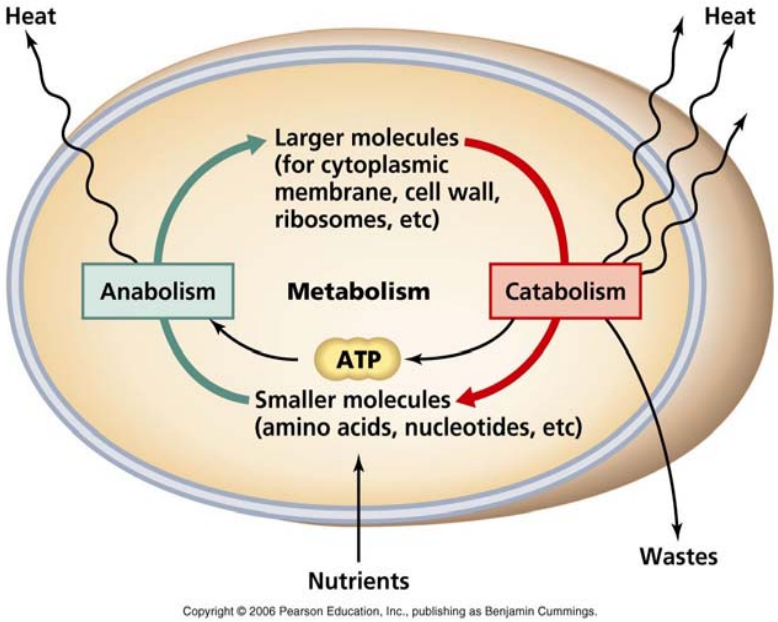
Metabolism basics



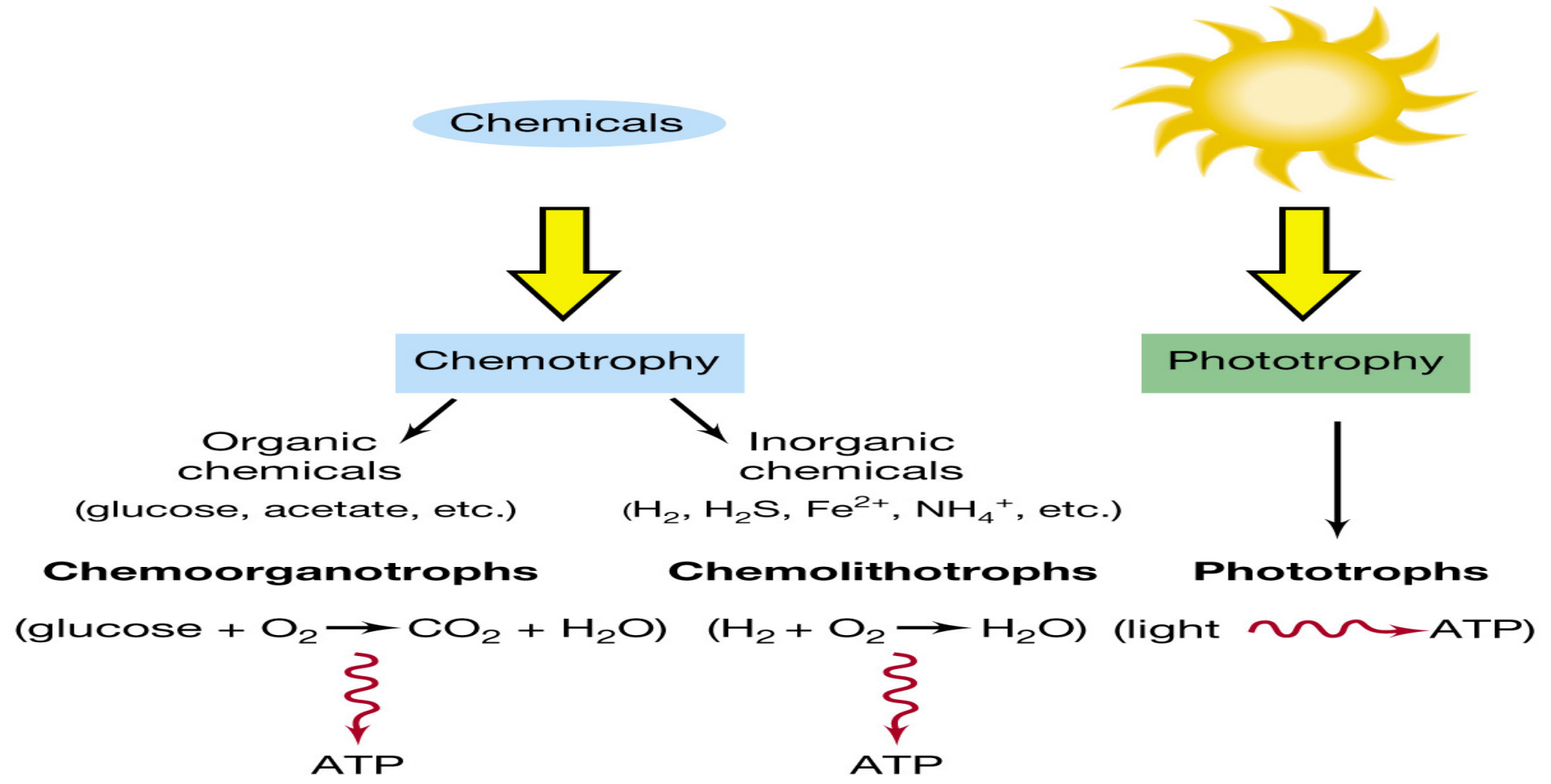
- Metabolism is the sum of all biochemical reactions in the cell (pathways)
- Catabolic pathways break down nutrients to yield smaller molecules and capture stored energy
- Anabolic pathways synthesize larger molecules from smaller precursors and use energy

Fonte di Energia

LUCE → fotosintetici(fotoautotrofi)

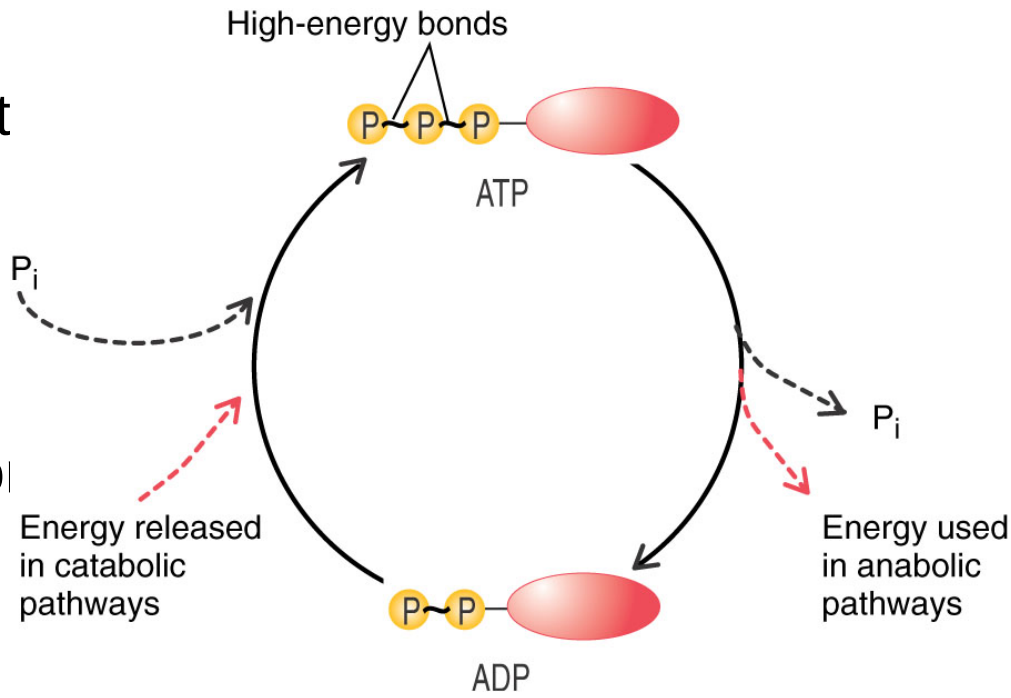
E. CHIMICA → chemioorganotrofi

→ chemioautotrofi(chemiolitotrofi)



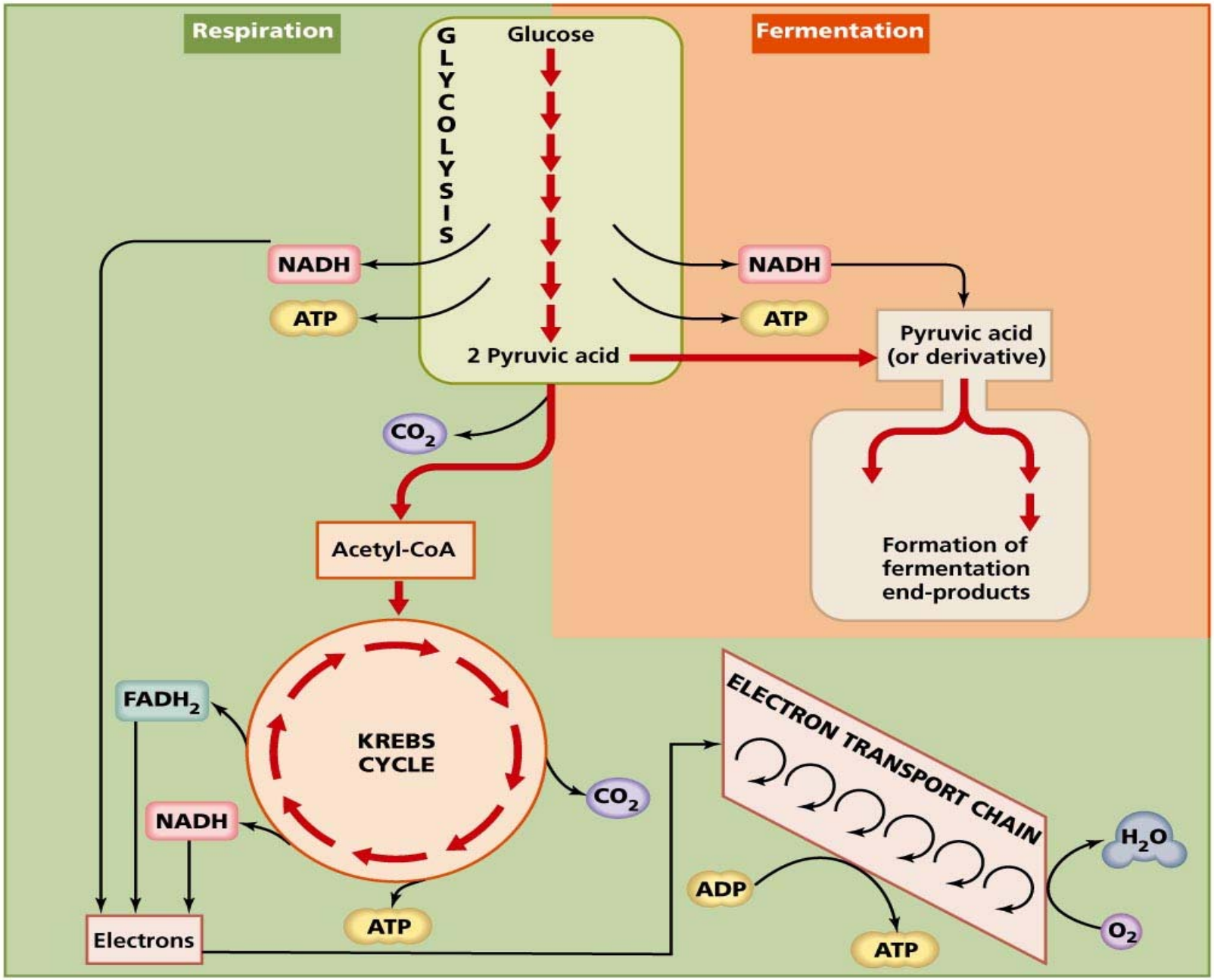
PRINCIPLES OF METABOLISM

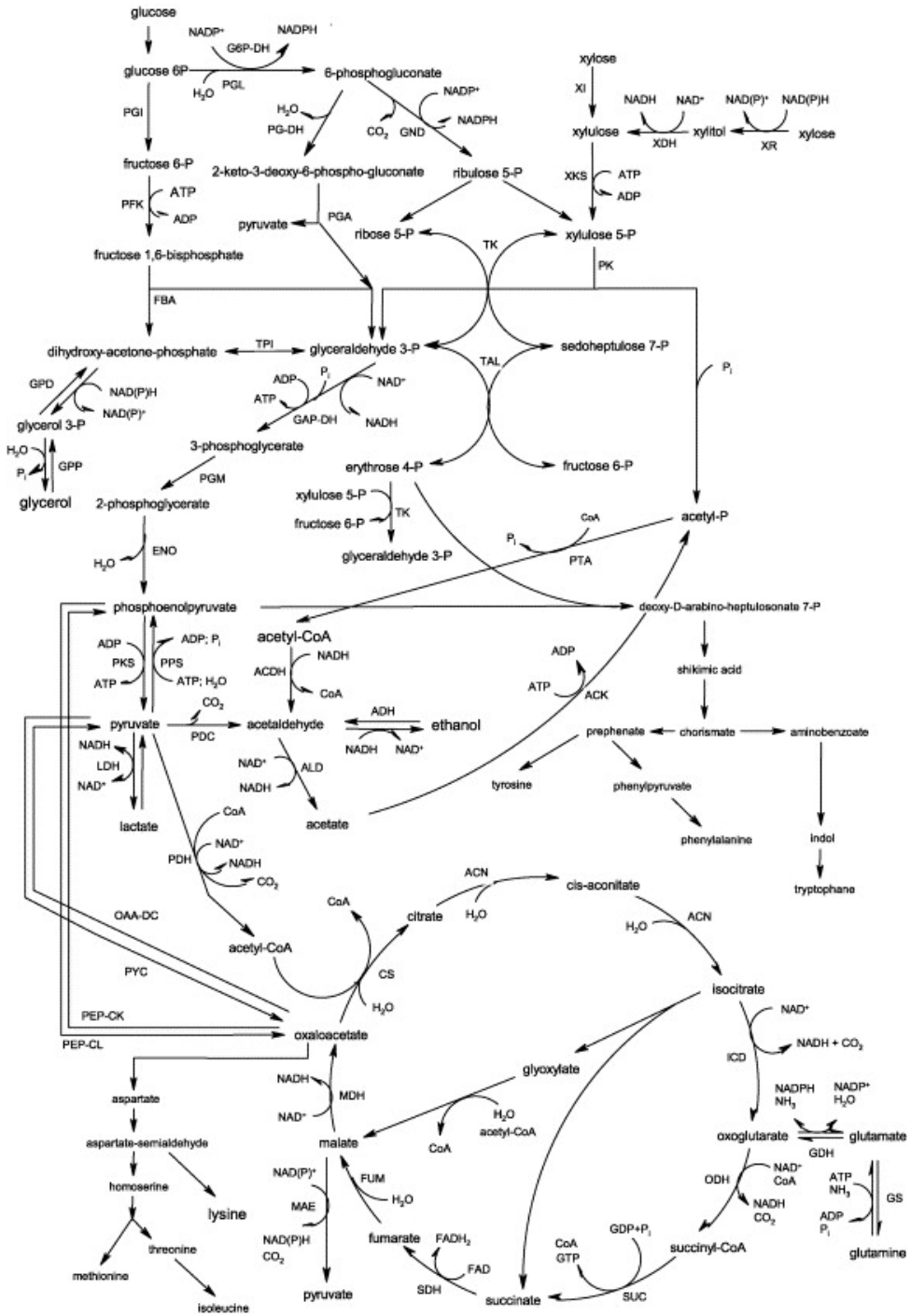
- Substrate phosphorylation
  - Uses chemical energy t add phosphate ion to molecule of ADP
- Oxidative phosphorylation
  - uses energy from proto motive force to add phosphate ion to ADP
- Photophosphorylation
  - Utilizing radiant energy from sun to convert phosphorylate ADP to ATP



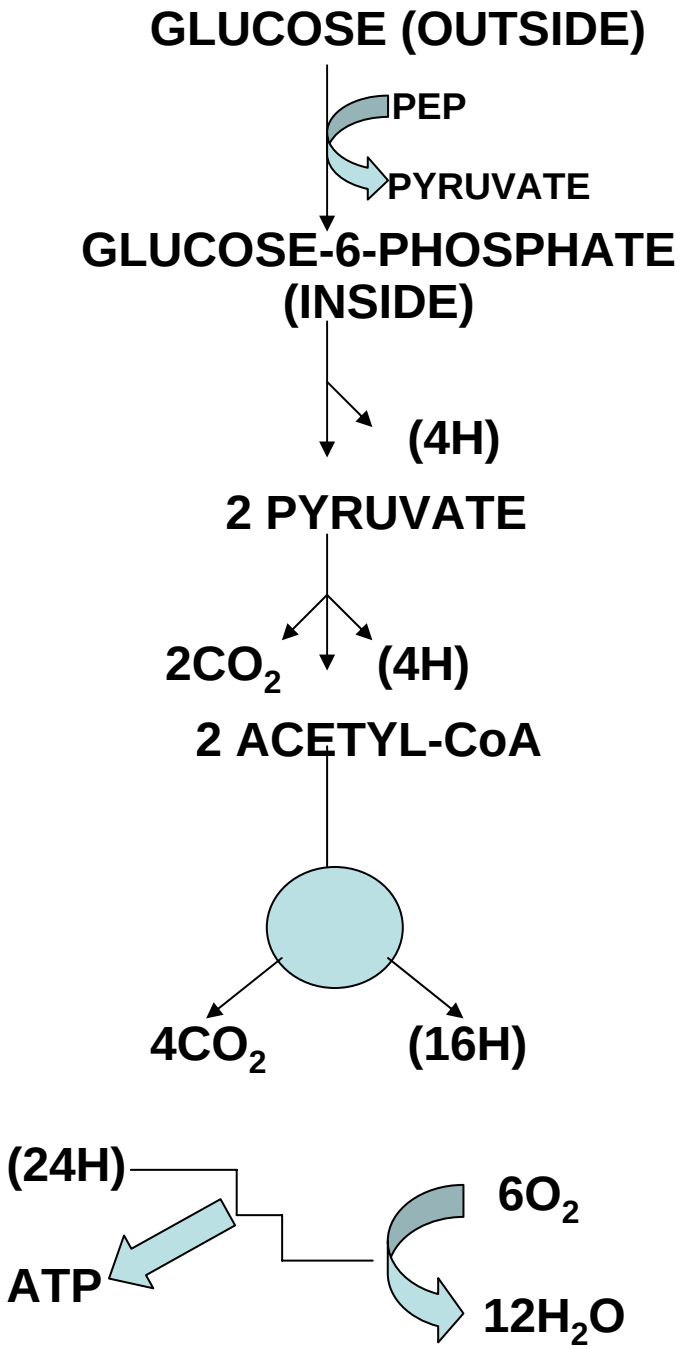
Metabolismo batterico

- **Donatore di elettroni**
  - Composto organico → chemio***organotrofi***
  - Composto inorganico → ***litotrofi***
- **Accettore di elettroni**
  - Ossigeno → ***aerobi***
  - Altro accettore inorganico → ***anaerobi***
  - Intermedio organico → ***fermentanti***





Overview of primary metabolic pathways.
ACDH, acetaldehyde dehydrogenase; ACK, acetate kinase ACN, aconitase; ADH, alcohol dehydrogenase; ALD, aldehyde dehydrogenase; CS, citrate synthase; ENO, enolase; FBA, fructose-bisphosphate aldolase; FUM, fumarase; GAP-DH, glyceraldehyde 3-phosphate dehydrogenase; GDH, glutamate dehydrogenase; GND, 6-phosphogluconate-dehydrogenase; GPD, glycerol 3-phosphate dehydrogenase; GPP, glycerol phosphatase; G6P-DH, glucose 6-phosphate dehydrogenase; GS, glutamine synthetase; ICD, isocitrate dehydrogenase; LDH, lactate dehydrogenase; MAE, malic enzyme; MDH, malate dehydrogenase; OAA-DC, oxaloacetate decarboxylase; ODH, 2-oxoglutarate dehydrogenase; PDC, pyruvate decarboxylase; PDH, pyruvate dehydrogenase; PEP-CK, phosphoenolpyruvate carboxykinase; PEP-CL, phosphoenol-pyruvate carboxylase; PFK, phosphofructokinase; PGA, 2-keto-3-deoxy-6-phosphogluconate aldolase; PG-DH, phosphogluconate dehydratase; PGI, phosphoclucose-isomerase; PGL, 6-phosphogluconolactonase; PGM, phosphoglycerate mutase; PK, phosphoketolase; PKS, pyruvate kinase; PPS, phosphoenolpyruvate synthetase; PTA, phosphotransacetylase; PYC, pyruvate carboxylase; SDH, succinate dehydrogenase; SUC, succinyl synthetase; TAL, transaldolase; TK, transketolase; TPI, triosephosphate isomerase; XDH, xylitol dehydrogenase; XI, xylose isomerase; XKS, xylulose kinase; XR, xylose reductase.



A. Transport of D-glucose into the cell by the PHOSPHOENOLPYRUVATE PHOSPHOTRANSFERASE SYSTEM

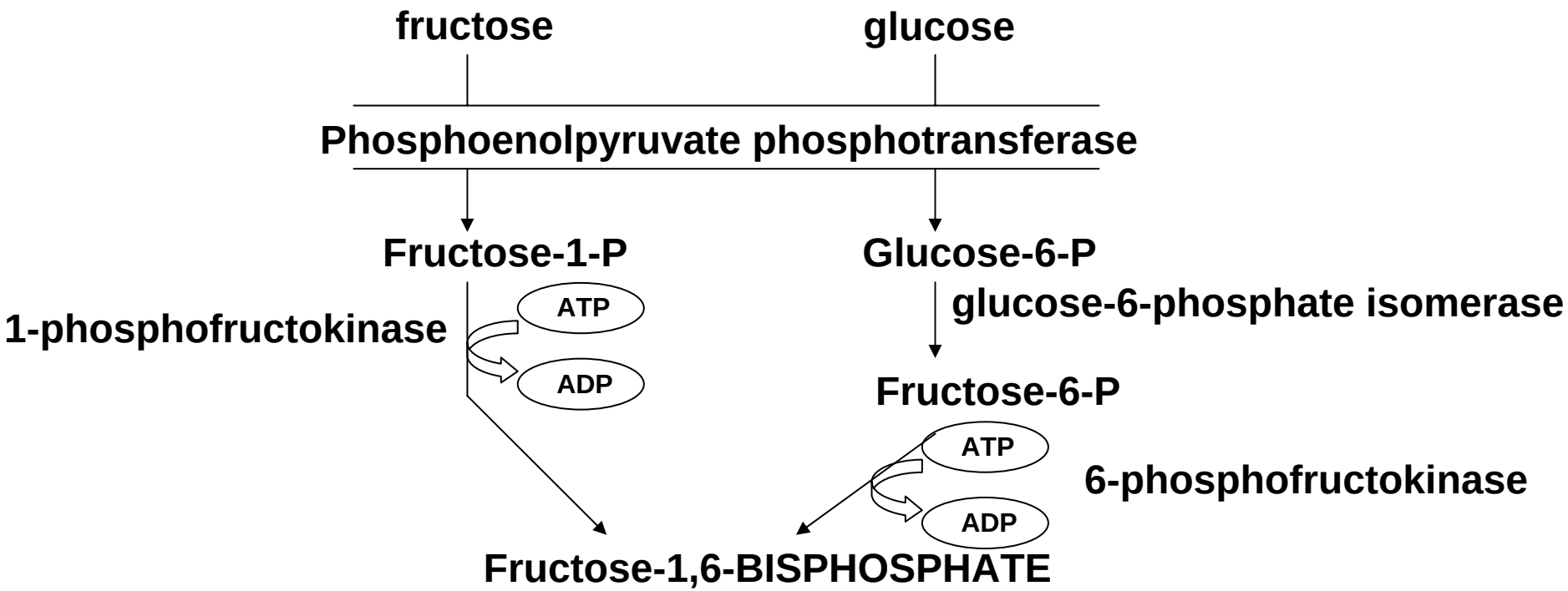
B. Degradation of D-glucose-6-P to pyruvate via the EMBDEN-MEYERHOF-PARNAS (EMP) pathway

C. Oxidative decarboxylation of pyruvate to acetyl-CoA by PYRUVATE DEHYDROGENASE

D. Oxidation of the acetyl moiety to CO_2 via the TRICARBOXYLIC ACID CYCLE

E. Oxidation of the reduced coenzymes in the RESPIRATORY CHAIN

THE FIRST STEPS OF GLUCOSE AND FRUCTOSE METABOLISM IN *E. coli*

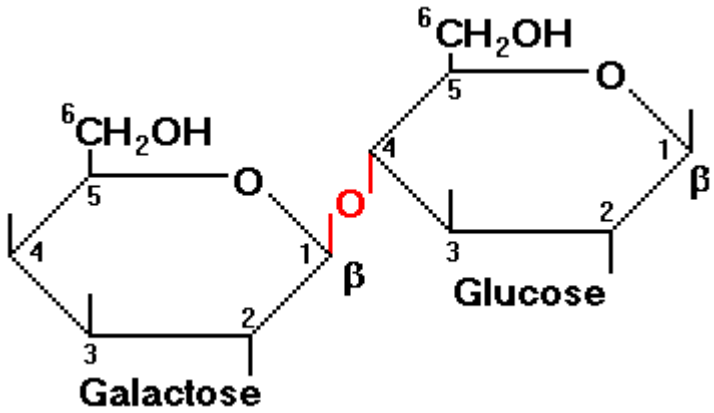


CONVERSION OF LACTOSE IN GALACTOSE AND GLUCOSE

lactose

Permease (energy-dependent) membrane

lactose



H_2O

β-galactosidase

galactose glucose

Conversion of galactose into glucose-1-phosphate

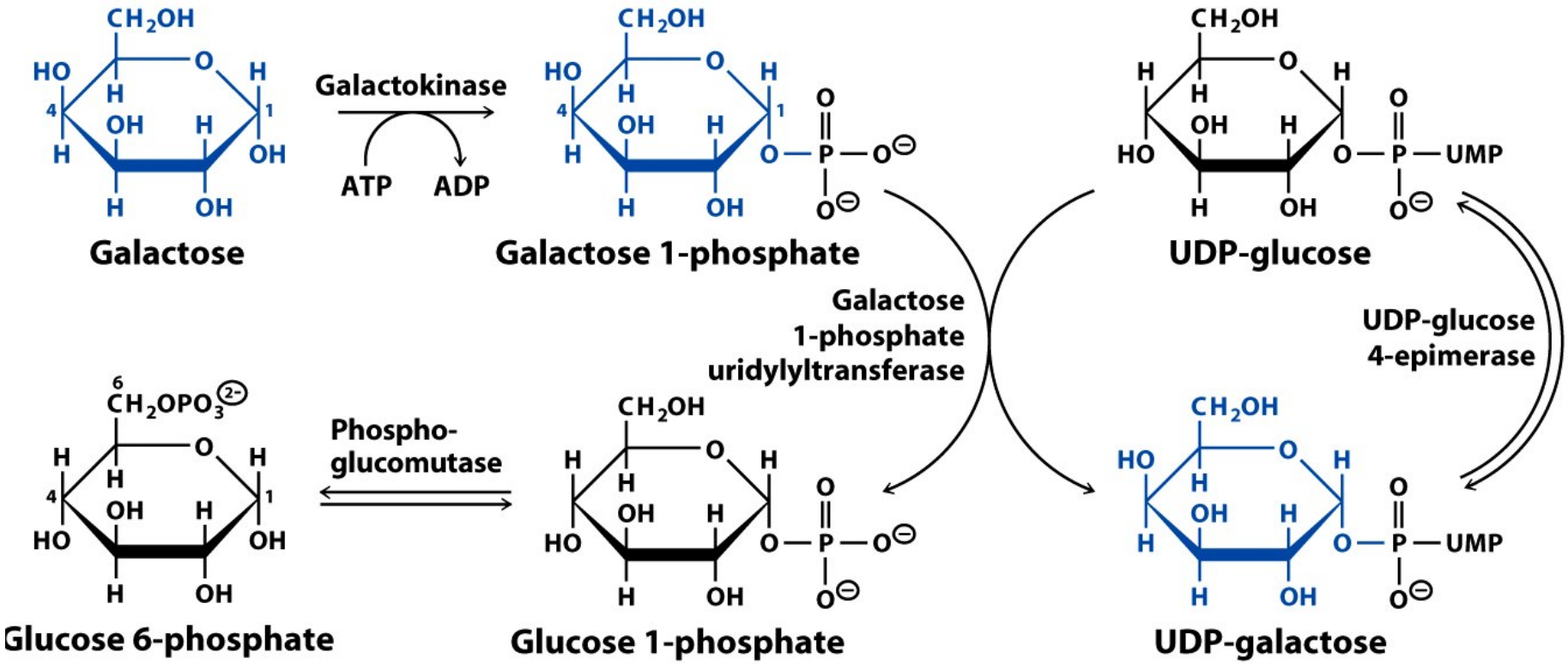
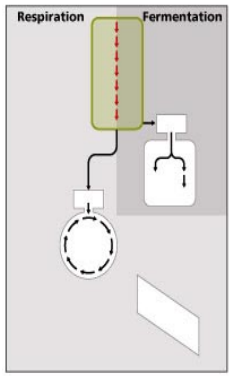
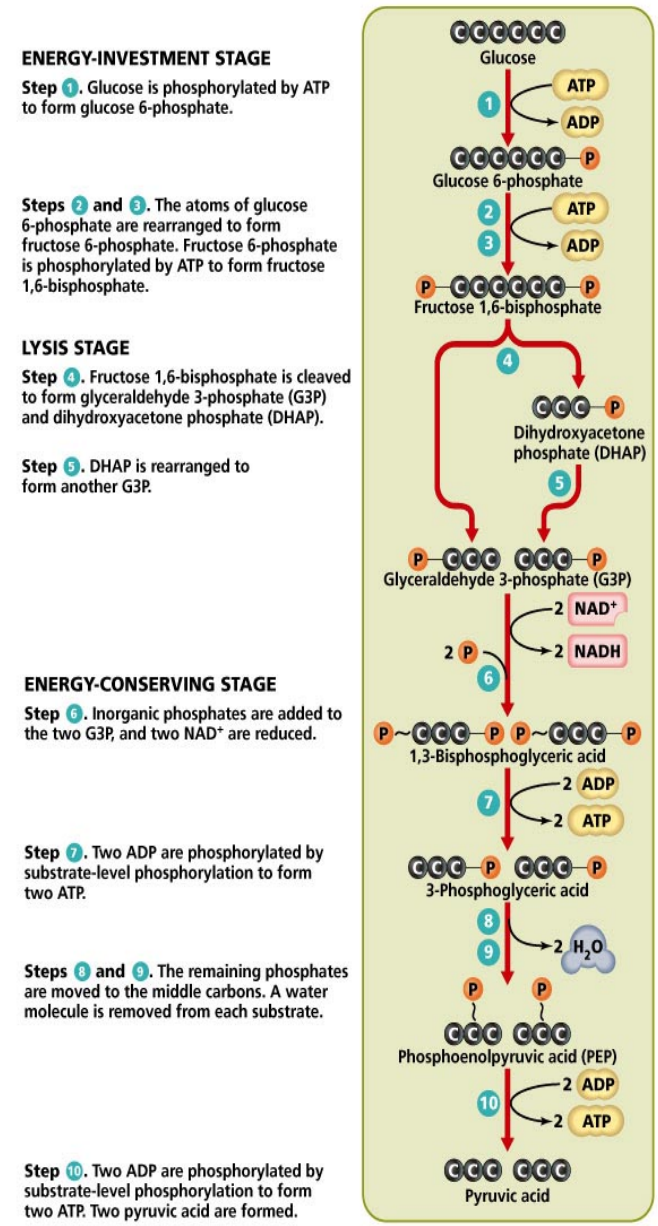


Figure 11-21 Principles of Biochemistry, 4/e

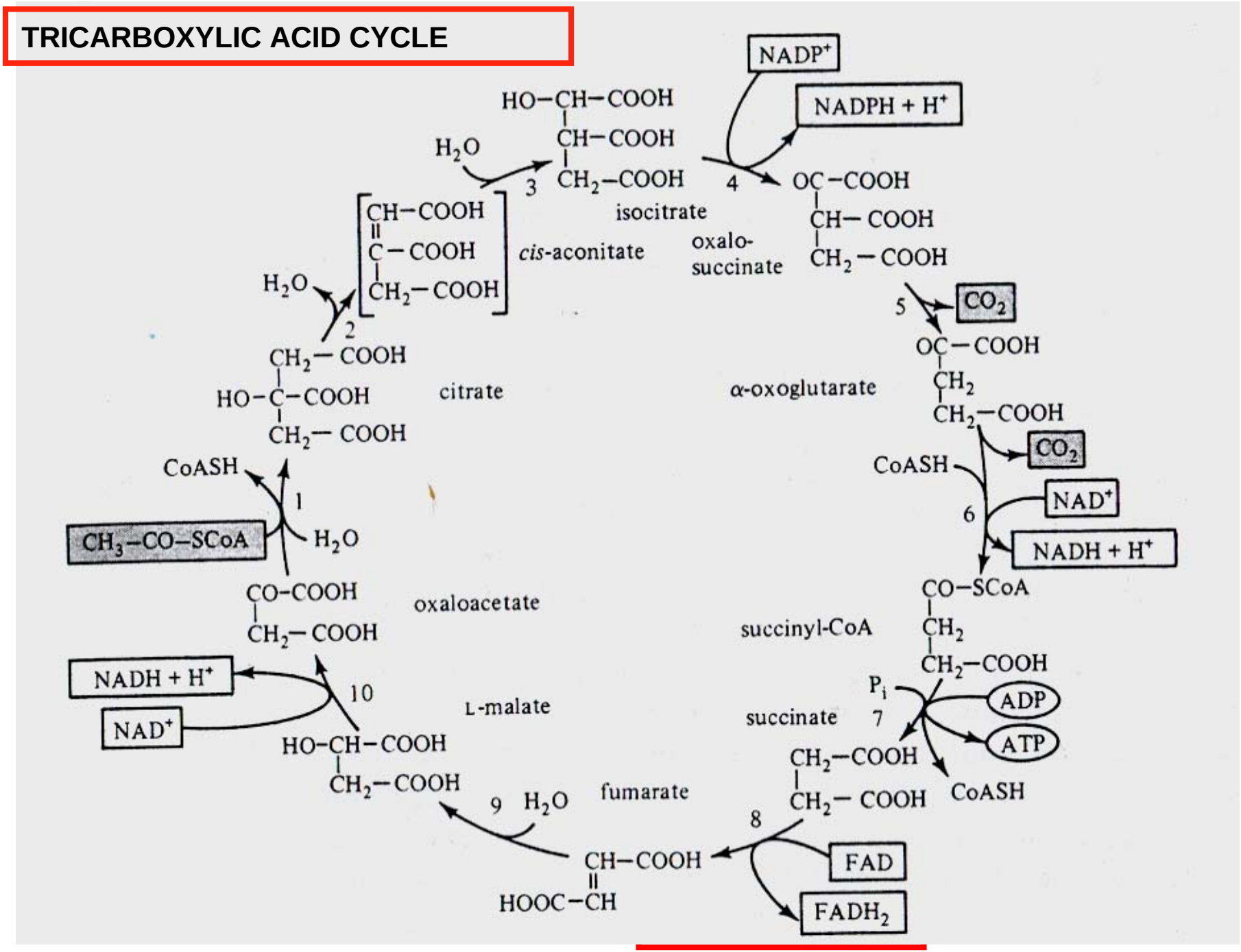
Products of glycolysis



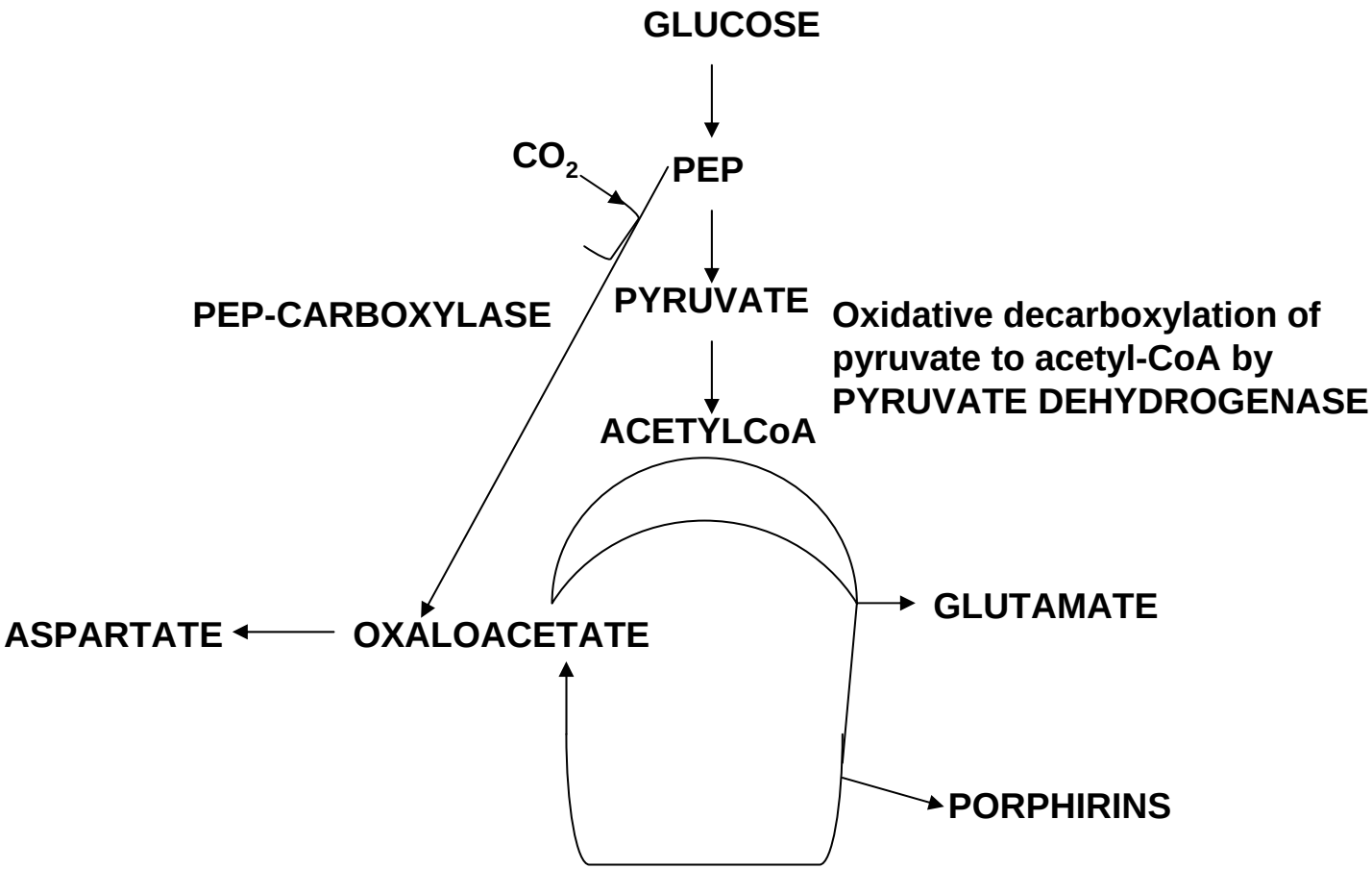


- 2 NADH and 4 ATP produced
- ATP production via substrate level phosphorylations
- Fermentation occurs if pyruvic acid does not enter the Krebs cycle and if electrons from glucose metabolism don’t go down ETS
- Fermentation typically anaerobic and yields acid bi-products

TRICARBOXYLIC ACID CYCLE

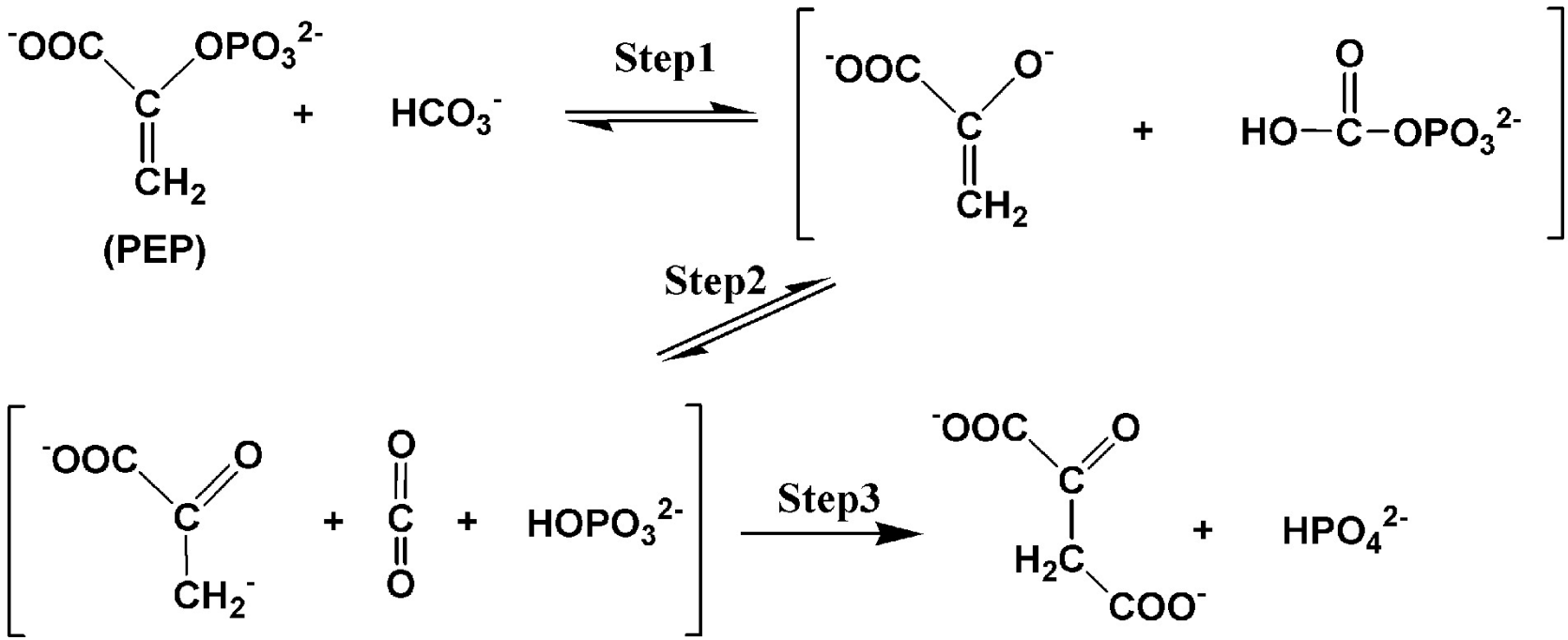


THE FUNCTION OF PEP CARBOXYLASE AS ANAPLEROTIC ENZYME DURING GROWTH OF *E. coli* ON GLUCOSE

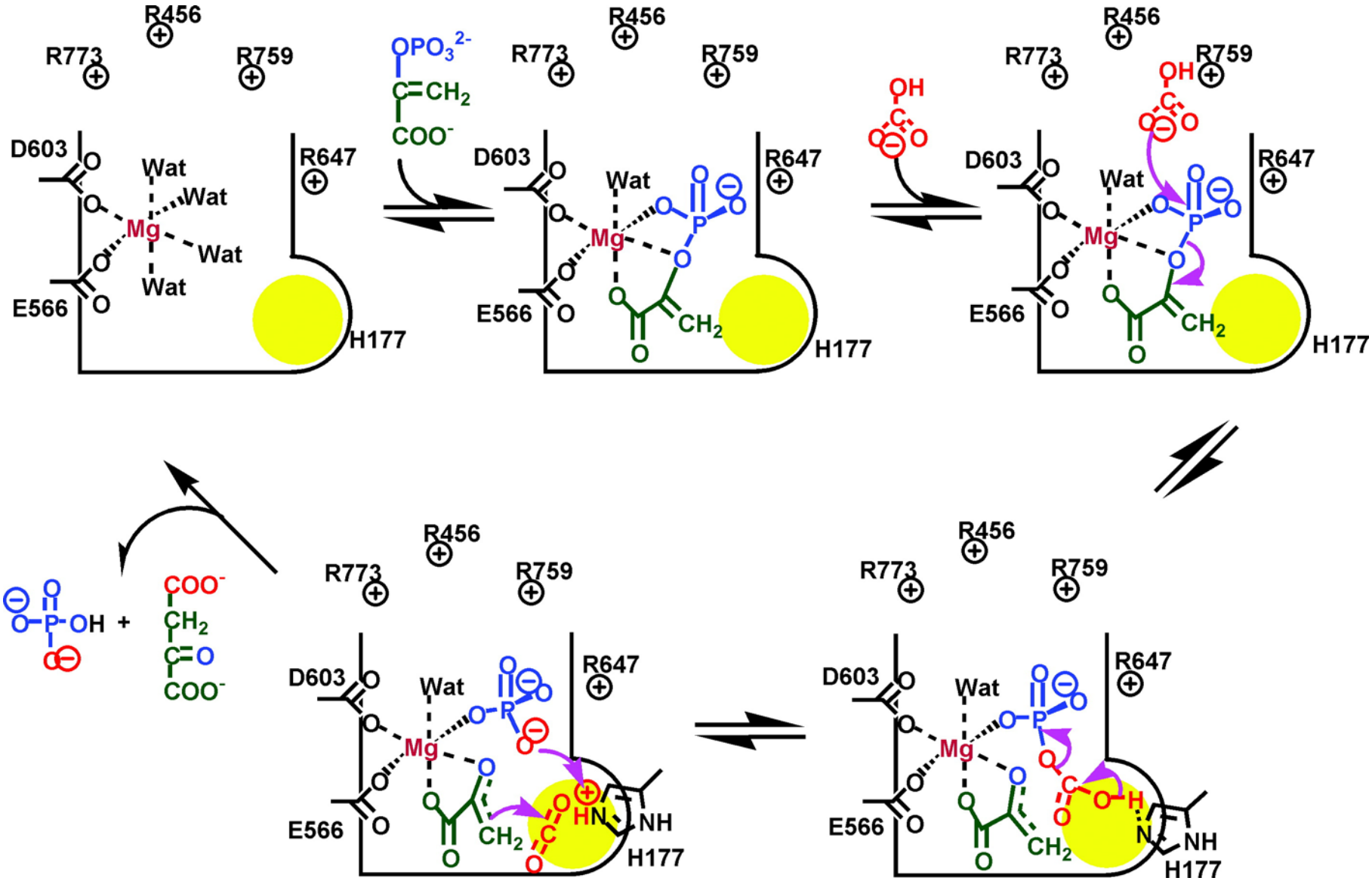


$$PEP + CO_2 \xrightarrow{\text{PEP- CARBOXYLASE}} OXALOACETATE + P_i$$

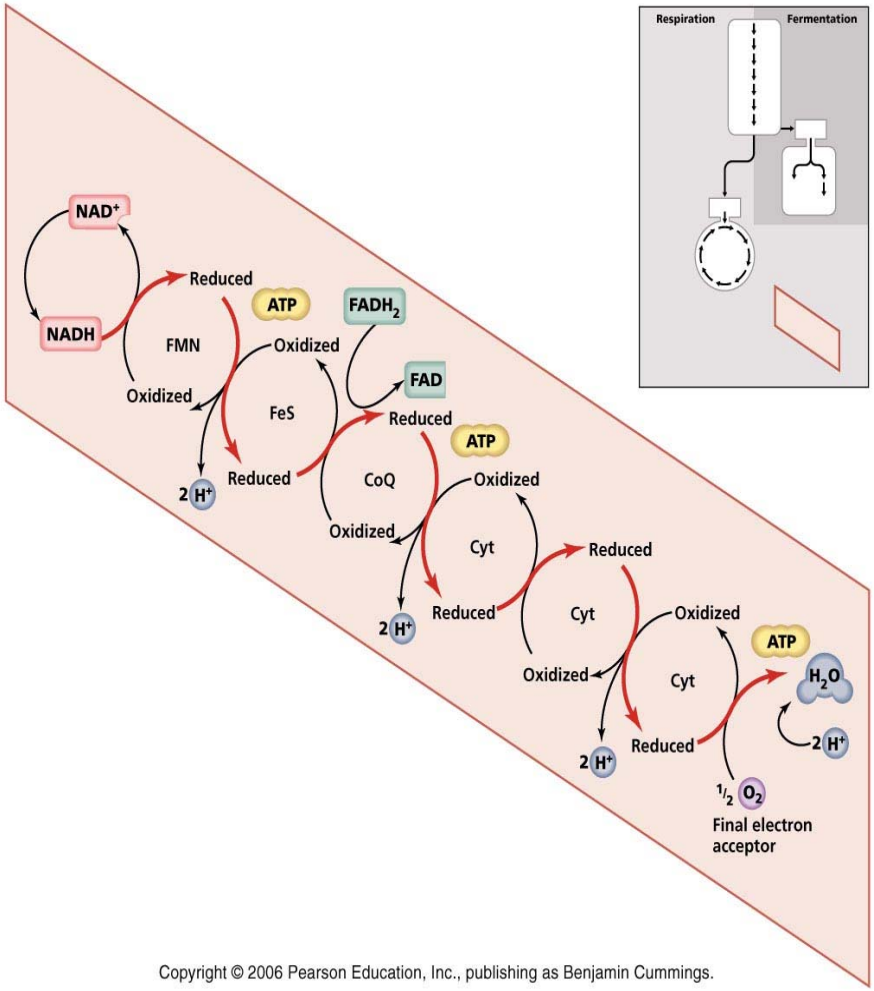
Phosphoenolpyruvate carboxylase



Phosphoenolpyruvate carboxylase mechanism

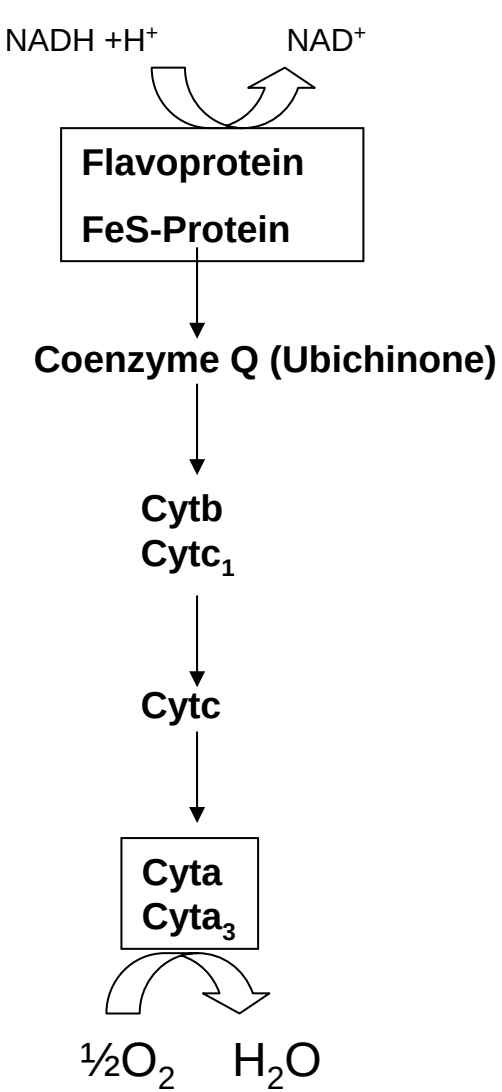


Respiration -- the electron transport system

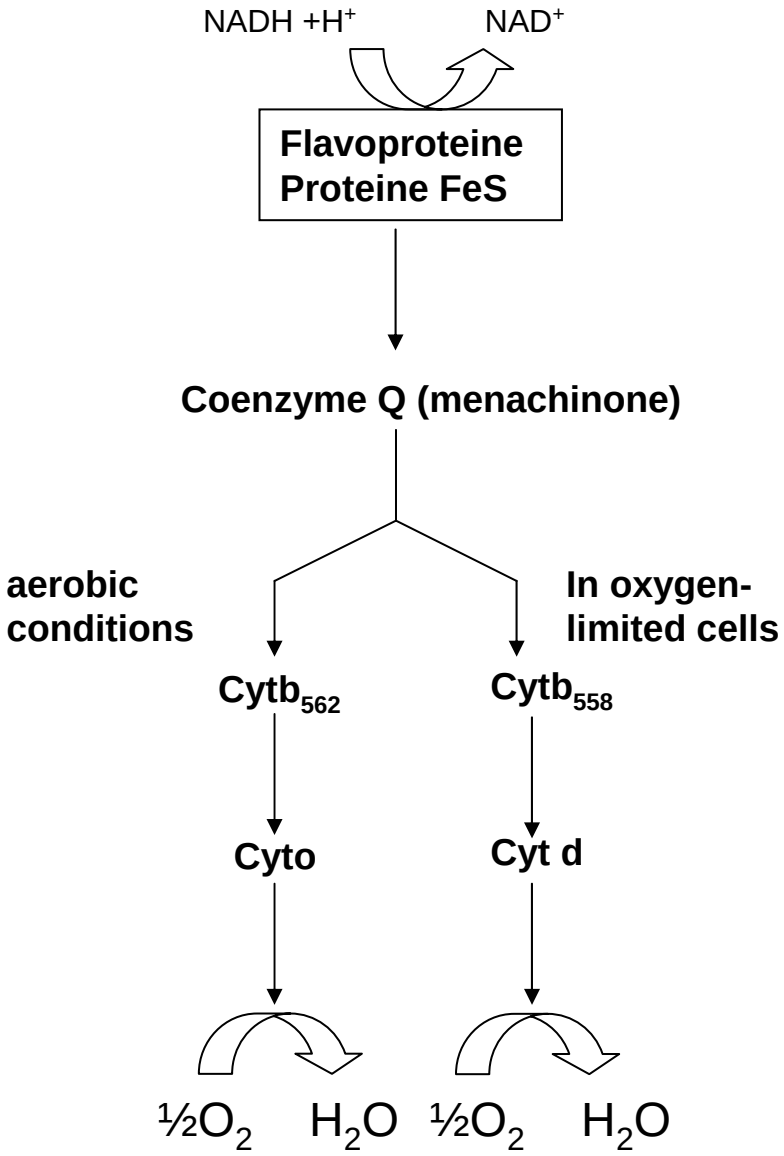


- Most of the ATP produced in microbes is produced by an electron transport system
- The system is a series of membrane bound electron carriers
- As electrons flow, energy is used to pump H+s out of cell
- Many different ETSs occur in microbes

Components of the respiratory chains of mitochondria and of *E. coli*



MITOCHONDRIA



E. coli

Pentose Phosphate Pathway

- Produces ATP
- Yields NADPH, important as a source of electrons for the reduction of other molecules
- Method of metabolising 5-C and 4-C sugars
- 5-C sugars important of amino acid biosynthesis
- Used in conjunction with glycolysis by most microbes