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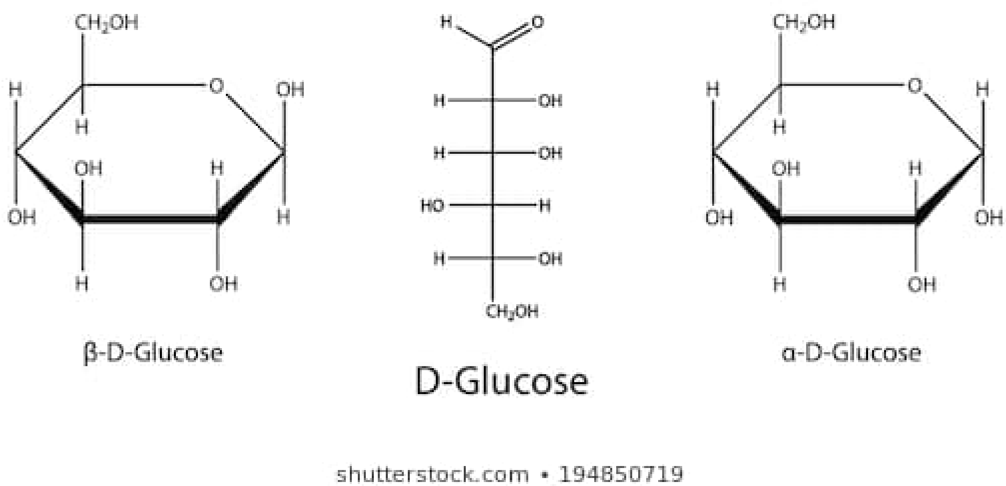
GLYCOLYSIS

(Embden-Meyerhof Parnas Pathway)

Definition : Glycolysis is the process in which glucose is converted into pyruvate (aerobic) or lactate (anaerobic) with simultaneous production of energy

Introduction:



Glycolysis converts glucose ($C_6H_{12}O_6$) molecules to two molecules of pyruvic acid ($C_3H_4O_3$). Pyruvic acid is more oxidized than glucose.

*The energy released from the oxidation is used to create 2 molecules of ATP from 2 ADP and 2 Pi this is an **anaerobic** process. Under anaerobic conditions the pyruvic acid can be **fermented** to lactic acid or to ethanol plus CO_2. Under **aerobic** conditions, glucose is oxidized all the way to carbondioxide and water.*

Glucose can also be synthesized from molecules such as pyruvic acid or lactic acid. This process is called **gluconeogenesis**

In mammals, glucose is the preferred fuel source for the brain and the only fuel source for red blood cells.Almost all organisms use glucose

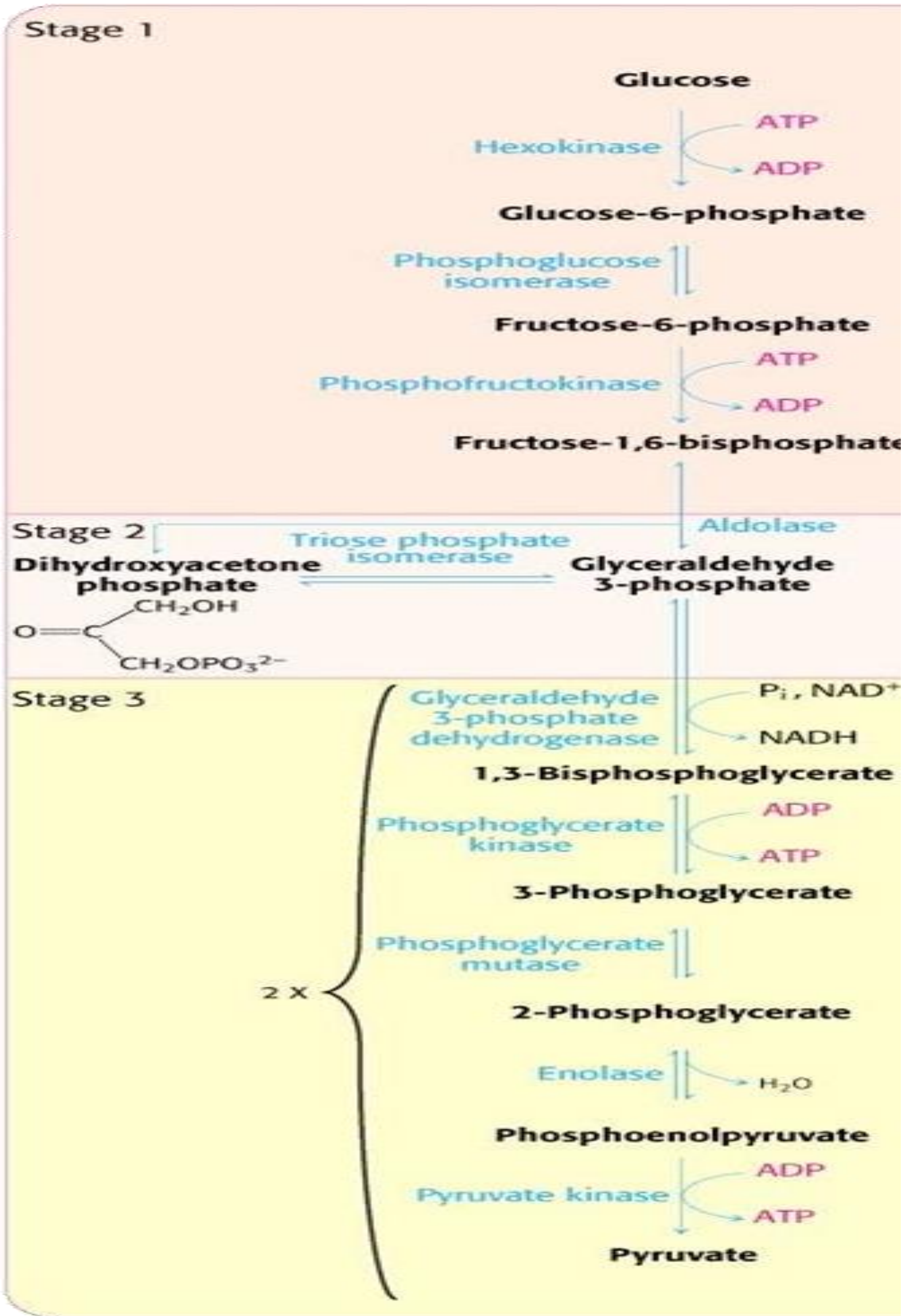
Significance

Glucose is an important fuel for most organisms.

- It takes place in cytoplasm of all cells
- Essentially all cells carry out glycolysis
- Brain and red blood cells are mostly dependent on glycolysis
- Only pathway taking place in all cells of the body
- Only source of energy for erythrocytes
- Anaerobic glycolysis forms the major source of energy for muscles
- Glycolysis is the preliminary step before complete oxidation
- It provides carbon skeleton for the synthesis of essential amino acids and glycerol part of fat
- Most of the reactions are reversible and used in gluconeogenesis

TABLE 16.3 Reactions of glycolysis

Step	Reaction	Enzyme	Reaction type
1	Glucose + ATP $\longrightarrow$ glucose 6-phosphate + ADP + H^+	Hexokinase	Phosphoryl transfer
2	Glucose 6-phosphate $\rightleftharpoons$ fructose 6-phosphate	Phosphoglucose isomerase	Isomerization
3	Fructose 6-phosphate + ATP $\longrightarrow$ fructose 1,6-bisphosphate + ADP + H^+	Phosphofructokinase	Phosphoryl transfer
4	Fructose 1,6-bisphosphate $\rightleftharpoons$ dihydroxyacetonephosphate + glyceraldehyde 3-phosphate	Aldolase	Aldol cleavage
5	Dihydroxyacetone phosphate $\rightleftharpoons$ glyceraldehyde 3-phosphate	Triose phosphate isomerase	Isomerization
6	Glyceraldehyde 3-phosphate + P_i + NAD^+ $\rightleftharpoons$ 1,3-bisphosphoglycerate + NADH + H^+	Glyceraldehyde 3-phosphate dehydrogenase	Phosphorylation coupled to oxidation
7	1,3-Bisphosphoglycerate + ADP $\rightleftharpoons$ 3-phosphoglycerate + ATP	Phosphoglycerate kinase	Phosphoryl transfer
8	3-Phosphoglycerate $\rightleftharpoons$ 2-phosphoglycerate	Phosphoglycerate mutase	Phosphoryl shift
9	2-Phosphoglycerate $\rightleftharpoons$ phosphoenolpyruvate + H_2O	Enolase	Dehydration
10	Phosphoenolpyruvate + ADP + H^+ $\longrightarrow$ pyruvate + ATP	Pyruvate kinase	Phosphoryl transfer


Stage 1
Glucose
Hexokinase
ATP
ADP
Glucose-6-phosphate
Phosphoglucose isomerase
Fructose-6-phosphate
Phosphofructokinase
ATP
ADP
Fructose-1,6-bisphosphate
Aldolase
Stage 2
Triose phosphate isomerase
Dihydroxyacetone phosphate
Glyceraldehyde 3-phosphate
CH2OH
CH2OPO3 2−
Stage 3
Glyceraldehyde 3-phosphate dehydrogenase
Pi, NAD+
NADH
1,3-Bisphosphoglycerate
Phosphoglycerate kinase
ADP
ATP
3-Phosphoglycerate
Phosphoglycerate mutase
2 X
2-Phosphoglycerate
Enolase
H2O
Phosphoenolpyruvate
Pyruvate kinase
ADP
ATP
Pyruvate

Energetics for aerobic glycolysis

- Glyceraldehyde-3-phosphate dehydrogenase – NADH - 2.5x2 =5 ATP
- 1,3 bis phospho glycerate

    kinase – ATP- 1x2 =2 ATP

- Pyruvate kinase - ATP - 1x2 =2 ATP

    Total 9 -2 = 7 ATP

- 7 ATP in aerobic glycolysis

Regulation of Glycolysis (Rate limiting)

- Hexokinase- high affinity for glucose will act even atlow glucose concentrations. So brain and RBCs get necessary energy.
- Phosphofuctokinase
- Pyruvate kinase – when energy is in plenty in the cell, glycolysis is inhibited. Insulin favours glycolysis and glucagon inhibits glycolysis