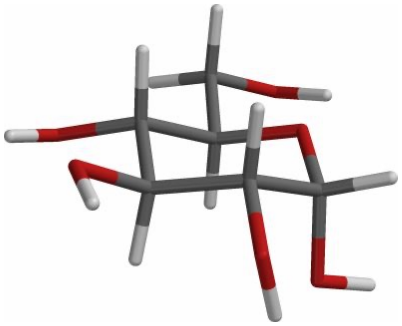

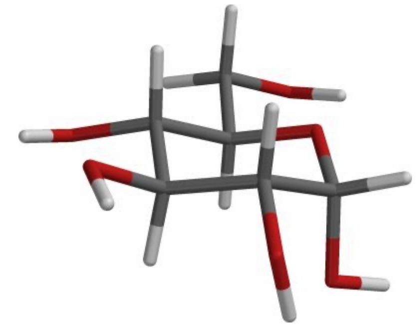

Chem 109 C
Bioorganic Compounds

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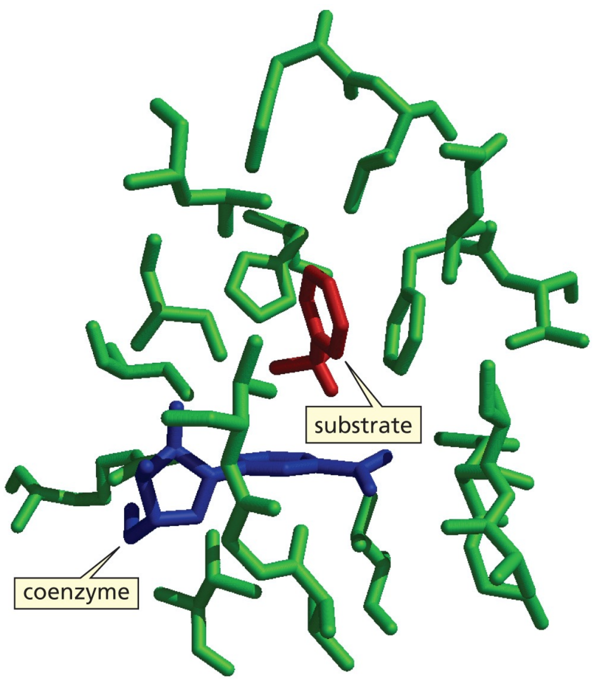
Chapter 23: Coenzymes

Overview and Introduction:

- enzymes are biological catalysts
- many enzymes are inactive without cofactors
- cofactors are 1) metal ions or 2) coenzymes
- coenzymes - organic molecules, derived from vitamins



Coenzyme	Vitamin	Reaction catalyzed
NAD^+, $NADP^+$ / NADH, NADPH	niacin, nicotinamide	oxidation/reduction of alcohols
FAD / $FADH_2$	riboflavin (B2)	oxidation/reduction, other
Thiamine pyrophosphate TPP	thiamine (B1)	acyl group transfer
Lipoic acid /dihydropipoic acid	lipoic acid	oxidation/reduction
Coenzyme A, CoASH	pantothenic acid (B5)	acyl group transfer
Biotin	biotin (B7)	carboxylation
Pyridoxal phosphate PLP	pyridoxin (B6)	6 amino acid reactions
Coenzyme B_{12}	vitamin B12	isomerization
Tetrahydrofolic acid, THF	folic acid	one-carbon transfer
Vitamin KH_2	vitamin K	carboxylation

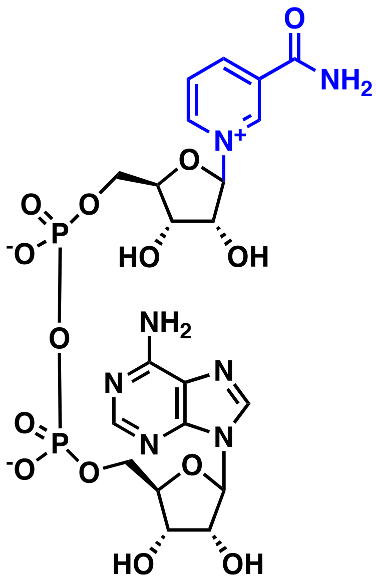
Vitamin KH_2 is not soluble in water

see Table 23.1 in Chapter 23

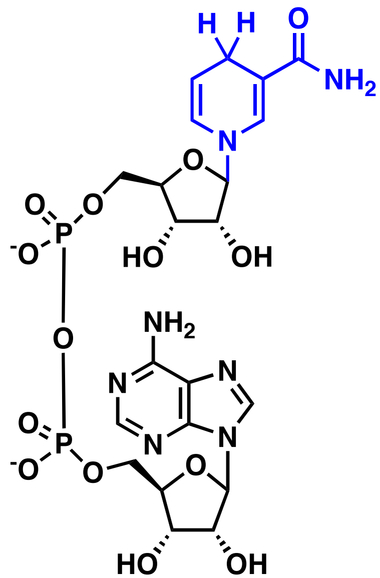
factors characterizing a coenzyme:

- **chemical structure**
- **associated vitamin**
- **type of reaction catalyzed**
- **reaction mechanism**
- **dietary source**
- **associated disease**

NAD$^+$-NADH, NADP$^+$-NADPH

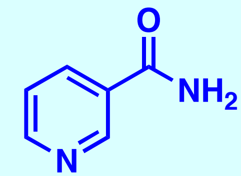


NAD$^+$



NADH

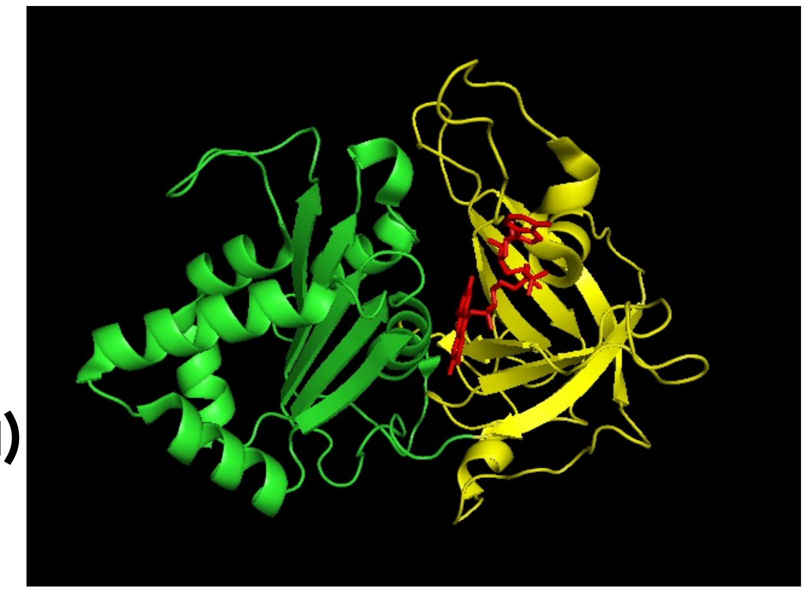
vitamin:



nicotinamide

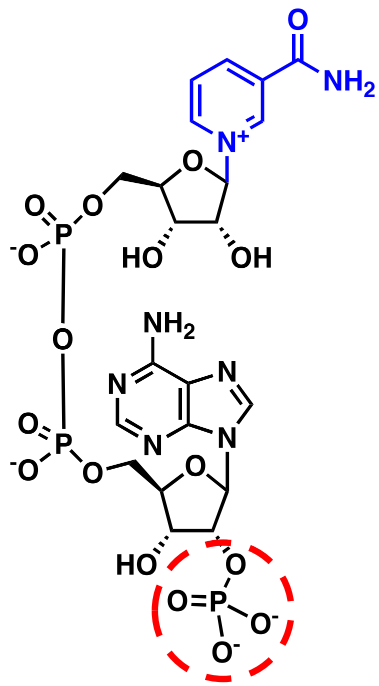
- NAD$^+$ is a catabolic enzyme
- [NAD$^+$]/[NADH] ~ 1000 : 1 (cytosol)

  [0.3 mM]

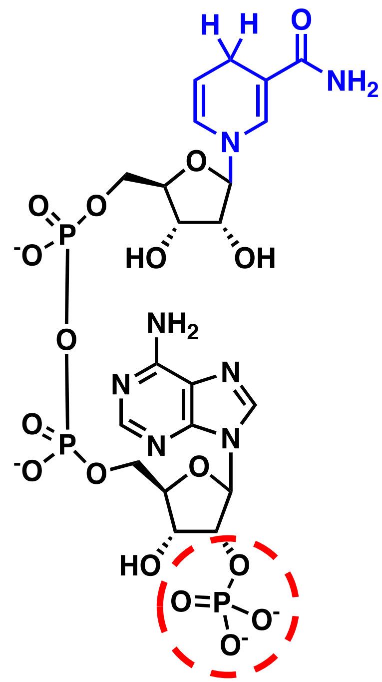


- catalyze redox (oxidation-reduction) reactions
- source of nicotinamide: meats, vegetables, peanuts etc.
- deficiency disease: pellagra (skin lesions, sensitivity to light etc.)

NAD$^+$-NADH, NADP$^+$-NADPH

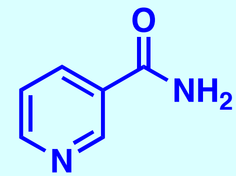


NADP$^+$



NADPH

vitamin:



nicotinamide

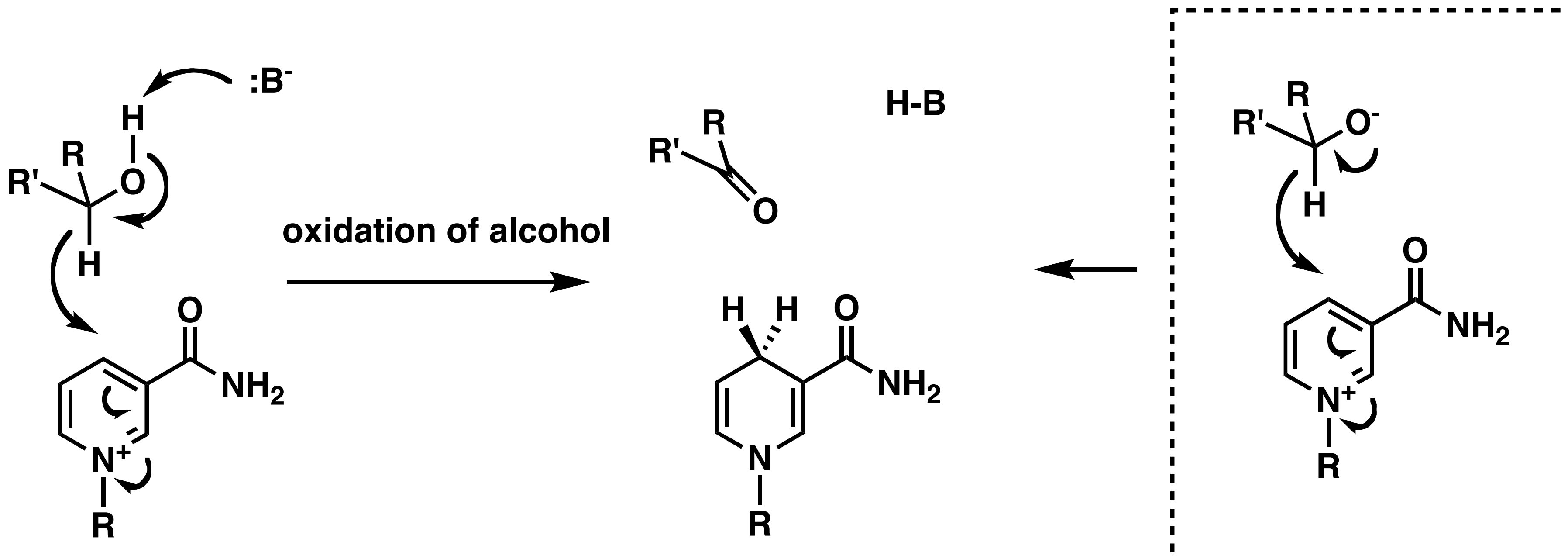
- **NADP$^+$ is an anabolic enzyme**
- **[NADP$^+$]/[NADPH] ~ 1 : 100**

- **catalyze redox (oxidation-reduction) reactions**
- **source of nicotinamide: meats, vegetables, peanuts etc.**
- **deficiency disease: pellagra (skin lesions, sensitivity to light etc.)**

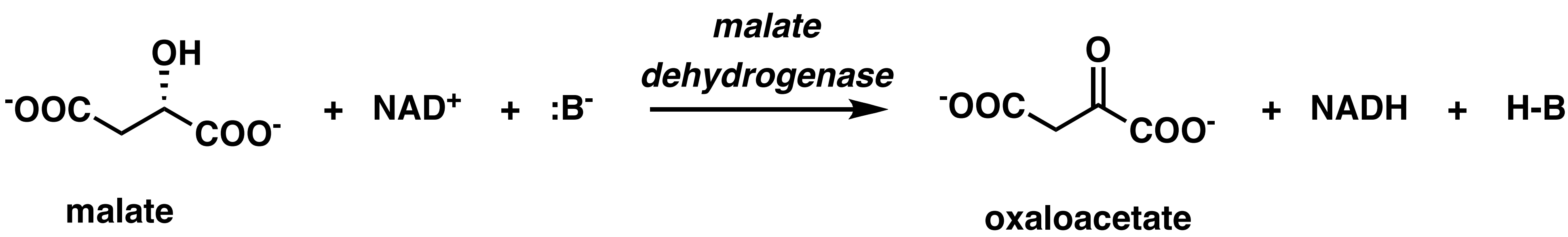
NAD$^+$, NADP$^+$

Oxidation with NAD$^+$ (or NADP$^+$):

General mechanism of oxidation:



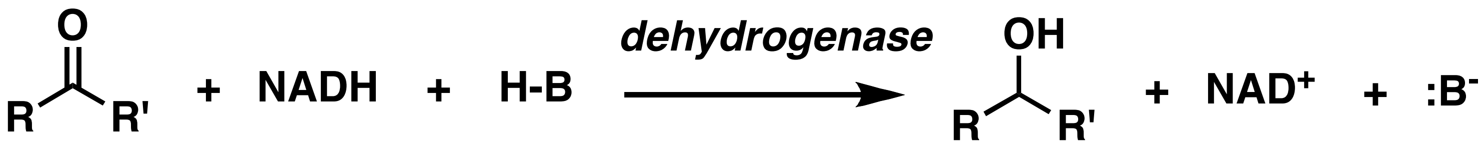
Oxidation with NAD^+ (or $NADP^+$), examples:



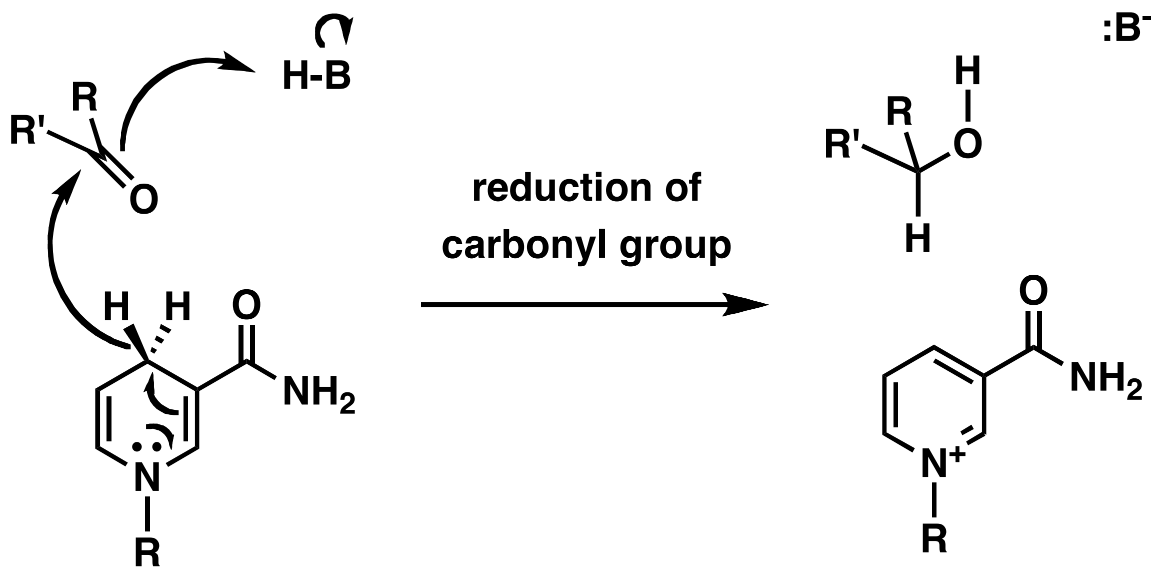
• important reaction in the citric acid cycle

NAD+, NADP+

Reduction with NADH (or NADPH), a reverse process:

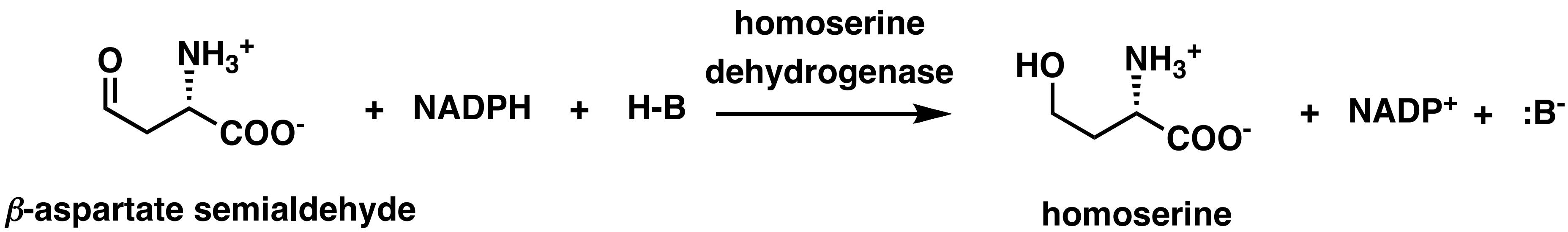


General mechanism of reduction:



- **NADH and NADPH are H^- donors**

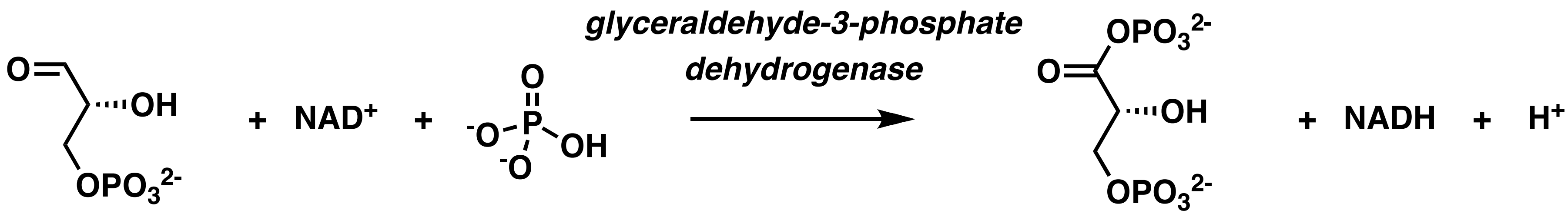
Reduction with NADPH (or NADH), examples:



- **important reaction in an anabolic pathway**

NAD^+, $NADP^+$

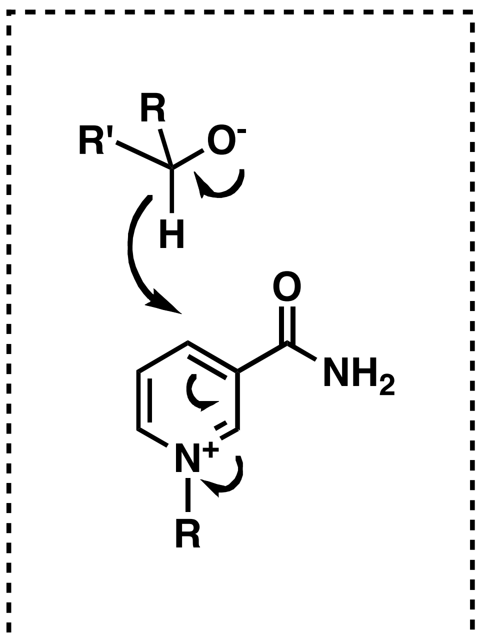
Oxidation - a more complex example:

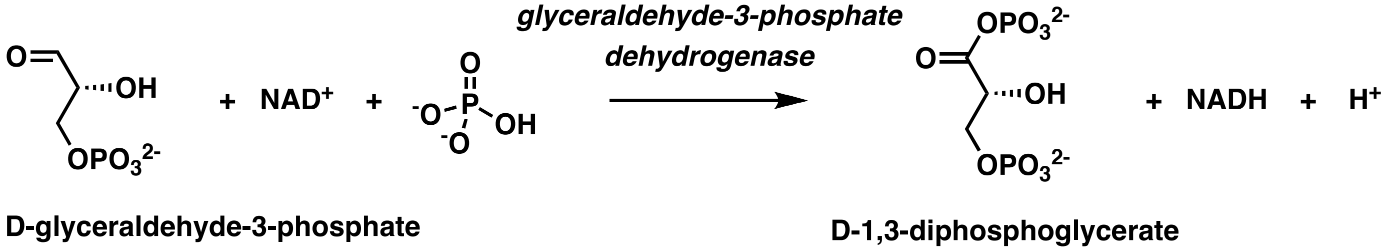


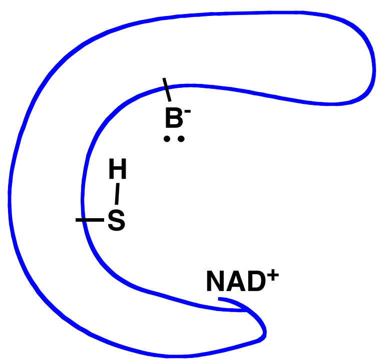
D-glyceraldehyde-3-phosphate

D-1,3-diphosphoglycerate

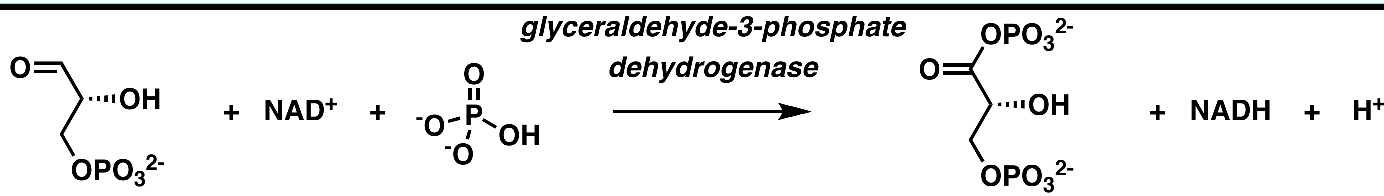
G3P



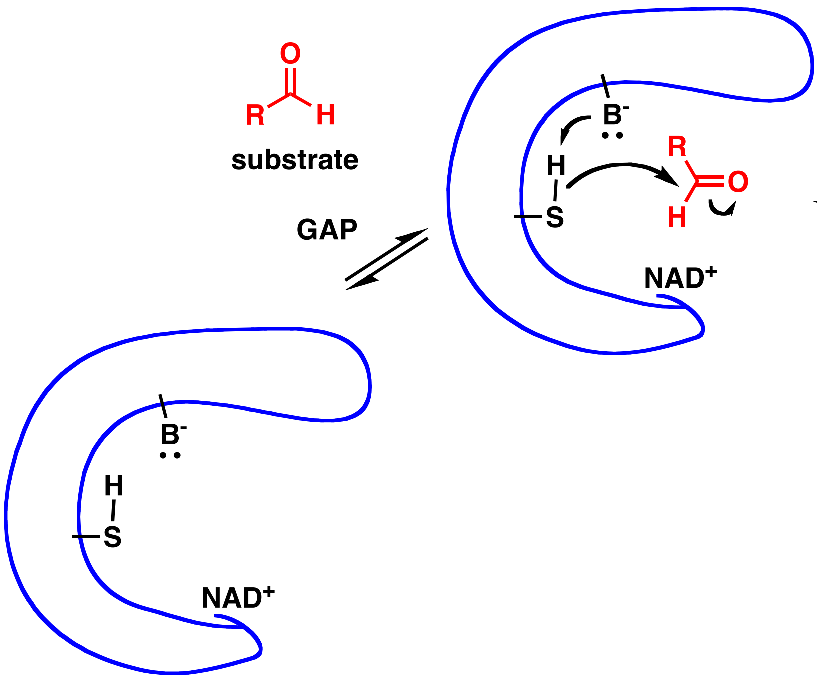

glyceraldehyde-3-phosphate
dehydrogenase
O
OH
OPO3 2-
+ NAD+ +
O
-O P OH
-O
OPO3 2-
O
OH
OPO3 2-
+ NADH + H+
D-glyceraldehyde-3-phosphate
D-1,3-diphosphoglycerate


B-
H
S
NAD+

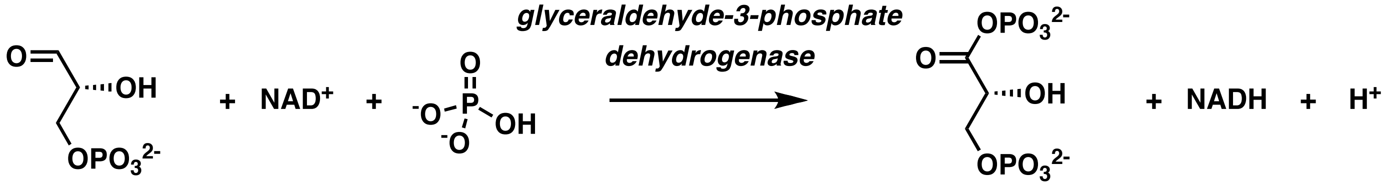
NAD$^+$, NADP$^+$



D-glyceraldehyde-3-phosphate D-1,3-diphosphoglycerate

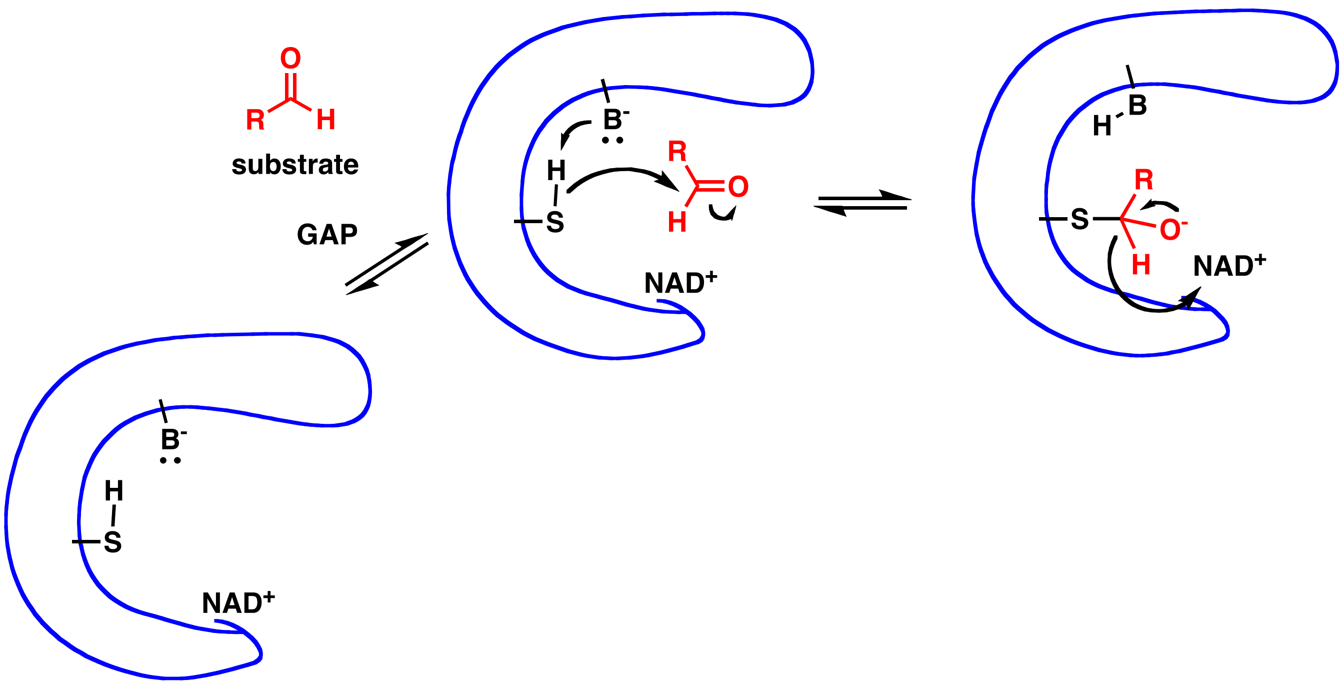


NAD$^+$, NADP$^+$

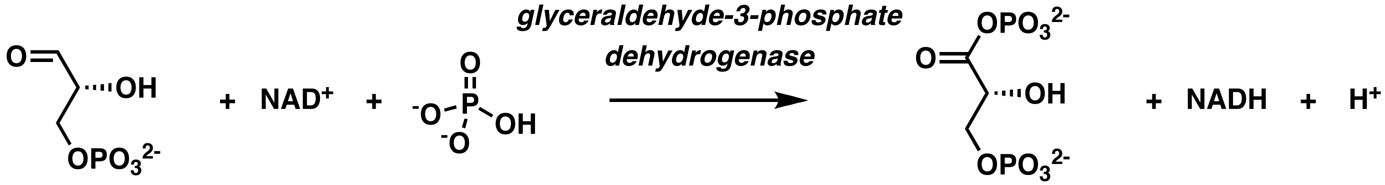


D-glyceraldehyde-3-phosphate

D-1,3-diphosphoglycerate

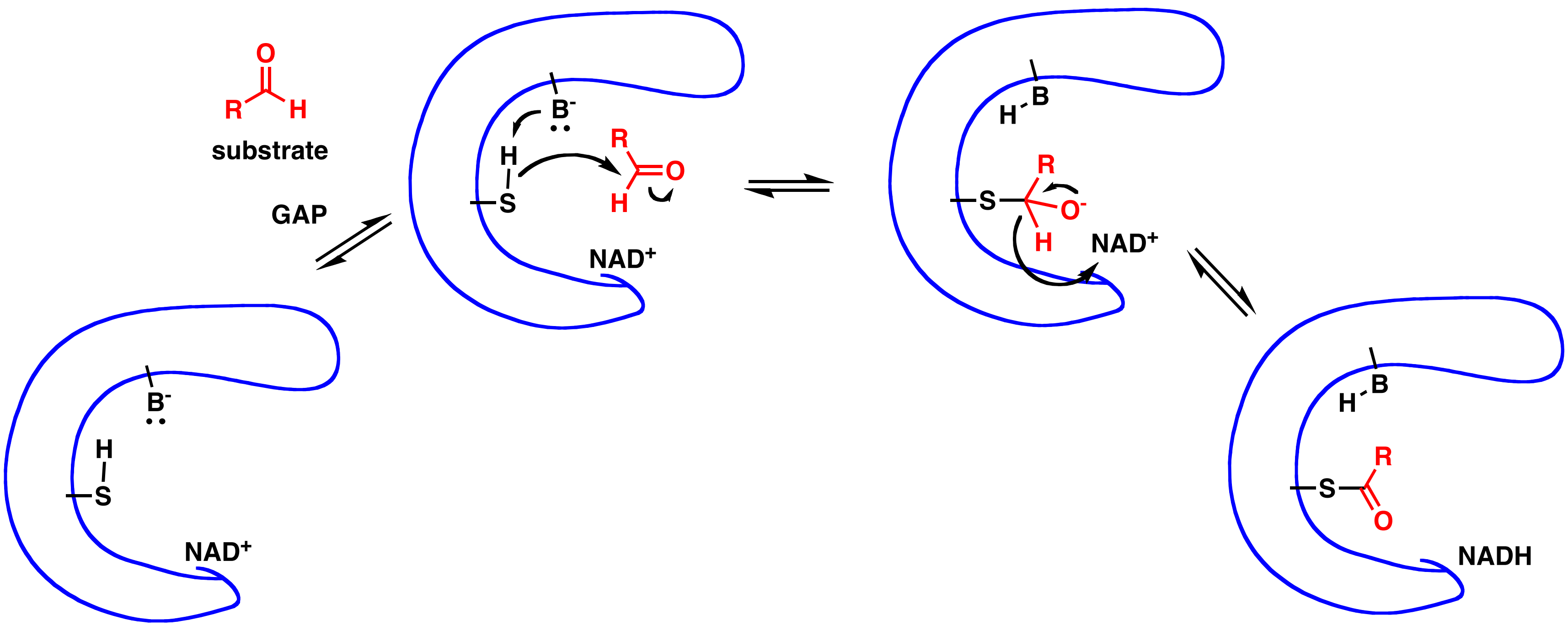


NAD^+, $NADP^+$

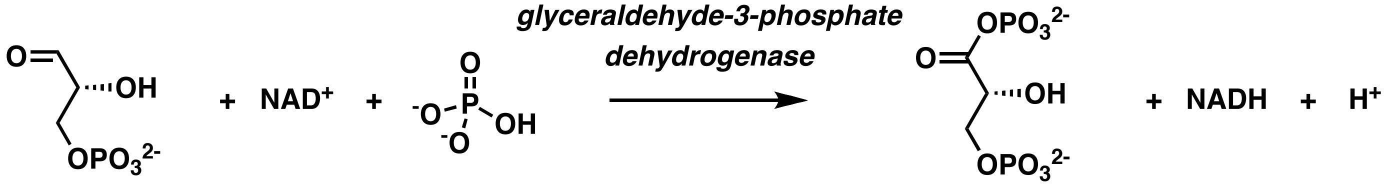


D-glyceraldehyde-3-phosphate

D-1,3-diphosphoglycerate

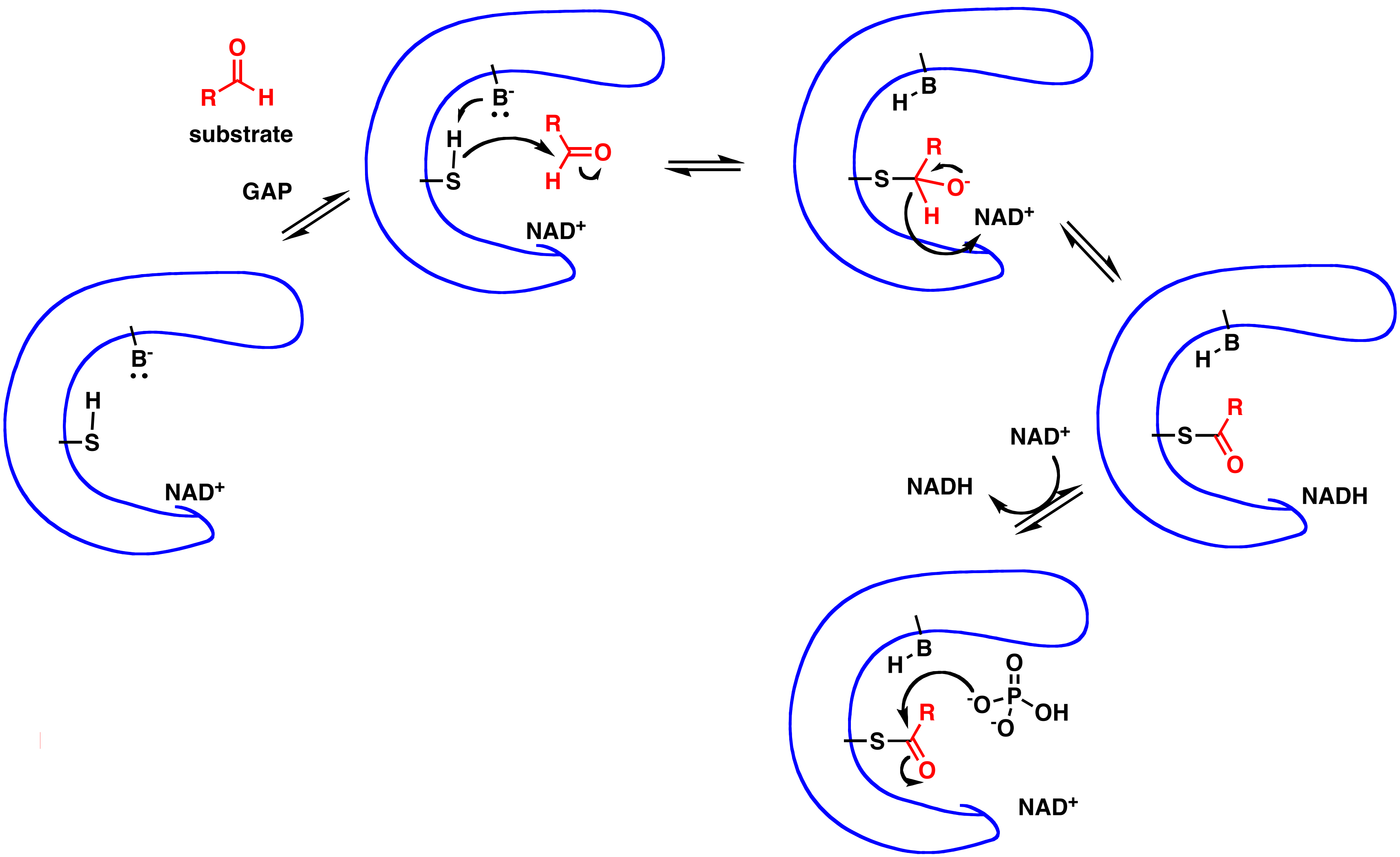


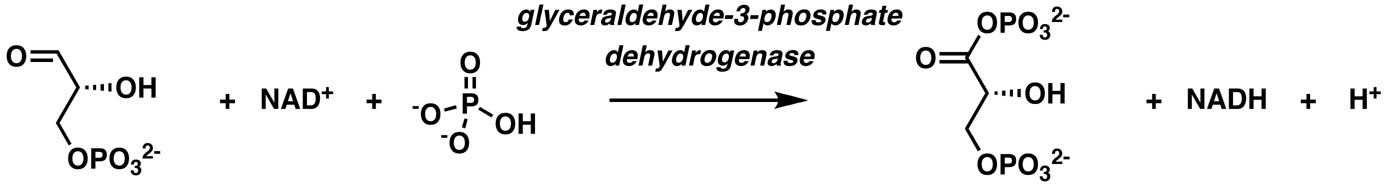
NAD⁺, NADP⁺



D-glyceraldehyde-3-phosphate

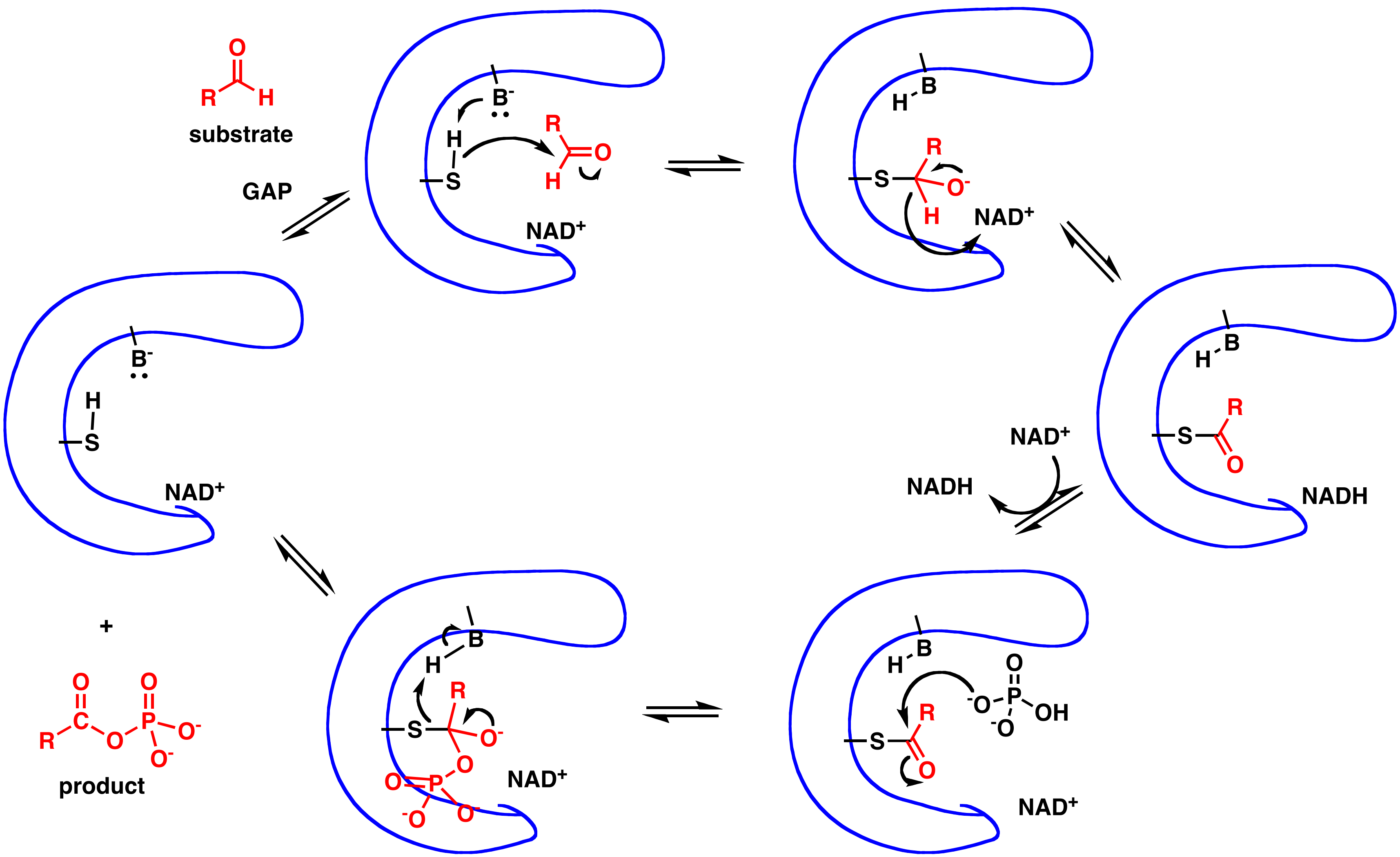
D-1,3-diphosphoglycerate





D-glyceraldehyde-3-phosphate

D-1,3-diphosphoglycerate



NAD⁺, NADP⁺

Stereochemistry of enzymatic reactions: enzyme reactions are stereospecific