Catabolism: Tricarboxylic acid cycle (TCA) or Citric acid cycle

Pyruvic acid.

($CH_3COCOOH$) is the simplest of the alpha-keto acids, with a carboxylic acid and a ketone functional group.

Pyruvic acid supplies energy to cells through the citric acid cycle (also known as the Krebs cycle) when oxygen is present (aerobic respiration), and alternatively ferments to produce lactate when oxygen is lacking (fermentation).

Pyruvate decarboxylation by the pyruvate dehydrogenase complex produces acetyl-CoA.

$$\text{Pyruvate} + NAD^+ \xrightarrow{\text{pyruvate dehydrogenase}} \text{Acetyl CoA} + CO_2 + NADH + H^+$$

Kreb's cycle(TCA) :

Acetyle CoA is the substrate of this cycle, it arises from the catabolism of many carbohydrates,lipids and amino acids. It is an energy-rich molecule composed of coenzyme A and acetic acid joined by a high –energy thiolester bond.

In the first reaction acetyl –CoA is condensed with a four-carbon intermediate , oxaloacetate, to form citrate and to begin the six–carbon stage. Citrate (a tertiary alcohol) is rearranged to give isocitrate which is oxidized and decarboxylated twice to yield α-ketoglutarate, then succinyl-CoA. 2NADH are formed and 2 carbons are lost from the cycle as CO_2 . Because 2 carbons were added as acetyl –CoA at the start ,balance is maintained and no net carbon is lost. Cycle now enters the four carbon stage during which 2 oxidation steps yield; 1$FADH_2$ and 3NADH per acetyl –CoA .

GTP (a high – energy molecule equivalent to ATP) is produced from succinyl–CoA by substrate–level phosphorylation. Oxaloacetate is reformed and ready to join with another acetyl-CoA.

TCA cycle generates : 2 CO_2s ,3 NADHs ,1 $FADH_2$,1 GTP for each acetyl –CoA molecule oxidized .

The cycle enzymes are widely distributed among M.O. The complete cycle is functional in many aerobic bacteria, the facultative anaerobes does not use the full TCA cycle under anaerobic conditions, this cycle is an important source of energy and provide carbon skeleton for use in biosynthesis.

Only 4ATP molecules is directly synthesized when 1 glucose molecules is oxidized to 6 CO_2 molecules by glycolysis and TCA cycle. Most ATP generated comes from the oxidation of NADH and $FADH_2$ in the electron transport chain.

The electron Transport Chain

Mitochondrial electron transport chain is composed of a series of electron carriers that operate together to transfer electrons from donors , like NADH and $FADH_2$ to acceptors such as O_2.

The electrons flow from carriers with more negative reduction potentials to those with more positive potentials and combine with O_2 and H^+ to form water. The electron transport chain carriers reside within the inner membrane of the mitochondria or in the bacterial plasma membrane.

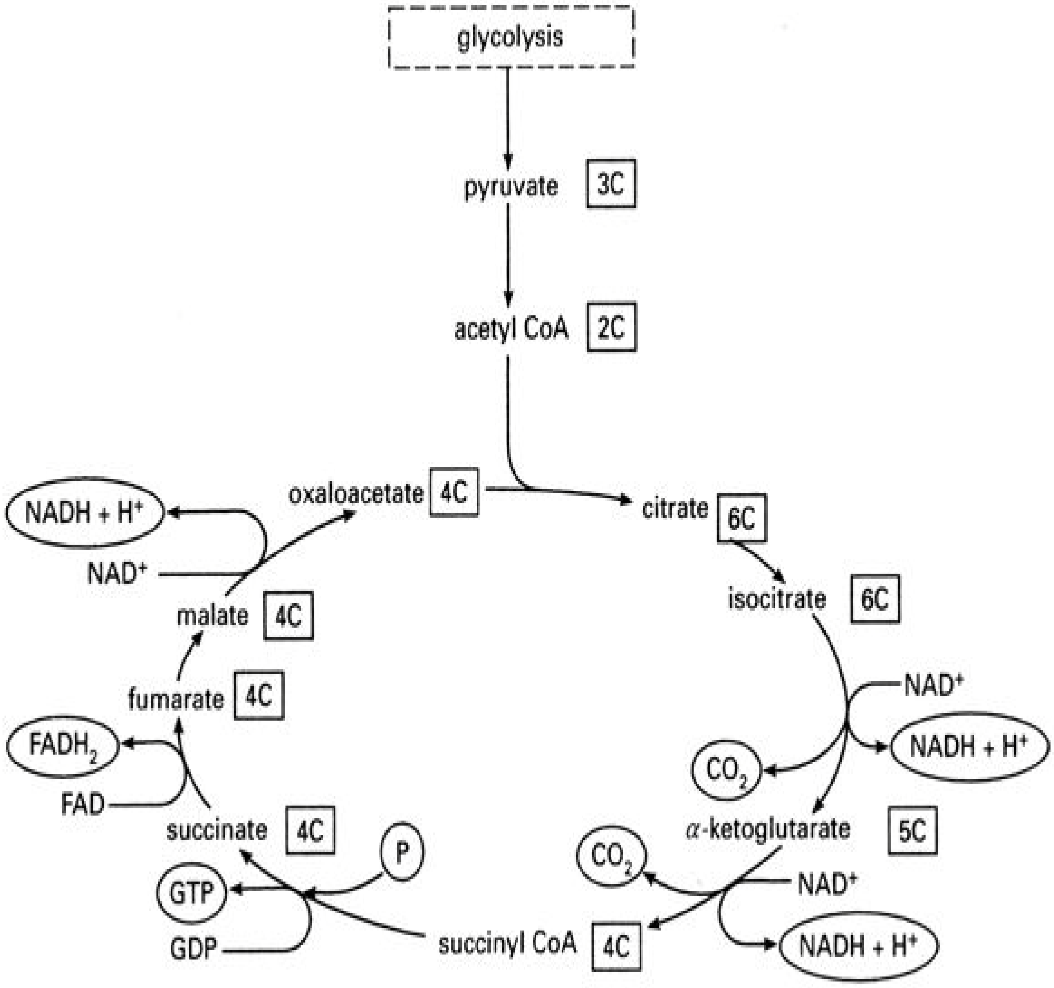
The process by which energy from electron transport is used to make ATP is called **oxidative phosphorylation** .

ATP yield from the aerobic oxidation of glucose

• **Glycolytic pathway**	
Substrate- level phosphorylation (ATP)	2 ATP
Oxidative phosphorylation with 2NADH	4-6 ATP
• **2 pyruvate to 2 Acetyle–CoA**	
Oxidative phosphorylation with 2 NADH	6 ATP
• **Tricarboxylic Acid Cycle**	
Substrat –level phosphorylation (GTP)	2 ATP
Oxidative phosphorylation with 6NADH	18 ATP
Oxidative phosphorylation with 2FADH2	4ATP
Total Aerobic Yield	36-38 ATP

Aerobic respiration is much more effective than anaerobic processes that not involving electron transport and oxidative phosphorylation.

Many M.O when moved from anaerobic conditions to aerobic conditions will reduce their rate of sugar catabolism and switch to aerobic respiration this phenomenon known as **Pasteur effect ,** this is of advantage to the m.o as less sugar must be degraded to obtain the same amount of ATP when the more efficient aerobic process can be employed .



The Kreb's cycle