

Fixing Jade's Exit Ticket: Seven Statements About Food, Energy and Matter

Learning target: I can find the errors in a classmate's statements about cellular respiration, explain what went wrong in each one, and rewrite each statement so that it is scientifically accurate.

Error analysis

About 35 min

Individual

MS-LS1-7 · practice

writing

independent practice

Standards connections

MS-LS1-7 (practice): Diagnosing and repairing wrong ideas about how food is rearranged (energy is released, not created; matter leaves as gases, it does not become energy; plants respire too; breathing is not the reaction) sharpens the model students must describe in the PE.

Purpose: practice · **Time:** about 35 minutes · **Format:** individual

Answers with reasoning

Jade's exit ticket (copied exactly) — 1. Only animals do cellular respiration. Plants do photosynthesis instead. 2. Cellular respiration creates new energy inside the mitochondria. 3. The atoms in an acorn can end up as part of a squirrel's muscle. 4. When sugar is broken down, some of its mass turns into energy, so the squirrel loses that mass for good. 5. Breathing in and out is the same thing as cellular respiration. 6. Fat is a food molecule that stores energy for a long time and is part of cell membranes. 7. A plant gets most of the matter for its body from the soil through its roots.

Part A: Diagnose

1. Mark each statement correct or incorrect. For the incorrect ones, copy the word or phrase that contains the mistake. For the correct ones, write 'none'.

Answer: 1: incorrect ('Only animals' / 'instead'). 2: incorrect ('creates new energy'). 3: correct (none). 4: incorrect ('mass turns into energy' / 'loses that mass for good'). 5: incorrect ('the same thing'). 6: correct (none). 7: incorrect ('most of the matter' / 'from the soil').

Why: Five incorrect, two correct. The give-away phrases are the ones students will need to rewrite in Part B.

Also acceptable: Accept any phrase from the statement that contains the error.

Part B: Explain and rewrite

For each incorrect statement, write three things: (a) **What Jade was thinking:** the reasonable idea that led to the mistake. (b) **Why it is wrong:** the evidence or the science that shows it. (c) **The rewrite:** a corrected statement in one or two sentences.

2. Statement 1 (plants do photosynthesis instead of cellular respiration).

Answer: (a) Jade was thinking that each kind of organism has one way of handling energy: plants capture it, animals release it, and the two processes are alternatives. (b) Every living cell needs energy released from sugar, including plant cells; sprouting seeds in the dark warm up and use oxygen, roots die in flooded soil for lack of oxygen, and a plant in a sealed box releases carbon dioxide at night. Plant cells have mitochondria. Photosynthesis makes the sugar; cellular respiration releases the energy from it. (c) Rewrite: Both plants and animals carry out cellular respiration in their cells. Plants also carry out photosynthesis, which builds the sugar that their cells later use.

Why: Full credit needs a sympathetic account of the confusion (one process per organism), evidence that plants respire, and a rewrite that keeps both processes for plants.

Also acceptable: Accept 'plants have mitochondria' as the evidence.

- Names the 'one process per organism' thinking
- Gives at least one piece of evidence that plants respire
- Rewrite says plants do both

3. Statement 2 (cellular respiration creates new energy).

Answer: (a) Jade was thinking that because a cell has more usable energy after respiration, the process must have made energy. (b) Energy cannot be created or destroyed. The energy was already present as chemical energy in the sugar and oxygen; the reaction converts it into energy the cell can use plus heat, because the products (carbon dioxide and water) hold less chemical energy than the reactants did. The energy in the sugar was captured from sunlight by a producer in the first place. (c) Rewrite: Cellular respiration releases energy that was stored in sugar and oxygen, converting it into a form the cell can use, with the rest leaving as heat.

Why: The rewrite must use 'releases' or 'converts' instead of 'creates' and locate the energy's origin in the food.

Also acceptable: A student who traces the energy back to sunlight is giving a strong answer.

- Identifies 'creates' as the error
- States that energy is converted, not created, and came from the food
- Rewrite uses release or convert

4. Statement 4 (mass turns into energy and is lost for good).

Answer: (a) Jade was thinking that if the squirrel gets energy out of the sugar and the sugar is gone, the sugar's mass must have become the energy. (b) Atoms are conserved in chemical reactions. The sugar's six carbon atoms, twelve hydrogen atoms and six oxygen atoms are all still there after respiration, rearranged into six carbon dioxide and six water molecules; the squirrel breathes out the carbon dioxide and loses the water in breath and urine. The mass leaves the squirrel as matter, not as energy. (c) Rewrite: When sugar reacts with oxygen, all of its atoms end up in carbon dioxide and water, which leave the squirrel's body; the mass leaves as these products while the energy is released separately.

Why: This is the matter-energy confusion in its most common form. The rewrite must say where the mass went.

Also acceptable: A student who adds that the mass is 'lost from the squirrel but not from the world' has the conservation idea.

- Identifies that mass does not become energy
- States that the atoms leave as carbon dioxide and water
- Rewrite tracks the atoms to the products

5. Statement 5 (breathing is the same as cellular respiration).

Answer: (a) Jade was thinking that because breathing uses oxygen and gives off carbon dioxide, and cellular respiration does too, they must be the same thing; the shared word 'respiration' encourages this. (b) Breathing is the movement of air into and out of the lungs; it delivers oxygen to the blood and removes carbon dioxide. Cellular respiration is the chemical reaction inside cells, mostly in the mitochondria, that uses that oxygen to release energy from sugar. Plants and single-celled organisms carry out cellular respiration without breathing at all. (c) Rewrite: Breathing moves oxygen in and carbon dioxide out of an animal's body; cellular respiration is the reaction inside every living cell that uses the oxygen and makes the carbon dioxide.

Why: The rewrite must separate the transport of gases from the reaction.

Also acceptable: Accept 'breathing supplies what cellular respiration needs' as the relationship.

- Explains the shared-word confusion
- Distinguishes gas transport (breathing) from the cell reaction
- Rewrite keeps both ideas and relates them

6. Statement 7 (a plant's matter comes mostly from the soil).

Answer: (a) Jade was thinking that roots pull matter up from the soil the way a straw pulls up a drink, and that a plant grows by taking in soil. (b) Most of a plant's dry mass is carbon, hydrogen and oxygen; the carbon came in through the leaves as carbon dioxide gas, the hydrogen came in as water through the roots, and the oxygen came in with both. Soil supplies water and small amounts of minerals, but not the bulk of the plant's matter; a plant can grow large in a pot of soil whose mass barely changes. (c) Rewrite: A plant builds most of its body from carbon dioxide taken from the air and water, using sugar made by photosynthesis; the soil supplies water and small amounts of minerals.

Why: This repairs the textbook table's claim that producers get matter from 'air, water and soil' as if the three were equal. The pot-of-soil evidence is the classic argument.

Also acceptable: A student who cites the previous lesson's carbon dioxide uptake data is giving a strong answer.

- Identifies the straw-like idea
- States that most plant matter comes from carbon dioxide (and water)
- Rewrite gives soil its real, small role

Part C: Step back

7. Two of Jade's mistakes come from the same confusion: mixing up matter and energy. Which two statements are they, and what is the one rule that fixes both?

Answer: Statements 2 and 4. The rule: matter and energy are tracked separately. Atoms are rearranged but never created, destroyed, or turned into energy; energy is converted from one form to another but never created or destroyed. In respiration, the atoms leave as carbon dioxide and water while the energy is released from chemical energy into usable energy and heat.

Why: Both errors come from letting matter and energy trade places. Any statement of 'keep separate accounts' earns credit.

Also acceptable: Accept 'atoms are conserved and energy is conserved, and one never becomes the other.'

- Names statements 2 and 4
- States a rule that keeps matter and energy separate and conserved

8. Statements 3 and 6 are correct. For each one, write the one piece of evidence or reasoning from this chapter that supports it.

Answer: Statement 3: the proteins and other molecules in the acorn are digested into small pieces and rebuilt into the squirrel's own proteins, including muscle, so the acorn's atoms really do become part of the squirrel; atoms are conserved along the way. Statement 6: fat releases about 9 kcal per gram, more than twice as much as carbohydrate, which is why animals use it for long-term storage; fats are also part of the membranes that enclose cells.

Why: Students should support correct statements with a reason, not just a label. The energy-per-gram value comes from Worksheet 5; the membrane role comes from the lesson.

Also acceptable: For statement 3, accept 'the carbon in the acorn's molecules ends up in the squirrel's molecules.'

- Supports statement 3 with digestion and rebuilding of food molecules
- Supports statement 6 with the energy-per-gram comparison or the membrane role

Teacher notes

The five incorrect statements target the chapter's most common misconceptions: plants only photosynthesize (statement 1), energy is created (2), mass becomes energy (4), breathing equals cellular respiration (5), and plants grow from soil (7). Statement 7 corrects the textbook's Figure 2 table, which lists air, water and soil as if they were equal sources of a producer's matter. Statement 6 is deliberately correct even though it is simplified: cell membranes are built mainly from phospholipids, close relatives of fats; at this grade level 'fats are part of cell membranes' is acceptable. When grading Part B, the (c) rewrite is worth the most: a rewrite that only inserts 'not' (for example, 'plants do not only do photosynthesis') should be sent back for a specific version. The extension's best student statements usually involve 'the carbon in the potato becomes carbon in my muscle' (partly true; most leaves as carbon dioxide) or 'the energy in the potato came from the soil.'

Scaffold offered to students: Three tests for any statement about respiration

Run each of Jade's statements through these tests. Matter test: does the statement keep track of every atom, or does matter appear, disappear or turn into something that is not matter? Energy test: does the statement say energy is released or converted (good), or created or made (bad)? Who test: does the statement claim a process belongs to only one kind of organism? If a statement fails a test, that test tells you what to rewrite.

Extension: Write the eighth statement

Write a new statement that a careful student might get wrong about the carbon in a potato's starch after you eat it, then trade with a partner and diagnose each other's statement using the three tests in the scaffold. Your statement must be tempting: it should sound right at first, and the error should be about where atoms go or where energy goes, not a simple vocabulary slip.