Working with Biological Toxins
Office of Biological Safety
Working with Biological Toxins

- What are toxins?
- Regulation of toxins (UC and Government)
- Toxin safety
- Toxin security
- Decontamination methods
- Occupational Health
Biological Toxins Come from Organisms

- Usually small proteins
- Bacteria: e.g., Botulinum toxin (*Clostridium botulinum*) and *Staph* enterotoxin (*S. aureus*)
- Plants: e.g., Ricin (castor beans)
- Animals: e.g., Conotoxins (cone snails) and Tetrodotoxin (puffer fish)
# Biological Toxins vs. Chemical Agents

<table>
<thead>
<tr>
<th>Bio-toxins usually...</th>
<th>Chemical agents usually...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural origin</td>
<td>Man-made</td>
</tr>
<tr>
<td>Not volatile</td>
<td>Many volatile</td>
</tr>
<tr>
<td>Not dermally active</td>
<td>Usually dermally active</td>
</tr>
<tr>
<td>More toxic than chemicals</td>
<td>Less toxic than many toxins</td>
</tr>
<tr>
<td>Odorless and tasteless</td>
<td>Odor and taste</td>
</tr>
<tr>
<td>Diverse toxic effects</td>
<td>Fewer types of effects</td>
</tr>
<tr>
<td>Generate immune response</td>
<td>No immune response</td>
</tr>
</tbody>
</table>
Toxins vs. Chemical Agents

- Most chemicals and many toxins regulated at UC by Department of Environmental Health and Safety (EH&S)
  - Researchers working with them must have a “Chemical Hygiene Plan” filed with EH&S
  - Contact EH&S at 2-6546
- Certain toxins are regulated by the Institutional Biosafety Committee (IBC)
Toxins Regulated by the UC IBC

- Abrin
- Aerolysin
- Botulinum toxin
- β-bungarotoxin
- *C. difficile* enterotoxin A
- *C. perfringens* lecithinase
- *C. perfringens* perfringolysin O
- *C. perfringens* Δ-toxin
- *C. perfringens* ε-toxin
- Conotoxin
- Diacetoxycirpenol
- Diptheria toxin
- Listeriolysin
- Modeccin
- Pertussis toxin
- Pneumolysin
- *Pseudomonas* toxin A
- Ricin
Toxins Regulated by the UC IBC

- Saxitoxin
- Shiga toxin
- *Shigella dysenteriae* neurotoxin
- *Staphylococcus* enterotoxins A-F
- Streptolysin O
- Streptolysin S
- T-2 toxin
- Taipoxin
- Tetanus toxin
- Tetrodotoxin
- Volkensin
- *Yersinia pestis* murine toxin
Why These Toxins?

Toxins were chosen for IBC oversight if they fell into at least one of these two categories:

• High level of toxicity: Lethal dose of 25 µg / kg or lower
• On the list of Federal Select Agents and Toxins

Please refer to The University of Chicago Biosafety Manual for supplementary information about the concepts presented in this training module.

http://biologicalsafety.uchicago.edu/page/university-chicago-biosafety-manual
What Is a “Select Agent”? 

• “Select Agents and Toxins”: Biological agents strictly regulated by the US Government 
• Select Agent toxin regulations are enforced by the CDC 
• Developed to decrease the risk of bioterrorism 
• Includes pathogens such as *B. anthracis* (anthrax), *Y. pestis* (plague), Ebola virus, etc.
Select Agent Toxins

- Abrin
- Botulinum toxin
- Conotoxin
- Diacetoxyscirpenol (DAS)
- Ricin
- Saxitoxin
- Staph enterotoxins A-E
- T-2 toxin
- Tetrodotoxin
Select Agent Toxins

- Only considered select agents if the amount held by a given PI exceeds a limit (select agent threshold)
- Depends on toxin; based on lethal dose (LD$_{50}$)
  - Lowest: 0.5 mg (Botulinum toxin): LD$_{50} = 0.001$ μg/kg
  - Highest: 1000 mg (DAS and T-2 toxin): LD$_{50} = 5000$ μg/kg
- Full list of toxins and thresholds on IBC website:
  http://researchadmin.uchicago.edu/docs/ibc/UC_ibc_Toxin.pdf
Select Agent Toxins

- It is against Federal law to possess a Select Agent toxin in quantities above the threshold!
- Usually the permitted level is much greater than needed for most of the work at UC
- If you think your lab possess more than the permissible amount contact the Biosafety Office IMMEDIATELY.
Routes of Exposure

Toxins are hazardous through various routes, which vary from toxin-to-toxin

Possible routes of exposure
- Aerosol (air)
- Dermal (skin)
- Ingestion (swallowing)
- Parenteral (needlestick or animal bite)
- Mucous membrane (eyes, nose, mouth)

To find out about your toxin, consult your IBC protocol or contact the Office of Biological Safety
Safe Handling of Toxins

- Biosafety Level 2 precautions should be sufficient for most toxins in small amounts
  - Gloves
  - Lab coat
  - Mucous membrane protection
  - Biohazard sign indicating what toxin is being used
  - Properly decontamination of the work area and any toxin waste before disposing
Safe Handling of Toxins

- The most hazardous form of toxin is powder
  - Inhalation of aerosols

- When possible, toxin should be in liquid form
  - Order as a liquid
  - When received, resuspend in liquid (if possible)
Safe Handling of Toxins

- If using powder, work should be done in a fume hood or a biological safety cabinet (BSC)
  - Fume hood: Will protect the worker from aerosols but...
    - Does not protect the sample
    - Does not protect the environment
  - BSC: Will protect the worker from aerosols and...
    - Also protects the sample
    - Also protects the environment
Decontamination of Toxins

- Some toxins are incredibly stable
- Decontamination depends on stability of toxin
- Possible methods of decontamination:
  - NaOCl (Household bleach ~ 5% NaOCl)
  - NaOCl + NaOH
  - Dry heat
  - Autoclaving
## Decontamination of Toxins: Chemical

Effective decontamination for toxins of different stabilities (Wannemacher, 1989)

<table>
<thead>
<tr>
<th>Toxin</th>
<th>2.5% NaOCl (~50% bleach) + 0.25 N NaOH</th>
<th>1% NaOCl (~20% bleach)</th>
<th>0.1% NaOCl (~10% bleach)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-2 toxin</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Tetrodotoxin</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Ricin</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Botulinum</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

- T-2 toxin is most resistant, requiring 50% bleach + 0.25 N NaOH
- Ricin and botulinum toxin are least resistant, requiring only 10% bleach
Decontamination of Toxins: Heat

Effective decontamination for toxins of different stabilities (Wannemacher, 1989)

<table>
<thead>
<tr>
<th>Toxin</th>
<th>Autoclaving</th>
<th>Dry Heat °F</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>T-2 toxin</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Tetrodotoxin</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Ricin</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Botulimum</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

- T-2 toxin is most resistant to heat, requiring minimum of 1500 °F
- Ricin and botulimum toxin are sensitive to autoclaving or 200 °F dry heat
Decontamination of Toxins

For extended table of decontamination of toxins:

– Consult UC Biosafety Manual:
  http://biologicalsafety.uchicago.edu/page/university-chicago-biosafety-manual

– Ask the Biosafety Office
Toxin Security

- When in use, toxins should **never be left unattended**
- Maintain an accurate **inventory** of all toxin stocks
- Material should be **secured** whenever unattended:
  - Locked room; caged area
  - Locked freezer; lock box
What If You’re Exposed to a Toxin?

• Needle stick or splash on skin
  – Squeeze out blood (if applicable)
  – Wash area with soap and water
  – Immediately contact UC Occupational Medicine (UCOM) at 773-702-6757
    • You will be given instructions on what to do next
  – After getting in touch with UCOM, contact your supervisor/PI
  – At some point, you or your PI should contact the Biosafety Office
What If You’re Exposed to a Toxin?

- Splash in eyes
  - Flush eyes in eyewash for 15 minutes
  - Immediately contact UC Occupational Medicine (UCOM) at 773-702-6757
    - You will be given instructions on what to do next
  - After getting in touch with UCOM, contact your supervisor/PI
  - At some point, you or your PI should contact the Biosafety Office
What If You’re Exposed to a Toxin?

- Aerosol inhalation
  - Remove gloves, lab coat, etc., and leave the room
  - Immediately contact UC Occupational Medicine (UCOM) at 773-702-6757
    - You will be given instructions on what to do next
  - After getting in touch with UCOM, contact your supervisor/PI
  - At some point, you or your PI should contact the Biosafety Office
Any Toxin Questions????

- Contact the Office of Biological Safety: Call or come by!
  - Abbott Hall 120
  - Joe Kanabrocki, Biosafety Officer: 4-7496
  - Allen Helm, Asst. Biosafety Officer: 4-6756