Factors affecting saccharomyces cerevisiae

Chapter 1: Introduction

Research Questions:

What is the effect of differing temperatures on Saccharomyces cerevisiae population growth?

What is the effect of differing pH levels on Saccharomyces cerevisiae population growth?

What is the effect of differing glucose concentrations on Saccharomyces cerevisiae population growth?

The yeast

Saccharomyces cerevisiae is a single celled fungus that reproduces asexually by budding or division. It is one of the most well studied eukaryotic model organisms in both molecular and cell biology.

S. cerevisiae is a very good type of yeast for biological studies owing to the rapid growth (doubling time 1. 5-2 hours at 30 °C), the dispersed cells and the ease of replica planting. Moreover is a non-pathogenic organism, so can be handled fearlessly with only little precautions. Also large amounts of commercial baker's yeast are available with result being an easy and cheap source for biochemical studies.

S. cerevisiae has round to ovoid cells between 3-8Î¼m in diameter.

1. 2 Respiration

In biology, respiration is defined as: " the process by which the energy in food molecules is made available for an organism to do biological work" (Kent, 2000; p. 100). It is also called Cellular respiration. This process of cellular respiration happens in every living cell as it is the only way to obtain energy in a form that will be usable for the cell, so it can carry out the functions of movement, growth and reproduction (ibid).

The food in yeasts must be obtained as they cannot produce it on their own. For yeasts, a very good source of energy is sugars. All strains of S. cerevisiae can metabolize glucose (a hexose sugar), maltose and trehalose.

1. 3 Types of Respiration

There are two main types of respiration that take place within a cell: Anaerobic respiration (without oxygen) and Aerobic respiration (with oxygen). S. cerevisiae can metabolize sugars in both ways, but in this research the cultures of yeast were exposed to air hence to oxygen, so aerobic respiration was mainly the way that yeast cells grew and reproduced.

1. 4 Enzymes

Thousands of chemical reactions are carried out within a cell. These reactions most of the times occur in a very slow rate. For that reason living organisms make biological catalysts which are called enzymes and speed up these reactions. “ Enzymes are globular proteins which act as catalysts of chemical reactions” (Allot, 2007; p. 18. Also cells can control which reaction occurs in their cytoplasm by making some enzymes and not others. Enzymes achieve to increase the rate of a reaction by decreasing the activation energy (the minimum amount of energy required for a reaction to occur) (Greenwood. Et al. 2007; p. 167) of the substrate or the substrates, when binding to the activation site (Greenwood. et al. 2007; p. 114).

Enzymes are sensitive molecules with very specific structure which enables them to carry out specific reactions. This structure including the active site can be damaged by various conditions and substrates. This damage is called denaturation and is usually permanent for an enzyme and if denaturation is occurred the enzyme can no longer carry out its function. As a result when enzymes are required to catalyze a reaction, is necessary that they have appropriate conditions. Different enzymes have different ideal conditions called optimum. The factors that affect the enzyme activity are: the temperature, the pH, the substrate concentration.

The effect of temperature, pH and substrate concentration upon the enzyme activity which affects the growth of S. cerevisiae yeast cells are studied in this research.

1. 5 Effect of Temperature

As the temperature is increased in an enzyme-catalysed reaction, the rate of reaction is increased up to maximum in a specific temperature. This is called optimum temperature. The optimum temperature of Saccharomyces cerevisiae is 30o- 32oC.

Above this temperature the rate starts to drop rapidly. This is due to the high energy that causes vibration inside the enzyme with result the bonds which maintain the structure of enzyme to break. This causes denaturation and the active site can no longer fit the substrate.

1. 6 Effect of pH (hydrogen ion concentration)

Most of the enzymes operate effectively in a small range of pH values. Between these pH values there is an optimum pH value in which the enzyme activity is the highest. The optimum pH of Saccharomyces cerevisiae is 5. 5. Acids and alkalis cause denaturation of the structure of the enzyme by breaking mainly hydrogen and ionic bonds with result the substrate can't fit the active site. Furthermore the charges of the amino acids within the active site are affected by pH changes, so the enzyme is not able to form an enzyme-substrate complex. Above and below the optimum pH the enzymatic activity hence the rate is reduced considerably.

1. 7 Effect of Substrate concentration

In an enzyme-catalysed reaction the rate increases in direct proportion to the substrate concentration. The optimum glucose concentration of Saccharomyces cerevisiae is 2%. At low substrate concentrations, the rate of enzymatic activity increases sharply as the substrate increases. This occurs due to the more frequent collisions between the substrate molecules and the unoccupied active sites. On the other hand, at high substrate concentrations the biggest part of the active sites have been occupied with result when increasing the substrate concentration there is little effect on the rate of enzymatic activity.

1. 8 Purpose of the research

The purpose of this research that is carried out to examine the growth of S. cerevisiae yeast cells in different factors and various conditions is not so in order to discover which are the optimum conditions in each factor (as this species of S. cerevisiae is very well studied and examined professionally because of its usage in food industry) but to examine in real conditions and not theoretical ones how altering the environment of a cell affects the way its enzymes work and help the whole cell to live and divide in all of the previously ways that were mentioned in the introduction part.