Aerobic and Anaerobic Energy Systems.

ADDITIONAL INFORMATION OF INTEREST FOR STUDENTS STUDYING FOR THE IDTA DANCE EXERCISE DIPLOMA

Glossary

Mitochondria = Specialised structure within a cell containing enzymes needed for the metabolic process.

Sarcoplasm = an interfibrillar substance of muscles.

Troponin = A complex of 3 proteins that are necessary for skeletal and cardiac muscle contraction.

ATP - Adenosine Triphosphate.

ATPase - molecules that run in reverse to synthesise ATP

PC - Phosphocreatine

P - Phosphate

ADP - Adenosine Diphosphate

C - Creatine (only 120g in the whole body)

NAD+ - Nicotinamide Adenine Dinucleotide = a coenzyme present in most living cells and derived from the B vitamin nicotinic acid; serves as a reductant in various metabolic processes.

FAD – Flavin Adenine Dinucleotide = Perhaps one of the most versatile of all the redox coenzymes. Flavins are usually stronger oxidising agents than NAD+

Redox reaction = A chemical change where one reactant is reduced and the other is oxidized. The reaction can only happen if both reactants are present and each changes simultaneously.

Aerobic Energy Systems in the 3 phases

1. Glycolysis – The breaking down of Carbohydrate into Pyruvic acid, which produces 2 ATP molecules. 10 chemical reactions take place within the body to convert Carbohydrates into Pyruvic acid.

2. Krebs Cycle – Known by two names the Citric Acid Cycle or the Tricarboxylic Acid Cycle and is responsible for the second phase of aerobic metabolism. Pyruvic acid produced during Glycolysis enters the mitochondria and is immediately changed into Acetyl Coenzyme A, this combines with Oxaloacetic acid to make a 6 compound carbon named Citric acid.

More chemical reactions occur within the muscles to create enough energy to re-synthesise 2 ATP molecules. Bi products of these reactions include Hydrogen (H) transported to the Electron Cycle Chain by the carrier molecules NAD+, FAD and Carbon Dioxide, which is exhaled by the lungs.

3. Electron Transport Chain – The hydrogen is taken into the inner membranes of the Mitochondria, here it is split into proton (H+) and an electron (H-). Then a series of redox reactions take place that release huge amounts of energy to resynthesise ATP.
As a result of the redox reactions the protons create energy by moving back through the inner membrane of the Mitochondria. This causes an imbalance of H+ so they go back through the membrane and create energy. The last exothermic reaction is the combining of the Hydrogen with Oxygen to form water. The overall ATP production during all the reactions of the ETC is 34 molecules of ATP, this being so, it is the highest producing phase of aerobic metabolism.

Anaerobic Energy Systems.

1. ATP-PC System = ATP = Adenosine Triphosphate a high-energy molecule made up of Carbon, Hydrogen, Oxygen and Nitrogen. PC = Phosphocreatine another high-energy molecule found in the sarcoplasm of muscle fibres.

When energy is needed the body breaks down the Adenosine Triphosphate using an enzyme called ATPase into ADP (Adenosine Diphosphate) This in turn breaks down the Phosphate (P) and so provides energy. To resynthesise ATP the body will reverse the above process, it should be noted that it takes less energy to resynthesise ATP than it does to break it down. Breaking down ATP increases the volume of ADP, which triggers the release of an enzyme known as Creatine Kinase, this will start the breakdown of PC into phosphate and Creatine; this being an exothermic reaction it gives the energy needed to resynthesise ATP at a fast rate.

2. Lactic Acid System. This system is also known as Anaerobic Glycolysis because the initial process is the same as Aerobic Glycolysis only without oxygen. Exactly the same 10 chemical reactions take place within the sarcoplasm (the high energy substance found within the muscle fibres) and turn the Carbohydrate into Pyruvic acid plus 2 molecules of ATP. This time the action being without oxygen the carrier molecule NAD+ cannot off load the Hydrogen (H+) this being a bi product of Glycolysis and causes a build up of H+ in the cells.

To try to break down the increase in acidity the Pyruvic acid accepts the H+ and forms Lactic Acid. If oxygen were present the H+ would be moved to the Mitochondria for use in the Krebs Cycle (the Citric acid/Tricarboxylic acid cycle) part of the second phase of the Aerobic metabolic cycle. It is thought that Lactic acid interferes with muscle contraction and disrupts the joining of Calcium to the Troponin. The acid will also irritate free nerve endings within the muscle and cause pain.

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