

Twelve Clues About Food: An Evidence Jigsaw on Energy and Matter

Learning target: I can work with a team to sort evidence cards under claims about how organisms release energy from food, store it, and build their bodies from it, and defend which cards support each claim.

Collaborative investigation

About 50 min

Jigsaw

MS-LS1-7 · practice

MS-LS2-3 · supports

collaboration

discussion

data analysis

Standards connections

MS-LS1-7 (practice): Sorting evidence under claims about energy release, storage and growth gives students the pieces they will assemble into a model of how food is rearranged in an organism; the jigsaw builds the evidence base for that model without yet drawing it.

MS-LS2-3 (supports): Several cards (fungus on a log, exhaled breath, sprouting seeds) show carbon dioxide leaving organisms, which is background for the ecosystem-scale cycling of matter studied in later chapters.

Purpose: practice · **Time:** about 50 minutes · **Format:** jigsaw

Answers with reasoning

The four claims — Claim 1: Living things release energy from food by reacting it with oxygen, giving off carbon dioxide and water. Claim 2: Producers and other organisms that are not animals carry out cellular respiration too. Claim 3: The matter in food is rebuilt into the body of the organism that eats it; atoms are conserved along the way. Claim 4: Organisms store food energy in molecules such as starch, glycogen and fat for later use.

Twelve evidence cards

1 Card 1: Warm seeds in the dark (teaching data)

A vented vacuum flask of 100 g of sprouting bean seeds, kept in a dark cabinet, rose from 21.0 °C to 25.2 °C in two days; the oxygen inside fell from 20.9% to 18.8% and the carbon dioxide rose from 0.04% to 2.1%. A matching flask of boiled seeds changed by less than 0.1 °C and showed no gas change.

2 Card 2: Yeast and sugar

Yeast is a single-celled fungus. An aquarium pump bubbles air slowly through a flask of warm water, sugar and yeast, and the gas leaving the flask is led by a tube into limewater, which turns cloudy within a few minutes, the standard test for carbon dioxide. An identical flask of warm water and yeast with no sugar takes far longer to cloud its limewater, about as long as plain room air does.

3 Card 3: Where muscle comes from

The proteins in food are taken apart during digestion into small pieces called amino acids. The blood carries the pieces to cells, which link them in new orders to build human proteins, including the proteins that make muscles contract. A child who grows new muscle has built it from the pieces of proteins in meals.

4 Card 4: Flooded roots

Soil has air pockets between its grains. When a garden bed stayed under water for nine days, the air pockets filled with water, and the tomato roots turned brown and soft and the plants wilted even though they had plenty of water. Roots in a raised bed that drained in a day stayed white and firm.

5 Card 5: Heart cells and skin cells

Under a microscope, a heart muscle cell is packed with mitochondria, with hundreds visible in one cell. A skin cell from the same animal has far fewer. Heart muscle contracts about once a second for an entire lifetime and never rests.

6 Card 6: Potato and iodine

A drop of iodine solution on a cut potato turns blue-black, the test for starch. A drop on a lettuce leaf barely changes color. A potato is an underground part of the plant where sugar made in the leaves is linked into starch and kept; in spring, a sprouting potato shrivels as the starch is used up.

7 Card 7: Breath and limewater

The air you breathe in is about 0.04% carbon dioxide; the air you breathe out is about 4%, roughly 100 times more. Blowing through a straw into limewater turns it cloudy in under a minute; pumping room air through the same limewater takes much longer to show any cloudiness.

8 Card 8: Shrinking seeds (teaching data)

Fifty bean seeds were dried and weighed: 20.0 g. Fifty seeds from the same packet were soaked and left to sprout in a dark cupboard for ten days, then dried completely and weighed: 16.4 g. The sprouts had roots and shoots several centimeters long, yet their dry mass was 3.6 g less than the unsprouted seeds.

9 Card 9: Birds before migration

Many small songbirds roughly double their body fat in the weeks before a long migration flight, eating constantly. They arrive at the other end thin. Fat releases about 9 kcal per gram, more than twice as much as the 4 kcal per gram released by carbohydrate or protein.

10 Card 10: The liver's sugar bank

After a meal, the liver links spare sugar molecules into long chains of glycogen and stores them. Between meals, the liver breaks glycogen back down into sugar and releases it into the blood, so the blood sugar stays steady even hours after eating.

11 Card 11: Fungus on a log

A shelf fungus has no mouth and no lungs. Its thin threads grow into a fallen log, absorb the log's molecules, and use them for energy and growth. A chunk of rotting log with its fungus, sealed in a jar with a carbon dioxide sensor, shows carbon dioxide rising steadily, and over the years the log loses mass.

12 Card 12: Breathing during exercise (teaching data)

A student's breathing rate was 14 breaths per minute while sitting and 32 breaths per minute after three minutes of jumping jacks. Her leg muscles felt warm. Working muscles need to release energy from sugar many times faster than resting muscles do.

Part A: Expert round (one set per person)

1. Your expert set: _____. For each of your three cards, write one sentence that says what the card shows and which claim or claims it supports. Your home group will rely on these sentences.

Answer: Set A: Card 1 shows living seeds warming, using oxygen and releasing carbon dioxide in the dark (Claims 1 and 2); Card 2 shows yeast releasing carbon dioxide only when it has sugar (Claims 1 and 2); Card 3 shows food proteins rebuilt into muscle proteins (Claim 3). Set B: Card 4 shows roots dying without oxygen in the soil (Claim 2, with Claim 1 because roots need oxygen); Card 5 shows cells that work hardest have the most mitochondria (Claim 1); Card 6 shows plants storing sugar as starch and using it later (Claim 4). Set C: Card 7 shows exhaled air carrying far more carbon dioxide than inhaled air (Claim 1); Card 8 shows sprouting seeds losing dry mass in the dark (Claims 1 and 2, and Claim 3 by tracking atoms); Card 9 shows birds storing fat for migration (Claim 4). Set D: Card 10 shows the liver storing glycogen and releasing sugar (Claim 4); Card 11 shows a fungus respiring without lungs (Claims 1 and 2); Card 12 shows breathing rising with energy demand (Claim 1).

Why: Each expert set was built to contain cards for different claims so that every student handles more than one idea.

Also acceptable: Accept any defensible claim assignment that is explained; the common placements are listed above.

- Identifies the set
- One sentence per card stating what it shows
- Names at least one correct claim per card

Part B: Home group task

1. Lay all twelve cards on the desk. Place each card under the claim it supports. A card may support more than one claim; if so, note the card number under each claim it supports.
2. For each claim, choose the two strongest cards and write a reason: what observation on the card would be hard to explain if the claim were false?
3. Find at least one card that supports Claim 2 even though the organism on it is not a plant. Agree on why it counts.
4. Decide which claim has the weakest support in this deck. Describe one piece of evidence that would strengthen it.
5. Prepare a one-minute defense of your sort. Every member must be able to explain the placement of any card.

Group record (fill in)

Claim	Card numbers that support it	Two strongest cards and why
Claim 1: energy released by reacting food with oxygen		
Claim 2: producers and non-animals respire too		
Claim 3: food matter is rebuilt into the body; atoms conserved		
Claim 4: energy stored in molecules for later		

2. Group answer: Which claim did your group judge to have the weakest support, and what evidence would strengthen it?

Answer: Most groups will judge Claim 3 (food matter rebuilt into the body) the weakest, since only Card 3 addresses it directly (Card 8 supports it indirectly). Evidence that would strengthen it: feeding an animal food labeled with a traceable form of carbon and later finding that carbon in its muscle; or weighing a growing animal and its food and waste to show that the gained mass came from the food.

Why: The deck is deliberately unbalanced so that groups must notice that a claim can be true and still thinly supported.

Also acceptable: A group that picks Claim 2 and argues that the seed and fungus cards are about non-animals but only Card 4 is about a mature plant is reasoning well.

- Names a claim and explains why its support is thin
- Proposes a specific piece of evidence that would address it

3. Group answer: Write the placement the neighboring group challenged, their argument, and how your group answered it.

Answer: Common challenges: 'Card 12 is about breathing, not cellular respiration' (reply: the breathing rate rose because the muscles were releasing energy faster and needed more oxygen delivered; breathing is the supply line for the reaction). 'Card 8 is about mass, not energy' (reply: the mass left as carbon dioxide and water, the products of respiration, so it is evidence of the reaction). 'Card 9 belongs under Claim 3 because fat becomes part of the body' (reply: it supports both; the card's main point is storage for later use).

Why: Grade the quality of the recorded exchange: a specific challenge and a reply that uses the card.

Also acceptable: Any reasonable challenge and evidence-based reply earns credit.

- Records a specific challenge
- Reply uses evidence from the card

Part C: Individual accountability (complete alone)

4. Explain why Card 2 (yeast) and Card 11 (fungus) belong under Claim 2 even though neither organism is a plant, and why they are also evidence for Claim 1.

Answer: Claim 2 says that organisms other than animals respire; yeast and shelf fungi are fungi, not animals and not plants, and both release carbon dioxide from food (the limewater turning cloudy; the sensor in the jar), so they show that cellular respiration is not limited to animals. They are also evidence for Claim 1 because the carbon dioxide appears only when food (sugar, the log's molecules) is available, which is what reacting food with oxygen predicts.

Why: Students should recognize that Claim 2 is about 'not only animals,' not about 'plants only.'

Also acceptable: Accept 'the fungus has no lungs, so the gas must come from its cells.'

- States that fungi are neither animals nor plants
- Links the carbon dioxide release to Claim 2 and to the food-plus-oxygen idea of Claim 1

5. Use Card 8 together with Card 1 or Card 7 to explain where the missing 3.6 g of dry mass went. Your answer must account for the atoms.

Answer: The 3.6 g of lost dry mass was starch and other stored food that the sprouting seeds broke down into sugar and reacted with oxygen. The carbon atoms of that sugar left the seeds as carbon dioxide gas and the hydrogen atoms left in water, so the solid matter weighed less. Card 1 shows the same kind of seeds using oxygen and releasing carbon dioxide in the dark, which is where the atoms went; Card 7 shows the same pattern in a person, whose exhaled air carries the carbon from food. The atoms were not destroyed; they were rearranged into gases that escaped the cupboard. The roots and shoots grew longer using some of the remaining sugar as building material, but the growth was built from matter already in the seed, so it could not add dry mass.

Why: Full credit tracks the carbon and hydrogen into carbon dioxide and water, cites Card 1 or Card 7 for the gas evidence, and states conservation of atoms.

Also acceptable: A student who notes that the seedlings could not gain dry mass in the dark because there was no photosynthesis is giving a strong answer.

- Lost mass identified as stored food used in respiration
- Atoms traced to carbon dioxide and water
- Cites Card 1 or Card 7
- States that atoms were conserved, not destroyed

6. Which single card is the best evidence that cellular respiration happens inside cells rather than being the same thing as breathing? Explain your choice.

Answer: Best choices: Card 5, because the cells that work hardest (heart muscle) are packed with mitochondria, which only makes sense if the energy-releasing reaction happens inside the cell; or Card 11, because a fungus with no lungs still releases carbon dioxide, so the reaction cannot be breathing. Card 2 (yeast, a single cell with no lungs) is also acceptable.

Why: Any of these cards separates the reaction from the transport of gases; the explanation must say why.

Also acceptable: A student who picks Card 1 and argues that seeds have no lungs is also correct.

- Picks Card 5, 11 or 2
- Explains that the card shows the reaction occurring in cells or in an organism with no lungs

7. Write a three-sentence model statement that describes what happens to the food an organism takes in, covering energy release, storage and growth. Cite at least three different cards by number as evidence for your sentences.

Answer: Model response: Food molecules such as sugar react with oxygen inside cells, mostly in the mitochondria, producing carbon dioxide and water and releasing energy for the organism's work (Cards 1, 5, 7). Energy the organism does not need right away is kept in storage molecules, such as starch in a potato, glycogen in the liver or fat in a migrating bird, and is released later by the same reaction (Cards 6, 9, 10). Other food molecules, especially proteins, are taken apart and rebuilt into the organism's own body, so the atoms in food become the atoms of the eater and are never destroyed (Cards 3, 8).

Why: Three sentences covering release, storage and growth, each tied to card numbers, earn full credit. The response should keep energy and matter distinct.

Also acceptable: The order of the three sentences does not matter; a student who adds that producers do this too and cites Card 4 or Card 8 has gone beyond the requirement.

- Energy release sentence with reaction inputs and outputs
- Storage sentence naming a storage molecule
- Growth sentence that says food atoms become body atoms
- At least three different cards cited

Scoring rubric

Criterion	4 • Exemplary	3 • Proficient	2 • Developing	1 • Beginning
Card placement	All twelve cards placed under a defensible claim, with multi-claim cards noted under each claim they support.	Ten or eleven cards placed defensibly; multi-claim cards placed under only one claim.	Several cards placed by surface features (for example, every card with a plant under Claim 2 only) rather than by what the evidence shows.	Cards left unsorted or sorted without reference to the claims.
Reasons for the strongest cards	For each claim, two cards named with a reason that says what would be hard to explain if the claim were false.	Two cards per claim named; reasons restate the card rather than connecting it to the claim.	Cards named for some claims only, or reasons missing.	No strongest cards identified.
Defense	Every member can explain any placement; the challenge is answered with evidence from the card, and the group revises a placement if the challenge is correct.	Defense given by one or two members; the challenge is answered without card evidence.	Defense restates the sort without reasons.	No defense or no record of the challenge.
Individual accountability (Part C)	All four Part C answers are accurate, cite cards by number, keep matter and energy distinct, and show the student understands the group's reasoning.	Three of four accurate with card citations; one thin or partly incorrect.	Two accurate; others restate the group result without reasoning.	Part C mostly blank or inaccurate.

Teacher notes

Print and cut the twelve cards; shuffle them before handing a deck to each home group so that sorting is genuine. Cards 1, 8 and 12 carry invented numbers and are labeled teaching data; the others state real, general facts: exhaled air is about 4% carbon dioxide, iodine turns blue-black with starch, heart muscle cells are rich in mitochondria, many songbirds roughly double their fat before migration, the liver stores and releases glycogen, and amino acids from food proteins are reassembled into human proteins. The deck is deliberately thin on Claim 3 so that groups practice noticing a claim with little support. If you run the limewater or yeast demonstrations, limewater is mildly irritating to eyes, so use goggles and have students blow through a straw gently. Do not demonstrate flooded roots in class; Card 4 is a paper case. The debrief should name which cards are about producers, which about fungi and which about animals, and end with the point that the same reaction runs in all of them.

Scaffold offered to students: Three questions for every card

If a card is hard to place, ask: (1) Does it show a gas going in or out, or heat appearing? Then it is about energy release (Claim 1), and if the organism is not an animal, also Claim 2. (2) Does it show a food molecule becoming part of a body? Then Claim 3. (3) Does it show a molecule being kept for later and used up afterward? Then Claim 4. Write the question numbers that apply on a sticky note on each card before you sort.

Extension: The thirteenth card

Write a thirteenth evidence card about an organism that is not on any existing card (for example, a shark, a cactus or a single-celled alga). The card must describe a specific, realistic observation that could be made with classroom tools or a sensor, label any invented numbers as teaching data, and support exactly one claim. Trade with a partner and have them place it; if they place it under a different claim than you intended, revise the card until the evidence points only one way.