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FOOD ENERGY AND THE CELL

1. The Origin of Food Energy:

Photosynthesis

Light energy is captured by the chlorophyll in the chloroplasts of plants, and used to fix the carbon dioxide in the air into glucose.

$$6CO_2 + 12\,H_2O + \textbf{LIGHT ENERGY} \xrightarrow{\text{chlorophyll}} C_6H_{12}O_6 + 6\,O_2 + 6\,H_2O$$

(p. 40, Fig. 2.14) Leaf Structure and Photosynthesis

2. Metabolism and the Release of Food Energy in the Cell:

a. Adenosine Triphosphate (ATP)

The chemical energy trapped inside the molecule of glucose is transformed into another kind of useable energy stored in "power packet" molecules called ATP.

b. Metabolism (Respiration)

An elaborate process of chemical reactions in an organism that use primarily oxygen and enzymes to break down glucose (and other macromolecules).

The result of this is the production of ATP "power packet" molecules of energy that are used by the cell for life processes:

$$C_6H_{12}O_6 + 6\,O_2 + 6\,H_2O \xrightarrow{\text{enzymes}} 6CO_2 + 12\,H_2O + \textbf{USABLE ENERGY (38 ATP)}$$

The chemical reactions involved in the breakdown of the glucose molecule take place in two areas of the cell (p. 41, Fig. 2.15).

c. Glycolysis

The process whereby a glucose molecule (with 6 carbons) is split into 2 smaller molecules (3 carbons each) called pyruvic acid.

This process: i) takes place in the cytoplasm of the cell
ii) requires no oxygen (anaerobic)
iii) makes only 2 ATP "power packet" molecules (out of a potential 38)

d. Cellular Respiration

The series of chemical reactions that continue to break down pyruvic acid molecules to make more energy.

This process: i) takes place in the mitochondria of cells
ii) requires oxygen (aerobic)
iii) makes 36 ATP "power packet" molecules

In this process: i) CO_2 is released
ii) hydrogen atoms combine with oxygen atoms to make water

3. Fermentation and Oxygen Debt

During strenuous activity, the circulatory system cannot supply enough oxygen to keep cellular respiration going fast enough to meet the new energy demands.

When this happens, two temporary chemical processes come into play:

i) Creatine Phosphate is used to make more ATP
ii) Anaerobic Respiration (lactic acid fermentation) -- Pyruvic acid breaks down into lactic acid instead of going into cellular respiration -- when this happens a short supply of ATP are made, while lactic acid builds up in the cell.

Eventually, as oxygen is absorbed into the cell, normal cellular respiration resumes.

4. Alcoholic Fermentation

Anaerobic metabolism (respiration) of glucose for simple organisms such as yeast and bacteria.

Pyruvic acid is broken down into alcohol and CO_2:

$$\textbf{GLUCOSE} \xrightarrow{\text{enzymes}} \textbf{ethyl acohol + carbon dioxide + energy (2 ATP)}$$

Fermentation of food materials is responsible for: making vinegar, alcoholic beverages, alcohol fuels, and also spoiling some food materials (i.e. when foods and vegetables rot)