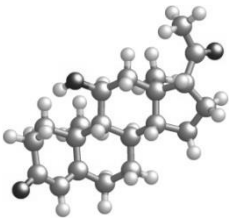

Chem!stry

Name: …… **( )**

Class: ……

Date: …… **/** …… **/** ……

From a Sandwich to a Scream

The Brief History of Energy

Traveller: Energy.
Origin: Your lunch.
Destination: Your cells.
Duration: Several hours.

A typical sandwich contains billions upon billions of buzzing electrons. The bonds they form hold together the sugars, carbohydrates, fats and proteins we call lunch. The energy in those bonds will eventually power your body, but it can do you no good locked in a sandwich. Luckily, electrons have you covered.

Our electron's journey begins with a bite. Attached to a starch molecule, it is pushed from your mouth to your stomach and then small intestine. Its starchy home is torn apart by enzymes from the pancreas, and now our intrepid electron is adrift on a molecule of glucose.

It crosses into the bloodstream, passing briefly through the liver, to join the rush of cells, chemicals and plasma that complete a circuit around the body roughly every minute. Before too long, it finds its way into a muscle cell.

The interior of a cell is far from safe. The electron's glucose raft is quickly cut into pieces by a ten-step chemical disassembly line. Hanging onto one of the pieces, our electron is now headed for the cell's power plant: the mitochondrion. This is where the electron's energy truly comes into its own. Inside, it will enter the final stage of its journey: a series of reactions known as the electron transport chain.

Like a boulder perched at the top of a hill, with a bit of a nudge, the electron tumbles from higher energy states to lower, releasing energy along the way. Enzymes manage the fall, stair-stepping the electron to ever-lower states.

Energy released at each step is used to drive a pump. Protons are pushed, one-by-one, across a membrane in the mitochondrion and pile-up on the far side. Like fans desperate to get inside a stadium, the protons have a single drive – to get back through the membrane. As they push through molecular turnstiles, the energy they release glues a phosphate to an ADP molecule:

adenosine diphosphate is turned into adenosine triphosphate. You may have heard of it as ATP. This is the cells ultimate source of energy.

By the time the electron has bumped its way down to the end of the chain, some 32 ATP molecules have been made. Drained, our electron joins forces with a leftover proton, and two of these hitch themselves onto an oxygen atom to form water. Flushed out of the cell, the water molecule makes its way to your lungs and moistens your breath.

But the electron's energy lives on, in the form of the ATP. When, a few hours after lunch, you stub your toe on a table, it helps activate a muscle cell contracting the diaphragm. This expels carbon dioxide and our cell's water molecule out of your lungs. The molecule shoots past your voice box and out into the world as a cry of pain.

MacGregor Campbell, From a Sandwich to a Scream, *New Scientist*, 14th November 2015, page 31.