Fuel for the Climb

How molecular structure affects stored energy

BIO.5.a "Construct an explanation of how the structural characteristics of carbohydrates and lipids store energy."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two structural features of carbohydrates and two of lipids. Circle a phrase for each type that connects its structure to energy storage or release.

Two Kinds of Fuel

1. Before a long climb, a hiker eats bread and carries a small packet of nuts. Both contain molecules that can eventually supply ATP, the cell's usable energy, but the molecules store energy in different structures. Bread starch is a carbohydrate made of many linked glucose units. Digestion breaks starch into glucose, which cells can use soon or connect into glycogen. Glycogen forms a highly branched chain. Enzymes can work at many branch ends at once, releasing glucose units quickly. Muscle cells keep glycogen nearby for demanding movement, when ATP must be replaced rapidly.

2. Nuts also contain triglycerides, a common kind of lipid. Each triglyceride joins one glycerol molecule to three fatty acid chains. These long chains contain many carbon-hydrogen bonds and relatively little oxygen. During cellular respiration, cells transfer electrons from fuel molecules toward oxygen; this process helps make ATP. Fatty acid chains have many energy-rich electrons available for transfer. Triglycerides are nonpolar, so they do not mix well with water and can be packed into droplets with little accompanying water. Per gram of stored material, this dry, concentrated reserve yields more energy than water-associated glycogen.

3. The hiker's body cannot treat the two reserves as interchangeable during every moment of the climb. Stored glycogen attracts water, so carrying large amounts adds mass, yet its branching allows fast access to glucose. Fat droplets avoid much of that water weight, making them useful for extended activity. However, breaking down fatty acids for ATP requires oxygen and generally cannot meet a sudden, intense demand as quickly as carbohydrate use can. In a steep scramble, muscle cells may rely more on glycogen. On a long, steady stretch, fat can contribute substantially to ATP production. Structure shapes both storage density and the rate of access.

2 ANSWER WITH EVIDENCE

Use the passage

1. How does the structure of starch let the hiker obtain usable fuel from bread?

2. How do fatty acid chains help a triglyceride supply energy to cells when oxygen is available?

3. Why can stored triglycerides provide more energy per gram of stored material than glycogen? Connect structure to storage.

4. Why might muscles rely more on glycogen than triglycerides during a sudden, steep scramble, even though triglycerides are more energy dense?

3 YOUR TURN

Your own words

Invent an animal and name one activity it does for a few seconds and another it does steadily for several hours. In 5 to 6 sentences, explain which energy reserve would better support each activity, linking at least two structural features to energy release or energy stored per gram, and include one limitation.

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PART 1 · READ AND MARK

Underline two structural features of carbohydrates and two of lipids. Circle a phrase for each type that connects its structure to energy storage or release. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How does the structure of starch let the hiker obtain usable fuel from bread?	**Starch is made of linked glucose units. Digestion breaks the links, releasing glucose that cells can use to make ATP.**
2	How do fatty acid chains help a triglyceride supply energy to cells when oxygen is available?	**Their many carbon-hydrogen bonds provide energy-rich electrons. Transferring those electrons toward oxygen during cellular respiration helps cells make ATP.**
3	Why can stored triglycerides provide more energy per gram of stored material than glycogen? Connect structure to storage.	**Triglycerides have long fatty acid chains that can supply many energy-rich electrons. Their nonpolar structure also lets them pack into droplets with little water, unlike water-associated glycogen.**
4	Why might muscles rely more on glycogen than triglycerides during a sudden, steep scramble, even though triglycerides are more energy dense?	**Enzymes can release glucose quickly from glycogen's many branch ends. Breaking down fatty acids requires oxygen and generally cannot meet a sudden, intense demand as quickly.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

My invented marsh runner sprints to escape predators but also swims steadily across wide ponds. Glycogen would help power its short sprint because enzymes can release glucose quickly from its many branch ends. For the long swim, stored triglycerides would provide a concentrated reserve. Their fatty acid chains contain many carbon-hydrogen bonds with electrons that can help cells make ATP. Because triglycerides are nonpolar, the runner can store them with little extra water weight. A limitation is that breaking down fatty acids requires oxygen and may not meet the sprint's sudden demand quickly enough.

Accept explanations that accurately connect molecular structure to energy release or storage density. Students may describe different invented animals and activities if their structural reasoning fits the activities.