
# FACULTY OF ENGINEERING & TECHNOLOGY

## DEPARTMENT OF BIOTECHNOLOGY

# Crabtree effect",

•When *Saccharomyces cerevisiae* is growing exponentially on glucose or fructose as carbon plus energy source, and in the presence of air, the glucose degradation proceeds mainly via aerobic fermentation.

•The yeast is growing on mannose or galactose, degradation proceeds simultaneously via respiration and fermentation.

•This situation results from a repression of the of the respiratory enzymes synthesis by high fermentation rates.

•This regulatory system, called the "Crabtree effect", consists actually of a repression of an energy source (respiration) by another energy source (fermentation). Various yeast strains were tested; the regulatory system was present in about 50% of them.

Crabtree effect refers to inhibition of respiration when glucose concentration is increased (or when glycolysis is increased).

It is observed in glycolytically active cells (like those involved in fermentations e.g yeast; and tumor cells), and not in every cell (which is contrary to Pasteur effect, observed in all kinds of cells).

The mechanism behind the Crabtree Effect can be well understood in terms of [ATP]/[ADP][Pi ] ratio .

It's the cytosolic [ATP]/[ADP][Pi ] ratio which regulates the rate of respiration and glycolysis in the cells. But, the regulatory mechanism of both the processes is entirely different, which ultimately leads to Crabtree Effect in such cells

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The regulation of respiration is controlled by free energy of hydrolysis of ATP (following equation gives an overview of Free Energy of ATP Hydrolysis)

Decrease in [ATP]/[ADP][Pi ] thus leads to an increase in the respiration rate, and increase in [ATP]/[ADP][Pi ] leads to a decrease in respiration. On the other hand, regulation of Glycolysis is positively controlled by ADP (AMP) and Pi and negatively by ATP (thus again, decrease in [ATP]/[ADP][Pi] leads to increase in glycolytic rate, while increase leads to decrease in the glycolytic rate). So, as evident, both respiration and glycolysis are regulated by the same set of factors, but by entirely different mechanisms.

Now, this distinguished control of respiration and glycolysis is what leads to Crabtree effect. To elaborate, since Crabtree Effect takes place only in those cells which are glycolytically active, an increase in glucose conc. will push it towards glycolytic pathway, leading to an increased ATP production (consuming ADP and Pi, from media).

This would tremendously increase the [ATP]/[ADP][Pi ] ratio, seriously lowering the free energy of ATP hydrolysis, and hence decreasing the rate of respiration to huge extent (But, the glycolysis induced increase in [ATP]/[ADP][Pi ] won't necessarily reduce the glycolytic rate itself, as it's dependent on ADP (AMP) and Pi too, which is often present in good amounts in medium, to activate the enzymes responsible for glycolysis; more over the inherent glycolytically active nature of the cells keeps the inhibition of glycolysis itself at the bay!). So, this is how in most simple terms, Crabtree Effect takes place.

***Significance***

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The alcohol production industry is highly dependent upon the Crabtree active *Saccharomyces cerevisiae*. Yeast produces alcohol only under anaerobic conditions (which must be maintained for higher alcohol output!). Under aerobic conditions, oxidative phosphorylation takes place, which stops the use of

• glycolytic pathway. But, if excess of glucose (substrate) is supplied to the culture, then Crabtree effect takes place, and respiration is inhibited even if aerobic condition prevails! This leads to excess production of alcohol rather than biomass production. So, Crabtree comes to a favorable use in alcohol industry.