Nanotechnology and the Developing World

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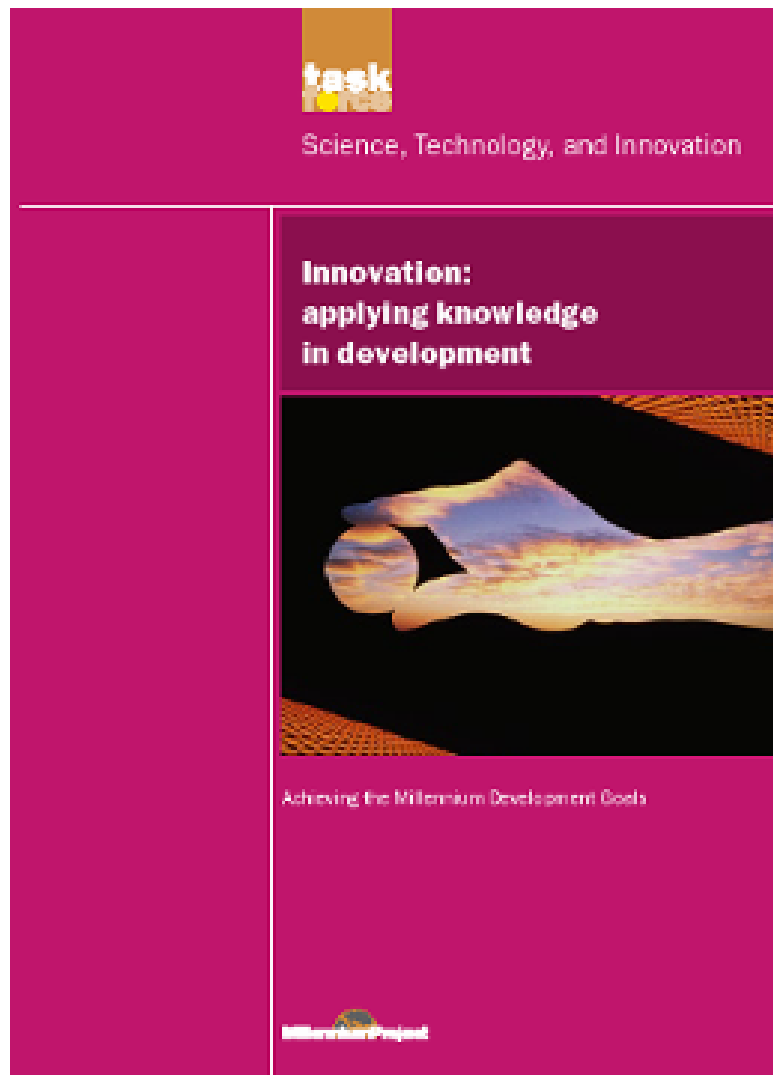University Health Network and
University of Toronto

Greatest ethical challenge of our time

Lifesaving Science
U of T bioethicists team up to tackle world health crisis
BY ALTHEA BLACKBURN-EVANS

SOUTH AFRICA
LIFE EXPECTANCY
40 YEARS

NORTH AMERICA
LIFE EXPECTANCY
80 YEARS

# United Nations Millennium Development Goals

- **Eradicate extreme poverty and hunger**
- **Achieve universal primary education**
- **Promote gender equality and empower women**
- **Reduce child mortality**
- **Improve maternal health**
- **Combat HIV / AIDS, malaria, and other diseases**
- **Ensure environmental sustainability**
- **Develop a global partnership for development**

task force

Science, Technology, and Innovation

Innovation: applying knowledge in development

Achieving the Millennium Development Goals

Millennium Project

The Millennium Development Goals cannot be achieved without a focused policy for science, technology and innovation

Which nanotechnologies are most likely to benefit people in developing countries?
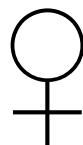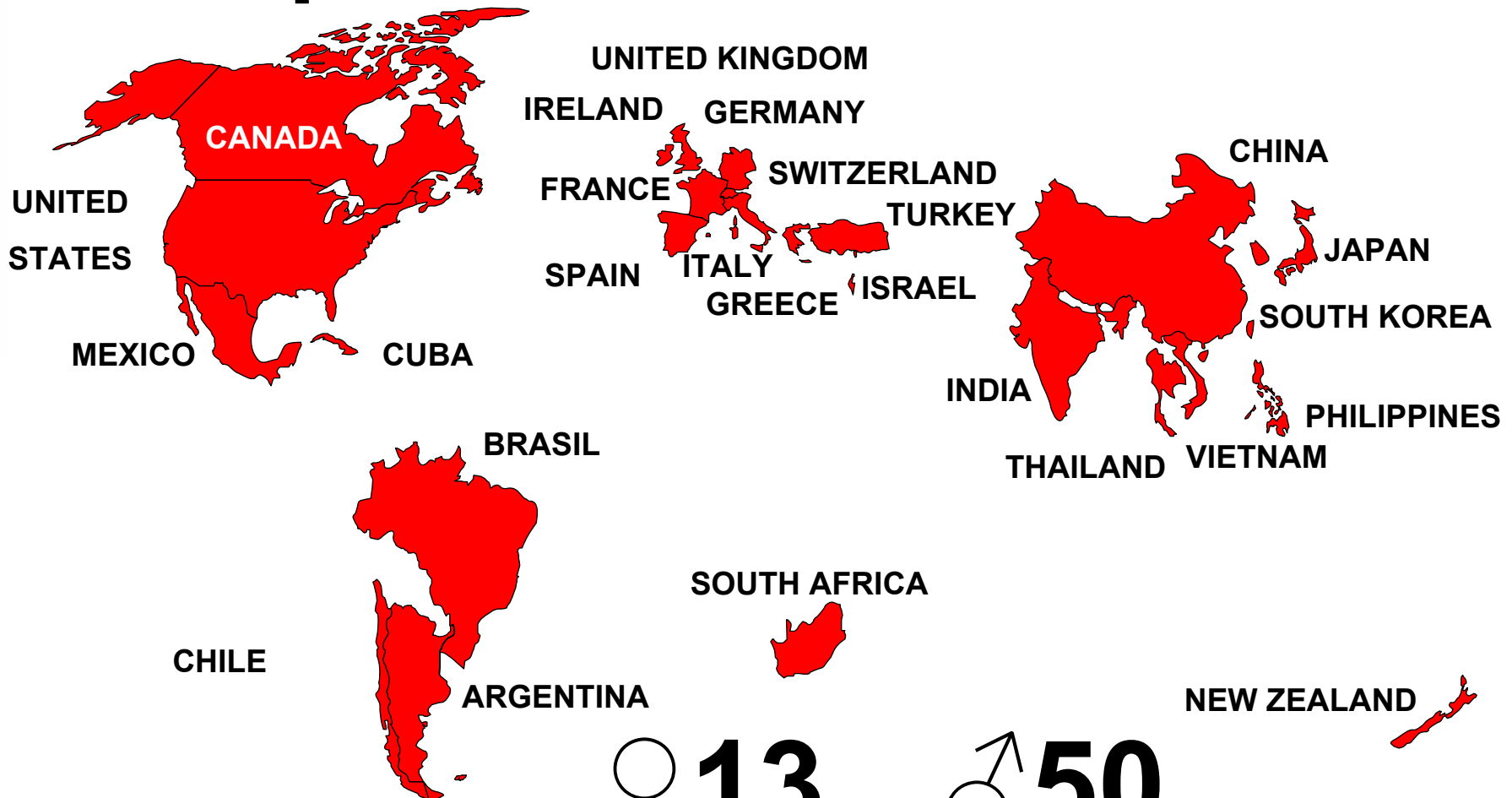
Top 10 nanotechnologies for the developing world

PLoS Med 2006; 2(5): e97

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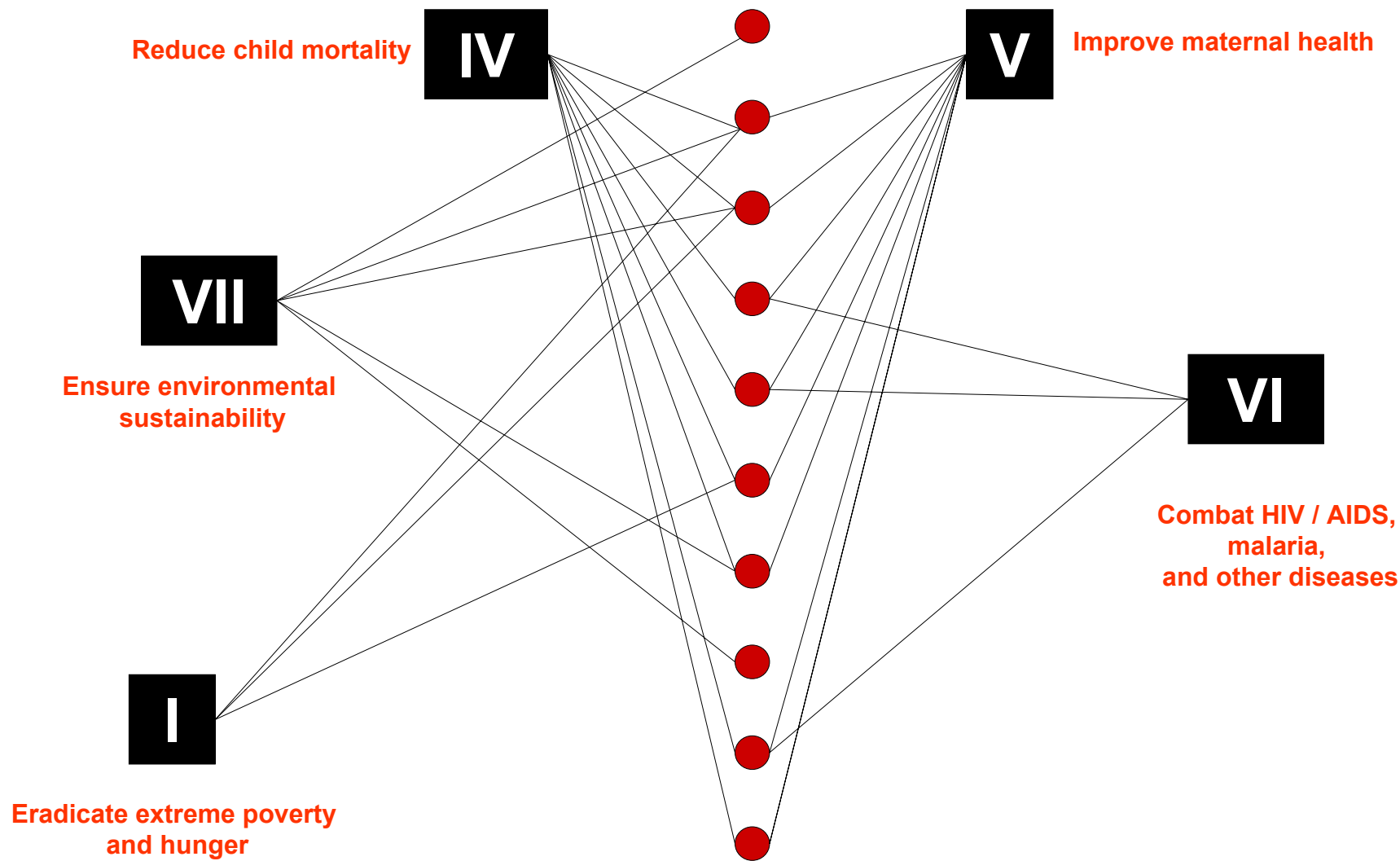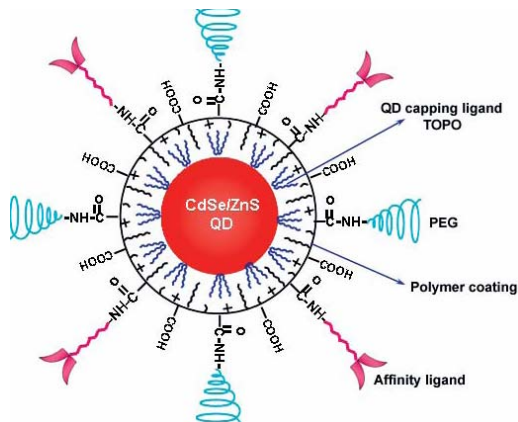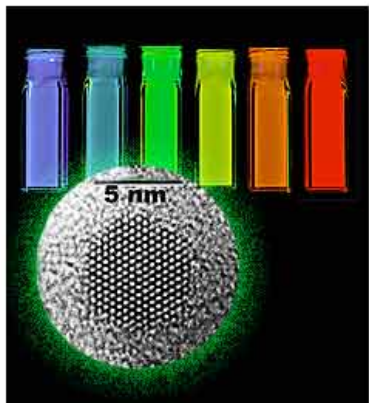
1. **Energy storage, production and conversion**
2. **Agricultural productivity enhancement**
3. **Water treatment and remediation**
4. **Disease diagnosis and screening**
5. **Drug delivery systems**
6. **Food processing and storage**
7. **Air pollution remediation**
8. **Construction**
9. **Health monitoring**
10. **Vector and pest detection and control**

Top 10 nanotechnologies vs. Millennium Development Goals

Reduce child mortality IV

V **Improve maternal health**

VII

Ensure environmental sustainability

VI

Combat HIV / AIDS, malaria, and other diseases

I

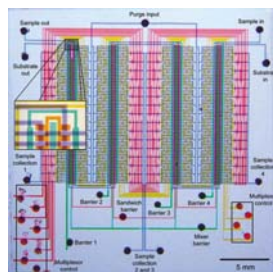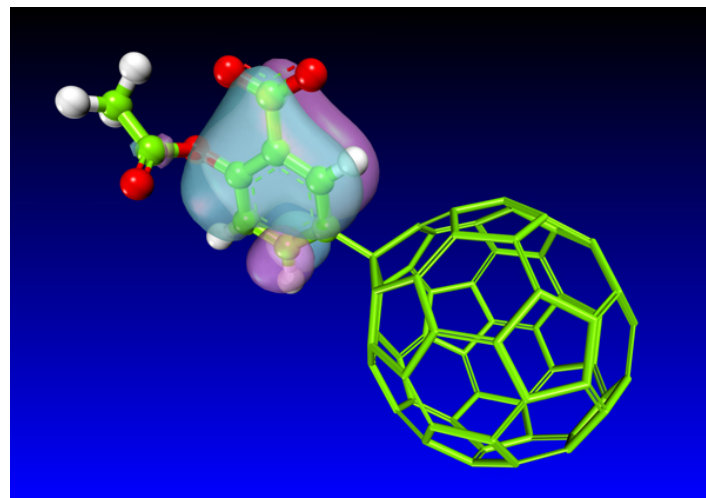**Eradicate extreme poverty and hunger**
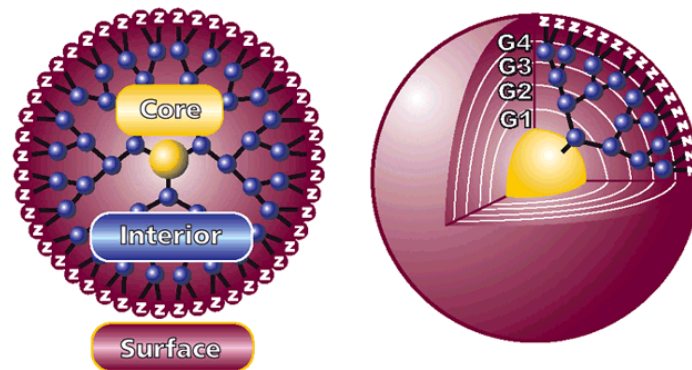
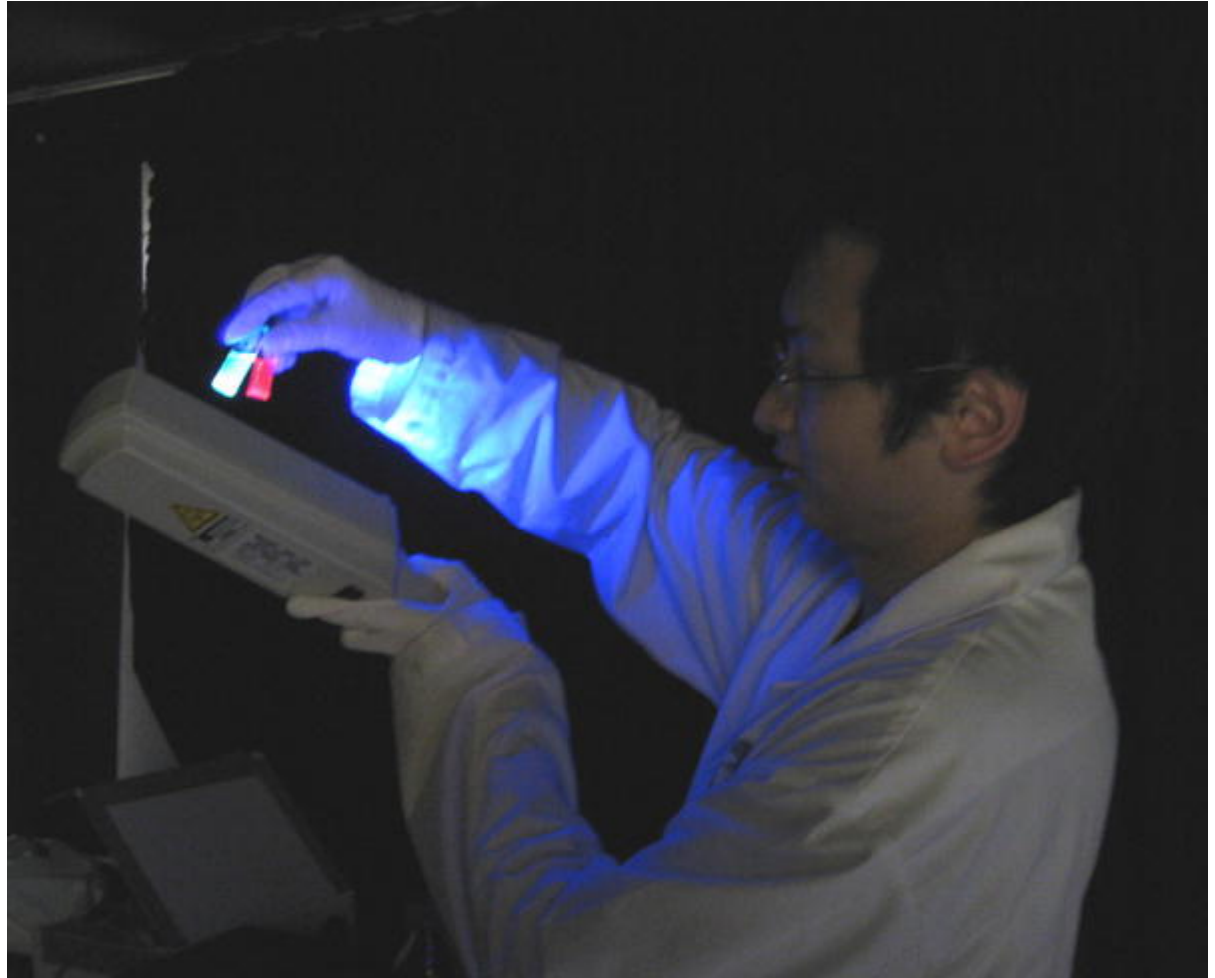**Quantum dots**

Dendrimers
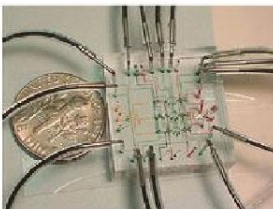
Lab on a chip

Buckyballs

Quantum dots for malaria

Decreasing infrastructure requirement of malaria diagnostic tests saves most lives

Test	Sensitivity (%)[*]	Specificity (%)[*]	Adjusted lives saved SD[†]	Malaria-related deaths averted SD[‡]	Unnecessary treatments averted SD[§]	Total possible adjusted lives saved (%)[ǁ]
Moderate infrastructure[¶]						
1	95	95	635,993 (177,657)	15,396 (16,680)	141,845,100 (13,780,159)	23
2	100	100	720,178 (164,731)	61,453 (19,528)	153,500,465 (9,157,093)	26
Minimal infrastructure[¶]						
3	80	80	1,125,343 (398,332)	−260,221 (71,761)	302,893,523 (23,761,961)	40
4	90	80	1,329,135 (454,830)	−14,694 (38,983)	302,893,523 (26,929,491)	48
5	90	90	1,574,136 (199,153)	−14,694 (44,426)	365,028,106 (30,421,389)	57
6	90	95	1,696,636 (267,343)	−14,694 (39,784)	396,095,397 (30,041,704)	61
7	95	80	1,431,031 (402,001)	108,070 (61,464)	302,893,523 (32,129,807)	51
8	95	90	1,676,032 (480,430)	108,070 (48,312)	365,028,106 (31,842,147)	60
9[#]	95	95	1,798,532 (557,684)	108,070 (54,660)	396,095,397 (19,853,132)	65
10	98	95	1,859,670 (393,620)	181,728 (45,921)	396,095,397 (39,734,068)	67
11	100	100	2,022,928 (288,721)	230,833 (53,055)	427,162,689 (29,167,835)	73
No infrastructure[¶]						
12	80	80	1,599,205 (429,882)	−6,596 (70,174)	364,781,060 (26,578,084)	57
13	90	80	1,868,415 (343,583)	317,746 (83,601)	364,781,060 (17,713,071)	67
14	90	90	2,192,062 (521,002)	317,746 (96,233)	446,861,090 (35,354,040)	79
15	90	95	2,353,885 (333,462)	317,746 (67,914)	487,901,105 (29,070,712)	85
16	95	80	2,003,021 (493,457)	479,917 (100,575)	364,781,060 (15,211,801)	72
17	95	90	2,326,667 (421,037)	479,917 (106,694)	446,861,090 (30,136,053)	84
18	95	95	2,488,490 (627,778)	479,917 (97,482)	487,901,105 (36,711,469)	89
19	98	95	2,569,253 (584,295)	577,220 (58,806)	487,901,105 (41,085,524)	92
20	100	100	2,784,919 (432,004)	642,088 (96,921)	528,941,121 (18,279,201)	100

Rafael ME et al. Nature 2006; 444, 39-48

Domestic innovation needed in developing world

Healthcare Biotechnology Innovation
in Developing Countries
nature biotechnology
nature publishing group

- ✓ **Strong and sustained political will**

- ✓ **Individual leadership**

- ✓ **Close linkages, active knowledge flow**

- ✓ **Focused efforts in niche areas**

- ✓ **Temporarily permissive IP environment for initial capacity building**

- ✓ **Private sector development**

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Examples of nanotechnology innovation in the developing world

- Nanodiagnostic systems for HIV, H-B, syphilis, pregnancy (Nano Biotech Ltd.)
- Nano drug delivery systems for cancer and for local delivery to eye and skin (CISR, U. Delhi, Dabur Research Foundation, Panacea Biotec)

Nano bone (Tsinghua University)

MEXICO

- Nanomagnets as drug transporters
- Carbon nanotubes for implants, prostheses, and biosensors

Polymer nanocomposites for controlled drug release, nanoscaffolds, and dental materials

SOUTH KOREA
CHINA
INDIA
THAILAND
PHILIPPINES
BRASIL
SOUTH AFRICA
CHILE
ARGENTINA

- Front runners
- Middle ground
- Up-and-comers

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MOLECULAR SOLUTIONS TO GLOBAL INFECTIONS

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Court E. *et al*. *Nanotechnology* 15, 3 (2004)