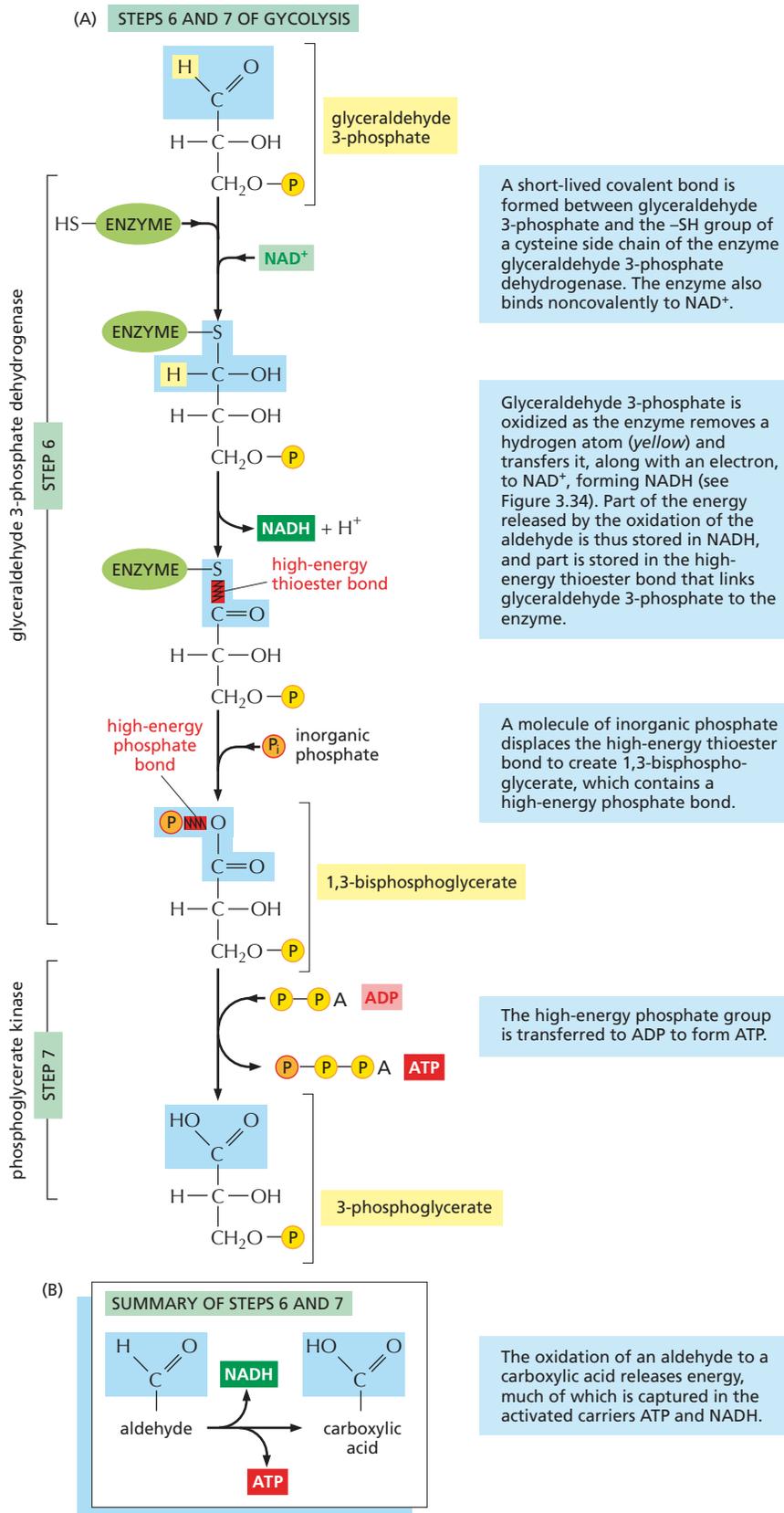


The reaction in step 6 is the only one in glycolysis that creates a high-energy phosphate linkage directly from inorganic phosphate—an example of the substrate-level phosphorylation mentioned earlier. How this high-energy linkage is generated in step 6—and then consumed in step 7 to produce ATP—is detailed in **Figure 13–9**.



### QUESTION 13–2

Arsenate ( $\text{AsO}_4^{3-}$ ) is chemically very similar to phosphate ( $\text{PO}_4^{3-}$ ) and is used as an alternative substrate by many phosphate-requiring enzymes. In contrast to phosphate, however, an anhydride bond between arsenate and carbon is very quickly hydrolyzed nonenzymatically in water. Knowing this, suggest why arsenate is a compound of choice for murderers but not for cells. Formulate your explanation in the context of Figure 13–7.

**Figure 13–9** The oxidation of glyceraldehyde 3-phosphate is coupled to the formation of ATP and NADH in steps 6 and 7 of glycolysis. (A) In step 6, the enzyme glyceraldehyde 3-phosphate dehydrogenase couples the energetically favorable oxidation of an aldehyde to the energetically unfavorable formation of a high-energy phosphate bond. At the same time, it enables energy to be stored in NADH. The formation of the high-energy phosphate bond is driven by the oxidation reaction, and the enzyme thereby acts like the “paddle wheel” coupler in Figure 3–30B. In step 7, the newly formed high-energy phosphate bond in 1,3-bisphosphoglycerate is transferred to ADP, forming a molecule of ATP and leaving a free carboxylic acid group on the oxidized sugar. The part of the molecule that undergoes a change is shaded in blue; the rest of the molecule remains unchanged throughout all these reactions. (B) Summary of the overall chemical change produced by the reactions of steps 6 and 7.