The State of the Art

by T Yoshida

THE 1980s and early 1990s have seen rapid advances in biotechnologies on many fronts. Here is a sample of achievements and prospects:

Pharmaceuticals

Today... production by microbial or animal cells of hormones, substances for breaking down blood clots, blood coagulants, lymphokins, interferons (anti-cancer), vaccines against viral, bacterial and parasitic diseases (e. g. hepatitis B and C, schistosomiasis, malaria).

And tomorrow... Breakthroughs may occur in the fields of anti-Aids vaccines or drugs and anti-cancer medicines.

Disease-resistant Plants

Today... Progress has been rapid since 1982, when the first transgenic plant was created. Several dozen plants have since been modified to increase growth performance and resistance to viruses and other pathogens. In 1994, several hundred trials were being carried out on transgenic plants in Europe, North America, Japan and Australia.

And tomorrow... Some of the transgenic plants already tested (potato, cotton, rapeseed, tomato, tobacco, soybean) are expected to be marketed by the mid-or late 1990s. A transgenic tomato variety with a prolonged shelf-life (USA) is already being marketed; this will also be the case for a virus-resistant tomato variety (Japan). However, delays due to safety requirements, public concern and the need for more research may slow down large-scale marketing of genetically modified crop species between now and the year 2000.

New Foods

Today... Bioconversion of starch into sweet products, food flavours and enhancers, fruitjuice processing; derivation of amino-acids and other nutrients, pigments and vitamins from micro-algae; new foods from fermentation; cheese-making enzymes, lactose-free dairy products, yeast hybrids.

And tomorrow... Products that may be marketed by 1995 include genetically modified, baker's yeast, new food colourings and ingredients, high added-value compounds from plant cell and micro-algal cultures. by the end of the century we may see genetically modified food bacteria for flavour and quality, modified food enzymes, novel biocatalysts for food processing, and increasing numbers of rapid biotests and biosensors for food contaminants or pathogens.

Faster-Growing Animals

Today... Already in commercial exploitation are: diagnostics, new vaccines and drugs, invitro fertilization and embryo transfer in domestic animals, growth hormone administration to increase growth and milk yield, feeds and feed additives. So far no transgenic domestic animals are on the market. Transgenic animals such as a transgenic mouse carrying a human cancer gene have been used in the laboratory as human disease models.

And tomorrow... Between now and the end of the century, the development of fish, pigs and cattle with rapid growth potential through the insertion of growth hormone genes, improved carcass quality and, for cattle, increased milk yield is expected to be rapid. Gene transfer may also lead to the multiplication of genetically superior animals through the development of disease-resistant breeds.

More Productive Fish and Algae

Today... Growth hormone genes from rainbow trout have been inserted into a number of other commercial fish species. No transgenic fish have yet been patented. A wide range of products derived from microalgae are used in the manufacture of food stuffs, cosmetics, dyes, paints, paper, textiles, etc.

And tomorrow... Vaccines for disease and stress control in aquaculture is a probable growth area. In Scandinavia nearly all trout and salmon produced by aquaculture are vaccinated, compared to 5 per cent ten years ago. Promising new antibiotics, anti-cancer agents and food additives will be developed.

The writer is a Professor at the International Centre of Co-operative Research in Biotechnology, Faculty of Engineering, Osaka University.

Courtesy — The UNESCO Courier

Virus as a Cancer Causing Agent

by Saqib Hussain Shirazi

CANCER is a malignant, invasive, cellular tumor that has the ability to spread through out the body or body parts. More than 100 clinically distinct types of cancer are recognized. However, most of them can be grouped into four categories.

1. Leukomias: Abnormal members of white cells are produced by bone marrow.

2. Lymphomas: Abnormal number of lymphocytes (a type of white cell) are produced by spleen and lymphnodes.

3. Sarcomas: Solid tumors grow from derivatives of embryonal mesoderm, such as connective tissues, cartilage, bone, muscle and fat.

4. Carcinomas: Solid tumors grow from epithelial tissues, the most common form of cancer.

Cancer has three major characteristics; hyperplasia, anaplasia and metastasis. Hyperplasia is uncontrolled proliferation of cells. Anaplasia is structural abnormalities of cells and metastasis is the ability of a malignant to detach itself from a new tumor and establish a new tumor at another site within the host.

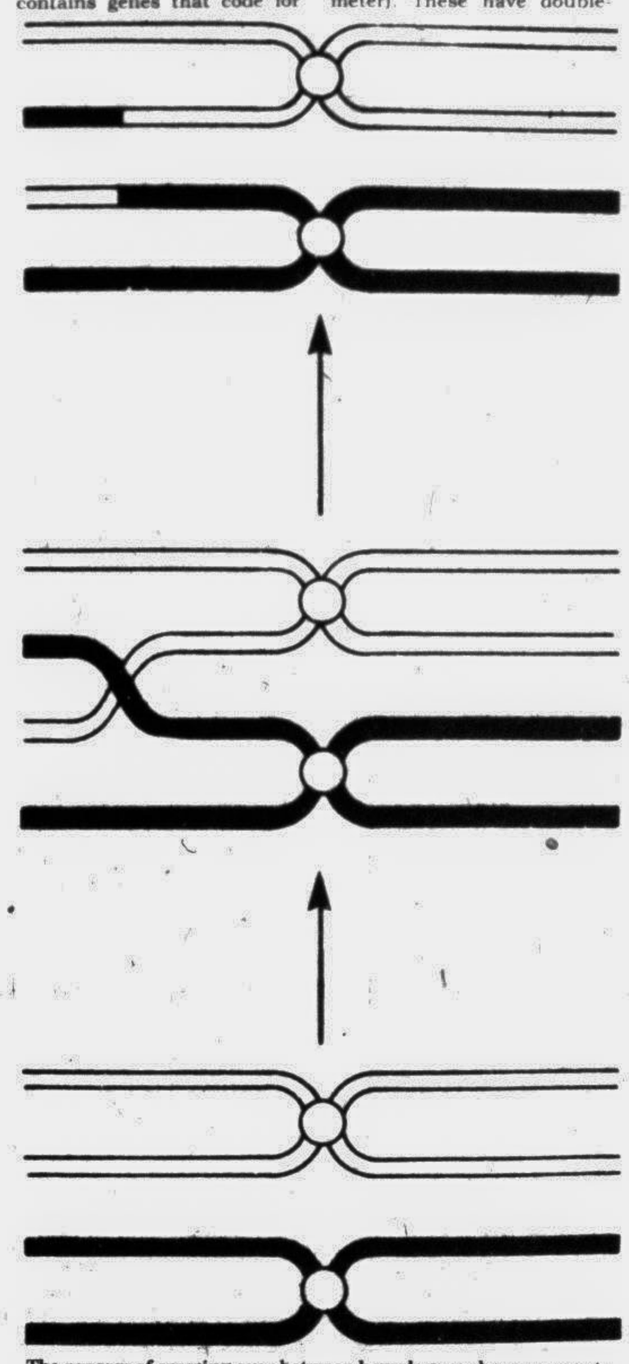
Cancer is caused by abnormal activation of cellulargenes. These abnormal genes are called oncogenes. The probability of mutations can be increased many fold when a person is exposed to certain chemical (eg. carcinogens), physical irritants (such as continued abrasion of the lining of food) or biological factors (in this regard it can be said that in many families there is a strong heriditory tendency to cancer).

For long term, microbiologists entertained the idea that cancer might be caused by viruses. But for many years these discoveries were not considered relevant to the cause of human cancer. However, recent studies have greatly strengthened the likelihood of their involvement. Many viruses can cause tumors in animals, either as a consequence of natural infection or after experimental inoculation.

By definition, tumor viruses are agents that can produce tumors when they infect appropriate animals. Such tumor-inducing viruses are called oncogenic viruses. Mentioning about interaction of tumor viruses with host cells, it can be said that host cells are either perimissive (cells which support virus growth, i.e. cells which are transformed) or nonpermissive (cells which are not transformed).

Depending on the nucleic acid, viruses can be grouped into two categories: DNA containing viruses which contain DNA as genetic material and RNA containing viruses which contain RNA as genetic material. Both have been found capable of inducing cancer in animals.

With DNA tumor viruses, eg. SV 40, the viral genome contains "early" and "late" regions. The late region consists of genes that code for the synthesis of coat proteins; they are not expressed in transformed cells. The early region is expressed soon after infection of cells; it contains genes that code for early proteins; for example, the SV 40 tumor antigen (T), which are necessary for the replication of viral DNA in permissive cells and for the transformation of nonpermissive cells. The transforming protein must be continuously synthesized for the cells to stay transformed.



The process of crossing-over between homologous chromosomes to generate recombinant chromosomes.

—Courtesy Harper's Review of Biochemistry

Five families of DNA containing viruses have been shown to contain members capable of tumor induction or cell transformation.

1. Papova viruses: These are 45-55 nm in size (1 nm = 10-9 meter). These have double-stranded circular DNA. Each of these viruses contain 5-8 genes.

2. Adenoviruses : These viruses are 70-90 nm in size. These viruses also have double stranded DNA virus of this group contains 30 genes.

3. Herpes viruses : Viruses of this group are grouped into two groups : a) Naked herpes viruses, these do not contain capsid envelop; b) Enveloped herpes viruses, these viruses are enveloped by capsid protein. Naked viruses are 100 nm and enveloped viruses are 200 nm in size.

4. Pox viruses: These viruses are large, brick shaped (diameter 230x400 nm) with a linear genome of double stranded DNA.

5. Hepatitis B Viruses: On the basis of their physical and chemical properties, hepatitis B have recently been classified as a new virus family. One strand of their DNA is incomplete and variable in length, these viruses contain DNA polymerase (an enzyme required for DNA synthesis in cells) that complete the strand length.

RNA viruses are now classified as retroviruses because they contain RNA directed DNA polymerase (on reverse transcriptase). After virus particles are absorbed and penetrated by host cells, the viral RNA serves as the template for the synthesis of viral DNA through the action of reverse transcriptase (this is an exception, normally RNA is synthesized by DNA). DNA then enters into the most genome where it remains dormant. But when it is activated by certain carcinogens it may transform normal cells into cancer cells.

Four morphologic groups of extracellular retroviruses as well as intracellular form are known.

1. A-type particles: These occur only intracellularly and consist of a ring shaped nucleoid surrounded by membrane. For example, rous sarcoma virus of chicken.

2. B-type viruses : These particles are 100-130 nm in diameter and contain an ecentric nucleoid; eg. leukomia viruses of birds.

3. C-type viruses : These particles are 90-110 nm in diameter and the nucleoids are centrally located, eg. mammaliar sarcoma viruses.

4. D-type viruses : This type of retroviruses are poorly characterized. Immature particles are ring-shaped. The mature particles are 100-200 nm in diameter, contain ecentric nucleoid, eg. human retroviruses.

It should be noted here, the theory, 'virus causes cancer', has not been established yet. Scientists are trying to establish the theory. Research is going on for establishing the theory. Few years ago, Professor Robert Gallow (discoverer of HIV virus which causes AIDS) claimed that one kind of retrovirus causes leukamia (blood cancer) but his claim was not accepted by 'Royal Society of Science' in London. Many scientists are still trying to prove the theory but nobody knows when they will become successful.

World Science Report

THE first ever World Science Report, prepared and published by UNESCO, was launched in Nairobi by the Director General Mr Federico Mayor on February 14 this year. There was a simultaneous launch in New Delhi by Prof M G K Menon, Member of the Rajya Sabha and former President of the International Council of Scientific Unions.

The Report, which is to be published every two years, shows that although the application of scientific discoveries has the potential to affect everyone, whether in the fight against disease or in providing for our energy needs, overcoming shortages of food and water or generally improving the quality of life, it is only the privileged few who feel the benefits of science.

"The Report," said Prof Menon, "has been put together by distinguished individuals. The four review articles, i e. on maths, physics, chemistry and biology, are an update of recent developments in these fields which you cannot bring together on your own. There is an enormous amount of very valuable information here," he added.

Just a handful of industrialized countries carry out over 80 per cent of the world's research and development activities. Most Latin American countries spend about US$10 or less per head on R&D, compared to US$300 per head in most European countries and over US$400 in Scandinavia, US$ 600 in the USA and almost 700 in Japan.

But comparing absolute sums of money spent can be misleading, says the report. Instead, the proportion of their wealth or the GDP spent on R&D makes comparisons easier. While Japan, the US and Europe still come out on top, surprisingly, the newly independent countries of Asia spend more of their wealth on R&D than some European countries, Australia and Canada.

What these figures hide, however, is the way science and technology is used within the national economy. (Japan, for instance, may spend more but it publishes very little). Its increasing role in creating wealth, says the Report, is putting a strain on basic research even in developed countries with a strong academic tradition.

But basic research is not a luxury. While many of its economic and social benefits are not immediate it helps in creating a capacity to ask new questions and solve problems — skills which must underlie any long-term commitment to science.

Despite obstacles, poor countries produce excellent scientists, including Nobel Prize winners. But starved of facilities and intellectual stimulation at home, they are often tempted to go abroad. Many of the partnership programmes mentioned in the report aim specifically at helping scientists maintain high standards no matter where they are.

Science may seem like the answer to the world's problems but not everyone sees it in this way. In the industrialized world, the public is growingly apprehensive about science, so much so that there is a serious campaign to improve its image through the media, science fairs and museums. Biotechnology or genetic engineering offers the prospect of increased freedom from illness and malnutrition. But ordinary men and women are uneasy about genetically altered foods or what may seem like Frankestein experiments with human life.

"This document," said Dr John V Kingston, Director of New Delhi's UNESCO office, "is valuable quarry for policy and decision makers involved in the application of science and technology for development." Since this is the first report of its kind, he added, its overview is limited because it covers only the basic sciences. "We hope that subsequent reports will deal with topical themes — engineering, computer technology or the environment."

Courtesy — UNESCO

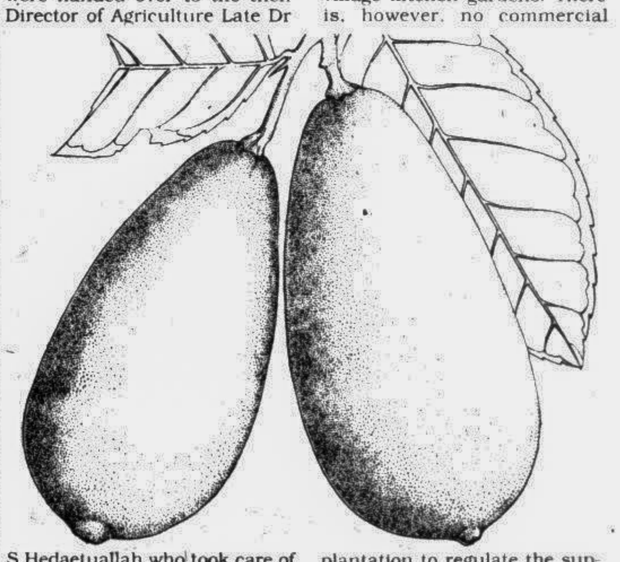
How Assam Lemon came to Bangladesh?

by Dr S D Chaudhuri

ASSAM Lemon botanically known as Citrus Lemon, Burn is now a very popular citrus fruit in Bangladesh market and because of its staggering fruit habit, it is available almost all round the year. Assam Lemon is a profusely bearing plant, as much as 200-500 fruits can be collected throughout the entire year. It's price vary from 4 to 20 Taka for every *hak* (4 fruits) depending on season and demand.

Assam lemon was almost unknown in Bangladesh until 1952. This citrus fruit was developed by me and my colleagues in Assam in the Citrus Research Station at Buni-hat, (now one of the principal Citrus Station of India) Assam when I was economic botanist there.

I brought four citrus plants when I came to East Pakistan and joined as economic botanist at Dhaka in 1948. The plants were handed over to the then Director of Agriculture Late Dr S Hedaetuallah who took care of the plants and got them multiplied.



The spread of the Assam lemon was phenomenal and it became an economic crop for small and marginal farmers, as it could be planted around small homesteads and does not require too much land or care.

Assam Lemon is not used as fresh fruit but widely used in the preparation of fresh juice lemonades, squashes and for culinary and confectionery purpose as flavouring and garnish. These can also be used for the production of lemon oil, citric acid etc.

Even without a special programme by agriculture extension department the plant spread and quickly attracted the interest of growers. Assam lemon is an excellent example of transfer of technology, with judicious selected horticultural crops can add to the employment enhancement of small farmers.

The above story is an attempt to make our young agricultural students know about the background and history of all our economic crops and encourage them to explore now potential crops. Unless we start this process now, history of many of our introduced crops will be lost to new generation.

It may be mentioned here that the round small citrus fruit known as "Rangpur lime" was the most popular citrus before Assam Lemon came to the market. Rangpur lime was in great demand in Calcutta market and fetched good money for lime growers but now it in decline.

Citrus lemon, is not grown as a commercial crop in Assam although it is one of the most important citrus fruits. The supply of lemons has always been erratic, inadequate and unevenly distributed, because it is entirely dependent on plants that are growing scattered in village kitchen gardens. There is, however, no commercial plantation to regulate the supply and demand.

There are many indigenous varieties of lemons, which though commercially unimportant, find a place almost in every garden. Of the numerous varieties *Kata Jamir, Tulia Tenga, Nemu Tenga, Pati lebu* and *Chinapati* are more generally grown and prized for their culinery qualities in every home. A short description of Assam Lemon is appended herewith for those interested in its cultivation.

A full-grown Assam Lemon plant under favourable soil and climatic conditions can produce a crop as large as 800 fruits or more annually. On an average 300 to 400 marketable fruits may be expected from a plant of normal growth. The maiden bearing starts from the second year of its orchard life and regular bearing begins from the fourth year onwards.

New Light Bulb Offers Energy Efficiency

A newly invented light bulb could offer significant energy savings — and better light — to future users worldwide, according to the US Department of Energy, reports USIS.

On October 20 the US Department of Energy (DOE) announced it was "inaugurating the use" of the new kind of light bulb in experimental installations at its Forrestal Headquarters Building and at the Smithsonian's National Air and Space Museum in Washington, DC.

The new kind of artificial light consists of a bulb filled with inert gas and a small amount of sulfur that is bombarded by microwaves to produce luminescence. The Washington Post wrote, "One golf-ball-sized sulfur bulb, when irradiated by the kind of compact microwave generator found in ordinary kitchen ovens, puts out as much light as hundreds of high-intensity mercury vapor lamps."

The new lighting technology, DOE said in a written statement, is most likely to take the form of "high quality, high-efficiency illumination for large indoor or outdoor spaces" once it is made commercially available.

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A small microwave generator at the base of the bulb bombards the inert gas, heating it. The hot gas energizes electrons in the sulfur, which then emit a large amount of visible light. The bulb itself is rotated quickly by a motor to cool it — otherwise it would melt.

Christine Ervin, an official at DOE, called the technology "advanced and promising," noting "it can save large amounts of energy and at the same time deliver more quantity and better quality light." She added the technology could improve lighting of public spaces while benefiting "the economy and the environment."

After the new lighting arrays were installed in the Forrestal Building, they reduced energy usage "by more than 60 per cent" for that area, Ervin said. DOE estimates that the cost of lighting large areas in the United States is $8,000 million a year, so if the new bulb is widely used savings could be significant.

According to DOE, the new lighting has attractive optical qualities, "closely simulating sunlight."

In current test arrays, two small bulbs are put into each end of a 72-metre-long reflective plastic "light pipe." One of these pipes now lights an area that had been lit by 240 175-watt mercury lamps in the Forrestal Building, producing four times as much light at one third the cost.

Experts note the "new-fangled" bulb emits less ultraviolet light than traditional large-area lighting, making it easier to avoid damaging displays or works of art. In addition, the new kind of light, which is optically somewhat similar to sunlight, seems to be good for growing plants.

At the moment, nobody knows how long the new bulbs will last. Since they do not have electrodes, there are no filaments to burn out — so they may last a long time. Light output doesn't seem to diminish after extensive use — and since this high-efficiency lamp does not make use of mercury, there is no toxic mercury to dispose of.

The bulbs were invented by Fusion Lighting, a small firm in Rockville, Maryland, with sponsorship from DOE and other government institutions. The light pipe technology was developed by AL Whitehead of Vancouver, British Columbia.

Concept of Computer and Computing

by Hasan Sadiqur Rahman

A Computer is an automatic electronic machine that can accept data, store vast amount of information and perform arithmetic at high speed to solve complex problems. Without human intervention Computer can process long sequence of instructions (called a programme) and solve a variety of problems ranging from making as payroll sheets, to scientific problem, such as the calculation of satellite trajectories.

Based on the operating principles, computer can be classified into one of the following types.

(i) Digital Computer
(ii) Analog Computer
(iii) Hybrid Computer

In Digital Computers the operation is essentially done by counting. All quantities are expressed as discrete digits or numbers. Digital computers are useful for evaluating arithmetic expressions and manipulations of data (such as preparation of bills, ledgers, solution of simultaneous equations, etc).

In Analog Computers, the computation is carried over by changing a physical quantity which is a continuous function of time e.g. voltage, current etc. This types of computers are not used in data processing; they were preferred in the Scientific, Engineering or in Defence applications. Now Analog Computers are not used frequently.

Computers which combine features of analog and digital types are called hybrid computers. A majority of the computers used in the world today are digital.

According to the computing ability and input/output, device handling capabilities the computers are classified as follows:

(i) Microcomputer or personal computer— A microcomputer or personal computer is the smallest general-purpose processing system. Functionally it is similar to any other large system. Microcomputers are self-contained units and usually designed for use by one person at a time.

(2) Minicomputers — A minicomputer is a medium-sized computer that is more costly and powerful than a microcomputer. An important distinction between a micro and a minicomputer is that a minicomputer is usually designed to serve multiple users simultaneously. Minicomputers are the popular data processing systems among the business organizations today.

(3) Mainframe computers— Computers with large storage capacities and high speed of processing are known as mainframe computers.

(4) Supper computers— These have extremely large storage capacities and computing speeds which are at least 10 times faster than other computers. The super computer is used for large scale numerical problems in scientific and engineering disciplines.

Computer is a problem-solving machine. It is widely nowadays. However, it cannot be said that the computer is suitable for solving all problems. It is sometimes more economical to solve relatively simple problems and problems that occur infrequently by mechanical methods. It on the other hand, a problem requires the processing of a large volume of input or output, is repetitive in nature, or requires great processing speeds and accuracy, it may be worthwhile and necessary to use a computer. There are, of course, problems that cannot be solves without computers. For example, in a space craft-launching operation data relayed to the ground by a spacecraft must be analyzed instantaneously to allow controllers to make- on-the-spot-decision; only a computer can record and analyze the mass of data fast enough for such decisions.