Metabolism: Concepts and Design

Dr Supanut Pairohakul

Basic Concepts – Revisions

- กฎเทอร์โมไดนามิกส์ (Law of Thermodynamics)
  - กฎข้อที่ 1 ของเทอร์โมไดนามิกส์

Basic Concepts – Revisions

- กฎเทอร์โมไดนามิกส์ (Law of Thermodynamics)
  - กฎข้อที่ 2 ของเทอร์โมไดนามิกส์

Basic Concepts – Revisions

- กฎเทอร์โมไดนามิกส์ (Law of Thermodynamics)
  - กฎข้อที่ 2 ของเทอร์โมไดนามิกส์ (quantitative considerations)

Basic Concepts – Revisions

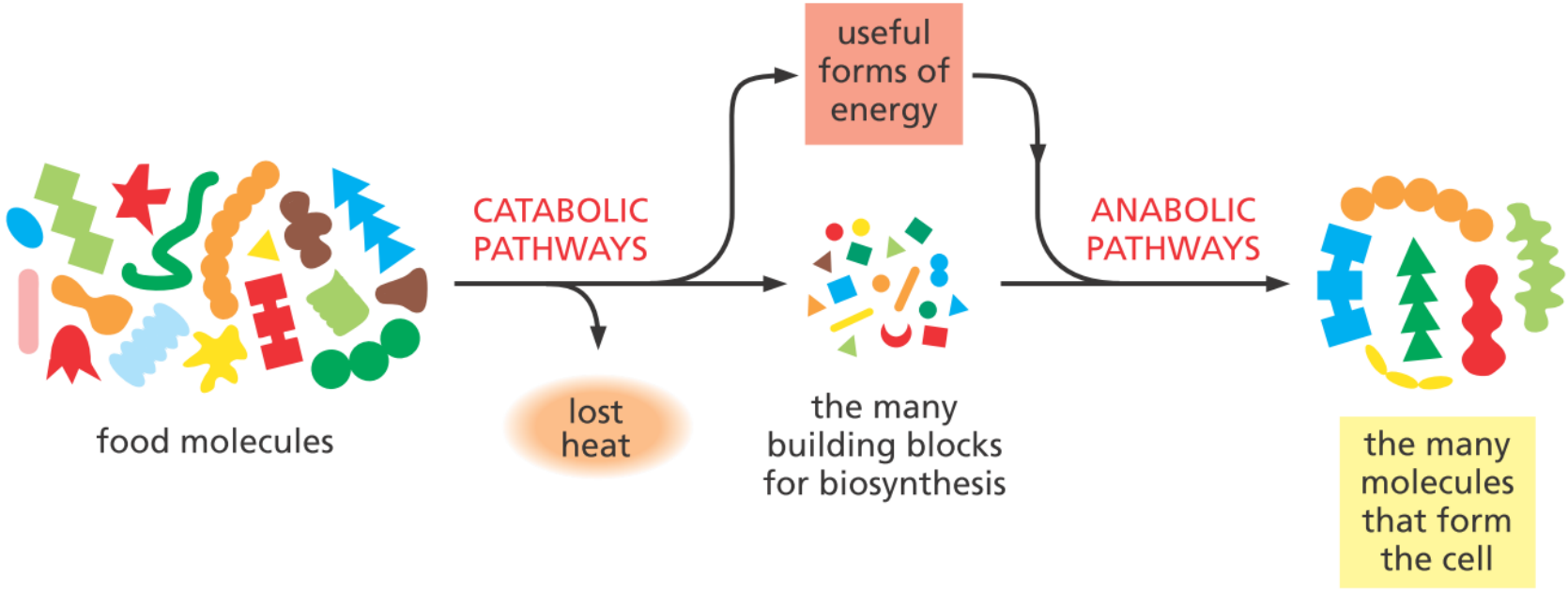
- กฎเทอร์โมไดนามิกส์กับการเกิดปฏิกิริยาเคมี (chemical reaction)

Basic Concepts – Revisions

- เมแทบอลิซึม (metabolism) – ลักษณะ (characteristics)

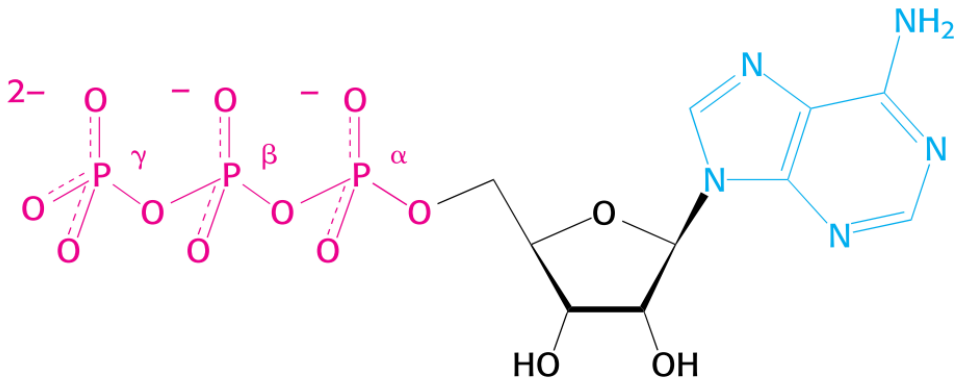
Basic Concepts – Revisions

- เมแทบอลิซึม (metabolism)
  - Anabolic pathway vs. Catabolic pathway

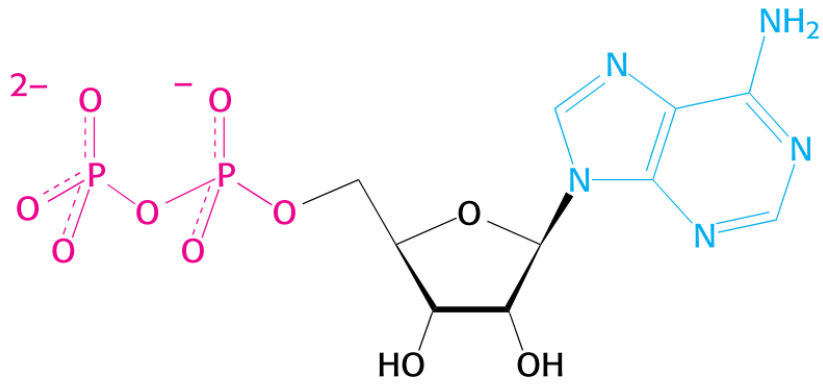


Basic Concepts – Revisions

- ATP (Adenosine Triphosphate)



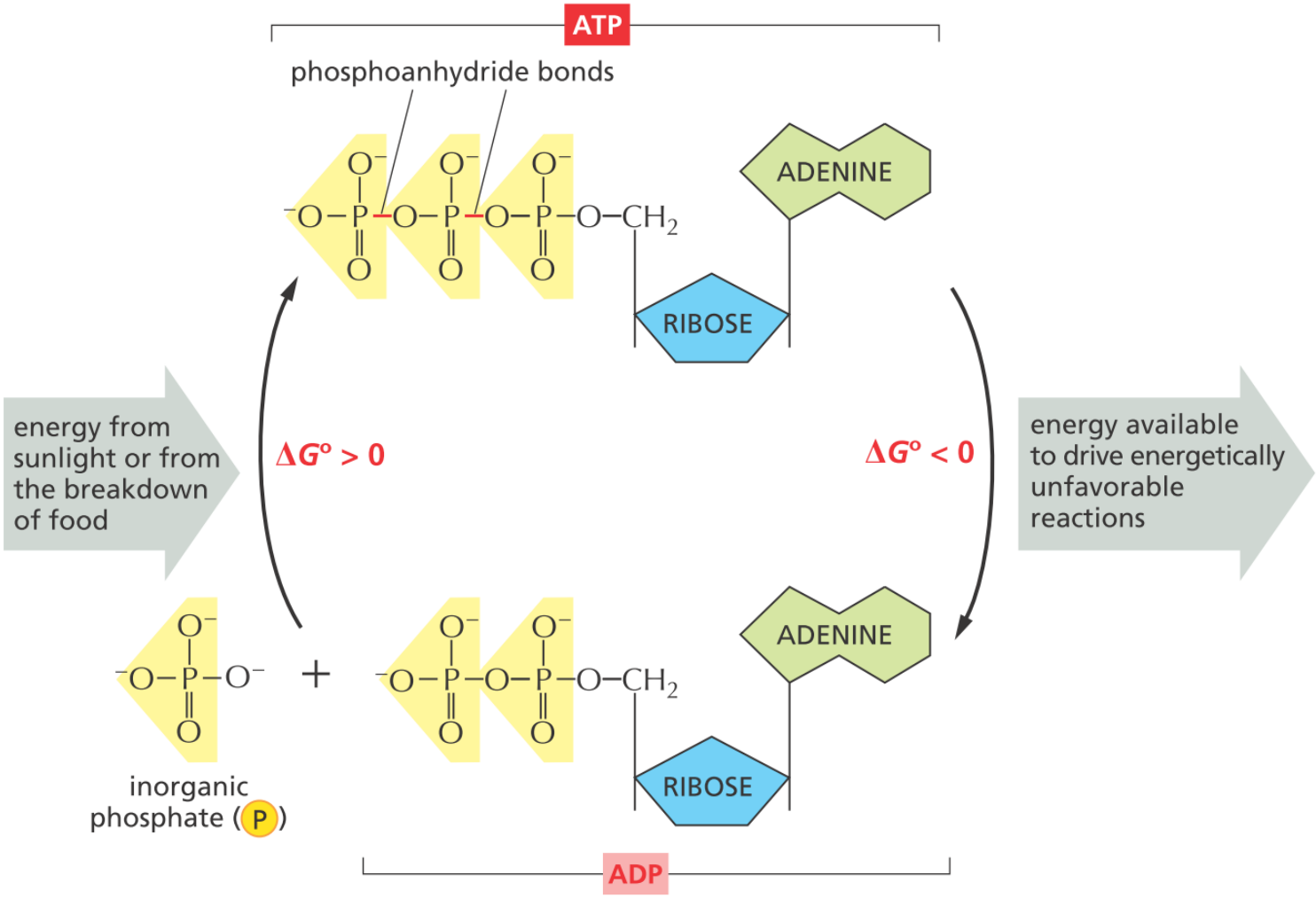
Adenosine triphosphate (ATP)



Adenosine diphosphate (ADP)

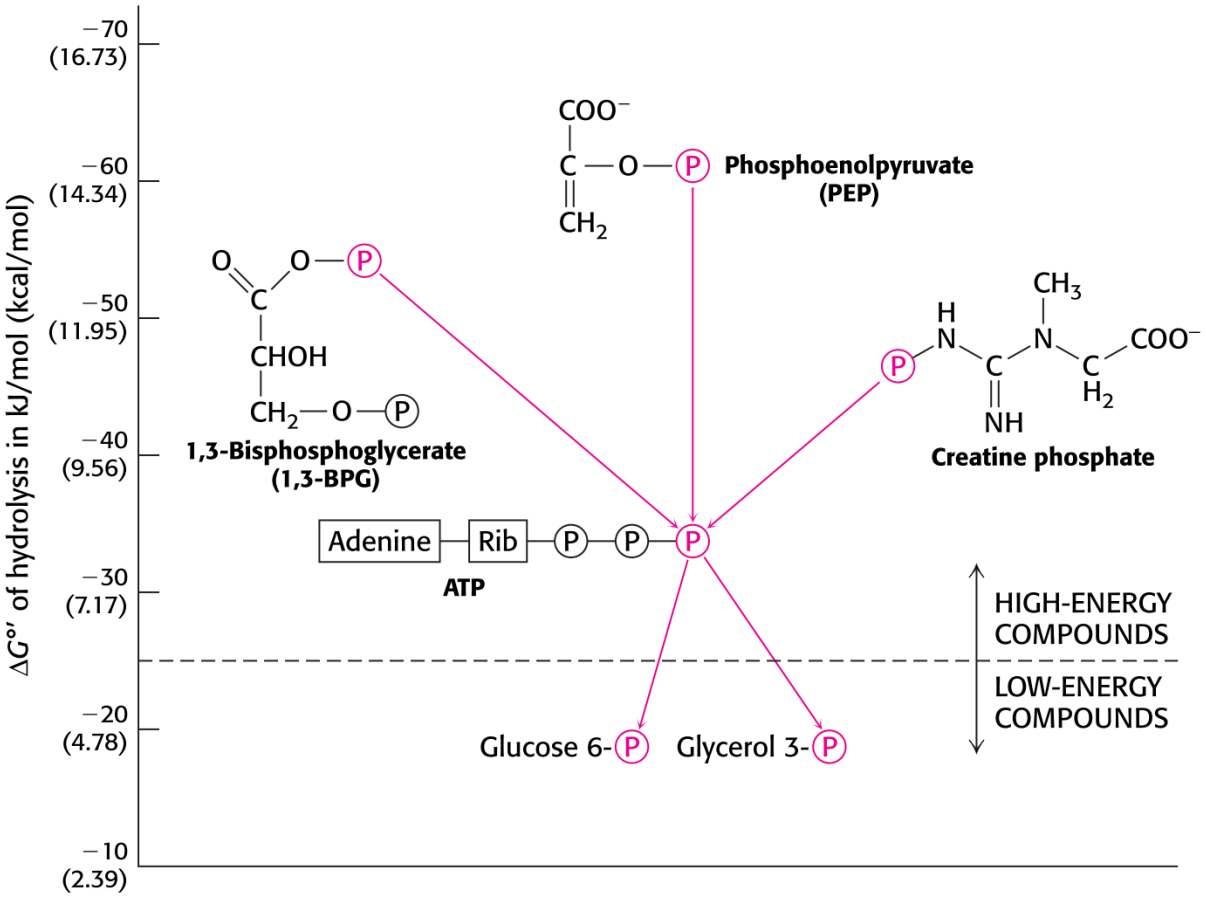
Basic Concepts – Revisions

- ATP (Adenosine Triphosphate)



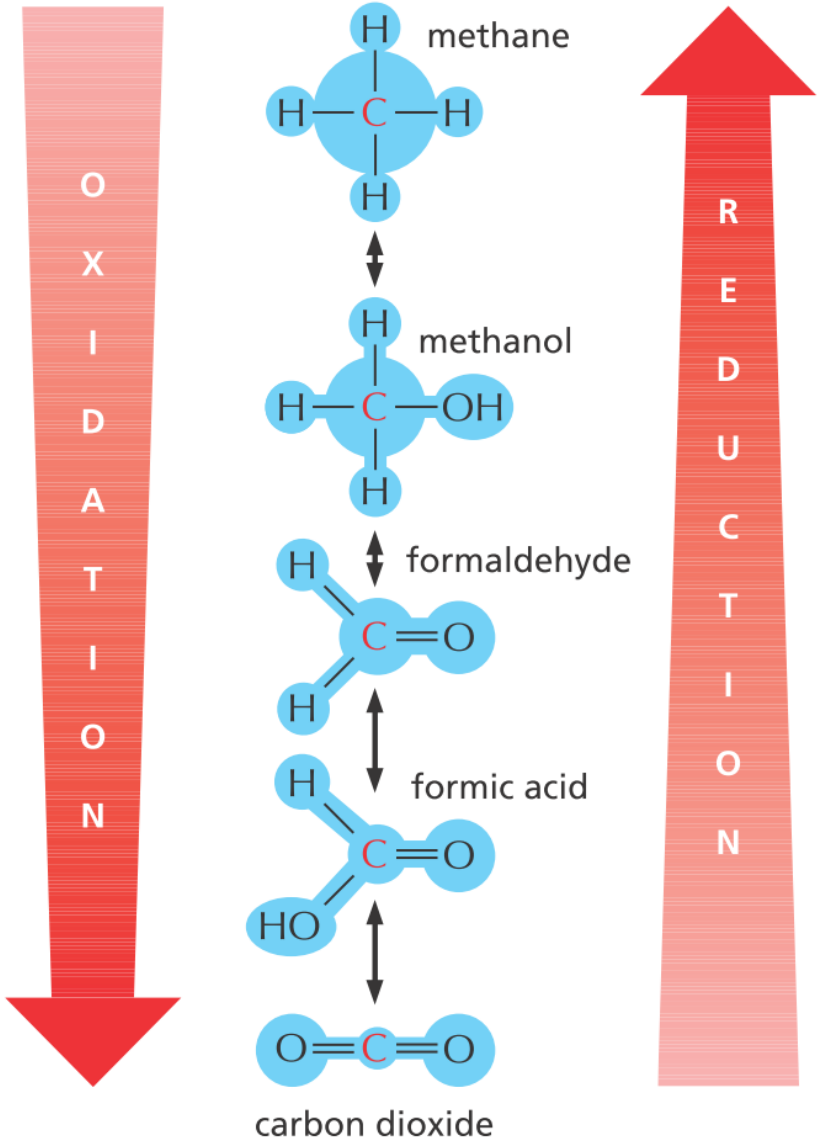
Basic Concepts – Revisions

- ATP (Adenosine Triphosphate)



Basic Concepts – Revisions

- Oxidation-Reduction



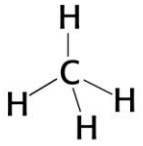
Basic Concepts – Revisions

- Oxidation-Reduction - Examples

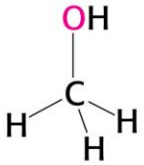
Basic Concepts – Revisions

- Oxidation-Reduction

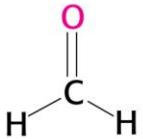
Most energy → Least energy



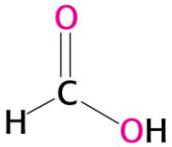
Methane



Methanol



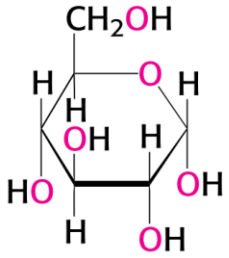
Formaldehyde



Formic acid

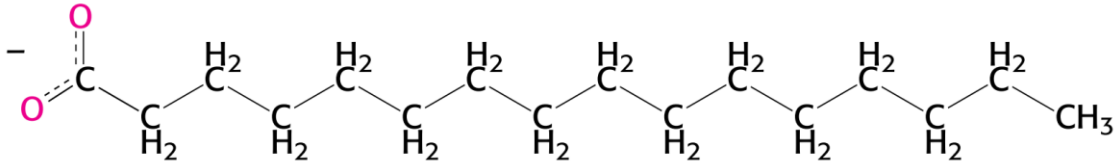
Carbon dioxide

$\Delta G^{\circ\prime}_{\text{oxidation}}$ (kJ mol^{-1})	−820	−703	−523	−285	0
$\Delta G^{\circ\prime}_{\text{oxidation}}$ (kcal mol^{-1})	−196	−168	−125	−68	0



Glucose

Fats are a more efficient fuel source than carbohydrates such as glucose.



Saturated fatty acid

Basic Concepts – Revisions

- Activated Carriers - Introduction

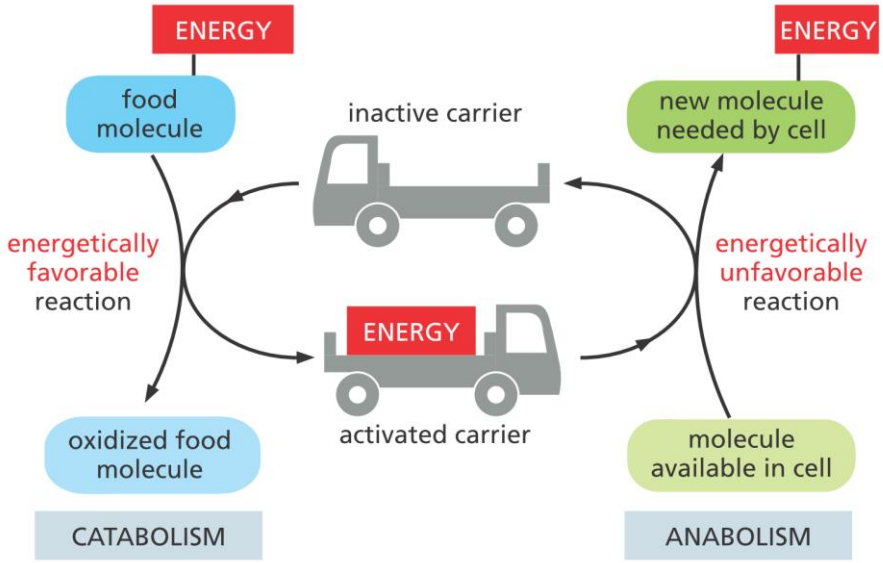


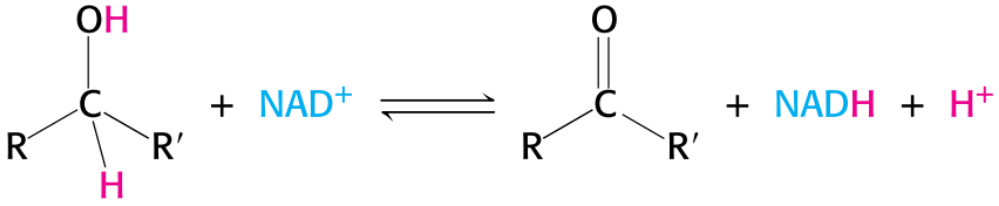
TABLE 15.2 Some activated carriers in metabolism

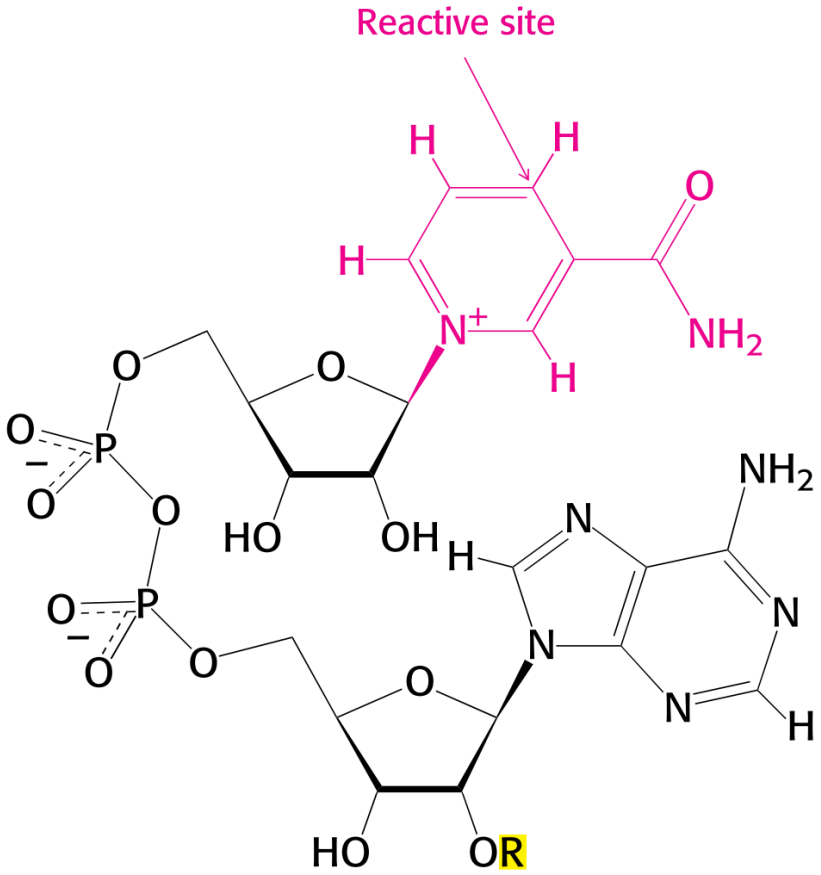
Carrier molecule in activated form	Group carried	Vitamin precursor
ATP	Phosphoryl	
NADH and NADPH	Electrons	Nicotinate (niacin) (vitamin B_3)
$FADH_2$	Electrons	Riboflavin (vitamin B_2)
$FMNH_2$	Electrons	Riboflavin (vitamin B_2)
Coenzyme A	Acyl	Pantothenate (vitamin B_5)
Lipoamide	Acyl	
Thiamine pyrophosphate	Aldehyde	Thiamine (vitamin B_1)
Biotin	CO_2	Biotin (vitamin B_7)
Tetrahydrofolate	One-carbon units	Folate (vitamin B_9)
S-Adenosylmethionine	Methyl	
Uridine diphosphate glucose	Glucose	
Cytidine diphosphate diacylglycerol	Phosphatidate	
Nucleoside triphosphates	Nucleotides	

Note: Many of the activated carriers are coenzymes that are derived from water-soluble vitamins.

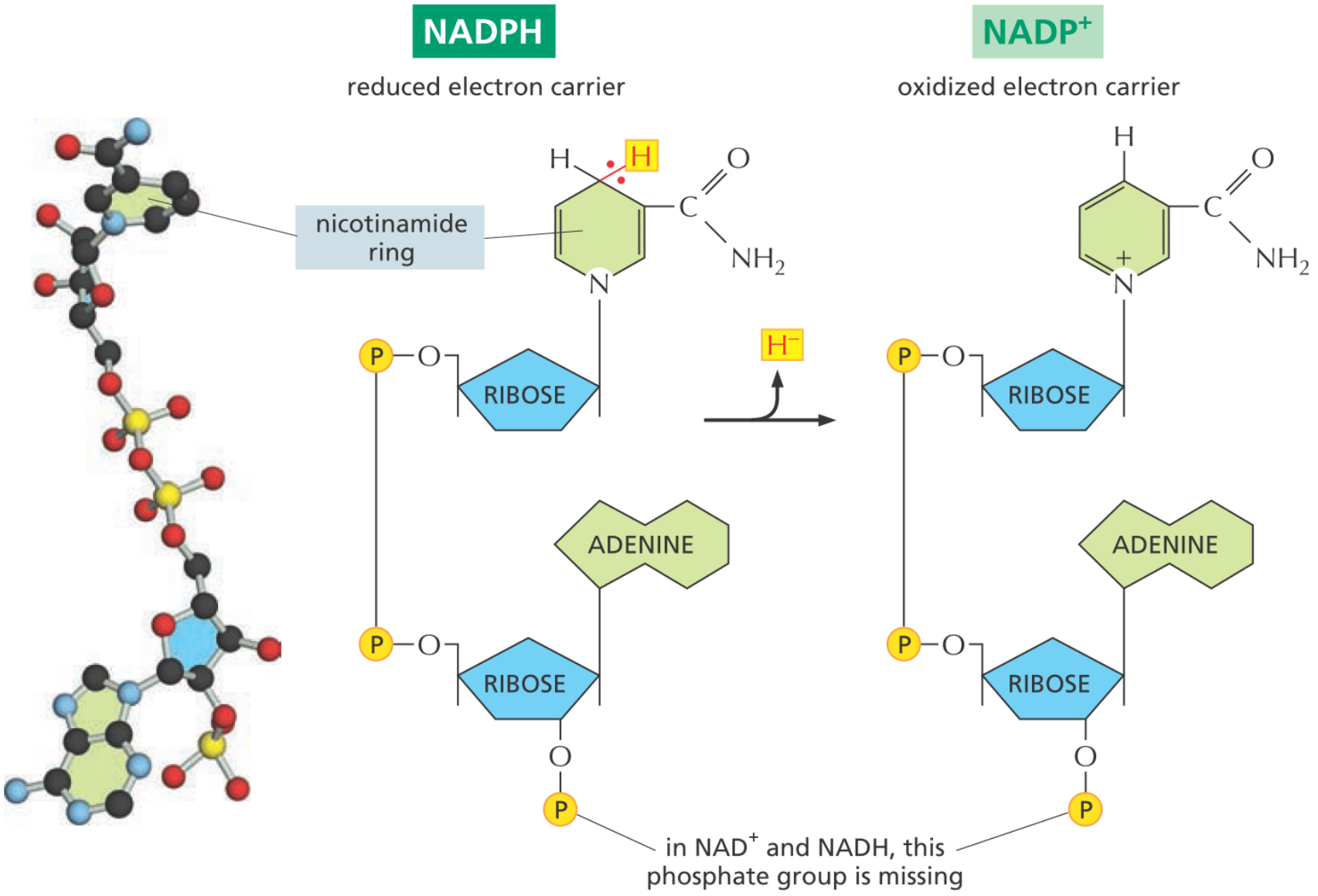
Basic Concepts – Revisions

- Activated Carriers (1) – NAD^+ / $NADP^+$



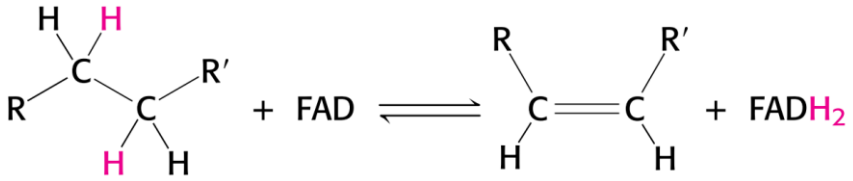


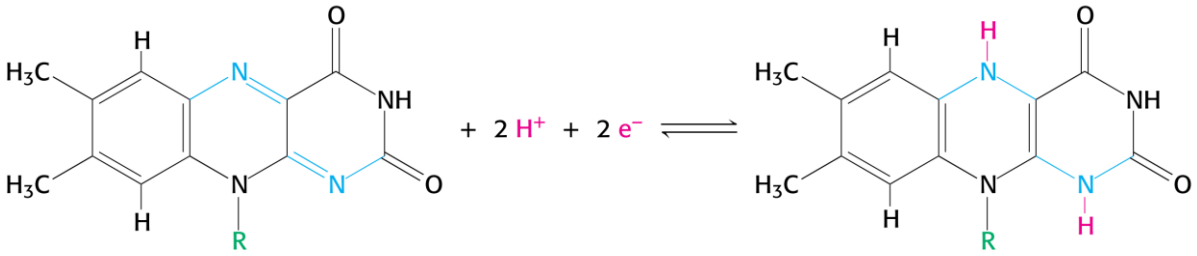
Basic Concepts – Revisions



Basic Concepts – Revisions

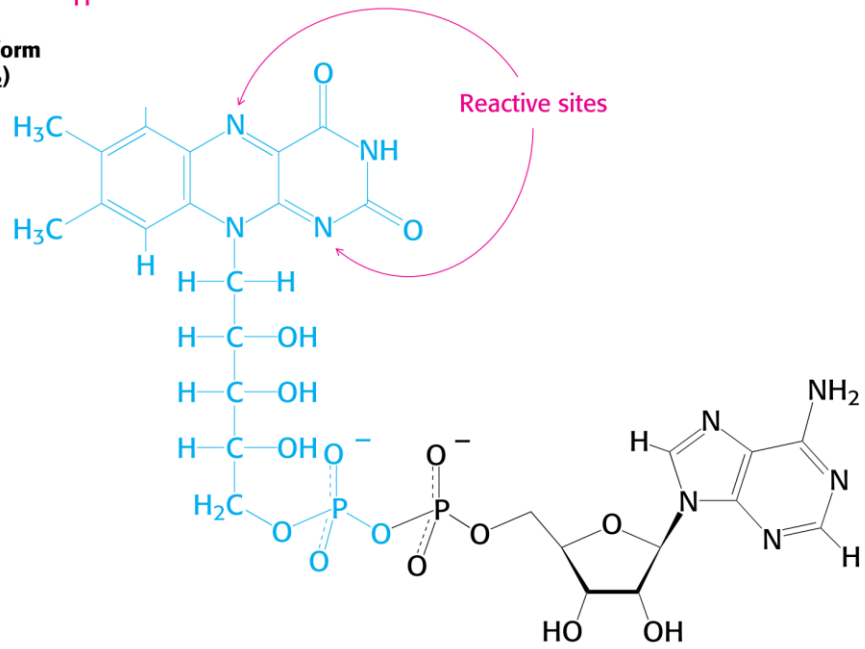
- Activated Carriers (2) – FAD





Oxidized form (FAD)

Reduced form ($FADH_2$)



Basic Concepts – Revisions

- Activated Carriers (3) - Acetyl Coenzyme A

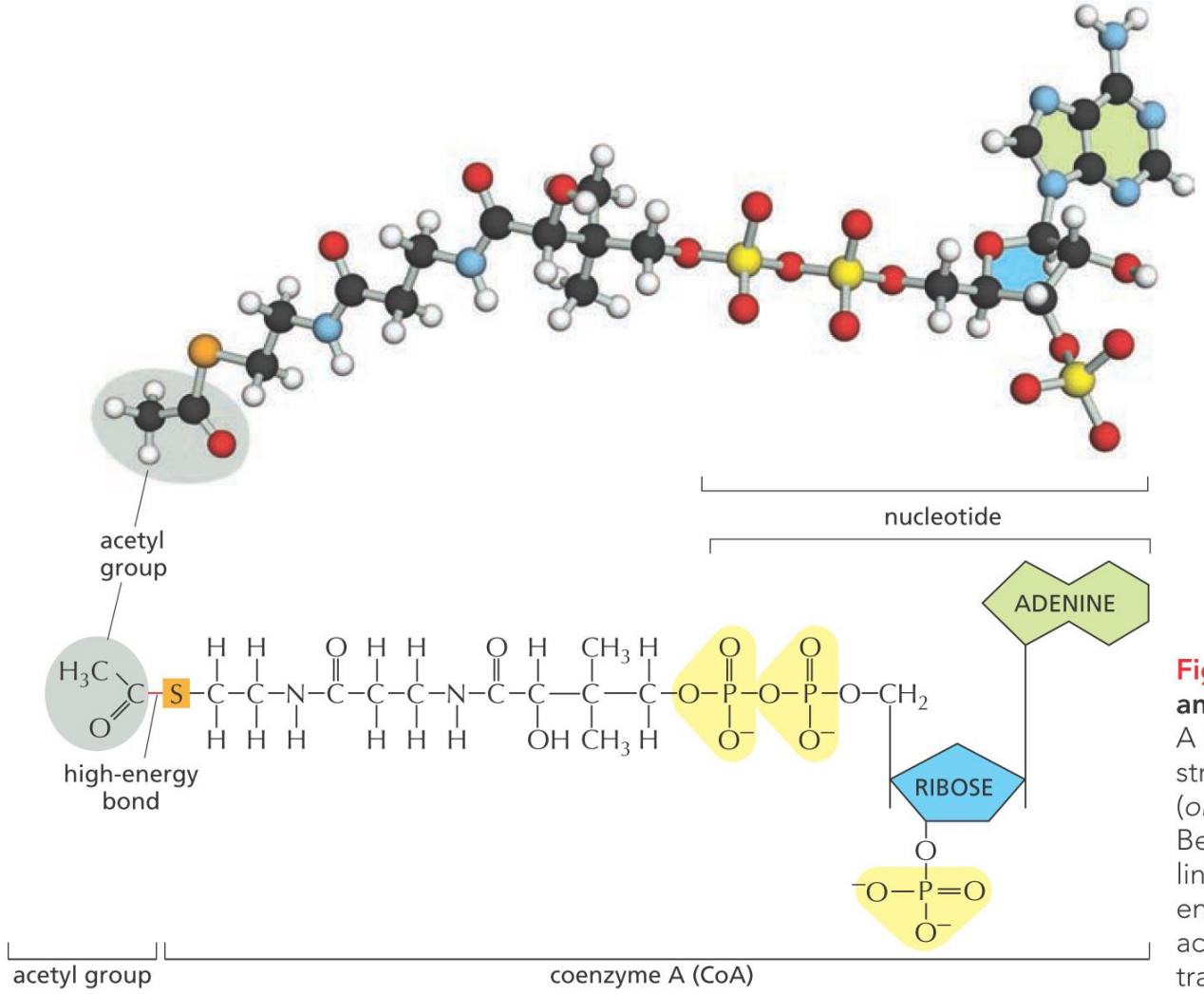
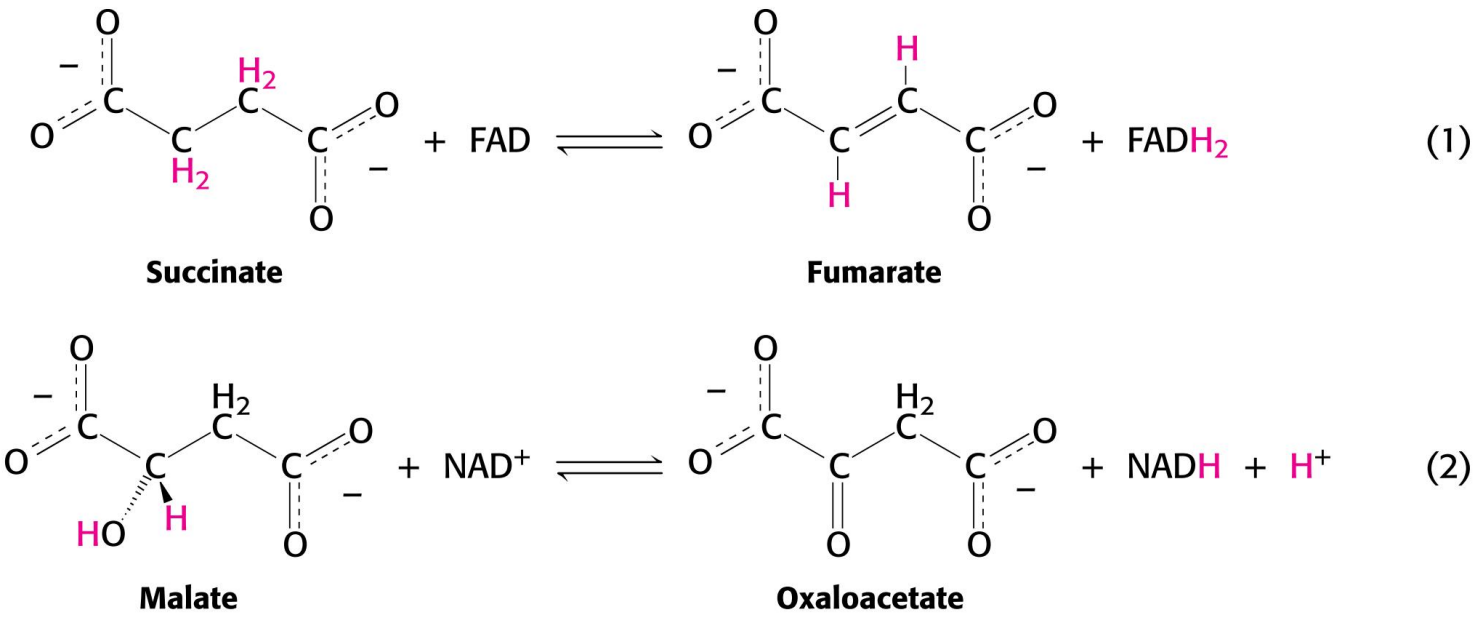


Figure 3–37 Acetyl coenzyme A (CoA) is another important activated carrier. A ball-and-stick model is shown above the structure of acetyl CoA. The sulfur atom (*orange*) forms a thioester bond to acetate. Because the thioester bond is a high-energy linkage, it releases a large amount of free energy when it is hydrolyzed. Thus the acetyl group carried by CoA can be readily transferred to other molecules.

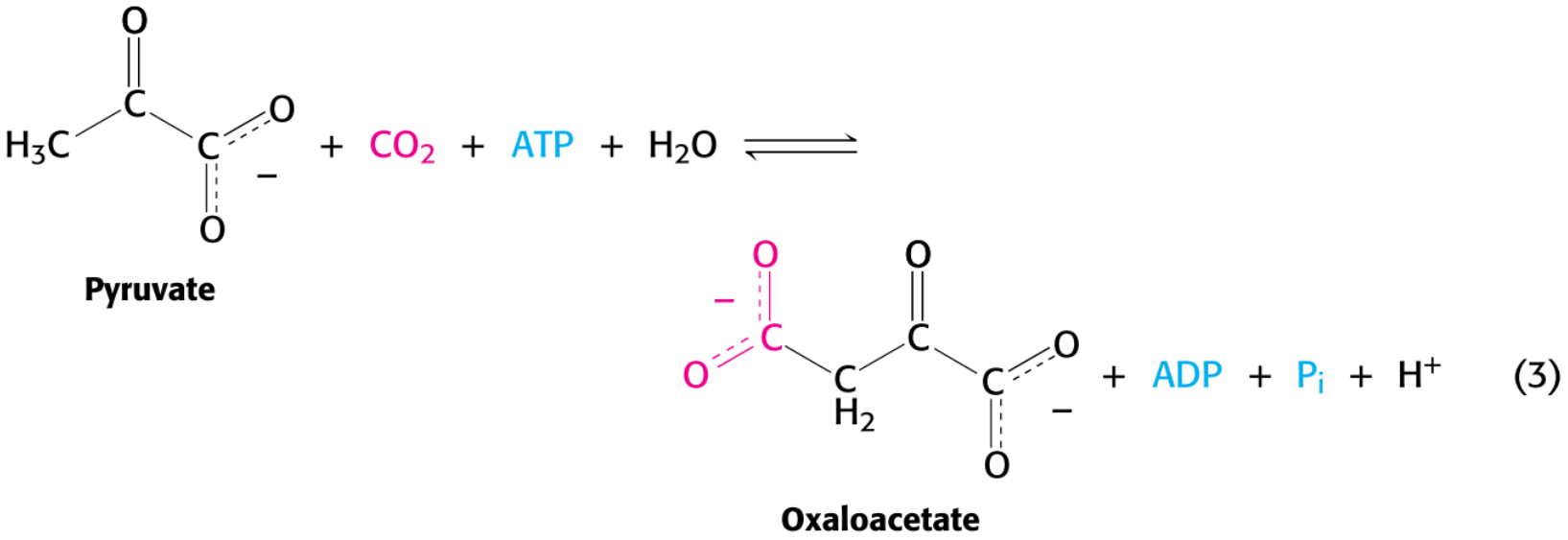
Key Reactions in Metabolism

- Key Reactions I: Oxidation-Reduction Reactions



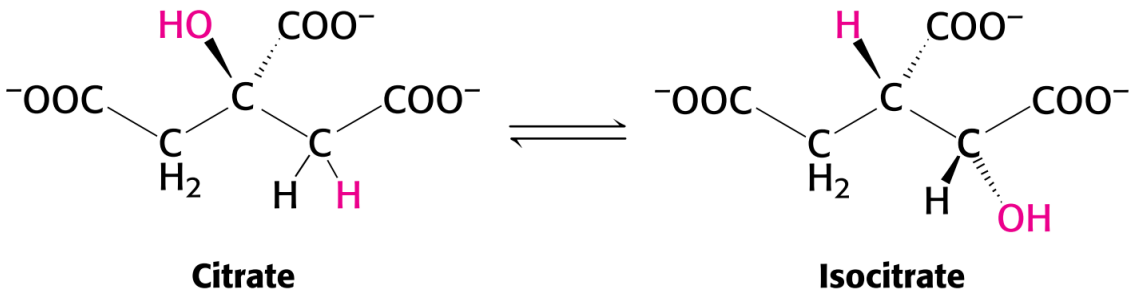
Key Reactions in Metabolism

- Key Reactions II: Ligation Reactions



Key Reactions in Metabolism

- Key Reactions III: Isomerization Reactions



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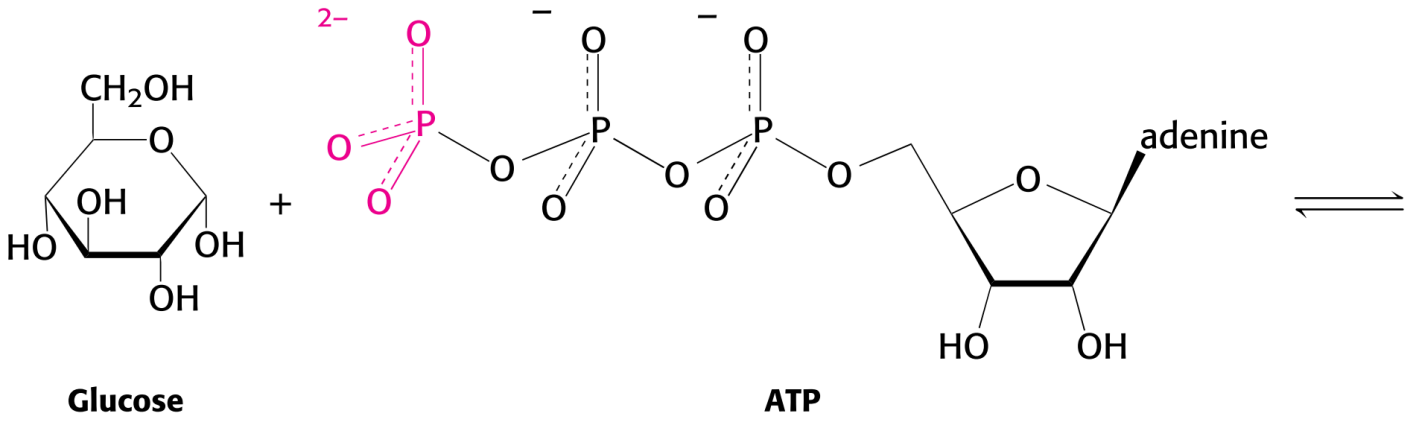
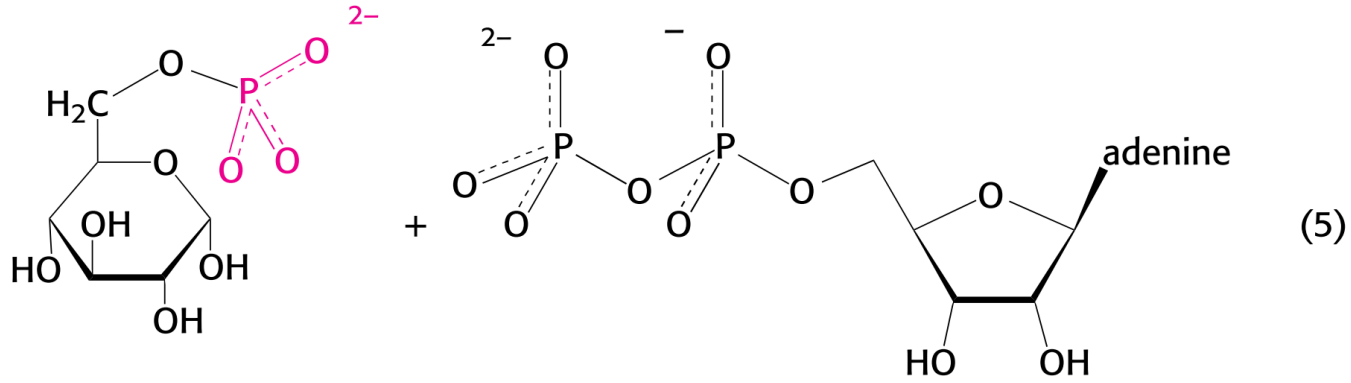
Key Reactions in Metabolism

- Key Reactions IV: Group-transfer Reactions



Glucose **ATP**



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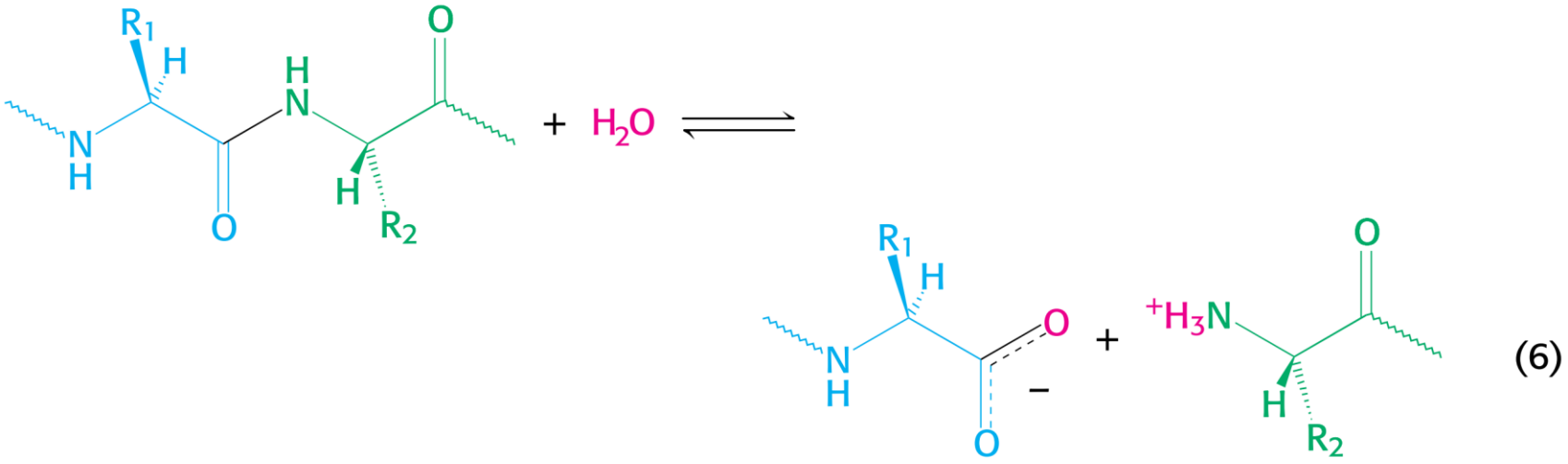
Glucose 6-phosphate (G-6P) **ADP**

Key Reactions in Metabolism

- Key Reactions V: Hydrolytic Reactions



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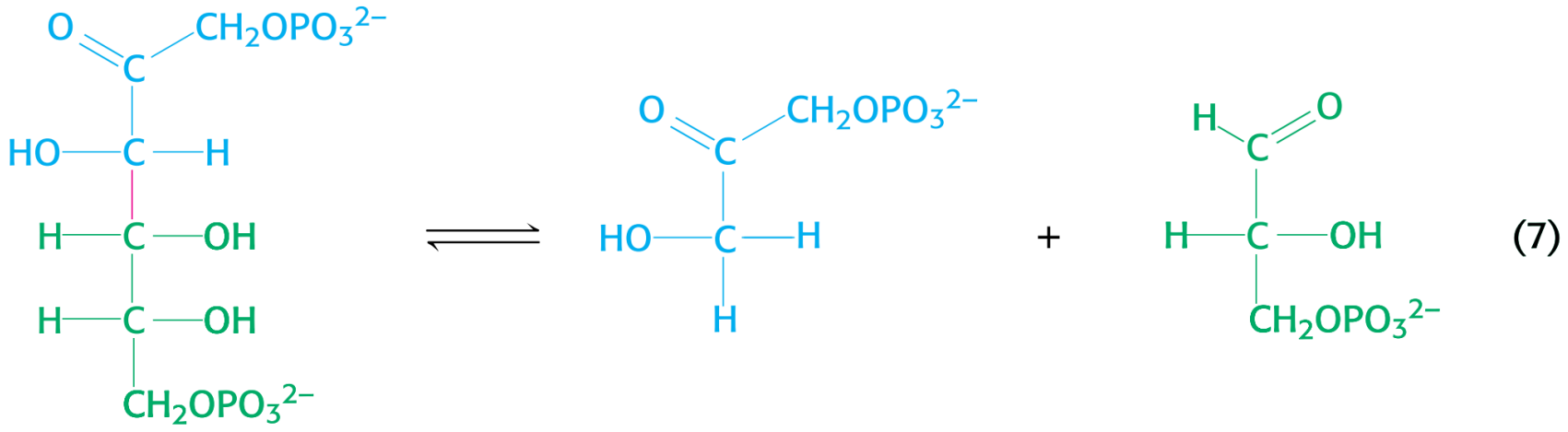
Key Reactions in Metabolism

- Key Reactions VI: Cleavage (other than hydrolysis / oxidation)



Fructose 1,6-bisphosphate (F-1,6-BP) ⇌ **Dihydroxyacetone phosphate (DHAP)** + **Glyceraldehyde 3-phosphate (GAP)** (7)