كلية الطب | جامعة القادسية

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College Of Medicine

Clinical Chemistry Department

Glycolysis

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Absorption of Monosaccharides

1- Simple Diffusion

- According to concentration gradient.
- Fructose & pentoses.

2 Facilitated Transport

GLUT5: glucose, galactose & fructose.

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3 Active Transport

Sodium glucose transporter (SGLT)I: glucose & galactose.

Fate of Absorbed Sugars

- Absorbed **Fructose and galactose** → liver → glucose → uptake by tissues

Pathways for glucose utilization

1 **Oxidation** for production of energy

2 **Provides other compounds:**

Carbohydrates: i.e. fructose, galactose & pentoses.

Glycerol 3-phosphate: triacylglycerol and phospholipids

Acetyl CoA: cholesterol and fatty acids

Non essential amino acids.

3 **Storage:** glycogen in liver & triacylglycerol in adipose tissue.

4 **Excretion in urine.**

Oxidation of glucose

I. The Major Pathways: **for energy production.**

A) Glycolysis: produces pyruvate under aerobic condition lactate under anaerobic condition.

B) Krebs' cycle: under aerobic condition, pyruvate is converted to active acetate for oxidation through Krebs' cycle.

II. The Minor Pathways: **for synthesis of other derivatives.**

A) Hexose monophosphate pathway (HMP): For production of pentoses and NADPH.

B) Uronic acid pathway: For production of uronic acids.

GLYCOLYSIS

- **Oxidation of glucose to pyruvate in presence of O_2 or lactate in absence of O_2.**
- **Site:** cytosol of all cells.
- **Steps:**

Phase I (Energy utilization phase):

Glucose is cleaved to two molecules of glyceraldehyde 3-phosphate. This phase consumes 2 molecules of ATP.

Phase II (Energy recovery phase):

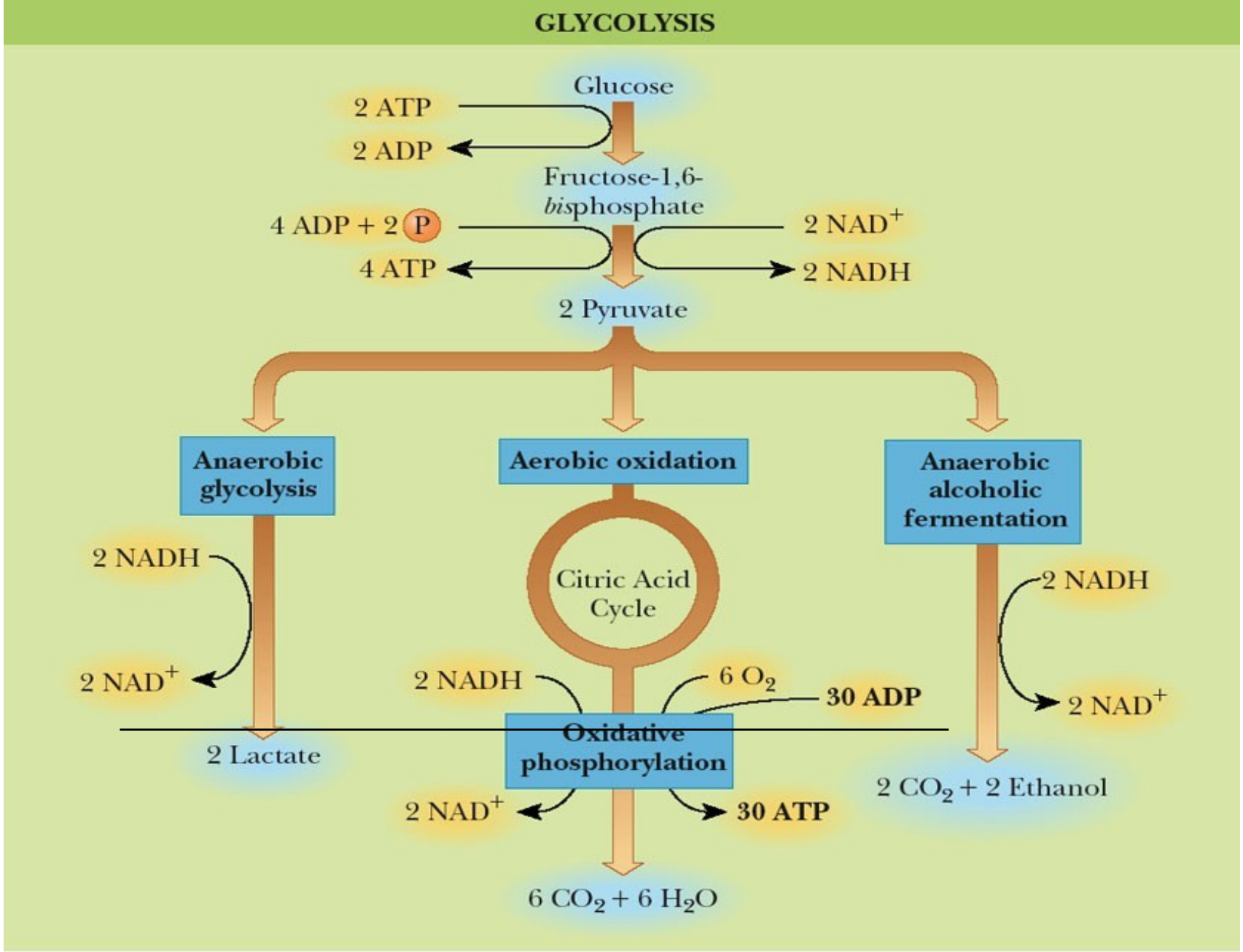
The two molecules of glyceraldehyde 3-phosphate are converted to pyruvate under aerobic state with generation of 10 ATPs.

Or lactate under anaerobic state with generation of 4 ATPs.

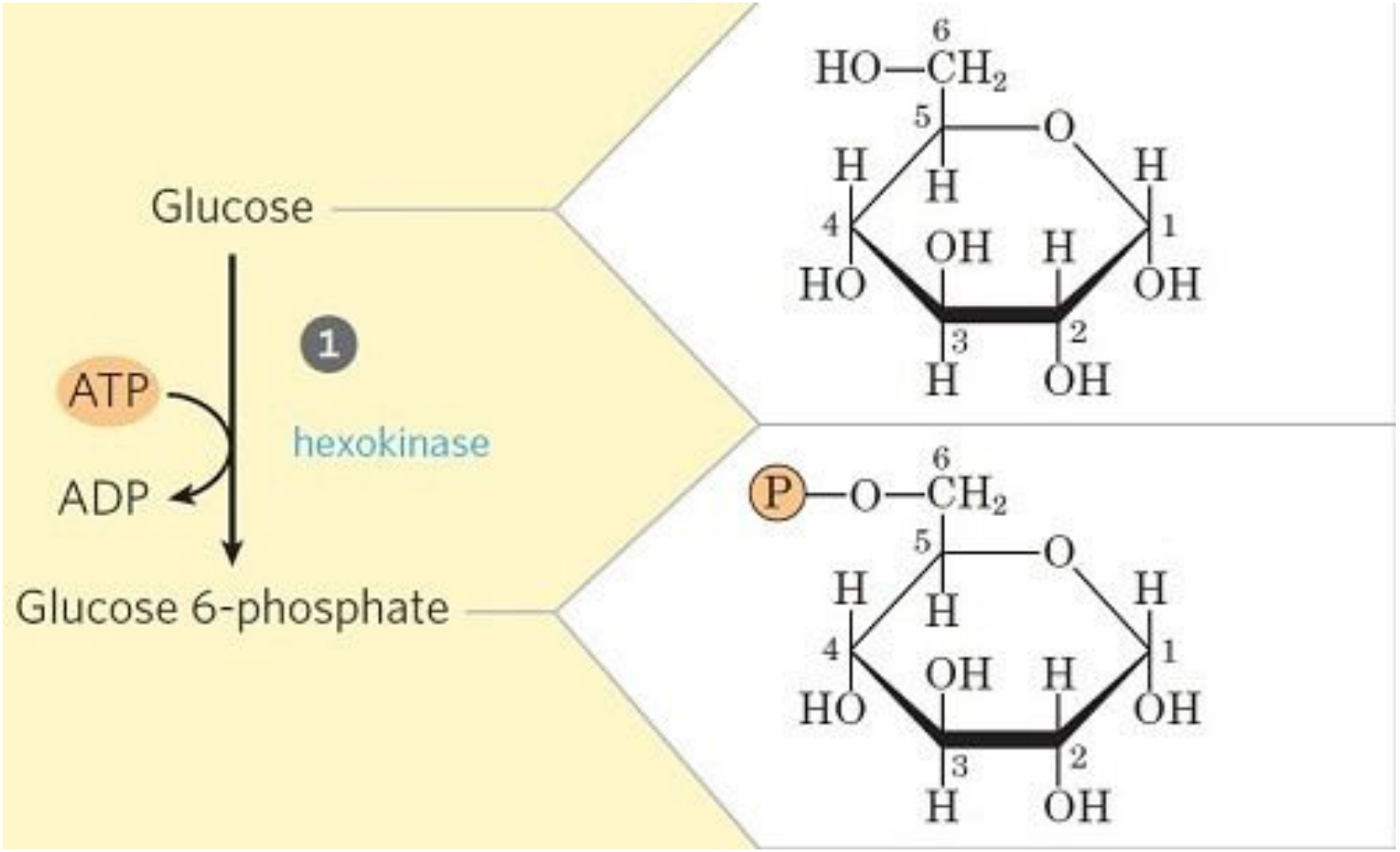
- All reactions are reversible except GK, PFK, PK.

GLYCOLYSIS

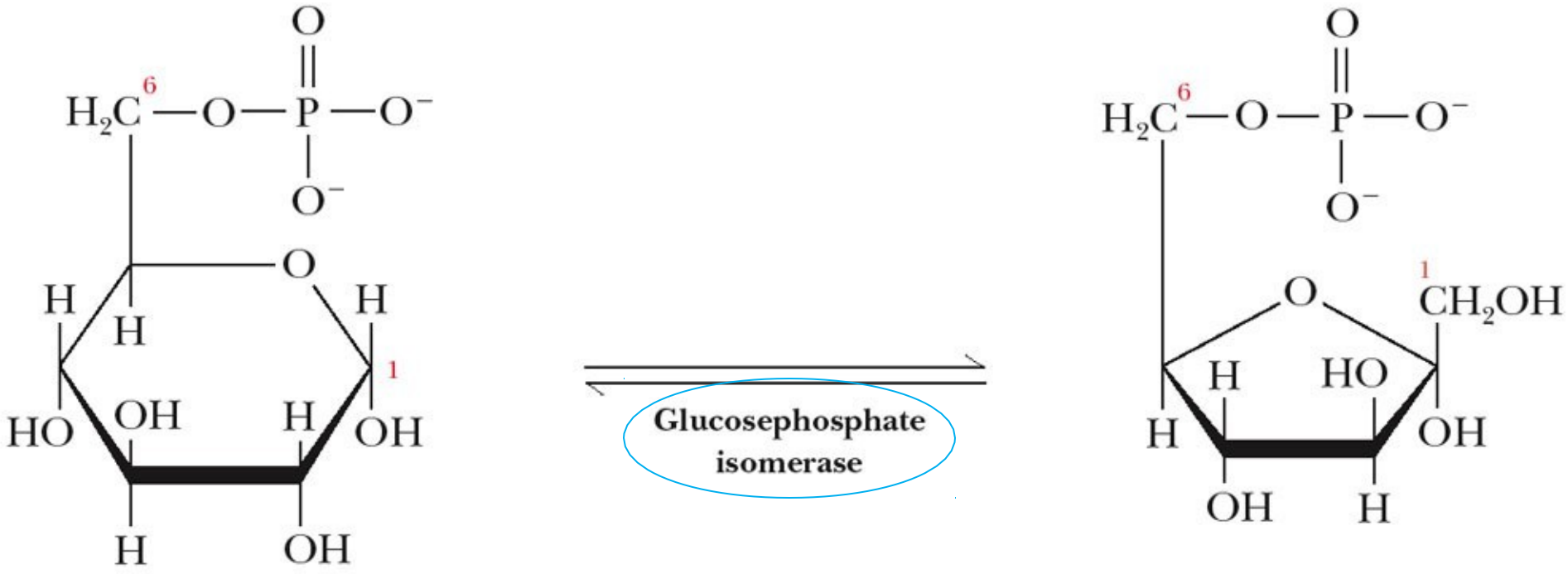
- 1st stage of glucose metabolism → glycolysis
- An anaerobic process, yields 2 ATP (additional energy source)
- Glucose will be metabolized via gycolysis; pyruvate as the end product
- The pyruvate will be converted to lactic acid (muscles → liver)
- Aerobic conditions: the main purpose is to feed pyruvate into TCA cycle for further rise of ATP


GLYCOLYSIS
Glucose
2 ATP
2 ADP
Fructose-1,6-
bisphosphate
4 ADP + 2 P
4 ATP
2 NAD+
2 NADH
2 Pyruvate
Anaerobic glycolysis
Aerobic oxidation
Anaerobic alcoholic fermentation
2 NADH
2 NAD+
Citric Acid Cycle
2 NADH
6 O2
30 ADP
Oxidative phosphorylation
2 NAD+
30 ATP
2 Lactate
2 NADH
2 NAD+
2 CO2 + 2 Ethanol
6 CO2 + 6 H2O

Phosphorylation of glucose to produce glucose -6-phosphate by hexokinase

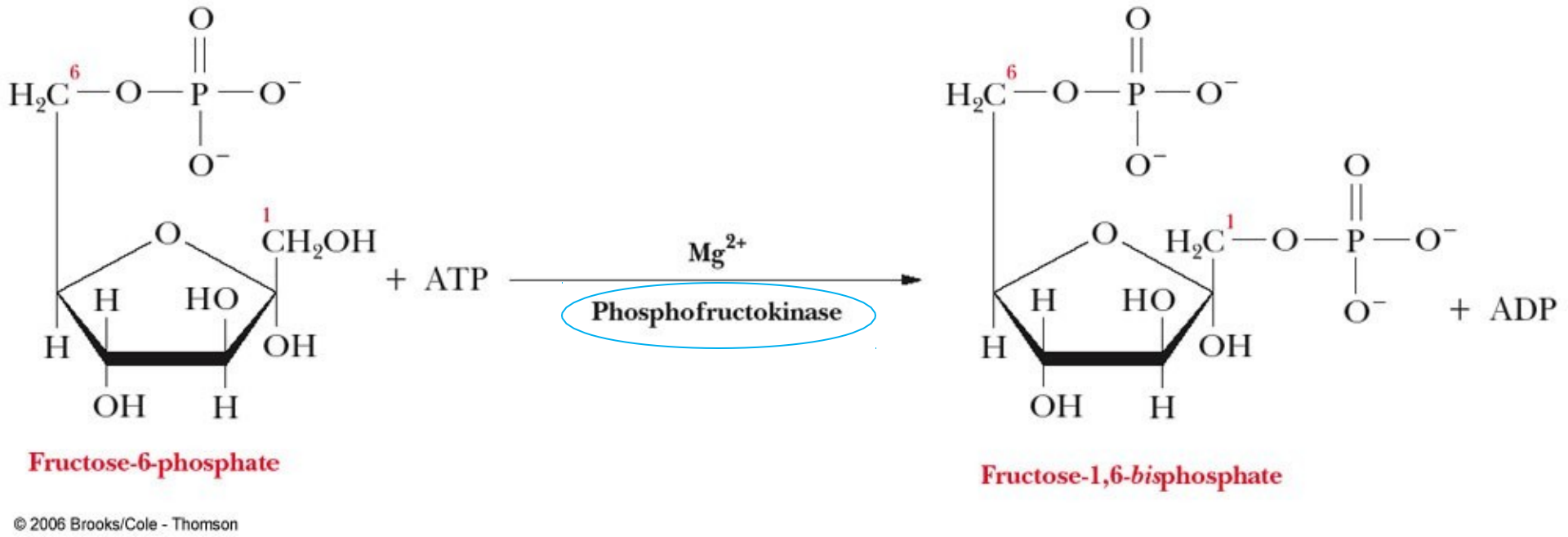


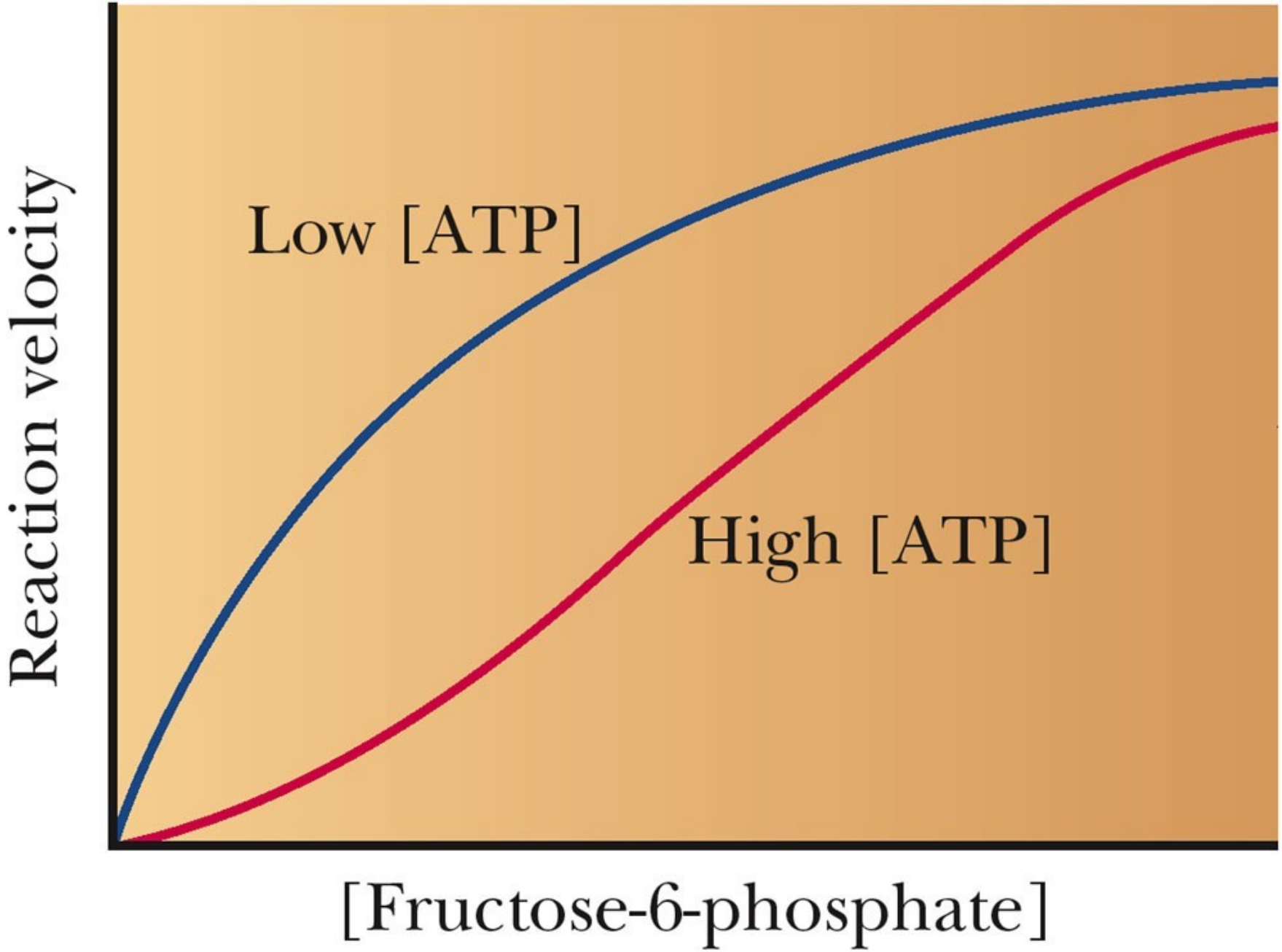
Step 2 Glucose-6-phosphate isomerize to give fructose-6- phosphate



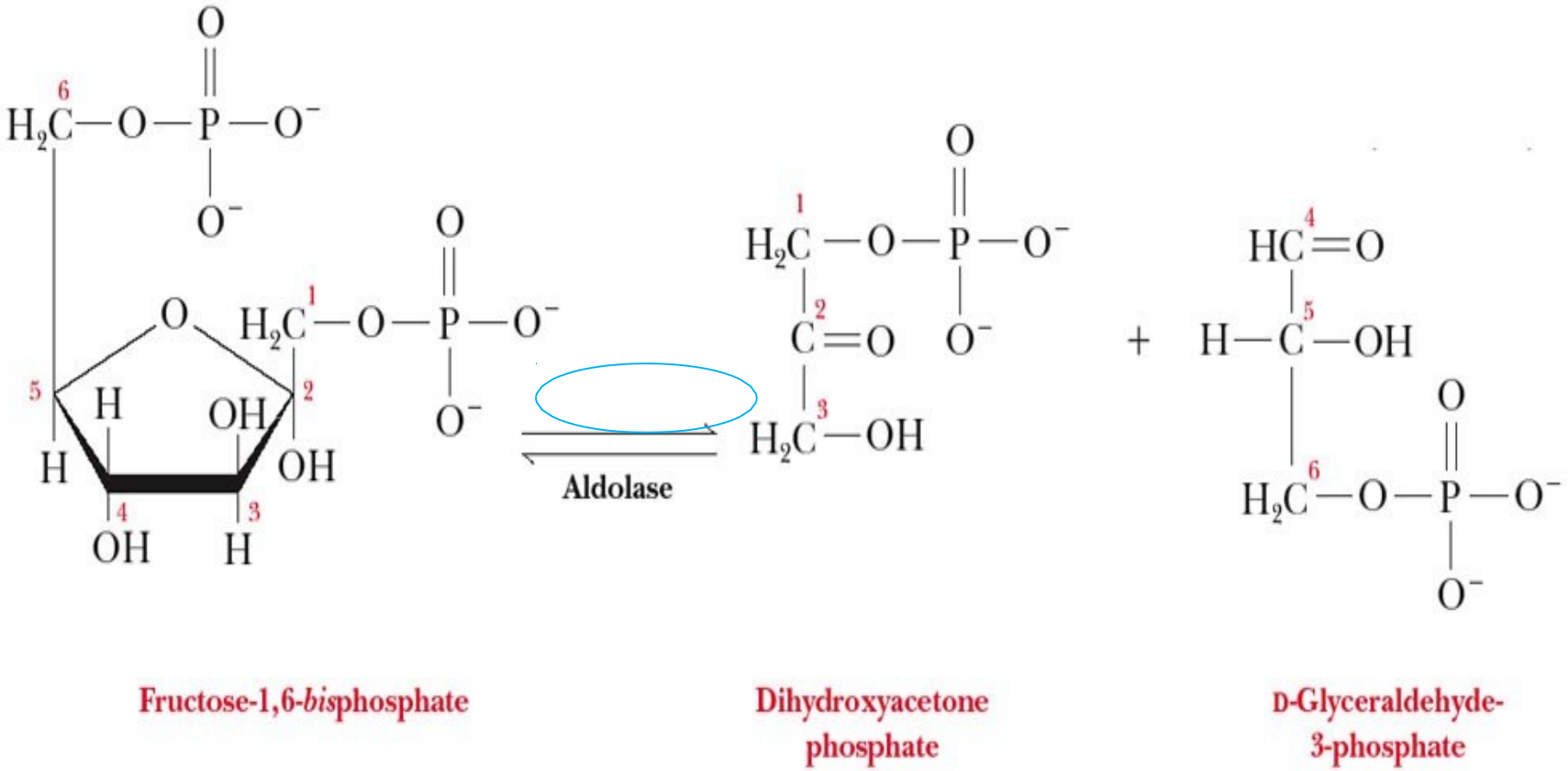
Step 3

Fructose-6-phosphate is phosphorylated producing fructose-1,6-*bis*phosphate



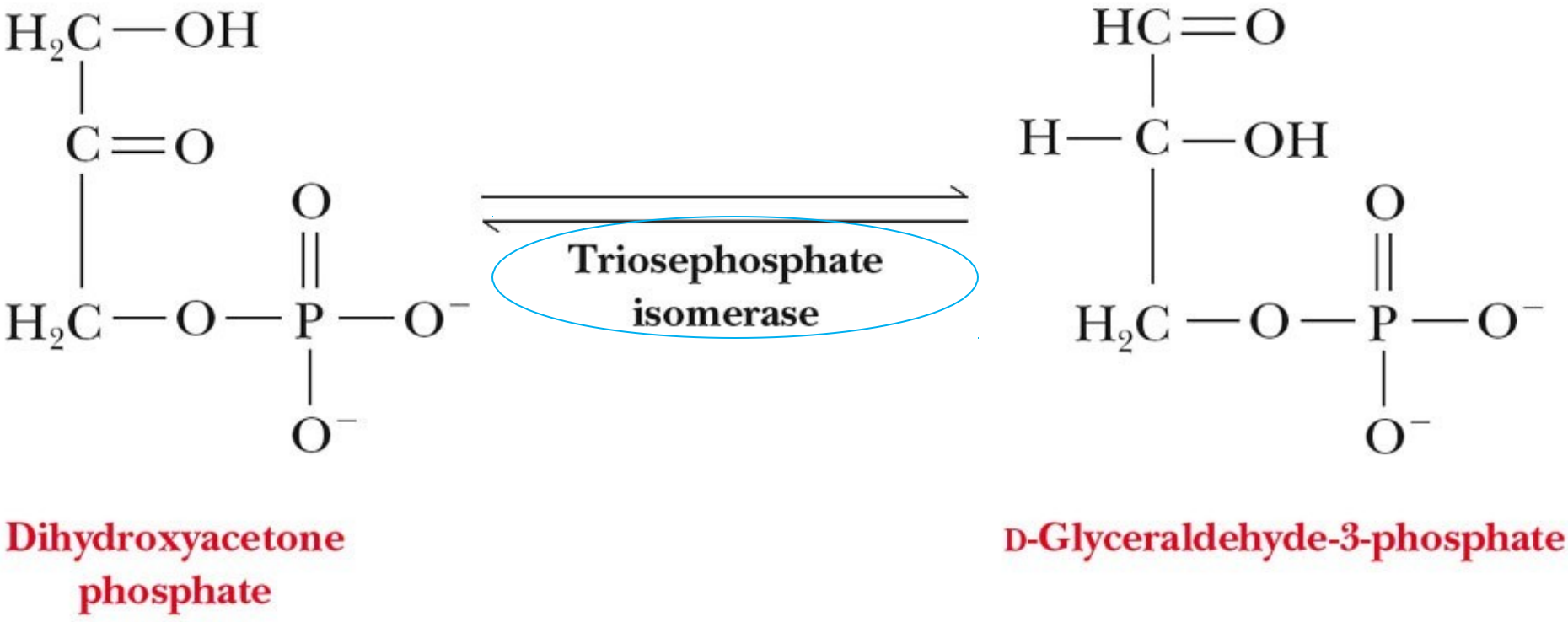


Step 4 Fructose-1,6-*bis*phosphate split into two 3-carbon fragments



Step 5

Dihydroxyacetone phosphate is converted to glyceraldehyde-3-phosphate

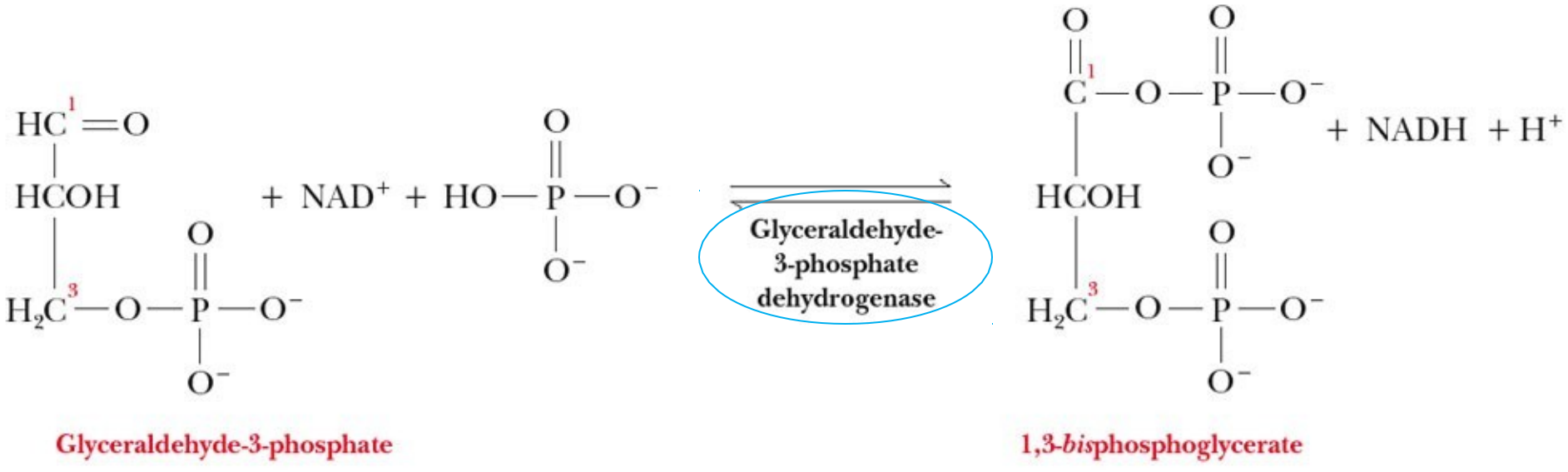


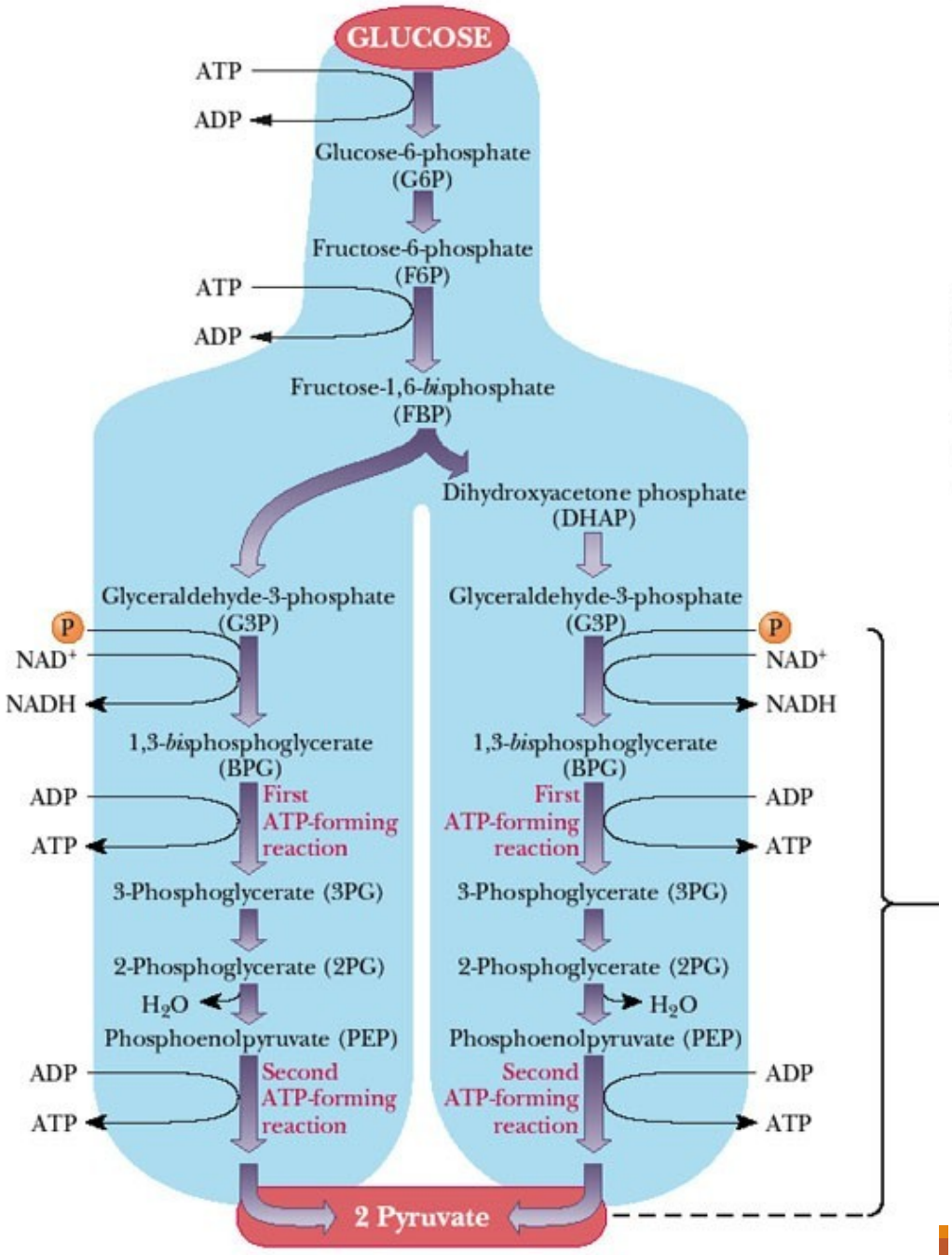
Glyceraldehyde -3-phosphate converts to pyruvate

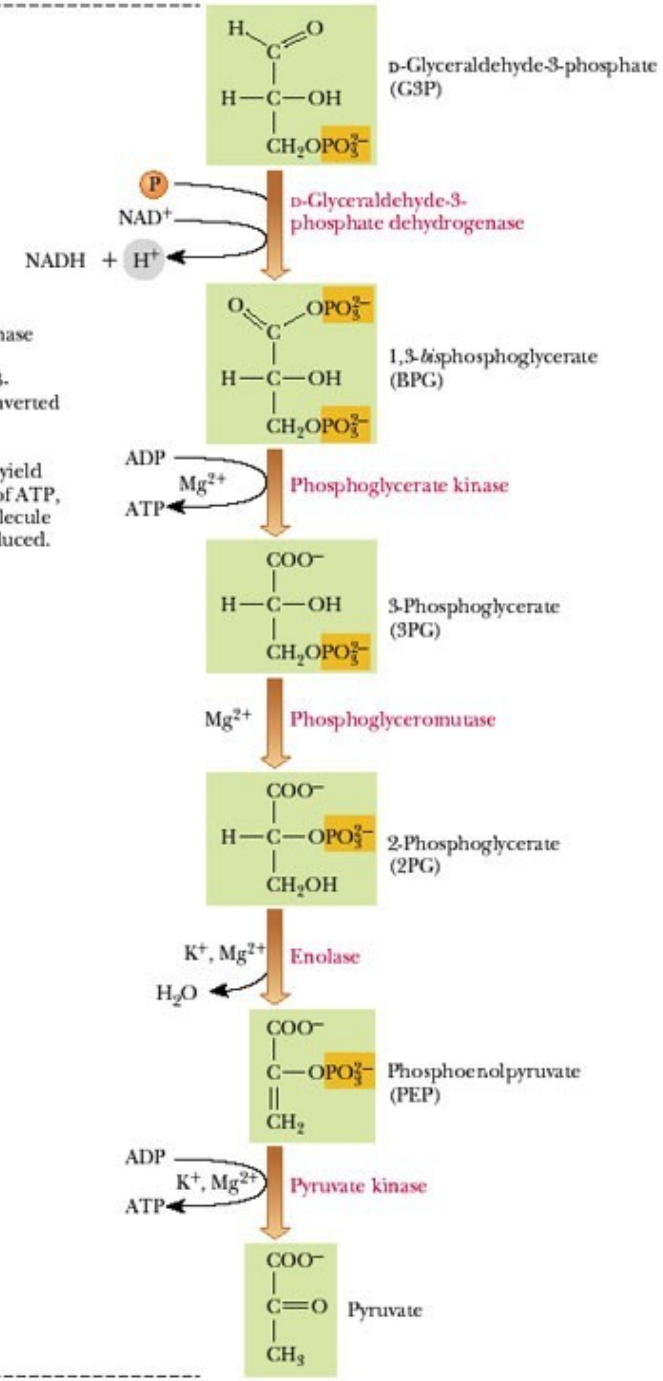
Payoff phase

Step 6

Glyceraldehyde-3-phosphate is oxidized to 1,3-*bis*phosphoglycerate







In the second phase of glycolysis, glyceraldehyde-3-phosphate is converted to pyruvate.

These reactions yield four molecules of ATP, two for each molecule of pyruvate produced.

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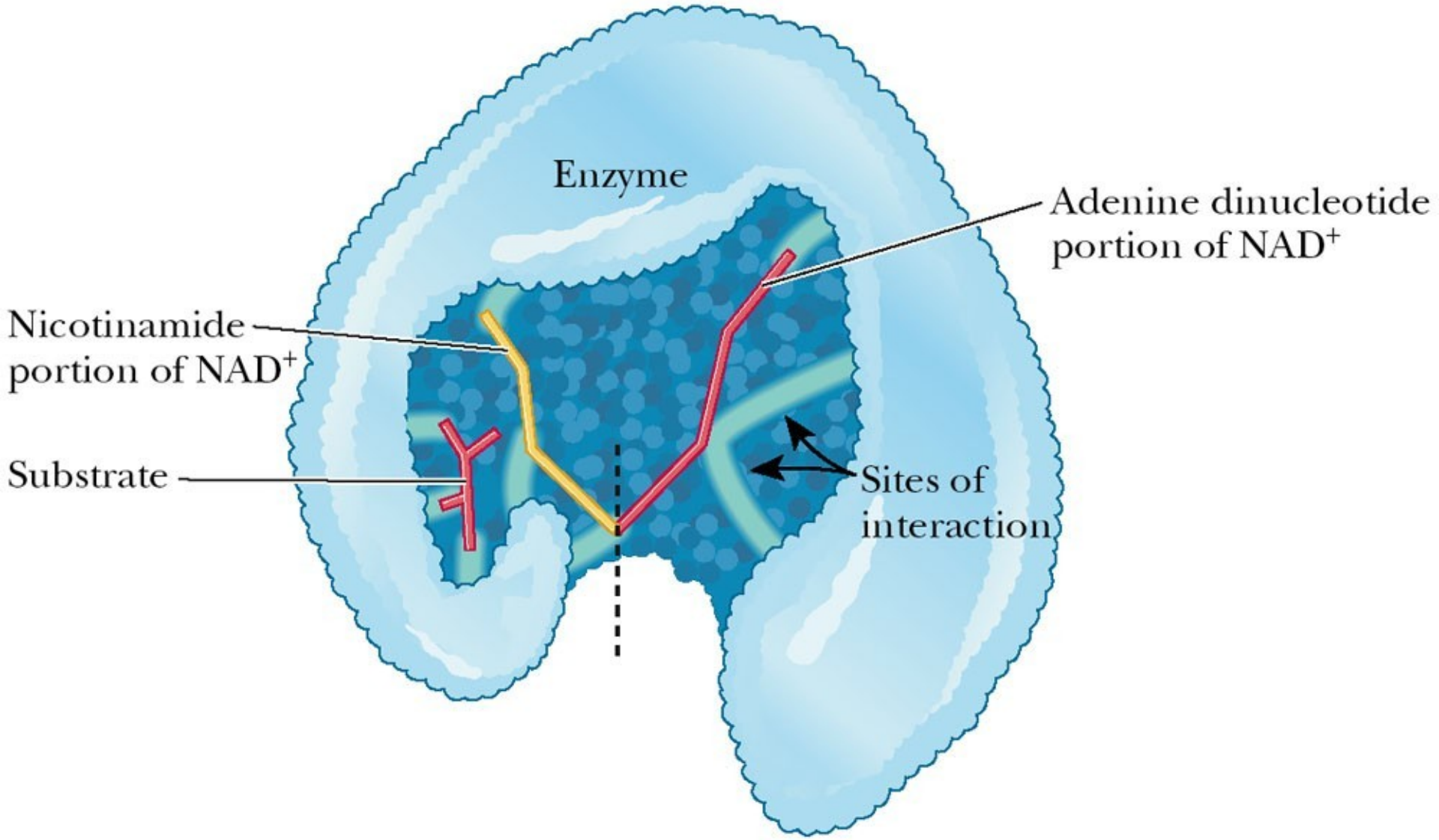
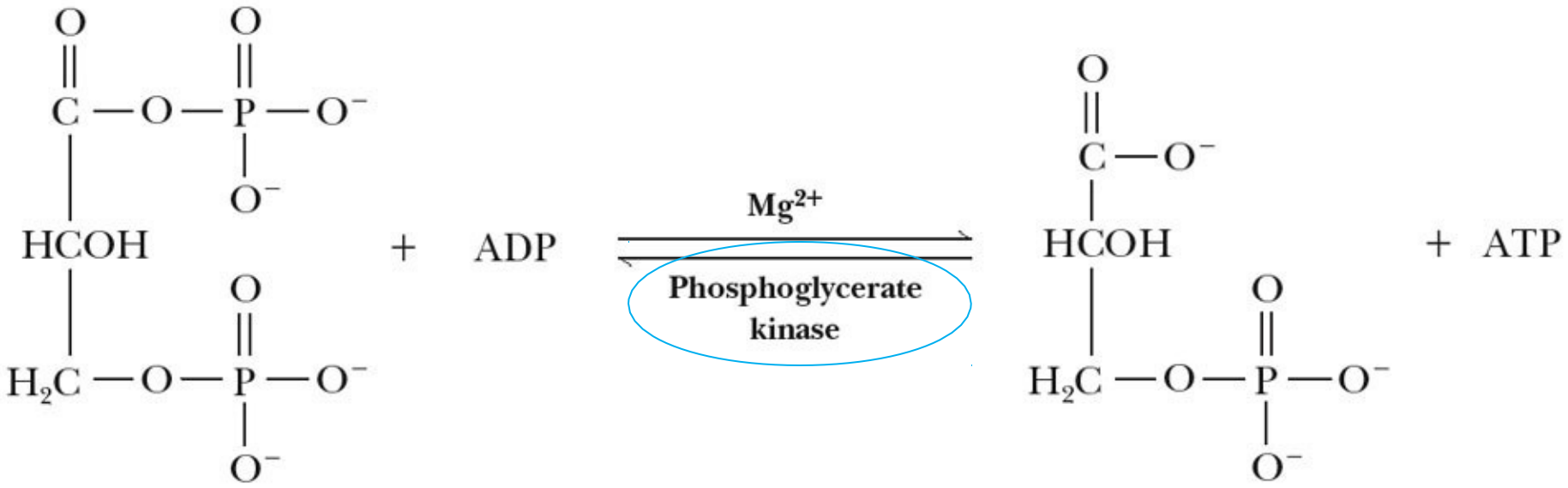


Fig. 17-8, p.475

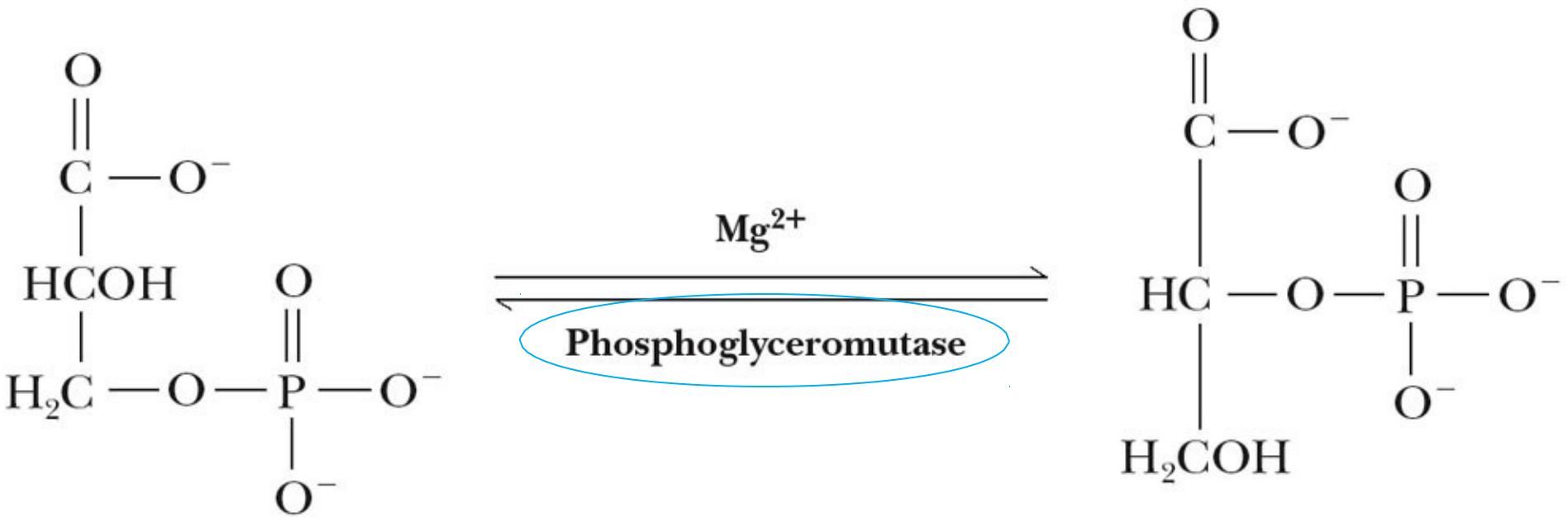
Step 7 Production of ATP by phosphorylation of ADP



1,3-*bis*phosphoglycerate

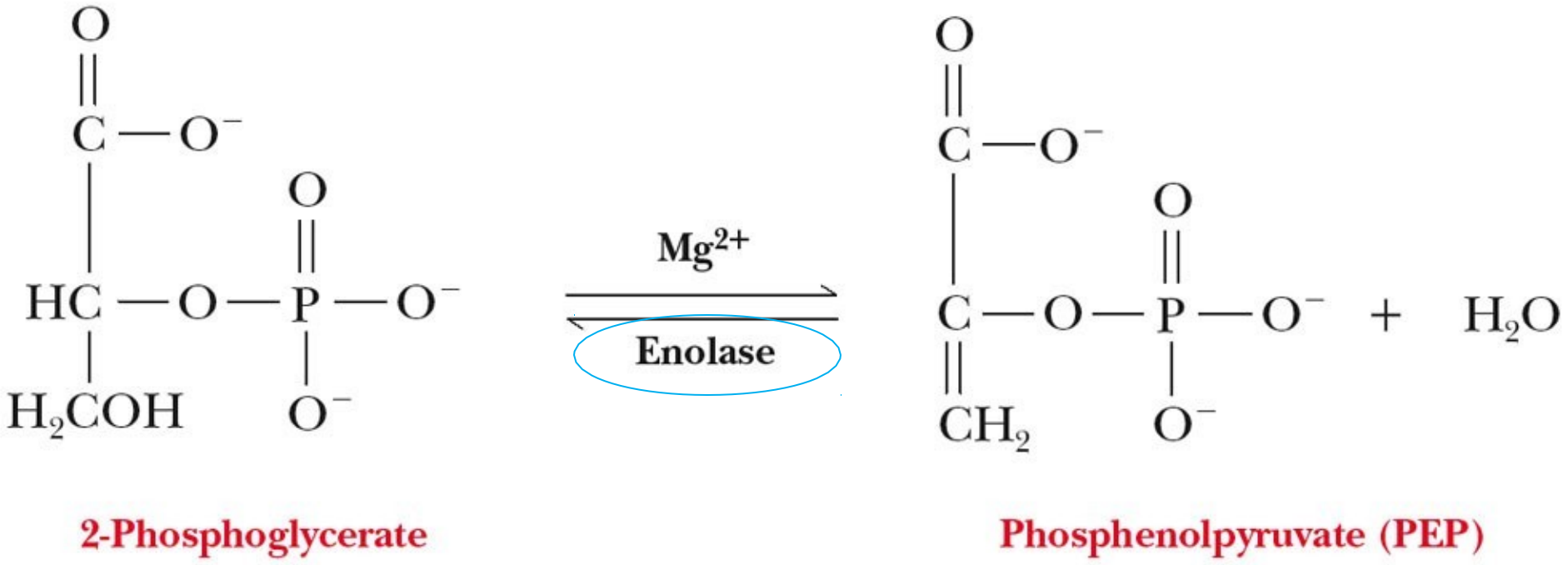
3-Phosphoglycerate

Step 8 Phosphate group is transferred from C-3 to C-2



Step 9

Dehydration reaction of 2-phosphoglycerate to phosphoenolpyruvate

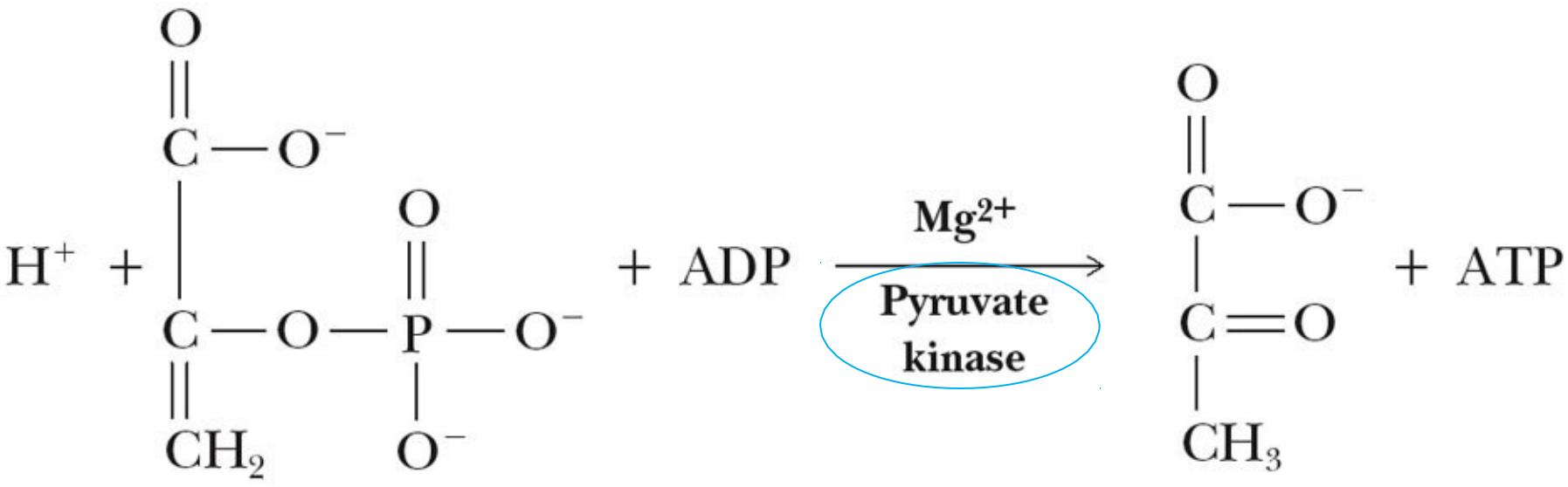


2-Phosphoglycerate

Phosphenolpyruvate (PEP)

Step 10

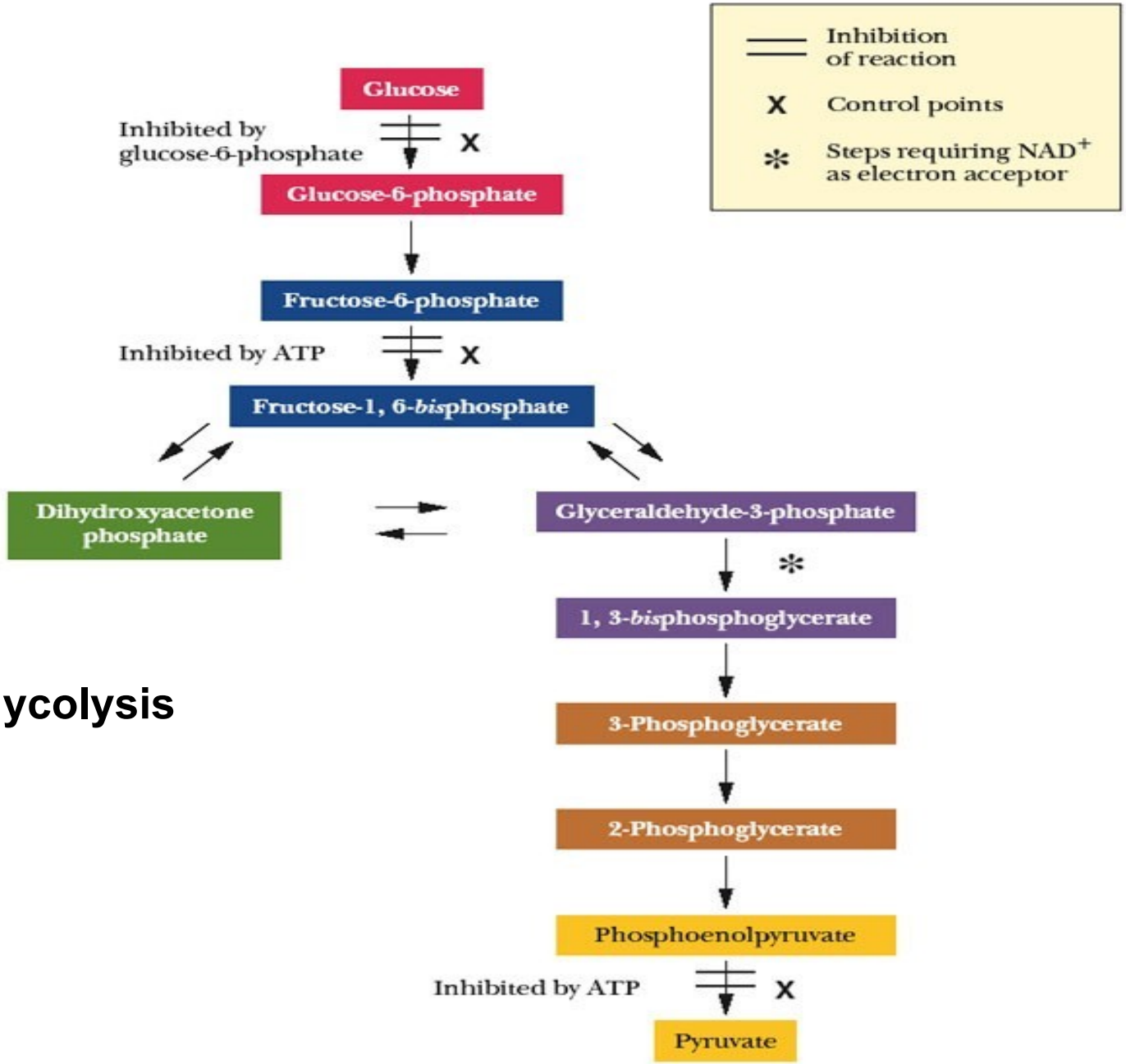
Phosphoenolpyruvate transfers its phosphate group to ADP → ATP and pyruvate



Phosphoenolpyruvate

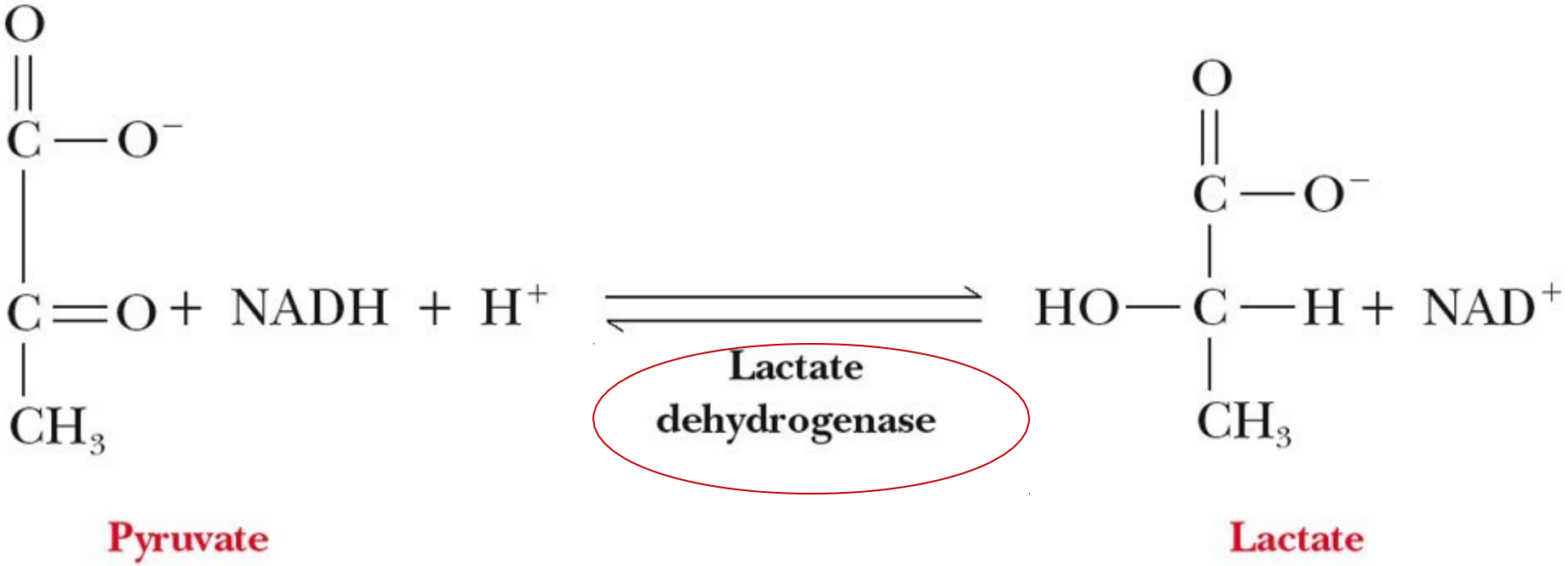
Pyruvate

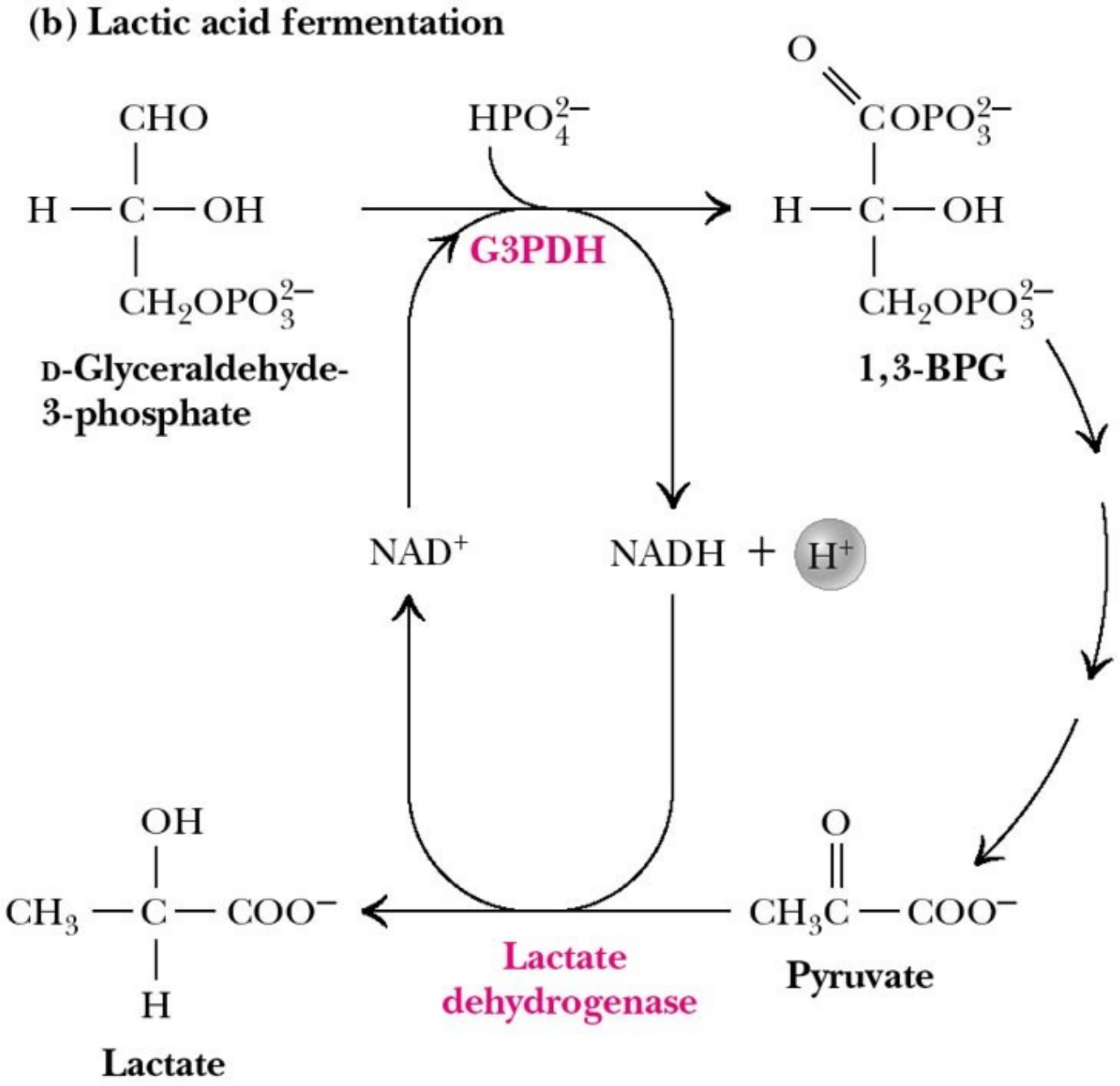
Control points in glycolysis

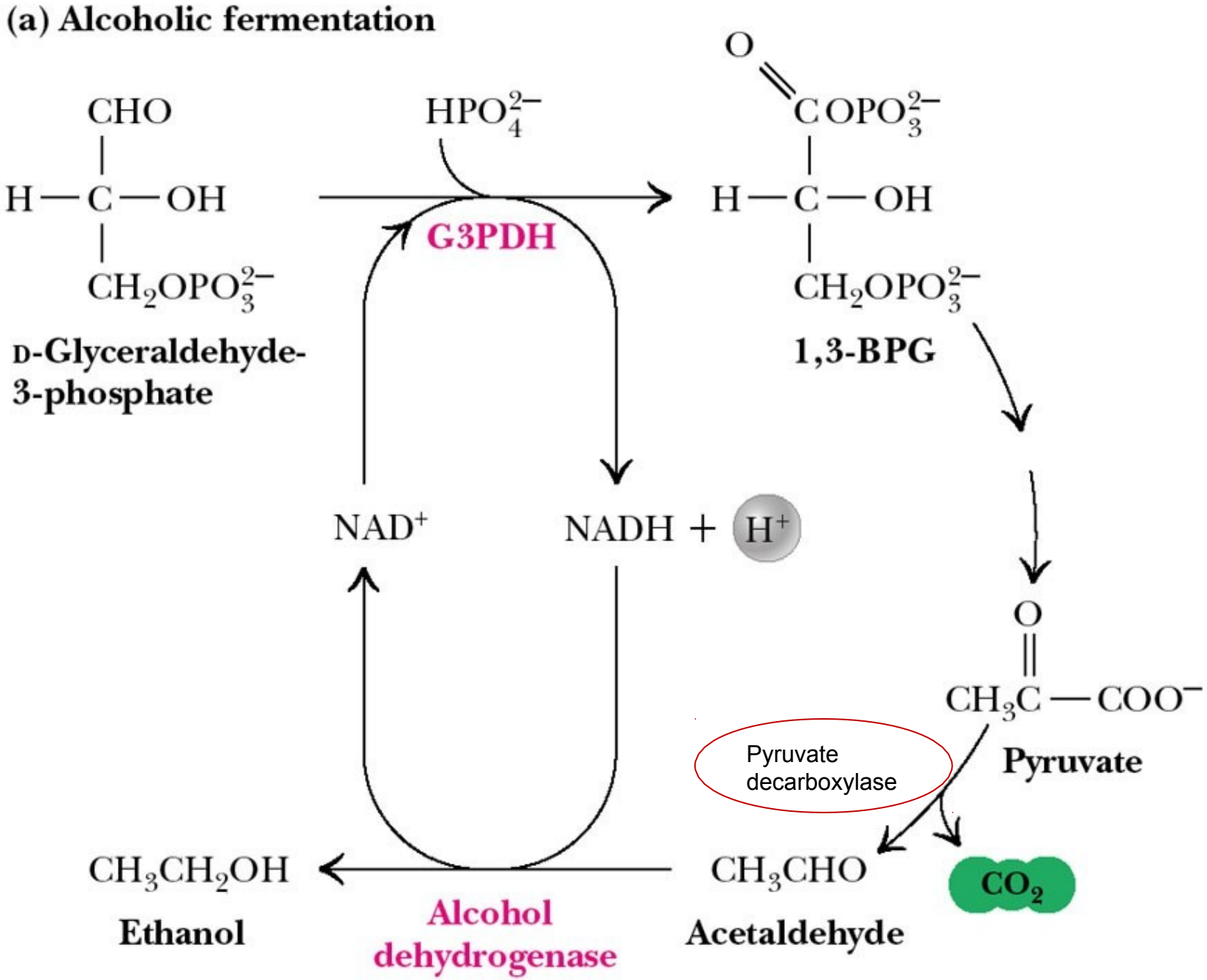


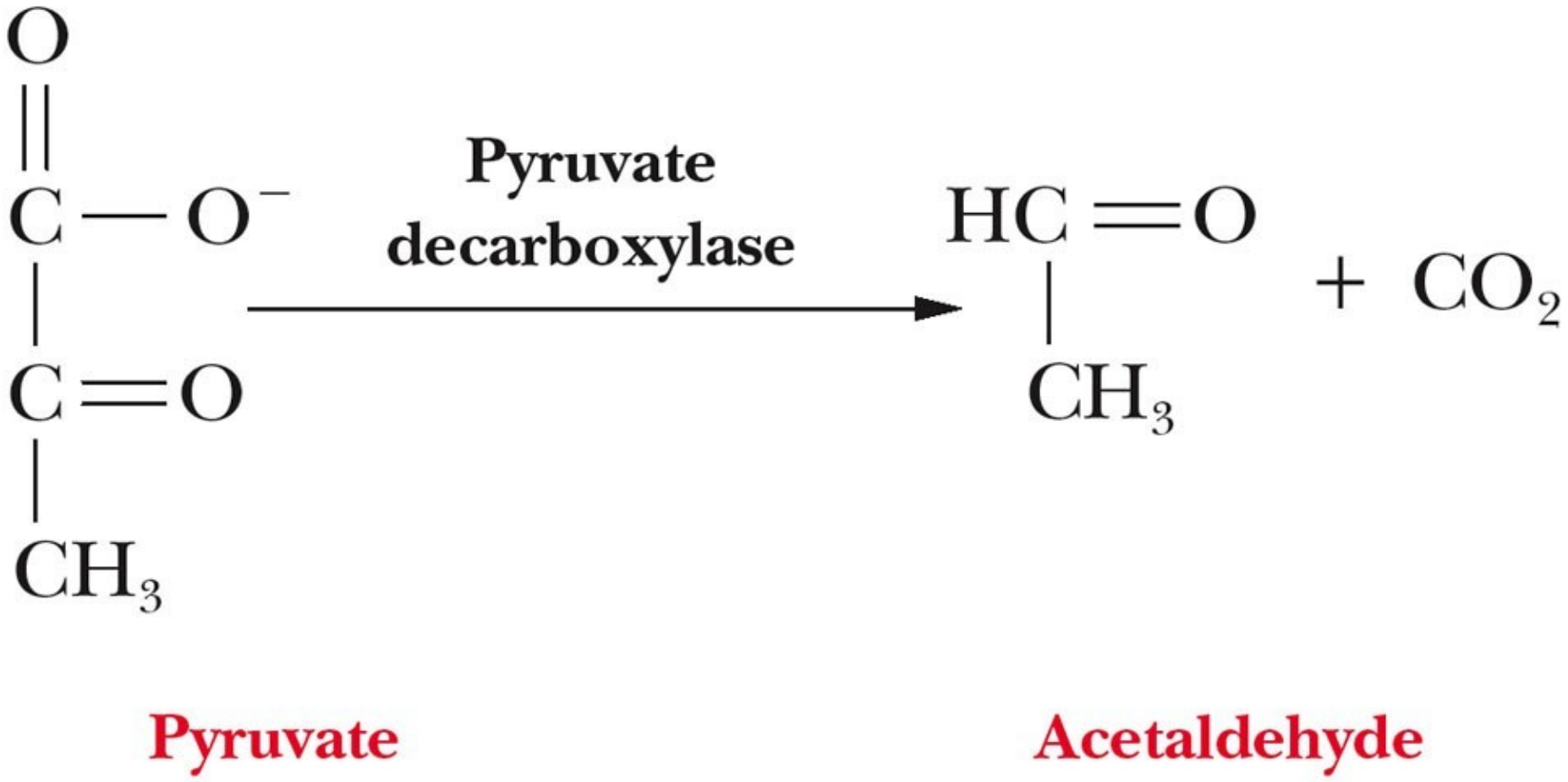
HOW IS PYRUVATE METABOLIZED ANAEROBICALLY?

Conversion of pyruvate to lactate in muscle




(b) Lactic acid fermentation
CHO
H — C — OH
CH2OPO3 2–
D-Glyceraldehyde-3-phosphate
HPO4 2–
G3PDH
O
COPO3 2–
H — C — OH
CH2OPO3 2–
1,3-BPG
NAD+
NADH + H+
OH
CH3 — C — COO–
H
Lactate
Lactate dehydrogenase
O
CH3C — COO–
Pyruvate





Acetaldehyde + NADH → Ethanol + NAD^+

Glucose + 2 ADP + 2 P_i + 2 H^+ → 2 Ethanol + 2 ATP + 2 CO_2 + 2 H_2O