



Laboratory Biosafety and Biosecurity Internationally

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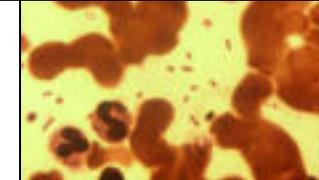
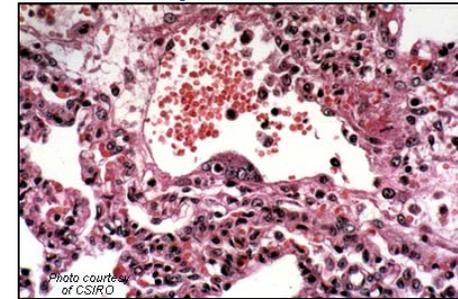
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Surveys of Life Scientists

- Learn about the state of biosciences, laboratory biosecurity, and laboratory biosafety in 4 regions
 - Asia
 - Middle East and Caspian Basin
 - Eastern Europe
 - Latin America
- 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
 - “Biosecurity measures protect infectious agents and toxins against theft or sabotage”
 - “Biosafety practices are designed to protect laboratory workers, the public, and the environment from *accidental* exposure to infectious agents and toxins”
 - Perceptions of risk

Nipah virus



Yersinia pestis

Survey Regions

- **Asia (n= 300)**
 - China
 - Hong Kong
 - Japan
 - Korea
 - Singapore
 - India
 - Pakistan
 - Thailand
 - Taiwan
 - Malaysia
 - Indonesia
 - Cambodia
 - Vietnam
 - Bangladesh
 - Philippines
 - Sri Lanka
- **Middle East and Caspian Basin (n=154)**
 - 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 (n=165)**
 - Cuba
 - Dominican Republic
 - Haiti
 - Belize
 - Costa Rica
 - El Salvador
 - Guatemala
 - Honduras
 - Nicaragua
 - Panama
 - Argentina
 - Bolivia
 - Brazil
 - Chile
 - Colombia
 - Ecuador
 - French Guiana
 - Guyana
 - Paraguay
 - Peru
 - Suriname
 - Uruguay
 - Venezuela
 - Mexico
- **Eastern Europe (n=146)**
 - 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

Types of Agents Studied by Respondents

Asia

- Bacteria (48%), viruses (38%), toxins (21%)
- 4 most commonly studied bacteria are:
 - *Salmonella typhi* (57%)
 - *E. coli* O157:H7 (52%)
 - *Vibrio cholerae* (42%)
 - *Shigella dysenteriae* (33%)
- 4 most commonly studied viruses are:
 - HIV (45%)
 - Dengue (41%)
 - Japanese encephalitis (30%)
 - SARS (23%)
 - HPAI (23%)

Middle East

- Bacteria (68%), viruses (49%), toxins (38%)
- 4 most commonly studied bacteria are:
 - *E. coli* O157:H7 (55%)
 - *Salmonella typhi* (49%)
 - *Mycobacterium tuberculosis* (45%)
 - *Shigella dysenteriae* (33%)
- 4 most commonly studied viruses are:
 - Hepatitis (70%)
 - HIV (39%)
 - HPAI (16%)
 - Other (14%)

Latin America

- Viruses (44%), bacteria (36%), parasites (22%), toxins (13%)
- 4 most commonly studied bacteria are:
 - *E. coli* O157:H7 (44%)
 - *Salmonella typhi* (44%)
 - *Mycobacterium tuberculosis* (35%)
 - *Shigella dysenteriae* (26%)
- 4 most commonly studied viruses are:
 - Dengue (38%)
 - HIV (36%)
 - Hepatitis (35%)
 - Other (27%)

Eastern Europe

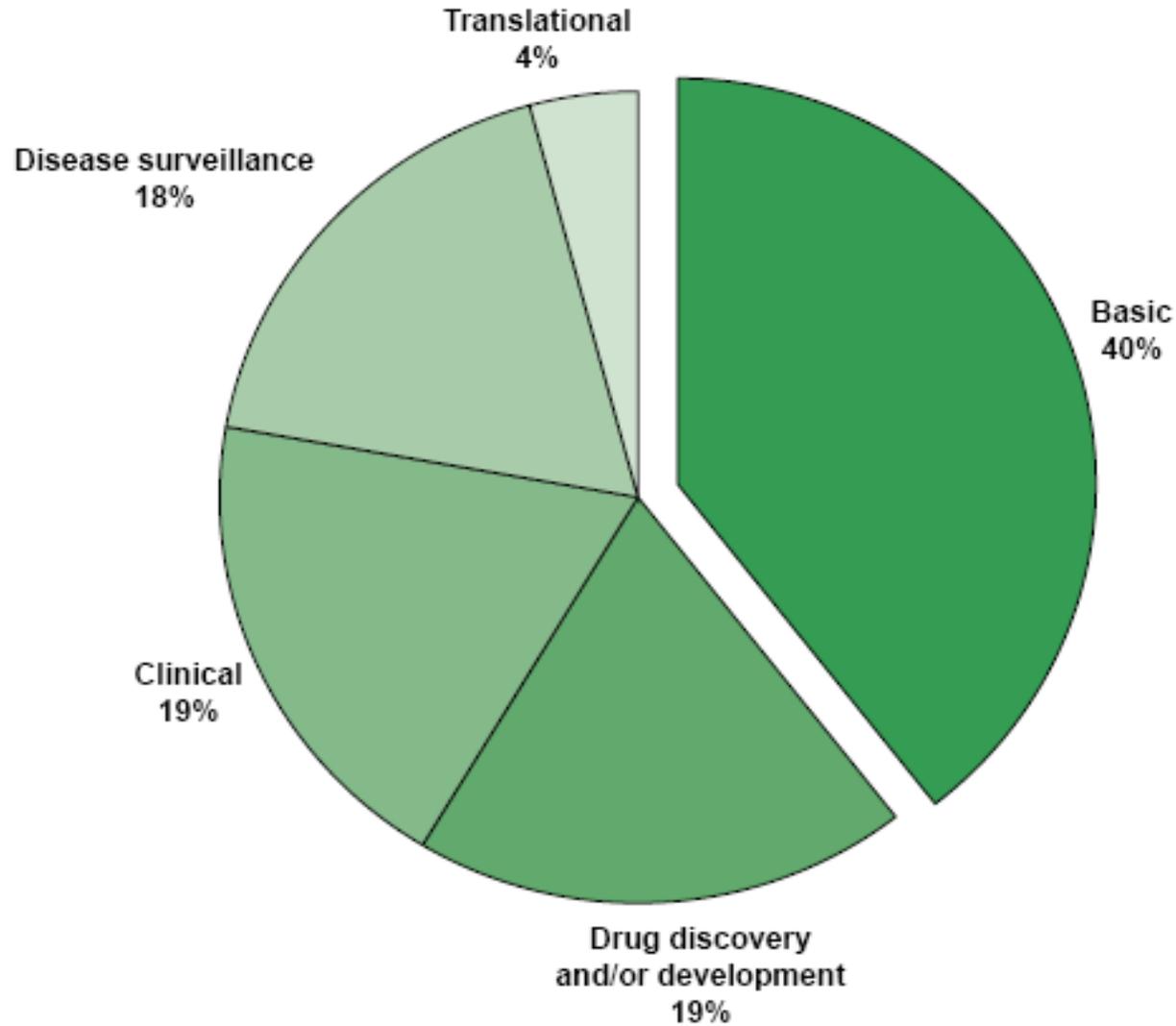
- Bacteria (60%), viruses (40%), toxins (37%)
- 4 most commonly studied bacteria are:
 - *E. coli* O157:H7 (46%)
 - *Salmonella typhi* (38%)
 - Other (36%)
 - *Mycobacterium tuberculosis* (22%)
- 4 most commonly studied viruses are:
 - Hepatitis (43%)
 - HIV (29%)
 - Tick-borne encephalitis complex (flavi) viruses (24%)
 - HPAI (17%)

Research Focus

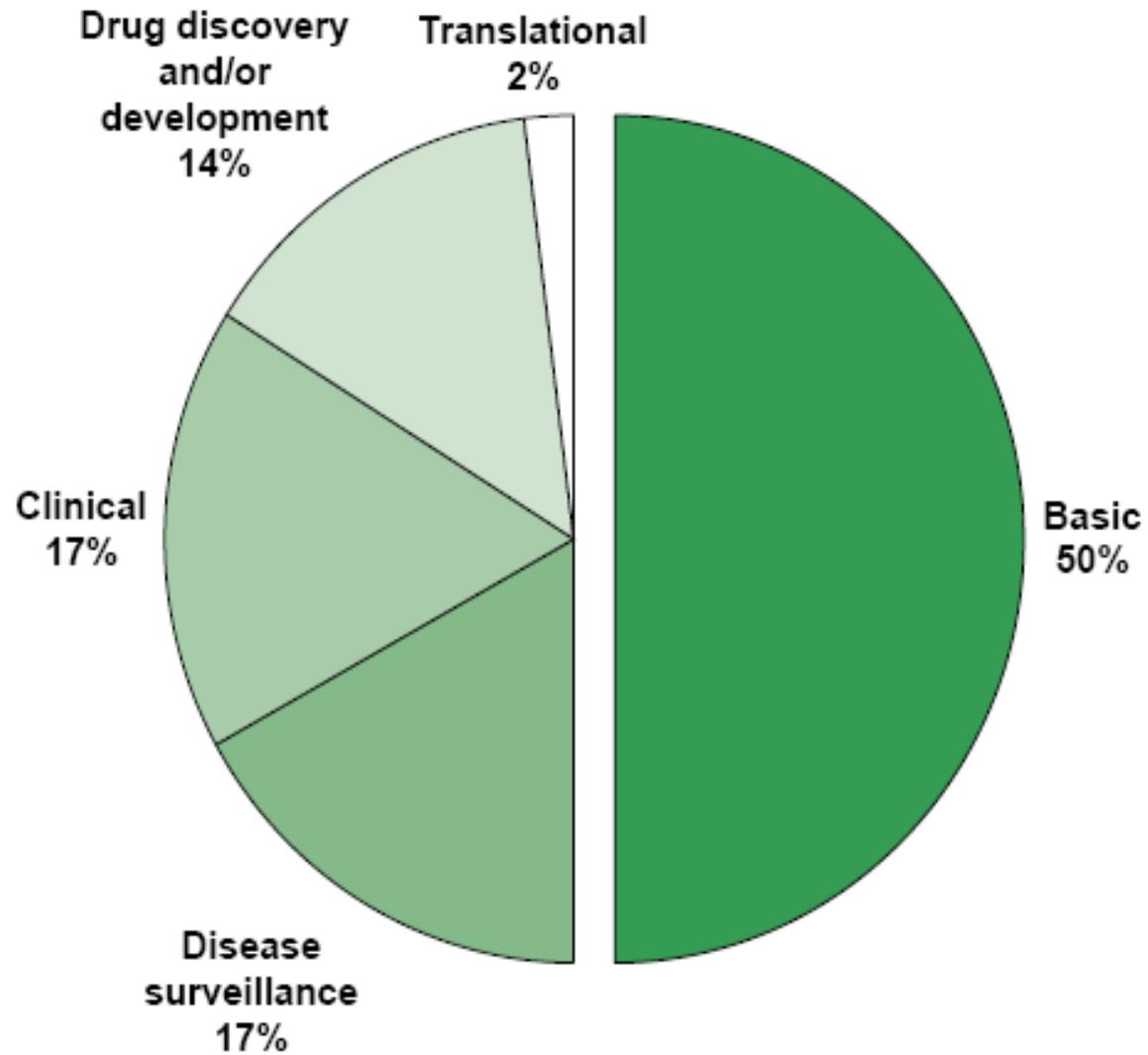
- **The majority across all regions identified diagnostics and epidemiology as their primary research objectives**
- **The stage of research varies across regions**
 - **Asia – largest percent of drug discovery and development**
 - **Middle East and Caspian Basin – largest percent of clinical research**
 - **Latin America – largest percent of basic research**



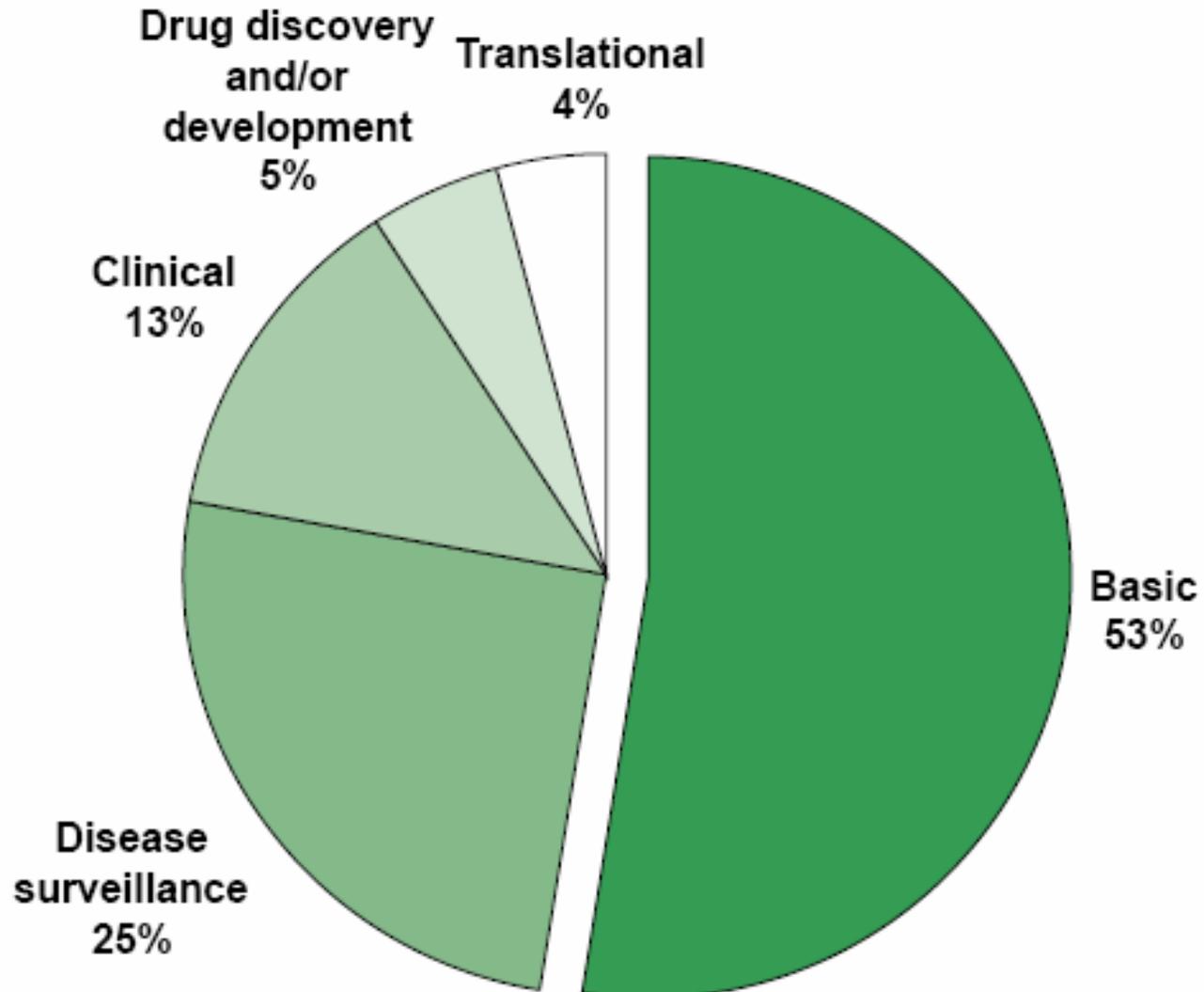
Research Focus: Asia



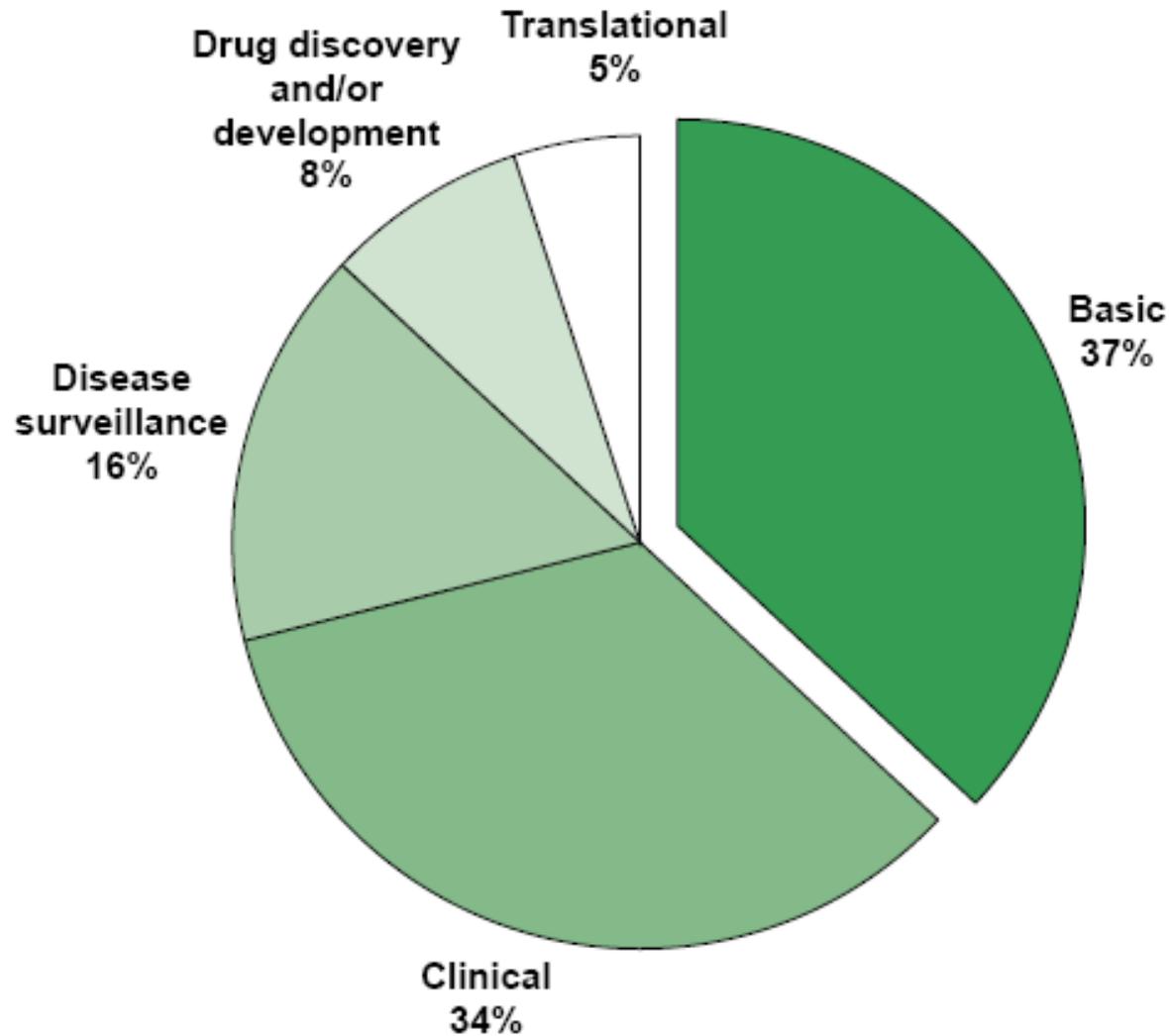
Research Focus: Eastern Europe



Research Focus: Latin America



Research Focus: Middle East

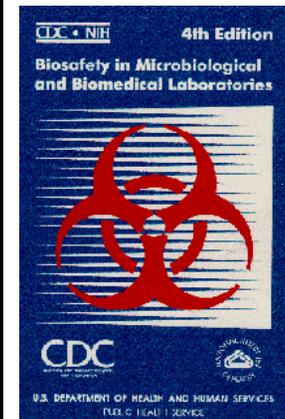
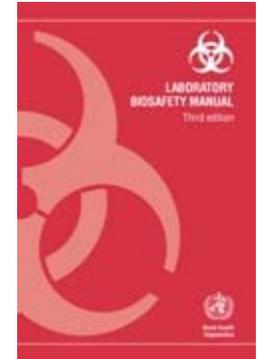


Research Techniques

- **Basic research techniques dominate across the regions**
 - **Classical PCR: Asia – 60%, Middle East – 64%, Latin America – 71%, Eastern Europe – 65%**
 - **ELISA: Asia – 57%, Middle East – 54%, Latin America – 62%, Eastern Europe – 60%**
 - **Electrophoresis: Asia – 56%, Middle East – 50%, Latin America – 59%, Eastern Europe – 57%**
- **Less utilization of newer tools, for example:**
 - **Sequencing**
 - **Asia – 40%, Middle East – 19%, Latin America – 40%, Eastern Europe – 30%**
 - **Genotyping technologies**
 - **Restriction fragment length polymorphism (RFLP): Asia – 23%, Middle East – 19%, Latin America – 22%, Eastern Europe – 20%**
 - **Single nucleotide polymorphism (SNP): Asia – 10%, Middle East – 6%, Latin America – 10%, Eastern Europe – 7%**
 - **Gene expression technologies**
 - **Microarrays: Asia – 11%, Middle East – 3%, Latin America – 5%, Eastern Europe – 7%**
 - **RNAi (dsRNA): Asia – 11%, Middle East – 6%, Latin America – 4%, Eastern Europe – 9%**

Top Resources for Guidance on Laboratory Biosafety and Biosecurity

	Asia	Middle East	Latin America	Eastern Europe
My country's government	70% (1)	52% (1 – tie)	62% (1)	71% (1)
WHO	51% (2)	52% (1 – tie)	53% (2)	41% (3)
BMBL	36% (3)	33% (3)	50% (3)	22% (4)
Laboratory director(s)	26% (4)	36% (2)	39% (4)	45% (2)



As Biosafety Level of laboratory increases, more respondents turn to WHO and BMBL

Biosafety Levels of Respondents' Laboratories

- **Most respondents work in basic bioscience laboratories**
 - BSL1: Asia – 22%, Middle East – 24%, Latin America – 18%, Eastern Europe – 26%
 - BSL2: Asia – 58%, Middle East – 60%, Latin America – 65%, Eastern Europe – 56%
- **Some work in containment laboratories**
 - BSL3: Asia – 18%, Middle East – 15%, Latin America – 17%, Eastern Europe – 15%
 - BSL4: Asia – 2%, Middle East – 1%, Latin America – 0%, Eastern Europe – 3%
- **Many do NOT know their biosafety level**
 - Asia – 21%
 - Middle East – 44%
 - Latin America – 19%
 - Eastern Europe – 35%



in a BSL3 lab

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 BSL and BSL3; the majority of HPAI, *Brucella*, and *Coxiella burnetti* work is done at BSL3 or BSL4
- Percentage of respondents that 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,
 - Only 20% in Latin America
 - ~ 30% in Eastern Europe

Biosafety Practices and Equipment

- **Use of personal protective equipment (PPE): 83 – 90% in all regions**
- **Waste decontamination**
 - **Asia – 67%, Middle East – 45%, Latin America – 52%, Eastern Europe – 41%**
- **Directional airflow (WHO: desirable for BSL2, required for BSL3)**
 - **~1/3 of labs in all regions; 56% - 65% are BSL2 and 15 – 18% are BSL3**
 - **Biosafety cabinets**
 - **Asia – 62%, Middle East – 49%, Latin America – 65%, Eastern Europe – 53%**



Biosecurity

- **Physical security implementation appears to be fairly consistent across regions**
 - **52% – 57% of respondents report always locking laboratory doors**
 - **~53% always have guards at building entrances**
 - **More sophisticated security measures are less common**
 - **Access controls (32% - 40%), intrusion sensors and alarms (20% - 36%), video monitors (11% - 25%)**

- **Information security: for all regions,**
 - **The use of passwords is the most common information security measure (51% – 59% always)**
 - **Destroying sensitive information before disposal varies from 31% in the Middle East and Latin America to 51% in Asia**

Biosecurity (cont.)

- **Personnel security**
 - **Picture ID badges are uncommon**
 - Asia – 46%, Middle East – 23%, Latin America – 28%, Eastern Europe – 20%
 - **Employers do not regularly conduct background checks of potential employees**
 - Asia – 34%, Middle East – 30%, Latin America – 26%, Eastern Europe – 26%
 - **A surprising number of respondents provide biosecurity training to new employees: 35% (Latin America) – 55% (Eastern Europe)**

- **Material Control & Accountability**
 - **66% – 78% report that the laboratory head is always aware of all infectious agents studied in the lab**
 - **45% – 55% maintain a current inventory**
 - **51% – 64% ship infectious substances according to IATA**

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 agent 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 that 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 that 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%

Collaborations

	Asia	Middle East	Latin America	Eastern Europe
Within their country	66%	51%	63%	66%
Within their region	29%	23%	49%	32%
With the US*	37%	25%	48%	37%

Challenges for Researchers

- **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**

Initial Conclusions

- **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 American scientists**
 - **For higher risk agents, respondents turn to WHO and CDC for guidance**

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