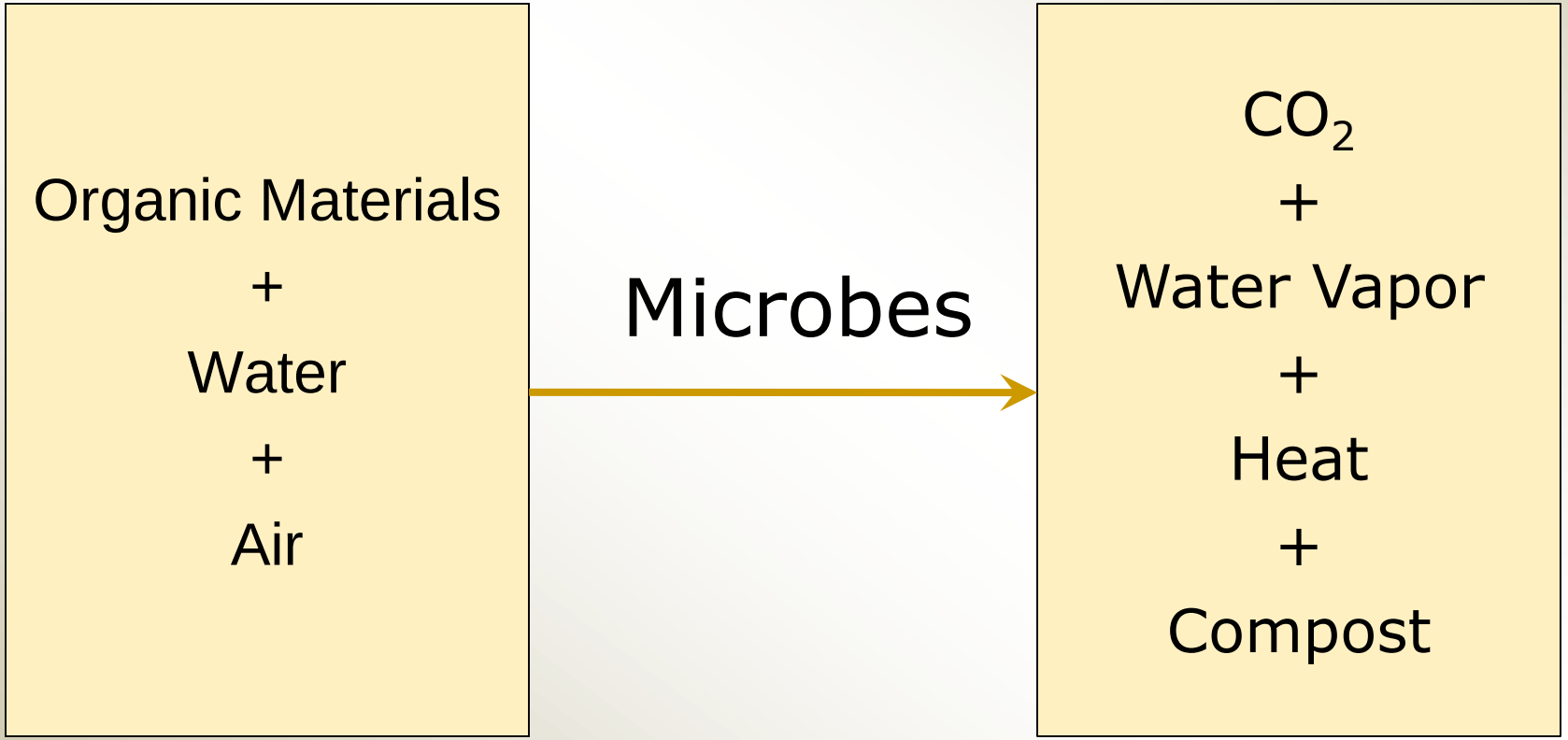
Lesson 2: Composting Fundamentals

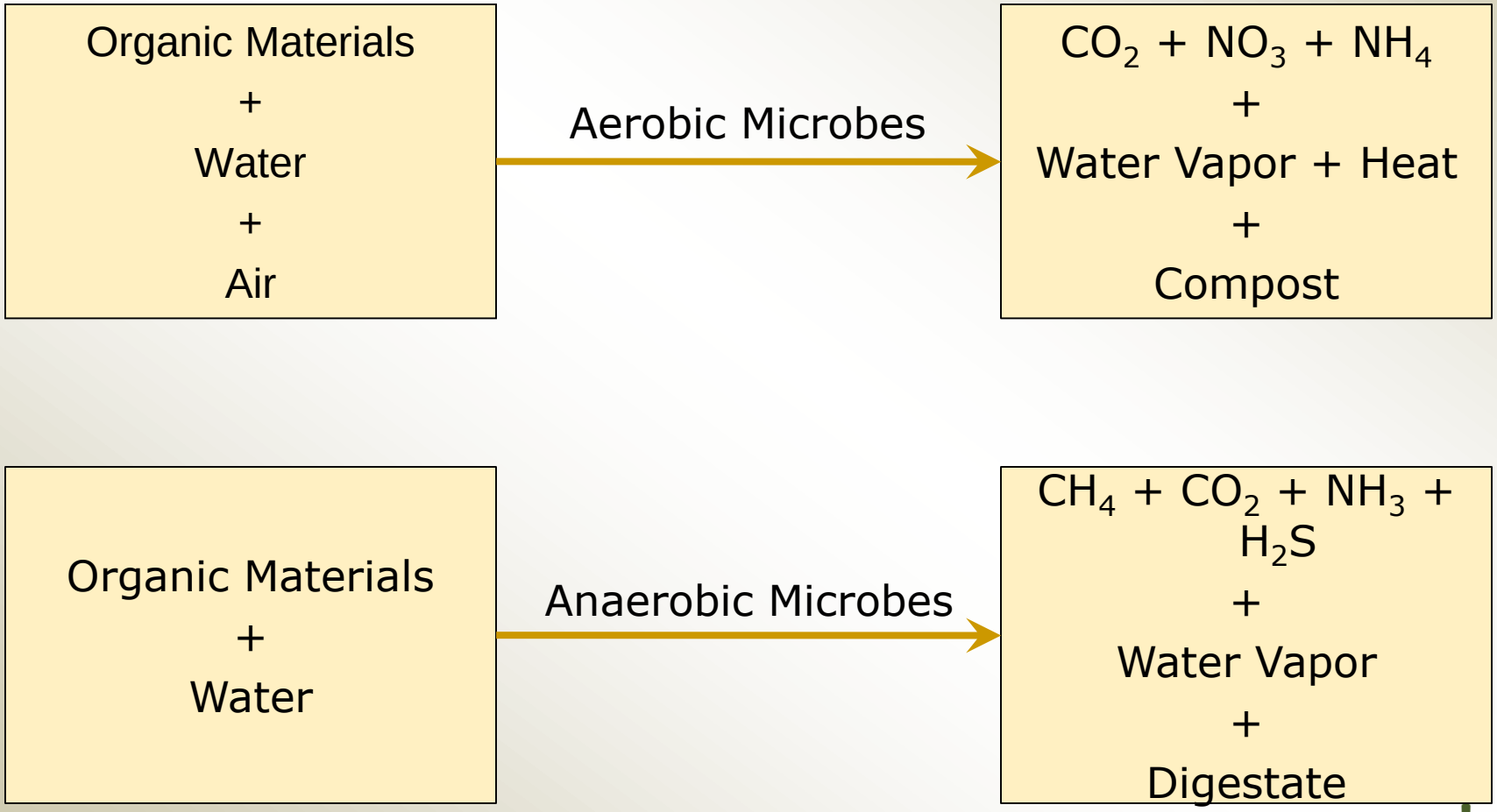
Learning Objectives:

- Be familiar with the microbes responsible for composting
- Understand conditions and impacts of aerobic vs. anaerobic decomposition
- Know the five fundamental principles of composting
- Know the characteristics and functions of bulking agents

Composting is a Microbial Process

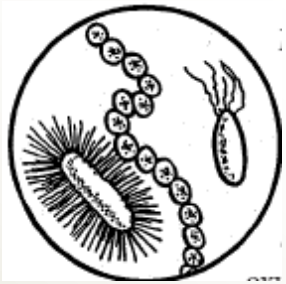


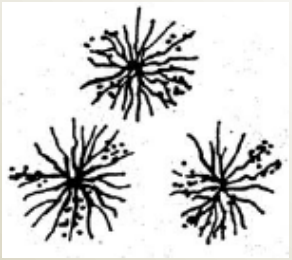
Aerobic vs. Anaerobic Digestion



kessler consulting inc.
innovative waste solutions

Composting Microbes





- Bacteria – primary decomposer; they generate the heat; many types involved in composting
  - Thermophilic bacteria active at 35 to 50 C (the fast decomposers)
  - Mesophilic bacteria active at 20 to 30 C
- Actinomycetes – not as efficient as bacteria, prefer woody materials, active at mesophilic temperatures
- Fungi – major decomposers but not as efficient as bacteria, active at mesophilic temperatures

Composting Macro-organisms

- Earthworms – capable of fully digesting organic waste, they coat materials with film that helps retain nutrients
- Insects – many kinds found in compost, they feed on organic matter, micro-organisms and other macro-organisms
- Nematodes – eat bacteria, fungal spores & other micro-organisms
- Mites – primarily eat yeast cells

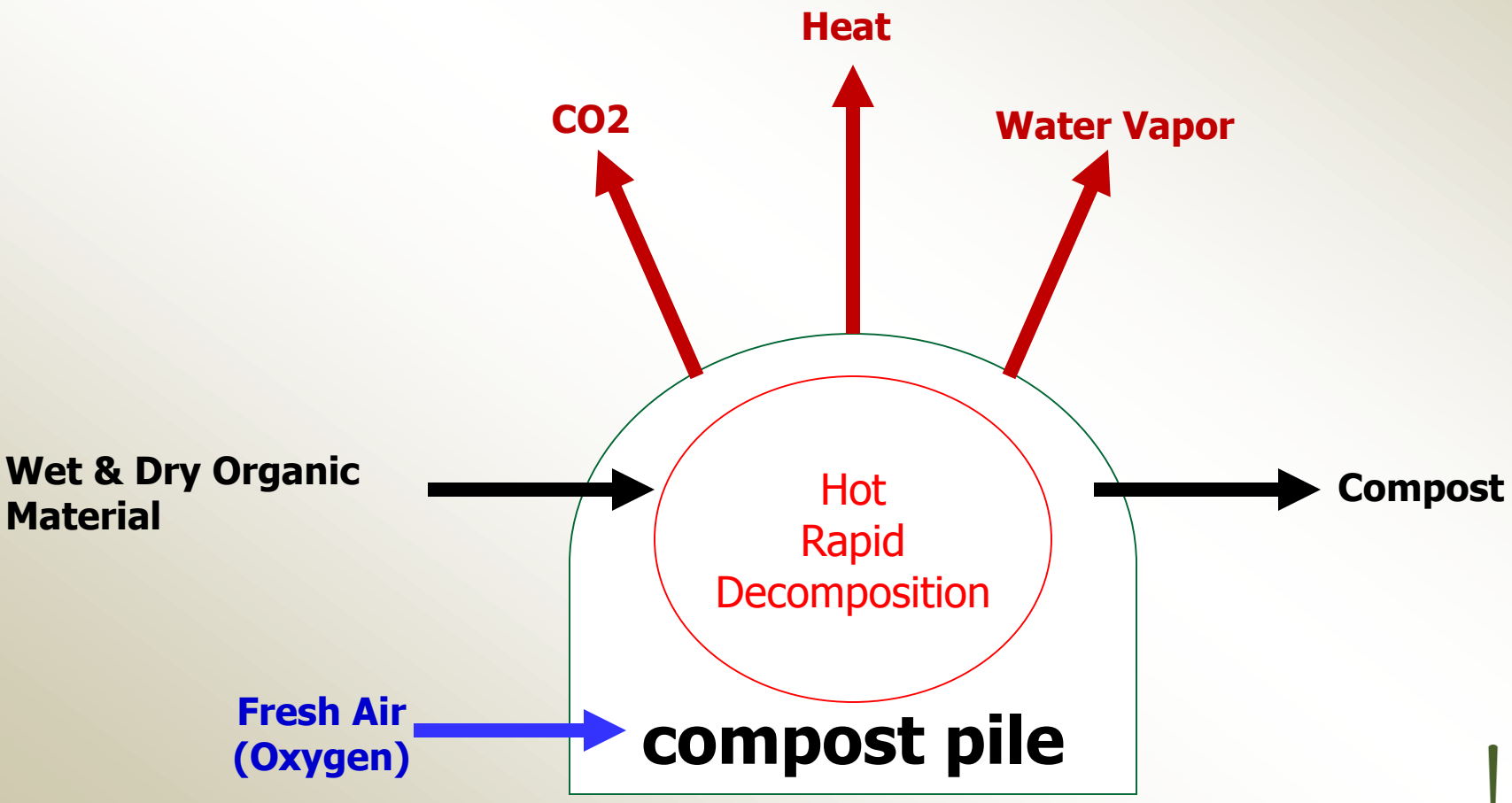
Primary Needs of Composting Microbes

- Carbon – for carbohydrates for energy
- Nitrogen – for nutrients and proteins to build biomass
- Oxygen – for aerobic respiration
- Moisture – necessary for biological functions
- pH - initial range of 5 to 8 is preferable

Recommended Conditions for Rapid Composting

Condition	Reasonable Range	Preferred Range
Carbon-to-Nitrogen (C:N) Ratio	20:1 - 60:1	25:1 - 35:1
Moisture content	40% – 65%	50% - 60%
Temperature	110°F - 150°F	130°F - 140°F
pH	5.0 - 9.0	6.5 - 8.0
Porosity	30% - 80%	50% - 80%

Composting Optimizes Conditions for Decomposition



kessler consulting inc.
innovative waste solutions

The Practical Goals of Composting

- Facilitate microbial decomposition
- Generate sufficient microbial activity to generate enough heat to destroy weed seeds and pathogens
- Try to make the highest quality product in the most efficient way possible
- Focus on process control and act quickly when problems occur so that they do not become nuisances

Adapted from:

Five Fundamental Principles

1. Proper ratio of Carbon to Nitrogen
2. Proper particle size to balance surface area and pore space
3. Proper moisture content
4. Mix materials and do not compact
5. Monitor temperature, moisture & odor

Principle 1 – Proper C:N Ratio

- Proper Carbon to Nitrogen (C:N) ratio is necessary to optimize composting conditions
- C:N = 30:1 to 40:1 is optimum for composting
- If C:N < 20:1, odors occur and nutrients may be lost
- If C:N > 40:1, composting process slows down

Good Sources of Carbon

Source	Carbon:Nitrogen Ratio
Yard trash	50 – 90:1
Straw & hay	50 – 80:1
Wood chips & sawdust	250 – 500:1

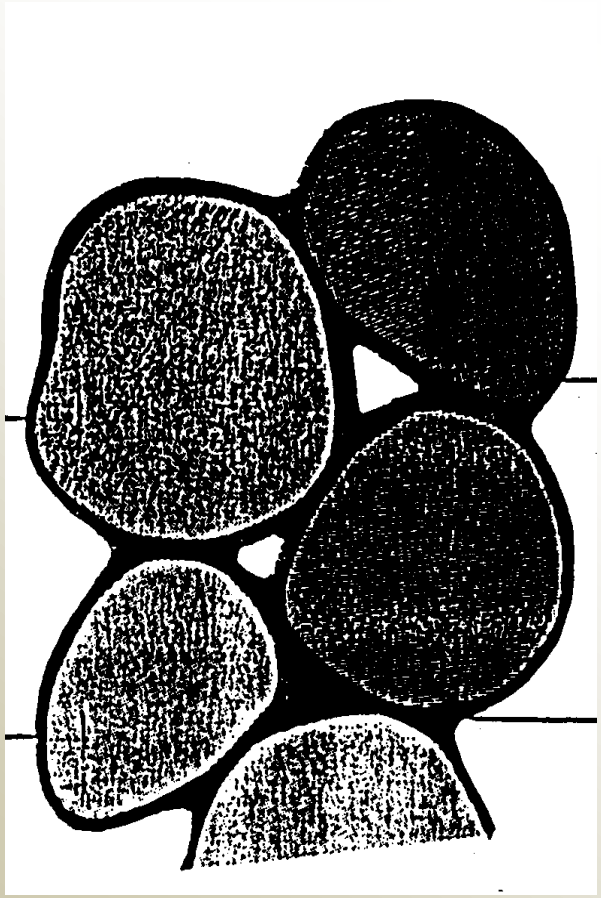
Good Sources of Nitrogen

Source	C:N Ratio
Vegetable Scraps	10 – 30:1
Fruit Scraps	10 – 30:1
Grass & Garden Cleanings	10 – 20:1
Chicken Manure	10 – 25:1
Cow Manure	20 – 30:1
Horse Manure	25 – 30:1

Principle 2 – Proper Particle Size

- Breaking large pieces of materials into small pieces will increase the surface area where “bugs” can live and feed
- This speeds up composting
- Not too big and not too small - a mixture of 1/4 – 4 inch size materials is ideal
- Pieces that are too small will not allow fresh air to flow through it

Principle 3 – Proper Moisture and Air



- A compost pile needs water because the organisms grow in a moist environment
- However, too much water and organisms drown without oxygen
- 40% - 50% moisture content (MC) is optimum to provide organisms with both air and water

Principle 4 – Mix Well; Do Not Compact

- Mix carbon & nitrogen materials together to provide a balanced diet
- Add water if mixture is too dry; or add more dry materials if mixture is too wet
- Do not compress/compact the mixture; keep space for air to flow in the compost pile

Principle 5 - Monitor the Compost Process

- Temperature – the primary way to determine if the bugs are healthy
- Moisture & Air – easily assessed by inspecting the quality of the compost pile
- Smell – Odor is a key indicator of whether composting is progressing properly

What is a Bulking Agent?

"Dry material that provides carbon, structural support and pore space for nitrogenous materials"

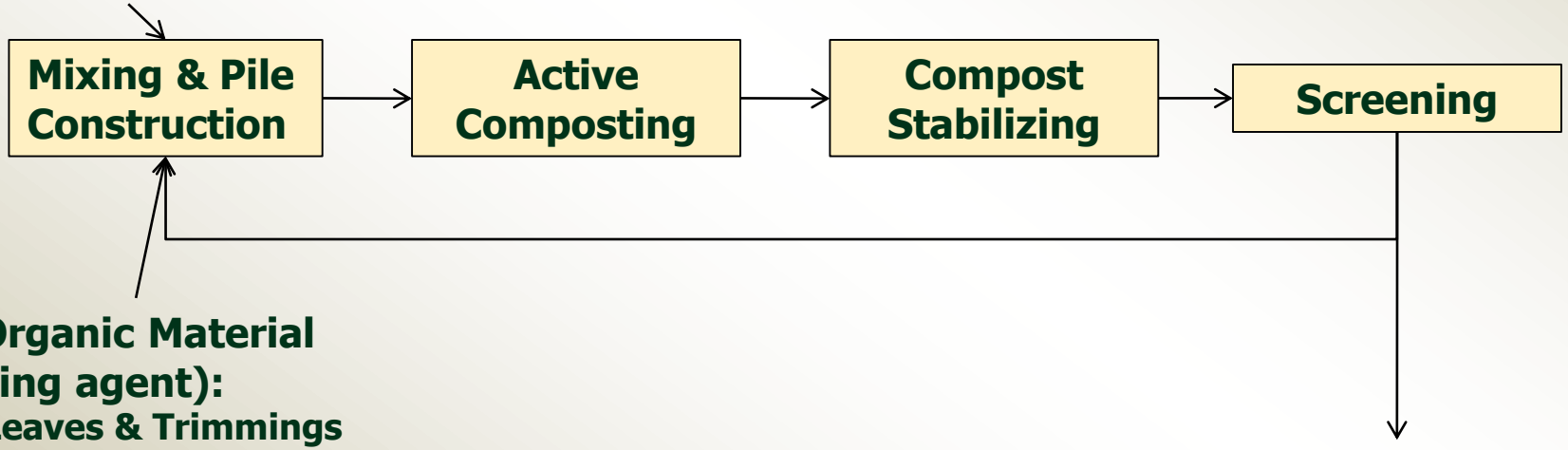
- Must be readily available for composting operation, e.g. ground yard trash
- Ideal bulking agent is dry
- Amount used depends on C:N ratio & Moisture Content

Multiple Functions of Bulking Agent

- Carbon source for high nitrogen materials
- Structural support and low bulk density to provide pore space
- Low MC for wet materials

Four Stages of Composting Operation

Wet Organic Material:
-Food waste
-Manure
-Grass clippings
-Garden scraps



Dry Organic Material (bulking agent):
-Dry Leaves & Trimmings
-Wood Chips & Sawdust

High-quality Finished Compost

kessler consulting inc.
innovative waste solutions

Two Types of Materials Are Needed

Dry Organic Materials

- Are high in carbon & low nitrogen
- Tend to be dry
- Have structure to allow aeration
- Carbon is primary food for composting organisms
- Includes such materials as:
  - Wood chips
  - Brush and tree trimmings

Wet Organic Materials

- Are high in nitrogen & low in carbon
- Have a high moisture content
- Nitrogen is primary building block for composting organisms
- Includes such materials as:
  - Grass
  - Fruits
  - Vegetables

Putting the Fundamentals into Practice

A correctly built and managed composting pile will:

- Reach high temperatures
- Destroy weed seeds
- Control pathogens
- Avoid odor problems
- Produce finished compost in 2 – 3 months

Putting the Fundamentals into Practice

- Managing the composting operation to optimize conditions requires many things (a preview of upcoming training topics):
  - Site selection and design
  - Composting methods
  - Equipment and staffing
  - Operational controls
  - Monitoring & recordkeeping
  - Site maintenance
  - But first, Regulatory Compliance