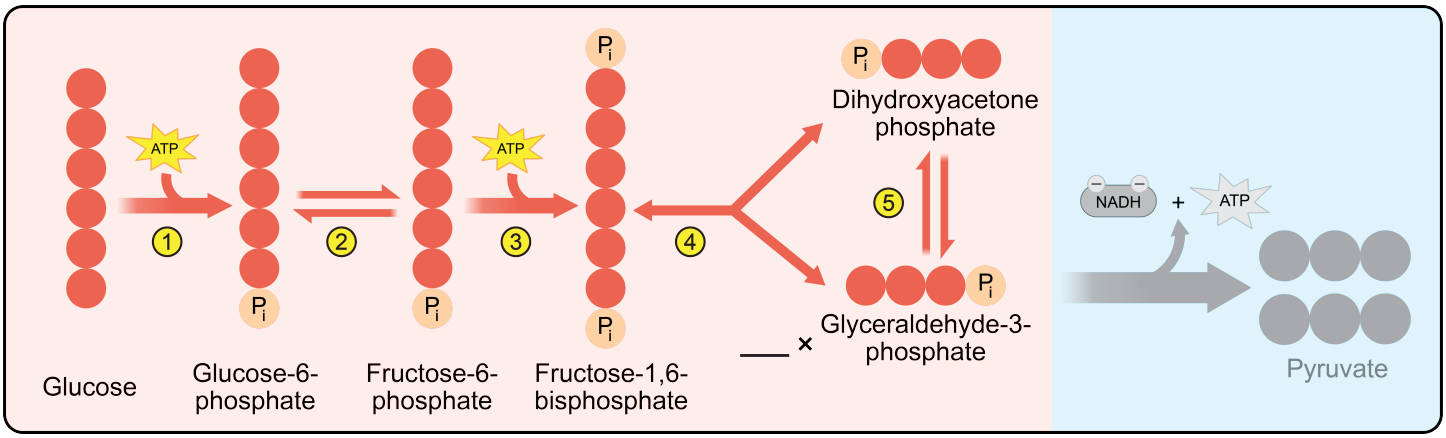
CONCEPT: GLYCOLYSIS

- Glycolysis is a sequence of ____ biochemical reactions.

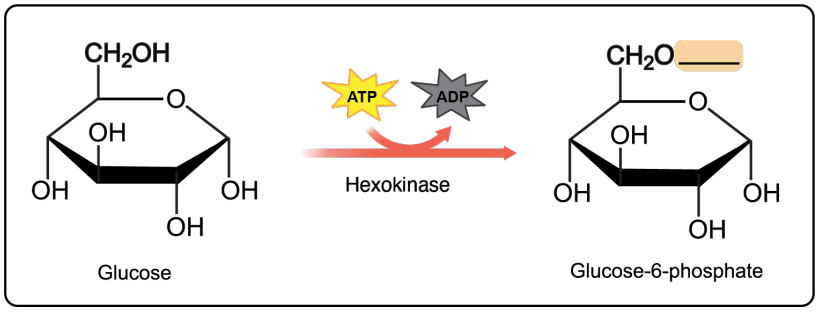
Phase A – Energy-Consuming Phase

- Phase A of glycolysis consists of its first ___ reactions.
  - □ Results in the conversion of 1 glucose molecule to 2 glyceraldehyde-3-phosphate (G3P) molecules.
  - □ Reactions ___ and ___ are irreversible and each consumes 1 ATP for energy.

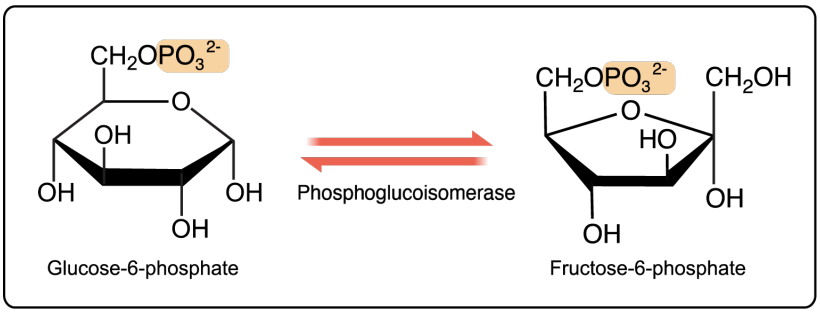


1 Phosphorylation: the enzyme _____ catalyzes the phosphorylation of glucose.

- □ Uses ATP as a source of energy and _____.



2 Isomerization: the enzyme phosphoglucoisomerase isomerizes glucose-6-phosphate to fructose-6-phosphate.



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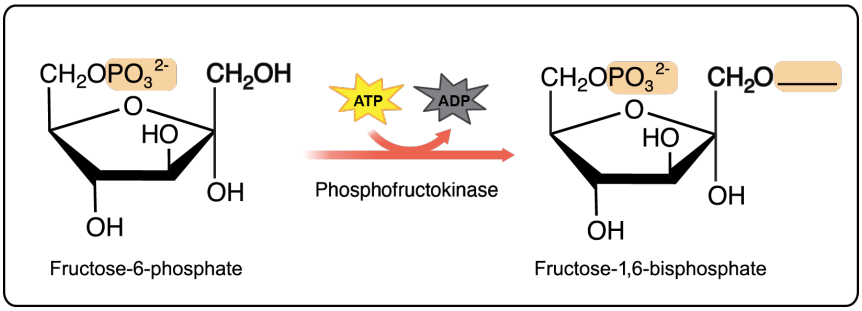
3 **Phosphorylation:** the enzyme _____ catalyzes the phosphorylation of fructose-6-phosphate.

□ Uses ATP as a source of energy and _____.



EXAMPLE: Which one of the following statements is incorrect about ATP in glycolysis reactions 1 and 3?

a) ATP provides the inorganic phosphate for phosphorylation reactions.

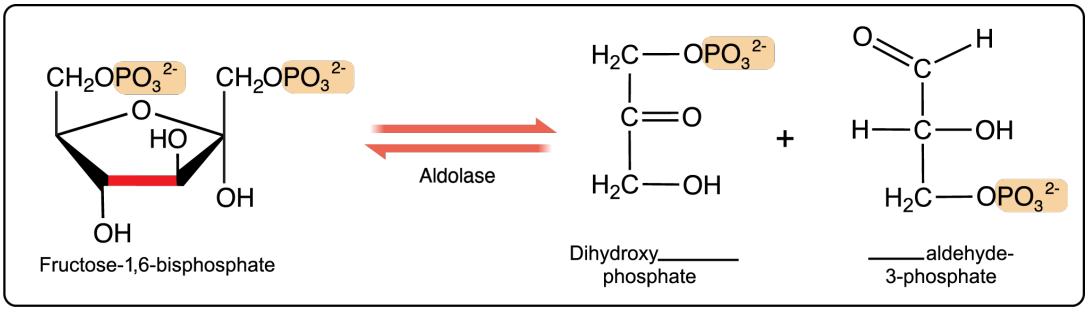
b) Hydrolysis of the high-energy P–O bond in ATP provides energy to carry out phosphorylation.

c) Energy produced in reactions 1 and 3 is used to synthesize ATP from ADP.

d) Kinases in reactions 1 and 3 use ATP as the coenzyme.

4 **Bond Cleavage:** the enzyme aldolase cleaves the _____ C–C bond of the fructose ring.

□ Results in the formation of 2 _____ phosphates.



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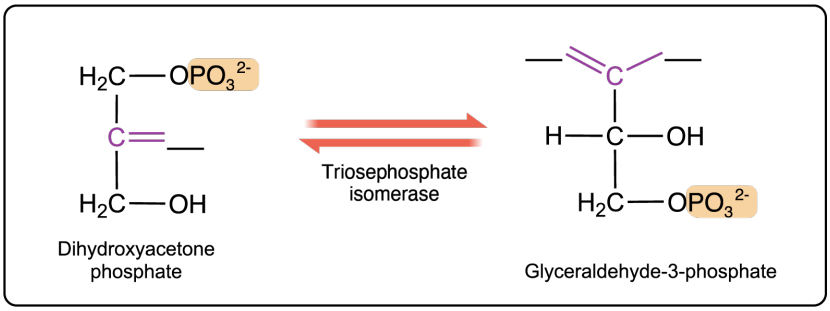
5 **Isomerization:** Dihydroxyacetone phosphate (DHAP) is isomerized to glyceraldehyde-3-phosphate (G3P).

□ Catalyzed by the enzyme triosephosphate _____.



EXAMPLE: Which one of the following statements is incorrect about glycolysis phase A?

a) Phosphorylation reactions 1 and 3 are catalyzed by kinases.

b) Bond cleavage in reaction 4 produces ATP.

c) Bond cleavage in reaction 4 produces two triose phosphates.

d) Isomerization of DHAP to G3P is catalyzed by triosephosphate isomerase.

PRACTICE: Classify each one of the following reactions as phosphorylation (P), isomerization (I), or neither (N).

a) ____ Conversion of glucose into glucose-6-phosphate.

b) ____ Conversion of glucose-6-phosphate into fructose-6-phosphate.

c) ____ Conversion of DHAP into G3P.

d) ____ Cleavage of fructose-1,6-bisphosphate into DHAP and G3P.

PRACTICE: Which one of the following compound pairs is produced by cleavage of fructose-1,6-bisphosphate?

a) Dihydroxyacetone phosphate and glyceraldehyde-3-phosphate

b) glyceraldehyde-3-phosphate and glyceraldehyde-2-phosphate

c) Glyceraldehyde-3-phosphate and CO_2

d) Dihydroxyacetone phosphate and 3-phosphoglycerate

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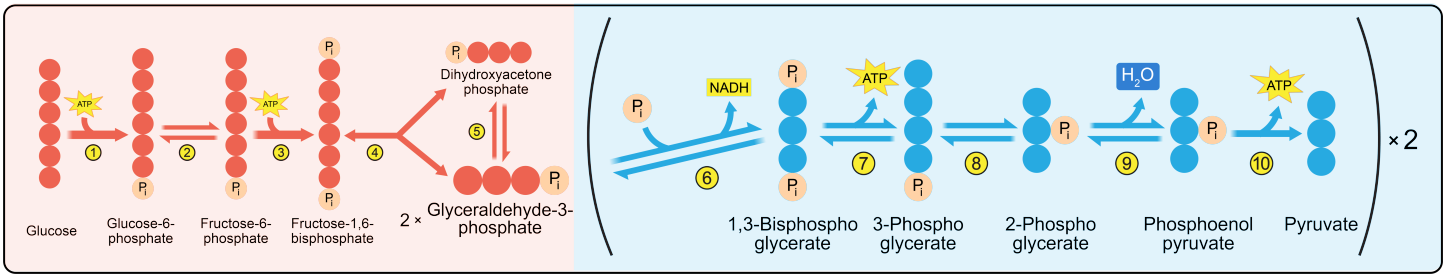
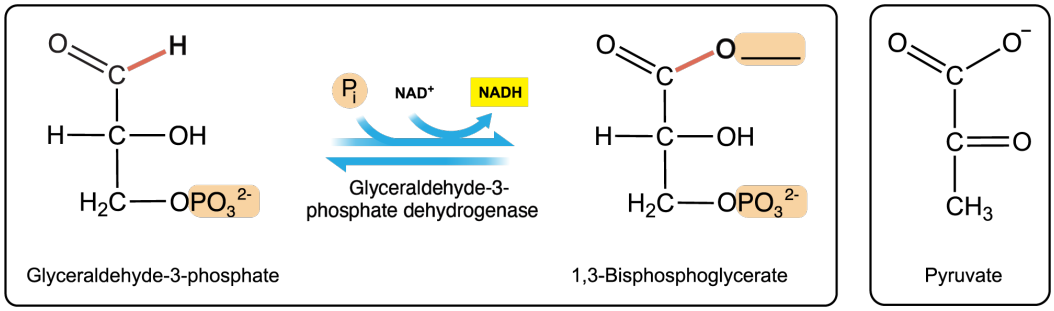
Phase B – Energy-Producing Phase

- Phase B of glycolysis consists of its last ___ reactions.
  - □ Converts G3P (× 2) to pyruvate (× 2) and extracts energy in the process.
  - □ Produces ___ NADH and ___ ATP molecules.
  - □ Reaction ____ of this phase is irreversible.



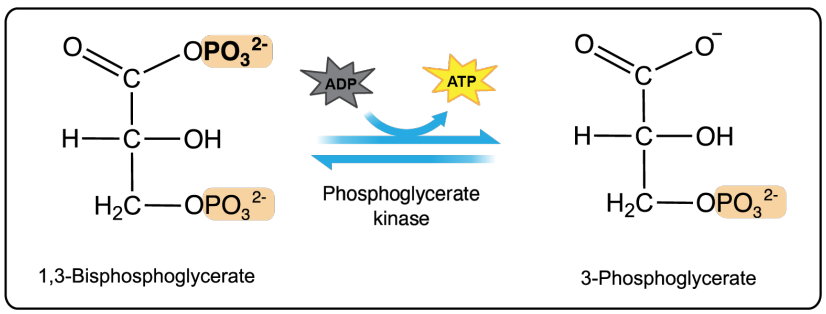
6 Oxidation × 2: G3P undergoes oxidation to produce 1,3-bisphosphoglycerate (1,3_____).

- □ Catalyzed by enzyme glyceraldehyde-3-phosphate _____.
- □ NAD^+ is reduced to _____.



7 Phosphate Transfer × 2: 1,3-bisphosphoglycerate (BPG) produces 3-phosphoglycerate (3PG) by losing a P_i group.

- □ Catalyzed by enzyme phosphoglycerate _____.
- □ ADP gains the P_i group to produce _____.



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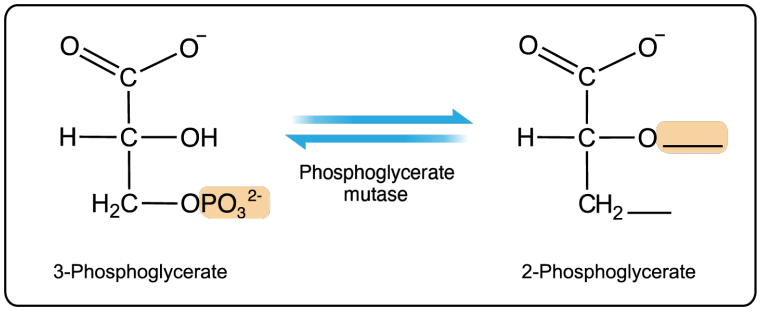
8 Isomerization × 2: 3-phosphoglycerate (3PG) undergoes isomerization to yield 2-phosphoglycerate (2PG).

□ Catalyzed by enzyme phosphoglycerate _____.



EXAMPLE: Which one of the following glycolysis reactions will produce an ATP molecule?

a) 3-Phosphoglycerate to 2-phosphoglycerate

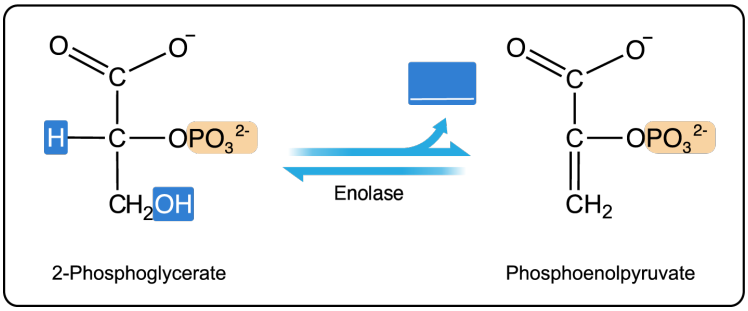
b) Glyceraldehyde-3-phosphate to 1,3-Bisphosphoglycerate

c) Glucose to glucose-6-phosphate

d) 1,3-Bisphosphoglycerate to 3-phosphoglycerate

9 Dehydration × 2: 2-phosphoglycerate (2PG) undergoes dehydration to produce phosphoenolpyruvate (PEP).

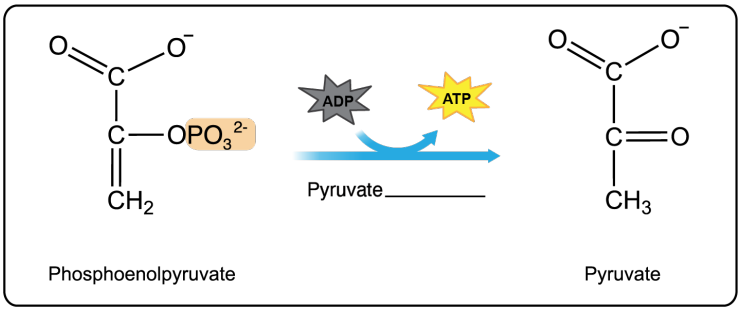
□ Catalyzed by the enzyme _____.



10 Phosphate Transfer × 2: PEP yields pyruvate by losing its P_i group.

□ Catalyzed by enzyme pyruvate _____.

□ ADP gains the P_i group to produce _____.



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EXAMPLE: Which of the following enzymes catalyzes the conversion of phosphoenolpyruvate to pyruvate?

a) Pyruvate dehydrogenase

b) Pyruvate carboxylate

c) Phosphoenolpyruvate carboxykinase

d) Pyruvate kinase

PRACTICE: Which enzyme catalyzes the oxidation of glyceraldehyde-3-phosphate in reaction 6 of glycolysis?

a) glyceraldehyde-3-phosphate dehydrogenase

b) glyceraldehyde-3-phosphate acyltransferase

c) glyceraldehyde-3-phosphate oxidase

d) triosephosphate isomerase

PRACTICE: What is the energy output of reaction 7 of glycolysis (1,3-bisphosphoglycerate to 3-phosphoglycerate)?

a) 2 ATP

b) 2 NADH

c) 1 ATP

d) 1 NADH and 1 $FADH_2$

PRACTICE: What product is formed when phosphoglycerate mutase moves the phosphate group in 3-phosphoglycerate?

a) Dihydroxyacetone phosphate

b) 2-Phosphoglyceraldehyde

c) 1,3-Bisphosphoglycerate

d) 2-Phosphoglycerate