

PBL The Poop on Composting

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Part I – The College Visit

Miles was visiting Simon Fraser University with his mother. The tour guide, Jen, was explaining that the SFU had numerous environmentally sustainable features, including solar panels, geothermal heated water, and composting toilets.

Miles' mother had just finished a 20 oz. Starbucks café mocha and was looking for a trash can just as Jen pointed to her coffee cup and said, "We have a composting program, too, and it looks like your coffee cup is compostable. You can check the cup to see if it says 'compostable.' As long as it is made of paperboard, and not plastic or styrofoam, it can be composted. So be sure to put it in the proper bin." Miles' mother nodded.

Jen continued, "This is our student-run garden. We grow tomatoes, lettuce, carrots, radishes and many other veggies, which we sell to the campus cafeteria or donate to the local food pantry. We also use the finished compost to fertilize the gardens."

Miles whispered to his mother, "Mom, you should start a compost pile at home. We could reduce the amount of waste we put in the landfill just by composting and make soil for your garden, too."

"I don't know much about composting, though."

After the tour finished Miles and his mother went to the cafeteria to get lunch. They each had a burger, french fries and a rootbeer. They picked up their trays and went over to the waste sorting station; a blue bin was labeled *Recyclable*, a green bin had a *Compost Organic Waste Only* label and a brown bin was marked *Landfill*.

"Miles, I'm so confused. What do I put in the compost bin and what do I put in the trash?"

"I know you can put the pop cup in the compost bin because it is marked 'compostable,' but I don't know about the french fries I didn't eat."

"And what about the paper plates?" his mother asked.

Questions

- According to Jen what can't be recycled at SFU?**
Things made out of plastic or styrofoam.
- Differentiate between waste and a natural resource. Explain how food waste could become a natural resource.**
Waste is something like a wrapper, a natural resource is like an apple core. But food waste can also break down and become a natural resource.
- Define "organic" as used in the phrase "organic waste only" on the compost bin.**
Organic means organic materials, that are grown and not made, like fruit, or grass clippings.
- Describe the general characteristics of compostable material. In other words, how do you know if something is compostable?**
Usually, there are labels or a sign on the material, and it tells you if it is compostable.
- Why do most composting resources discourage composting of pet waste?**
The organic materials can be contaminated by the pet waste.
- What are the dangers of having a composting unit in your backyard?**
There are bacteria that is in compost that you could contract a disease from it.

7. ***In Port Coquitlam and Coquitlam we have residential green bins collected every week. Where do the content of them get trucked to?***

The green bins get dumped into the back of the truck, and gets put into a composting landfill, where they create compost, and give it to places like greeneries to sell back for soil and to grow plants.



Part II – Environmental Science Class

Miles decided to attend SFU with the solar panels and composting toilets because it was important to him that the campus was committed to environmental sustainability, plus it wasn't too far from home. He also registered for environmental science his 1st semester to learn more about environmental sustainability issues. On campus, he continued to use the green bins for his compostable waste, like banana peels and apple cores, but he wasn't sure what happened to the compostable material from there.

The 3rd week in his environmental science class, his instructor, Dr. Hall, explained a bit about composting. Miles took the following notes about composting:

The Science of Composting

Food makes up the largest percentage of waste going to the landfill - 15%, or about 3.5 million tons per year in Canada!

Each person in BC throws out about \$640 worth of food every year

Composting is 1 means of reducing waste that is sent to the landfill

Definitions:

Composting—biological decomposition of organic matter

Compost—material produced from composting that can be used as a fertilizer or soil additive

Composting Recipe:

1. Layer greens & browns

- Greens are high in nitrogen

- includes coffee grounds (tell mom), fruit rinds and cores, vegetable peels, old bread, tea bags, crushed eggshells, grass clippings

- cow & pig manure is high in nitrogen too, but don't use pet waste in composting

- nitrogen is a critical component for building proteins

- proteins are the molecular machines of the body

- nitrogen is important in supporting a growing population of bacteria for composting

- too much nitrogen can lead to a stinky compost pile because ammonia (NH₃) gas is released

- Browns are high in carbon

- leaves, sawdust, paper products, wood chips

- browns are dry

- add browns on top of greens to reduce fruit fly problems and reduce other pest problems

- carbon-rich material is a source of energy

- glucose (C₆H₁₂O₆) is used as energy during cellular respiration to make ATP

- carbon dioxide (CO₂) is released as a waste product

- The ideal ratio of C:N is ~25:1, but it is difficult to get this exact ratio because compostable material contains varying amounts of m

—Best advice: Use about 2–3 × more browns than greens and check to make sure pile does not smell

—Aerate frequently

—Aerobic bacteria utilize oxygen in the spaces of the compost pile during respiration

—Oxygen can be maintained by frequent turning with a pitchfork or compost turned

—Under anaerobic conditions H_2S (hydrogen sulfide—which smells like rotten eggs) may be produced, therefore maintaining sufficient oxygen to encourage aerobic decomposition is usually preferable

Composting Critters:

Many different organisms help break down organic matter through physical and chemical decomposition

- Primary consumers eat food waste

—The organic matter provides the "food" and energy to primary consumers

—Sowbugs (aka roly-poly), millipedes, and earthworms chew and shred organic materials

—they are physical decomposers

—bacteria and fungi are chemical decomposers because they use enzymes to break down organic matter

- Secondary consumers eat primary consumers (ex. springtails)

Managing the Composting Process:

1. Monitor moisture

—want 40–60%

—squeeze test: Grab a handful of compost and pack into a ball (like making a snowball)

—if it has the right amount of moisture it will stick together, but if you can squeeze water out, the pile is too wet

—If the ball falls apart, it is too dry

—too much water is a problem because air spaces become filled with water and anaerobic decomposition will occur (smelly!)

2. Monitor temperature

—aerobic decomposition releases heat

—in hot composting, the temperature will rise to 50°C or more (with the right amount of moisture and enough organic matter.

—the pile will need to be turned when the temperature drops below 45°C to introduce oxygen and mix organic matter

—fast temperature changes can destroy weed seeds and other pathogens

—in cold composting, temperatures do not increase dramatically and decomposition occurs slowly

—doesn't require much effort

The Finished Product:

The compost is ready to use when it is dark and crumbly.

An easy way to check if decomposition is complete is to take a ¼ cup of compost and keep it in a sealed Ziploc bag for a few days

The composting process is complete if it smells earthy, but needs more time if it smells bad.

Miles was really excited about composting because he wanted to reduce his environmental impact as much as possible. He already recycled and donated unwanted clothes to the thrift store but he knew he could do more. As he was thinking about all the waste his family produced, he heard Dr. Hall ask for volunteers to help with composting on campus. Miles immediately volunteered.

Miles met with Dr. Hall later that day to discuss what he would be doing.

“Miles, it’s nice to meet you. We have been collecting compostable materials on campus for about two years now. We count on help from students like you to run the composting program. Your responsibilities will include weighing and adding new material to the compost pile, recording the temperature of the compost pile, and aerating. These tasks must be performed every day, though you are only responsible for Tuesdays; our other volunteers will cover the rest of the week. If you are sick and can’t pick up the compostables, please be sure to let me know since we don’t want the compost collection bins to attract fruit flies. Also, the compost pile should not smell. If you notice a smell, then you should aerate. You’ll find a compost aerator in the shed. It looks like a corkscrew, and you just push it down into the compost then pull it out which will add air to the pile.”

“I’m very excited to learn how to compost. I plan to show my mom how to start composting at home.” “That’s great, you’ll be an expert on composting by the end of the year. We have a composting windrow on campus, which is a long row of layered greens and browns outside, but at home you could use a composting bin or try vermicomposting. We’ll use the finished compost in our student gardens so you’ll also get to see the results of all your hard work in the spring.”

“That’s great.”

The next week Miles collected the compost from the compost bins and added it to the windrow and covered it with a layer of wood chips. He recorded a temperature of 100°F with the compost thermometer, which was 25°F warmer than the air temperature. Finally, he used an aerator to mix up the compost. As he aerated he noticed a faint odor, and grew concerned that something was wrong.

Questions

1. Look up the definition for “putrefaction.” Define the term in your own words.

The process of waste rotting and

2. What conditions might have caused the compost pile to smell, and why?

The compost pile needed to aerate, because air needed to be added to the pile.

3. Do you think Miles should let Dr. Hall know there was an odor when he aerated? Explain.

Yes because compost isn't supposed to smell, it will damage the compost.

4. Bacteria perform cellular respiration during decomposition. Provide the chemical equation for aerobic cellular respiration.

Glucose + Oxygen + Carbon Dioxide + Water + Energy

5. Why is the temperature of the compost pile higher than the ambient air temperature?

The organic matter needs oxygen to break down, and create carbon dioxide/heat.

6. Now that you know more about composting, identify the misconception Miles has about compost in Part I, then list at least four benefits of composting.

Reduces carbon footprint, produces bacteria that breaks down waste, produces soil & fertilizer

7. Dr. Hall mentions vermicomposting. What is vermicomposting?

Vermicomposting is using worms to compost your organic waste.



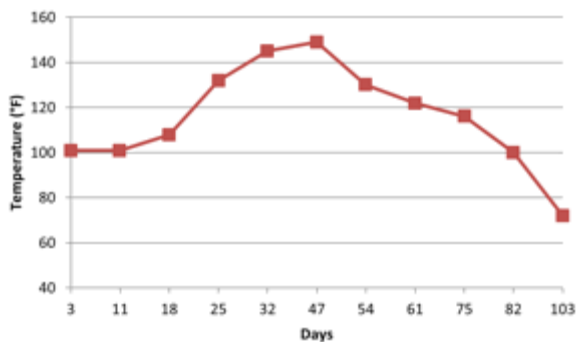


Part III – Composting Cool Down

Miles had learned even more about composting since class. He learned there are three primary classes of bacteria: psychrophilic, mesophilic and thermophilic and that these classifications are based on the temperatures at which the bacteria thrive. Psychrophilic bacteria, or cold-loving bacteria, thrive at temperatures less than 60°F, mesophilic bacteria 68–113°F, and thermophilic, or heat-loving bacteria, thrive at temperatures above 113°F. These bacteria are the workhorses of compost and extract energy from organic material through cellular respiration and use it for growth and reproduction. Cellular respiration is the process of breaking down glucose to generate energy, carbon dioxide and water. Heat also is released in this process, which helps destroy pathogens during composting.

Every day that Miles collected organic waste he added leaves, a carbon-rich material, on top of the compostable material collected from the cafeteria and around campus, which was mostly nitrogen-rich material like the banana peels and apple cores he put in the bins. The material was added to the compost windrow. He also used a 36" long compost thermometer to record the internal temperature of the compost. He recorded the temperature of the

pile every day he helped with composting. Miles didn't notice any smell, but he did note that when the internal temperature of the compost windrow was graphed it had dropped 46°F since Thanksgiving (Day 47). He also noted that sometimes the collection bins had plastic wrappers in it. He wasn't sure what to do about the plastic contamination.



Questions

1. **What is a mesophilic bacteria?**

Mesophilic bacteria is an mesophile (an organism) that grows in certain

2. **temperature thermophilic and mesophilic phases of composting on the graph (right).**

The graph goes up as the compost develops, but as it lengthens, the produce goes down

2. **Is there likely to be any decomposition after Day 103? Explain.**

No because it has already started to decrease in utility.

3. **Miles decides he should try to do some troubleshooting before contacting his professor about the drop in temperature. Provide two different hypotheses for the drop in temperature then design an experiment to test each hypothesis. Explain the basis (or reason) for each test.** (on the bottom of the page)

3. ***Miles doesn't want to pick through the compost bins to pull out the plastic. Do you think he should pull out the plastic? Why or why not?***

He should pull out the plastic because plastic is not compostable, and it could damage his compost bin, and effect the composting of the other waste.

Part IV – Humanure: Composting to the Extreme

In the spring, Miles' mother returned to campus for a visit and shared the following conversation with him:

Mom: I brought a care package for you. There are homemade chocolate chip cookies, granola bars, bananas, and tea. The tea is caffeinated, for when you're up late studying.

Miles: Thanks Mom.

Mom: Well, how are classes going?

Miles: Great. And I'm still helping with the composting program on campus. I've really learned a lot about composting and when I come home in the summer, I can help you start composting. Do you want to see the composting toilets? They're really cool.

Mom: I guess, but it sounds really gross and I bet they smell like an outhouse.

Miles: They don't smell, Mom.

Mom: Actually I am trying to learn more about composting, but we're not installing a composting toilet.

Miles: Mom, humanure is a valuable resource.

Mom: Human...what?

Miles: Human manure. It's all about composting human feces and urine, so it's a valuable resource instead of waste. I learned about it in environmental science.

Mom: Gross.

Miles: I think you have fecophobia, Mom.

Mom: Ok, can we please stop talking about this now.

Miles: Hey, there's Jen. Jen was our tour guide for the campus visit and she is also is one of the volunteers with Dr. Hall on the composting project.

Jen: Hi, Miles.

Miles: Hi, Jen. What are you up to?

Jen: I'm going out to the campus garden.

Miles: I've been telling my mom she should start composting; then she can use the finished compost on her garden.

Jen: I'd be happy to give you a tour of the garden. We have some beautiful spinach right now.

Mom: I'd love to see the garden. I've been reading *Composting for Dummies* so I can start composting at home.

Did you know that organic material in a landfill does not decompose?

Garbologists, or people who study trash, have found newspapers and food in landfills that still haven't decomposed after 30 years!

Miles: I knew you'd come over to the green side eventually, Mom.

Mom: I don't know that composting will really make that much of a difference, but I'm excited to have a natural fertilizer for my garden.

Questions

1. What are the potential hurdles to getting people to start composting at home?

It takes a lot of time and effort to create a compost bin, and start composting.

2. Explain why waste is slow to decompose in a municipal landfill.

The trash doesn't have enough oxygen and water to decompose because it's too tightly packed together.

3. Given what you have learned about composting, is an outhouse a type of composting toilet, as Miles' mother alluded to? Explain. How could the smell associated with an outhouse be ameliorated?

Yes, because it uses no water and nothing gets flushed. The smell could be fixed by adding an air freshener.

4. What do you think are the primary concerns associated with the use of humanure?

I think the smell is a concern, it can create pollution and damage people's health.

5. Use the internet to find a manufacturer of a composting toilet. Briefly describe how it works.

Composting toilet use the natural process of decomposition of recycling human waste. Waste entering the toilet is 90% water, and goes into the vent system. The small amount (10%) is converted into soil.

6. What are the environmental benefits of a composting toilet? What drawbacks are likely associated with composting toilets?

You can use less water, there could be less odour and it lowers household costs like your water bill. If maintained poorly, the smell would get stronger, and too much water could lead to slower composition.

7. Miles' mother is not convinced that composting will significantly lower her environmental impact. Do you think we have an ethical obligation to reduce our environmental impact by composting? Explain.

I think everyone should compost because the more waste that we put into trash, the more landfills and pollution that our planet will have.

3. The waste isn't breaking down, and there isn't enough oxygen. When waste doesn't break down, heat doesn't extract, and when there is no oxygen, the waste can't break down, so it cools.