lPacket 2.2 - Animals Unit

First & Last Name: _____ Period/Hour:_____

NOTE: Check each page to be sure all blanks are completed.

Driving Question: What happens to food when it is consumed?

Anchoring Phenomenon: We have recently considered why diets vary based on activity. Using cattle as an example, we will now explore how animal cells acquire the atoms they're made from and the energy they need to function from food. We will also investigate how the amount of food animals consume relates to the amount of mass their bodies gain.

Deeper Questions

1. How is food digested after it is consumed?
2. How do cells acquire the energy they need to function?
3. Why do animals only keep a small amount of the mass of the food that they consume?

Schedule

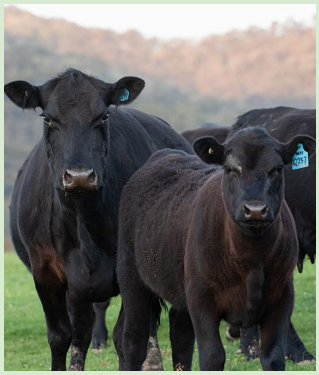
Part 1: Introduction
- Initial Ideas & Data Dive
- Discussion & Developing Explanations

Part 2: Core Ideas
- Core Ideas
- Revisions of Part 1 Explanations

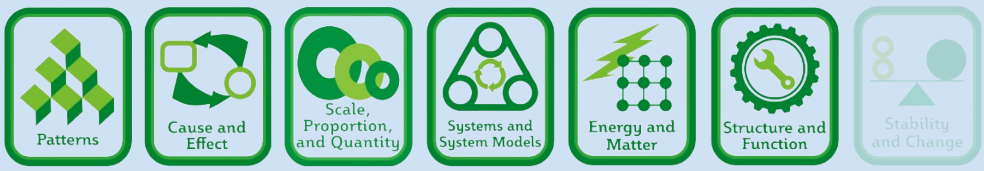
Part 3: Investigation
- Mealworm Mass Investigation

Part 4: Review & Assessment
- Ranking Your Readiness
- Formative Assessment & Mastery Check

Part 5: Life Connections
- Life Connections - Interview An Expert



NGSS Standards (*PEs & CCCs are summarized below. SEPs are noted throughout the packet*).
HS-LS1-2. How bodily systems interact in multicellular organisms. HS-LS1-6. How carbon, hydrogen, and oxygen from sugar molecules form amino acids and/or other molecules. HS-LS1-7. How bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy.



Semester Schedule

1. Matter & Energy
1.1: What happens when something burns?
1.2: How does burning change matter & energy?
1.3: Unit Assessment

2. Animals
2.1: How do animal cells use food?
2.2: What happens to food when it is consumed?
2.3: How do cells acquire atoms from food?
2.4: Unit Assessment

3. Plants
3.1: How do plant cells differ from animal cells?
3.2: How do plant cells obtain matter and energy?
3.3: How can we investigate plant growth and function?
3.4: Unit Assessment

4. Ecosystems
4.1: Why do different places have different amounts of species?
4.2: How does human activity affect species?
4.3: Unit Assessment

These materials were partly developed with assistance from artificial intelligence.

Resource Links: Class Website; Pt 1 Video; Core Ideas; Summary Video; Practice Test; Part 3 Sample Data; Part 3 Instructions; Part 5 Video; Macromolecule Images; Summary of Digestion;

Part 1: Introduction – Growing Cows (2.2.1)

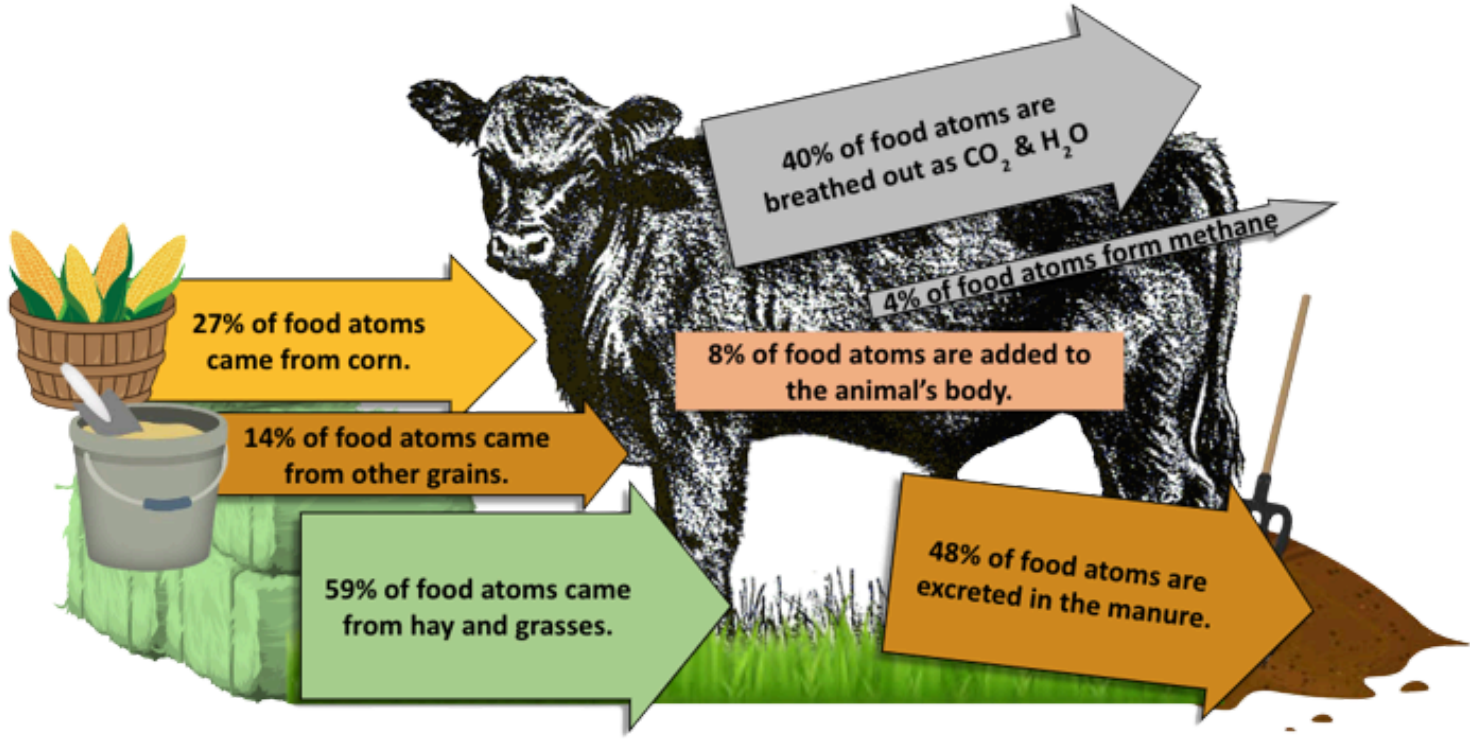
Overview: In this activity, you will begin by discussing your initial ideas about what happens to food when it is consumed. You will then analyze data and work in teams to develop your initial explanations.

Initial Ideas - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Engaging in Argument from Evidence

1. Students are visiting a farm. The farmer explains that a growing cow eats about 15 lbs. of food a day! However, it gains less than 1.5 lbs. in body mass. Three students are unsure why this is. **Do you agree or disagree with each student's claim**?
    a. Avery thinks that the matter (atoms) in the food is turned into energy used by the cow to grow.
    b. Bristol believes that a lot of the atoms from the cow's food are eventually breathed out.
    c. Chandra argues that almost all the atoms in the food are excreted as feces and urine.
2. **Work in your small groups to discuss your ideas.** How are your ideas similar or different? Decide as a group whether each statement is correct (and why). Be prepared to present your ideas.

Data Dive - *Read the directions below.* *SEP: Analyzing & Interpreting Data*

Begin by starting the Data Dive Video on a device all students can observe. Next, look at the data shown below. This shows the sources of atoms in a growing cow's diet and what happens to the food atoms after they are consumed. *NOTE: All values are estimates based on movement of carbon-based molecules - see data at Kohn, 2018.*



Data Dive Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*

1. **Begin by individually attempting to make sense of these images**. What trends or patterns do you notice? How does this relate to any prior knowledge or experience that you have?
2. **Next, work in your teams to discuss your ideas**. Where do you agree? Where do you disagree? Can you use this data to reach an agreement? Do others have prior knowledge/experience that could help?
3. **What is one claim that would be supported by this data?** Explain how this evidence supports your claim using scientific concepts and explanatory models.
4. **What is a second claim that would be supported by this data?** Explain how this evidence supports your claim using scientific concepts and explanatory models.
5. **Does this data support or refute any of the initial claims on the previous page?** Based on the data, which stance is most supported (Avery, Bristol, or Chandra)? Explain
6. **Can this data explain why a cow eats 15 pounds of food but gains less than 1.5 pounds a day?** What happens to the other 13.5 pounds? Make a claim and support it with evidence and reasoning.

Discussion - *Record your ideas in the spaces below.* *SEP: Asking Questions & Defining Problems*

As a class, discuss your ideas about this data. What are the ideas that most agreed on? Where did your ideas differ as a class? Record your ideas in the spaces below.

We generally agree that…	***We disagreed or were unsure if…***

Initial Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Designing Solutions*

How does food change after it is consumed, and why do animals only gain a small percentage of the food's mass? Write down an initial explanation in the space below. Don't worry if you aren't completely sure about this. You will come back and revise this explanation throughout this unit.

Part 2: Core Ideas (2.2.2)

Overview: In this activity, you will begin with a short presentation to provide you with information that will help you improve and revise your initial ideas. Your instructor will decide on how to implement this portion. You will then work in small teams to address the questions listed below.

Driving Questions - *Record your ideas separately (e.g., on a white board or scratch paper).*
SEP: Developing & Using Models

1. What are the two primary purposes of consumed food?
2. What do each of the following macromolecules provide to cells? *Fat, Protein, Carbohydrates.*
3. What is digestion? How does digestion change macromolecules?
4. What are enzymes? What is the primary function of enzymes during digestion?
5. What happens to food molecules after enzymes break apart macromolecules?
6. What are examples of molecules that the blood transports to *and* from cells?
7. What happens to most glucose molecules after being absorbed by cells?
8. How are the carbon dioxide (CO_2) and water vapor (H_2O) that an organism breathes out related to the food molecules and oxygen that it consumes?
9. What is ATP? What does ATP do for the cell?
10. Summarize what occurs during cellular respiration. What happens to the matter and energy in glucose?
11. Where does cellular respiration occur?
12. Why do animals gain only a small fraction of the mass of consumed food? What occurs with the remaining food mass?

Revising Explanations - *Record your ideas in the spaces below.* *SEP: Constructing Explanations & Developing Solutions*

How does food change after it is consumed, and why do animals only gain a small percentage of the food's mass? Based on this new information, how would you now respond to this question?

_____

_____

_____

Use this space to record notes as needed.

Part 3A: Mealworm Mass Set-up (2.2.3a)

Pre-Investigation Questions - *Work together to prepare verbal answers to these questions. When ready, raise your hand. Your instructor will listen, give feedback, and decide if you're ready to start the investigation.*
SEP: Developing & Using Models

1. Summarize how digestive enzymes change macromolecules in consumed food.
2. How are the carbon dioxide (CO_2) and water (H_2O) that an organism breathes out related to the food molecules and oxygen that it consumes?
3. Summarize what occurs during cellular respiration. What happens to the atoms and energy in glucose?
4. Why do animals only gain 10% of the mass of the food they consume? What happens to the other 90%

This activity was completed _____ (*instructor signature*)

Overview: We are trying to figure out what happens to matter and energy in food after it is consumed. In this investigation, you will collect data as worms consume potatoes. You will compare the change in the mass of the potatoes to the change in mass of the worms. You will also measure changes to CO_2 levels in the air. (*We are using worms for this investigation because cows are too big and expensive for our classroom*).

Materials needed for both investigations (per group): mealworms (at least a dozen per group); gallon-sized sealable bags (e.g., Ziplock freezer bags); 25 ml of BTB per group (pre-measured in 50 ml centrifuge tubes if possible); 2-3 shallow disposable plastic cups; a chunk of potato; paper towel; digital balance; tweezers; marker and tape for labeling. *Instructor Note: prepare sealable bags with materials in advance if possible.* ***Verbally remind and confirm that students wash their hands after handling the worms.***

Hypothesis - *Discuss your ideas and record your predictions in the spaces below.*
SEP: Planning & Carrying Out Investigations

1. Which of the following will occur as the worms eat the potatoes? **Circle one**.

a) The mass gained by the worms will be the same as the mass of the potatoes they consume.
b) The mass gained by the worms will be less than the mass of the potatoes they consume.
c) The mass gained by the worms will be greater than the mass of the potatoes they consume.

2. How will CO_2 levels change inside the sealed bag as the worms eat the potatoes? **Circle one**.
   CO_2 levels will: *a) Increase b) Decrease c) Stay the same*

3. Explain your reasoning: _____

_____

Directions - *Carefully read the directions below before beginning. Record info where prompted.*

1. ☐ Acquire the needed materials from your instructor as directed.
2. ☐ Your mealworms may still be in bedding (such as shredded paper or sawdust shavings). If so, separate the worms from their bedding using a pencil or tweezers.
3. ☐ Place a disposable cup onto the digital balance. "Zero" out the scale (by pressing T or "tare"). Then gently pour about 15 g of mealworms into this container. Record this data in the Results section (p. 7).

4. ☐ Place another disposable cup onto the digital balance. "Zero" out the scale (by pressing T or "tare"). Then place your chunk of potato in the cup and record its mass in the Results section.
5. ☐ Gently place the cup of worms into the sealable plastic bag. Then remove the chunk of potato from the cup and gently lower it into the cup with the worms.
6. ☐ Rinse or use paper towel to wipe out the cup that contained the potato. Pour the BTB into the cup.
7. ☐ Place a piece of tape on the sealable plastic bag. Add a) your the last names of your group members, b) your class period & teacher; and c) the date.
8. ☐ Gently lower the cup of BTB into the sealable plastic bag (be careful not to spill). Tightly seal the bag; make sure some air remains inside (*your worms need air to breathe!*).
9. ☐ "Zero" out the scale. Carefully place the sealable plastic bag containing the worms, potato, and BTB onto the scale. If this is too large for the scale, place a small tray on the scale and zero out the scale (press T or "tare"). Record this mass in the Results section (Total Bag Mass).
10. ☐ Place your sealed plastic bag and all other materials in the location determined by your instructor.

Part 3B: Mealworm Mass Final Data Collection (2.2.3b)

Overview: You will determine whether the mass gained by the worms is equivalent to the mass lost by the potatoes. You will also determine how CO_2 levels changed as the worms ate the potato.

Directions - *Carefully read the directions below before beginning. Record info where prompted.*
SEP: Planning & Carrying Out Investigations

1. ☐ After 24^+ hours, acquire your sealed bag. Before opening the bag, zero your balance, and carefully place the sealable plastic bag containing the worms, potato, and BTB onto the scale. If this is too large for the scale, place a small tray on the scale and zero out the scale (press T or "tare"). Record the final mass in the data table on the previous page.
2. ☐ Observe the inside of your bag of worms. Is there now water vapor inside? Record this in Results.
3. ☐ Remove the cup of BTB. Did it change color? Record this information in the Results section.
4. ☐ Dispose of your BTB in the manner determined by your instructor. Rinse and wipe out the cup.
5. ☐ Place this disposable cup onto the digital balance. "Zero" out the scale (by pressing T or "tare"). Remove what remains of your chunk of potato from the cup of worms and place in the cup on the balance. Record the final mass of the potato in the Results section.
6. ☐ Dispose the potato in the manner determined by your instructor. Rinse/wipe out the cup.
7. ☐ Place this disposable cup onto the digital balance. "Zero" out the scale (by pressing T or "tare"). Pour your cup of mealworms into this cup. Record the final mass of the worms.
8. ☐ Clean up all remaining items in the manner determined by your instructor.

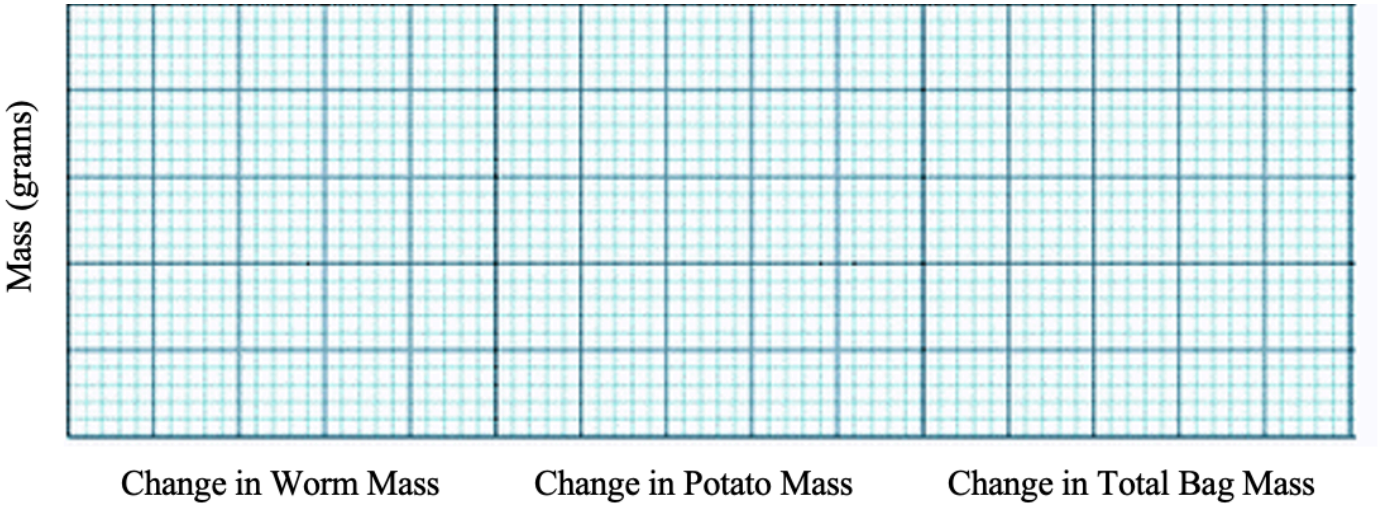
Results - *Record your data below after 24⁺ hours.* *SEP: Planning & Carrying Out Investigations*

Item	Initial Mass (g)	Final Mass (g)	Change in Mass (g)
Worms			
Potato			
Total Bag Mass (worms, potato, & BTB)			

Was water vapor present inside of your bag of worms after 24 hours? Yes No (*circle one*)

Initial Color of BTB: _____ Final Color of BTB: _____

Use your data to create a bar graph below based on the change in mass. Be sure to label your data with specific units (in grams) from your data table.



Post-Investigation Questions - *Record your ideas in the spaces below.* *SEP: Engaging in an Argument from Evidence.*

1. The change in potato mass was **equal to/different from** (*circle one*) the change in worm mass.
2. Based on your data, the amount of atoms in the potato (*circle one*) **increased / decreased / didn't change.**
   Hint: what happened to the mass of the potato? Remember - if something gains mass, it gains atoms. If it loses mass, it loses atoms.
3. Based on your data, the amount of atoms in the air (*circle one*) **increased / decreased / didn't change.**
   Hint: did the BTB change color? What does this indicate?
4. Based on your data, the amount of atoms inside the bag (*circle one*) **increased / decreased / didn't change.**
   Hint: what happened to the mass of the bag? Was it roughly the same mass as when you started (assuming no one opened the bag; disregard minor changes in mass if the scale is not fully accurate).
5. If the mass lost by the potato did not equal the mass gained by the worms, where did these atoms go? What do you think happened to the atoms in the potato that were not added to the body of the worms?

_____

_____

6. If something loses mass, it loses atoms. If something gains mass, it gains atoms. **Based on this information, what happened to the atoms in the potato as it was consumed?** Explain using data.

7. You likely observed that animals moved (*kinetic energy*) as they consumed the potato. The bag was likely also slightly warmer (*thermal energy*) than before. **Where did this energy come from?** Explain.

8. Animal cells are mostly made from water, fat, and protein. **Where did the worms acquire these macromolecules to make cells & gain more mass?** Defend your ideas with evidence & reasoning.

9. **How does food change after being eaten? Why do animals gain only a small part of its mass?**

10. **Use arrows, labels, and brief explanations to show how matter and energy in the potato was transformed as it was eaten by a worm.** Include all of the following: *1) carbohydrates, 2) glucose, 3) oxygen (O_2), 4) CO_2, 5) H_2O, 6) high energy bonds, 7) motion, 8) heat.* (Image Source)

Part 3C: Potato Enzyme Lab (2.2.3c)

Pre-Investigation Questions - *Work together to prepare verbal answers to these questions. When ready, raise your hand. Your instructor will listen, give feedback, and decide if you're ready to start the investigation.*
SEP: Developing & Using Models

1. What are enzymes? What is the primary function of enzymes during digestion?
2. Why do we need to break down food?

This activity was completed _____ (*instructor signature*)

Overview: In this lab we will observe the effect of **temperature** (boiling, freezing, room temperature) and **pH** (acid, base, neutral) on the catalytic activity of catalase in raw potatoes.

Materials needed for investigations (per group): raw potato (peeled and cut into small, equal cubes or mashed), hydrogen peroxide (3% H_2O_2), test tubes or small clear cups, graduated cylinder or measuring spoons, stopwatch, vinegar, baking soda solution or ammonia (base 9-12 pH), distilled water, ice bath, hot water bath/microwave

Directions - *Carefully read the directions below before beginning. Record info where prompted.*

1. ☐ Gather 3 equal amount of potato (cubes or 1 tsp mashed)
2. ☐ Place into 3 separate test tubes: Tube 1: ice - place in ice-water for 5-10 minutes; Tube 2: room temperature - keep at room temperature; Tube 3: hot - boil for 5 minutes or microwave
3. ☐ Add substrate: add 5 mL (1 tsp) of hydrogen peroxide to each tube
4. ☐ Record observations on data table: measure the height of the foam produced over 60 seconds
5. ☐ Dispose of materials appropriately
6. ☐ Gather 3 equal amount of potato
7. ☐ Place into 3 separate test tubes: Tube 1: neutral - add 1 tsp water; Tube 2: acidic - add 1 tsp vinegar; Tube 3: basic - add 1 tsp ammonia/baking soda solution
8. ☐ Add 5 mL of hydrogen peroxide to each tube
9. ☐ Record observations on data table: measure the height of the foam produced over 60 seconds

Data -

Tube	Condition	Foam Height (mm)	Observations
A1	Ice Bath (Cold)		
A2	Room Temp		
A3	Boiled (Hot)		
B1	Water (Neutral)		
B2	Vinegar (Acid)		
B3	Ammonia		

	(Base)		

Post-Lab Questions -

1. What caused the bubbles/foam to form?
2. Which temperature produced the most foam?
3. Why did the ice-cold potato react more slowly?
4. What happened to the enzyme in the boiled sample?
5. What does this tell you about high fevers and enzymes in the human body?
6. Which pH level had the highest enzyme activity? What does this tell you about enzymes and pH sensitivity?
7. Your body uses digestive enzymes just like catalase. Why must your body maintain a stable temperature?
8. Why is your stomach very acidic?
9. What might happen if the pH of your stomach changed dramatically?
10. Why is chewing food important for enzyme activity?

Part 4: Review & Assessment (2.2.4)

Step 1: Review each Driving Question. Circle any questions that are still unclear to you.
Step 2: Identify and discuss any remaining confusion with your instructor.
Step 3: Complete the Formative Assessment (individually or small groups). Compare responses as a class.
Step 4: Individually complete a Mastery Check. If needed, your instructor will provide further support.

Animals, Packet 2 Formative Assessment (2.2.4)

Name: _____ Hour____ Date:_____ Score:_____

Directions: A 3x5 notecard with *handwritten* notes can be used to guide your answers. Your instructor may allow you to work in assigned groups. If so, have a different person write each response while others assist.

1. Students are visiting a farm. The farmer explains that a growing cow eats about 15 lbs. of food a day! However, it gains less than 1.5 lbs. in body mass per day. Three students are unsure why this is. **Do you agree or disagree with each student's claim**?

a. Avery thinks that the matter in the food is turned into energy used by the cow to grow. *Agree/Disagree*
b. Bristol believes that a lot of the atoms from the cow's food are eventually breathed out. *Agree/Disagree*
c. Chandra argues that almost all the atoms in the food are excreted as feces and urine. *Agree/Disagree*

2. Provide an explanation. Why did you agree or disagree with each student's claim?

a) _____

b) _____

c) _____

Writer:

3. What happens to fats, proteins, and carbohydrates in the cow's food immediately after being consumed? Include and underline the following: *molecules, enzymes, bloodstream, cells.*

_____

_____

_____

Writer:

4. A cow consumes 15 lbs. of food daily, but only gains 1.5 lbs. per day. The cow produces 7 lbs. of feces (dry weight). **What is happening to the 5.5 lbs. of atoms that weren't added to the animal's body or feces?**

_____

_____

_____

Writer:

5. Summarize what occurs during cellular respiration. Include and underline each of the following: *a) glucose & oxygen, b) CO_2 & H_2O, c) high energy bonds, d) ATP.*

_____

_____

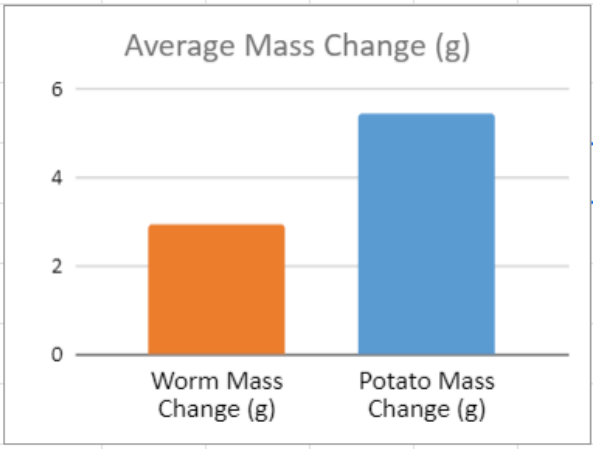
_____

_____

Writer:

Background: A class recorded the initial mass of mealworms and potato chunks. They then fed the potato to the worms and measured the final mass of the worms (including their feces) and the potato. Here is their data:

	Worm Mass Change (g)	Potato Mass Change (g)
Group 1	2	4.8
Group 2	2.4	6.3
Group 3	4.4	5.2
Group 4	2.8	5.2
Group 5	3.1	5.7
AVERAGE	**2.94**	**5.44**



This data shows the average mass gained by worms compared to the average mass lost by the potatoes they consumed.

6. Four students make claims about what happened to the potato as it was consumed by the worms:

Student 1: Almost all atoms in the potato were added to the worms' bodies to increase their mass.
Student 2: Some atoms from the potato were rearranged to form water vapor.
Student 3: Some atoms from the potato were rearranged to form carbon dioxide.
Student 4: Some atoms from the potato were broken down by the worms' digestive tracts.

Determine whether each argument is backed by a) this data and b) your knowledge of cellular respiration, and explain why.

1) Supports/Refutes. Why?

2) Supports/Refutes. Why?

3) Supports/Refutes. Why?

4) Supports/Refutes. Why?

Writer:

7. How does cellular respiration help explain the "missing mass" of the potato that wasn't added to the worms? Describe the process of cellular respiration and its connection to the observed trends in the data.

Part 5: Life Connections – Interview an Expert (2.2.5)

Background - *Complete the reading before answering the questions below.* *SEP: Planning & Carrying Out Investigations*

You will either interview a professional or watch a video interview. This is called social science research. It involves collecting data about people and their ideas. Interviews are often used as a source for this data.

Part 1 - Planning

1. Briefly summarize the topics that were covered in class this week in one sentence:

   This week in class, we tried to figure out _____

   _____

2. As a group, discuss what questions you still have about this week's topics. Ideally, use some of the following to start your questions: *Who, What, When, Where, Why, How*

   _____

   _____

   _____

3. From this list, choose a **research question** for your group and complete the prompt below:

   We are unsure _____

   _____

4. Turn your research question into a **hypothesis**. What do you think is the answer to your research question given what you currently know?

   We hypothesize that _____

   _____

5. Create three interview questions that you could ask this individual that may provide information related to your research question. Try to focus on their particular area of expertise as you craft your questions.

   1. _____

   2. _____

   3. _____

6. Be prepared to briefly describe your research question and hypothesis. Explain how your interview questions will provide you with information that will help to address your research question.

Part 2 – Interview Field Notes - Use the space below to record some field notes as the guest speaker presents to the class. Record anything that you hear or observe that might be relevant to your research question.

_____

_____

_____

_____

_____

_____

Part 3 – Analysis & Debrief *(your instructor may choose to use verbal discussion instead of written responses)*

1. Does your data (your observations and field notes from this interview) support or refute your hypothesis? Circle one: Supports it / Refutes it / Not sure

   Explain: _____

   _____

2. Briefly summary three key statements that are supported by the information in this video:

   1. _____

   2. _____

   3. _____

Part 5B: Life Connections – Chicago Cyanide Murders (2.2.5)

Use with slides presentation: The Chicago Cyanide Murders Case Study Presentation

Background. Five people in Chicago die after taking Tylenol capsules. *Adapted from the biology corner*.

In September of 1982, Jeanna Kellerman gave her 12 year old daughter a painkiller when she awoke during the night complaining of a sore throat. At 7 am the next morning, her daughter was found collapsed on the bathroom floor, and later pronounced dead.

Adam Janus, a postal worker in another Chicago suburb also died unexpectedly, though originally it was thought he had suffered from a heart attack. While his family gathered to mourn their loss, his brother and sister became ill and later died.

In the days that followed, three more unexplained deaths occurred in nearby Chicago suburbs. Investigators found that all of the victims had taken an extra strength Tylenol hours before their death. They suspected that someone had tampered with the medication.

Symptoms exhibited by each of the victims included:

- weakness, dizziness, sleepiness
- flushed, bright red, skin tone
- headache
- shortness of breath and rapid breathing
- vomiting
- confusion and disorientation

Questions:

1. What additional information would you need to determine if these deaths were connected?

   _____

2. If poison is suspected in the deaths, how would you proceed with the investigation?

   _____

Autopsy Report

The medical examiner concluded that each of the victims had died of hypoxia. Hypoxia means that the person suffered from a lack of oxygen, or they were suffocated. The reason for the hypoxia is not always clear at the first examination. Even though the victims died of hypoxia, their level of oxygen in their blood was approximately 110 mm Hg. The normal range is 75-100 mm Hg.

The medical examiner also showed the tissue samples from the heart, lungs, and liver showed massive cell death. On further investigation, it was shown that the tissues had damage to the mitochondria of the cells.

3. Recall your knowledge of the function of organelles. If the mitochondria were damaged, what process of the cells would this interfere with?

   _____

4. While poison is the main suspect in the case, what are other ways a person could die of hypoxia?

   _____

5. Analyze the oxygen levels of the victims. Were the levels higher or lower than normal?

_____

6. How can you reconcile this observation with the cause of death being hypoxia?

_____

Toxicology reports show that the victims had been poisoned with cyanide. The poison was traced back to extra strength Tylenol where the murderer had opened the capsules and replaced acetaminophen (a pain killer) with cyanide. Cyanide acts very quickly, often killing within minutes of ingestion and authorities were slow to identify the cause of the deaths. Once the cause was identified, stores removed Tylenol and other drugs from shelves.

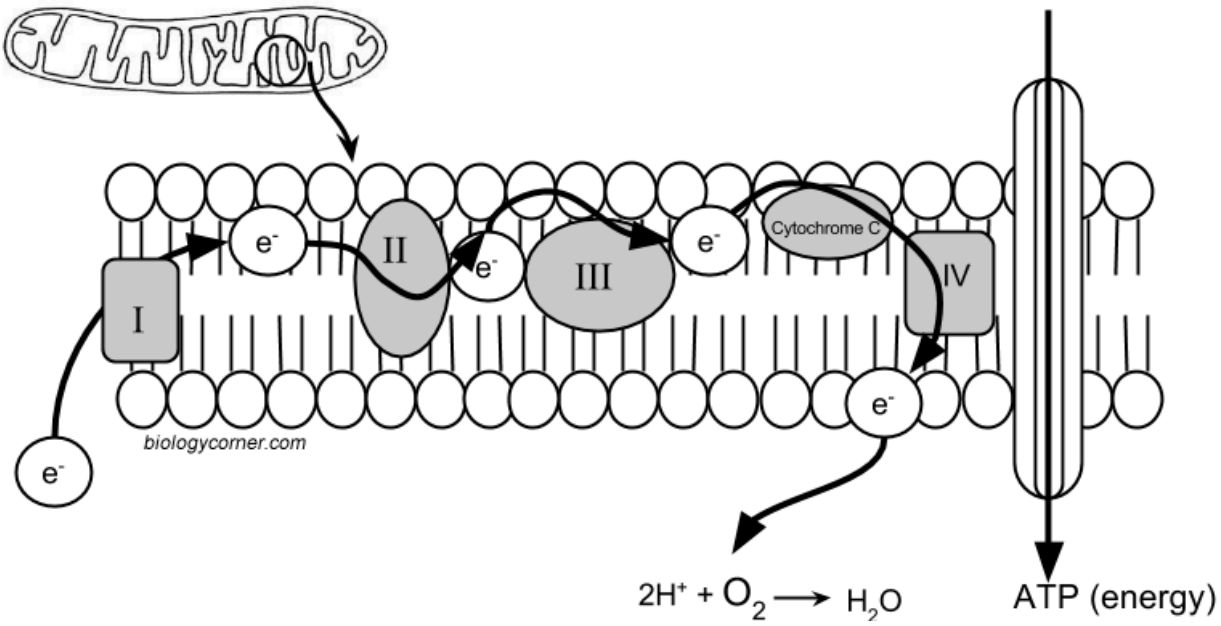
No one was ever charged with the crime and it is still an ongoing investigation. Since the Chicago Tylenol murders, drug companies have changed how medicines are packaged. Cyanide is an effective poison because it directly interferes with cellular respiration that occurs in the mitochondria causing death within minutes of being ingested.

7. Why are mitochondria called the "powerhouse of the cell?" What is this "power" used for and why is it important for staying alive?

_____

Why Do We Need Oxygen?

Everyone knows you need to breathe to live. Have you ever thought about why oxygen is so important? The victims of the cyanide poisoning all had high levels of oxygen in their blood, but the poison was interfering with how the cells use that oxygen. To understand, we need to take a very close look at the mitochondrion.



Inside the mitochondria, there are several layers of membranes. In fact, these membranes resemble the membrane that surrounds the cell. It has a bilayer of phospholipids and embedded proteins. On the diagram above, the proteins are labeled I, II, III, IV, and Cytochrome C.

The proteins in the membrane pass electrons from one to the other, this is known as the electron transport chain. The passing of these electrons allows ATP (adenosine triphosphate) to be generated. At the end of the electron transport chain, Cytochrome C passes the electron to its final acceptor, oxygen. Oxygen then binds with proteins to create water. This process is continuous in cells, with ATP constantly being generated and oxygen being used as the final electron acceptor. Cyanide inhibits cytochrome C, preventing the last protein from doing its job. The electron stops at the end of the chain and cannot be passed to oxygen. The whole chain grinds to a halt and no ATP can be made.

COLORING:

- ☐ On the model of mitochondria, highlight the area (arrows) that is the ELECTRON TRANSPORT CHAIN in yellow
- ☐ Place an X over the protein that is inhibited by cyanide.
- ☐ Color the phospholipid bilayer blue.
- ☐ Color the ATP synthase red. (This is a protein that generates ATP.)

8. What is the relationship between the ETC and oxygen?

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9. Cyanide is an extremely fast acting poison. In fact, it was developed as a suicide pill (called L-pill) during WWII so that British and American spies could avoid being captured alive. Given what you know about ATP and cellular respiration, explain why cyanide is so fast acting.

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10. Given what you know about cyanide poisoning, do you know that giving a person oxygen would be an effective treatment? Why or why not?

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