Biological Energy

Nutrition Facts

Serving Size 101 g

Amount Per Serving

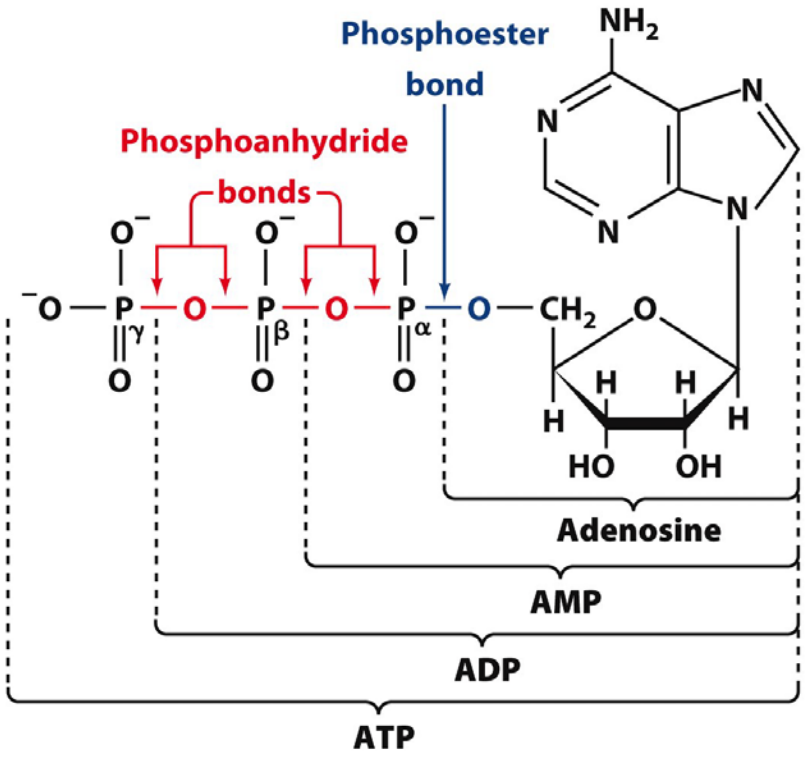
Calories 98	Calories from Fat 58
	% Daily Value*
Total Fat 6.5g	**10%**
Saturated Fat 4.1g	**20%**
Trans Fat 0.0g	
Cholesterol 0mg	**0%**
Sodium 45mg	**2%**
Total Carbohydrates 8.3g	**3%**
Dietary Fiber 1.1g	**4%**
Sugars 1.9g	
Protein 1.4g	

Vitamin A 74% • Vitamin C 2%
Calcium 6% • Iron 5%

Nutrition facts	/100 g	/40 g
Energy	1793 kJ/428 kcal	717 kJ/171 kcal
Protein	24,7 g	9,9 g
Carbohydrate	40,5 g	16,2 g
Sugar	28,8 g	11,5 g
Fat	17,7 g	7,1 g
Saturated fatty acid	13,3 g	5,3 g
Trans fat	0,02 g	0,008 g
Fiber	3,7 g	1,5 g
Sodium	0,4 g	0,15 g
Vitamin C	27,6 mg	11 mg

1 cal = 4.184 J

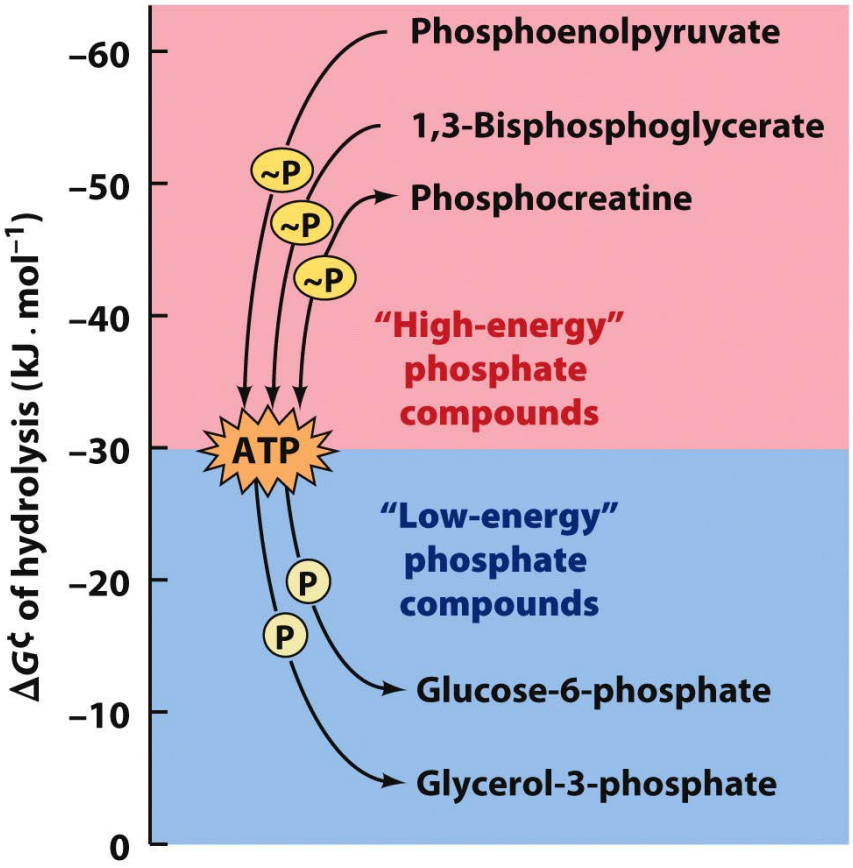
ATP – the energy conduit



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

Opposite of condensation

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

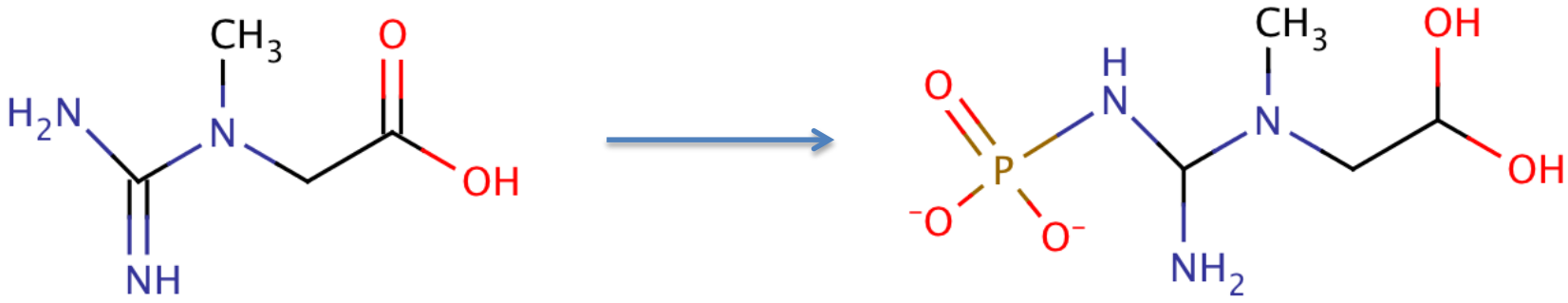
One very common ATP-binding motif is the Walker-A Motif

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

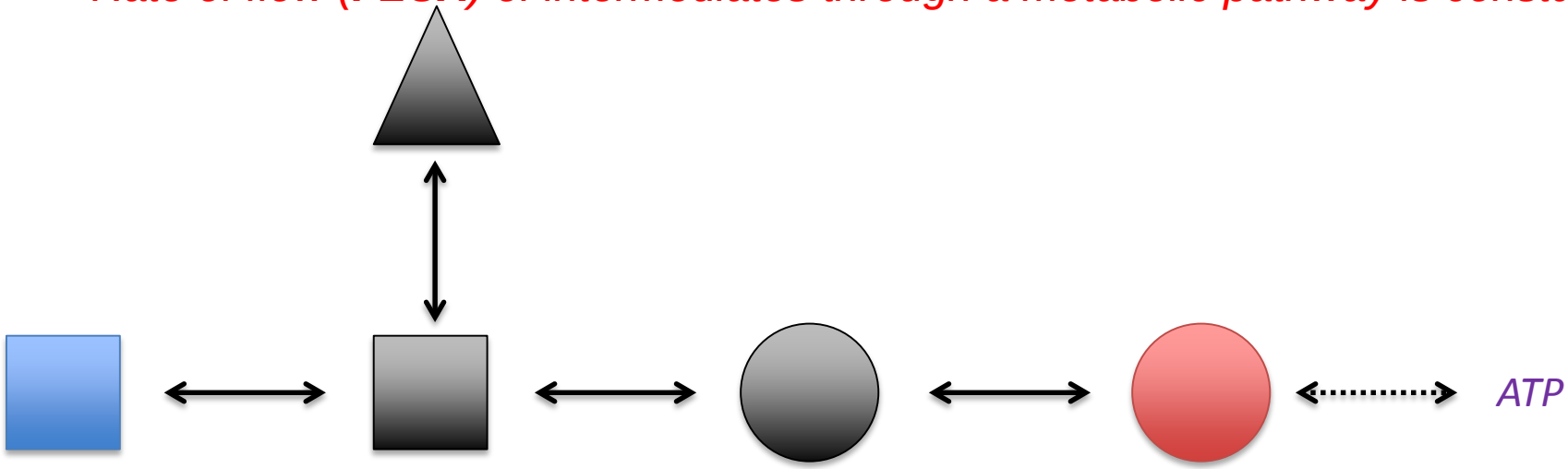


The creatine/phosphocreatine system generates an ATP “Buffer” that can store ATP energy for times of need.

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  ?

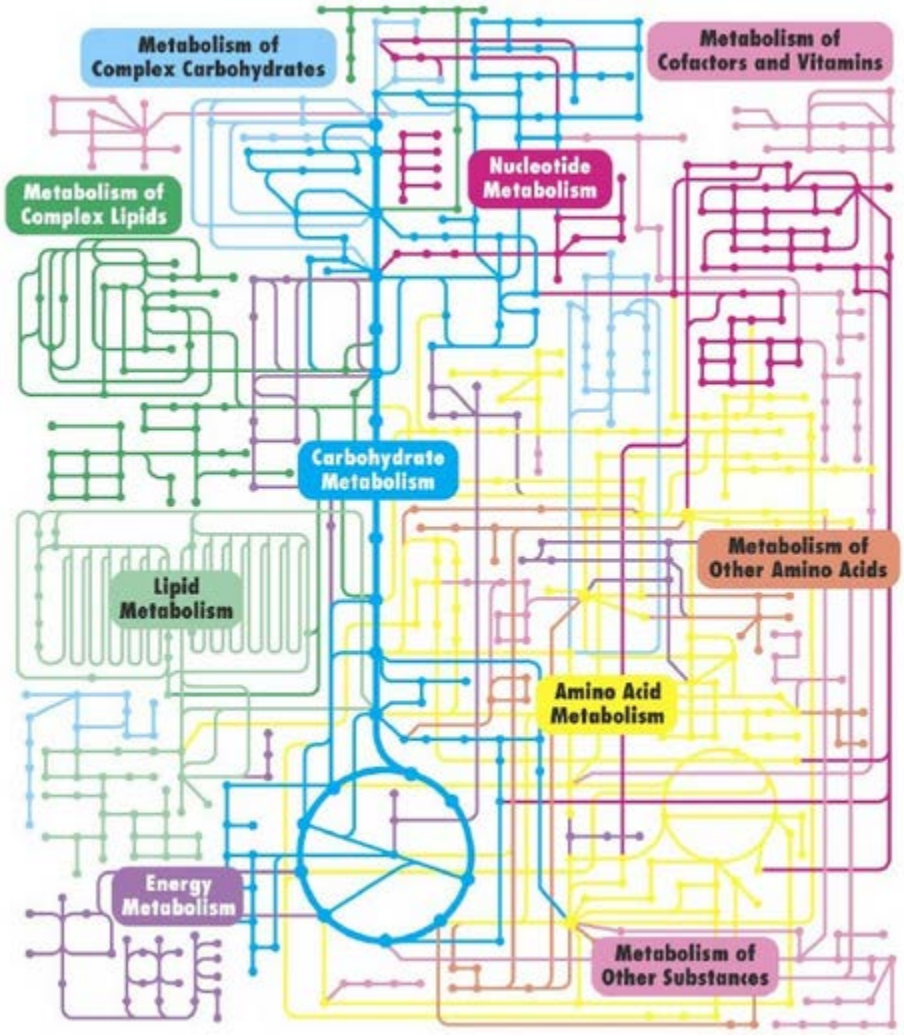
Sudden need for *ATP*?

Sudden surge in concentration of *ATP*?

When we have enough ATP, energy gets stored!

Starch or Fat

Food and Bioenergy



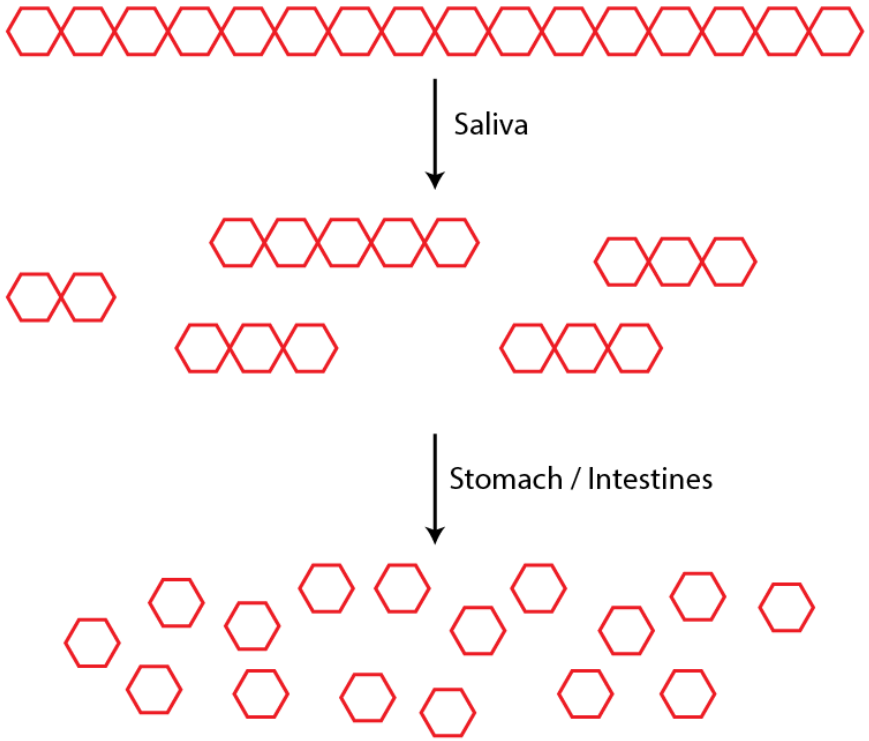
Sugar Metabolism

Glucose
↓
G6P
↓
F6P
↓
FBP
↓
GAP
↓↓
13BPG
↓↓
3PG
↓↓
2PG
↓↓
PEP
↓↓
Pyruvate

Goal: Get to Glucose or one of the intermediates

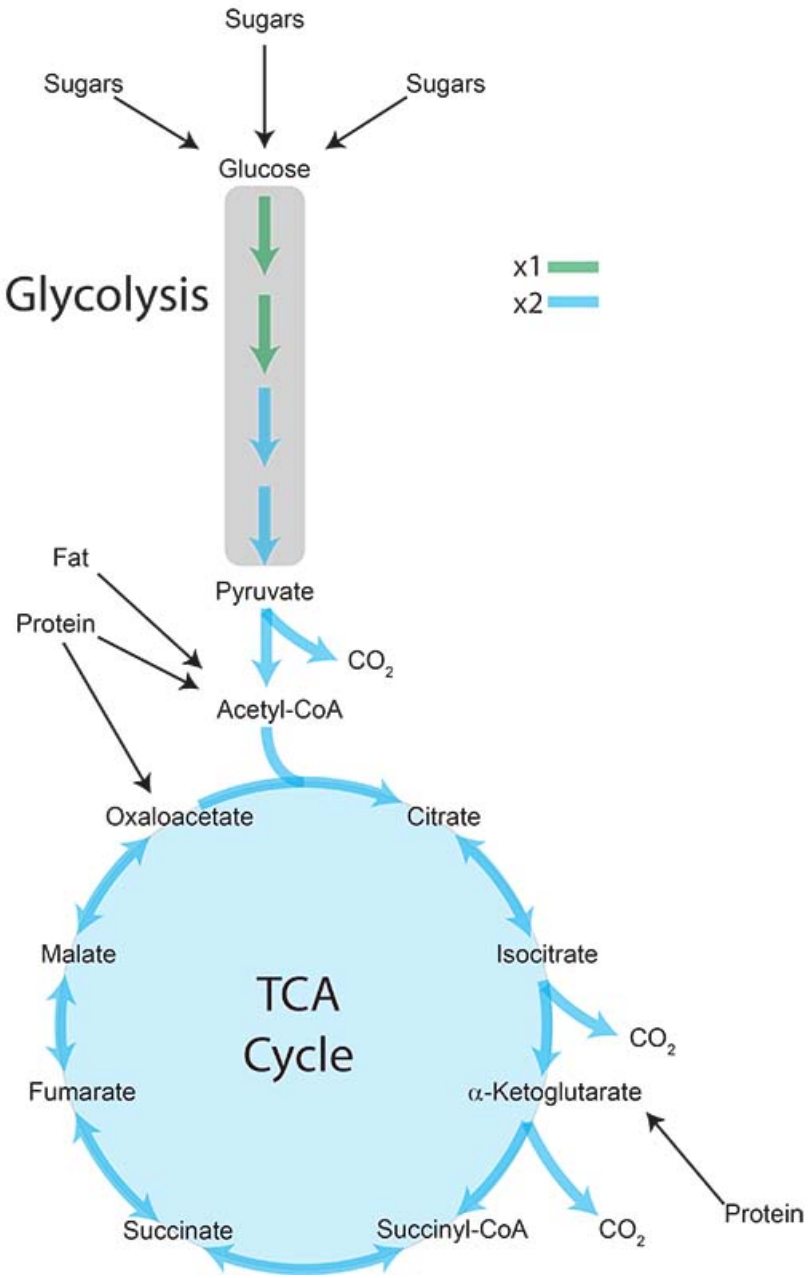
Digestion Bottleneck

Dietary sugar can ONLY be transported into our blood as monosaccharides!

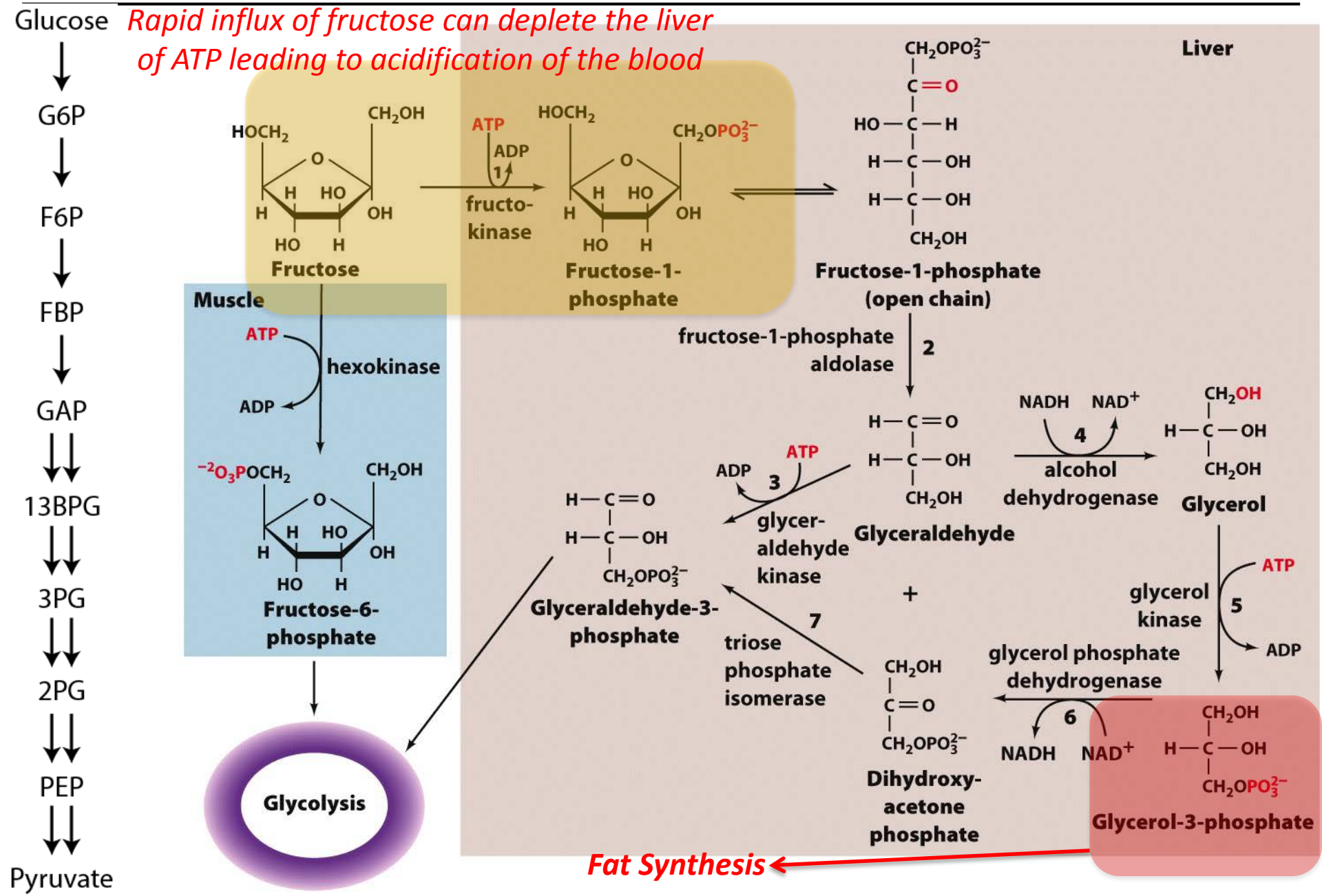


Electron Flow and Metabolism

Glucose
↓
G6P
↓
F6P
↓
FBP
↓
GAP
↓↓
13BPG
↓↓
3PG
↓↓
2PG
↓↓
PEP
↓↓
Pyruvate



Metabolism of Fructose



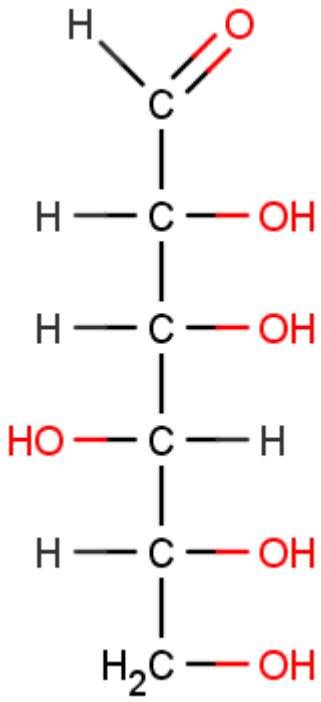
Oxidation-Reduction Reactions

Why do we care?

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

Aerobic Respiration

$$C_6H_{12}O_6 + 6\ O_2$$



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 balar charge.

Examples

C_2H_2

C_2H_4

C_2H_6

$_3CH_2CH_2CO_2H$

$_3CH_2CH_2CO_2^{-1}$

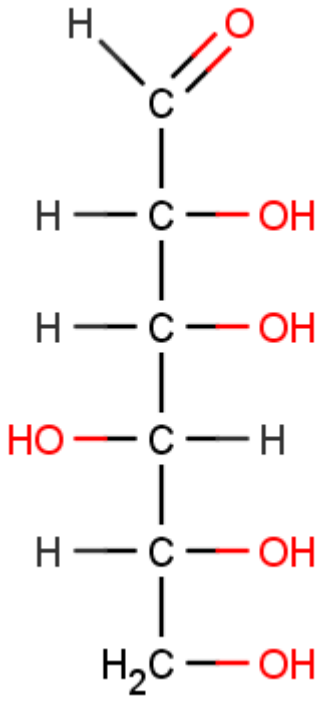
Oxidation-Reduction Reactions

Why do we care?

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

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.



Oxidation-Reduction Reactions

Why do we care?

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

Aerobic Respiration

$$\mathbf{C_6}H_{12}O_6 + 6\ O_2 \leftrightarrows \mathbf{6\ C}O_2 + 6\ H_2O$$

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

Examples

C_2H_2

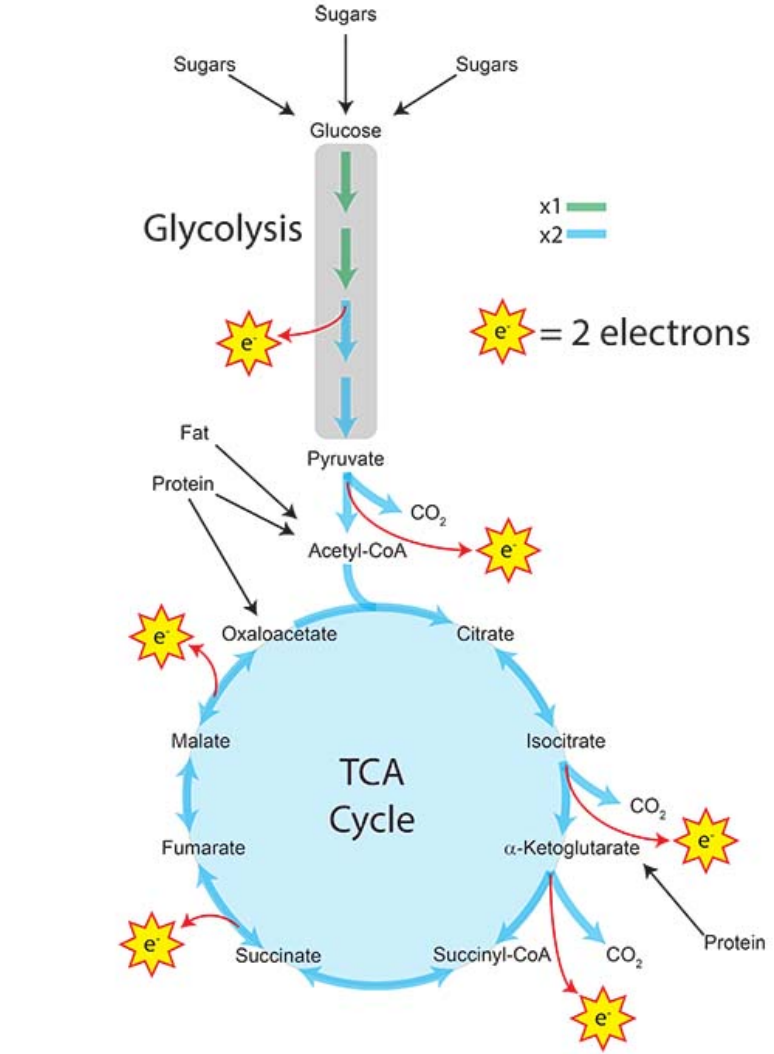
C_2H_4

C_2H_6

$CH_3CH_2CH_2CO_2H$

$CH_3CH_2CH_2CO_2^{-1}$

Electron Flow and Metabolism



Oxidation-Reduction Reactions

Why do we care?

Electron transfer reactions!

Aerobic Respiration

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

Anaerobic Respiration – Fermentation
(the cool one!)

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

Fat Oxidation