DIGESTION OF POLYSACCHARIDES AND DISACCHARIDES

Dietary Carbohydrates – all are hydrolyzed to monosaccharides by combined action of several enzymes.

E.g. Humans

1. $(Starch)_n + H_2O \xrightarrow[\text{Salivary } \alpha\text{-amylase}]{\text{Mouth}} (Starch)_{n-1} + Glucose$

   Polysaccharide

2. Stomach – Salivary α-amylase inactivated by low pH.

3. Small intestine

$$Starch + H_2O \xrightarrow[\alpha\text{-amylase}]{\text{Pancreatic}} Glucose + Maltose + \text{Limit dextrin}$$

$$Maltose + H_2O \xrightarrow{\text{Maltase}} 2\ Glucose$$

$$Dextrin + n H_2O \xrightarrow[\alpha\text{-amylase}]{\text{Dextrinase}} n\ Glucose$$

Maltase

$$Lactose + H_2O \xrightarrow{\text{Lactase}} Galactose + Glucose$$

$$Sucrose + H_2O \xrightarrow{\text{Sucrase}} Glucose + Fructose$$

Polysaccharides / Glycoproteins (Foods) $\longrightarrow$ Mannose

GLYCOLYSIS

1. Aerobic

1 Glucose (6c) $\xrightarrow[\text{steps}]{10}$ 2 Pyruvate (3c)

2. Anaerobic

1 Glucose $\xrightarrow[\text{steps}]{11}$ 2 Lactate

$C_6H_{12}O_6$ $\xrightarrow{10\text{ steps}}$ Free energy → ATP

$\xrightarrow{10\text{ steps}}$ 2 $CH_3-C(=O)-COOH$ Pyruvate

$\xrightarrow{11\text{ steps}}$ 2 $HO-CH(CH_3)-COOH$ Lactate

GLUCOSE

↓ Glycolysis

2 Pyruvate

- Anaerobic → 2 Ethanol + $2CO_2$ — e.g. Alcohol fermentation by Yeast
- O_2, CO_2 | Aerobic → 2 Acetyl CoA
- Anaerobic → 2 Lactate — e.g. Active muscle

2 Acetyl CoA

O_2 | TCA Cycle → $4CO_2 + 4H_2O$

e.g. Animal, Plant and Microbial cells under aerobic conditions.

Anaerobic glycolysis in an active skeletal muscle

Sum:

(iii) $Glucose + 2Pi + 2ADP \longrightarrow 2Lactate^- + 2H^+ + 2ATP + 2H_2O$

(i) $Glucose \longrightarrow 2Lactate^- + 2H^+$

$\Delta G^{0'} = -47$ Kcal/mol

(ii) $2Pi + 2ADP \longrightarrow 2ATP + 2H_2O$

$\Delta G^{0'} = +14.6$ Kcal/mol

$\Delta G^{0'}_s = -47 + (+14.6) = -32$ Kcal/mol

Overall STD-free energy change of glycolysis.

But;

$Glucose \longrightarrow 2Lactate^- + 2H^+ \quad -47$ Kcal/mol

$Glucose + 6O_2 \longrightarrow 6CO_2 + 6H_2O \quad -686$ Kcal/mol

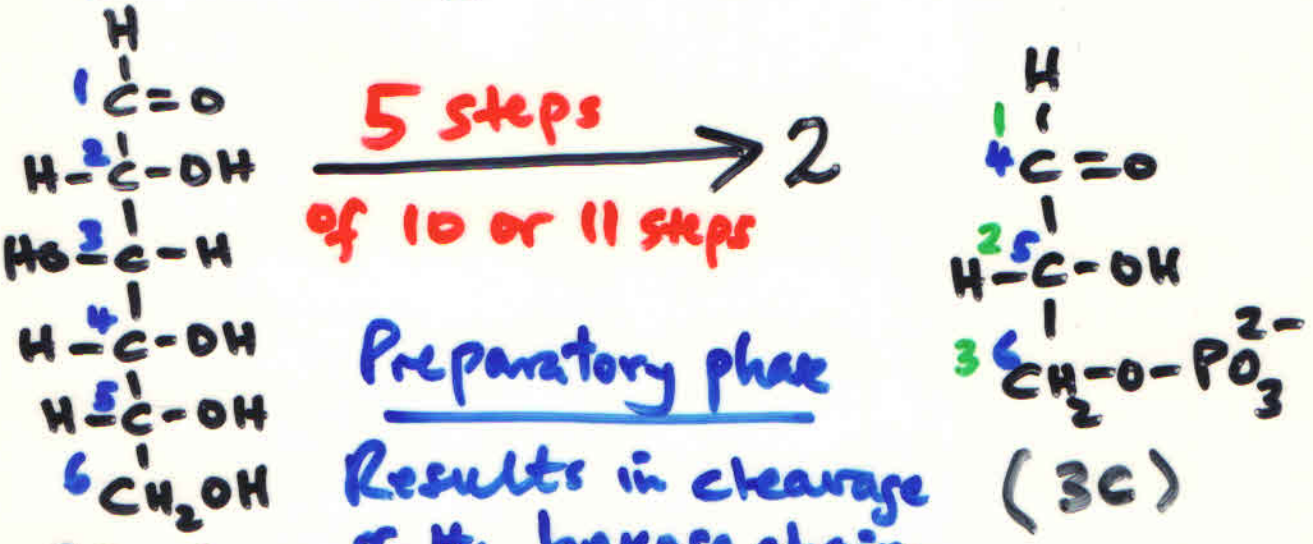
$\therefore \frac{47}{686} \times 100 \simeq 7\%$ Glycolysis produces only about 7% of the energy inherent in a glucose residue.

2 Lactate contain most of the energy which can only be released by complete oxidation to $CO_2 + H_2O$ with O_2 as the oxidant.

GLYCOLYSIS has 2 Phases;

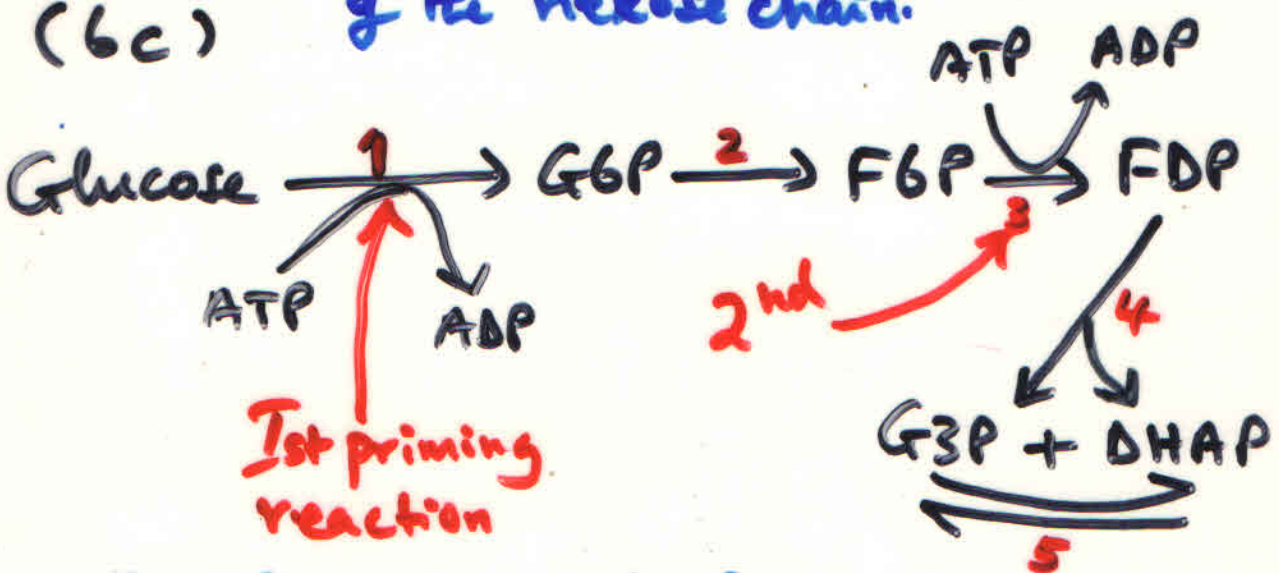
← Investiment phase

1st Phase – Involves phosphorylation of glucose and its conversion to glyceraldehyde 3-phosphate (G3P).



Preparatory phase

Results in cleavage of the hexose chain.



2ATPs utilized to fix a phosphate group at C6 and C1' of glucose respectively.

Other hexoses i.e. Fructose, Galactose and Mannose also enter the preparatory phase and end up being converted to G3P. G3P is the common product of all hexoses – Discussed later (in detail)

THE CITRIC ACID CYCLE / THE TRICARBOXYLIC ACID CYCLE / THE KREBS CYCLE

Glycolysis — how cells obtain energy (ATP) from CHOs in the "absence" of O_2. The pathway is unable to tap all the energy trapped in CHOs e.g. glucose.

Mammals — Cells are aerobic so they oxidize organic fuels to $CO_2 + H_2O$. The aerobic phase of catabolism is known as respiration i.e. Consumption of O_2 and CO_2 formation by cells.

Respiration occurs in 3 major stages:

STAGE I — Organic fuels are oxidized to yield 2-Carbon groups in form of AcetylCoA.

STAGE II — The 2-Carbon groups (acetyl groups) to yield CO_2 and energy rich H_2 atoms.

STAGE III — H atoms are split into $H^+ + e^-$. The e^- reduce O_2 to H_2O. ATP is formed.