“BLUE MARBLE HEALTH”

Peter Hotez, MD PhD
“The Bottom Billion”

- 1.29 billion today live less than $1.25 per day (22%)
- Just over 40% live on less than $2 per day

“The Colors of Poverty”
www.ejordanphotography.com
The Neglected Tropical Diseases

The 17 “NTDs” Most common infections of the “bottom billion”

- Ascariasis 800 million
- Hookworm 700 million
- Trichuriasis 600 million
- Schistosomiasis 400 million
- Lymphatic Filariasis 100 million
- Food-borne Trematodes 50 million
- Dengue 50 million
- Onchocerciasis 20 million
- Trachoma 20 million
- Leishmaniasis 10 million
- Chagas disease 10 million
- Buruli ulcer < 1 million
- Leprosy < 1 million
- African Sleeping Sickness < 1 million
- Rabies < 1 million

“The Biblical Diseases”
The NTDs: The World’s Disablers

NTDs & Poverty

The 17 NTDs
Chronic & Disabling Conditions

- Reduce productive capacity
- Impair intellectual & physical development in children
- Cause adverse pregnancy outcomes

The Most Widespread NTDs:
Ascariasis, Trichuriasis, Hookworm

Village of Paquila, Guatemala

Age Class (years)

Prevalence (%)

Ascaris  Trichuris  Hookworm  Strongyloides
NTDs and Child Development

Hookworm and Ascariasis

- Hookworm leads to 40% reduction in future wage earnings

Child growth, Intellectual Cognitive development

Mental Retardation in Varying Intensity Groups of Hookworm Infestation

- Child growth, Intellectual Cognitive development

Property of the Global Network
Female Genital Schistosomiasis, Girls, & HIV/AIDS

Zimbabwe
OR = 3 increase in HIV/AIDS
Kjetland et al. AIDS 2006

Tanzania
OR = 4 increase in HIV/AIDS
Downs et al. AJTMH 2011

100 million girls & women
Africa’s most common gynecologic condition?

Urogenital Schistosomiasis
King C, 2001

HIV Prevalence in Adults Aged 15-49
UNAIDS, 2010
The Beginning of NTD Control

Hawking and Mao: The Pioneers of “Preventive Chemotherapy” (MDA)

Hotez PJ. Forgotten People, Forgotten Diseases  ASM Press,
“Franchising Preventive Chemotherapy”

Lymphatic filariasis - Zanzibar

Trachoma - Morocco

Lymphatic filariasis – South Pacific

Schistosomiasis - Egypt
The Bottom Billion Suffers from Multiple NTDs!

Ascariasis, Trichuriasis, Hookworm, Schistosomiasis, LF, Onchocerciasis, Trachoma, Food-borne Trematodes
The Rapid Impact Package

US $0.50 all inclusive

DRUGS

+ Delivery
+ Equipment
+ Health education materials
+ Training of personnel
+ Monitoring and Evaluation

US $0.50 per person per year
NTD Scale up with the U.S. Government
Today, only 36% of the world’s bottom billion who require Preventive Chemotherapy actually receive it.

Total reliance of the public support from the governments of the US and UK.

We’re relying completely on US and UK and some private support to eliminate LF, Onchocerciasis, Trachoma, Leprosy.
OUR MISSION
JUST OVER
IN A MINUTE
END
The Technical Gaps

Global Helminth Atlas: www.thiswormyworld.org
Swiss Tropical and Public Health Institute
Most of the NTDs Occur among the Poor in Wealthy (G20) Countries!!

- NTDs in the G20 (+ Nigeria)
  - 77% Leprosy
  - 71% Food-borne trematodiases
  - 67% Leishmaniasis
  - 61% Chagas disease
  - 60% Lymphatic filariasis
  - 43% Hookworm
  - 17% Schistosomiasis

58% of the “bottom billion” in G20 countries

G20 countries provide 75% of the global economy
Most of the NTDs Occur among the Poor in Wealthy (G20) Countries!!
Poverty in China

Widespread Hookworm and other NTDs in SW China

http://www.plosntd.org/article/info:doi/10.1371/journal.pntd.0001599
Poverty in the United States

46 million Americans living poverty

20 million in extreme poverty

4-5 million on less <$2 per day

http://www.plosntd.org/article/info:doi/10.1371/journal.pntd.0001599
5 million Americans with NTDs
Toxocariasis 2.8 million
Chagas disease 1 million
Trichomoniasis 0.8 million
Cysticercosis 0.2 million
Dengue 0.1 million
“Blue Marble Health”

- No longer developed vs. developing
- Unexpected NTD Disease Burden from the G20 Nations
- G20 share a level of economic wealth that make it possible to treat all of the bottom billion people who need MDA
- Eliminate Lymphatic Filariasis, Onchocerciasis, Trachoma, Leprosy, and Food-borne trematodes
• Extraordinary opportunity for science diplomacy
• For most of the remaining NTDs we need new control tools
  • Drugs
  • Diagnostic
  • Vaccines
• Incredible scientific horsepower among the G20: India, China, Saudi Arabia, South Africa, Indonesia, in addition to the U.S. and Europe
Origins of Vaccine Diplomacy

[Image of an old photograph of a scientist with a microscope]

[Image of a Western Union telegram]

[Image of a child receiving a vaccination]

[Image of various medical and political artifacts]
Modern Day Vaccine Diplomacy

Organization of the Islamic Conference

Approximately one-third of NTDs in OIC countries
Pakistan, Iran, Indonesia, Gulf Oil States

“Conflict And Contagion”
The Decade of Vaccines and the GAVI Alliance

Accelerate uptake of new vaccines

Shape & increase predictability of vaccine markets
Increasing Number of GAVI Vaccine Suppliers based in Emerging Markets

Source: UNICEF Supply Division, 2011
PDPs Work across Different Diseases and Modalities

Aeras: Aeras Global TB Vaccine Foundation
DNDi: Drugs for Neglected Diseases Initiative
FIND: Foundation for Innovative New Diagnostics
GATB: Global Alliance for TB Drug Development
Sabin/HHVI: Human Hookworm Vaccine Initiative
IAVI: International AIDS Vaccine Initiative
IDRI: Infectious Disease Research Institute
IOWH: Institute for One World Health
IPM: International Partnership for Microbicides
IVCC: Innovative Vector Control Consortium
IVI: International Vaccine Institute
MMV: Medicine for Malaria Venture
MVI: Malaria Vaccine Initiative (PATH)
MVP: Meningitis Vaccine Program (PATH)
PDVI: Pediatric Dengue Vaccine Initiative
PATH VAC: PATH’s Vaccine Development Program

1. PVS includes Rota Vaccine Program (RVP), Pneumo Vaccine Project (PVP), Enteric Vaccine Initiative (EVI), Influenza Vaccine Development Program (IVDP)
2. Includes HAT, visceral leishmaniasis, chagas, hookworm, and dengue
3. Includes cholera, typhoid, and rotavirus

“A scientist who is also a human being cannot rest while knowledge which might reduce suffering rests on the shelf.”

–Dr. Albert B. Sabin
Sabin Portfolio of Vaccines

- **Human Hookworm Vaccine**
  - Bivalent recom protein vaccine
  - Na-GST-1 + Na-APR-1
  - Alhydrogel formulation + synthetic lipid A
  - IND filing FDA – Phase 1 testing Brazil (FIOCRUZ Biomanguinhos)

- **Human Schistosomiasis Vaccine**
  - Monovalent recombinant protein vaccine
  - Sm-TSP-2
  - Alhydrogel formulation + synthetic lipid A
  - cGMP pilot manufacture Brazil (Instituto Butantan)

- **Chagas disease and Leishmaniasis Vaccines**
  - Bivalent recombinant protein vaccines
  - Alhydrogel formulation + synthetic lipid A
  - cGMP pilot manufacture Mexico (Birmex)

- **SARS vaccines**
Product Development Methodology

- R&D: Selection and ranking of candidate antigens
- Molecular Biology
- Process Development and Scale-up
- Formulation and Adjuvant Development
- Technology Transfer

Quality Control
Goals of Anti-Hookworm Vaccine

- **Human Hookworm Vaccine**
  - Reduction of 80% of moderate/heavy hookworm infections
  - Worm burden reduction
  - Egg reduction
  - Reduced intestinal blood loss
  - Reduction in anemia and malnutrition
Anti-Enzyme Antibodies: Targeting Hookworm Blood Loss
Vaccines Can Improve Preventive Chemotherapy

Albendazole MDA Alone

Albendazole MDA + Vaccinations

B Lee & K. Bacon Univ Pitt
Completed Genome Projects & Vaccines

Buruli Ulcer
Chagas Disease
Afr. Trypanosomiasis
Leishmaniasis
Leprosy
Leptospirosis
Lymphatic Filariasis
Schistosomiasis
Trachoma

The Schistosome Tetraspanins

Sabin-Brazil Technology Transfer
Completed Genome Projects & Vaccines

Buruli Ulcer
Chagas Disease
Afr. Trypanosomiasis
Leishmaniasis
Leprosy
Leptospirosis
Lymphatic Filariasis
Schistosomiasis
Trachoma
Chagas disease: an Emerging Maternal Health Threat

- Chagasic cardiomyopathy develops in 20-30% of seroconverted patients
- 10% of pregnancies in Latin America?
- 300,000 seropositive pregnant women
- 40,000 in North America alone
- Maternal-to-child transmission
- 5-10%
Nanoparticle for Chagas Disease Vaccine
Vaccine Diplomacy in the Middle East & Pakistan

• Highest concentration of NTDs in the World’s Hotspots
  • 1/3 of NTDs in OIC countries (“the Islamic countries)
  • Up to 25% of NTDs in nuclear countries including Iran, Pakistan
  • 65 million people in poverty in the Middle East
  • Urgency for vaccines against leishmaniasis, dengue, Rift Valley fever, brucellosis,
Eliminating the World’s 17 NTDs

- Urgent needs to scale up MDA
- Parallel development of a new generation of NTD control tools
  - Drugs
  - Diagnostics
  - Insecticides
  - Vaccines
<table>
<thead>
<tr>
<th>Country</th>
<th>2011 GDP(^1)</th>
<th>2011 GDP Rank</th>
<th>Percentage of Global GDP</th>
<th>Support for NTD R&amp;D(^2)</th>
<th>Percentage of Global Public R&amp;D</th>
<th>Rank in % of Global Public Neglected Disease R&amp;D Support</th>
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</thead>
<tbody>
<tr>
<td>United States</td>
<td>$15.0 trillion</td>
<td>1</td>
<td>21%</td>
<td>$1.35 billion</td>
<td>69.2%</td>
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<td>China</td>
<td>$7.2 trillion</td>
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<td>Japan</td>
<td>$5.9 trillion</td>
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<td>Germany</td>
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<td>4%</td>
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<tr>
<td>Brazil</td>
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<td>3%</td>
<td>$11 million</td>
<td>0.6%</td>
<td>10</td>
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<tr>
<td>Italy</td>
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<td>8</td>
<td>3%</td>
<td>&lt;$10 million</td>
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<tr>
<td>India</td>
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<td>3%</td>
<td>$34 million</td>
<td>1.7%</td>
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<tr>
<td>Canada</td>
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<td>2%</td>
<td>$10 million</td>
<td>0.5%</td>
<td>9</td>
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<tr>
<td>Russia</td>
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<td>&lt;$10 million</td>
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<tr>
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<tr>
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<td>$31 million</td>
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<td>South Korea</td>
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<td>15</td>
<td>1%</td>
<td>&lt;$10 million</td>
<td>&lt;0.5%</td>
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<tr>
<td>Netherlands</td>
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<td>1%</td>
<td>$24 million</td>
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<td>Indonesia</td>
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<td>17</td>
<td>1%</td>
<td>&lt;$10 million</td>
<td>&lt;0.5%</td>
<td>Not ranked</td>
</tr>
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Where's Brazil, China, Indonesia, Mexico, Saudi Arabia, South Africa?
• Diplomatic pressure on the G20 nations to control NTDs and invest in NTD R&D

• Redirecting U.S. global health ODA to NTDs and R&D

• The Global Health Observatory

• Regionalization of national regulatory authorities

• Reform of IP
NIH Appropriation vs. Appropriation in 1998 Dollars
A Plea for Science Advocacy

- 72% of Americans cannot name a living scientist
  - 15% Stephen Hawking
  - 01% James Watson
  - 01% Bill Nye the Science Guy
- 59% of Americans cannot name an institution where medical research is conducted
  - 10% Mayo Clinic
  - 09% NIH
  - 06% Johns Hopkins
- Only 9% of Americans identified the NIH as the major funder for biomedical research in America: 15% named FDA
Thank You!

- Donors and Grant Support
  - Bill & Melinda Gates Foundation
  - Dutch Ministry of Foreign Affairs
  - Southwest Electric Energy Medical Research Institute
  - Carlos Slim Institute of Health
  - Texas Children’s Hospital
  - Mort Hyman
  - Blavatnik Charitable Foundation
  - Mr. & Mrs. Howard Harpster