Self-Review Questions (SRQ) For Study Session 1

Now that you have completed this study unit, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting or Online interactive sessions. You can also check your answers at the Self-Review Answers section which is located at the end of this Module.

Write short notes on Biotechnology

2. In brief, discuss the process of Genetic Modification.

3. Write short notes on Cell bioprocessing; distinguish between upstream and downstream bioprocessing.

4. What are Enzymes? Briefly discuss the factors that affect enzyme activity.

5. Discuss the distribution of biodiversity and factors responsible for the distribution

Self-Review Answers (SRA) for This Study

1. Biotechnology is the use of living systems and organisms to develop or make products, or "any technological application that uses biological systems, living organisms or derivatives thereof, to make or modify products or processes for specific use". Depending on the tools and applications, it often overlaps with the (related) fields of bioengineering, food biotechnology, biomedical engineering, bio-manufacturing, molecular engineering, microbiology, biochemistry, etc.

2. The first step is to choose and isolate the gene that will be inserted into the genetically modified organism. The gene can be isolated using restriction enzymes to cut DNA into fragments and gel electrophoresis to separate them out according to length. Polymerase chain reaction (PCR) can also be used to amplify up a gene segment, which can then be isolated through gel electrophoresis. If the chosen gene or the donor organism's genome has been well studied it may be present in a genetic library. If the DNA sequence is known, but no copies of the gene are available, it can be artificially synthesized.

The gene to be inserted into the genetically modified organism must be combined with other genetic elements in order for it to work properly. The gene can also be modified at this stage for better expression or effectiveness. As well as the gene to be inserted most constructs contain a promoter and terminator region as well as a selectable marker gene. The promoter region initiates transcription of the gene and can be used to control the location and level of gene expression, while the terminator region ends transcription. The selectable marker, which in most cases confers antibiotic resistance to the organism it is expressed in, is needed to determine which cells are transformed with the new gene. The constructs are made using recombinant DNA techniques, such as restriction digests, ligations and molecular cloning. The manipulation of the DNA generally occurs within a plasmid.

3. Cell therapy bioprocessing is a discipline that bridges the fields of cell therapy and bioprocessing (i.e., biopharmaceutical manufacturing), and is a sub-field of bioprocess engineering. The goals of cell therapy bioprocessing are to establish reproducible and robust manufacturing processes for the production of therapeutic cells.

Upstream bioprocessing

The upstream process is defined as the entire process from early cell isolation and cultivation, to cell banking and culture expansion of the cells until final harvest (termination of the culture and collection of the live cell batch).

The upstream part of a bioprocess refers to the first step in which microbes/cells are grown, e.g. bacterial or mammalian cell lines, in bioreactors. Upstream processing involves all the steps related to inoculum development, media development, improvement of inoculum by genetic engineering process, optimization of growth kinetics so that product development can improve tremendously.

Downstream bioprocessing

The downstream part of a bioprocess refers to the part where the cell mass from the upstream are processed to meet purity and quality requirements. Downstream processing is usually divided into three main sections: cell disruption, a purification section and a polishing section. The volatile products can be separated by distillation of

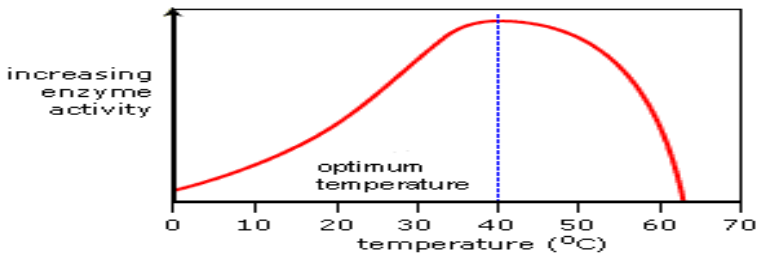
the harvested culture without pre-treatment. Distillation is done at reduced pressure at continuous stills. At reduced pressure distillation of product directly from fermenter may be possible.

4. Enzymes are macromolecular biological catalysts. Enzymes accelerate, or catalyze, chemical reactions.

Factors affecting Enzyme Activity

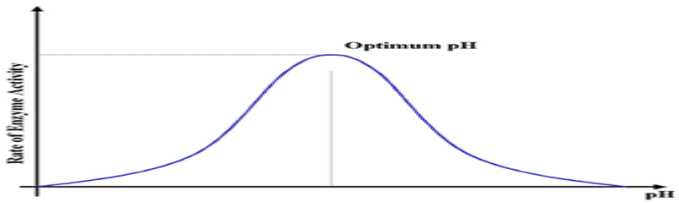
Temperature

The temperature at which the maximum rate of reaction occurs is called the enzyme's Optimum Temperature. Increasing temperature increases the Kinetic Energy that molecules possess. In a fluid, this means that there are more random collisions between molecules per unit time. As temperature increases, more bonds, especially the weaker Hydrogen and Ionic bonds, will break as a result of this strain. Breaking bonds within the enzyme will cause the Active Site to change shape. Eventually, the enzyme will become denatured and will no longer function.



pH - Acidity and Basicity

Different enzymes have different Optimum pH values. This is the pH value at which the bonds within them are influenced by H^+ and OH^- Ions in such a way that the shape of their Active Site is the most Complementary to the shape of their Substrate. At the Optimum pH, the rate of reaction is at an optimum. Any change in pH above or below the Optimum will quickly cause a decrease in the rate of reaction, since more of the enzyme molecules will have Active Sites whose shapes are not (or at least are less) Complementary to the shape of their Substrate.



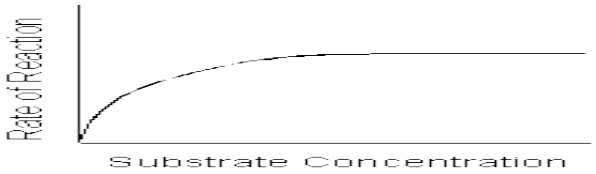
Small changes in pH above or below the Optimum do not cause a permanent change to the enzyme, since the bonds can be reformed. However, extreme changes in pH can cause enzymes to Denature and permanently lose their function. Enzymes in different locations have different Optimum pH values since their environmental conditions may be different. For example, the enzyme Pepsin functions best at around pH2 and is found in the stomach, which contains Hydrochloric Acid (pH2).

Concentration

Changing the Enzyme and Substrate concentrations affect the rate of reaction of an enzyme-catalysed reaction. Controlling these factors in a cell is one way that an organism regulates its enzyme activity and so its Metabolism.

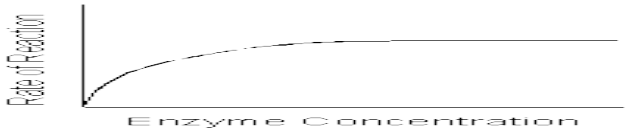
Substrate Concentration

Increasing Substrate Concentration increases the rate of reaction. This is because more substrate molecules will be colliding with enzyme molecules, so more product will be formed. However, after a certain concentration, any increase will have no effect on the rate of reaction, since Substrate Concentration will no longer be the limiting factor. The enzymes will effectively become saturated, and will be working at their maximum possible rate.



Enzyme Concentration

Increasing Enzyme Concentration will increase the rate of reaction, as more enzymes will be colliding with substrate molecules. However, this too will only have an effect up to a certain concentration, where the Enzyme Concentration is no longer the limiting factor.



Enzyme Inhibitors

Enzyme reaction rates can be decreased by various types of enzyme inhibitors.

5. Biodiversity is not evenly distributed, rather it varies greatly across the globe as well as within regions. Among other factors, the diversity of all living things (biota) depends on temperature, precipitation, altitude, soils, geography and the presence of other species. The study of the spatial distribution of organisms, species and ecosystems, is the science of biogeography.

Diversity consistently measures higher in the tropics and in other localized regions such as the Cape Floristic Region and lower in Polar Regions generally. Rain forests that have had wet climates for a long time, such as Yasuní National Park in Ecuador, have particularly high biodiversity.

Terrestrial biodiversity is thought to be up to 25 times greater than ocean biodiversity. A recently discovered method put the total number of species on Earth at 8.7 million, of which 2.1 million were estimated to live in the ocean. However, this estimate seems to under-represent the diversity of microorganisms.

References

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