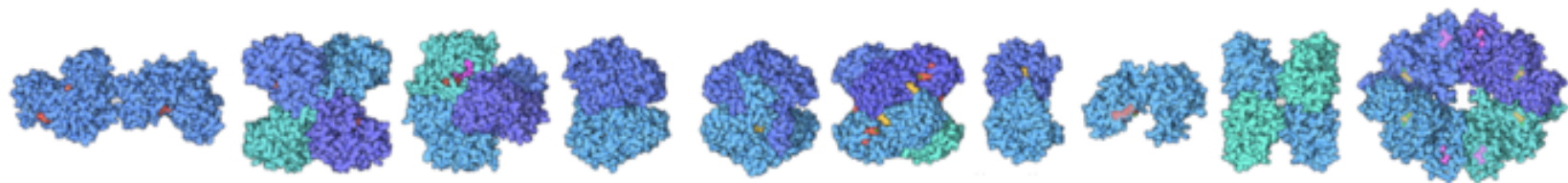


La glicolisi



Introduzione

- Una via metabolica molto antica (il nome, dove avviene e perché)
- $\text{Glucosio} + 2 \text{NAD}^+ + 2 \text{ADP} + 2 \text{Pi} \rightarrow 2 \text{piruvato} + 2 \text{NADH} + 2 \text{H}^+ + 2 \text{ATP} + 2 \text{H}_2\text{O}$
- Universale
- Specifica di alcuni organismi e di alcuni tessuti
- Classica via catabolica, ma alcuni suoi intermedi partecipano ad altre vie metaboliche

Le reazioni della glicolisi /1

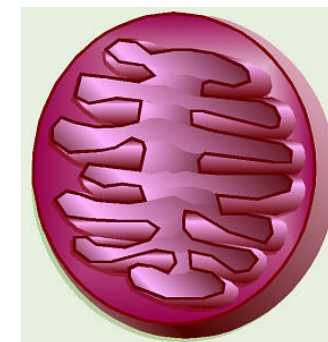
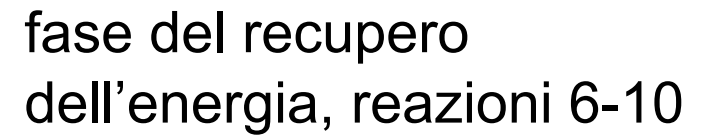
La **glicolisi** si svolge attraverso una serie di 10 reazioni, ciascuna catalizzata da un enzima specifico.

Una molecola di glucosio (6 atomi di C) è scissa in due molecole di piruvato (3 atomi di C). L'energia liberata è usata per sintetizzare ATP e per ridurre NAD⁺.

È composta da **fase endoergonica** e **fase esoergonica**.

Fase	Entra	Esce	Bilancio
Endoergonica	1 glucosio	2 G3P	-2 ATP
Esoergonica	2 G3P	2 piruvato	+ 4 ATP + 2 NADH

Hexose MonoPhosphate Shunt

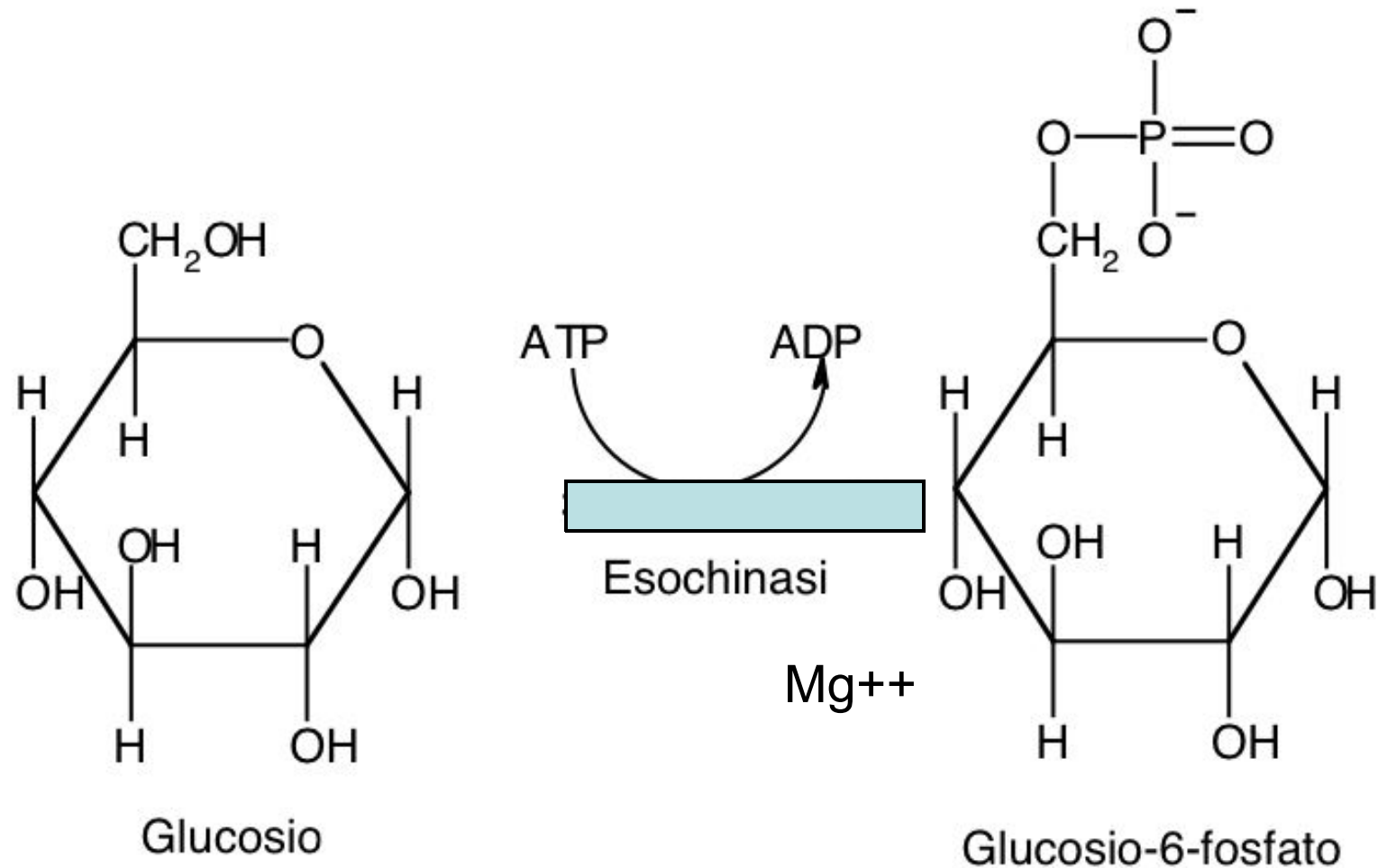
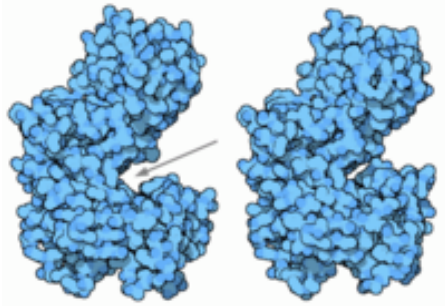


ETC

02

Esocinasi

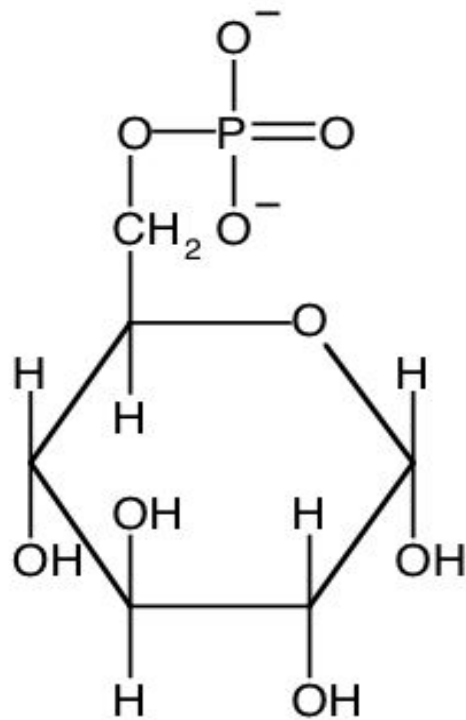
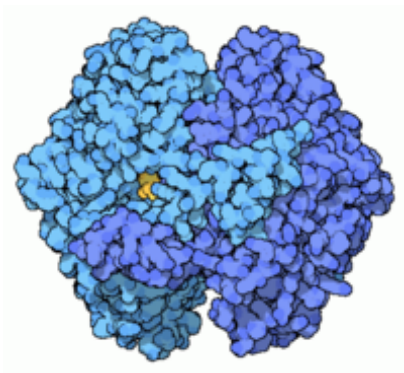
(Fosforilazione del Glucosio)



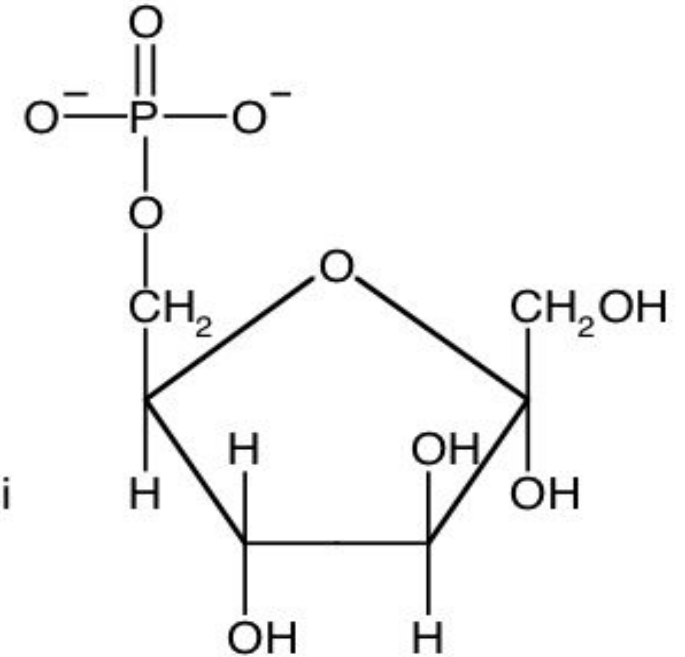
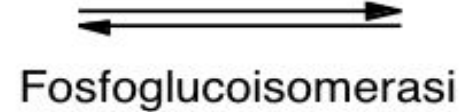
$$\Delta G'^{\circ} = -16,7 \text{ kJ/mole}$$

$$\Delta G = -33,4 \text{ kJ/mole}$$

Fosfoglucoisomerasi (isomerizzazione)



Glucosio-6-fosfato



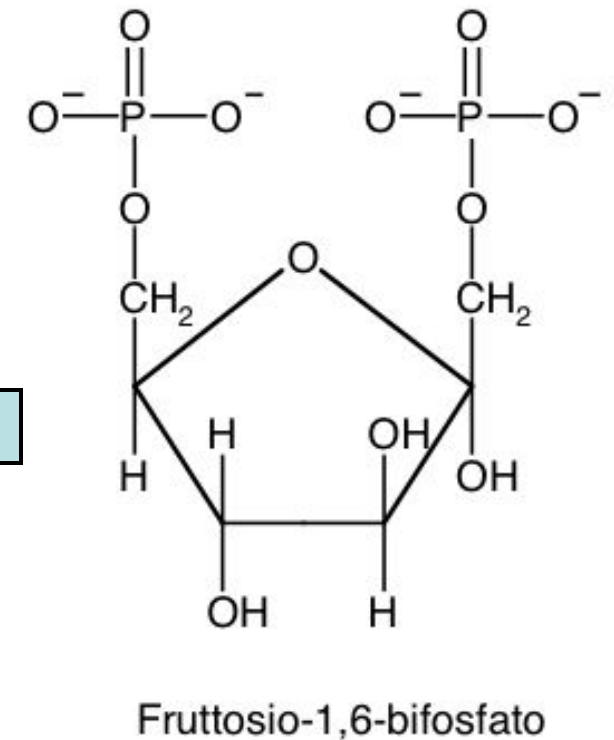
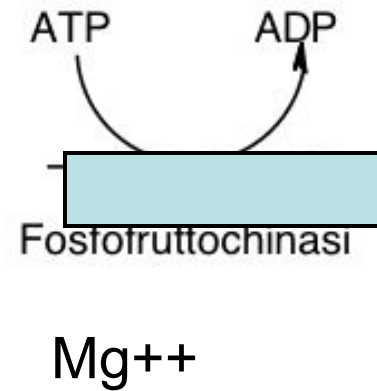
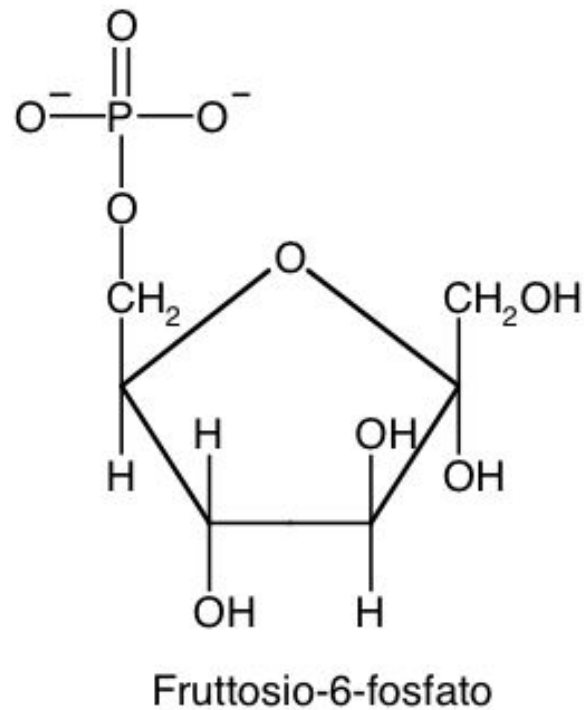
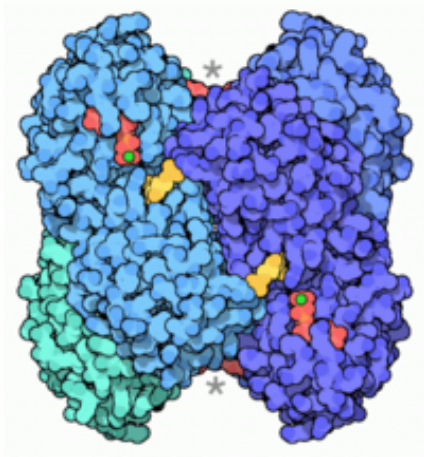
Fruttosio-6-fosfato

$$\Delta G'^{\circ} = +1,7 \text{ kJ/mole}$$

$$\Delta G = -2,5 \text{ kJ/mole}$$

Fosfofruttocinasi

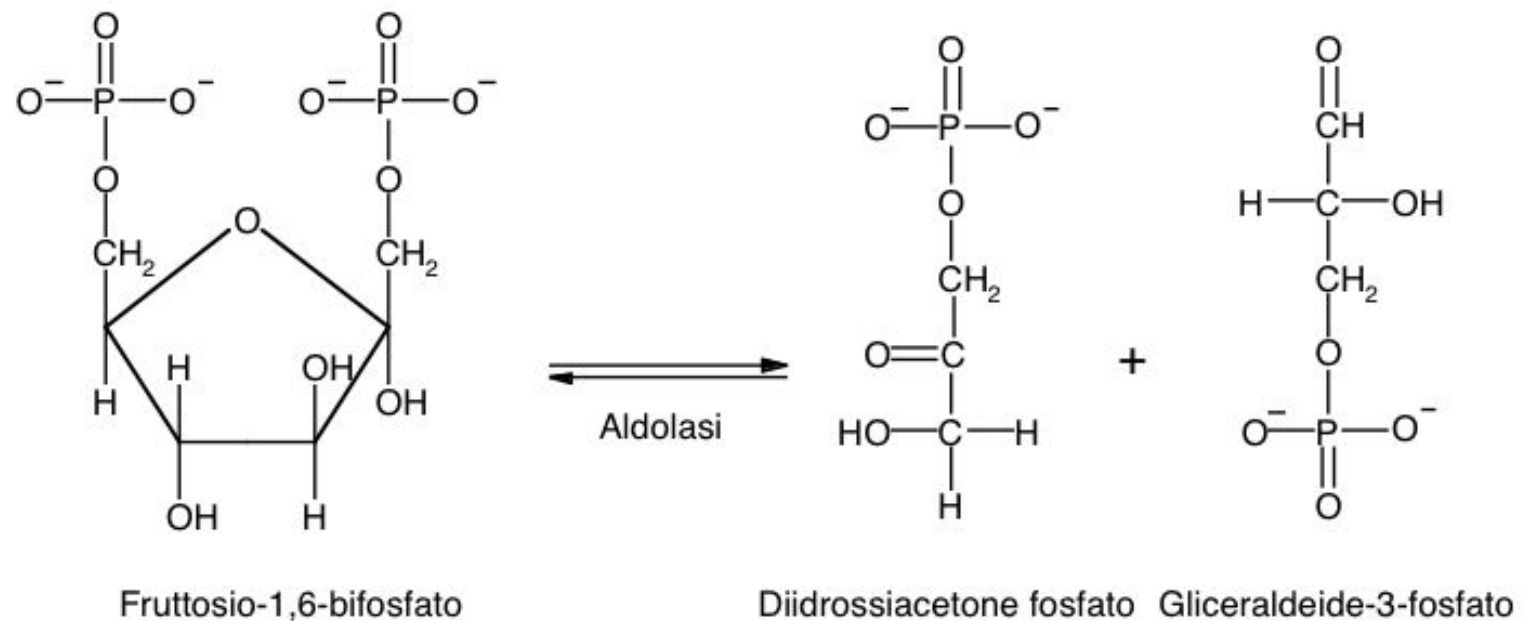
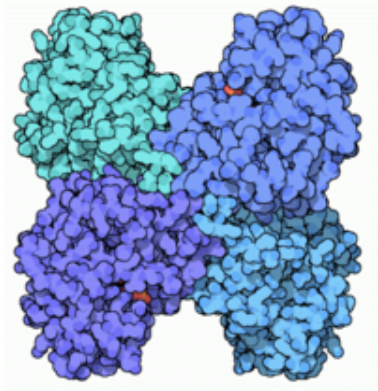
(fosforilazione)



$$\Delta G'^{\circ} = -14,2 \text{ kJ/mole}$$
$$\Delta G = -22,2 \text{ kJ/mole}$$

Aldolasi

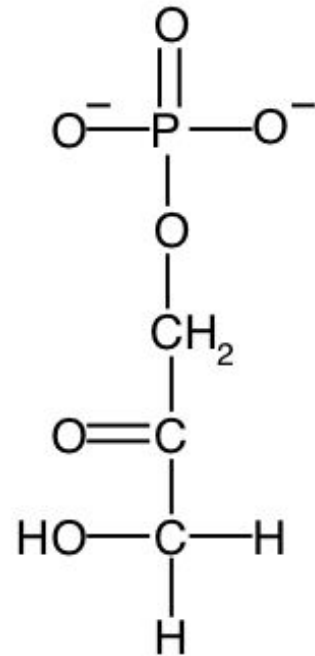
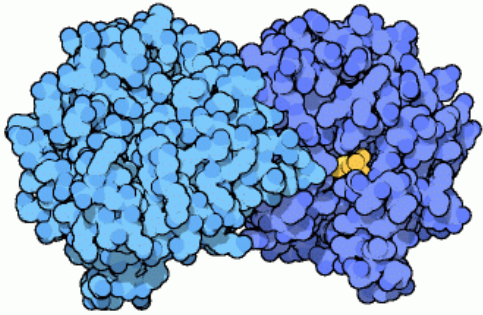
(scissione)



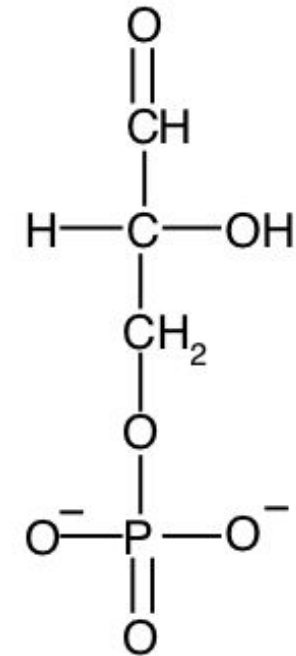
$$\Delta G'^{\circ} = +23,8 \text{ kJ/mole}$$

$$\Delta G = -1,3 \text{ kJ/mole}$$

Triosofosfato isomerasi (isomerizzazione)



Diidrossiacetone fosfato

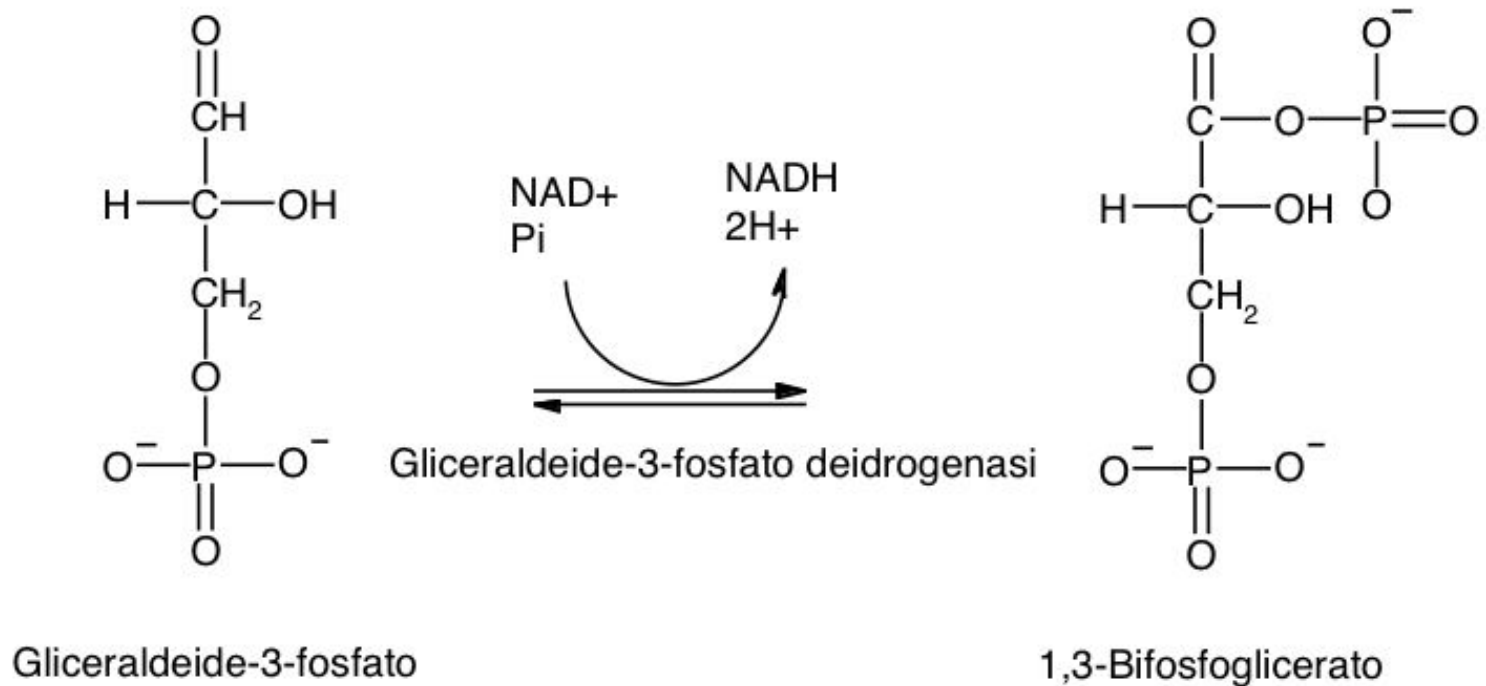
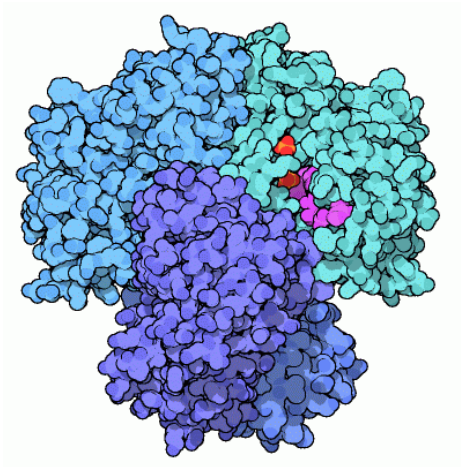


Gliceraldeide-3-fosfato

$$\Delta G'^{\circ} = +7,5 \text{ kJ/mole}$$

$$\Delta G = +2,5 \text{ kJ/mole}$$

Gliceraldeide-3-fosfato deidrogenasi (ossidazione)

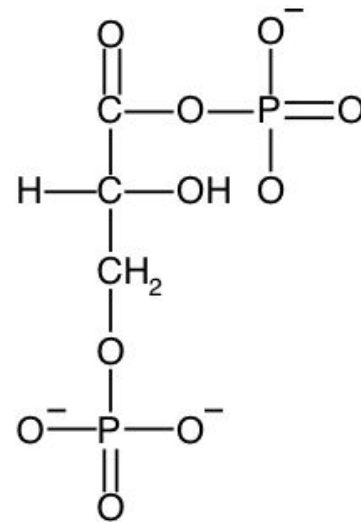
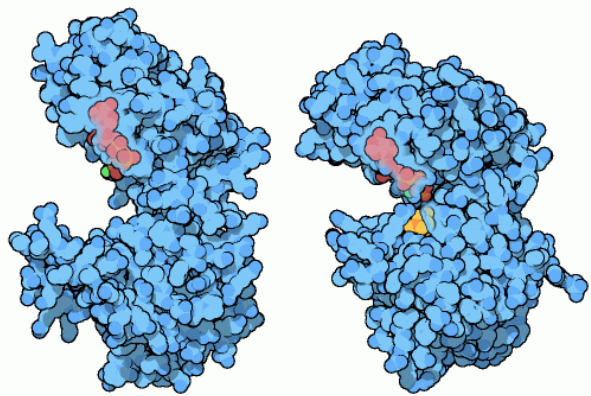


$$\Delta G'^{\circ} = +12,6 \text{ kJ/mole}$$

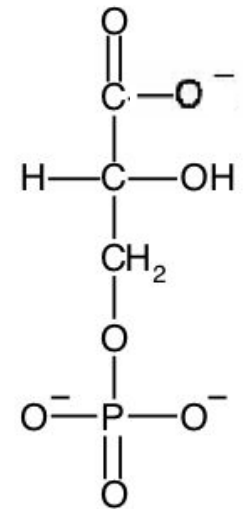
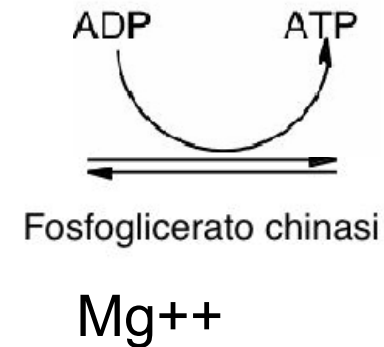
$$\Delta G = -3,4 \text{ kJ/mole}$$

Fosfoglicerato cinasi

(fosforilazione a livello di substrato)



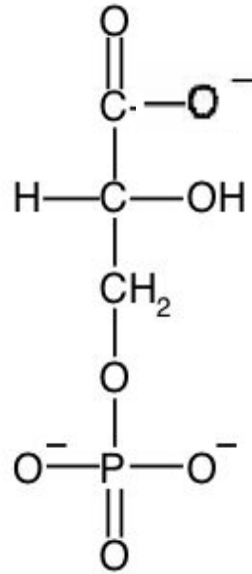
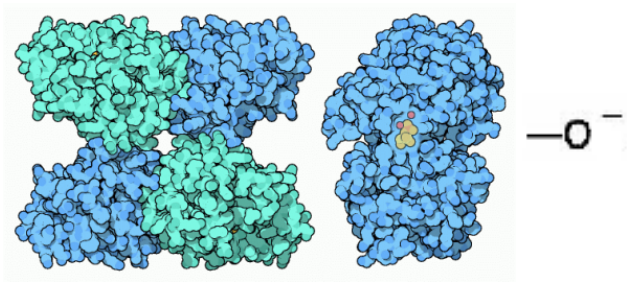
1,3-Bifosfoglicerato



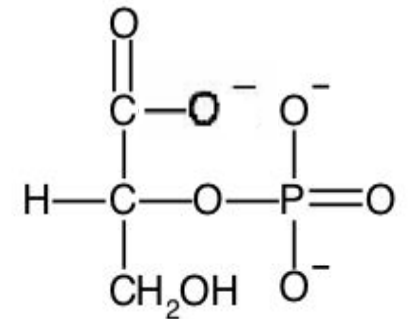
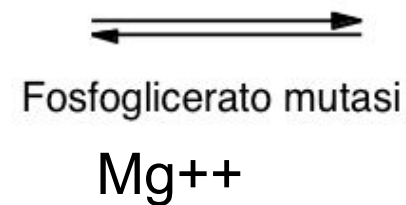
3-Fosfoglicerato

$$\begin{aligned}
 \Delta G'^{\circ} &= -37 \text{ kJ/mole} \\
 \Delta G &= +2,7 \text{ kJ/mole}
 \end{aligned}$$

Fosfoglicerato mutasi (isomerizzazione)



3-Fosfoglicerato

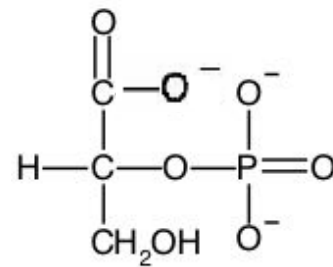
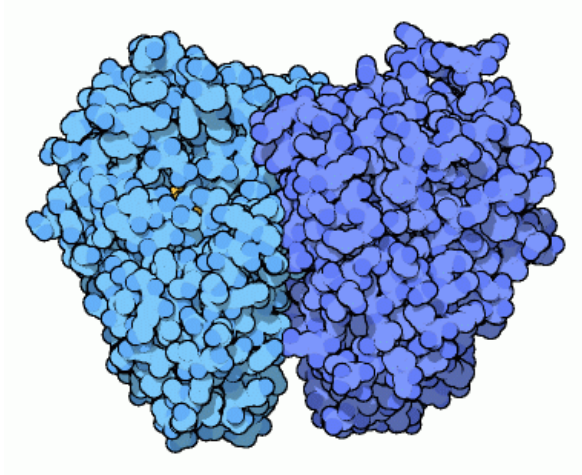


2-Fosfoglicerato

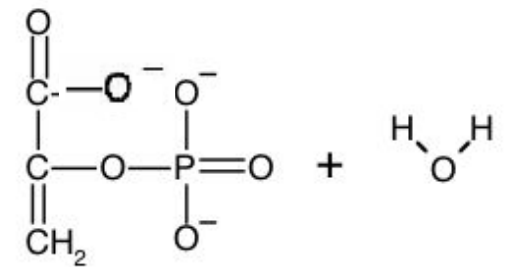
$$\Delta G'^{\circ} = +8,8 \text{ kJ/mole}$$

$$\Delta G = +1,6 \text{ kJ/mole}$$

Enolasi (disidratazione)



2-Fosfoglicerato



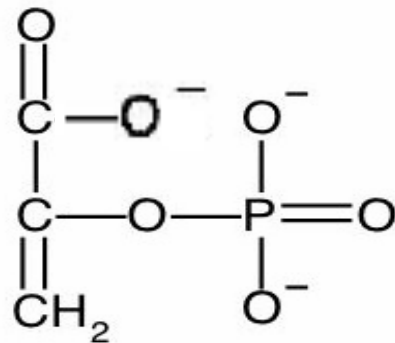
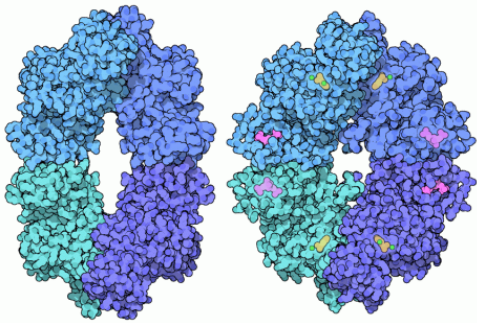
Fosfoenolpiruvato

$$\Delta G'^{\circ} = +3,5 \text{ kJ/mole}$$

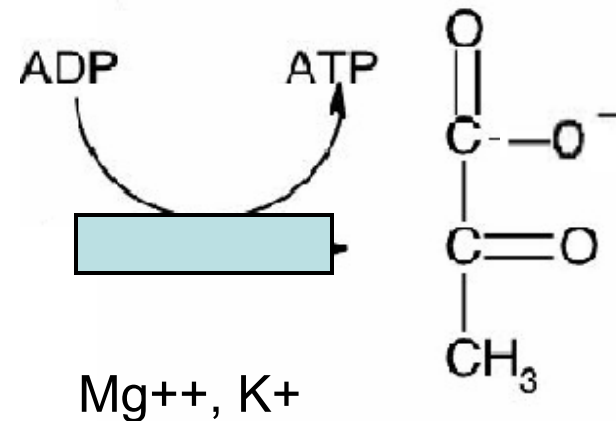
$$\Delta G = -6,6 \text{ kJ/mole}$$

Piruvato cinasi

(fosforilazione a livello di substrato dell'ADP)



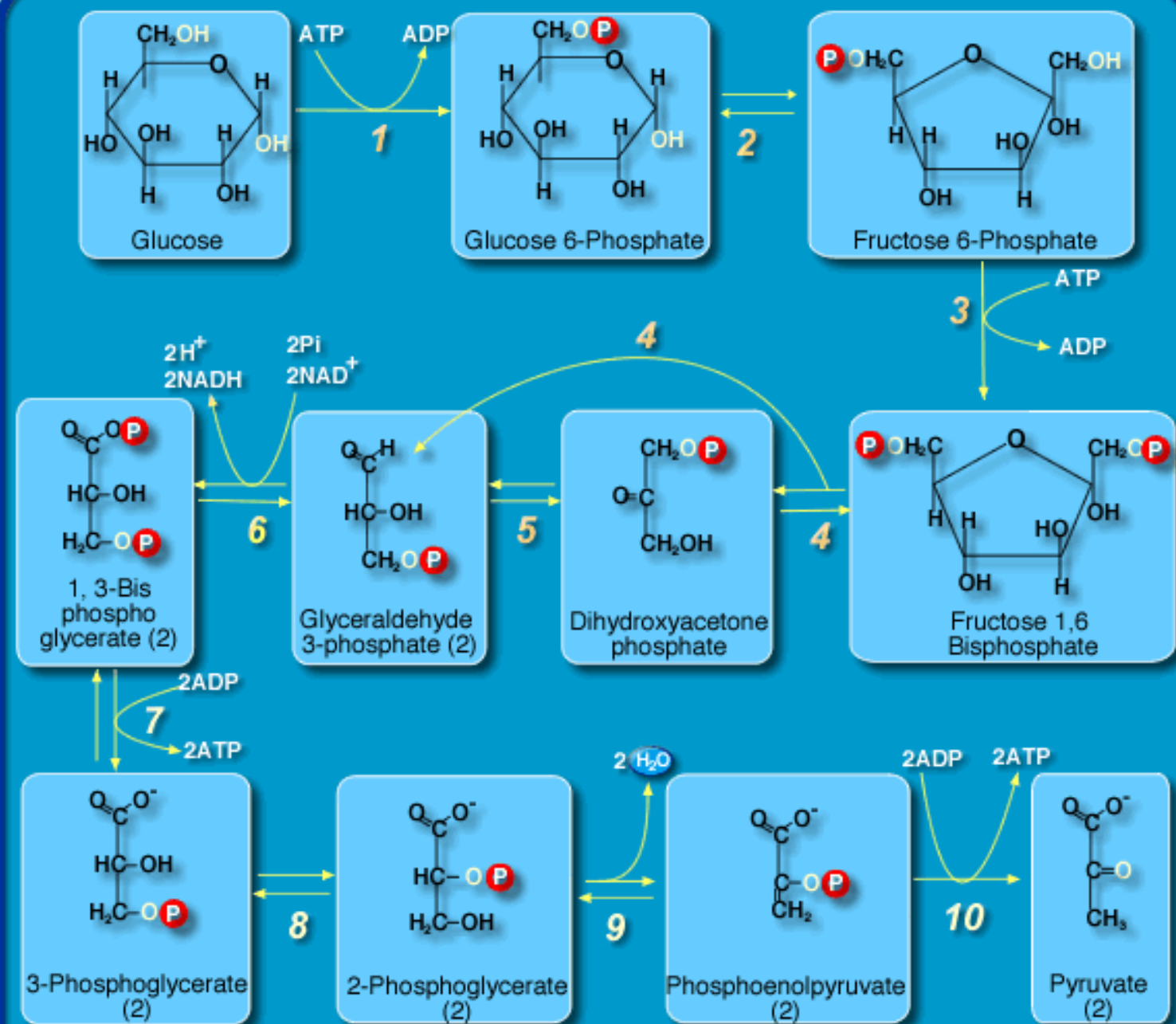
Fosfoenolpiruvato



Piruvato

$$\Delta G'^{\circ} = -62,4 \text{ kJ/mole}$$

$$\Delta G = -33 \text{ kJ/mole}$$



ENZYMES

● Preparatory phase

● Payoff phase

- 1 Hexokinase
- 2 Glucose Phosphate Isomerase
- 3 Phosphofructokinase
- 4 Fructose diphosphate aldolase

- 5 Triose phosphate Isomerase
- 6 Glyceraldehyde Phosphate Dehydrogenase

- 7 Phosphoglycerate Kinase
- 8 Phosphoglyceromutase
- 9 Enolase
- 10 Pyruvate Kinase



I prodotti della glicolisi anaerobica

- 2 molecole di piruvato
- 4 molecole di ATP (meno le due usate per l'attivazione del glucosio)
- 2 molecole di NADH

REGOLAZIONE DELLA GLICOLISI

Nei tessuti, la glicolisi è molto regolata, così che le cellule possono modulare velocemente il processo.

Il controllo degli enzimi chiave della glicolisi avviene attraverso effettori allosterici e modificazioni covalenti (fosforilazione).

ATTIVAZIONE: FOSFOFRUTTOCHINASI e PIRUVATO CHINASI

CARENZA energetica (ADP, AMP)

Disponibilità di glucosio in cellula

Presenza in cellula di NAD^+

INIBIZIONE: FOSFOFRUTTOCHINASI e PIRUVATO CHINASI

ECCESSO energetico (ATP)

elevata concentrazione glucosio-6 fosfato → inibizione
ESPOCHINASI (allo scopo di promuovere sintesi di glicogeno).

DESTINO DEL PIRUVATO

- **In presenza di ossigeno:** il piruvato entra nel mitocondrio, subisce una **decarbossilazione ossidativa** e trasformato in acetil-CoA che, a sua volta, entra nel **ciclo di Krebs**. L'ossidazione continua poi in **catena respiratoria**.
- **In assenza di ossigeno** (anossia): nel citoplasma il piruvato può essere convertito attraverso la **fermentazione** in molteplici prodotti finali a seconda degli enzimi presenti; tutte queste reazioni hanno comunque lo scopo di riossidare il NADH, coenzima della Gliceraldeide-3-PDH.