

## Cuban science: a jewel in the Caribbean crown



It is a widely held view that science and technology (S&T) are a necessary tool for development in any society. What is lacking in most developing countries is a vision for an effective science policy and, most importantly, the political will to implement this policy. My visit in 2000 to Cuba's research institutes in biotechnology, medicine, agriculture and the basic sciences, and my meetings with Cuban scientists, left absolutely no doubt in my mind that Cuba's progress in science has not been achieved overnight. Rather, this progress is the result of a vision and of planning and implementation involving the political directorate, technocrats and scientists.

One year after the Cuban revolution in 1959, it was decided at the highest political level to link the future of Cuba to the future of science in Cuba. Biotechnology was selected as the focus, reportedly by President Fidel Castro himself. The rationale behind this decision was that, given the limited financial and human resources at the time, S&T had to be development-oriented. Biotechnology was an area of great potential, as it could be used for improving health, mainly through the development of new vaccines; increasing crop yield and enhancing animal production; and for earning hard currency through the marketing of biotechnology products.

Measures were then put in place to create new institutions and train a critical mass of scientists. The Cuban Academy of Sciences (founded in 1861) was reorganized in 1961, 13 institutes were created within the Ministry of Health and the National Centre for Scientific Research (CENIC) was founded in 1964. CENIC's initial role was to train and prepare scientists to staff a number of research institutes still on the drawing board at the time, of which the most internationally renowned is the Centre for Genetic Engineering and Biotechnology (CIGB), founded in 1986.



The Cuban National Centre for Scientific Research (CENIC), founded in 1964

### Biotechnology, the heart of Cuban science

In 1981, Cuba fell prey to a serious epidemic of dengue fever. The National Centre for Scientific Research summoned a Meeting of Directors from 12 research centres to deal with the crisis. They recalled a suggestion made by Prof. Clarke, a US Scientist who had met with President Fidel Castro in 1973, concerning the use of interferon in viral infections. It seems that two major decisions were taken at this Meeting of Directors, the first being to start work immediately on the production of interferon and the second to build the necessary scientific research capacity for the development of biotechnology. That very year, Cuban interferon was effectively used in the treatment of dengue. This heralded the beginning of accelerated research in molecular biology and genetic engineering that would ultimately lead to the opening of the CIGB.

Today, the CIGB is regarded as the flagship in biosciences in the entire so-called Third World. It is the pride of all Cubans and very much the heart of Cuban science.

Located west of Havana, the CIGB is very much a self-contained centre with state-of-the-art equipment, production facilities and with over 1000 employees involved in the dual functions of research and production. The staff includes 700 highly skilled researchers, some of whom are housed in a neighbouring high-rise apartment building. Those I happened to meet seemed highly motivated and very dedicated. Many of them received training abroad in such countries as France, Germany, the UK and Canada.

The main building contains well maintained air-conditioned laboratories, administrative offices, service areas, an auditorium with translation facilities and seating capacity of 400, lecture rooms, language laboratories, a library and a gymnasium. The research facilities include five greenhouses and a biotherium equipped for different animal species. The CIGB counts a number of divisions with specific orientations and goals. Among these are the Vaccine



Source of commentary: Granma International, Cuba

The monoclonal antibody CIMAher, seen here, is used in Cuba on brain and neck tumours, in combination with radiotherapy, and is patented in 17 nations. CIMAher has been developed by the Centre for Molecular Immunology (CIM) in Havana, which signed an agreement on 15 July 2004 with CancerVax Corporation in California for the transfer of biotechnological technology from Cuba to the USA for the co-operative production of anti-cancer vaccines. A plant has been constructed at the CIGB to manufacture the batches for the first clinical trial in the USA, that of a therapeutic vaccine against lung cancer developed at the CIM. The vaccine is based on epidermal growth factor (EGF), a protein closely related to cellular growth. The CIGB's other new plant, in operation since August 2004, is producing the active pharmaceutical ingredients for the Cuban vaccine against Type B Hemophilus influenzae, a bacterium responsible for a large percentage of meningitis, pneumonia and otitis cases, responsible for the deaths of half a million children worldwide every year; in 2003, Dr Vicente Vérez Bencomo, the vaccine's principal author, explained that Quimi-Hib 'will permit the country to save US\$2-3 million a year from imports used in the National Immunization Programme'. The new plant is capable of producing 10 million doses a year.

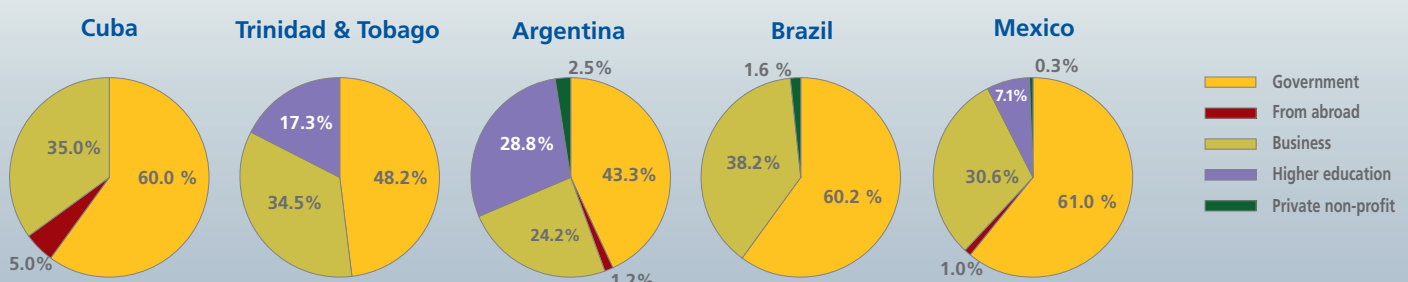
Division, Pharmaceutical Division, Plant Molecular Biology Division, Mammal Cell Genetic Division and the Quality Assurance Division.

A company by the name of Heber Biotec was established in 1991 to market the CIGB's 160 products. Among the products available in over 50 countries are a Hepatitis B vaccine, human alpha interferon, certain enzymes, diagnostic kits which include one for HIV and a cattle tick vaccine. Work is being done on an HIV/AIDS vaccine, a meningitis vaccine, a Hepatitis C vaccine, pharmaceuticals, transgenic fish production and in plant molecular biology (insects and fungal diseases, papaya, coffee, potatoes and tomatoes). The HIV/AIDS vaccine is currently being tested.

Like other scientific organizations in Cuba, the CIGB does not work in isolation. It forms the core of a network of institutions involved in biotechnology research and development (R&D). This network includes:

- the **Centre for Molecular Immunology**, the focus of which is cancer and the production of pharmaceuticals;
- the **National Biopreparations Centre**, the main focus of which is the production of Hepatitis B vaccines. The centre also produces media and vaccines in Cuba that were initially developed elsewhere;
- the **Finlay Institute**, named after national hero Dr Juan Carlos Finlay (1833-1915), whom Cubans claim deserved a Nobel Prize for discovering that yellow fever virus was transmitted by mosquitoes (he was nominated but did not win). The main research at this 112-year old institute fitted out with modern facilities centres on producing new vaccines by combining existing vaccines such as those against influenza and cholera. The meningococcal type B vaccine used to fight meningitis was produced at this institute and earning from the export of this vaccine have netted Cuba US\$40 million;
- the **National Centre for the Production of Laboratory Animals** meets the growing needs of the country's various research centres. The centre produces a variety of animals ranging from mice to monkeys, as well as their food.

GERD in Cuba by source of funds, 2002  
Other countries are given for comparison



Source: UNESCO Institute for Statistics, May 2005



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Street scene in Havana in 2003

Undoubtedly, the greatest strength in Cuban S&T is biotechnology but this has not been achieved without sacrifice; approximately US\$1 billion was invested in biotechnology from 1990 to 1997.

In the past five years, two new institutions have opened their doors, the Centre of Medical Genetics and the Centre of Bio-informatics.

**The best health in the developing world**

In the late 1950s, a Cuban infant had a one chance in ten of dying, mainly from diarrhoea and respiratory diseases. There were just over 6000 doctors and one medical school at the time. The health system, I was told, was in a state of rapid decline in those days with medical care beyond the reach of the average Cuban. Along with education and S&T, health was therefore given top priority in the 1960s.

Today, UNICEF places Cuba just four notches behind the USA and ahead of all developing countries in terms of children's health. There are 14 medical schools and 60 000 doctors for a population of 11.2 million; this translates into one doctor for approximately every 200 persons. Cuba has the lowest mortality rate (8 per 1000 compared to 11 per 1000 in Great Britain) and the highest life expectancy (73) in Latin America.



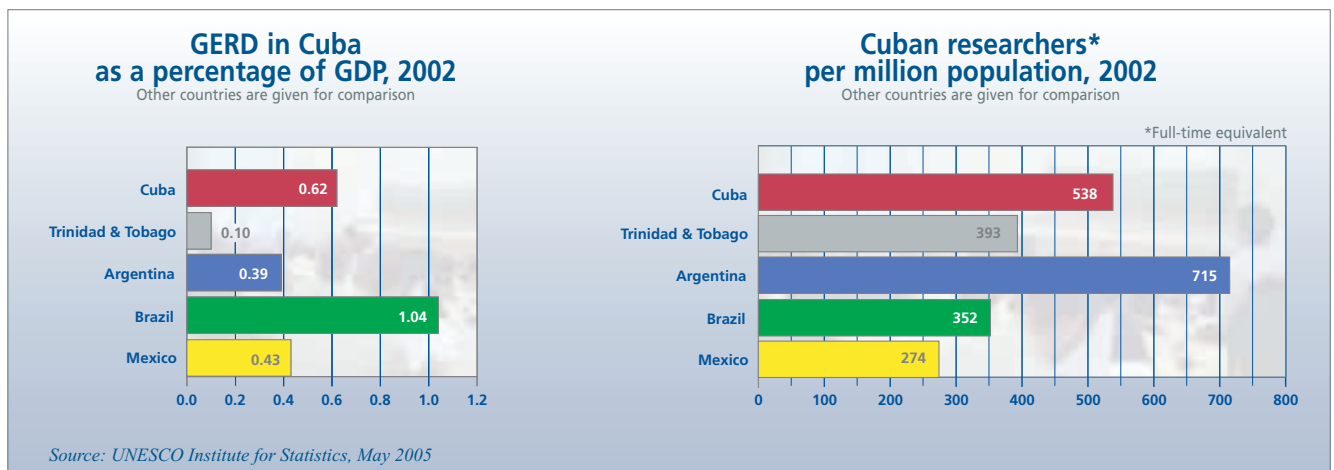
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Cybercafé in Havana in 2003

Mass immunization has resulted in the almost total eradication of several contagious diseases. Cuba was declared by the Pan-American Health Organization (PAHO) to be the first polio-free country in the Americas. In 1997, no cases of whooping cough, infantile tetanus, poliomyelitis, measles, mumps, rubella or yellow fever were diagnosed. The reasons for Cuba's outstanding health programme are many, among which the fact that medical care, including the supply of drugs, is free to all; the health of mother and child is given priority; the family doctor programme puts doctors and nurses in every neighbourhood to provide primary care. (The family doctor's home is already in existence: a three-story building with a clinic on the first floor, the doctor's living quarters on the second and the nurse's quarters on the third); the availability of 12 vaccines (PAHO recommends seven), including a pneumococcal vaccine developed in Cuba to combat pneumonia, which used to kill thousands of children; and the testing of expectant mothers to avoid abnormalities in newborns. Last but not least, Cuba has an active and effective surveillance and prevention programme. For example, the first cases of a dengue outbreak in December 1996 were detected in January 1997 and circumscribed to just 15 cases thanks to the effectiveness of the Cuban surveillance system.

The emphasis placed on health is borne out by the fact that Cuba's first success in producing a biotechnology product came in 1984 when, with the help of US cancer specialist Randelip Lee Clarke, insulin was produced. More than two million Cubans suffer from diabetes.

In addition to my discussions with medical scientists and doctors, I visited the Pedro Kouri Institute for Tropical



Medicine (IPK) established in 1937 and now under the directorship of Gustavo Kouri, grandson of the founding father. The stated goal of the institute is the pursuit of excellence in R&D in such areas as tropical medicine, microbiology and communicable diseases. One focus of microbiology is tuberculosis, as the number of cases augmented recently. The institute is also involved in a number of nature control and eradication programmes, including one for the prevention of AIDS. The institute is also working with the CIGB to produce a dengue vaccine. Great emphasis is placed on preventative medicine – and wisely so, as this reduces health care costs. The institute has a 170-bed hospital which houses mainly AIDS patients. There is also an educational component. A number of courses, mainly postgraduate, are offered for the training of national and foreign professionals. Some of these courses have been sponsored by UNESCO and PAHO. The institute provides advisory services to several countries and has a very active exchange programme.

### Of tobacco, sugar and neem

Cuban S&T is intimately linked to development and the agricultural sciences are no exception. Research focuses on crops that generate substantial foreign exchange, such as sugar and tobacco, and those that will enable Cuba to feed itself and meet the requirements of the expanding tourism industry. Cuba grows about two-thirds of its own rice requirements. The country has been encouraging organic farming for environmental and economic reasons.

At the Institute of Basic Research in Tropical Agriculture, I was somewhat surprised by the amount of research being done on neem<sup>10</sup> to create a natural pesticide. Neem culture got under way in 1991; by 2000, there were over 500 000 neem trees in Cuba. There is a joint proposal with the Caribbean Agriculture and Research Development Institute (CARDI) to produce the technology for the agro-industrial exploitation of the neem tree to obtain pesticides and veterinary products. In point of fact, the proposal goes further, suggesting a pilot programme in St Kitts & Nevis for the production and marketing of the neem pesticides.



Street scene in Garagüey

Other projects of the Cuban institute include pest management utilizing vegetable residues – only tobacco residue to-date has been used as an insecticide –, a maize hybrid and an integrated management of papaya culture to improve yield.

### Basic research confined mainly to universities

Research in the basic sciences is conducted primarily at the universities. It seemed to me during my visit that the state of the economy and the country's commitment to biotechnology meant that the basic sciences, though certainly not neglected, could not be afforded the same level of research support.

This does not necessarily mean that the scientists working in these areas are less active or motivated. They attend international conferences and undertake frontier work with researchers abroad. In fact, members of The Institute of Computer Science, Mathematics and Physics host a major international conference every two years. At a meeting with the Head of the Institute and some other members, interest was expressed in establishing links with the rest of the Caribbean. I believe there is potential here for co-operation.

Since my visit in 2000, the government has defined three new priorities for S&T, in consultation with the Cuban scientific community, one of which is basic sciences; the other two are information and communication technologies and social sciences. All three are to be reinforced.

New avenues for co-operation have opened up: in capacity-building in basic and pedagogical sciences – Cuba hosted the XIII<sup>th</sup> Inter-American Conference on Physics Education in July 2003, for example –, in climate change research, hurricane forecasting, renewable energies, science popularization and, last but not least, gender issues: women make up 65% of human resources in S&T in Cuba.



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Branch of a neem tree (Azadirachta indica)

Harold Ramkissoon<sup>11</sup>

10. The neem tree belongs to the mahogany family (Meliaceae). Cultivated over wide areas of Asia, Africa, Australia, the Americas and the south Pacific, the neem tree has been dubbed 'the village pharmacy' for its medicinal properties (against diabetes, high cholesterol, cancer, etc.). Neem oil is used for preparing body cleansing products and cosmetics, such as soap, shampoo and skin creams. The tree also acts as an insecticide: many of the tree's secondary metabolites have biological activity, such as azadirachtin present in the tree's seeds, which breaks the insect's lifecycle. Source: <http://Wikipedia.org>

11. For Prof. Ramkissoon's affiliation, see p. 19