TALK ON APPLICATION OF BIOTECHNOLOGY IN THE PROCESS INDUSTRIES

BY PROFESSOR DR MOHD. ALI HASSAN, UNIVERSITI PUTRA MALAYSIA

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In conjunction with our 17th Annual General Meeting on 13 September 2003, the Chemical Engineering Technical Division organised the above-mentioned talk. It was held at Conference Hall A, Bangunan Ingenieur, Petaling Jaya.

We were privileged to listen to Prof. Dr Mohd. Ali Hassan, a well-established figure in Biotechnology in Malaysia. He is currently the Deputy Dean of Research and Postgraduate Study at the Faculty of Food Science and Biotechnology, Universiti Putra Malaysia.

Prof. Dr Mohd. Ali Hassan started the talk at about 10.45 a.m. by drawing our attention to the fact that this year (2003) marks the celebration of 50 years of the discovery of the structure of DNA (deoxyribonucleic acid).

Biotechnology is defined as technology that utilises living organisms and their biological processes for the production of products and services. While it traditionally involved enzymes, fermentation and bioprocess engineering, modern biotechnology is more of an application of molecular techniques as tools for new or improved products and services. It is multi-disciplinary, with bioprocess engineering, biochemistry and microbiology as the cornerstones.

Application of biotechnology dates back to 6000 BC when the Sumerians and Babylonians produced beer, and 4000 BC when the Egyptians produced bread by fermentation. By the 1700s, man had been able to look at cells through the microscope. The first cells that were seen through a microscope were those of cork. There was rapid development in the application of biotechnology in the 20th century, culminating in the sequencing of the human genome in 2002.

Prof. Dr Mohd. Ali Hassan then proceeded into the fundamentals of biotechnology. The functional units in biological systems are cells the size of a few microns. In a human, there are 10^{14} cells, each of which contains 23 pairs of chromosomes. A human is known to have about 30,000 genes. The human genome is made up of about 3 x 10^9 base pairs of DNA; an unfolded DNA from a single cell is 1.8m long! DNA is made up of four bases, namely cytosine, thymine, adenine and guanine (C, T, A, G in short). Prof. Dr Mohd. Ali drew on a comparison with the computer, which is programmed with only the binary system of 0 and 1, to highlight the complexity of the human genetic make-up.

A codon is a sequence of three bases that codes for a certain amino acid. Codons make up segments of a gene, which is the part of the DNA that carries the genetic information required to form a particular protein. Proteins are made up of a chain of combinations of 22 amino acids. Each protein has a specific function in the living system. Humans have 30,000–40,000 proteins, but not all of them are expressed all the time. The genome is the total DNA in the nucleus.

In *molecular biology*, techniques used are gel electrophoresis, utilisation of restriction enzymes, and polymerase chain reaction (PCR). These are briefly described below.

1) Restriction endonucleases are enzymes that cut the DNA chain at a specific sequence of DNA bases.
2) Gel electrophoresis is the separation of DNA chains based on size and length. It uses electric current on agarose gel to get specific bands. This technique is useful in obtaining DNA fingerprints, which are unique to individuals.
3) Polymerase chain reaction is a technique to make millions of copies of specific DNA or genes. It involves denaturing of the DNA at the region of interest and synthesis of new DNA strands. Continued rounds of amplification of this denaturing and synthesis process swiftly produce large numbers of identical fragments. Each fragment contains the DNA region of interest.

DNA sequencing is used to identify sequences of bases in the DNA, e.g in the human genome project.

Genetic engineering involves splicing of genes to produce recombinant DNA and cloning of cells that possess the desired traits, thereafter multiplying them. The resulting culture then undergoes DNA purification by means of gel-electrophoresis. One of the applications of genetic engineering was in the creation of Dolly, the cloned sheep.

Currently, genetic engineering is

used in forensics, identification of babies/relatives/the dead, identification of genetic disorders/diseases, identification of virus and bacteria, and to improve agricultural crops and produce. It is interesting to note that in the last category, there are even terminator genes used to protect the interest of production companies. These genes ensure that the public cannot cultivate the crops.

Bioprocess engineering is the application of engineering principles to design, develop and analyse processes using biocatalysts (cells or enzymes, free or immobilised). Its components are the biological sciences, engineering sciences, chemical engineering and biochemical engineering. Tools in molecular biology are being used to develop improved biocatalysts. Cells are regarded as bioreactors or miniature bio-factories. Traditionally, bioprocess engineering produced glucose, high fructose syrups, antibiotics, vaccines, biopesticides, biomass, health supplements and biofertilisers. New bioproducts are biodetergents, microbial consortia, beneficial microbes, insulin, interferon, growth hormones, vitamins, bioplastics, novel enzymes, novel microbes and new drugs. It has the potential to produce antibodies, therapeutic peptides and rapid diagnostic kits.

In the process industries, biotechnology is applied in the areas of food technology, industries, agriculture and environmental technologies. Prof. Dr Mohd. Ali Hassan gave some case studies on the application of biotechnology. One of the proposed projects in Malaysia is a CDM (Clean Development Mechanism) project aimed at reducing greenhouse gases and pollution from palm oil mills and producing value-added bioproducts. Among companies from all over the world that have switched to biotechnology are the producers of vitamin B2, antibiotics, acrylamide, bio-polymers, and those involved in wood pulp processing and brightening, zinc refining, production of ethanol from biomass and oil well completion. Advantages from the incorporation of biotechnology in the processes are reduction in air, water and land pollution discharges or emissions, costs, use of hazardous chemicals and solvents, waste generation, energy and water consumption, substitution of non-biodegradable or hazardous feedstock, improved product quality and safer processes. In short, the 4Rs, namely reduce, reuse, recycle and re-process, could be put into practice.

Despite its many advantages, there exist public concerns regarding biotechnology. These are on genetically modified crops and foods, transgenic animals, the *'halal'* issue, reproductive cloning and therapeutic cloning, and the question of ethics. There is a need to keep the public informed to gain a rational acceptance of the new technologies.

With awareness of our mega-biodiversity, the future outlook for biotechnology in Malaysia seems bright. Indeed, with trained resources, political will and government support that bring the necessary incentives to investors, Malaysia could very well have her own Bio-Valley. The Kyoto protocol, with the requirement for certified emission reduction to gain carbon credit, can be a pushing factor towards the switch to biotechnology. Biotechnology is set to be an engine of growth through the creation of new bioproducts that generate "bio-income"; by developing the appropriate biotechnological industries, Malaysia has the potential to be a centre of biotechnological products and services. Prof. Dr Mohd. Ali Hassan highlighted that the Japanese are interested in the carbonaceous slurry from our empty palm oil fruit bunches, which can be used to produce energy. Our palm oil bunches are also a rich source of ligno-cellulosic biomass, which in the future will be used to produce polylactic acid, a bio-degradable polymer.

Prof. Dr Mohd. Ali Hassan ended his talk with an enthusiastic call to harness biotechnology and our bioresources to improve the current industrial practice and competitive edge. His wake-up call was that we are sitting on a "biotech gold mine"! This realisation should be our impetus to develop the appropriate technology with input from our local experts. With God's grace, *Malaysia Boleh!*

After a Question and Answer session, the talk ended at about 12.05 p.m.

The Chemical Engineering Technical Division would like to thank Prof. Dr Mohd. Ali Hassan for giving the above-mentioned talk and vetting the above report.

Jokes Column

SURGEONS AND ENGINEERS

Four surgeons were taking a coffee break and were discussing their work. The first said, "I think accountants are the easiest to operate on. You open them up and everything inside is numbered."

The second said, "I think librarians are the easiest to operate on. You open them up and everything inside is in alphabetical order."

The Third said, "I like to operate on electricians. You open them up and everything inside is color-coded."

The fourth surgeon said, "I like Engineers... they always understand when you have a few parts left over at the end..."