Science in Cuba: A bet on sovereignty

Orfilio Peláez Mendoza

JANUARY 15, 1960 was a milestone for the fledgling Cuban Revolution. During the ceremony commemorating the 20th anniversary of the Speleological Society, Fidel Castro stated in one of his most daring prophecies: "The future of our country has to be necessarily a future of men of science, a future of men of thought."

The path to achieving such a strategic goal began to be outlined in the heat of the Literacy Campaign. On February 20, 1962, the University Reform was conducted along with the creation of the then National Commission of the Academy of Sciences of Cuba.

The main goals of the reform included modernizing education, improving its quality, adapting it to the needs of the country and incorporating scientific research in all institutions of higher education.

Thus, new courses were introduced in the curriculum, including Mathematics, Geology, Psychology, Economics, Industrial Engineering and Mining Engineering. The Mining and Metallurgy Research Center and the Cuban Research Institute of Sugarcane Derivatives were also created.

Such promising foundation steps have their apex in the establishment of the National Center for Scientific Research (CNIC in the Spanish acronym) on July 1st, 1965. Conceived at first as an entity for graduate studies in basic sciences, it soon became a multidisciplinary research center.

The opening of CNIC broke schemes and represented a transcendental step in the daring decision of the country's authorities to bet on scientific and technological development, a vital premise for achieving full sovereignty in the future.

Flagship

The guarantee of having graduated more than 32,000 experts in various fields of knowledge over 45 years would suffice to qualify the creation of the CNIC as a true achievement.

Young people who over the years had become central players in the national science scene acquired in the iconic building located on the outskirts of the Cuban capital, the skills and knowledge that would enable them to excel as researchers or managers.

Here it should suffice to mention the names of Dr. Rosa Elena Simeón,

Minister of Science, Technology and Environment, an office she held until her death in 2004; Ismael Clark, current president of the Academy of Sciences of Cuba; Dr. Gustavo Kourí, director of the Pedro Kourí Institute of Tropical Medicine (IPK); and Dr. Agustín Lage, who holds the same position at the Molecular Immunology Center.

The first institution created in Cuba to foster the progress of different areas of knowledge at the service of the economic and social development of the Island became a kind of "mother cell", since many specialists trained in its laboratories contributed to founding other first-tier institutions, including the Center for Genetic Engineering and Biotechnology, the Center for Agricultural and Livestock Health, the Centre for Neuroscience and the Immunoassay Center.

With some 700 employees and a team consisting of 72 researchers and professors (39 Doctors of Science and 19 Masters), the CNIC produces drugs, teams, diagnostic kits, technologies and services of high added value, which represent new exportable products and contribute to the well-being of citizens. In the last five years alone, 114 invention patents from the Center were recognized in 60 countries, 44 product registrations were obtained - 25 in Cuba and the rest in over 15 countries, while its experts maintain a prolific presence in the publication of articles in prestigious international journals. For Dr. Carlos Gutiérrez Calzado, director general of the CNIC, it is impossible to assess the most remarkable results of the Center without mentioning, first of all, Policosanol, or PPG, a drug obtained from sugarcane wax for the treatment of hypercholesterolemia.

The drug received one of the two gold medals awarded to CNIC products by the World Intellectual Property Organization (WIPO).

This medication has patents in over 50 countries, including the United States, Japan and Australia. In 2004 it received the Gold Medal of the Department of Health and Biotechnology of Taiwan.

In follow-up studies conducted in more than 3,000 patients taking Policosanol, a remarkable decrease in the frequency of severe vascular events was observed. The list of relevant impacts of CNIC includes the development of water and wastewater disinfection systems based on the use of ozone gas, the ozone therapy network that currently comprises more than 45 health centers in all Cuban provinces, and the development of Coralline Hydroxyapatite HAP 200, an effective biomaterial used as implant or to reconstruct or replace the bone tissue damaged by different causes, as well as in the manufacture of artificial eyes.

Also worth mentioning is the generalization of the Diramic System for rapid microbiological diagnostic of infection-causing agents, which in 2007 received the other Gold Medal awarded by WIPO for products developed at the National Center for Scientific Research.

Architects of excellence

For a poor and blockaded country, investing resources in the creation of a Center for Genetic Engineering and Biotech was undoubtedly an unusual event, little understood by many, when it occurred on July 1st, 1986.

Officially open in Havana by President Fidel Castro himself, the entity known by the Spanish acronym CIGB has contributed exceptionally to place Cuba among the world leaders in such an important sector, which today represents one of the main sources of the flow of foreign exchange into the Island.

Besides the economic contribution generated by exporting to 36 countries, the products created by the iconic institution have the great value of contributing to the prevention and treatment of 26 diseases in Cuba, as stated by its director, Dr. Luis Herrera Martinez.

The art of conducting research and producing with excellence, meeting all the requirements of international standards, was key in the success of CIGB.

It should suffice to mention, for example, the development of the recombinant anti-hepatitis B vaccine (Heberbiovac B), registered in over 32 countries in Latin America, Asia and Europe, whose introduction in the national health system has enabled eradicating this severe disease among Cuban children under 5 years of age (no cases have been reported since 1999) and significantly reducing its incidence on the Cuban population in general.

All young people under 25 years old have been immunized against hepatitis B. The use of this product has been endorsed by the World Health Organization (WHO) since 2001.

The scientific impacts of CIGB include the recombinant vaccine against the cattle tick, known by the trade name *Gavac*. Massively used in Cuba since 1999, it has significantly reduced the incidence and mortality associated with hemoparasite diseases transmitted by this acarid, in addition to reducing by almost 90% the imports of traditional chemical acaricides used for this purpose.

The search for and development of the so-called combined vaccines include the tetravalent Trivac-HB (pertussis, tetanus, diphtheria and hepatitis B), which received two national awards from the Academy of Sciences of Cuba in 2005, and until then the only one of its kind in Latin America; and more recently the pentavalent vaccine which, in addition to including immunization against the four above mentioned diseases, prevents against *Haemophilus influenzae* type B, the bacteria that causes meningitis and pneumonia in young children.

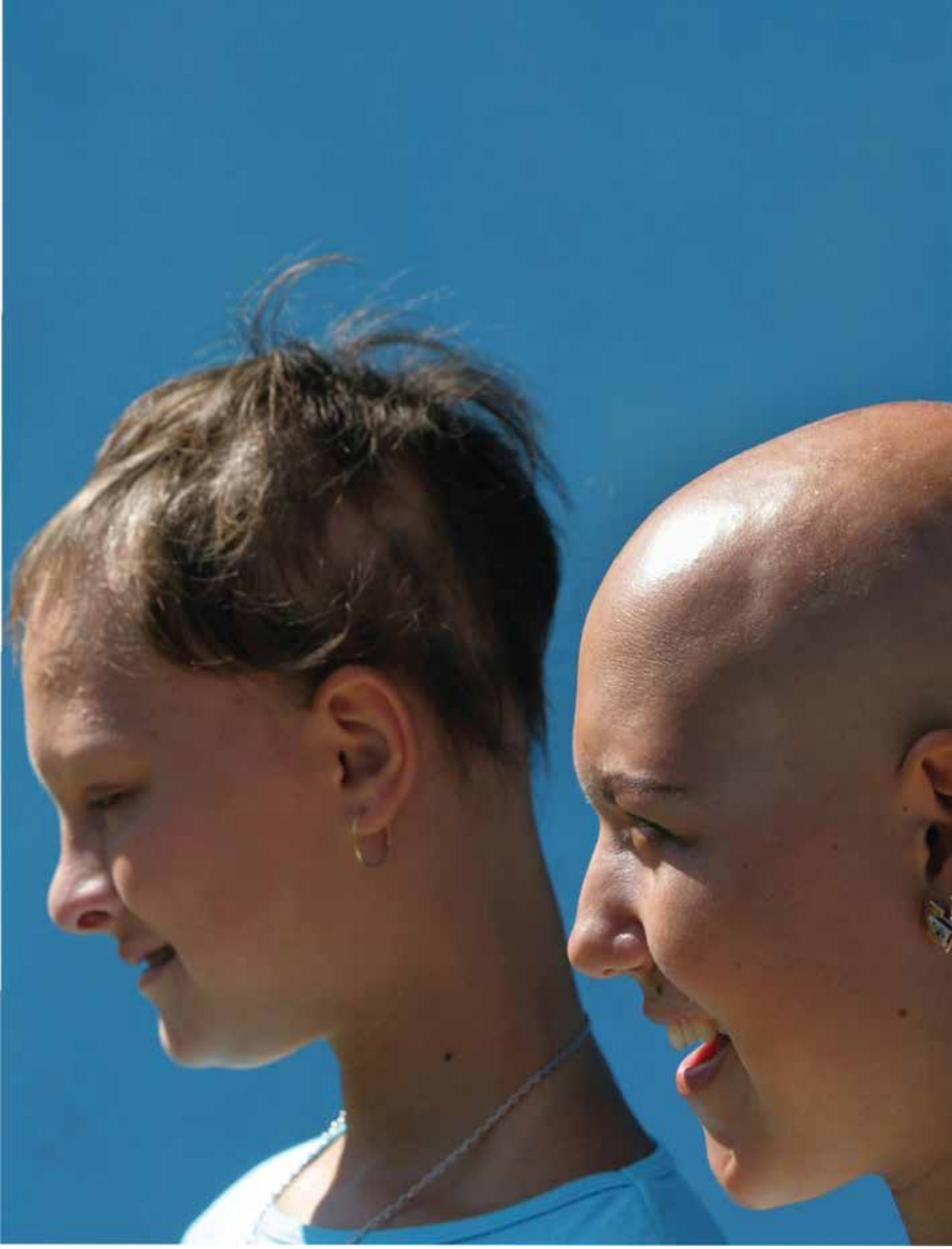
Among the most recent results, mention should be made of Heberprot-P, an injectable drug used to accelerate the healing of complex advanced-state wounds and ulcers in the lower limbs of diabetic patients, significantly reducing the risk of amputation.

Cuba has provided free medical treatment to more than 25,000 persons affected by the accident at the Chernobyl plant in Ukraine in 1986, the worst nuclear disaster in history. Since 1990, when the first group of patients arrived on the Island, doctors have been monitoring patients from Russia, Belarus and Ukraine with sequelae ranging from leukemia and thyroid cancer to psychological and neurological disorders and alopecia, a condition that causes hair loss.

This drug is based on human recombinant epidermal growth factor, a protein that exists in mammals and which promotes regeneration. It obtained sanitary registration in Algeria and several Latin American countries, and has been used with promising results in more than 10,000 Cuban and Venezuelan patients.

According to the board of CIGB, the beginning of Phase II of clinical trials for Heberprot-P in high-level hospitals in Spain has been recently approved; this could open the door for marketing the product in the European Union.

Currently, an entity belonging to the so-called Scientific Center of West Havana (comprising several tens of Research and Development Centers employing more than 7,000 professionals of the highest level) is developing several biomedical projects oriented to the search of new drugs and vaccines, whose potential use is encouraging.



In the list of drugs, we should mention: the potential therapeutic vaccine against hepatitis C virus, a new protein compound with antitumor properties, the formulation of suppositories containing recombinant streptokinase for the treatment of hemorrhoid crisis, and the design of a new therapeutic vaccine against human papillomavirus.

An example of international recognition of the CIGB is the fact that in mid-2010 Drs. Luís Herrera Martínez, director general, and Gerardo Guillén Nieto, Research director, were included among the "Top 18 Global Industry Experts" in the area of vaccine production.

Jewel for life

The Immunoassay Center, another pillar of the Scientific Center of West Havana, was officially open on September 7, 1987, to foster the design and production of technologies and strategies aimed at the massive research of various diseases.

A true jewel of Cuban science, the institution has the capacity to develop the teams, means of diagnosis, and software it uses, as well as to provide technical assistance to all its clients in all services provides. Dr. José Luís Fernández Yero, founding director of the Immunoassay Center, explained that the leading products of the entity are the so-called Ultramicroanalytical System, known by the acronym SUMA, and the UMELISA and UMTEST reactives.

Today, added Dr. Fernández Yero, we have 28 diagnostic kits which, through a network of 194 laboratories set up throughout the Island enable detecting 17 diseases linked to several top-priority national programs under the Ministry of Public Health, as in the case of the Mother and Child, Epidemiological Surveillance and Blood Certification programs.

The use of SUMA technology has enabled performing tests for the early diagnosis of congenital hypothyroidism in all Cuban children born since 1986. Just a decade later, nearly three million children had been tested, of whom 739 had the disease.

If they hadn't been diagnosed and treated on time, they would have grown up with severe mental retardation. It should be remembered that after Canada, Cuba was the second country in America to have complete coverage of congenital hypothyroidism in children, before the United States.

The contributions of the Center have also been the basic pillar of the program for prenatal diagnosis of congenital malformations (between 1982 and 2007, more than three million pregnant women were tested, avoiding the birth of 6,880 children with deformities) and of the increase in the number of diseases studied in neonatal research, by incorporating the corresponding immunochemical tests for detecting congenital suprarenal gland hyperplasia, galactosemia and biotinidase deficiency.

If not treated in a timely manner, these hereditary-metabolic diseases can

cause irreparable damage to the quality of life or the death of children in the first weeks after birth.

We should also mention that every pregnant woman is tested for hepatitis B and HIV. Thanks to the results of the Center, HIV-positive mothers could have their healthy babies after taking the appropriate measures to avoid transmitting the disease to the child.

As appropriately stated by Dr. Fernández Yero, the greatest pride of the group of researchers and technicians is to do science for the health of Cubans and other peoples.

Today there are about 580 overseas laboratories equipped with SUMA technology, 11 in China and most of them in the rest of Latin America, mainly in Venezuela, Mexico, Colombia and Argentina. Another screening test developed by the institution is UMELISA PSA (English acronym for Prostatic Specific Antigen), to quantify the specific prostate antigen in the blood of mature men, as a complementary test in the diagnosis of prostate diseases, among them cancer, which is currently the second leading cause of death from malignant tumors among Cuban men.

Range of impacts

The future of the men of science envisioned by the leader of the Cuban Revolution over 50 years ago is now a tangible reality, despite severe economic and financial constraints derived from iron-clad embargo imposed by the United States government for half a century, the demise of the Soviet Union and of the European socialist camp and the international crisis, not to mention internal factors such as the low efficiency and decapitalization of the country's production base and infrastructure.

Today Cuba has 220 science and technology units, of which 115 are research centers employing more than 30,000 people.

The Caribbean nation has more than one million university graduates, 65 institutions of higher education, more than 41,000 professors, some 8,000 doctors of sciences and an average of 1.8 scientist and engineer per 1,000 people.

Life expectancy in 2009 was 77.97 years, and infant mortality rate 4.8 per 1,000 live births.

The pharmaceutical and biotechnology industries are undoubtedly the most recognizable faces of Cuban science in the world, due to the development of cutting-edge technologies and products.

Besides those referred to in the previous paragraphs, also worth mentioning are the cases of the anti-meningococcal B vaccine, the *Haemophilus Influenzae* type B vaccine, and the Nimotuzumab monoclonal antibody developed by the Molecular Immunology Center (CIM) for the treatment of advanced brain, head and esophagus tumors.

This injectable product acts against the epidermal growth factor receptor and inhibits the growth of the malignant lesion.

Combined with traditional treatment regimens, the vaccine leads to a significant decrease in tumor size in a high percentage of cases (oncologists prefer to speak of increased rates of complete and partial remission), besides increasing the life expectancy and quality of life of patients. The product has sanitary registration in 25 countries and clinical trials are currently under way in the United States, Japan, Canada and Germany, while in Cuba it is being evaluated for another eleven types of neoplasm.

Another promising result presented by the Molecular Immunology Center is the design and development of a therapeutic vaccine against lung cancer, which is beginning to be introduced in primary healthcare.

Until September 2010, CIM had already obtained 259 patents abroad and 432 were being processed.

But Cuba is recognized, moreover, for its contribution to research into climate change, the recovery of beaches damaged by erosion, environmental impact studies, the increasing effectiveness of the national meteorological service, the development of products and technologies based on the use of zeolites and its vast experience in the knowledge of soils.

With its feet on the ground, as regards the non-availability of the abundant resources dedicated to nanoscience by rich nations, Cuba also penetrates the world of "miniatures" and has a national program aimed at adjusting new materials and cutting-edge technology, which find in nanotechnology one of their foundation.

In this sphere, the work of the Institute of Science and Technology of Materials (IMRE) of the University of Havana stands out in a particular way, with experts who have published numerous findings on the subject in prestigious international journals, obtaining patents and graduating tens of masters and doctors.

Despite media disinformation campaigns, no honest person can ignore that Cuba today is a country of researchers, technicians and highly skilled workers; a nation of innovators and creators; a land where, for the good of all its people, science is an everyday word.

Abstract – On January 15, 1960, Fidel Castro Ruz, then prime minister of the Revolutionary Government, said that Cuba's future would necessarily have to be a future of men of science, a future of men of thought. Half a century after this prophetic announcement, the Caribbean island is a country of researchers, specialists and highly skilled workers, boasting one of the world's most important biotechnological industries, with achievements comparable to those of leading nations in this field of knowledge. Now, scientific activity in Cuba is on the way to becoming a powerful productive force, bringing in considerable foreign currency and generating greater well-being for society.

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