UNIT 2

THE BENEFITS AND USES OF MICROBES

A. MICROBIAL BIOTECHNOLOGY

1 *Read* What is biotechnology? *and decide which of the words below can be used instead of those underlined in the passage.*

all over the world – at the beginning of – based on practical experience – beer production – before – bread making – examinations – includes – increase – innovations – innumerable – medicines – modify – qualities – safe – so far – which have existed for

WHAT IS BIOTECHNOLOGY?

Biotechnology is not something new but represents a developing and expanding series of technologies dating back thousands of years, to when humans first began to use microbes to produce food and beverages such as bread and beer and to modify plants and animals through progressive selection for desired traits. Biotechnology encompasses many traditional processes such as brewing, baking, wine-making, cheese production and sewage treatment where the use of microorganisms has been developed somewhat empirically over countless years.

The new biotechnology revolution began in the 1970s and early 1980s, when scientists learned to alter precisely the genetic constitution of living organisms. This 'genetic engineering' permitted breakthroughs in medicine and agriculture. Some of the most exciting advances will be in new pharmaceutical drugs and gene therapies to treat previously incurable diseases, to produce healthier foods, safer pesticides, innovative environmental technologies and new energy sources.

Exciting new medical treatments and drugs based on biotechnology are appearing with ever-increasing regularity. Prior to 1982 insulin for human diabetics was derived from cow and pig pancreases. The gene for human insulin was then isolated, and cloned into a microorganism, which was then mass-produced by fermentation. This genetically engineered human insulin, identical to the natural human hormone, was the first commercial pharmaceutical product of recombinant DNA technology and now supplies millions of insulin users worldwide with a safe, reliable and unlimited source of this vital hormone. Biotechnology has also made it easier to detect and diagnose human, animal and plant diseases. In clinical diagnosis, there are now hundreds of specialised kits available for simple home use or for complex laboratory procedures. Biotechnology methods can now improve the nutrition, taste and appearance of plants and various food products, enhance resistance to specific viruses and insect pests and produce safer herbicides. For food safety, new probes can rapidly detect and accurately identify specific microbial pathogens in food.

2 *Answer these questions about* What is biotechnology?

a. What foods and beverages have traditionally been produced using microbes? • **b.** What did the new biotechnological revolution concern and when did it begin? • **c.** What are the main fields of application of genetic engineering? • **d.** What was human insulin derived from until the early eighties? • **e.** What was the breakthrough which made possible to produce genetically engineered human insulin? • **f.** What are the advantages of biotechnological methods applied to agriculture? • **g.** How can biotechnology help food safety?

B. THE COLOURS OF BIOTECHNOLOGY

GENETIC ENGINEERING

Genes are segments of DNA which comprise the fundamental basis of all life and determine the properties of all living forms of life.

Recombinant DNA techniques, popularly termed 'gene cloning' or 'genetic engineering', offer potentially unlimited opportunities for creating new combinations of genes that at the moment do not exist under natural conditions. These techniques allow the splicing of DNA molecules of quite diverse origin, and when combined with techniques of genetic transformation, etc., facilitate the introduction of foreign DNA into other organisms. The foreign DNA or gene construct is introduced into the genome of the recipient organism host in such a way that the total genome of the host is unchanged except for the single manipulated gene.

Thus, DNA can be isolated from cells of plants, animals or microorganisms (the *donors*) and can be fragmented into groups of one or more genes. Such fragments can then be coupled to another piece of DNA (the *vector*) and then passed into the host or recipient cell, becoming part of the genetic complement of the new host. The host cell can then be propagated in mass to form novel genetic properties and chemical abilities that were unattainable by conventional ways of selective breeding or mutation.

Life forms containing 'foreign' DNA are termed '*transgenic*'.

The basic molecular requirements for the *in vitro* transfer and expression of foreign DNA in a host cell (gene transfer technology) are as follows:

The vector or carrier system – Two broad categories of vector molecules have been developed as vehicles for gene transfer, namely *plasmids* (small units of DNA distinct from chromosomes) and *bacteriophages* (or bacterial viruses). Plasmids have been found in an increasingly wide range of organisms, e.g. bacteria, yeasts and mould fungi; they have been studied mostly in Gram-negative bacteria.

Splicing genes – Site-specific *restriction endonuclease enzymes* produce specific DNA fragments that can be joined to any similarly treated DNA molecule using another enzyme, DNA *ligase*. Restriction enzymes are present in a wide range of bacteria.

Introduction of vector DNA recombinants – The new recombinant DNA can now be introduced into the host cell by *transformation* (the direct uptake of DNA by a cell from its environment) or *transduction* (DNA transferred from one organisms to another by way of a carrier or vector system) and if acceptable the new DNA will be cloned with the propagation of the host cell. Novel methods of ensuring DNA uptake into cells include *electroporation* and *mechanical particle* ***delivery*** or *biolistics*.

3 *Match these words from* Genetic engineering *with the definitions below:*

biolistics – electroporation – gene – genetic engineering – genome – in vitro – plasmid – transduction – transgenic organism – vector

a. Section of DNA that codes for a defined biochemical function: .....

b. Directed manipulation of genes: .....

c. The DNA sequence of all the genes of an organism: .....

d. DNA segment that allows another piece of DNA to be 'cloned' using recombinant DNA techniques: .....

e. Organism that has been altered to contain a gene from another organism, usually from another species: .....

f. Latinism literally meaning 'in glass', which is translated to mean 'in the test tube', 'in the laboratory': .....

g. Small, easy to manipulate piece of DNA extensively used in genetic engineering as the basis for vector molecules: .....

h. Genetic technique which consists in transferring a piece of DNA from one organism to another via natural DNA exchange processes: .....

i. Manipulating cells by exposing them to a strong electrical field - .....

j. Method which consists in mixing DNA with small metal particles. These are then fired into a cell at very high speed. They puncture it and carry the DNA into the cell - .....

4 *Why do you think these fruits and vegetables are genetically engineered:* melons and peaches, potatoes, sweet corn, strawberries, tomatoes? *Choose among the options below.*

a. ..... is/are genetically engineered to be thicker, enhance flavour, contain more solids, more vitamins and more lycopene.

b. ..... is/are genetically engineered to be more disease resistant, contain more starch and less water in order to absorb less oil when fried.

c. ..... is/are genetically engineered to stay sweet longer by preventing sugars from turning to starch.

d. ..... is/are genetically engineered to improve flavour and sweetness in fruits produced for the winter market.

e. ..... is/are genetically engineered to produce plants that can withstand frosts and berries that can be home frozen without turning to pulp.

5 *Which one is a* cloned *animal and which one is a* transgenic *animal?*

a. A ..... animal is an animal whose hereditary traits have been permanently altered by genetic engineering techniques leading to an incorporation of new gene or inactivation of gene sequencing.

b. A ..... animal is an animal that is genetically identical to the animal it is derived from. Identical twins is an example of how nature can do so.

C. MICROBES: BUILDING BLOCKS FOR BIOTECHNOLOGY

MICROORGANISMS USED IN BIOTECHNOLOGY

Some of the organisms more commonly used in biotechnology include:
Aspergillus. A type of filamentous fungus that has been used for genetic engineering in a few cases and which is also used to produce citric acid by fermentation.
Bacillus subtilis. This Gram-positive bacterium is widely used as a cloning host, especially for the expression of secreted proteins.
Candida utilis. A yeast used in fermentations to produce chemicals.
Clostridium acetobutylicum. A bacterium used as a source of enzymes.
Corynebacterium glutamicum. This is widely used in fermentation processes producing amino acids for food supplements.
Escherichia coli. This very versatile Gram-negative bacterium is used in many biotechnological processes. It is by far the most common host cell for recombinant DNA work. It is also used in fermentations to make many amino acids and other products since it grows on many very cheap fermentation substrates, grows fast, and can be manipulated genetically to accumulate many different chemicals. It is also very chemically versatile and quite non-pathogenic (with the exception of a few strains which, obviously, are not used for biotechnology).
Penicillum. A group of filamentous fungi used primarily to produce penicillin antibiotics.
Pseudomonas. A group of soil bacteria that contain some extremely diverse chemical abilities, which biotechnology has harnessed in bioremediation.
Saccharomyces. Saccharomyces cerevisiae is brewers' and bakers' yeast, and as such is probably the most widely exploited microorganism. *Saccharomyces* are also used in recombinant DNA work because they are eukaryotes and hence have the same sort of genetic structure as the humans, secrete proteins in a similar way, and so on, but are almost as easy to ferment as bacteria.
Streptomycetes. These Gram-positive bacteria are used to produce a range of chemicals, especially antibiotics. They have also been used as the host for genetic engineering.

(from: *Biotechnology from A to Z* – Oxford)

7 *Copy the table in your exercise book and then complete it with the missing information about these microorganisms commonly used in biotechnology.*

MICROORGANISM	TYPE	USE
Aspergillus	fungus	for genetic engineering and to produce citric acid
Bacillus subtilis		
Candida utilis		
Clostridium acetobutylicum		
Corynebacterium glutamicum		

MICROORGANISM	TYPE	USE
Escherichia coli		
Penicillum		
Pseudomonas		
Saccharomyces		
Streptomycetes		

8 *Find words matching the definitions below choosing among those underlined in* Microorganisms used in biotechnology. *Tip: copy the definitions in your indexed book.*

a. ..... are organisms whose cells possess a nucleus.
b. ..... are polymers of amino acids linked via peptide bonds.
c. ..... are proteins that control the various steps of all chemical reactions.
d. ..... are substances which kill microorganisms or stop their growth.
e. ..... are the basic building blocks of proteins.
f. ..... is a series of procedures that are used to join together DNA segments.
g. ..... is an adjective meaning 'which does not cause disease'.
h. ..... is the manipulation of the genes in an organism with the aim of improving its characteristics.
i. ..... is the use of microorganism metabolism to remove pollutants from the environment.
j. A ..... is an organism containing another one.