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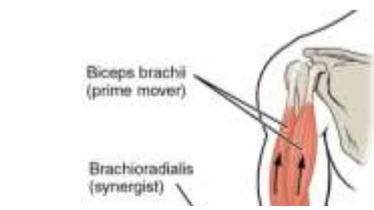
Glucose and Exercise: The special case of our muscles.

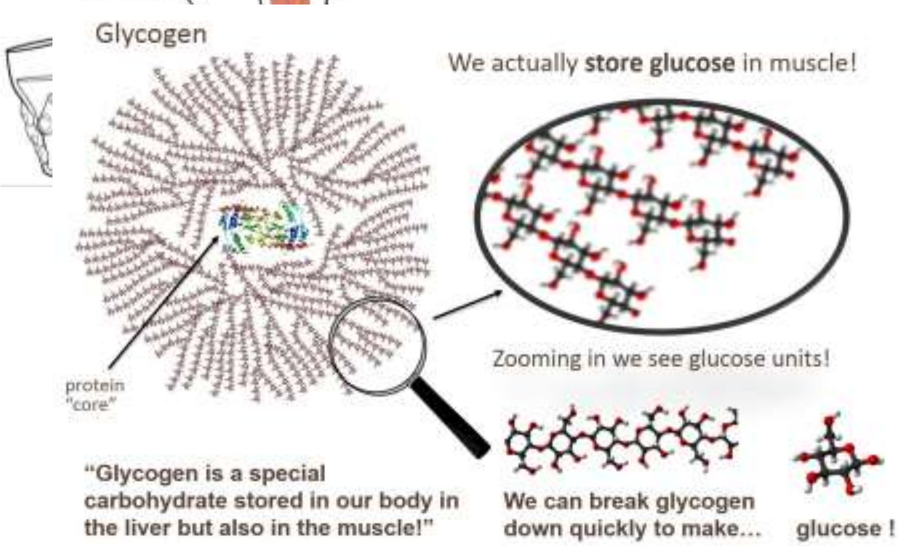
Just like a car needs fuel to move, your body needs fuel to move around and perform strenuous exercise. Your muscles typically use carbohydrates for this fuel because carbohydrates can be efficiently transformed into very large quantities of energy. This chemical reaction happens in nearly every cell of your body. A sugar called glucose, which is the building block of carbohydrates, circulates in your blood. Along with the oxygen in the blood, glucose is pulled into cells all over the body where the two react to release a lot of energy.

Inside our cells: $C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$ + ENERGY

But what happens when the glucose in our blood gets used up? We always need energy, but we're not always eating carbs! Well, it turns out we store a pretty big reserve of glucose linked together as a special carbohydrate called glycogen. Our bodies mostly store glycogen in the liver, and one of the liver's main jobs (along with a nearby organ called the pancreas) is to maintain our blood sugar. Glycogen's chemically branched structure can be broken down quickly, releasing glucose into the blood so it can be delivered to the rest of our cells.



Muscles, however, need ***a lot*** of energy—and right away! Even though the liver is able to release glucose into the blood very quickly, it's not fast enough for our muscles. So, our bodies have a little trick- we store glycogen right inside our muscles! When they need a quick dose of energy, the glycogen is right there and is broken down into glucose.



When you exercise, you've probaby noticed a number of ways your body responds. You sweat, your heart rate and breathing rate increase, and after exercise, you may be tired or even sore the next day. What do these responses have to do with the reaction that gives you energy? Quite a bit!

Increased heart rate increases your circulation rate. This means your blood is flowing faster to all of your cells. And because you are breathing faster, the blood is carrying not only glucose to those cells but also the other important reactant—oxygen! Oxygen is carried in your blood by an iron-containing protein called hemoglobin. Hemoglobin binds to oxygen, and the combination is what gives your blood its red color. (Hemoglobin without oxygen is more of a purple color.) When you exercise, your blood delivers as much oxygen as possible to all of your hard working muscle cells, including the cells of your heart (yes, it's a muscle!) which is pumping even harder than normal. There's a huge demand for oxygen and your breathing rate tries to keep the blood supplied with oxygen. However, the muscles have another trick to help the body out. Not only do muscles keep their own store of quick glucose in the form of glycogen, they also store a supply of oxygen! Your muscles actually contain a protein called myoglobin. As you might expect, myoglobin is an altered form of hemoglobin. Like

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hemoglobin, it contains iron, binds oxygen, and creates a red appearance. If you were able to see the muscle tissue inside your body, it would appear red for this reason. When your muscles get to work during exercise, the myoglobin proteins begin to release some of the oxygen where it can be used in the muscle cells nearby.

In summary, the equation (unbalanced) for the energy-producing "respiration" reaction in our cells is

1. $C_6H_{12}O_6$ (from the blood) + O_2 (from the blood) → CO_2 + H_2O + ENERGY

But your muscles have a second equation working for them! Same reaction, yes, but special reserves of each reactant allow more energy to be produced immediately inside of the muscle tissues—just where you need it the most!

2. **$C_6H_{12}O_6$** (from **glycogen** in your muscles) + **O_2** (from **myoglobin** in your muscles)
→ CO_2 + H_2O + ENERGY

In this way, our muscles have special reserves of the two reactants needed to generate a lot of energy in the body!

Questions:

1. What are the two primary places glycogen is stored in the body? Why is it stored in both places? Describe what each supply is for.

2. Why is muscle tissue red? What does this have to do with providing energy to the muscles?

3. Why do breathing and heart rate increase during exercise? Explain how these responses tie directly to the reaction that gives our cells energy.

4. Why might you sweat more during exercise? Does this have anything to do with the reaction in our cells? Or are there other reasons we sweat when we exercise? (Hint: Some of the energy we make using the reaction is given off as heat inside our cells. How does sweating help us to deal with that heat energy?)

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