

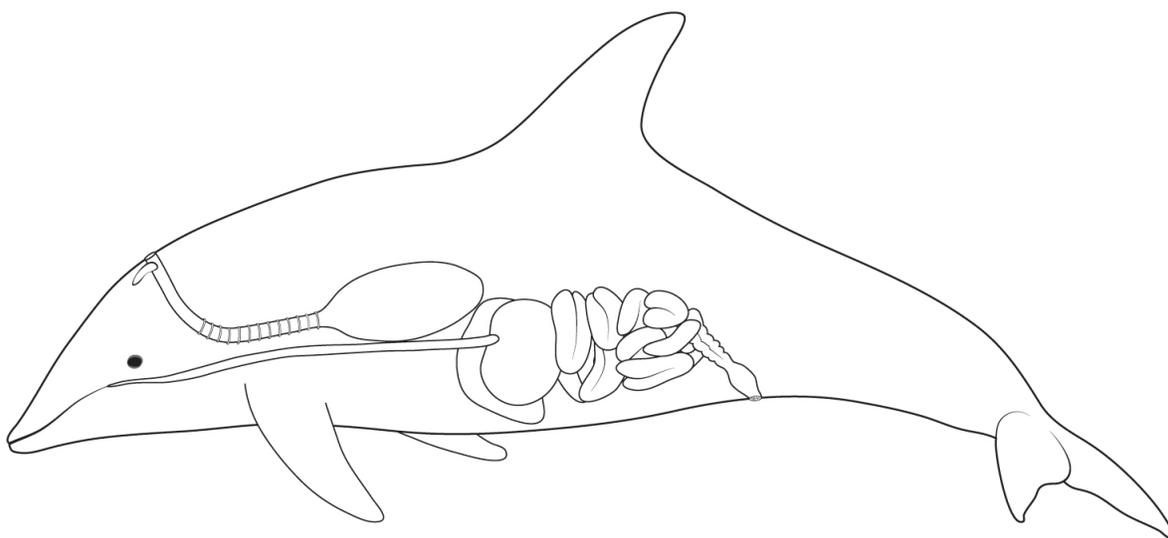
6.1: Grading Dolphins Worksheet

*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 21 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 dolphin 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 a dolphin eats as it moves and grows?

Dolphins 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)

What happens to the air a dolphin breathes as it moves and grows?

Oxygen moves from the air into the dolphin's blood in its lungs. Dolphin cells use the oxygen as one of the reactants needed for cellular respiration.

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

A. Investigating how dolphins grow and function

A class was interested in how dolphins grow. The teacher started the lesson by telling his students that a dolphin 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	Jared: "The dolphin's body turned the mass of the food into energy in order to grow."
Agree	Disagree	Anup: "The dolphin breathed out most of the extra mass of the food as gases, like CO ₂ ."
Agree	Disagree	Bianca: "The dolphin'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 Anup and Bianca 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:

- Jared's claim is incorrect because it violates the principle of conservation of matter: Matter cannot be converted to energy in chemical or physical changes.**
- Anup's claim correctly recognizes CO₂ as a product of cellular respiration. A good 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.**
- Bianca's claim correctly recognizes that undigested food leaves the salmon's body as feces. Again, a good response could recognize that there is no information about how much of the food is digested by the salmon.**

1 point for rejecting Jared's claim as impossible

1 point for recognizing Anup'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 Bianca'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 dolphins and observed each dolphin in its own pool at a local aquarium. Then they gave each dolphin 30 kg of food and made sure the dolphins always had the same amount of water in the aquarium. After one week, the students measured the masses of the dolphins, leftover food and dolphin feces. Below are the data they generated.

Sample	Change in Dolphin mass (kg)	Change in food mass (kg)	Mass of solid waste (kg)
1	+2.0	-20.0	+4.0
2	+2.0	-20.1	+5.0
3	+3.0	-20.3	+5.0
4	+1.0	-10.9	+4.0

5	+4.0	-20.3	+7.0
Average	+2.4	-18.3	+5.0

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

- Jared's claim
- Anup's claim**
- Bianca'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 dolphin mass) together account for only an average of 8 out of 20 kilograms that the average dolphin ate. So the data support Anup's claim better than the other two.

1 point for choosing Anup'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?

Level 3 responses propose questions that target limitations in the data (recognize there is an unaccounted for matter pool, i.e., gas); 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 dolphins grow and function

Fat is mostly made of molecules such as stearic acid: C₁₈H₃₆O₂. Decide whether each of the following statements is true or false about what happens to the atoms in a dolphin's fat when he swims for a long distance and loses weight.

Some of the atoms in the dolphin's fat are:

True	False	incorporated into CARBON DIOXIDE in the air.
True	False	converted into ENERGY that he uses when he swims.
True	False	BURNED UP AND DISAPPEAR.
True	False	converted into HEAT.
True	False	incorporated into WATER VAPOR in the air.

1 point for correctly answering each line. 5 points total.

Explain your answers. What happens to the atoms in the fat of a dolphin who loses weight?

Level 4 students recognize the connection between this question and the Matter Change Question for cellular respiration. They could explain this connection in two ways:

- They may simply explain that the fat molecules are being used for cellular respiration, meaning that the products are CO₂ and H₂O.**
- They may invoke conservation laws and "follow the rules."**
 - Atoms cannot be burned up or disappear.**
 - Atoms cannot change into forms of energy.**
 - There must be products of the Matter Change that include the atoms in stearic acid: C, H, and O.**

1 point for explaining the connection in either of the above ways

C. Something interesting about dolphins

What is something interesting that you learned about the dolphin that makes this animal different from other animals?

1 point for correct fact from readings or discussion.