Lecture 18

Bioenergetics and Glycolysis

1. Why living system cannot be at equilibrium?

Answer: Living organisms are open systems and therefore can never be at equilibrium.

2. Discuss "How living things maintain the steady state".

Answer: Living things maintain steady state by energy input in form of nutrients, which is broken down during catabolism generating the required energy. The same energy is used to maintain their highly organized structures, in synthesising cellular components and many other such processes.

3. Discuss the How living things maintain the steady state. How anabolisms depend on catabolism?

Answer: Catabolism is the dergadative phase of nutrient metabolism in which organic nutrient molecules(carbohydrates, fats and proteins) are broken down into smaller, simpler end products(CO_2, NH_3 etc) it also releases energy in form of ATP and as reduced electron carriers; the rest is lost as heat.

In anabolism biosynthesis takes place i.e small simple precursors are built up into larger and more complex molecules (lipids, polysaccharides, proteins and nucleic acids). The supply of energy and precursors required for metabolism is provided by catabolism

4. During glycolysis how many molecules of ATP are generated? Discuss with proper calculations?

Answer: During glycolysis i.e conversion of 1 glucose molecule into 2 molecules of pyruvate, 8 molecules of ATP are generated.

The energetics of the glycolysis can be represented in form of an equation:

$$\text{Glucose} + 2\text{ATP} + 2\text{NAD}^+ + 4\text{ADP} + 2\text{P}_i \longrightarrow$$
$$2 \text{ pyruvate} + 2\text{ADP} + 2\text{NADH} + 2\text{H}^+ + 4\text{ATP} + 2\text{H}_2\text{O}$$

The left hand side shows all the inputs and right hand side shows the output. Cancelling the common terms from both the sides gives the overall equation for glycolysis:

$$\text{Glucose} + 2\text{NAD}^+ + 2\text{ADP} + 2\text{P}_i \longrightarrow$$
$$2 \text{ pyruvate} + 2\text{NADH} + 2\text{H}^+ + 2\text{ATP} + 2\text{H}_2\text{O}$$

Thus, the total ATP generated= 2 NADH + 2 ATP = (2 x 3) + (2x1) = 8 ATP

5. What is substrate level phosphorylation?

Answer: Glycolysis is regulated at the following steps:

- Conversion of glucose to fructose-6- phosphate – the enzyme hexokinase is regulated by the level of glucose. High glucose level activates the enzyme and low glucose level inhibits the enzyme. Glucose-6-phosphate is also found to allosterically inhibit the enzyme activity.
- Conversion of fructose- 6- phosphate into fructose-1,6- bisphosphate – high level of ATP and citrate inhibit Fructose-1,6- bisphosphate kinase 1 enzyme.

  Apart from this fructose-2,6- bisphosphate is also found to allosterically regulate the enzymes activity.

- Conversion of phosphenolpyruvate to pyruvate kinase- the enzyme pyruvate kinase involved in this reaction is allosterically inhibited by ATP. High concentration of ATP,acetyl coA, long chain fatty acids inhibit pyruvate kinase.