

# The Cuban Biotechnology: Innovation and universal health care

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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** Source: CUBA: Biotechnology Facts (2006), World Security Institute
- **Western Havanna Biocluster employs 12,000 workers and more than 7,000 scientists and engineers** Source: Lage (2006), STWR, <http://www.stwr.org/health-education-shelter/socialism-and-the-knowledge-economy-cuban-biotechnology.html>
- **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)

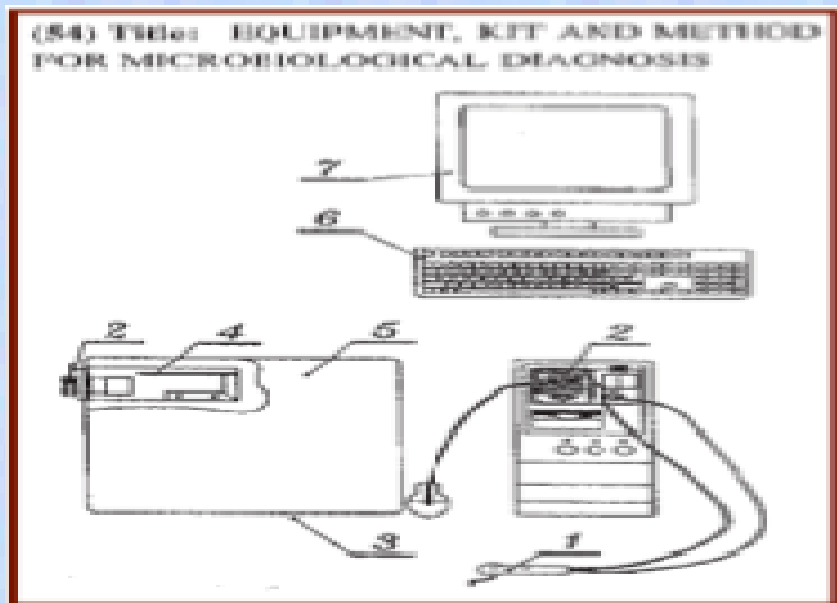
Sources: WIPO Resources,

<http://www.wipo.int/tools/en/gsearch.html?cx=000395567151317721298%3Aaqr59qtb0&cof=FORID%3A11&q=wipo+awards+cuba&sa=Search#1128>

\*WHO list of vaccines for purchase by UN agencies as of March 2010, [http://www.who.int/immunization\\_standards/vaccine\\_quality/pq\\_suppliers/en/](http://www.who.int/immunization_standards/vaccine_quality/pq_suppliers/en/)

# Cuban-based health biotechnology

- Diramic (WIPO Gold Medal 2007)

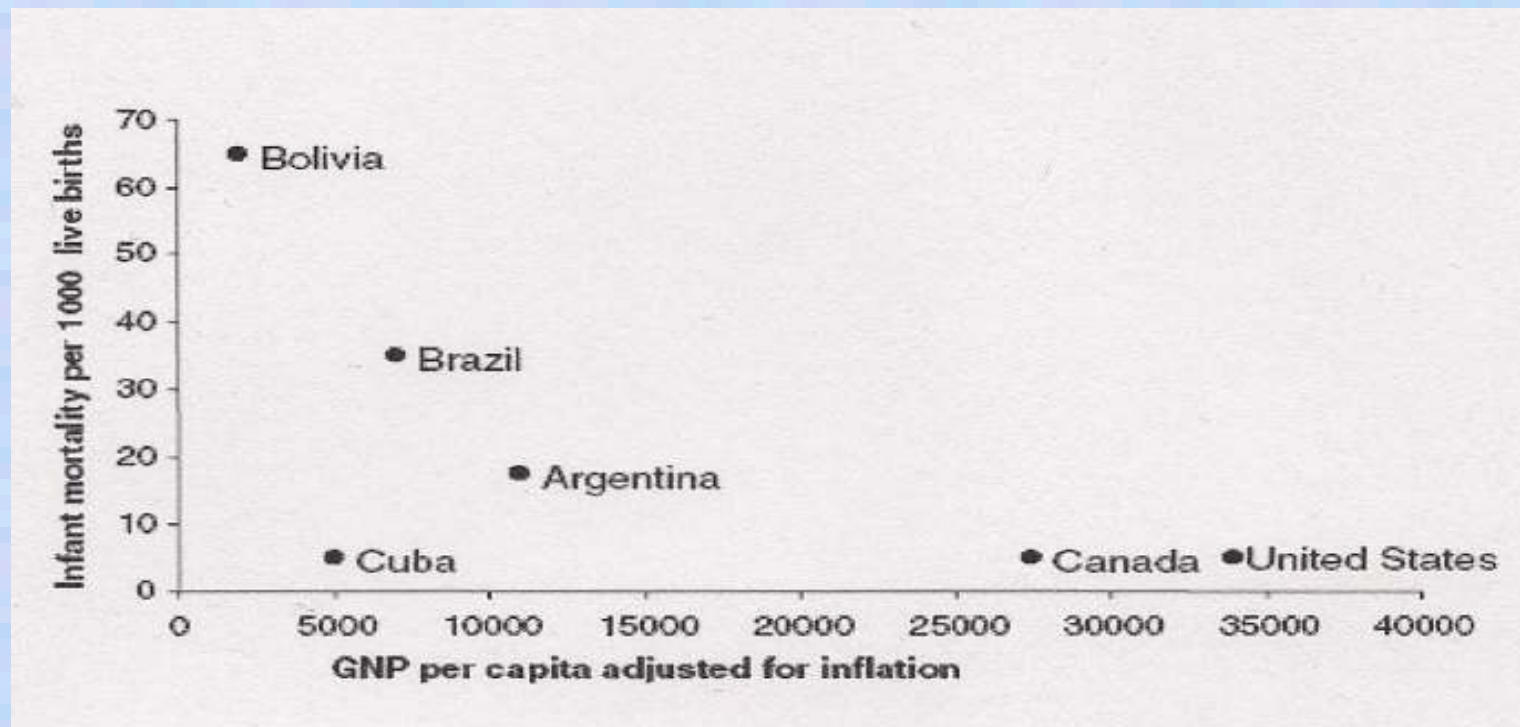


## Cuban-based health biotechnology

- 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

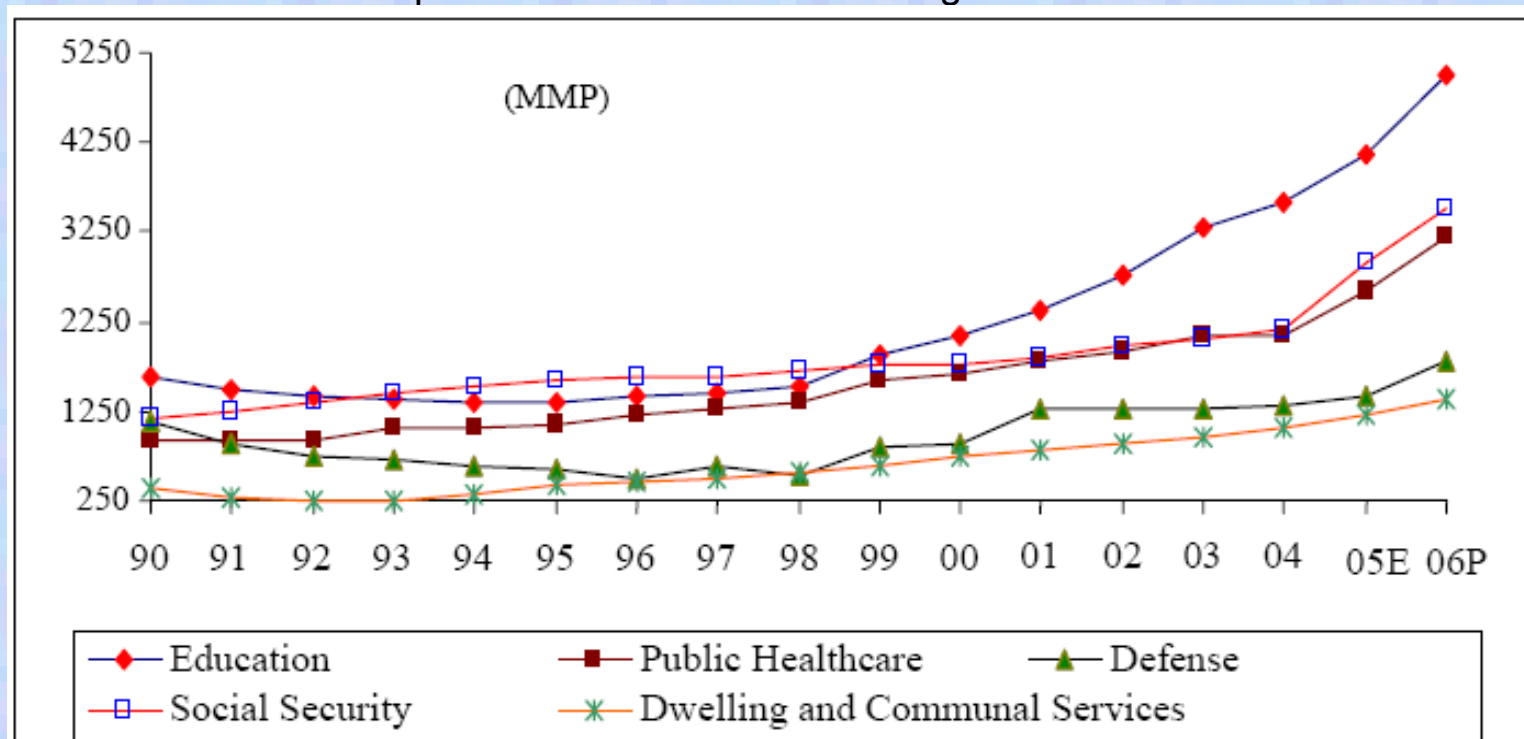
- Effective mechanism of social compensation.
- Social justice as precondition of economic and technological development.
- Two main components: Universal healthcare and universal education.

## 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



Source: Molina 2009, Cuba: Economic Restructuring, Recent Trends and Major Challenges, The IDEA Working Paper Series 02/2009

# 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

\* Lopez E (2002), Development of Cuban biotechnology, Journal of Commercial Biotechnology

## 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

\* Lopez E (2002), Development of Cuban biotechnology, Journal of Commercial Biotechnology

# The State as insurer

## Summary

- Rapid increase of biomedical research
- Development of new ideas and products
- Social policy-based infrastructure as a strategic asset

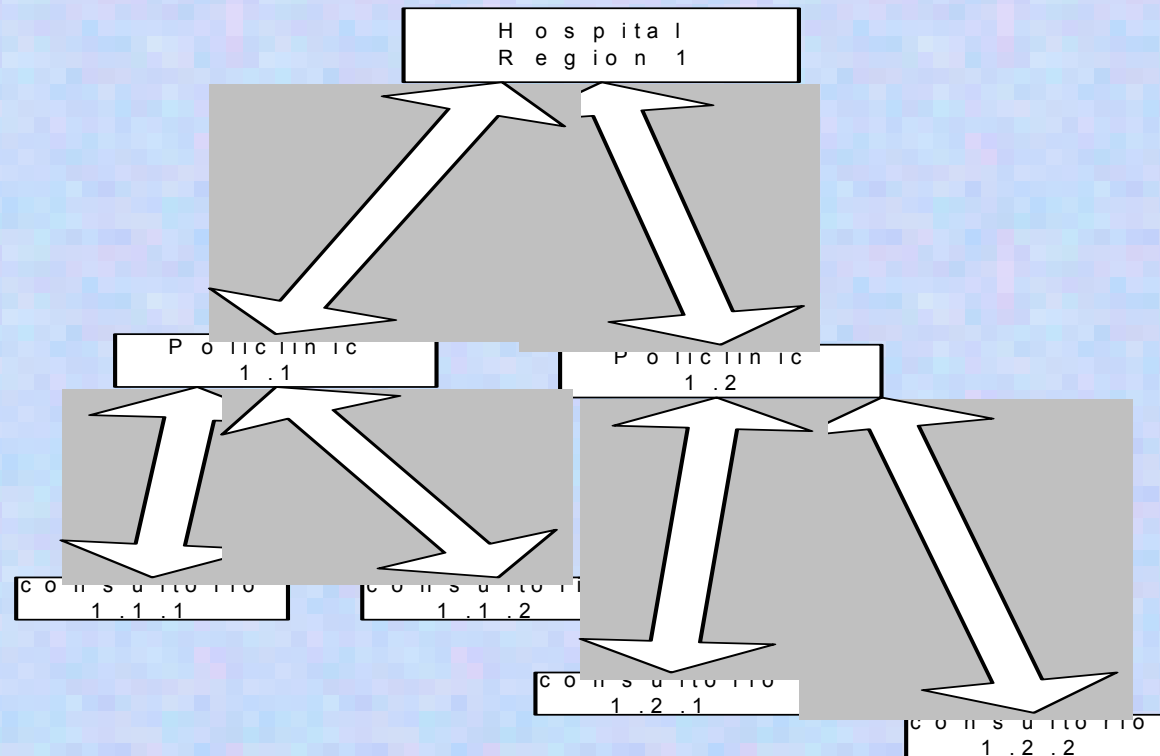
# Commitment to primary care

- 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

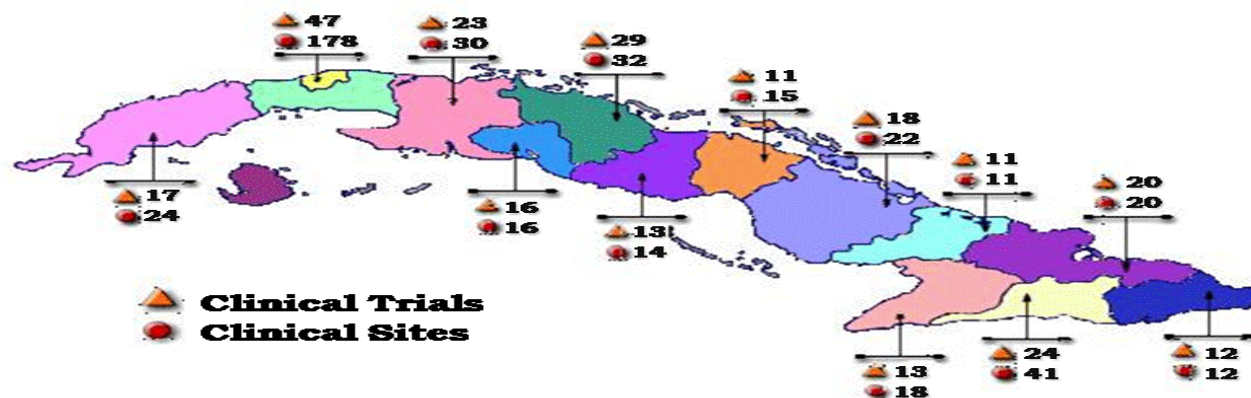
- Family doctor directly linked to the health system



# Commitment to primary care

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

## MULTICENTER CLINICAL TRIALS IN PROVINCES. January 2008



# Commitment to primary care

## Summary

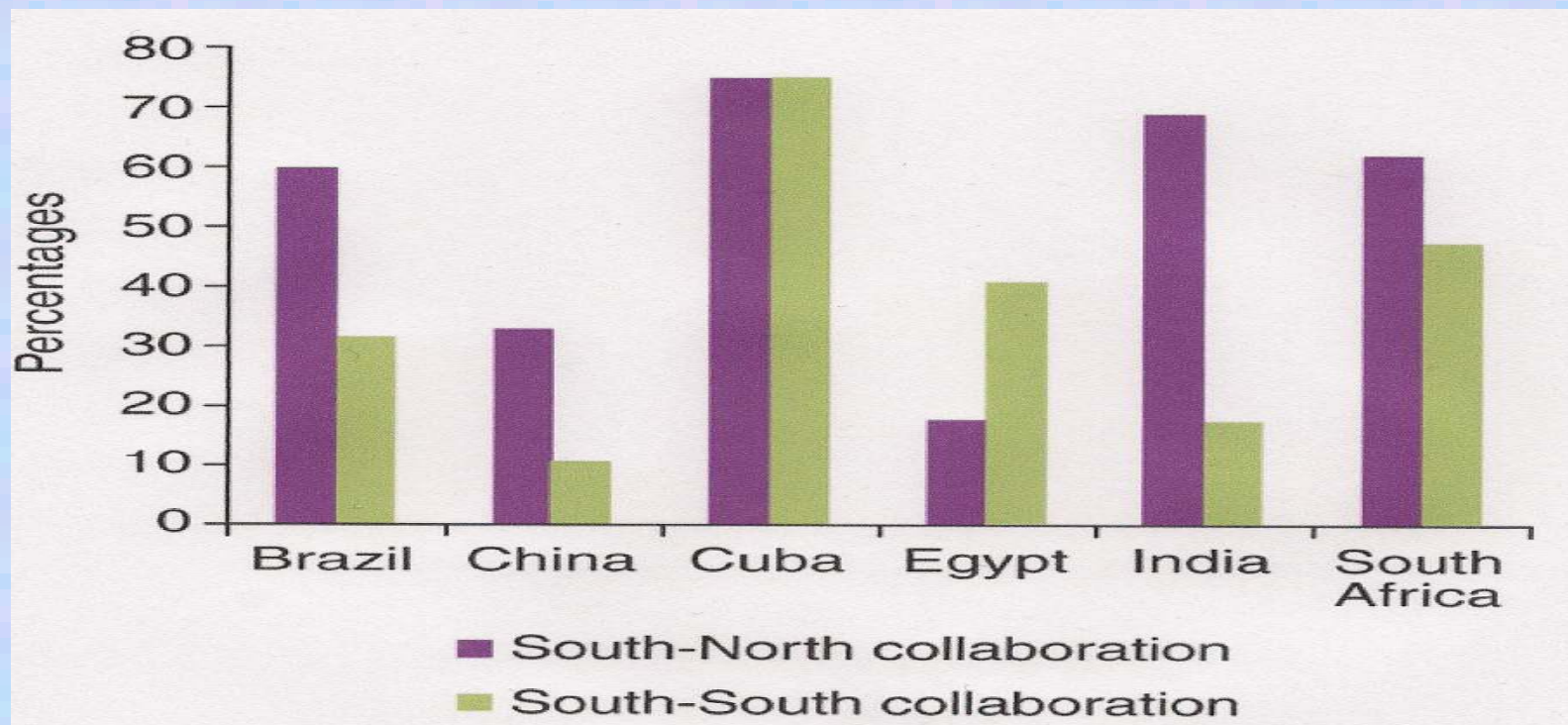
- Comprehensive national records
- Improved resource allocation
- Socially productive innovation

## 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)



Source: Ubieta(2008), Life Sciences symposium: Public Sector IP Management, Geneva, December 15, Ginebra  
University of Bremen

# 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

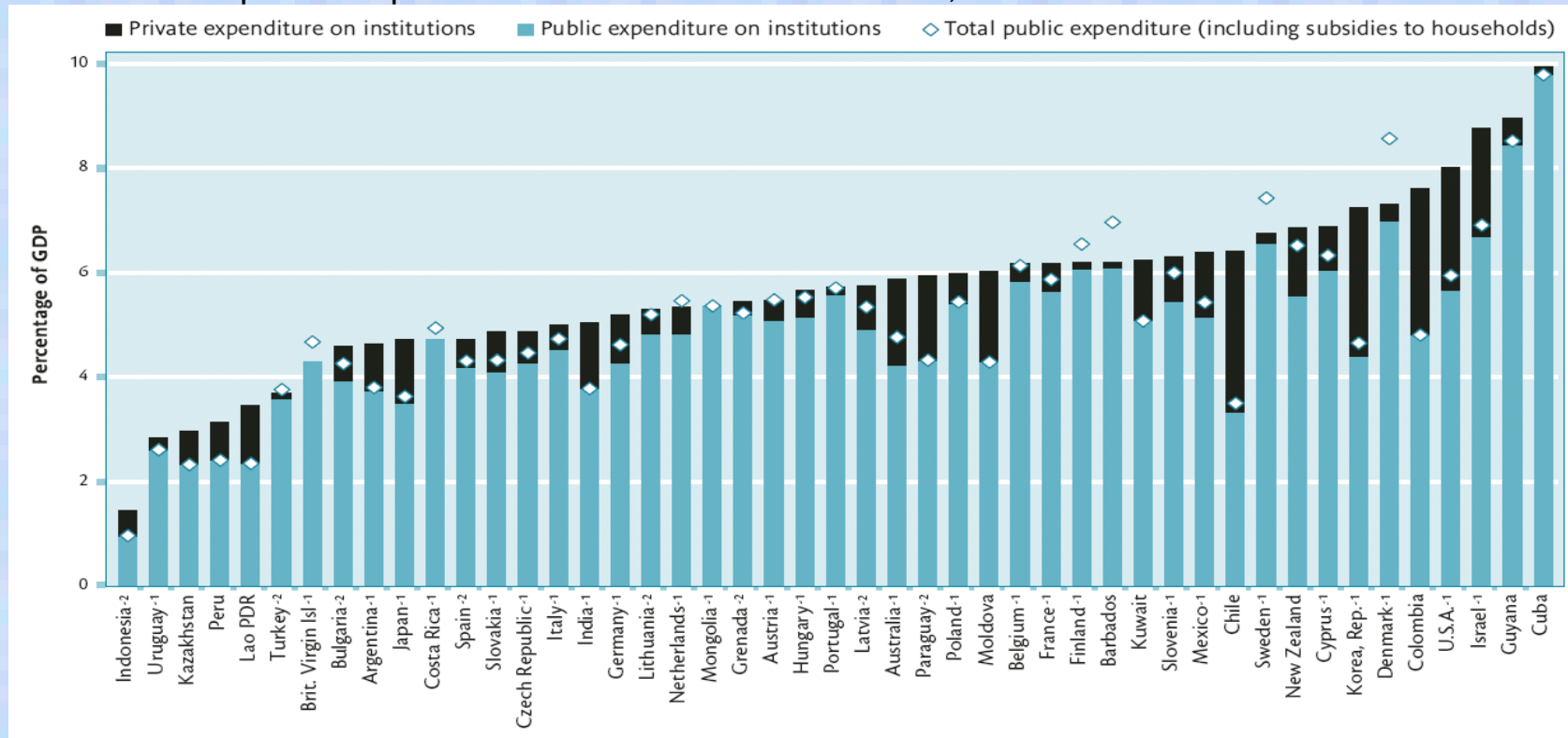
- Placing social policy at the centre of the development policy
- Building social institutions based on universality and solidarity
- Building internal and external networks

Thanks

# Just in case

# The State as insurer

Public and private expenditure on educational institutions, 2005



Source: UNESCO, Institute for Statistics, 2007

# The State as insurer

- Health care expenditures increased during the crisis

2000 6,6 %

## Cuba's Public Health Budget 1990, 1995, 1998

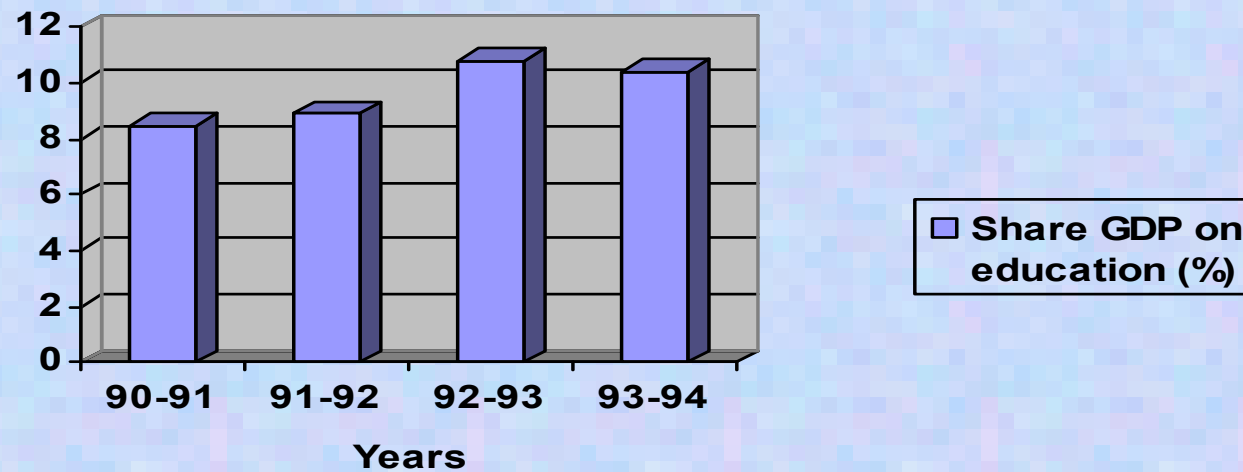
Year	Health Budget*	Per Inhabitant	% of GDP	% of Natl. Budget
1990	1,045.1	98.6	5.3	7.4
1995	1,221.9	111.3	5.8	8.8
1998	1,473.1	132.4	6.4	13.1

Source: The Cuban Approach to Health Care: Origins, Results, and Current Challenges, Medicc.org, (WHO 2009)

*\*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

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

Source: CIGB-Heber Biotech, Business Project Portfolio 2010

# Cuban-based health biotechnology

## Historical development of CIGB products approved for commercialization

Year	Biotech product (generic name)	Indication(s)
1981–1990	Leuferon (human IFN)	Viral infections and cancer
	Hebertrans (leukocyte extract termed transfer factor)	Immune deficiencies, herpes and ataxia telangiectasia
	Heberon alfa R (recombinant IFN- $\alpha$ 2b)	Hepatitis C and cancer
	Hebermin (recombinant EGF) produced in <i>Escherichia coli</i> )	Burns and ulcers
	Heberbiovac HB (recombinant HbsAg)	Hepatitis B
1991–2000	Heberkinasa (recombinant streptokinase)	Cardiovascular disease
	GAVAC (recombinant Bm86 protein vaccine)	Cattle tick ( <i>Boophilus microplus</i> )
	Heberon Gamma R (recombinant IFN- $\gamma$ )	Juvenile rheumatoid arthritis
2001–2007	Quimi-Hib (Hib vaccine)	Pneumonia and meningitis
	Bivalent 'HB-Hib' recombinant vaccine comprising HBsAg and Hib)	Hepatitis B, pneumonia and meningitis
	Trivac HB (tetraivalent (DPT-HB) vaccine)	Diphtheria, tetanus, whooping cough and hepatitis B
	Heberpenta (pentavalent (DPT-HB+Hib) vaccine)	As above plus <i>Haemophilus influenzae</i> meningitis
	Heberviron (recombinant IFN- $\alpha$ 2b and ribavirine)	Hepatitis C
	Hebervital (recombinant granulocyte colony stimulating factor)	Leukopenia, neutropenia
	Heberitro (recombinant erythropoietin- $\alpha$ )	Anemia
	HeberNem ( <i>Corynebacterium paurometabolum</i> C924 strain)	Biological control of plant nematode infestation
	Acuabio I (invertebrate and fish nutritional supplement containing a defined combination of amino acids)	Prevention of white spot disease

<sup>a</sup>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

Company	Creation date	Number of workers	Extention (m <sup>2</sup> )	Commercial branch
CIGB	1986	1245	10000	Heber Biotec
CIM	1994	400	15000	CIMAB
Finlay Inst.	1991	920	23000	Vacunas Finlay
CENSA	1980	406	8000	
CNIC	1965	1193	35000	DALMER
CIREN	1989	309		-
CIE	1987	244	9000	Tecnosuma
CENPALAB	1982	414	74000	
BIOCEN	1992	800	166000	
CNC*	1990		-	Neuronic

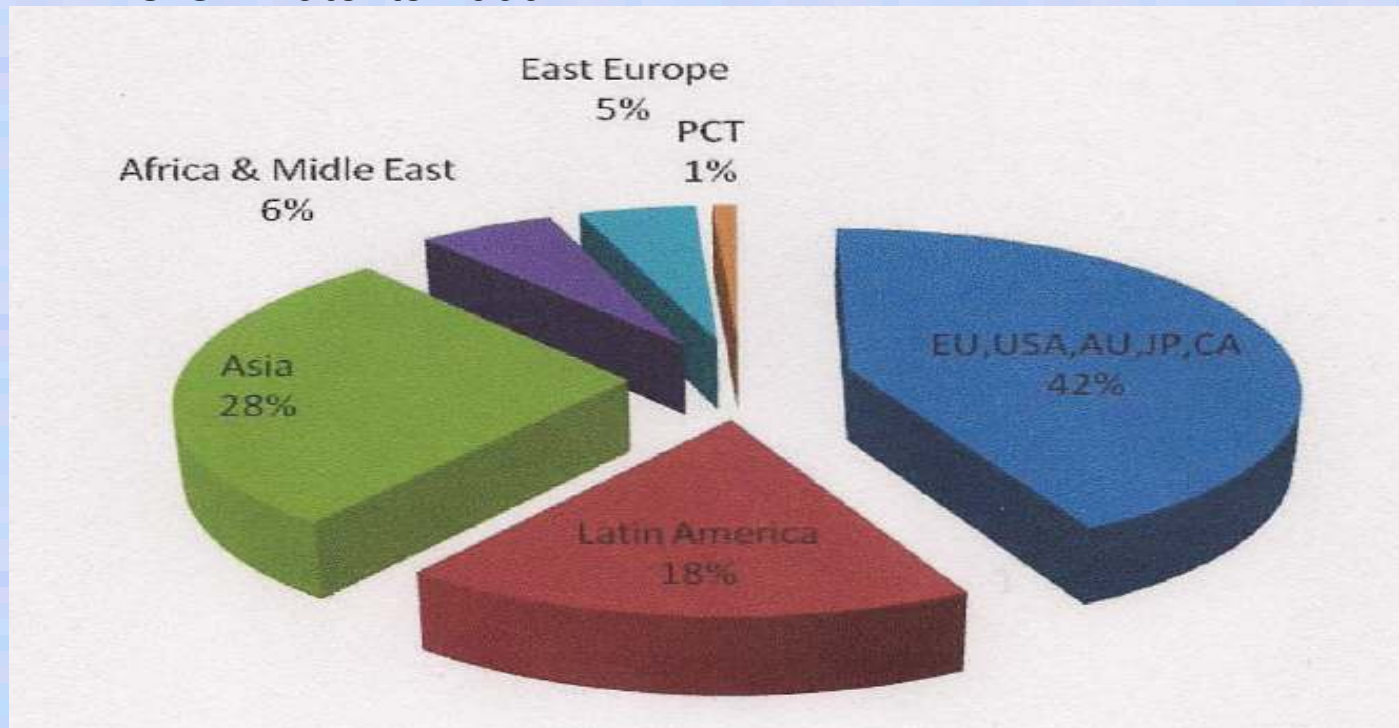
Source: CIGB-Heber Biotec, Business Project Portfolio 2010

# 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

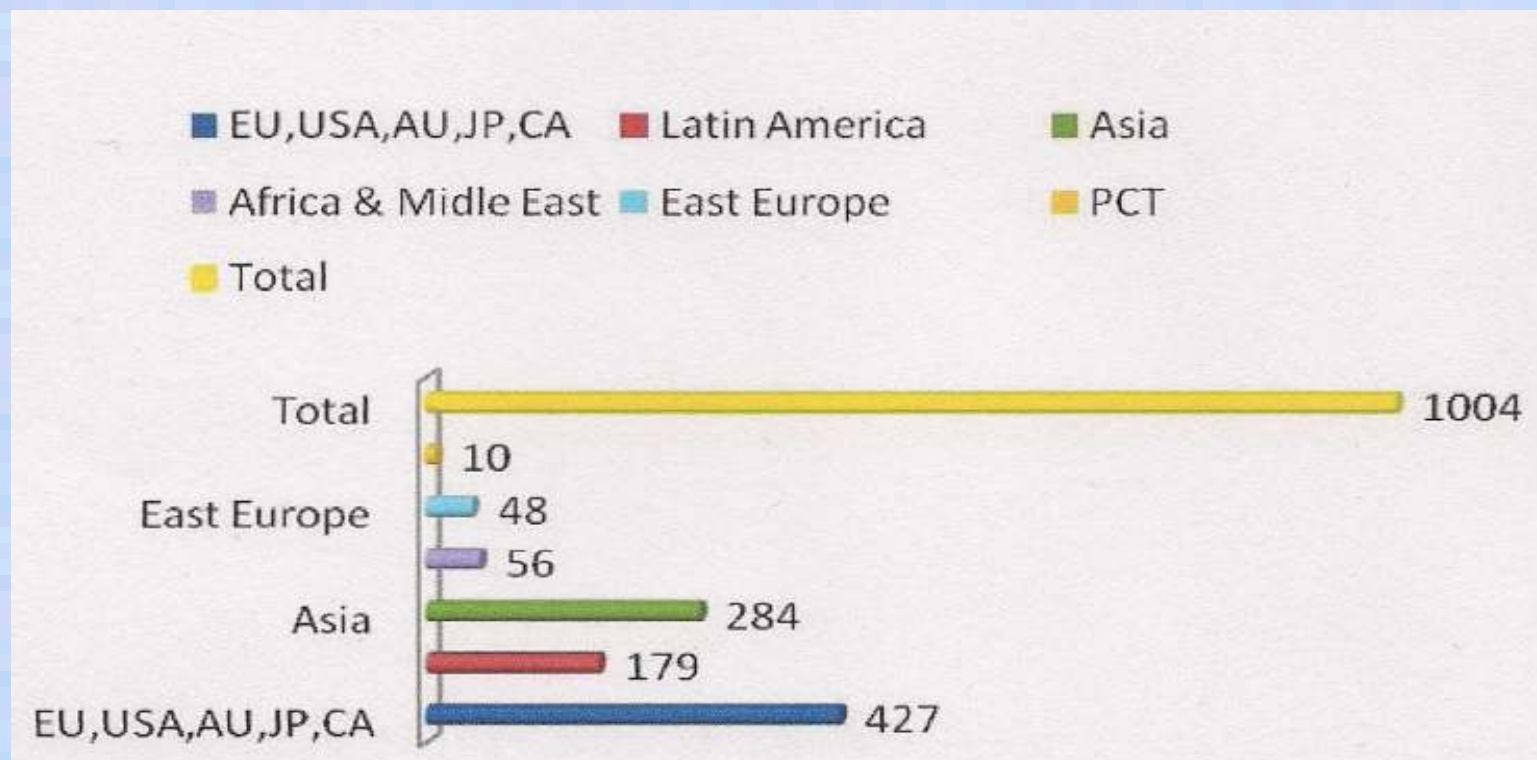
CIGB Patents 2009



Source: CIGB-Heber Biotech, Business Project Portfolio 2010

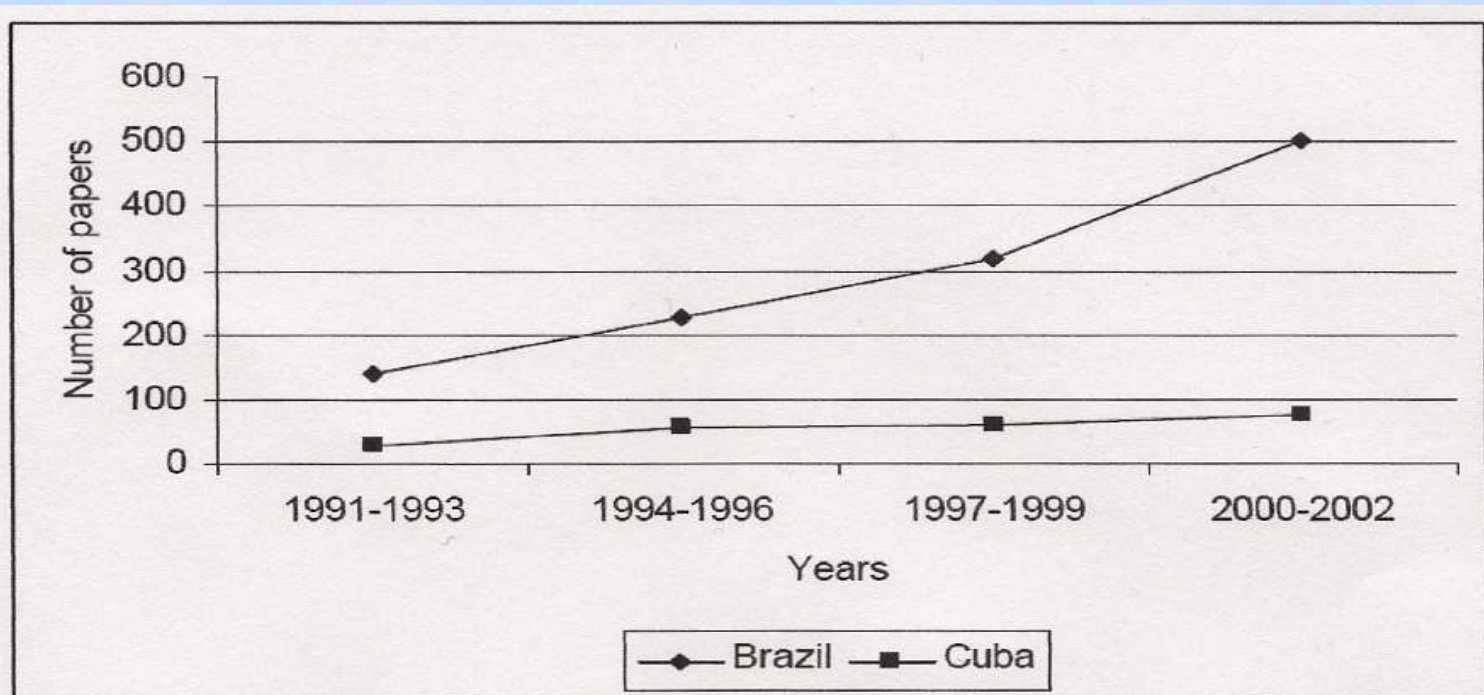
# Cuban-based health biotechnology

CIGB Patents 2009



Source: CIGB-Heber Biotech, Business Project Portfolio 2010

# Cuban-based health biotechnology



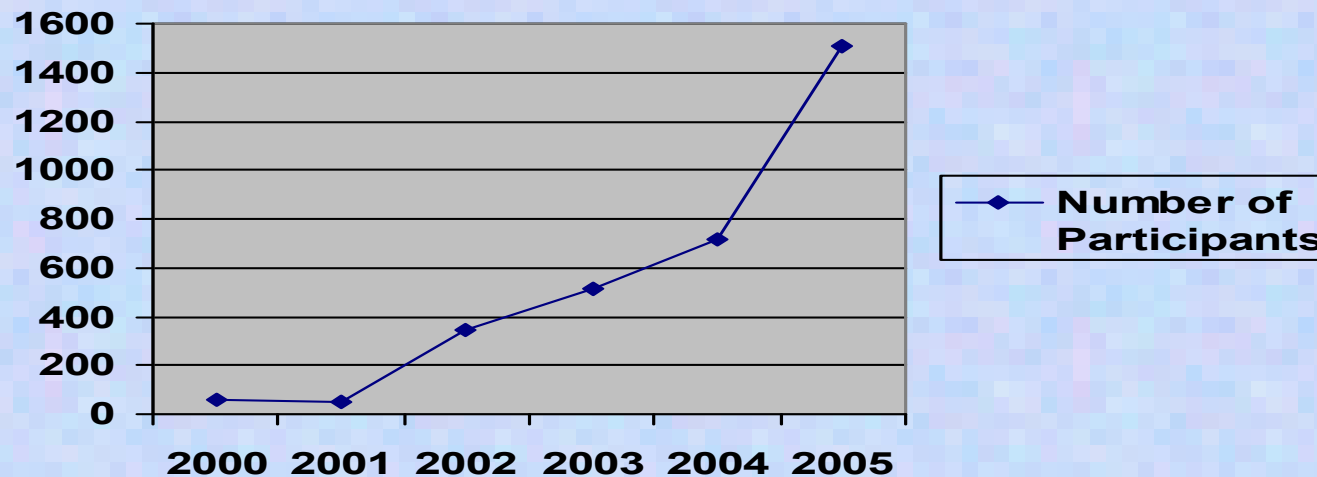
**Figure 2:** Number of papers in health biotechnology in Brazil and Cuba, 1991-2002  
Source: Science-Metrix (data from Science Citation Index Expanded, ©Thomson ISI)

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

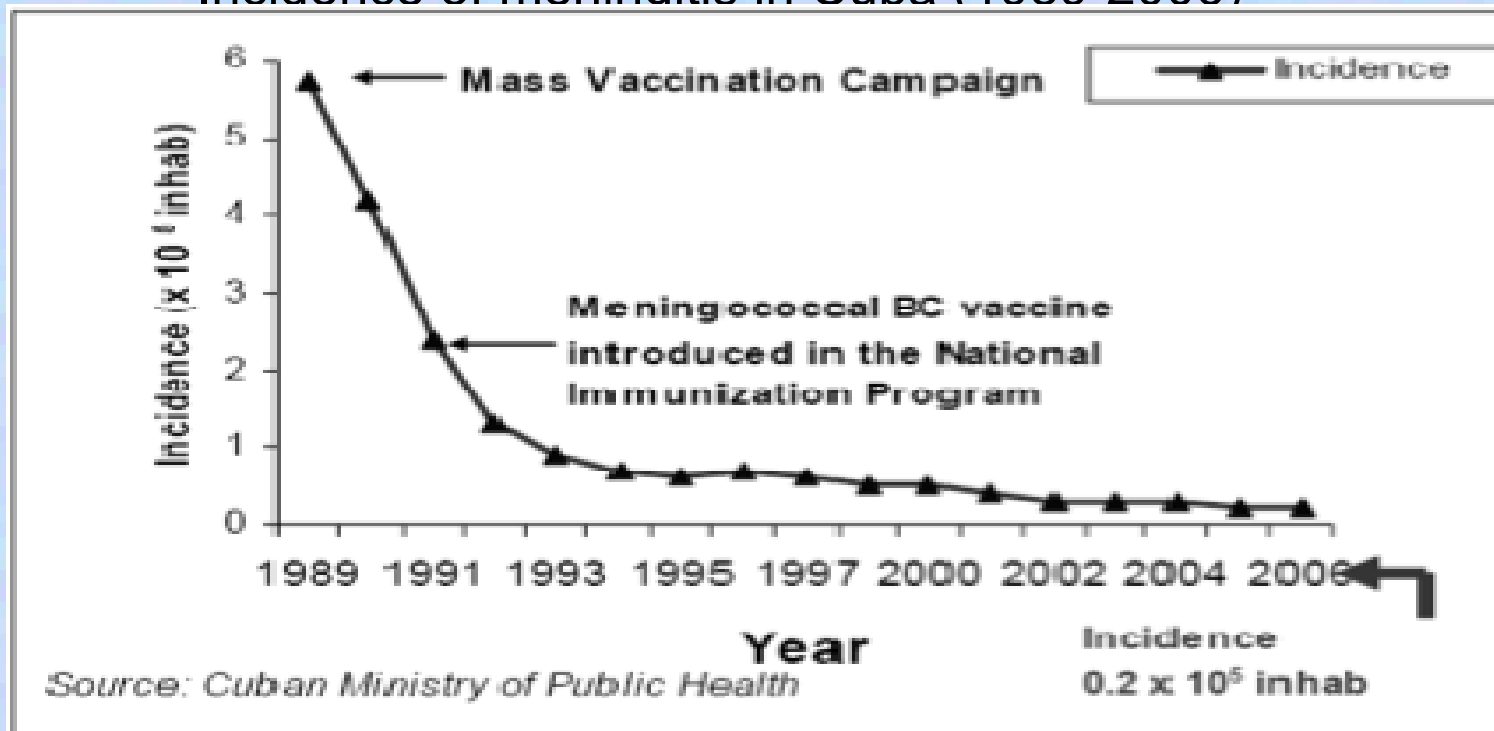


# Health indicators

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

# Health indicators

Incidence of meningitis in Cuba (1989-2006)



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

# Health indicators

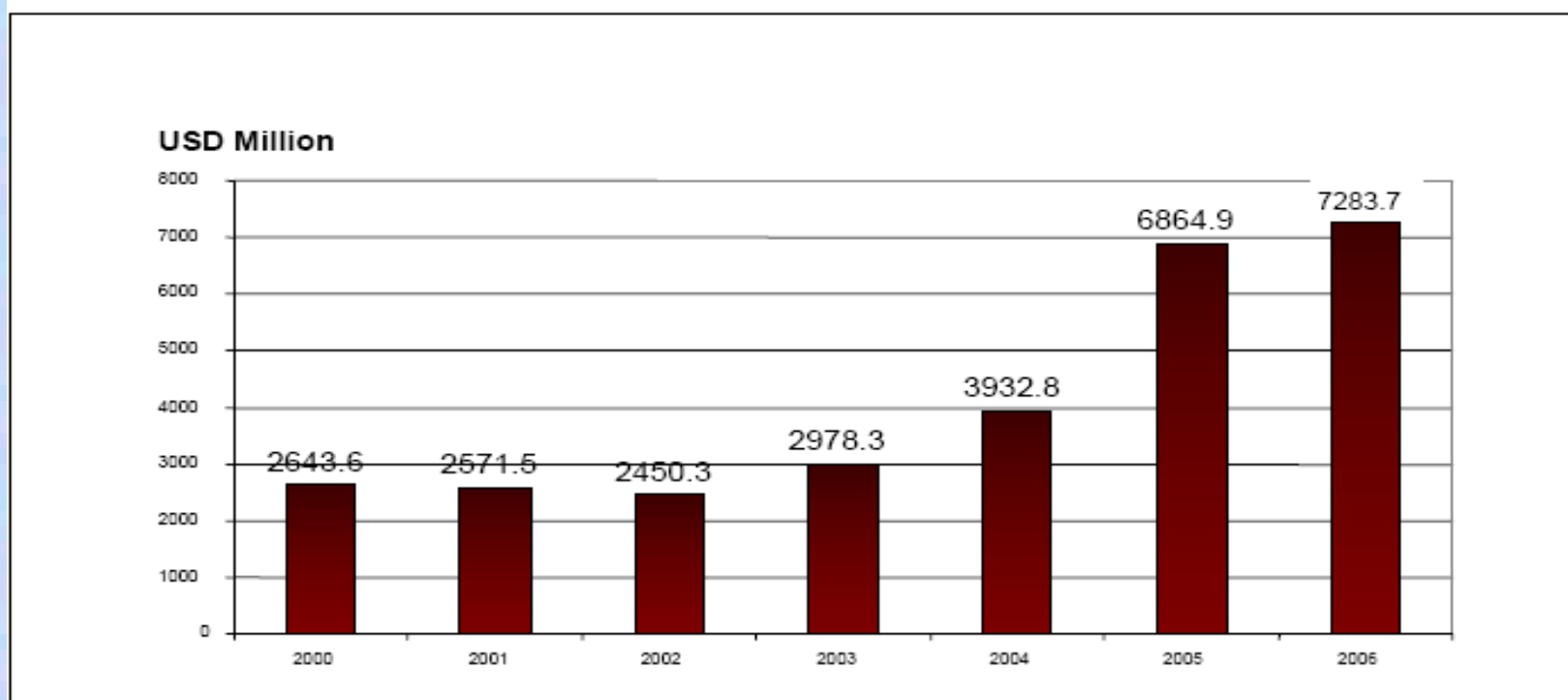
In 2001, Cuba reached the goals the United States has set for 2010

USA: Goals for 2010	Cuba: 2001 Results
Infants 2-18 months 99%	Infants 2-18 months 99%
15-24 years 75-90%	15-24 years 94.5%
Prenatal Transmission 75%	Prenatal transmission 95%
Reduction by 2000, 61,9%	Reduction by 2001, 96-99%

Source: MEDICC, Vol V No. 1, 2003, [http://www.medicc.org/publications/medicc\\_review/V/1/feature.html](http://www.medicc.org/publications/medicc_review/V/1/feature.html)

# Cuban Economy

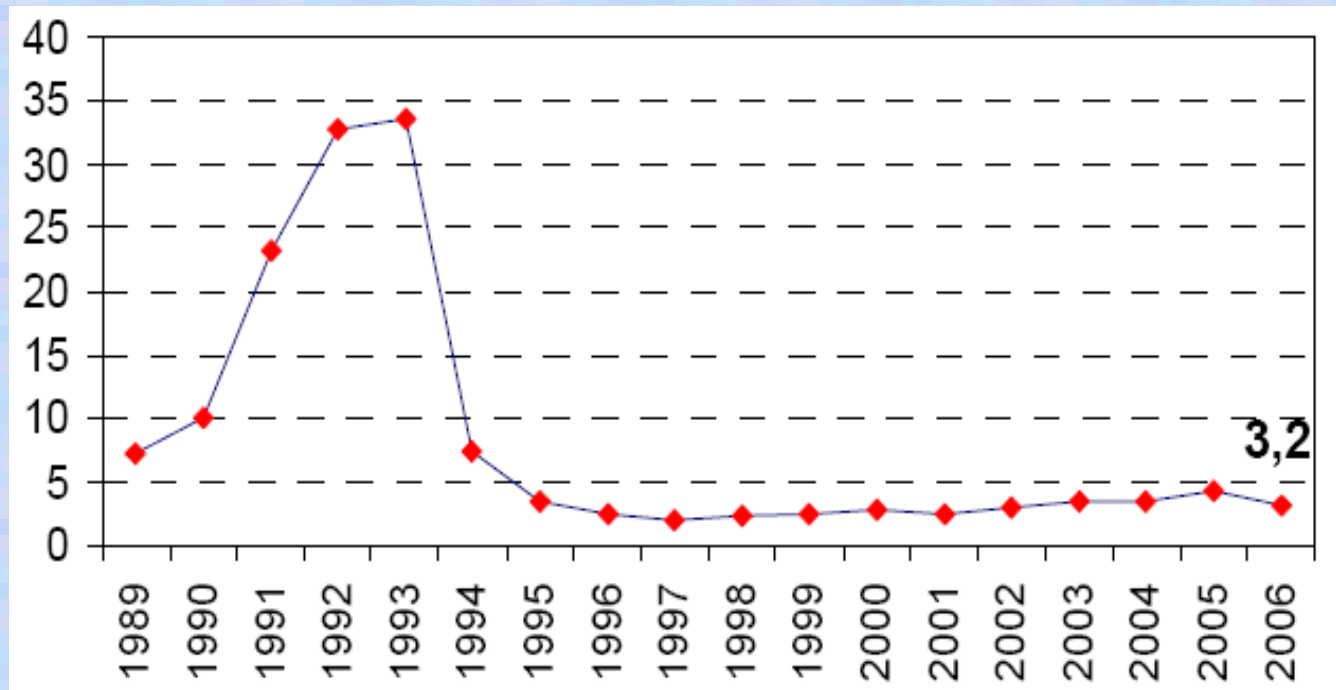
Export of services



Source: Molina 2009, Cuba: Economic Restructuring, Recent Trends and Major Challenges, The IDEA Working Paper Series 02/2009

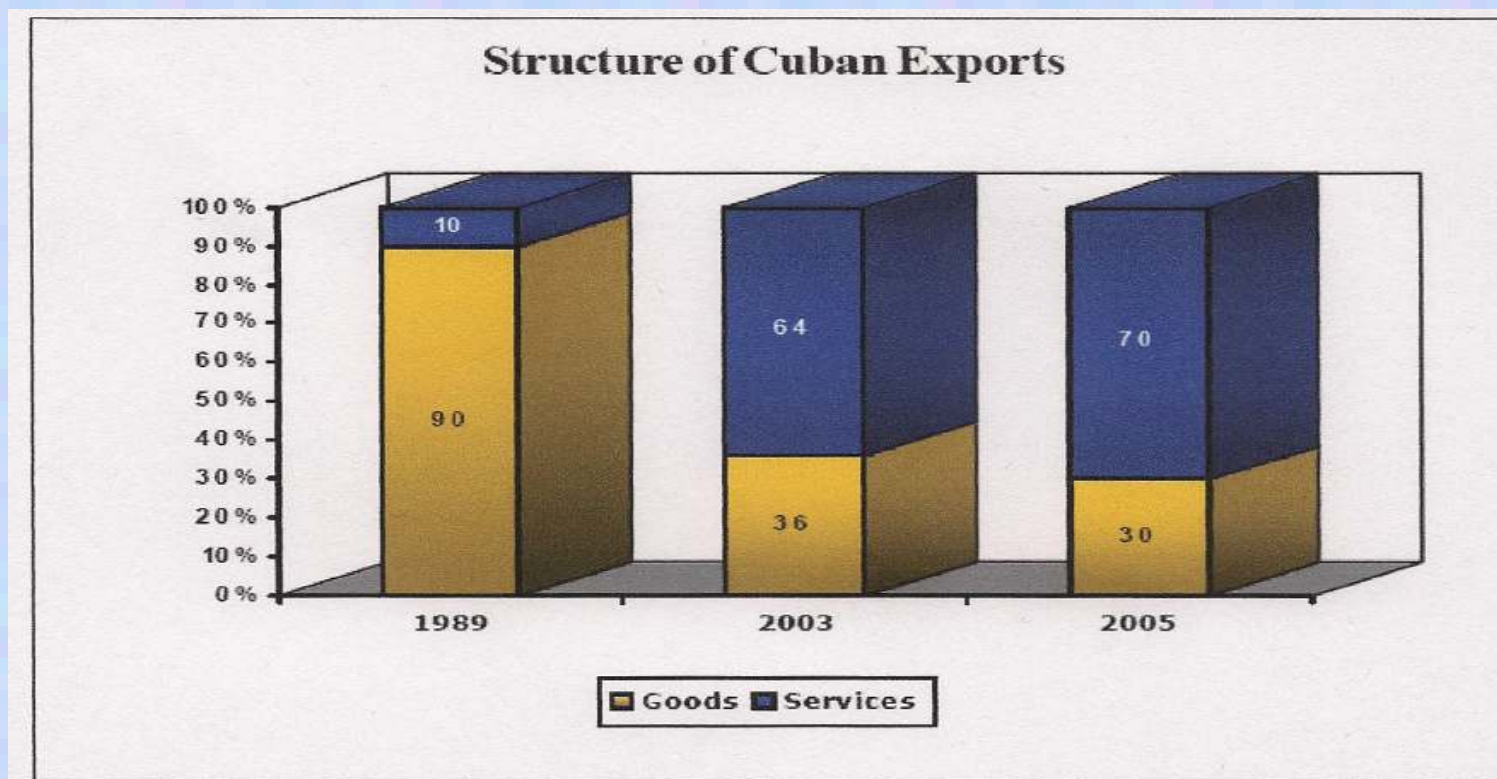
# Cuban Economy

Budget deficit/GDP



Source: Molina 2009, Cuba: Economic Restructuring, Recent Trends and Major Challenges, The IDEA Working Paper Series 02/2009

# Cuban Economy



Source: Molina 2009, Cuba: Economic Restructuring, Recent Trends and Major Challenges, The IDEA Working Paper Series 02/2009