

# **Working with Biological Toxins**

## **Office of Biological Safety**



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# Working with Biological Toxins

- What are toxins?
- Regulation of toxins (UC and Government)
- Toxin safety
- Toxin security
- Decontamination methods
- Occupational Health



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## 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)



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# Biological Toxins vs. Chemical Agents

## Bio-toxins usually...

- Natural origin
- Not volatile
- Not dermally active
- More toxic than chemicals
- Odorless and tasteless
- Diverse toxic effects
- Generate immune response

## Chemical agents usually...

- Man-made
- Many volatile
- Usually dermally active
- Less toxic than many toxins
- Odor and taste
- Fewer types of effects
- No immune response



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# 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)



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## Toxins Regulated by the UC IBC

- Abrin
- Aerolysin
- Botulinum toxin
- $\beta$ -bungarotoxin
- *C. difficile* enterotoxin A
- *C. perfringens* lecithinase
- *C. perfringens* perfringolysin O
- *C. perfringens*  $\Delta$ -toxin
- *C. perfringens*  $\epsilon$ -toxin
- Conotoxin
- Diacetoxycirpenol
- Diphtheria toxin
- Listeriolysin
- Modeccin
- Pertussis toxin
- Pneumolysin
- *Pseudomonas* toxin A
- Ricin



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## 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



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## 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  $\mu\text{g}$  / kg or lower
- On the list of Federal Select Agents and Toxins



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8

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.



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## Select Agent Toxins

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



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## 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):  $LD_{50} = 0.001 \mu\text{g/kg}$
  - Highest: 1000 mg (DAS and T-2 toxin):  $LD_{50} = 5000 \mu\text{g/kg}$
- Full list of toxins and thresholds on IBC website:

[http://researchadmin.uchicago.edu/docs/ibc/UC\\_ibc\\_Toxin.pdf](http://researchadmin.uchicago.edu/docs/ibc/UC_ibc_Toxin.pdf)



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## 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.



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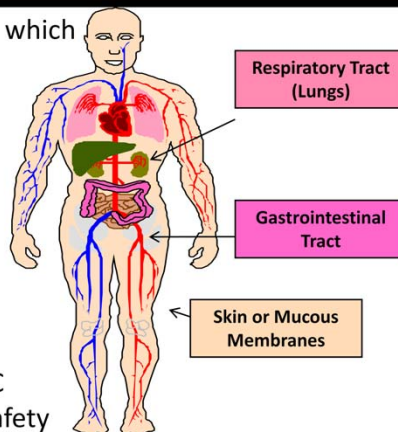
# Routes of Exposure

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



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13

# 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



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14

## 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)



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15

# 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 ☐



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16



## 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



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# Decontamination of Toxins: Chemical

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

Toxin	2.5% NaOCl (~50% bleach) + 0.25 N NaOH	1% NaOCl (~20% bleach)	0.1% NaOCl (~10% bleach)
T-2 toxin	Yes	No	No
Tetrodotoxin	Yes	Yes	No
Ricin	Yes	Yes	Yes
Botulinum	Yes	Yes	Yes

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



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# Decontamination of Toxins: Heat

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

Toxin	Autoclaving	Dry Heat °F			
		200	500	1000	1500
T-2 toxin	No	No	No	No	Yes
Tetrodotoxin	No	No	Yes	Yes	Yes
Ricin	Yes	Yes	Yes	Yes	Yes
Botulinum	Yes	Yes	Yes	Yes	Yes

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



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## 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



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# 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



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21

# 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



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## 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



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# 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



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## 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



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