

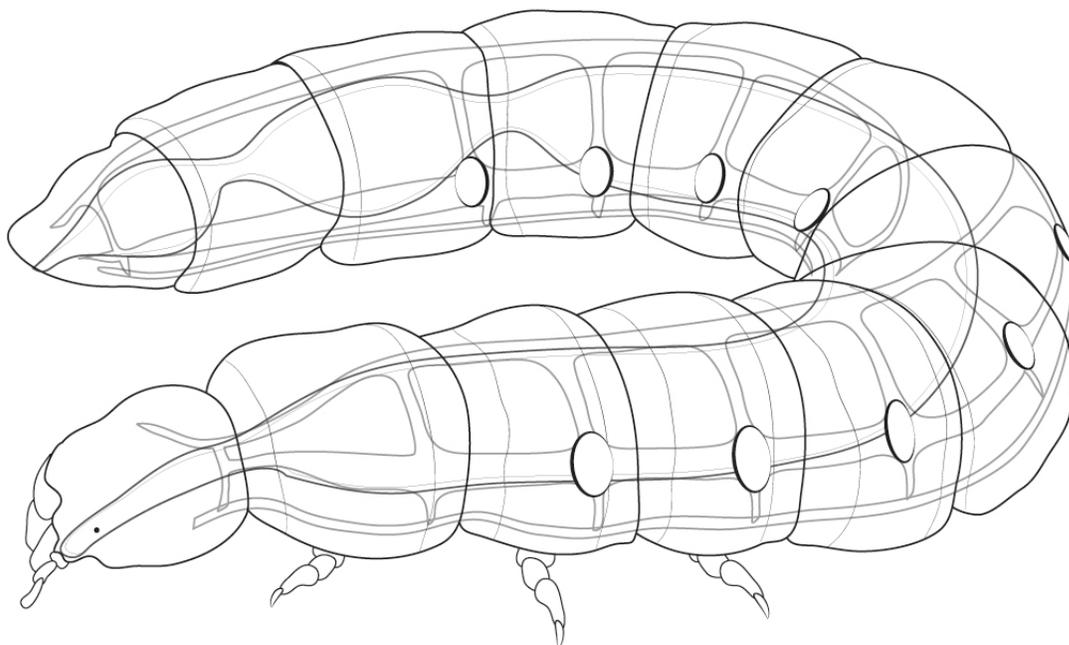
6.1: Grading Mealworms Worksheet

*This worksheet has “grading” in the title because at this point, students can be held accountable for correct answers. Level 4 (correct) responses to the questions are in **blue bold italics** below.*

Red italics suggest ways to grade student responses by giving them points for correct or partially correct answers. There are 16 points total on this worksheet.

Draw and label arrows that represent the molecules that carbon atoms are in as they move into, through and out of the mealworm as it moves and grows.

Label each arrow to show the kind of molecules that the carbon atoms are in: large organic molecules (LOM), small organic molecules (SOM), or carbon dioxide (CO₂).



What happens to the food the mealworm eats as it moves and grows?

Mealworms digest the food they eat, turning large organic molecules into small organic molecules. They use the digested food they eat in two ways: for biosynthesis (for growth) and for cellular respiration (for energy).

1 point each for digestion, cellular respiration, and biosynthesis (3 points total)

How do a mealworm's cells get oxygen from the air when it grows and moves? What do they do with the oxygen?

Oxygen moves from the air into the mealworm's cells through holes and tube in its body (spiracles and tracheae). Mealworm cells use the oxygen as one of the reactants needed for cellular respiration.

1 point each for getting oxygen from air and using oxygen for cellular respiration (2 points total)

A. Investigating how Mealworms grow and function

A class was interested in how mealworms grow. The teacher started the lesson by telling his students that a mealworm eats a lot of food each week but only gains a little bit of weight. The teacher asked, "What happened to the mass of the rest of the food?"

a. Three students shared their ideas about what happened. Do you agree or disagree with what each student claims?

Agree	Disagree	Evan: "The mealworm's body turned the mass of the food into energy in order to grow."
Agree	Disagree	Madison: "The mealworm breathed out most of the extra mass of the food as gases, like CO ₂ ."
Agree	Disagree	Li: "The mealworm's body got rid of most of the extra mass of the food as solid waste (feces)."

1 point for correctly answering each line. 3 points total. Note that based on the information given, either agreeing or disagreeing with Evan and Boe is reasonable (see explanation below).

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

The best explanations will consider answers to the Matter Movement and Matter Change Questions: Three things can happen to food that animals eat: (a) undigested large organic molecules eliminated as feces, digested food used either for (b) cellular respiration and energy or (c) biosynthesis and growth. Students can use this knowledge to evaluate the three claims:

- **Evan's claim is incorrect because it violates the principle of conservation of matter: Matter cannot be converted to energy in chemical or physical changes.**
- **Madison's claim correctly recognizes CO₂ as a product of cellular respiration. A Level 4 response could reasonably be "not sure" if there is an explanation that we can't be sure how much of the food is used for cellular respiration.**
- **Li's claim correctly recognizes that undigested food leaves the salmon's body as feces. Again, a Level 4 response could recognize that there is no information about how much of the food is digested by the salmon.**

1 point for rejecting Evan's claim as impossible

1 point for recognizing Madison's claim as possible due to cellular respiration (but possibly disagreeing with the claim that cellular respiration accounts for MOST of the mass)

1 point for recognizing Li's claim as possible due to undigested food (but possibly disagreeing with the claim that undigested food accounts for MOST of the mass)

3 points total

c. The class generated some data. They measured the starting mass of 5 mealworms and put each mealworm in its own container. Then they gave each mealworm 0.3 grams of food and made sure the mealworms always had the same amount of water in their containers. After one week, the students measured the masses of the mealworms, leftover food and mealworm feces. Below are the data they generated.

Sample	Change in mealworm mass (g)	Change in food mass (g)	Mass of solid waste (g)
1	+0.02	-0.20	+0.04
2	+0.02	-0.21	+0.05
3	+0.03	-0.23	+0.05
4	+0.01	-0.19	+0.04

5	+0.04	-0.23	+0.07
Average	+0.02	-0.18	+0.05

Which claim do you think is best supported by the data?

- Evan's claim
- Madison's claim**
- Li's claim

Explain how the patterns in the data support the claim that you chose.

The best responses recognize that undigested food (solid waste) and growth (change in salmon mass) together account for only an average of .03 out of .21 grams that the average mealworm ate. So the data support Madison's claim better than the other two.

1 point for choosing Madison's claim

1 point for pointing to mass differences as evidence

2 points total

d. What additional evidence would you collect to help show that the claim you chose is the best claim?

The best responses propose questions that target limitations in the data (recognize there is an unaccounted for matter pool, i.e., water); they focus on matter tracing and are constrained by principles such as matter to energy conversion.

1 point for identifying additional evidence that could be collected (could be water, oxygen, CO₂, or other conditions)

B. A question about how mealworms grow and function

When lots of mealworms are together in a small container, the container gets warm. How do you think food contributes to the mealworm's body heat?

Level 4 responses recognize that stored energy (chemical/potential/bond energy OR C-C, C-H bonds, or calories) in the food is converted to heat. They may mention that heat is released in the process of cellular respiration.

1 point for identifying that the chemical energy in food is converted to heat or that heat is released during cellular respiration

C. Something interesting about Mealworms

What is something interesting that you learned about mealworms from your readings and discussion?

1 point for correct fact from readings or discussion.