The Globalization of the Biological Threat

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www.BEPstate.net

www.biosecurity.sandia.gov

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Evolution of the Biological Threat

- The biological threat has evolved in concert with
  - Increasing emergence and reemergence of highly infectious disease
  - Advance of biotechnology globally
  - Rise of transnational, asymmetric terrorism

- The recent "globalization" of the biological threat has broadened the availability of materials, technologies, and expertise needed to maliciously disseminate infectious disease

Mt. Merapi, Yogyakarta, Indonesia

Infectious Disease

- Global outbreaks of emerging and reemerging infectious disease present a growing threat to international security
- Most dangerous infectious diseases are often tropical diseases that emerge in developing countries
- Infectious diseases now spread across borders as never before
- Natural outbreaks represent unpredictable sources of dangerous pathogens for terrorists

SARS virus

FMD outbreak UK

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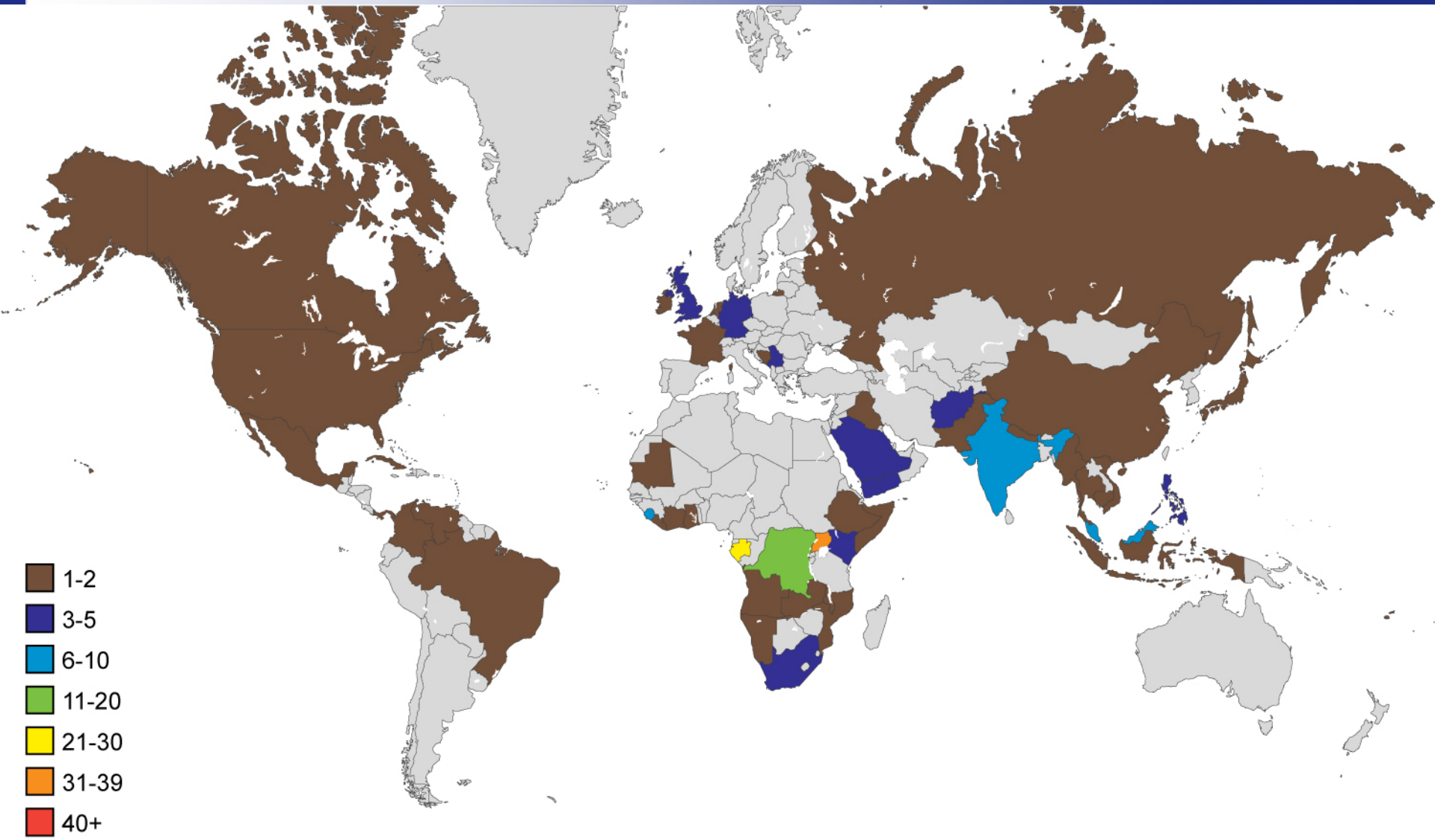
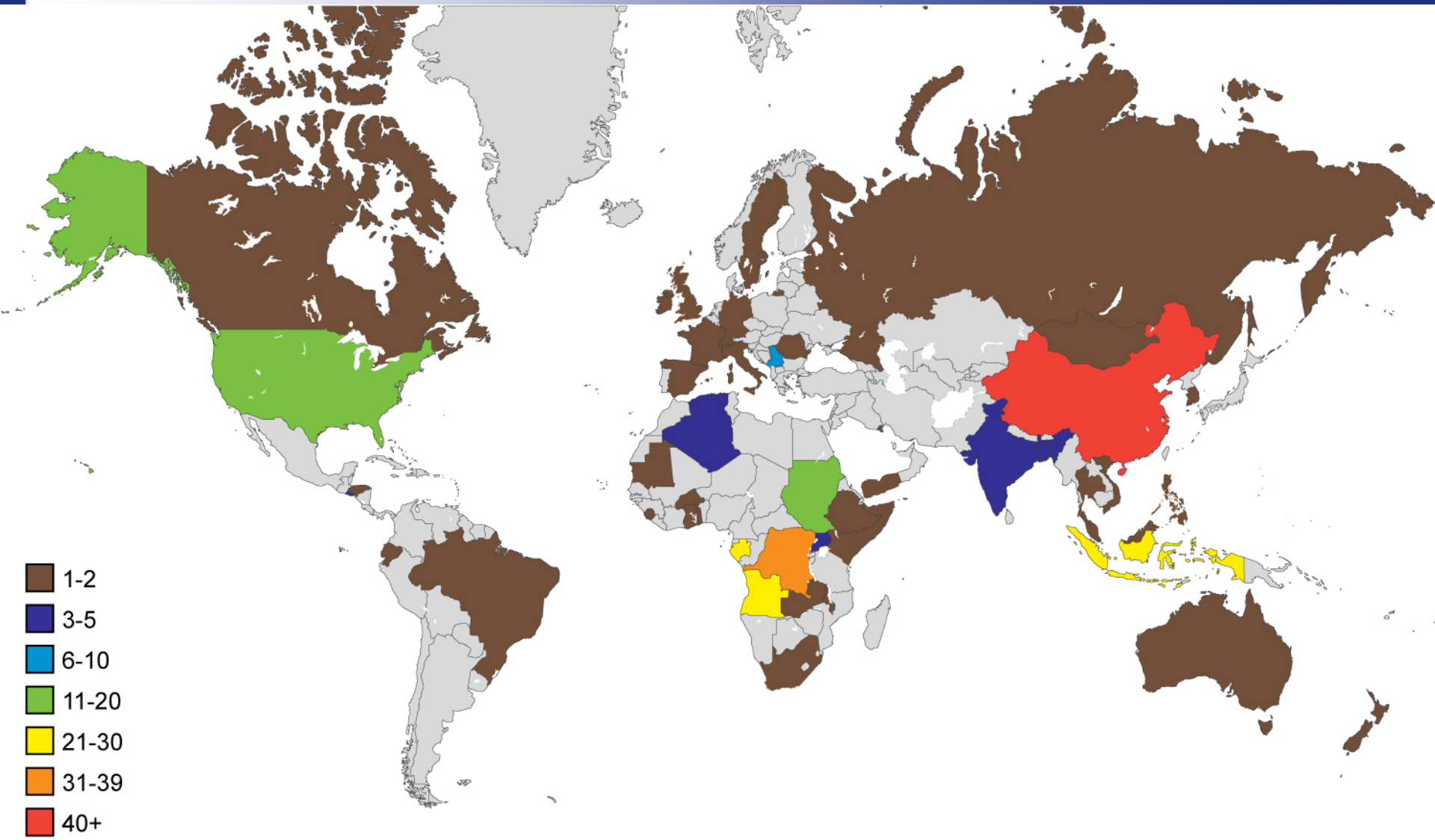
WHO Outbreak Reports for Emerging Infectious Diseases 1996-2000



WHO Outbreak Reports for Emerging Infectious Diseases 2001-2005



Biotechnology and the Life Sciences

- Rapid expansion of bioscience worldwide is perhaps the most significant influence on the biological threat
- Viable and virulent organisms are stored and used in more legitimate bioscience facilities across the globe than ever before
- Individuals with the expertise necessary to misuse biology can be found in nearly all areas of the life sciences internationally
- The tools necessary to develop and disseminate a low-grade biological weapon are ubiquitous

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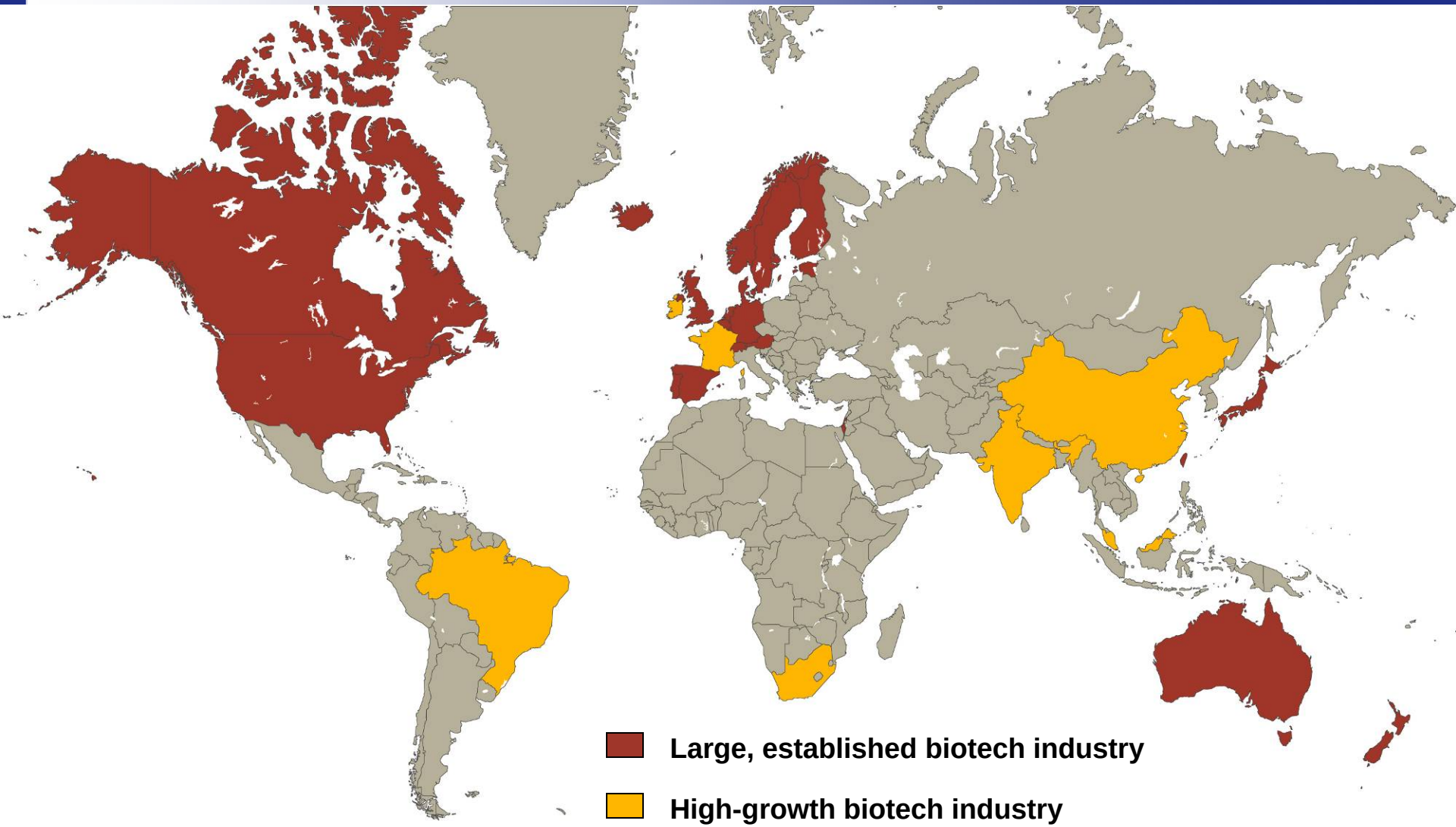
Large Biotechnology Industry and Clusters of Expertise, 2004-2005



http://mbbnet.umn.edu/scmap/biotechmap.html

Transnational Terrorism

- Well financed and sophisticated terrorism has risen sharply over the last 15-20 years
- Terrorists engage in asymmetric warfare – employing unconventional tactics that experts believe will increasingly focus on acquiring and using WMD
- Terrorists are active in regions with expanding biotechnology and outbreaks of infectious disease
- Al Qaeda has repeatedly expressed interest in biological weapons
  - Osama bin Laden (1998): acquiring WMD is a "religious duty"
  - December 2001: cache of technical books, journal papers, rudimentary equipment found at abandoned training camp near Kandahar, Afghanistan
  - October 2003: Jemaah Islamiyah training manual for chem and bioterrorism discovered in the Philippines
  - September 2006: call for scientists to use bio and dirty bombs against the United States

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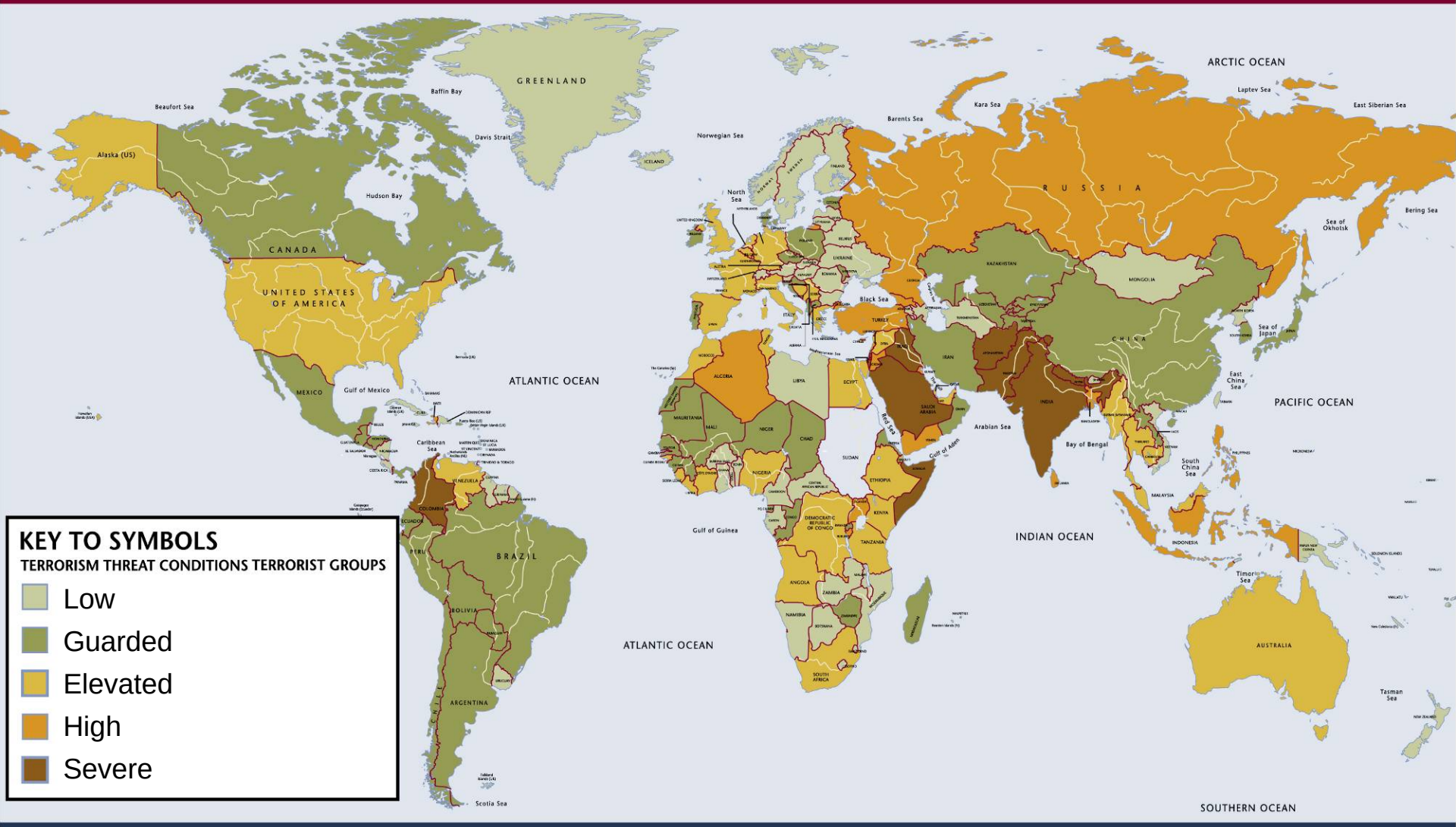
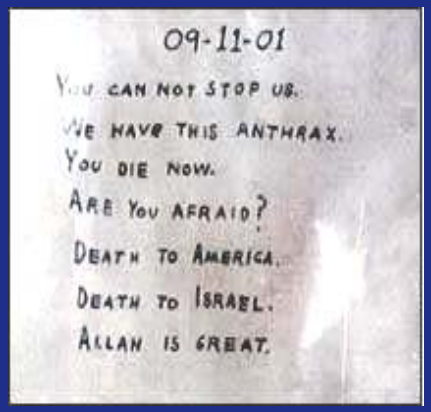
Global Terrorism Risk



http://www.aon.com/risk_management/terrorism_mitigation/terrorism_risk_map.jsp

Challenges to Preventing Bioterrorism

- **Building blocks for biological weapons are dual use**
  - **Materials**
  - **Technologies**
  - **Expertise**



- **Attempts to control biological expertise, information, equipment, and technology risk stymieing the advance of science and harming the fight against infectious diseases**

- **Limiting step for most bioterrorists is acquiring viable and virulent pathogens**
  - **Dangerous pathogens are widely distributed but tend to exist in specific natural environments, facilities, and transport systems**

- **Legitimate bioscience must continue to work with dangerous pathogens**
  - **Protecting legitimate bioscience globally is a critical prevention measure to reduce the bioterrorist threat**

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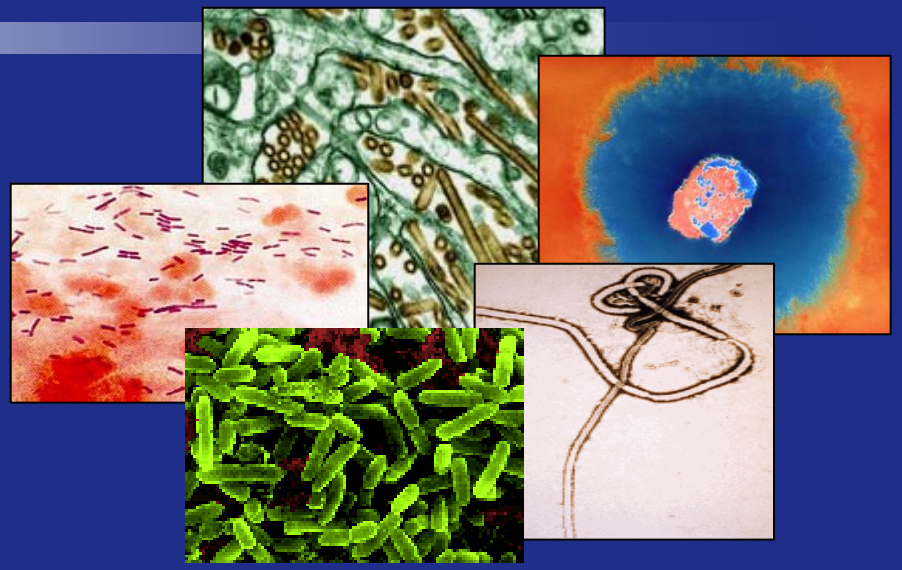
Sandia Surveys of Life Scientists



- Survey focus areas
  - Types of pathogens and toxins used in research
  - Research objectives for those agents
  - Laboratory capacity
    - Available tools and techniques
    - Personnel
  - Status quo for biosafety and biosecurity policies and procedures
  - Perceptions of risk
- 765 respondents from primarily developing countries across four regions
  - Asia: n=300
  - Middle East and Caspian Basin: n=154
  - Latin America: n=165
  - Eastern Europe: n=146

Yersinia pestis

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Surveyed Countries

- Asia
  - Bangladesh, Cambodia, China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, Vietnam
- Middle East and Caspian Basin
  - Algeria, Azerbaijan, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kazakhstan, Kuwait, Kyrgyzstan, Lebanon, Libya, Morocco, Oman, Qatar, Saudi Arabia, Syria, Tajikistan, Tunisia, Turkey, Turkmenistan, United Arab Emirates, Uzbekistan, Yemen
- Latin America
  - Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Suriname, Uruguay, Venezuela
- Eastern Europe
  - Albania, Armenia, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Georgia, Hungary, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia, Serbia and Montenegro, Slovakia, Slovenia, Ukraine

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Surveys: Bio Agents Studied

- **Overall**
  - **53.4% studied bacteria (most commonly studied class of organisms in all but Latin America)**
  - **43.6% studied viruses (most commonly studied class of organisms for Latin America)**
  - **28.4% studied toxins**
  - **17.9% studied parasites**

- **Most commonly studied bacteria**
  - **Across all regions: *Salmonella typhi* (38-57%), *E. coli* O157:H7 (44-55%), *Shigella dysenteriae* (14-33%)**
  - ***Mycobacterium tuberculosis* (22-45%) one of most common in Eastern Europe, Middle East, and Latin America but only studied by 14% of respondents in Asia**

- **Most commonly studied viruses**
  - **Blood borne pathogens: HIV (29-45%), Hepatitis (35-70%) but not commonly studied in Asia**
  - **Asia: Dengue (41%) and Japanese encephalitis (30%)**
  - **Emerging viruses:**
    - **HPAI: 8 - 23%; Latin America is least active and Asia is most**
    - **SARS: 4 - 23%; Latin America is least active and Asia is most**

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Surveys: Research Techniques

- Across the regions
  - Basic research techniques dominate
  - Less utilization of newer tools
- In general, Middle East lags adoption of newer techniques
  - Sequencing: 19%
  - Microarrays: 3%
  - Chimeras: 1.3%

Research technique	% of all respondents using technique
Classical PCR	64%
ELISA	57%
Electrophoresis	56%
Sequencing	35%
RFLP	22%
SNP	8.4%
Microarrays	7.6%
RNAi	7.8%
Chimeras	5.3%
SAGE	1.8%

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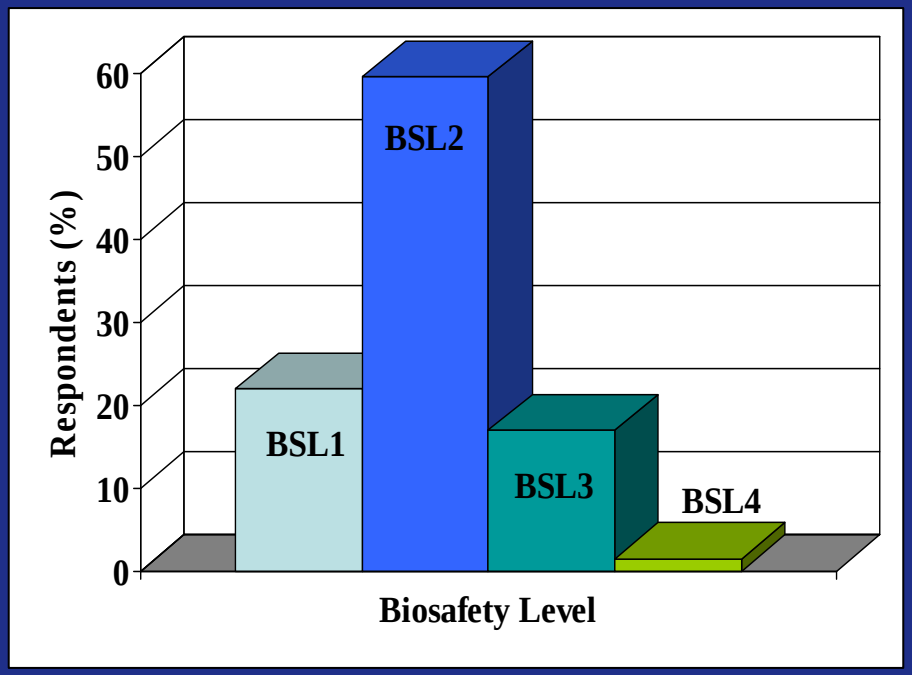
Surveys: Reported Biosafety Levels

- Most respondents work in basic biosafety labs
- Significantly fewer respondents work in containment labs
- Many do NOT know their biosafety level
  - Latin America: 19%
  - Asia: 21%
  - Eastern Europe: 35%
  - Middle East: 44%



Surveys: Often Inadequate Biosafety by US Standards

- In Asia: ~2/3 of respondents studying Japanese encephalitis, HPAI, and SARS use BSL 2
- In the Middle East: most respondents studying Brucella, HPAI, and *Mycobacterium tuberculosis* use BSL2
- In Latin America: most respondents studying Hanta virus, Yellow fever virus, Dengue, and *Mycobacterium tuberculosis* use BSL2
- In Eastern Europe: *Mycobacterium tuberculosis* is evenly split between BSL2 and BSL3; the majority of HPAI, *Brucella*, and *Coxiella burnetti* work is done at BSL3 or BSL4

- Percentage of respondents who will do the experiment anyway if they do not have a particular item of safety equipment
  - Nearly 50% in Asia
  - ~45% in the Middle East,
  - ~ 30% in Eastern Europe
  - Only 20% in Latin America

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Surveys: Perceptions of Risk

- Respondents very worried about lab-acquired infections
  - Asia – 46%
  - Middle East – 46%
  - Latin America – 57%
  - Eastern Europe – 33%

- Respondents very worried that the biological agents in their laboratory could be used to cause harm
  - Asia – 44%
  - Middle East – 36%
  - Latin America – 42%
  - Eastern Europe – 24%

- But, not from *their* lab….

- Respondents who think it is likely or very likely that an employee would steal an agent with an intent to cause harm
  - Asia – 15%
  - Middle East – 17%
  - Latin America – 9%
  - Eastern Europe – 7%

- Respondents who think it is likely or very likely that an outsider would steal an agent with an intent to cause harm
  - Asia – 14%
  - Middle East – 15%
  - Latin America – 7.5%
  - Eastern Europe – 8%

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Surveys: Challenges to Research

- The cost of doing research was the biggest challenge in
  - Asia and Eastern Europe

- Delays in shipments of reagents and/or equipment was the biggest challenge in
  - The Middle East and Latin America
- Lack of necessary equipment is a significant challenge in all four regions

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Surveys: Key Conclusions and Opportunities

- Biotechnology and bioscience is more advanced in Asia and Eastern Europe than Latin America; the Middle East lags behind
- Many commonalities across regions
- Cost is a significant factor
  - Lower cost / lower technology solutions to managing biosafety and biosecurity risks must be made available

- This study indicates possible avenues for providing education on biosafety and biosecurity
  - Collaborations, including a strong reliance on Western scientists
  - For higher risk agents, respondents turn to WHO and CDC for guidance

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Some General Observations from Sandia's Overseas Work

- Dangerous pathogens widely distributed internationally, particularly in the tropics
  - Natural reservoirs in the environment
  - Legitimate bioscience facilities
- Diagnostics often limited to traditional methods that rely on agent isolation and amplification
  - Large collections of viable and virulent agents in diagnostic and clinical facilities, not just research facilities
  - Modern molecular diagnostics rarely used or understood

- Dangerous pathogens are often not used in Biosafety Level 3 and 4 (high containment) facilities
  - Legitimate bioscience facilities that work with dangerous pathogens often lack modern safety and security systems
- Rapid expansion of high containment capacity throughout world, especially in Asia
  - Increasing reliance on engineered solutions for reducing safety risks
  - Policies, procedures, and practices (people) receive less attention
  - Little appreciation for operational and maintenance costs

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Summary

- The biological threat has evolved in concert with
  - Increasing emergence and reemergence of highly infectious disease
  - Advance of biotechnology globally
  - Rise of transnational, asymmetric terrorism
- Bioterrorism threat will increase over time
- Increasing vulnerability of the legitimate international bioscience sector to both accidental release and exposure, and intentional theft and misuse
- Need to mitigate biological risks caused by highly infectious disease agents—internationally
- Enhancing laboratory biosafety and biosecurity in legitimate facilities around the world is a critical element of reducing biological threats globally

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