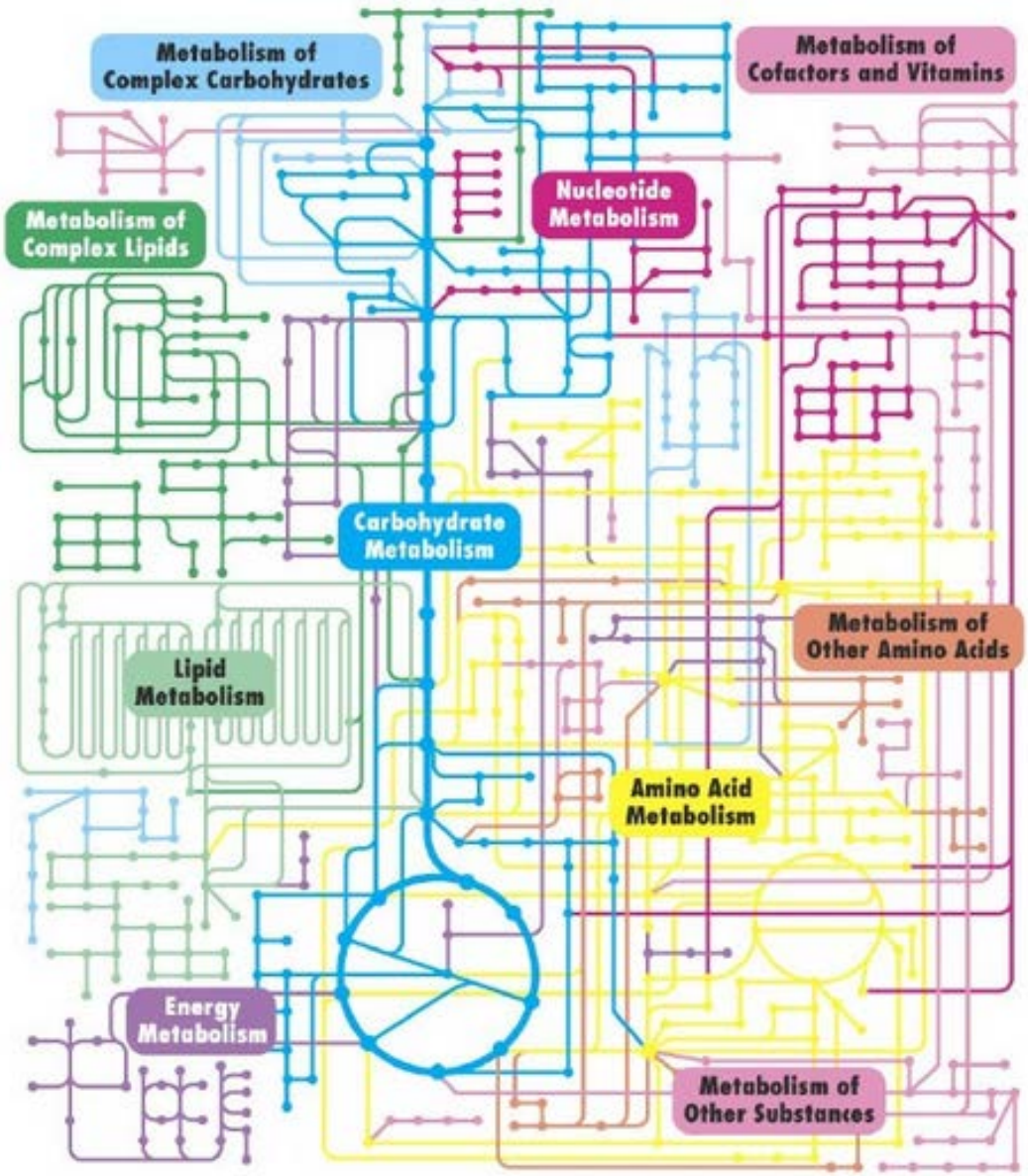
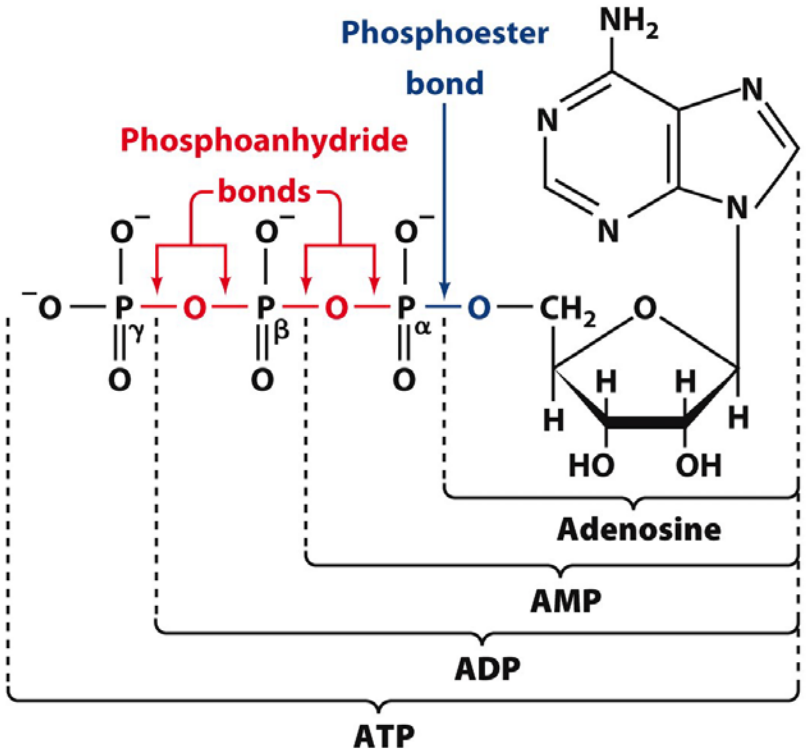
Food and Bioenergy



ATP – the energy conduit



High Energy Bond - The energy required to **hydrolyze** a bond

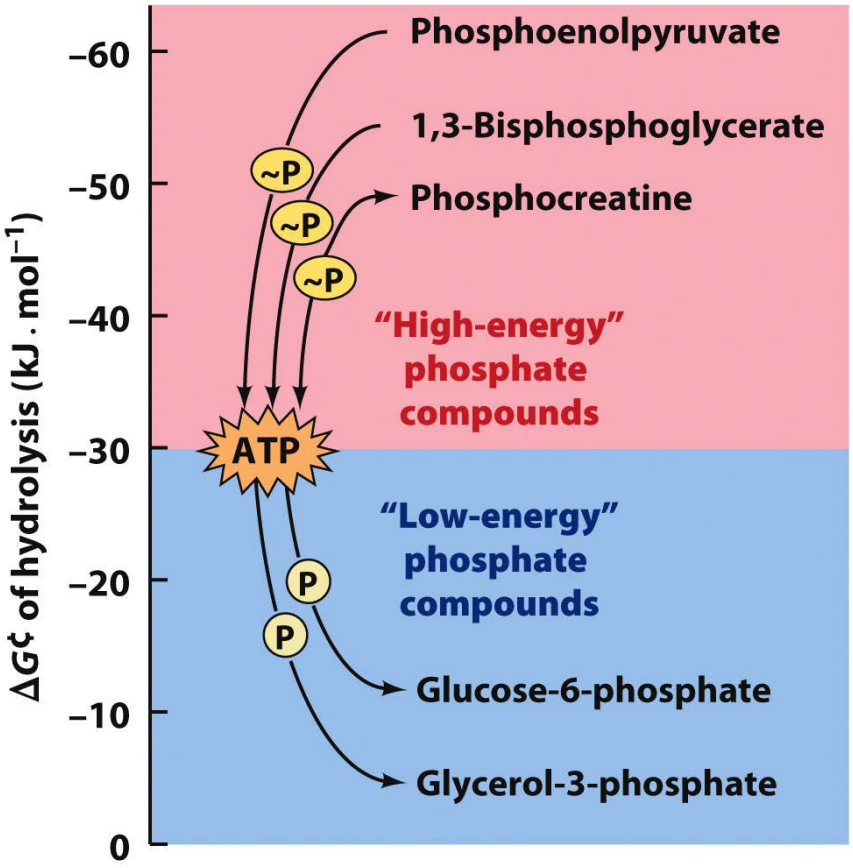
Opposite of condensation

$ATP + H_2O \rightarrow ADP + HPO_4^{2-} + ENERGY$

Central premise of metabolism

- Creating bonds (building molecules) takes energy → ATP is consumed
- Breaking bonds produce energy → ATP gets made

Role of ATP



"Energy Conduit" – ATP is a general intermediate in energy transfer from really high energy compounds to lower energy phosphate compounds

Biological systems are able to evolve such that multiple enzymes utilize this intermediate

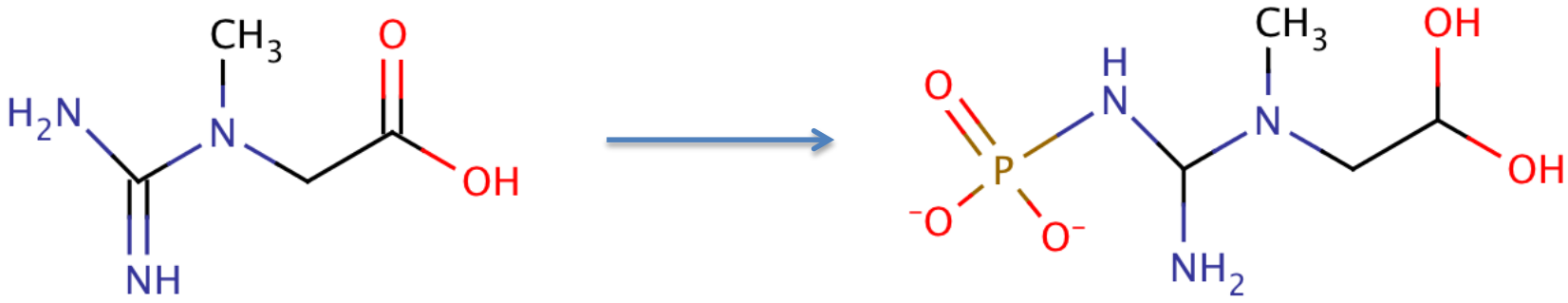
Enzymes can easily adopt an ATP-binding fold and then evolve to bind another substrate

Phosphocreatine as an Energy Reservior

ATP + creatine ⇌ phosphocreatine + ADP

ATP can be generated from phosphocreatine within 5 seconds of a muscle burst!

Think of this as a seesaw – The more creatine or ATP that is available, the more phosphocreatine that will be made

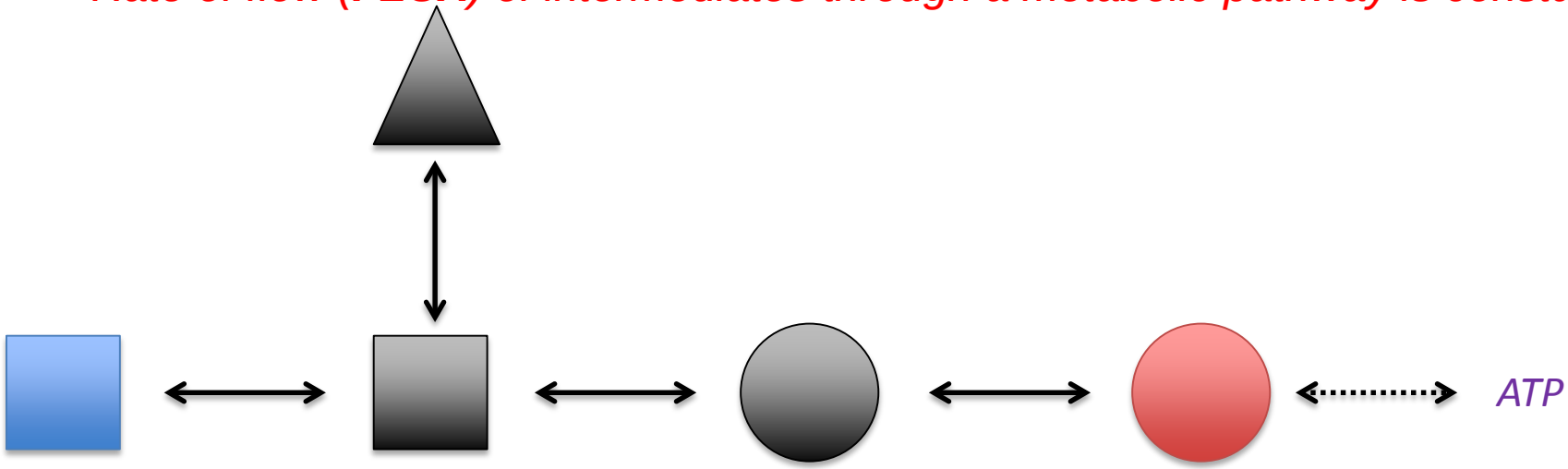


The creatine/phosphocreatine system generates an ATP “Buffer” that can store ATP energy for times of need.

Bioenergy Production vs. Storage

The concentration of any metabolic intermediate must be constant

*Rate of flow (**FLUX**) of intermediates through a metabolic pathway is constant*



What happens if:

Sudden concentration elevation of  ?

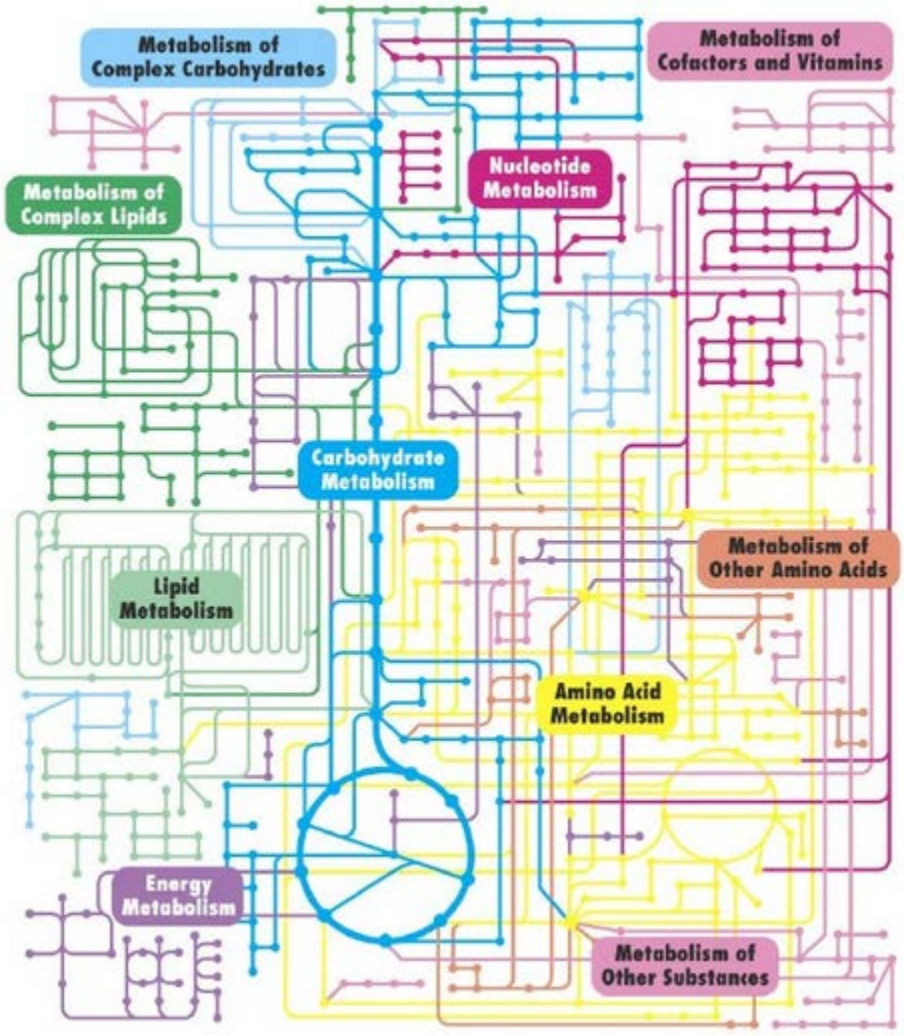
Sudden need for *ATP*?

Sudden surge in concentration of *ATP*?

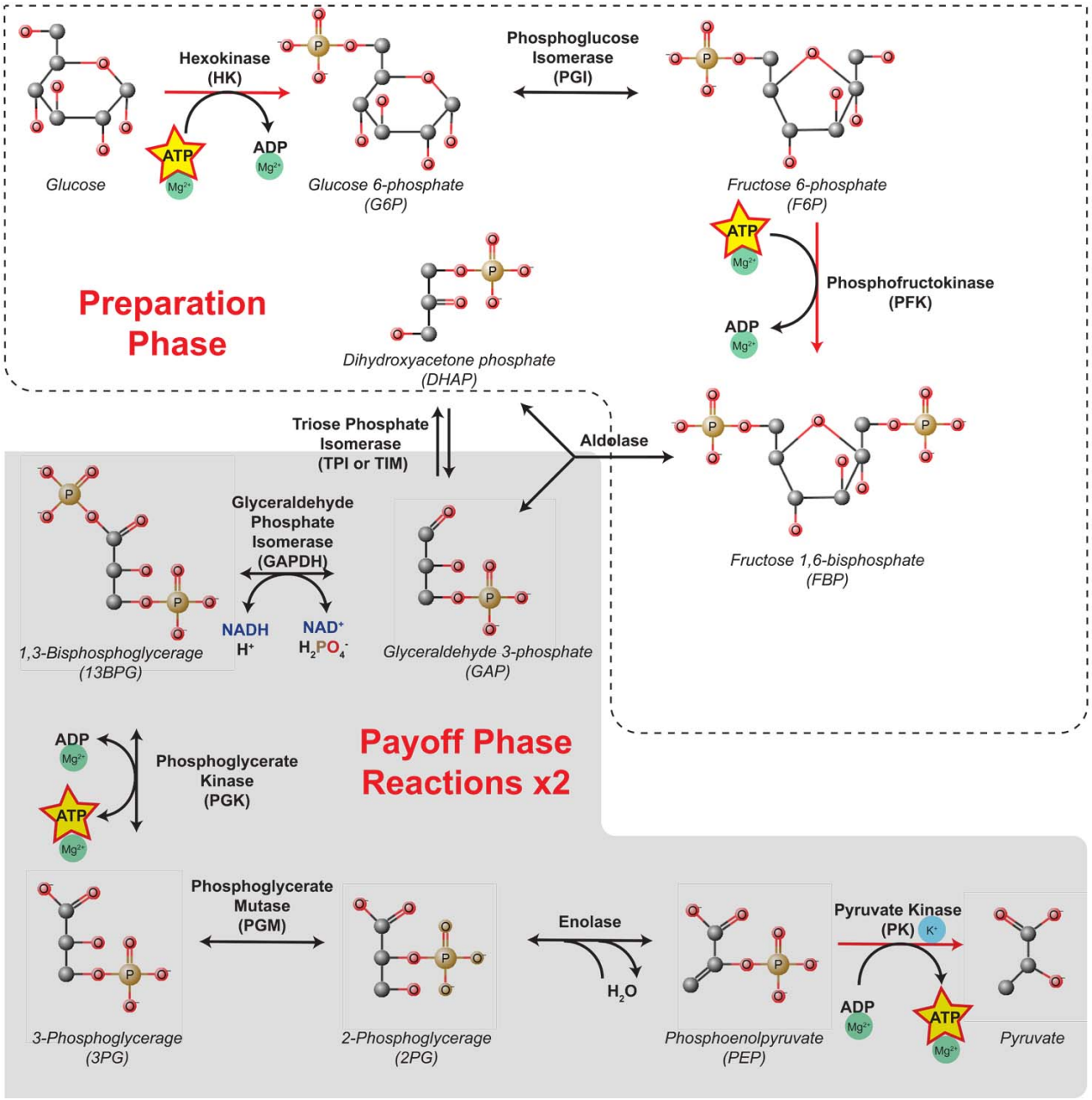
When we have enough ATP, energy gets stored!

Starch or Fat

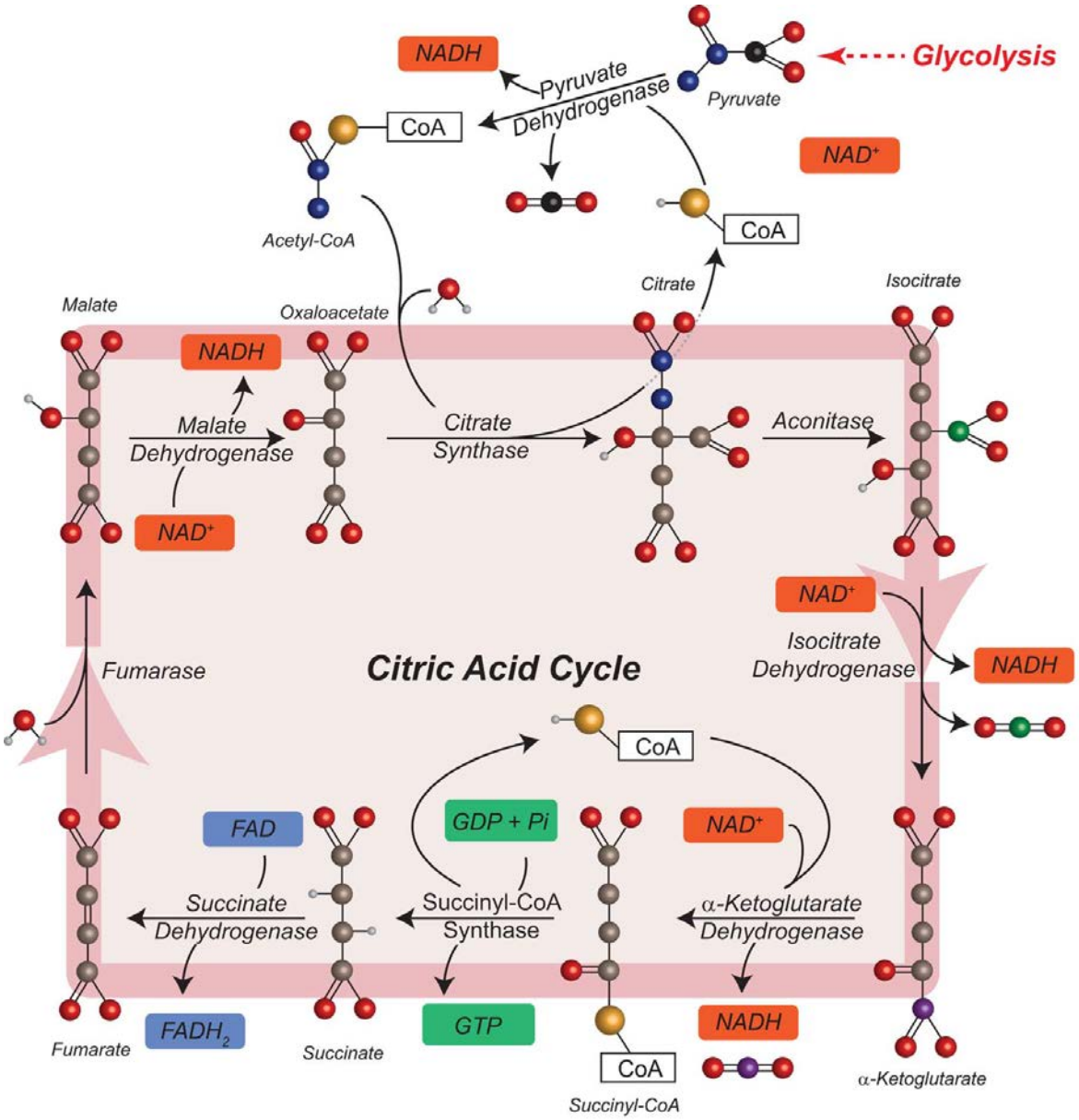
Food and Bioenergy



Overall Process



Overall Process



Oxidation-Reduction Reactions

Why do we care?

Electron transfer reactions are at the core of metabolism! Counting electrons will let us

Aerobic Respiration

$$C_6H_{12}O_6 + 6\ O_2 \leftrightarrows 6\ CO_2 + 6\ H_2O$$

Assigning oxidation states:

- Oxygen counts as -2
  - Except in O_2 → oxygen is 0 in O_2.
- Hydrogens count as +1
  - Except in H_2 → hydrogen is 0 in H_2.
- The oxidation state of carbon will balance the charge.

Examples

C_2H_2

C_2H_4

C_2H_6

$CH_3CH_2CH_2CO_2H$

$CH_3CH_2CH_2CO_2^{-1}$

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Determine how many electrons would be produced from each of the following examples:

Examples

C_2H_2

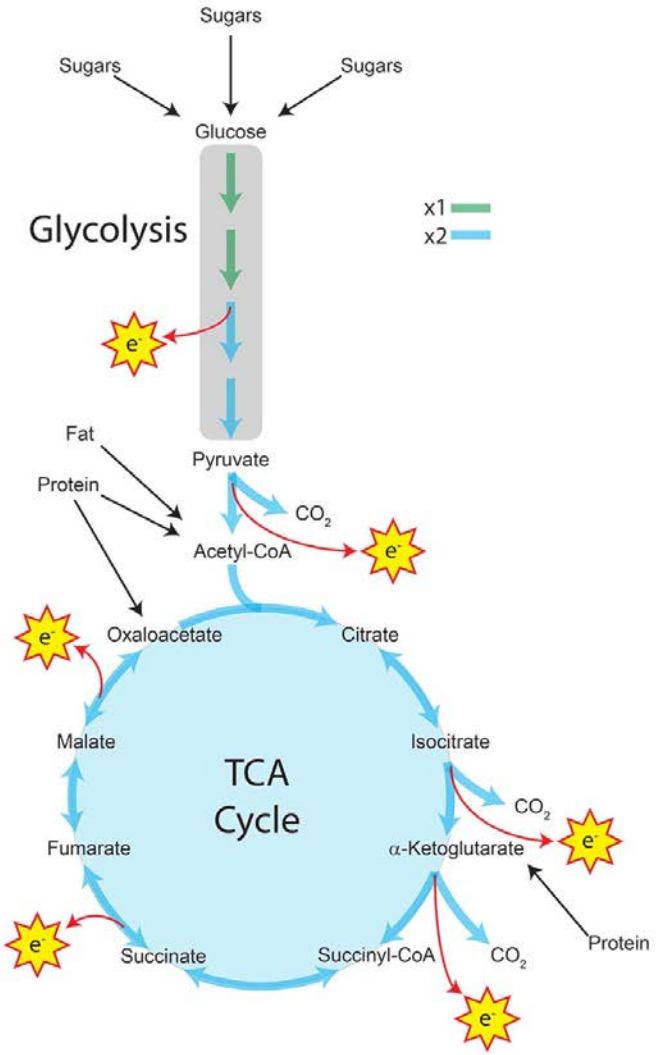
C_2H_4

C_2H_6

$CH_3CH_2CH_2CO_2H$

$CH_3CH_2CH_2CO_2^{-1}$

Electron Flow and Metabolism



$4\ e^-$

$3\ ADP + 4\ H^+ + O_2 \rightarrow 2\ H_2O + 3\ ATP$

$C_6H_{12}O_6 + 6\ O_2 \leftrightarrows 6\ CO_2 + 6\ H_2O$

Examples

C_2H_2

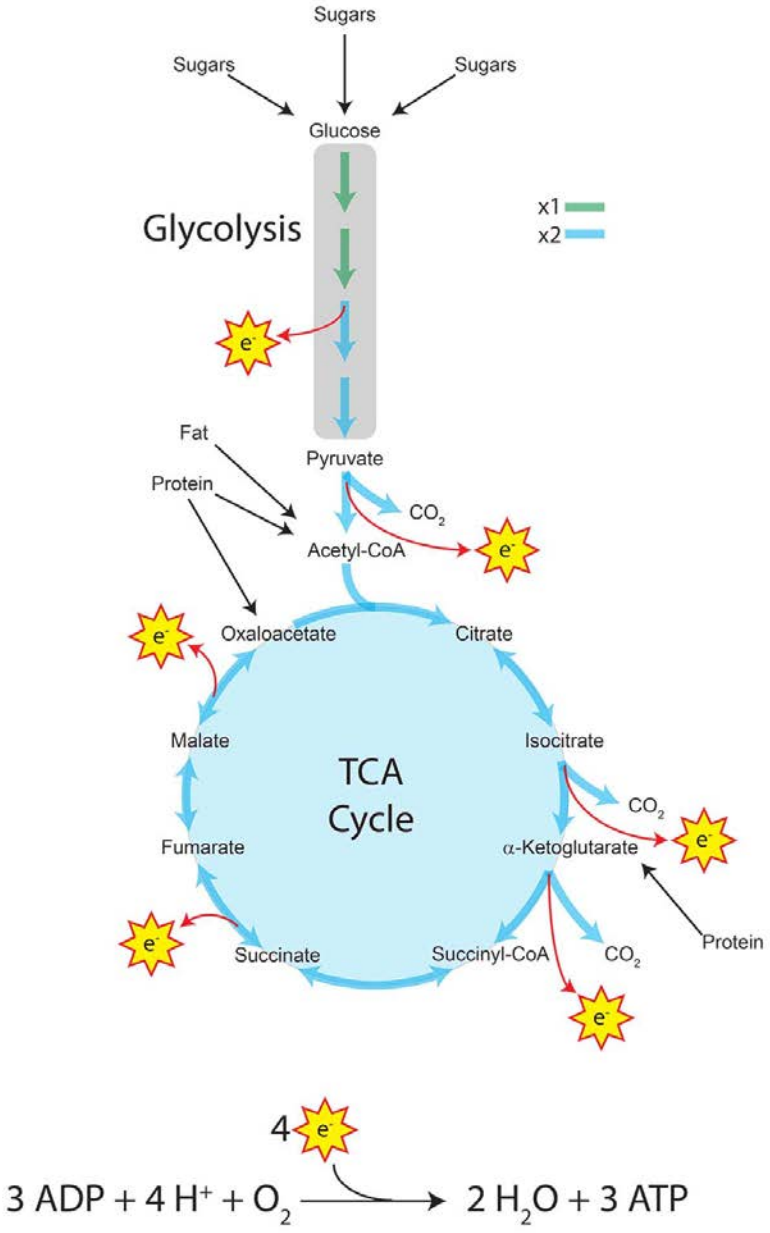
C_2H_4

C_2H_6

$CH_3CH_2CH_2CO_2H$

$CH_3CH_2CH_2CO_2^{-1}$

Anaerobic Respiration – no oxygen



Aerobic Respiration

$$C_6H_{12}O_6 + 6\ O_2 \leftrightarrows 6\ CO_2 + 6\ H_2O$$

Anaerobic Respiration – Fermentation (the cool one!)

$$C_6H_{12}O_6 \leftrightarrows 2\ CO_2 + 2\ CH_3CH_2OH$$

Anaerobic Respiration Summary