Transcript
11-114-Glycolysis

A few introductory words of explanation about this transcript.

This transcript includes the words sent to the narrator for inclusion in the latest version of the associated video. Occasionally, the narrator changes a few words on the fly in order to improve the flow. It is written in a manner that suggests to the narrator where emphasis and pauses might go, so it is not intended to be grammatically correct.

The Scene numbers are left in this transcript although they are not necessarily observable by watching the video.

There will also be occasional passages in blue that are NOT in the video but that might be useful corollary information.

There may be occasional figures that suggest what might be on the screen at that time.

Much of this material comes from a treatise put together by David S. Goodsell in the February, 2004 "Molecule of the Month" feature at the Protein Data Bank…

http://www.pdb.org/pdb/static.do?p=education_discussion/molecule_of_the_month/pdb50_1.html

All of the enzyme molecules were obtained from that site and processed in various ways. The product molecules were scrounged from various small molecule libraries and processed as well for this video.

105 Intro

Glucose is a good fuel molecule because it is stable and soluble, so it is easily transported through the bloodstream to places where it is needed. And it is packed with chemical energy.

Burning glucose in test tube, forms carbon dioxide, water and energy in the form of light and heat. Our cells also burn glucose, but they do it in many small, well-controlled steps, so that they can capture the energy in more useable forms, such as ATP.

Enzymes are molecules that increase the rate of bio-chemical processes, and almost all enzymes are proteins. Today we will look at the ten enzymes that make possible the ten steps in the breakdown of sugar – the process is called glycolysis.

110 Step One

This molecule is Hexokinase. A kinase is an enzyme that attaches a phosphate group to another molecule. The enzyme isn't changed by the reaction, it is just the agent of change.

Hexokinase captures a glucose molecule in its active site and holds it in just the right orientation – like a robot arm might do on an automobile assembly line. It then takes the last phosphate group from an ATP molecule and attaches it to the glucose.

Glucose and ATP go in and glucose-6-phosphate and ADP come out.

120 Step Two

This enzyme is PhosphoGlucose Isomerase and it's job is to change the shape of the molecule we just made. It takes the glucose-6-phosphate and shuffles a few atoms and makes fructose-6-phosphate.

130 Step Three

This is the step three enzyme -- PhosphoFructoKinase It captures the molecule we just made as well as another ATP molecule. Then it transfers a phosphate group from the ATP to the fructose6,phosphate…producing fuctose1,6,biphosphate and another ADP molecule.

140 Step Four

At this stage, the sugar molecule is primed and the cell is ready to start breaking it up. This molecule is Fructose 1, 6-bisphosphate Aldolase and it cuts the molecule in the middle, producing two similar pieces, each with a single phosphate attached. This enzyme has multiple sub-units.

150 Step Five

Now while the two halves of the sugar are very similar, they are not identical. This molecule – Triose Phosphate Isomerase – will change the shape of one of the pieces to be identical with the other, and we end up with two molecules of Glyceraldehyde 3-phosphate.

160 Step Six

Glyceraldehyde-3-Phosphate Dehydrogenase is another enzyme with multiple subunits. It will add one more phosphate to each Glyceraldehyde Phosphate

170 Step Seven

Now at step seven, we are ready to make some ATP. The glucose has been split into halves, each of which now has two phosphates attached. Phosphoglycerate

kinase takes each of these molecules and transfers one of each of their phosphates to a pair of ADP molecules, creating two new ATP molecules.

180 Step Eight

The last three steps of glycolysis will remove the remaining phosphates from the two pieces, and use them to make two more molecules of ATP. Phosphoglycerate mutase begins this final capture of energy by shifting the phosphate from the end of the molecule to a strategic place in the center.

190 Step Nine

In the ninth step of glycolysis, the cell places the phosphate in an uncomfortable position, making it easy to remove to form ATP. The enzyme enolase removes a water molecule, forming a new double bond in an awkward place in the carbon skeleton of the molecule. This enzyme contains two identical active sites.

200 Step Ten

In the last step of glycolysis, the cell is finally ready to make a net gain in ATP production. Pyruvate kinase removes the remaining phosphates and places them on ADP, to create new ATP molecules. This allows the unstable little sugar fragments to rearrange into stable pyruvate molecules. These pyruvates leave glycolysis and are subsequently burned up completely into carbon dioxide and water, or converted into throw-away molecules like alcohol or lactic acid.

210 Pass In Revue

Here is a visual revue of the ten enzymes and the intermediate molecules they produce.