TRINITY COLLEGE FOR WOMEN NAMAKKAL

DEPARTMENT OF NUTRITION AND DIETETICS (UG)

NUTRITIONAL BIOCHEMISTRY

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Presented by

Mrs. R. Rupa

HOD/ASSISTANT PROFESSOR

DEPARTMENT OF N&D

http://www.trinitycollegenkl.edu.in/

Glycolysis

INTRODUCTION

- Glycolysis comes from a merger of two words : Glykys – Sweet Lysis – Breakdown / Splitting.

- It is also known as Emden Meyerhof Parnas Pathway or EMP Pathway.

- Glycolysis is the sequence of 10 enzyme catalyzed reaction that converts glucose into pyruvate with simultaneous production of ATP.

- The major pathway of glucose metabolism occurs in the cytosine of the cell.

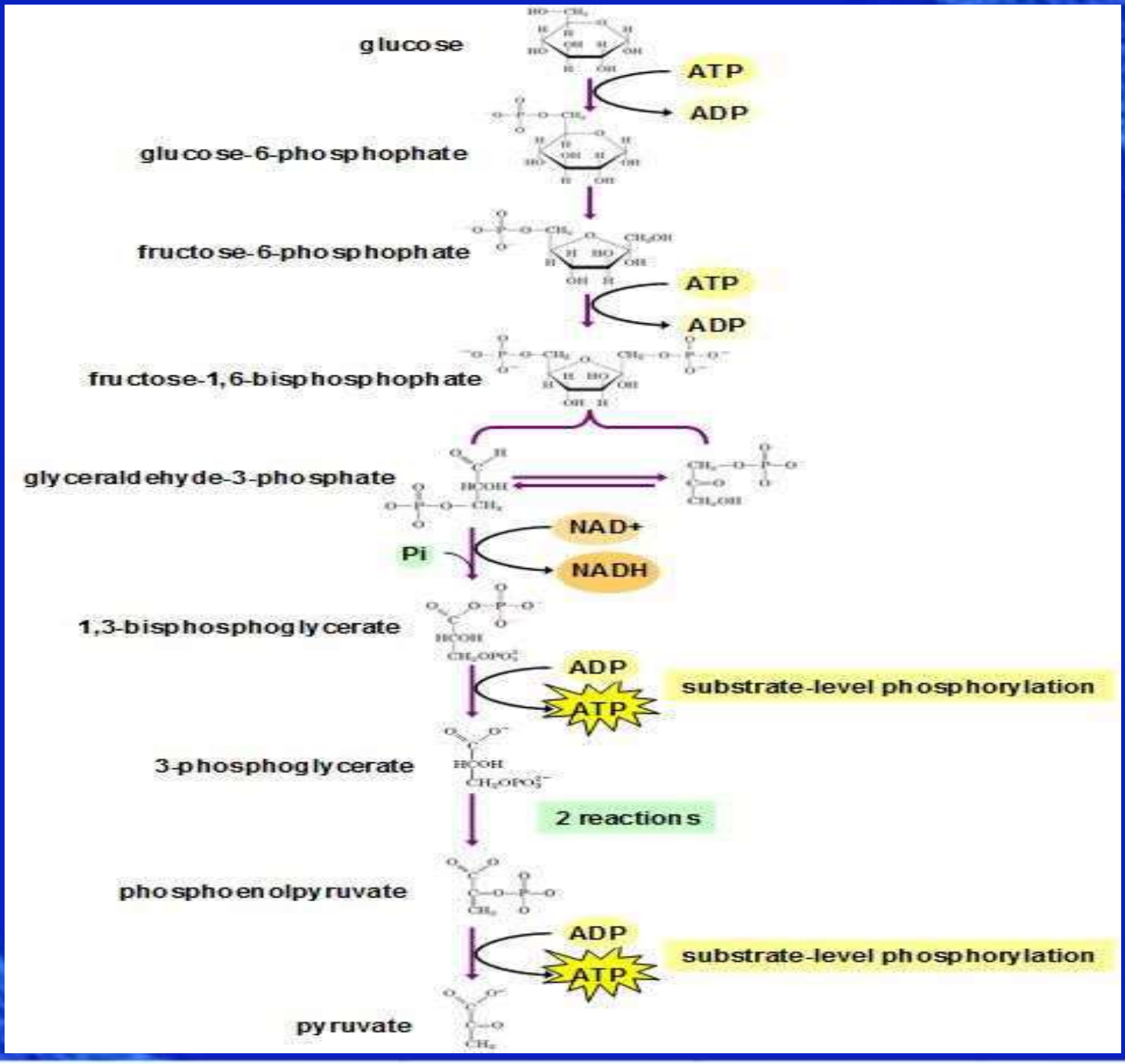
- This unique pathway occurs aerobically as well as aerobically & doesn't involve molecular oxygen

- In this oxidative process, 1 Molly of glucose is partially oxidised to 2 moles of pyruvate. It also includes formation of Lactate from Pyruvate.

- In aerobic organisms, glycolysis is the prelude to Citric acid cycle and ETC.

- The glycolytic sequence of reactions differ from species to species only in the mechanism of its regulation & in the subsequent metabolic fate of the pyruvate formed.

- Glycolysis is the central Pathway for Glucose catabolism.


glucose
ATP
ADP
glucose-6-phosphophate
fructose-6-phosphophate
ATP
ADP
fructose-1,6-bisphosphophate
glyceraldehyde-3-phosphate
NAD+
Pi
NADH
1,3-bisphosphoglycerate
ADP
ATP
substrate-level phosphorylation
3-phosphoglycerate
2 reactions
phosphoenolpyruvate
ADP
ATP
substrate-level phosphorylation
pyruvate

Two Phases Of Glycolysis

Gycolysis leads to breakdown of 6-C glucose into two molecules of 3-C private with the enzyme catalyzed reactions being categorized into 2 phases:

- ✓ Phase 1 – Preparatory phase
- ✓ Phase 2 – Payoff phase

Preparatory Phase

✓It consist of the 1st 5 steps of glycolysis in which the glucose is enzymatically phosphorylayed by ATP to yield Fructose-1, 6biphosphate.

✓This fructose -1,6-biphosphate is then split in half to yield 2 molecules of 3-carbon containing Gyceraldehyde-3-phosphate /dihyroxyacetone phosphate.

✓Thus the first phase results in cleavage of the hexose chain .

✓This cleavage requires an investment of 2 ATP molecules to activate the glucose mole and prepare it for it's cleavage into 3-carbon compound.

Payoff Phase

✓This phase constitutes the last 5 reactions of Gycolysis.

✓ This phase marks the release of ATP molecules during conversation of Gyceraldehyde-3- phosphate to 2 moles of Pyruvate.

✓Here 4 moles of ADP are phosphorylated to ATP. Although 4 moles of ATP are formed, the net result is only 2 moles of ATP per mole of Glucose oxidized, since 2 moles of ATP are utilized in Phase 1.

Stepwise explanation Glycolysis

Step 1: Phosphorylation

Glucose is phosphorylated by ATP to form sugar phosphate.

This is an irreversible reactions & is catalyzed by hexokinase.

Step 2: Isomerization

It is a reversible rearrangement of chemical structure of carbon oxygen from C1 to C2, forming a ketose from the Aldose.

Thus, isomerization of the aldose Glucose 6-phosphate gives the ketose, Fructose-6- phosphate.

Step 3: Phosphorylation

Here the Fructose-6-phosphate is phosphorylated by ATP to fructose -1,6- bisphosphate.

This is an irreversible reaction and is catalyzed by phosphofructose enzyme.

Step 4: Breakdown

This six carbon sugar is cleaved to produce two 3-C molecules: glyceraldehyde-3- phosphate(GAP)&dihydroxyacetone phosphate(DHAP).

This reaction is catalyzed by Aldose.

Step 5: Isomerization

Dihydroxyacetone phosphate is oxidized to form Glyceraldehyde-3-phosphate.

This reaction is catalyzed by triosephosphate isomerase enzyme.

Step 6 :

2 molecules of Gyceraldehyde-3-phosphate are oxidized.

Glyceraldehyde-3-phosphate dehydrongenase catalyzed the conversion of Gluceraldehyde3-phosphate into 1,3-bisphosphoglycerate.

Step 7:

The transfer of high energy phosphate group that was generated earlier to ADP, from ATP.

This phosphorylation i.e.addition of phosphate to ADP to give ATP is termed as substrate level phosphorylation as the phosphate donor is the substrate 1,3-bisphosphate(1,3-BPG).

 The product of this reaction is 2 molecules of 3-phosphoglycerate.

Step 8 :

The remaining phosphate-ester linkage in 3-phosphoglycerate, is moved from carbon 3 to carbon 2,because of relatively low free energy of hydrolysis, to form 2 – phosphoglycerate(2- PG).

Step 9: Dehydration of 2-PG

This is the second reaction in glycolysis where a high-energy phosphate compound is formed.

The 2-phosphoglycerate is dehydrated by the action of employees to phosphoenolpyruvate (PEP) .

This compound is the phosphate Ester of the employees tautomer pyruvate.

This is a reversible reaction.

Step 10 : Transfer Of phosphate from PEP to ADP

This last step is the irreversible transfer of high energy phosphoryl group from phosphoenolpyruvate to ADP.

This reaction is catalyzed by pyruvate kinase.
This is the 2nd substrate level phosphorylation reaction in glycolysis which yields ATP.

This is a non-oxidative phosphorylation reaction.

Energy yield in glycolysis:

- **ENERGY YIELD IN GLYCOLYSIS:**

STEP NO.	REACTION	CONSUMPTION of ATP	GAIN of ATP
1	Glucose → glucose-6-phosphate	1	-
3	Fructose-6-phosphate → fructose-1,6-biphosphate	1	-
7	1,3-diphosphoglycerate → 3-phosphoglycerate	-	1x2=2
10	Phosphoenolpyruvate → pyruvate	-	1x2=2
		2	4
		Net gain of ATP=4-2=2	

Thank you

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