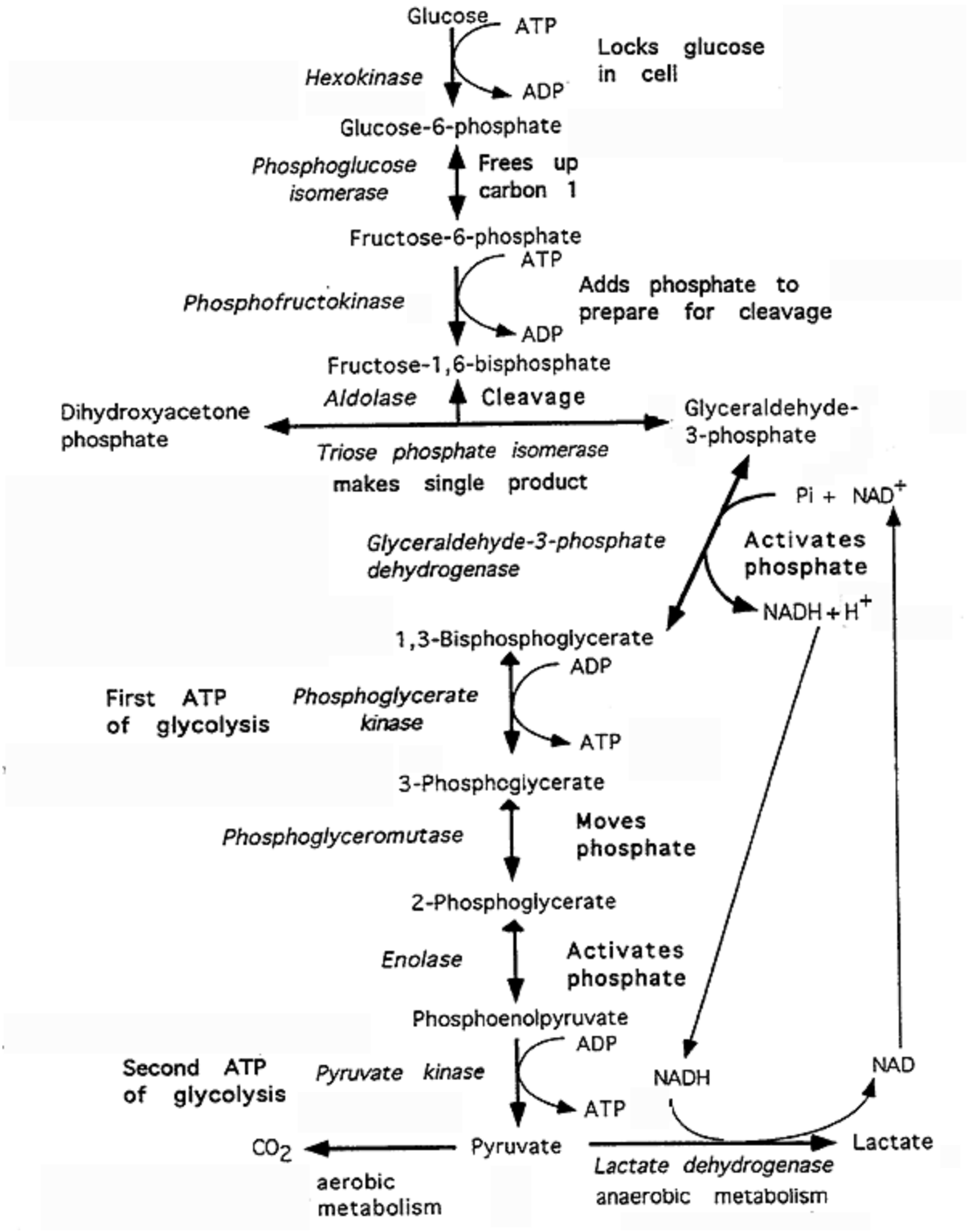
The Glycolysis Pathway:



Dehydrogenase (DH): "oxidation-reduction" reactions, look for NADH or $FADH_2$

Kinase: "Substrate Level Phosphorylation"

Overall Pathway:

Glucose is metabolized to pyruvate.

All intermediates carry phosphate groups to lock them into the cell (stops diffusion).

Hexokinase / Glucokinase: both **irreversible**

Glucose + ATP ----> Glucose-6-phosphate + ADP

Hexokinase:

Catalyzes the phosphorylation of hexoses in general and is found in **all cells** that metabolize glucose.

Has a **low Km** (**high affinity**) so that it is active even at low glucose concentrations.

Glucokinase:

Glucose specific, found in **liver**.

Has a **high Km** (**low affinity**) to ensure a n appropriate response to elevation of glucose from the diet.

Phosphofructokinase-1 (**PFK-1**): **irreversible**

Fructose-6-phosphate + ATP ------> Fructose-1,6-bisphosphate + ADP

Rate-Limiting, Major Regulated Step.

Aldolase:

Fructose-1,6-bisphosphate <----> Dihydroxyacetone phosphate +Glycerladehyde-3-phosphate

Completes the first phase of glycolysis.

These trioses are interconverted by triose phosphate isomerase ---------->

To produce a **single product**, **glyceraldehyde-3-phosphate**.

Two molecules of glyceraldehyde-3-phosphate **continue through glycolysis**.

Glyceraldehyde-3-phosphate Dehydrogenase: ***Oxidation-Reduction***

Glyceraldehyde-3-phosphate + NAD^+ + P_i <---> 1,3-Bisphosphoglycerate + NADH

NADH formed must be **reoxidized** to **regenerate NAD^+ to sustain glycolysis**.

Energy released from this reaction is conserved as a **high energy phosphate bond** in **1,3-bisphosphoglycerate**.

Inorganic phosphate, rather than ATP, provides the **source** of the **phosphoryl group**.

Aerobic Conditions:

Mitochondrial systems oxidize NADH and produce ATP.

Phosphoglycerate Kinase: "***Substrate Level Phosphorylation***"

1,3-bisphosphoglycerate + ADP <----> 3-phosphoglycerate + ATP

1,3-Bisphosphoglycerate is a **high energy intermediate** that drives the phosphorylation of **ADP to ATP**.

Remember: Two molecules are proceeding through glycolysis, so **2 ATP**.

Pyruvate Kinase: "***Substrate Level Phosphorylation***"

Phosphoenolpyruvate + ADP -------> Pyruvate + ATP

Irreversible, Highly Regulated.

Produce 2 ATP.

Lactate Dehydrogenase: "***Anaerobic***"

Pyruvate + NADH ----> Lactate + NAD^+

This step **regenerates NAD^+** for glyceraldehyde-3-phosphate dehydrogenase or **glycolysis would STOP**.

H_4: heart isozyme, **high affinity** for lactate (**low Km**), **allosterically inhibited** by **pyruvate**.

When **pyruvate** is **high** oxidizes to **Acetyl CoA**.

M_4: muscle isozyme, **produces lactate** in muscle when **pyruvate is high**.

Energy Yield:

Anaerobic (i.e. RBC): Pyruvate ---> Lactate, **2 ATP per glucose molecule**.

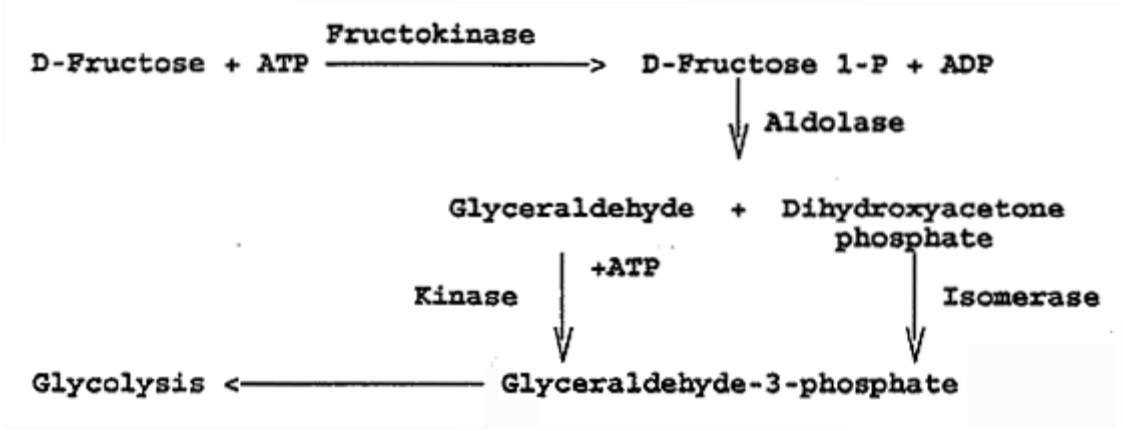
Aerobic: Mitochondrial oxidation of NADH via electron transfer ***shuttles***.

NADH ----> 2 ATP, a-glycerol phosphate shuttle (**4 ATP per glucose**)

NADH ----> 3 ATP, malate-aspartate shuttle (**6 ATP per glucose**)

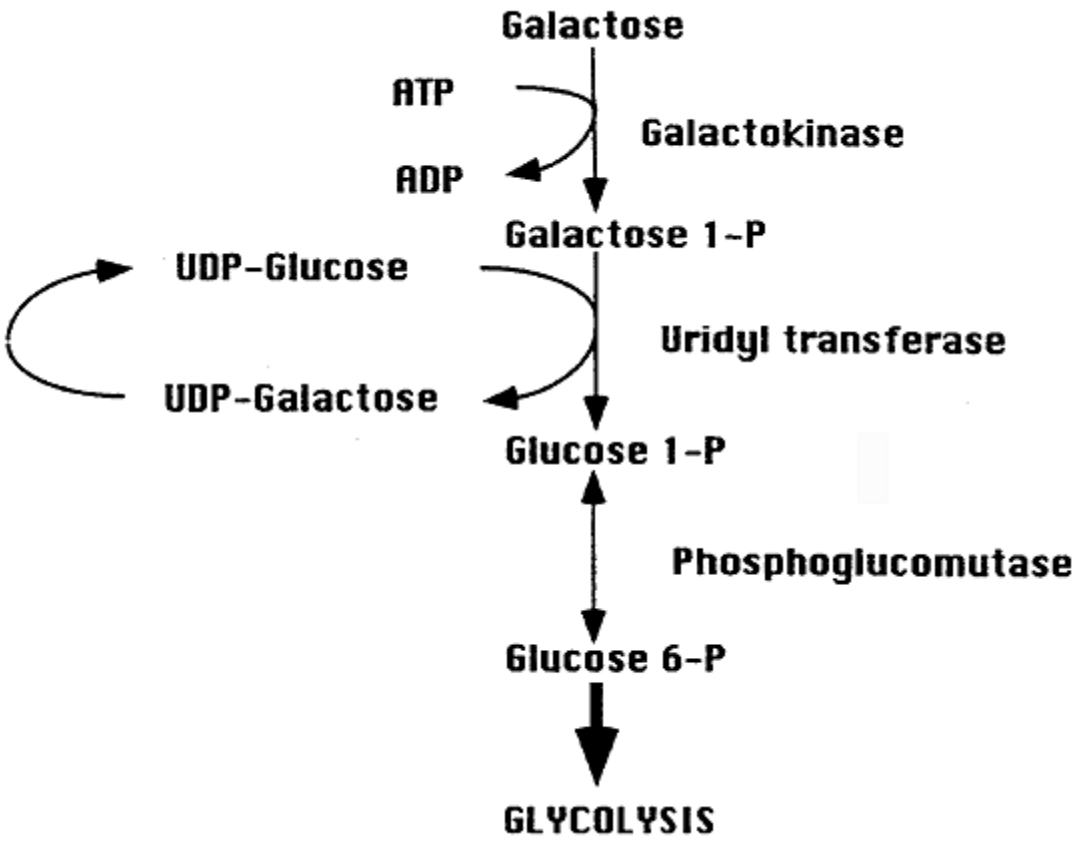
Fructose Metabolism:

Occurs in **liver**.



Galactose Metabolism:

Occurs in **liver**.



UDP-Glucose is an activated form of glucose found as an intermediate in **glycogen formation**.

UDP-Glucose is recycled from **UDP-Galactose** thus, there is **no NET change** in **concentration** of this compound.

Fructose and Galactose Energy Production: still 2 ATP.

(Fructose enters at glyceraldehyde-3-phosphate)

(Galactose enters at glucose-6-phosphate)