The Cuban Biotechnology: Innovation and universal health care

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Innovation & Inequality Workshop
15, 16 May 2010, Pisa, Italy

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Outline
1. Cuban based health biotechnology
2. State as insurer
3. Commitment to primary care
4. External linkages
5. Challenges
6. Essential points
Cuban-based health biotechnology

• 300 biotechnology centers  

• Western Havanna Biocluster employs 12,000 workers and more than 7,000 scientists and engineers  

• 500 patent applications in 2003  
  Source: Thorsteinsdóttir et al. 2004, Nature Biotechnology

• Exports to more than 50 countries

• 100 million dollars a year in export earnings  
  Source: Kaplan W, Laing R (2005), World Bank
Cuban-based health biotechnology

• Relevant products
  - World’s first vaccine against meningitis B (WIPO Gold Medal 1989)
  - PPG: To treat cardiovascular diseases (WIPO Gold Medal 1996)
  - Hepatitis B vaccine* (pre-qualified for purchase by the WHO in 2001)
  - World's first synthetic vaccine against Haemophilus influenzae type b (WIPO Gold Medal 2005)
  - Surfacen: To treat infant respiratory distress syndrome (WIPO Gold Medal 2007)

Cuban-based health biotechnology
- Diramic (WIPO Gold Medal 2007)
Cuban-based health biotechnology

- Cuban biotechnology integrated into development strategy

- Science as a means of reducing inequality

- Cuban Biotech integrated into the health system

- It covers 80% of the domestic demand
Health indicators

Infant mortality and gross national product (GNP) in selected Latin American countries and the United States, 2003

Source: Cooper et al. (2006)
Inequality and Innovation

• State as insurer

• Commitment to primary care

• External linkages
The State as insurer

• Effective mechanism of social compensation.

• Social justice as precondition of economic and technological development.

• Two main components: Universal healthcare and universal education.
The State as insurer

• Public and universal health care system
  - To maintain a healthy population as a political objective
  - State financial commitment
  - Insurance function
The State as insurer
Public expenditure in the domestic budget

The State as insurer

- Creation of a knowledge base: Creation of an educated and skilled population
  - Literacy campaign (1960-61)
  - Sustained and high levels of investment in education (10% of GDP > 6% recommended by UNESCO)
  - Universal education (2,3 millions students in the whole educational system 2002*, adult literacy rate: 100% 2003-2008, Primary school net enrolment/attendance: 98% 2003-2008)
  - Public research institutions and universities (58 universities)

Source: World Bank 2000, UNESCO

The State as insurer

• Creation of a knowledge base (biomedical research)
  - National Centre for Scientific Research (1965)
  - Institutions in the biomedical field during the 80’s
    - Centre for Biological Research (1981)
    - Centre for Genetic Engineering and Biotechnology (1986)
    - Centre for Immunoassay (1987)
The State as insurer

• 1 Billion US$ invested in the Biotechnology during 1990-1996

• Program of import substitution covering 422 products implemented

The State as insurer

Summary

• Rapid increase of biomedical research

• Development of new ideas and products

• Social policy-based infrastructure as a strategic asset
Commitment to primary care

• Family doctors network
  - Serve approx. 150 families in the community surrounding the clinics
  - Deal with 80% of the health problems
  - New medical school curriculum based on primary health care (health promotion and disease prevention)
  - Doctor integrated in the community
Commitment to primary care

• Family doctor directly linked to the health system
Commitment to primary care

- Family doctors provide information for clinical trials to the health system based National Coordinating Center of Clinical Trials
Commitment to primary care

Summary

• Comprehensive national records

• Improved resource allocation

• Socially productive innovation
External linkages

• Building scientific capacity: Curie Institute (Paris), Pasteur Institute (Paris), Heidelberg University (Heidelberg, Germany), Harvard University (Cambridge, MA, USA)

• Promotion of technological learning (Interferon served as the model product for Cuban biotechnology)
External linkages

Percentage of firms in international health biotech collaboration, comparing South-South with North-South

Source: Melon et. al. (2009), Nature Biotechnology, 27
External linkages

• South-south cooperation(1)

Technology transfer:
- Biocon BioPharmaceuticals Ltd. (BBPL) in India
- Biotech Pharmaceutical Co. Ltd. in China
- Delta Laboratories in Colombia
- Eurofarma Laboratorios Ltda in Brazil
- Ferozsons Labs in Pakistan
- Innogene Kalbiotech in Indonesia
- Laboratorio Elea S.A.C.I.F.yA in Argentina
- Laboratorios PiSA in Mexico
- Eske Group in Peru
External linkages

Technology Transfer Projects CIGB (2008)


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External linkages

• South-south cooperation(2)
  - Export of medical services: 2006, 28,664 Cuban health professionals were serving abroad in 68 countries.
  
  - Cuba’s Comprehensive Health Program: 27 countries in Latin America, the Caribbean, Africa and Asia (since 1998)
  
  - Four cooperation programs since 2000: 1) joint projects in prevention and treatment of HIV in 19 countries, 2) Cuba-Venezuela bilateral agreement “oil for doctors”, 3) vision restoration program in 27 Third World countries, 4) Disaster Response Contingent (since 2005)
  
  - The Latin American Medical School (opened since 1999)
External linkages

Summary

• South-South cooperation brings prestige and influence

• Networks with other institutions

• Access to foreign markets

• Data collection for new products.
Challenges

• American Embargo (the longest in modern history)

• Medical diplomacy makes a few enemies

• Potential strains in the Cuban health system

• Ageing population
Essential points

Inequality must not be a necessary outcome of innovation

• Placing social policy at the centre of the development policy

• Building social institutions based on universality and solidarity

• Building internal and external networks
Thanks
Just in case
The State as insurer
Public and private expenditure on educational institutions, 2005

The State as insurer

- Health care expenditures increased during the crisis

2000 6.6 %


<table>
<thead>
<tr>
<th>Year</th>
<th>Health Budget*</th>
<th>Per Inhabitant</th>
<th>% of GDP</th>
<th>% of Natl. Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>1,045.1</td>
<td>98.6</td>
<td>5.3</td>
<td>7.4</td>
</tr>
<tr>
<td>1995</td>
<td>1,221.9</td>
<td>111.3</td>
<td>5.8</td>
<td>8.8</td>
</tr>
<tr>
<td>1998</td>
<td>1,473.1</td>
<td>132.4</td>
<td>6.4</td>
<td>13.1</td>
</tr>
</tbody>
</table>


*in millions of Cuban pesos
The State as insurer

- Education expenditures increased during the crisis

Data from: Gasperini (2000), World Bank
## Cuban-based health biotechnology

### CIGB Biomedical Project’s Pipeline 2010

<table>
<thead>
<tr>
<th>Project</th>
<th>Area</th>
<th>Discovery</th>
<th>Preclinical</th>
<th>Phase I</th>
<th>Phase II</th>
<th>Phase III</th>
<th>Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heberprot-P</td>
<td>Wound healing</td>
<td></td>
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<tr>
<td>HBV vaccine (NASVAC)</td>
<td>Infectious</td>
<td></td>
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<tr>
<td>HCV vaccine (CIGB-230)</td>
<td>Infectious</td>
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<tr>
<td>CIGB-500 (Cytoprotective agent)</td>
<td>Cardiovascular</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>CIGB-300</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>CEA recombinant antibody fragment (CIGB-M3)</td>
<td>Cancer</td>
<td></td>
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<tr>
<td>HPV vaccine</td>
<td>Cancer</td>
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<tr>
<td>Prostate cancer vaccine</td>
<td>Cancer</td>
<td></td>
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<tr>
<td>CIGB-370 (anti-tumor agent)</td>
<td>Cancer</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>CIGB-166 (anti-VEGF antibody)</td>
<td>DMAE /Cancer</td>
<td></td>
<td></td>
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<tr>
<td>CIGB-247 (VEGF vaccine)</td>
<td>Cancer</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>CIGB-552 (anti-tumor peptide)</td>
<td>Cancer</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Dengue vaccine</td>
<td>Infectious</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dengue anti-viral molecules</td>
<td>Infectious</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>CIGB-845 (neuro-protective agent)</td>
<td>Neurology</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Peptide for Rheumatoid Arthritis</td>
<td>Autoimmunity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: CIGB-Heber Biotech, Business Project Portfolio 2010
## Cuban-based health biotechnology

### Historical development of CIGB products approved for commercialization

<table>
<thead>
<tr>
<th>Year</th>
<th>Biotech product (generic name)</th>
<th>Indication(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hebertrans (leukocyte extract termed transfer factor)</td>
<td>Immune deficiencies, herpes and ataxia telangiectasia</td>
</tr>
<tr>
<td></td>
<td>Heberon alfa R (recombinant IFN-α2b)</td>
<td>Hepatitis C and cancer</td>
</tr>
<tr>
<td></td>
<td>Hebermin (recombinant EGF) produced in <em>Escherichia coli</em></td>
<td>Burns and ulcers</td>
</tr>
<tr>
<td></td>
<td>Heberbiovac HB (recombinant HbsAg)</td>
<td>Hepatitis B</td>
</tr>
<tr>
<td>1991–2000</td>
<td>Heberkinasa (recombinant streptokinase)</td>
<td>Cardiovascular disease</td>
</tr>
<tr>
<td></td>
<td>GAVAC (recombinant Bm86 protein vaccine)</td>
<td>Cattle tick (<em>Boophilus microplus</em>)</td>
</tr>
<tr>
<td></td>
<td>Heberon Gamma R (recombinant IFN-γ)</td>
<td>Juvenile rheumatoid arthritis</td>
</tr>
<tr>
<td>2001–2007</td>
<td>Quimi-Hib (Hib vaccine)</td>
<td>Pneumonia and meningitis</td>
</tr>
<tr>
<td></td>
<td>Bivalent ‘HB-Hib’ recombinant vaccine comprising HbsAg and Hib</td>
<td>Hepatitis B, pneumonia and meningitis</td>
</tr>
<tr>
<td></td>
<td>Trivac HB (tetravalent (DPT-HB) vaccine)</td>
<td>Diphtheria, tetanus, whooping cough and hepatitis B</td>
</tr>
<tr>
<td></td>
<td>Heberpenta (pentavalent (DPT-HB+Hib) vaccine)</td>
<td>As above plus <em>Haemophilus influenzae</em> meningitis</td>
</tr>
<tr>
<td></td>
<td>Heberviron (recombinant IFN-α2b and ribavirine)</td>
<td>Hepatitis C</td>
</tr>
<tr>
<td></td>
<td>Hebervital (recombinant granulocyte colony stimulating factor)</td>
<td>Leukopenia, neutropenia</td>
</tr>
<tr>
<td></td>
<td>Heberitro (recombinant erythropoietin-α)</td>
<td>Anemia</td>
</tr>
<tr>
<td></td>
<td>HeberNem (<em>Corynebacterium paurometabolum</em> C924 strain)</td>
<td>Biological control of plant nematode infestation</td>
</tr>
<tr>
<td></td>
<td>Acusabio I (invertebrate and fish nutritional supplement containing a defined combination of amino acids)</td>
<td>Prevention of white spot disease</td>
</tr>
</tbody>
</table>

*Table does not list new formulations of existing products, such as Heberbiovac HB, Heberon alfa R liquid without albumin, Heberon alfa R lyophilized without albumin, and Heberkinasa without albumin, Hebervis and Citoprot-P.*

Source: Lopez et al (2007), NATURE BIOTECHNOLOGY VOLUME 25 NUMBER 11 NOVEMBER
Cuban-based health biotechnology
CIGB Biomedical Project's Pipeline 2010

<table>
<thead>
<tr>
<th>Company</th>
<th>Creation date</th>
<th>Number of workers</th>
<th>Extention (m²)</th>
<th>Commercial branch</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIGB</td>
<td>1986</td>
<td>1245</td>
<td>10000</td>
<td>Heber Biotec</td>
</tr>
<tr>
<td>CIM</td>
<td>1994</td>
<td>400</td>
<td>15000</td>
<td>CIMAB</td>
</tr>
<tr>
<td>Finlay Inst.</td>
<td>1991</td>
<td>920</td>
<td>23000</td>
<td>Vacunas Finlay</td>
</tr>
<tr>
<td>CENSA</td>
<td>1980</td>
<td>406</td>
<td>8000</td>
<td></td>
</tr>
<tr>
<td>CNIC</td>
<td>1965</td>
<td>1193</td>
<td>35000</td>
<td>DALMER</td>
</tr>
<tr>
<td>CIREN</td>
<td>1989</td>
<td>309</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CIE</td>
<td>1987</td>
<td>244</td>
<td>9000</td>
<td>Tecnosuma</td>
</tr>
<tr>
<td>CENPALAB</td>
<td>1982</td>
<td>414</td>
<td>74000</td>
<td></td>
</tr>
<tr>
<td>BIOCEN</td>
<td>1992</td>
<td>800</td>
<td>166000</td>
<td></td>
</tr>
<tr>
<td>CNC*</td>
<td>1990</td>
<td></td>
<td></td>
<td>Neuronic</td>
</tr>
</tbody>
</table>

Source: CIGB-Heber Biotech, Business Project Portfolio 2010
Cuban-based health biotechnology

- Complete name of the Centres
- CIGB: Centre for Genetic Engineering and Biotechnology
- CIM: Centre for Molecular Immunology
- Finlay Inst: Finlay Institute
- CENSA: National Centre for Animal and Plant Health
- CNIC: National Centre for Scientific Research
- CIREN: International Centre of Neurological Restoration
- CIE: Centre for Immunoassays
- CENPALAB: National Centre for Production of Laboratory Animals
- BIOCEN: National Centre for Bioproduction
- CNC: Centre for Neurosciences
Cuban-based health biotechnology

CIGB Patents 2009

Source: CIGB-Heber Biotech, Business Project Portfolio 2010
Cuban-based health biotechnology
CIGB Patents 2009

Source: CIGB-Heber Biotech, Business Project Portfolio 2010
Cuban-based health biotechnology

Figure 2: Number of papers in health biotechnology in Brazil and Cuba, 1991-2002
Source: Science-Metrix (data from Science Citation Index Expanded, ©Thomson ISI)

Source: Thorsteinsdóttir et al. (2005), Different Rhythms of Health Biotechnology Development in Brazil and Cuba, Journal of Business Chemistry
Commitment to primary care

- They encourage the acceptance of local health biotechnology by participating in clinical trials

Clinical Trial participants Centre for Molecular Immunology (CIM)

Source: Centre for the Study of the Cuban Economy (CEEC) 2008
## Health indicators

<table>
<thead>
<tr>
<th></th>
<th>Infant mortality rate (per 1000 live births)</th>
<th>Life expectancy at birth</th>
<th>Under five mortality rate per 1000 live births</th>
<th>Per capita expenditure on health (2006) PPP int. $</th>
<th>Total expenditure as % of GDP(2006)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cuba</strong></td>
<td>5,3</td>
<td>79</td>
<td>8</td>
<td>674</td>
<td>7,7</td>
</tr>
<tr>
<td><strong>Region of the Americas</strong></td>
<td>11</td>
<td>76</td>
<td>19</td>
<td>2788</td>
<td>12,8</td>
</tr>
<tr>
<td><strong>European Region</strong></td>
<td>10</td>
<td>74</td>
<td>15</td>
<td>1719</td>
<td>8,4</td>
</tr>
<tr>
<td><strong>High income group average</strong></td>
<td>4</td>
<td>80</td>
<td>7</td>
<td>3848</td>
<td>11,2</td>
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<tr>
<td><strong>Global average</strong></td>
<td>28</td>
<td>68</td>
<td>67</td>
<td>790</td>
<td>8,7</td>
</tr>
</tbody>
</table>

Source: *World Bank, WHO Statistics 2009*
Health indicators

Incidence of meningitis in Cuba (1989-2006)

Source: Campa et. al (2007), MEDICC Review, Fall, Vol 9, No 1
Health indicators

In 2001, Cuba reached the goals the United States has set for 2010

<table>
<thead>
<tr>
<th>USA: Goals for 2010</th>
<th>Cuba: 2001 Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants 2-18 months 99%</td>
<td>Infants 2-18 months 99%</td>
</tr>
<tr>
<td>15-24 years 75-90%</td>
<td>15-24 years 94.5%</td>
</tr>
<tr>
<td>Prenatal Transmission 75%</td>
<td>Prenatal transmission 95%</td>
</tr>
<tr>
<td>Reduction by 2000, 61.9%</td>
<td>Reduction by 2001, 96-99%</td>
</tr>
</tbody>
</table>

Cuban Economy

Export of services

Cuban Economy

Budget deficit/GDP


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Cuban Economy

Structure of Cuban Exports