decimated by another species.

Actinomycetes
The characteristically earthy smell of newly plowed soil in the spring is caused by actinomycetes, a higher form of bacteria similar to fungi and molds. Actinomycetes are especially important in the formation of humus. While most bacteria are found in the top foot or so of topsoil, actinomycetes may work many feet below the surface. Deep under the roots they convert dead plant matter to a peat-like substance. While they are decomposing animal and vegetable matter, actinomycetes liberate carbon, nitrogen and ammonia, making nutrients available for higher plants. They are found on every natural substrate, and the majority are aerobic and mesophilic. Five percent or more of the soil's bacterial population is comprised of actinomycetes.

The reason bacteria tend to die rapidly as actinomycete populations grow in the compost pile is that actinomycetes have the ability to produce antibiotics, chemical substances that inhibit bacterial growth.

Protozoa
Protozoa are the simplest form of animal organism. Even though they are single-celled and microscopic in size, they are larger and more complex in their activities than most bacteria. A gram of soil can contain as many as a million protozoa, but a gram of compost has many thousands less, especially during the thermophilic stage. Protozoa obtain their food from organic matter in the same way bacteria do, but because they are present in far fewer numbers than bacteria, they play a much smaller part in the composting process.

Fungi
Fungi are many-celled, filamentous or single-celled primitive plants. Unlike more complex green plants, they lack chlorophyll and the ability to make their own carbohydrates. Most of them are classified as saprophytes because they live on dead or dying material and obtain energy by breaking down organic matter in dead plants and animals. Like the actinomycetes, fungi take over during the final stages of the pile when the compost has been changed to a more easily digested form. The best temperature for active fungi in the compost heap is around 70° to 75°F, though some thermophilic forms prefer much greater heat and survive to 120°F.

Use of Inocula
Composting developments have been accompanied by considerable discussion of the importance of special inocula (bacterial activators), supposedly containing several pure strains of laboratory organisms or other biological factors essential in the decompositon of organic matter and nitrogen fixation, e.g., "enzymes", "hormones", "preserved living organisms", "activated factors", "biocatalyst", etc. In fact, several commercial composting processes are built around the use of some special inoculum, often known only to its discoverer and proponent, who claims it to be fundamental to the successful operation of the process. The need of such inocula has always been debatable, and most composting studies have strongly indicated that they are not necessary.

Physical Decomposers
The larger organisms that chew and grind their way through the compost heap are higher up in the food chain and are known as physical decomposers. The following is a rundown of some of the larger physical decomposers that you may find in nearly any compost heap. Most of these creatures function best at medium or mesophilic temperatures, so they will not be in the pile at all times.

Mites
Mites are related to ticks, spiders, and horseshoe crabs because they have in common eight leg-like jointed appendages. They can be free-living or parasitic, sometimes both at once. Some mites are small enough to be invisible to the naked eye, while some tropical species are up to a half-inch in length. Mites reproduce very rapidly, moving through larval, nymph, adult and dormant stages. They attack plant matter, but some are also second level consumers, ingesting nematodes, fly larvae, other mites and springtails.

Millipedes
The worm-like body of the millipede has many leg bearing segments, each except the front few bearing two pairs of walking legs. The life cycles are not well understood, except that eggs are laid in the soil in the springtime, hatching into small worms. Young millipedes molt several times before gaining their full complement of legs. When they reach maturity, adult millipedes can grow to a length of 1 to 2 inches. They help break down plant material by feeding directly on it.

Centipedes
Centipedes are flattened, segmented worms with 15 or more pairs of legs--1 pair per segment. They hatch from eggs laid during the warm months and gradually grow to their adult size. Centipedes are third level consumers, feeding only on living animals, especially insects and spiders.

Sowbugs
The sowbug is a fat-bodied, flat creature with distinct segments. In structure, it resembles the crayfish to which it is related. Sowbugs reproduce by means of eggs that hatch into smaller

versions of the adults. Since females are able to deposit a number of eggs at one time, sowbugs may become abundant in a compost heap. They are first level consumers, eating decaying vegetation.

Snails and Slugs
Both snails and slugs are mollusks and have muscular disks on their undersides that are adapted for a creeping movement. Snails have a spirally curved shell, a broad retractable foot, and a distinct head. Slugs, on the other hand, are so undifferentiated in appearance that one species is frequently mistaken for half of a potato. Both snails and slugs lay eggs in capsules or gelatinous masses and progress through larval stages to adulthood. Their food is generally living plant material, but they will attack fresh garbage and plant debris and will appear in the compost pile.

Spiders
Spiders, which are related to mites, are one of the least appreciated animals in the garden. These eight-legged creatures are third level consumers that feed on insects and small invertebrates, and they can help control garden pests.

Springtails
Springtails are very small insects, rarely exceeding one-quarter inch in length. They vary in color from white to blue-grey or metallic and are mostly distinguished by their ability to jump when disturbed. They feed by chewing decomposing plants, pollen grains, and fungi.

Beetles
The rove beetle, ground beetle, and featherwinged beetle are the most common beetles in compost. Featherwinged beetles feed on fungal spores, while the larger rove and ground beetles prey on other insects as third level consumers. Beetles are easily visible insects with two pairs of wings, the more forward-placed of these serving as a cover or shield for the folded and thinner back-set ones that are used for flying. A beetle's immature stage is as a soft-skinned grub that feeds and grows during the warm months. Once grubs are full grown, they pass through a resting or pupal stage and change into hard-bodied, winged adults. Most adult beetles, like the larval grubs of their species, feed on decaying vegetables, while some, like the rove and ground beetles, prey on snails, insects, and other small animals. The black rove beetle is a predator of snails and slugs. Some people import them to their gardens when slugs become a garden problem.

Ants
Ants feed on a variety of material, including aphid honeydew, fungi, seeds, sweets, scraps, other insects, and sometimes other ants. Compost provides some of these foods, and it also provides shelter for nests and hills. They will remain, however, only while the pile is relatively cool. Ants prey on first level consumers, and may benefit the composting process by bringing fungi and other organisms into their nests. The work of ants can make compost richer in phosphorus and potassium by moving minerals from one place to another.

Flies
Many flies, including black fungus gnats, soldier flies, minute flies, and houseflies, spend their larval phase in compost as maggots. Adults can feed upon almost any kind of organic material. All flies undergo egg, larval, pupal, and adult stages. The eggs are laid in various forms of organic matter. Houseflies are such effective distributors of bacteria that when an individual fly crawls across a sterile plate of lab gelatin, colonies of bacteria later appear in its tracks. You can see how during the early phases of the composting process, flies provide ideal airborne transportation for bacteria on their way to the pile. If you keep a layer of dry leaves or grass clippings on top of your pile and cover your garbage promptly while building compost, your pile will not provide a breeding place for horseflies, mosquitoes, or houseflies which may become a nuisance to humans. Fly larvae will not survive the thermophilic temperatures in the well managed compost pile. Mites and other organisms in the pile also keep fly larvae reduced in number.

Worms

Nematodes or eelworms, free-living flatworms, and rotifers all can be found in compost. Nematodes are microscopic creatures that can be classified into three categories: those that are predataors on other nematodes, bacteria, algae, protozoa, etc. and those that can be serious pests in gardens where they attack the roots of plants. Flatworms, as their name implies, are flattened organisms that are usually quite small in their free-living form. Most flatworms are carnivorous and live in films of water within the compost structure. Rotifers are small, multicellular animals that live freely or in tubes attached to a substrate in the pile. Their bodies are round and divisible into three parts-- a head, trunk, and tail. They are generally found in films of water and many forms are aquatic. The rotifers in compost are found in water which adheres to plant substances where they feed on microorganisms.

Earthworms

If bacteria are the champion microscopic decomposers, then the heavyweight champion is doubtless the earthworm. Pages of praise have been written to the earthworm, ever since it became known that this creature spends most of its time tilling and enriching the soil. The great English naturalist, Charles Darwin, was the first to suggest that all the fertile areas of this planet have at least once passed through the bodies of earthworms.

The earthworm consists mainly of an alimentary canal which ingests, decomposes, and deposits casts continually during the earthworm's active periods. As soil or organic matter is passed through an earthworm's digestive system, it is broken up and neutralized by secretions of calcium carbonate from calciferous glands near the worm's gizzard. Once in the gizzard, material is finely ground prior to digestion. Digestive intestinal juices rich in hormones, enzymes, and other fermenting substances continue the breakdown process. The matter passes out of the worm's body in the form of casts, which are the richest and finest quality of all humus material. Fresh casts are markedly higher in bacteria, organic material, available phosphorus and potassium than soil itself.

Earthrworms thrive on compost and contribute to its quality through both physical and chemical processes, and reproduce readily in the well managed pile. Since earthworms are willing and able to take on such a large part in compost making, it is the wise gardener who adjusts his composting methods to take full advantage of the earthworm's special talents.

GLOSSARY

Aeration - The process by which the oxygen deficient air in compost is replaced by air from the atmosphere. Aeration can be enhanced by turning compost.

Aerobic composting - Decomposition of organic materials by microorganisms in the presence of oxygen.

Anaerobic - Characterized by the absence of oxygen.

Bacteria - A group of microorganisms having single-celled or non cellular bodies. Some bacteria provide a gummy substance (a mucus) that binds soil particles together.

Biodegradable - Waste material which is capable of being broken down into basic elements by biological processes, especially by bacterial action. Most organic waste, such as food, leaves and paper are readily biodegradable under the right conditions.

Bulking agent - Relatively large-sized particle materials, such as wood chips, brush, and bark which create air spaces within compost.

Carbon-to-nitrogen ratio - (expressed as C:N) - The ratio of the weight of organic carbon (C) to that of total nitrogen (N) in organic material.

Compost - A mixture of decomposed organic matter (e.g., food waste, leaves, and lawn clippings) used to improve the physical properties of the soil, such as texture and aeration. Depending on the waste source, compost may have some nutrient value.

Composting - The managed biological decompostion of organic material.

Cubic yard - A unit of measure equivalent to 27 cubic feet or 22 bushels. A box that is 1 yard wide, 1 yard long, and 1 yard high has a volume of 1 cubic yard. For compacted leaves, one cubic yard is roughly equivalent to 500 pounds, assuming an average rate of compaction and moisture content.

Carbon - The element that occurs in anything that is or was once alive; the essential element for energy for the microorganisms in composting.

Decomposition - The breaking down of organic material, such as fallen leaves, by microorganisms.

Decomposers - The microorganisms and invertebrates that cause the normal degradation of natural organic materials.

Fast composting - An intensive composting method that produces finished compost in two months, more or less. This method requires an ideal mixture of materials and frequent turning to maximize aeration.

Fungi - A group of simple plants that lack chlorophyll, a photosynthetic pigment.

Humus - That stable organic remnant of matter remaining after the major portion of plant and animal residues have decomposed. It is usually dark in color.

Leachate - Liquid that results when ground or surface water comes in contact with solid waste and extracts material, either dissolved or suspended, from the solid waste.

Mesophilic - Favoring an environment of moderate temperature between 40° -110° F (4°-43° C). Mesophilic microorganisms are most common at the beginning and later stages of the compost process.

Mold - A wooly growth produced on damp or decaying organic matter or on living organisms; a fungus.

Mulch - Material put between rows or around the bases of plants to conserve moisture and to discourage the growth of weeds. Wood chips and fallen leaves make excellent mulches.

Municipal solid waste (MSW) - Garbage, refuse, trash and other solid waste from residential, commercial, and industrial activities.

N:P:K Ratio - The ratio of nitrogen to phosphorus to potassium in a compost product; indicates fertilizer value.

Nitrogen - The element that comprises four-fifths of the earth's atmosphere. The essential element for reproduction for the microorganisms in composting.

Nutrient-holding capacity - The ability to absorb and retain nutrients so they will be available to the roots of plants. Composting improves this in the soil.

Nutrients - Minerals and organic compounds that provide sustenance for organisms.

Organic - Derived from living organisms. Organic wastes include food, leaves, grass clippings, etc.; containing carbon to carbon bonds.

Organic matter - The matter derived from living or once-living organisms that can gradually be broken down to yield important plant nutrients; composed of materials which contain carbon-to-carbon bonds and are biodegradable; includes paper, wood, food scraps, yard trimmings and leaves. Organic matter content is said to be the single most important indicator of a soil's fertility.

Oxygen demand - The requirement for oxygen exerted in aerobic decomposition by microbial respiration.

Pathogen - Any organism capable of producing disease or infection. High temperatures (above 131°F or 55°C) over a consecutive period (3 days) have been shown to effectively kill pathogens. To be on the safe side, exclude known pathogens, for example, a potential source could be pet droppings.

Percolation - Downward movement of water through the pores or spaces in rock or soil.

Resource recovery - The utilization of solid waste as a source of raw materials in the manufacture of new products, or as a fuel or energy source. Recycling, waste-to-energy, and composting are considered resource recovery methods.

Respiration - A metabolic function consuming oxygen.

Solid waste management - The activities which collect, separate, store, transport, transfer, process, treat, and dispose of our solid waste. Possible management activities include reducing, reusing, recycling, composting, recovering, and landfilling.

Screening - The process of passing compost through a screen or sieve to remove and improve the consistency and quality of the end-product.

Self-heating - Spontaneous increase in temperature of organic masses that can result from microbial action.

Slow composting - A minimal effort composting method that produces finished compost in a year or more. Slow composting requires little maintenance.

Thermophilic - Favoring higher temperatures ranging from 113° - 155°F (45°-68°C). Thermophilic microorganisms thrive when the compost pile heats up.

Topdressing - Applying a layer of compost, or other material, to the surface of soil.

Vermicomposting - The process by which worms convert organic matter into worm castings (droppings).

Volume reduction - The processing of materials to decrease the amount of space they occupy. Compaction, shredding, composting and burning are all methods of volume reduction.

Worm castings - The dark, fertile, granular excrement of a worm. Castings are rich in plant nutrients.

Yard trimmings - Leaves, grass clippings, yard residue, brush, and other organic garden debris.

RESOURCES

BOOKS

Home Composting: A Training Guide. N. Dickson, T. Richard, B. Kozlowski, and R. Kline. 1989. Available from: NRAES, Riley Robb Hall, Cornell University, Ithaca, NY 14853

Let It Rot; The Gardeners Guide to Composting., S. Campbell. 1975. Garden Way Publishing. Storey Communications, Inc. Pownal, Vermont 05261.
152 pp.

The Incredible Heap: A Guide to Compost Gardening. C. Catlon and J. Gray. 1984
St. Martin's Press, Inc., New York, NY 10010.

The Rodale Guide to Composting. J. Minnich and M. Hunt. 1979. Rodale Press, Emmaus, PA 18049. 405 pp.

Worms Eat My Garbage. M. Appelhof. 1982. Flower Press, 10332 Shaver Road, Kalamazoo, MI 49002. 89 pp.

The Earth Work Book. J. Minnich. 1977. Rodale Press, Emmaus, PA 18049.
327 pp.

The Complete Book of Composting. J.I. Rodale. 1960. Rodale Books, Inc. Emmaus, PA 18049. 1007 pp.

Easy Composting. V. Sussman. 1982. Rodale Press, Emmaus, PA 18049.

Compost Gardening. W.E. Shewell-Cooper. 1974. Newton Abbot, David and Charles.

The Compost Heap. H. Rockwell. 1974. Doubleday, New York.

Compost Critters. B. Lavies. 1993. Dutton Children's Books, New York.

Composting and Recycling Municipal Solid Waste. C. Diaz, G. Savage, L. Eggerth, C. Golueke. 1993. Lewis Publishers. 296 pp.

Rubbish! The Archaeology of Garbage. W. Rathje and C. Murphy. 1992. HarperCollins Publishers, New York. 250 pp.

Backyard Composting. Harmonious Technologies. 1992. Harmonious Press, Ojai, CA 93024. 96 pp.

BROCHURES

"Home Composting." Fact sheet series, Cornell University Cooperative Extension. Available from: Distribution Center, 7 Research Park, Cornell University, Ithaca, NY 14850.

"Compost for the Home Garden." L.H. MacDaniels and R.E. Kozolowski. March 1985. Home-Grounds-Garden fact sheet series, page 700, Cornell University Cooperative Extension. Available from: Distribution Center, 7 Research Park, Cornell University, Ithaca, NY 14850.

"Ecology of Compost: a Public Involvement Project." D.L. Dindal. Available from SUNY College of Environmental Science and Forestry, Public Relations Office, 123 Bray Hall. Syracuse, NY 13210.

"A Guide for Municipal Composting of Organic Landscape Refuse". W.A. Thomas, W.J. McLaurin and G.L. Wade. Publication 91-005, available from Extension Ag. Economics Dept., The University of Georgia, Athens, GA 30602

"A Guide for Organizing and Promoting a Community Composting Program". W.A. Thomas, W.J. McLaurin and G.L. Wade. Special Report 233, available from Extension Ag. Economics Dept., The University of Georgia, Athens, GA 30602.

The following publications are available from local county Extension offices in Georgia:

Fact Sheet MP426: "Composting"
Fact Sheet MP438: "Mulching"
Fact Sheet MP427: "Grasscycling"
Circular 816: "Composting and Mulching: A Guide to Managing Organic Landscape Refuse".

ORGANIZATIONS

Biodynamic Farming & Gardening Association, Inc.
P.O. Box 550
Kimberton, PA 19442
(215) 935-7797

Harmonious Technologies
Dept. PG
P.O. Box 1865-100
Ojai, CA 93024
(805) 646-5207

National Gardening Association
180 Flynn Avenue
Burlington, VT 05401
(publish "Growing Ideas:
A Journal of Garden-Based Learning")
(802) 863-1308

Local Cooperative Extension Service Offices

Regional Home Composting Demo. Sites
For location nearest you, call Georgia
Department of Community Affairs at (404) 656-9790

Seattle Tilth Association
4649 Sunnyside Ave. N.
Seattle, WA 98103

Keep America Beautiful
For local affiliate nearest you, call Georgia Clean
and Beautiful at (404) 656-5534

Local solid waste manager
Call your Department of Public Works
for information

Composting Council
114 S. Pitts St.
Alexandria, VA
(703) 739-2401
(703) 739-2407 FAX
(composting information provided for public and government)

National Recycling Coalition
1101 30TH Street, NW, Suite 305
Washington, D.C. 20007
(202) 625-6406

Renew America
1400 16th St., NW, Suite 710
Washington, D.C. 20005
(202) 822-6424
(202) 371-1284 FAX
(educational information on solid waste topics including composting)

Source Separated Composting and Organics Recycling Asso. (SCOR)
4218 SW Donovan
Seattle, WA 98136
(206) 932-4621
(206) 932-0427 FAX
(municipal and backyard composting)

MAGAZINES

Biocycle, J.G. Press. Emmaus, PA 18049

Organic Gardening. J.G. Press. Emmaus, PA 18049

Resource Recycling. Resource Recycling, Inc. Portland, OR 97210

SLIDE SETS

"Guide to Recycling Organic Landscape Refuse". 62 slides and script on home composting, mulching and grasscycling. Available on loan from County Extension offices in Georgia.

“Home Composing”. 48 slides and script on backyard composting developed by Cornell Cooperative Extension. Available from Home Grounds Lending Library, 20 Plant Science Building, Cornell University, Ithaca, NY 14850. Purchase price $35.00.

“The Decomposer Food Web.” Copyright 1980 by Daniel L. Dindal. 70 slides and script focusing on the organisms of aerobic decomposition and composting. Available from: J.G. Press, Inc., Box 351, Emmaus, PA 18049. Available on loan from Home Grounds Lending Library, 20 Plant Sciences Building, Cornell University, Ithaca, NY 14850.

“Home Composting”. 55 slides and script on backyard composting. Available from: Community Compost Education Program, 4649 Sunnyside Avenue, N., Seattle, WA 98103. $85 purchase price. Available on loan from Home Grounds Lending Library, 20 Plant Science Building, Cornell University, Ithaca, NY 14850.

VIDEO

“Zoo Doo and You Can Too.” August 1987. A 60 minute video focusing on a composting program at the Seattle Zoo and the demonstration composting facility run by the Community Compost Education Program in Seattle. Produced by Dr. Paul Connett, Chemistry Department, St. Lawrence University, Canton, NY 13617. Available on loan from the Cornell Waste Management Institute, Hollister Hall, Ithaca, NY 14853-3501.

“Composting: A Recipe for Success”. 1991. A 21 minute video on home composting. Host A. Cort Sinnes says in the video “There are as many ways to make compost as there are to bake a cake.” The focus in this program is on one foolproof “recipe” that virtually guarantees success for even the first-time composter. Best of all, this fast, high heat method can produce finished compost in as little as 14 days. Cost $14.95 + shipping and handling. Available from International Marketing Exchange, Inc. P.O. Box 775, McHenry, IL 60051-0775, (815) 363-0909.

"Turning Your Spoils To Soil". Why should we compost at home? Because it's easy, produces a free soil enhancer and helps our environment by reducing the amount of trash we send to landfills and incinerators each day! Information on grasscycling is also included. Available from Connecticut DEP, Recycling Program, Home Composting Video, 165 Capitol Ave., Hartford, CT 06106. $10 per copy.

"The Magic of Composting" Available from Recycling Council of Ontario, 489 Colles St., #504, Toronto, Ontario, Canada M6G-1A5, (416) 960-1025.

NOTES: