Risk Assessment

International Biological Threat Reduction Department
Sandia National Laboratories
October 15, 2006

Overview of the Principles of Laboratory Biosecurity
ABSA pre-conference course

www.biosecurity.sandia.gov

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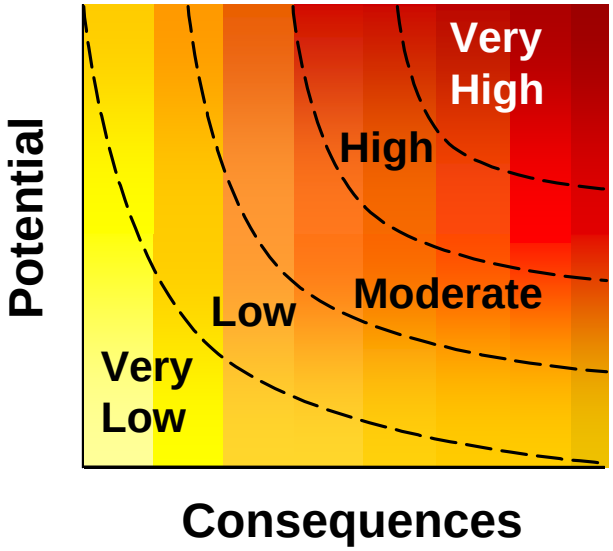
under contract DE-AC04-94AL85000.

Risk

- Is a function of the likelihood an adverse event will occur
- Laboratory work with pathogens will always involve some level of safety and security risk
  - Distinguish between “acceptable” and “unacceptable” risks
  - Cannot protect against every conceivable adverse event
- Resources for risk mitigation are not infinite
  - Existing resources should be used efficiently

Biosecurity and Biosafety Based on Risk Management

- Most biological materials occur in nature and can be isolated from nature
- Critical not to compromise legitimate bioscience operations
  - Systems should be designed to address unique situations
- Management must distinguish between “acceptable” and “unacceptable” risks
  - Ensure that protection and the cost is proportional to the risk

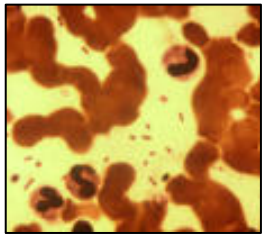


- Protect against unacceptable risk scenarios

- Develop incident response plans for acceptable risk scenarios

Challenges to Securing Biological Agents

- **Dual-use characteristics**
  - **Valuable for legitimate, defensive, and peaceful commercial, medical, and research applications**
    - **Possession does not imply intent**
- **Nature of the material**
  - **Living and self-replicating organisms**
  - **Cannot be reliably quantified**
    - **Cannot keep an accurate inventory**
  - **Used in very small quantities**
    - **Cannot visually discern whether material is missing**
  - **Exist in many different process streams in facilities**
    - **Decentralization makes restricting access to authorized individuals more difficult**
  - **Contained biological samples are virtually undetectable**
    - **Cannot use sensors to alert unauthorized removal**
- **Laboratory culture**
  - **Biological research communities not accustomed to operating in a security conscious environment**

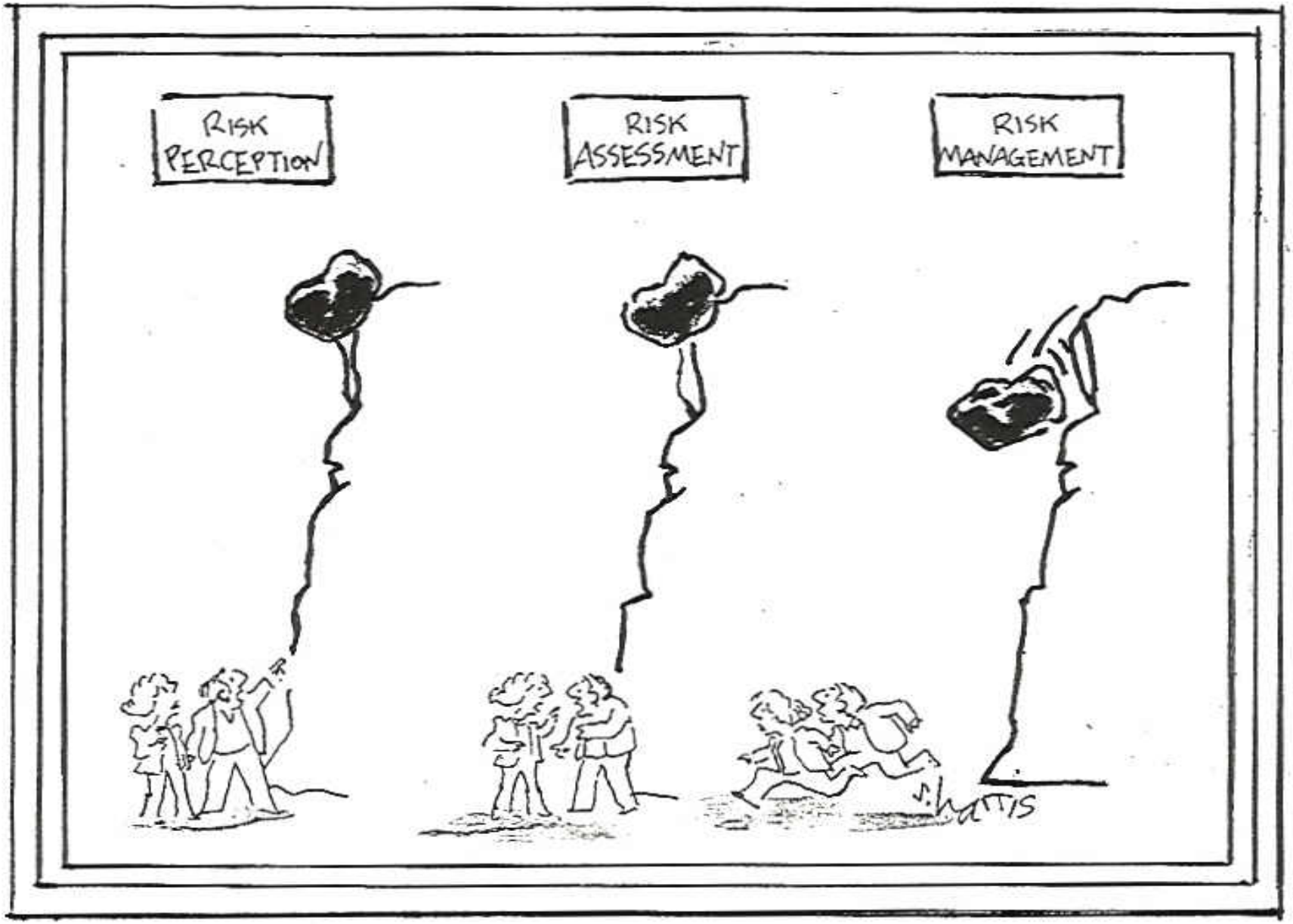


Yersinia pestis

Biosecurity Cost-Benefit Considerations

- **Bioscience facilities are not unique repositories**
  - **Most agents can be isolated from nature**
  - **Many similar collections of agents exist worldwide**
- **Relatively few agents can be easily grown, processed, weaponized, and successfully deployed while maintaining virulence/toxicity**
  - **Very few agents used as a weapon could cause mass human, animal, or plant casualties**
- **Need a methodology to make informed decisions about how to design an effective and efficient biosecurity system**

FMD outbreak, U.K.


RISK PERCEPTION
RISK ASSESSMENT
RISK MANAGEMENT

Risk Perception in Laboratories

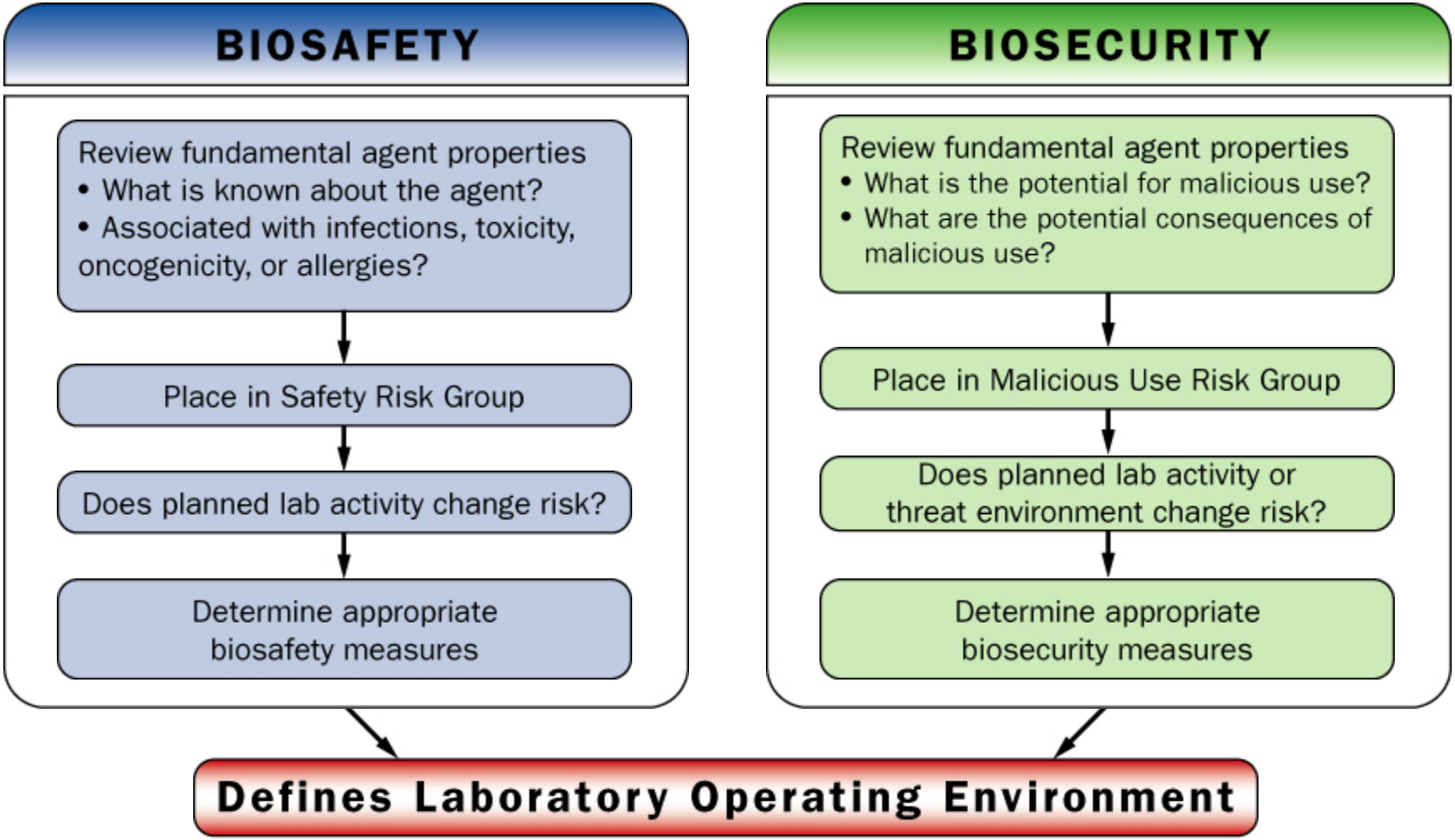
Biosafety risks: laboratory-acquired infections

- History of lab-acquired infections
  - Often attributed to carelessness or poor technique
  - Relatively few cases can be attributed to direct accident (mouth pipetting and sharps injuries)
  - Exposure to airborne pathogens generally presumed to be most plausible cause
  - Brucellosis is most common
- Sporadic infections in community as a result
  - 1973 and 1978—England had 3 secondary cases of smallpox
  - 1950—2 cases of Q fever in household of scientist
  - 1990—1 documented case of Monkey B virus from animal handler to wife
  - SARS—including 3 generations (9 cases)

Biosecurity risks: laboratories as sources of material for malicious use

- Bioterrorism has emerged as a threat to international security
  - 1984 Rajneeshee religious cult attacks
  - 1990s Aum Shinrikyo attempts
  - 2001 Anthrax attacks in the US
- Examples of illicit acquisition
  - 1990s—Aum Shinrikyo ordered *Clostridium botulinum* from a pharmaceutical company
  - 1995—Larry Wayne Harris, a white-supremacist, ordered 3 vials of *Yersinia pestis* from the ATCC
  - 1995—Laboratory technician Diane Thompson removed *Shigella dysenteriae* Type 2 from hospital's collection and infected co-workers

Risk Assessment: Integrated Biosafety and Biosecurity

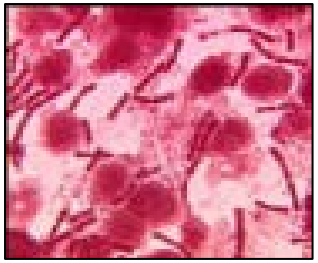


Risk Assessment

- **Enables the professional (e.g. biosafety officer, responsible official) to:**
  - **Become familiar with the proposed work activities (procedures, equipment, personnel)**
  - **Be a knowledgeable and credible partner with the investigator to develop a safe and secure environment for the work**

- **Review all activities associated with infectious materials**
  - **Proposed work activities**
  - **Personnel**
  - **Storage**
  - **Transfer and transport**
  - **Destruction**

Biosecurity Risk Assessment



1. Evaluate assets (agent assessment)
2. Evaluate lab activity
3. Evaluate threat environment

Biosecurity Risk Assessment: Malicious Use Risk Group Evaluation

- **Assess value of the agents from an adversary's perspective**
  - **Consequences**
    - **Population**
      - Transmissibility
      - Mortality
      - Morbidity
    - **Economic**
    - **Psychological**
  - **Weaponization potential**
    - **Acquisition**
      - Natural
      - Laboratory
      - Synthetic biology
    - **Production**
      - R&D
      - Covert production
      - Ease of storage
    - **Dissemination**
      - Route of infection (e.g. aerosol, ingestion)
      - Environmental hardiness

REPORTS

Chemical Synthesis of Poliovirus cDNA: Generation of Infectious Virus in the Absence of Natural Template

Jeronimo Cello, Aniko V. Paul, Eckard Wimmer*

9 AUGUST 2002 VOL 297 SCIENCE www.sciencemag.org

JOURNAL OF VIROLOGY, Feb. 2001, p. 1205–1210 Vol. 75, No. 3
0022-538X/01/$04.00+0 DOI: 10.1128/JVI.75.3.1205–1210.2001
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Expression of Mouse Interleukin-4 by a Recombinant Ectromelia Virus Suppresses Cytolytic Lymphocyte Responses and Overcomes Genetic Resistance to Mousepox

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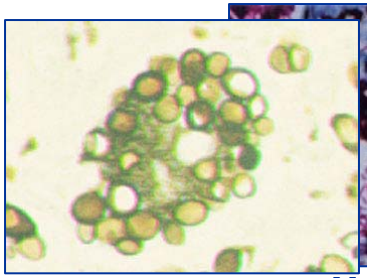
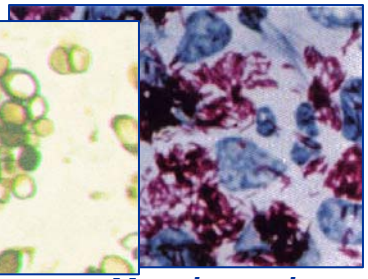
Biosecurity Risk Assessment: Malicious Use Risk Groups

- **Nonpathogenic**
  - Malicious use would have insignificant or no consequences
- **Low**
  - Difficult to deploy, and/or
  - Malicious use would have few consequences
- **Moderate**
  - Relatively difficult to deploy, and
  - Malicious use would have localized consequences with low to moderate casualties and/or economic damage, and potentially cause pervasive anxiety
- **High**
  - Not particularly difficult to deploy, and
  - Malicious use could have national or international consequences, causing moderate to high casualties and/or economic damage, and the potential to cause mass panic and significant social disruption
- **Extreme**
  - Would normally be classified as highly attractive, except that they are not found in nature (eradicated)
  - Could include genetically engineered agents, if they would otherwise be classified as highly attractive

Malicious Use Risk Group Examples



Coccidioides immitis

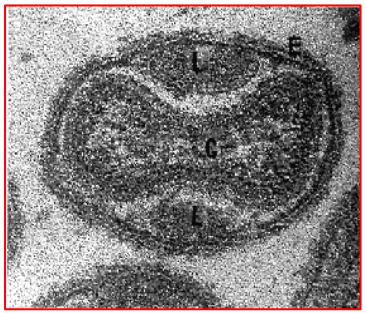


Mycobacterium leprae

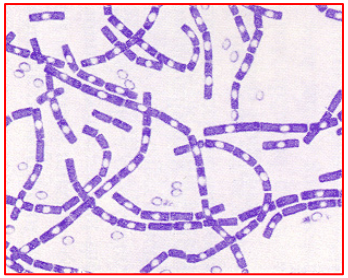
- **Nonpathogenic**
  - ***Bacillus cereus, Lactobacillus acidophilus*, Saccharomyces cerevisiae**
- **Low Malicious Use Risk (LMUR)**
  - ***Mycobacterium leprae***
    - **Consequences: Not highly virulent, not highly contagious, completely curable**
    - **Weaponization potential: Production is a significant challenge, not environmentally hardy**
- **Moderate Malicious Use Risk (MMUR)**
  - ***Coccidioides immitis***
    - **Consequences: Not contagious, 5-10 out of every 1000 infected develop life-threatening infection**
    - **Weaponization potential: Requires technical skills to handle safely, easy to procure virulent strain, easy to grow**

Malicious Use Risk Group Examples

- **High Malicious Use Risk (HMUR)**
  - ***Bacillus anthracis***
    - **Consequences: High fatality rate, not contagious, early diagnosis is difficult**
    - **Weaponization potential: History of malicious use, wide endemic area (but many less virulent strains), very stable, easy to grow and produce spores**
- **Extreme Malicious Use Risk (EMUR)**
  - **Variola major virus**
    - **Consequences: High fatality rate, contagious, few vaccinated**
    - **Weaponization potential: History of weaponization, very stable, difficult to obtain**



Variola major



Bacillus anthracis

Biosecurity Risk Assessment: Other Assets at Biological Facilities

- **Security Information or Systems**
  - **May be targeted to facilitate gaining access to dangerous biological materials**
- **Other Facility Assets**
  - **May be targeted by political extremists, disgruntled employees, etc.**
  - **May include:**
    - **High containment laboratories**
    - **Animals**

Biosecurity Risk Assessment: Elements That May Modify Risk

- **Consider lab experiment**
  - **Does planned experiment produce an agent with higher weaponization potential or higher potential consequences?**
    - **For example: Increased stability, GMOs, large quantities, aerosol challenges**

Biosecurity Risk Assessment: Elements That May Modify Risk

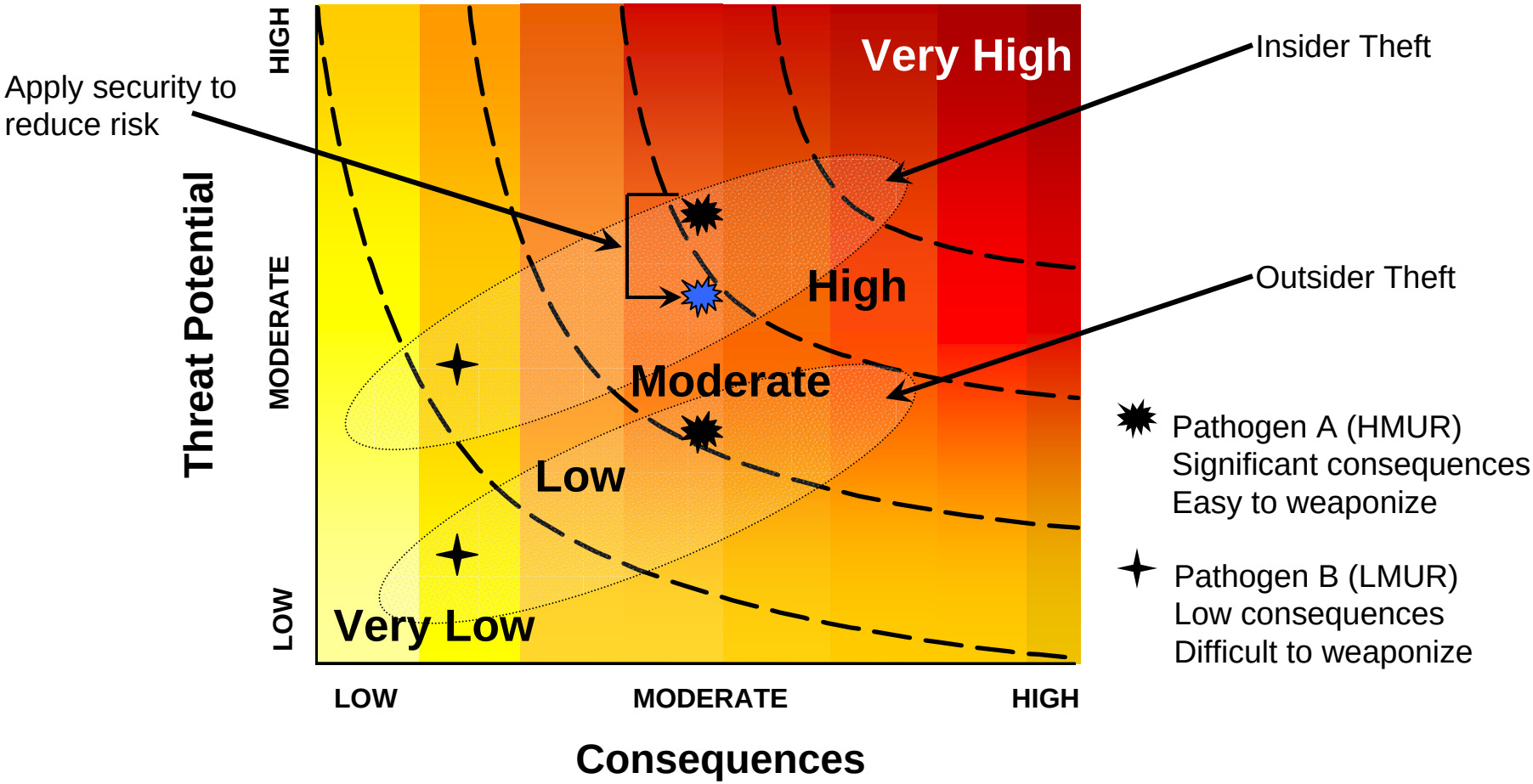
- **Adversary Classes**
  - **Terrorist**
  - **Extremist**
  - **Criminal**
- **Insiders**
  - **Authorized access to the facility, dangerous pathogens, and/or restricted information**
  - **Distinguish Insiders by level of authorized access**
    - **Site**
    - **Building**
    - **Asset**
  - **Facility management, site security, and local law enforcement interviews**
- **Outsiders**
  - **No authorized access**
  - **Local law enforcement, site security, and intelligence community interviews**

Threat Potential

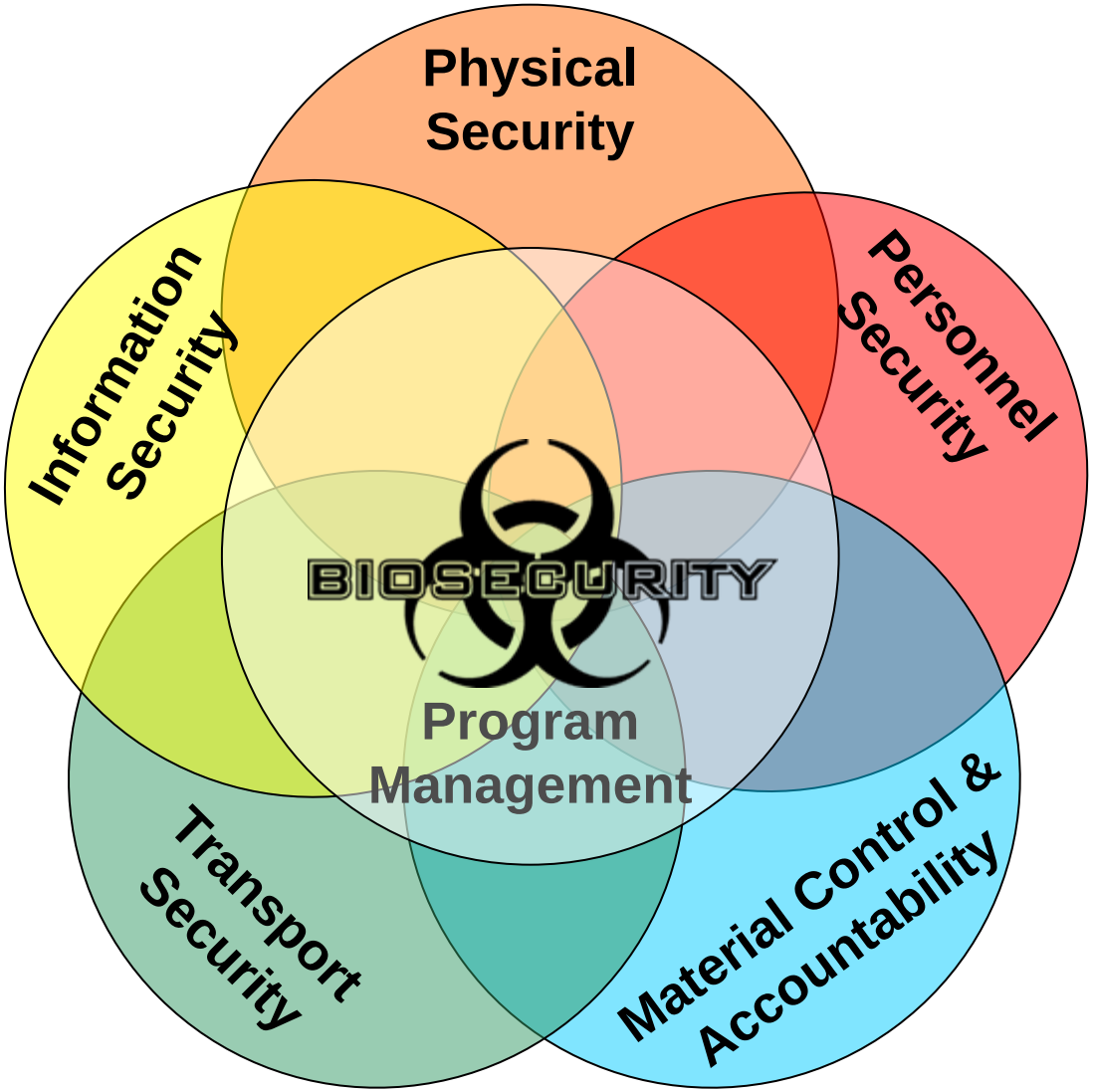
Evaluate threat potential of possible adversaries:

- **Motive**
  - **Form of potential consequences**
  - **Level of difficulty associated with achieving the desired result**
  - **Facility environment**
  - **Perception of being caught**
- **Means**
  - **Technical tools and knowledge**
    - **Overcome security system**
    - **Conduct BW**
- **Opportunity**
  - **Access**
    - **Does the adversary have routine access?**
    - **Are there other authorized individuals that might be present?**
    - **Would an unauthorized individual be noticed?**

Biosecurity Risk: Insider vs. Outsider Threat



Risk Management: Implementation of Biosecurity



Conclusions

- **Need to integrate biosafety and biosecurity considerations into decisions about laboratory operations**
- **Biological facility risk assessment provides an opportunity to concentrate resources on the highest risks**
  - **Tiered system of protection based on risk assessment and risk management methodologies**
- **Parallels exist between safety and security risk assessment processes**