



Toxic Substances

Aim & Objectives

The aim of the session is to understand the nuances and protection measures for substances and chemicals that possess health hazards

Objectives

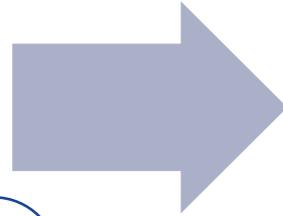
- Identify toxic substances
- Discuss the measure of toxicity
- Determine constraints for working with toxic materials
- Describe the differences between chemical and biohazard toxicity

How do we measure Toxicity?

- Everything is capable of causing harm if administered in sufficiently large quantities

Dosage

- Amount swallowed or absorbed through the skin
- Concentration in the air breathed in over time



Units

- mg/kg – g/kg
- mg/m³ – g/m³
- PPM

COSHH – Control of Substances Hazardous to Health

Industries covered:

- Agriculture
- Baking
- Beauty
- Caterers
- Cleaning
- Chemical Industry
- Engineering
- Fumigation
- Hairdressers
- Offshore oil and gas
- Printing
- Motor vehicle repair
- Welding
- Woodworking

Acute Exposure Guideline Levels – members of the public



Immediately Dangerous to Life and Health

A threshold concentration of a substance in the air, in which an operator must have suitably reliable RPE (e.g. BA)

Substance	IDLH (ppm)
Chlorine	10
Hydrogen Cyanide	50
Acrylonitrile	60
Ammonia	300
Carbon Monoxide	1200

AEGL – 10 minutes

Material	AEGL 1	AEGL 2	AEGL 3	IDLH	LFL/LEL
Ammonia (NH ₃)	30	220	2700	300	150,000
Carbon Monoxide (CO)	NR	420	1700	1200	125,000
Hydrogen Sulphide (H ₂ S)	0.75	41	76	100	43,000
Chlorine (Cl ₂)	0.5	2.8	50	10	-
Hydrogen Cyanide (HCN)	2.5	17	27	50	56,000
Sulphur Dioxide (SO ₂)	0.2	0.75	30	100	-
Phosphine (PH ₃)	NR	4.0	7.2	50	18,000
Phosgene (COCl ₂)	NR	0.6	3.6	2	-

Occupational Exposure Limits – EH40

Substance	CAS number	Workplace exposure limit				Comments
		Long-term exposure limit (8-hr TWA reference period)		Short-term exposure limit (15-minute reference period)		
		ppm	mg.m ⁻³	ppm	mg.m ⁻³	
Sulfotep (ISO)	3689-24-5	-	0.1	-	-	Sk
Sulphur dioxide	7446-09-5	0.5	1.3	1	2.7	
Sulphur hexafluoride	2551-62-4	1000	6070	1250	7590	
Sulphuric acid (mist)	7664-93-9	-	0.05	-	-	The mist is defined as the thoracic fraction
Sulphuryl difluoride	2699-79-8	5	21	10	42	
Talc, respirable dust	14807-96-6	-	1	-	-	
Tantalum	7440-25-7	-	5	-	10	
Tellurium and compounds, except hydrogen telluride (as Te)		-	0.1	-	-	
Terphenyls, all isomers	26140-60-3	-	-	0.5	4.8	
Terphenyl, hydrogenated	61788-32-7	2	19	5	48	
1,1,2,2-Tetrabromoethane	79-27-6	0.5	7.2	-	-	Sk
Tertiary-butyl-methylether	1634-04-4	50	183.5	100	367	

Lethal Doses and Concentrations

LD₅₀ = lethal dose to kill 50% of a population of 10 within 14 days

- Sugar = 29.7g/kgbw (rat, ORAL)
- Ethanol = 12g/kgbw (human, ORAL)
- Caffeine = 0.192g/kgbw (rat, ORAL)
- VX = 0.14mg/kgbw (human, ORAL [estimated])
- Botulinum Toxin = 1ng/kgbw (human, ORAL)

LC₅₀ = lethal concentration of vapour / gas to kill 50% of a population of 10 or more in 4 hrs

1/100 = pphundred

1/1,000,000 = ppmillion

Carbon Monoxide

0.002% = 20ppm

12.5% = 125,000ppm

Hydrogen Sulphide

1/100 = pphundred

1/1,000,000 = ppmillion

Hydrogen Sulphide

0.0005% = 5ppm 1st alarm

0.001% = 10ppm 2nd alarm

4.3% = 43,000ppm LEL

Biohazards

Difference to Chemical Hazard

- Viruses & bacterium reproduce:
 - 10g of chemicals will never become more than 10g
 - 0.001g of biohazard will grow as much as they can
- Solid, liquid or aerosol forms
- Found in living creatures
- Contaminating the working environment.

Established Infection

- Infection will be established if:
- Pathogen released in adequate numbers (infectious dose)
- Form & purity are sufficient
- Environmental conditions are suitable
- A suitable host is present.

Pathogen	Infectious Dose/ Organisms (route)
Vibrio Cholerae	10 ⁸ (ingestion)
Influenza A2	800 (nasopharyngeal inoculation)
West Nile Fever	1 (intramuscular inoculation)

Hazard Groups (HG)

- Infectious substances classified according to risk (personal, communal):
- HG1: Unlikely to cause human disease
- HG2: Can cause human disease
- HG3: Can cause severe human disease – curable
- HG4: Causes severe human disease – no cure
- Chemdata provides initial advice on Class 2 & 3 transport classifications later.

Encountering Biohazards

Research /
testing
cultures

Patient
specimens

Animal
products

Agriculture

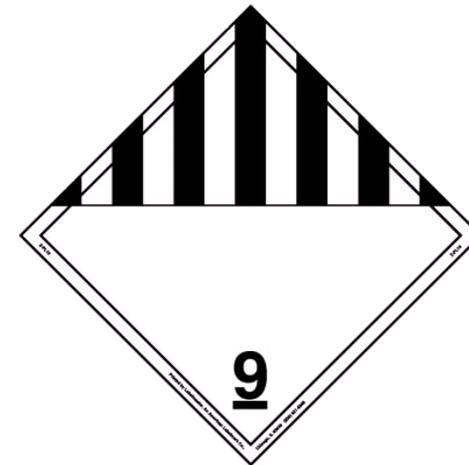
‘Sharps’

Genetically
modified
organisms

Clinical
waste

Other Hazards

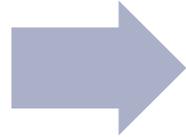
- Non-infectious genetically modified organisms
- Dry ice used (-78oC) during transport & storage
- Preserve biological samples
- Cold burns, asphyxiation, condenses water out of air (fog)
- Aerosols / propellants



Classification of Infectious Substances

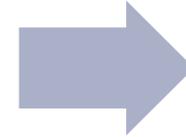
Category A:

- Debilitating or fatal to human and/or animal



Category B:

- Not meeting criteria for category A



Exceptions:

- Blood for transfusions, organs for donation.

What is ricin?

Ricin is a highly toxic, water-soluble protein, often occurring as a white powder

Discovered in 1888 and extracted from the seeds of the castor plant (*Ricinus communis*).

It can be isolated from the waste of castor oil extraction process

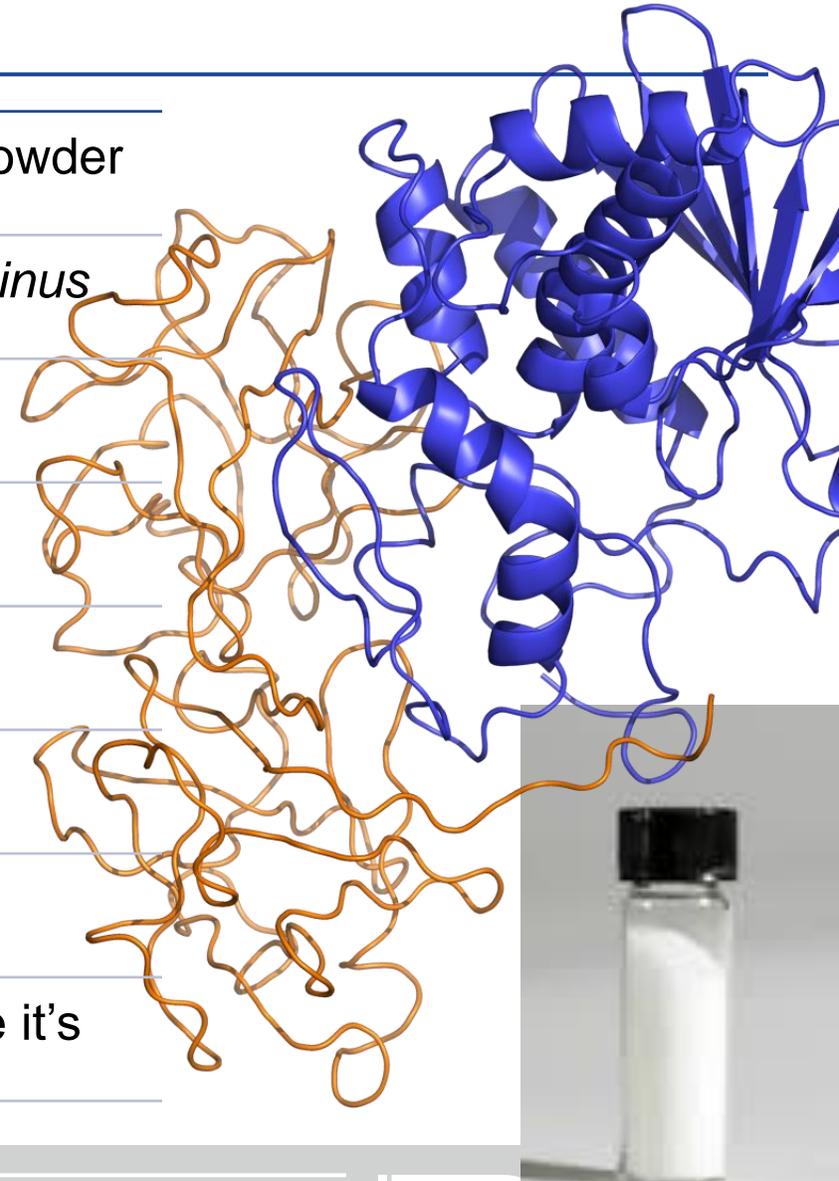
One of the most toxic substances known

Concern over weaponisation – toxic through most exposure routes

When in the body, it induces apoptosis within cells

Apoptosis (aka programmed cell death) = cell self-destruct trigger

High temperatures (>80°C) can denature/degrade the protein and reduce its toxicity (cooking is part of castor oil production)



How can you acquire castor seeds (beans)

- Readily available from 'herbal/natural remedy' outlets
- Castor seeds contain 1-5% by weight ricin.



10 Castor Bean Tropical Mix, Ricinus Communis Impala Rare Jatropha Castor Bean Oil Plant Seeds

Brand: SVI

4.0 ★★★★★ (46)

Lowest price in 30 days

-45% £5⁹⁹ (£0.60 / count)

Was: £10.99 ⓘ

£5⁹⁹ (£0.60 / count)

FREE delivery 29 - 30 January.

[Details](#)

📍 Deliver to Joshua - Cheltenham
GL51 6

In stock

Quantity: 1 ▾

Add to basket

Buy Now

Extracting ricin



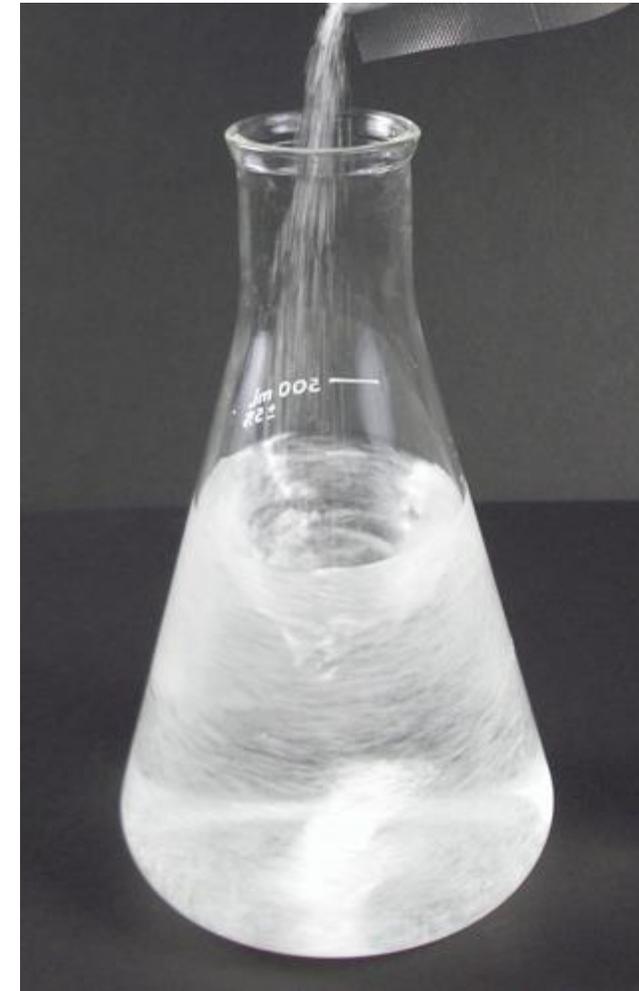
Use an oil press or crush & squeeze seeds



Collect the 'meal', discard the oil

Extracting ricin

Extract proteins from the meal with acidified salt water (pH 3.8 – use hydrochloric acid), discard remaining pulp



Add ammonium sulphate to liquid filtrate gradually, ricin protein (A/B) will precipitate (selective fractionation)
- further purification can be achieved through liquid chromatography

How toxic is ricin?

- Ricin causes cells to self-destruct (apoptosis) – cancer treatment
- Various symptoms occur following specified exposure routes:

Ingestion

- Diarrhoea
- Vomiting
- Hallucinations
- Seizures
- Liver and Renal Failure

Inhalation

- Difficulty Breathing
- Tightness of chest
- Chemical pneumonia
- Respiratory failure
- Red blood cell destruction

Absorption

- None
 - Unless through damaged skin
- Solvents may aid absorption

- All can occur within 72hrs (depending on dose)
- Even small amounts via inhalation (or injection) can be lethal
- Ingestion requires greater doses to be lethal in comparison to inhalation/injection
- Accidental ricin poisoning is rare (30 seeds, injection)

How toxic is ricin?

- Reports of just 1 milligram is enough to kill an adult
- More detailed reports suggest that 22 μg per Kg body mass is lethal = 2.2mg (100kg [15st 10lb] person)
- There is no antidote, simply treating the symptoms sufficiently to increase chances of survival.



Substance	LD ₅₀	100kg dose
Heroin	21.8 mg/kg	2.18g
LSD	16.8 mg/kg	1.68g
Hydrogen Cyanide	3.7 mg/kg	0.37g
Robustoxin (from Sydney funnel-web spider)	140 μg /kg	14mg
Amatoxin (from Amanita phalloides mushrooms)	100 μg /kg	10mg
Ricin	22 μg /kg	2.2mg

PPE & Decontamination

- Use of BA and GTS recommended (Chemdata states liquid tight suits)
 - Risk from skin exposure is low, primary routes are inhalation and ingestion
 - Priority activities such as MTFA, life-saving activities can afford lower levels of PPE – minimum recommended requirements are BA
 - Where BA is not available then powered respiratory protection is recommended. At the absolute minimum, particulate filtering RPE is a must
 - Ricin particles less than 10µm is required for effective inhalation admission:
 - <1 µm remain airborne for long periods,
 - 3 – 5 µm remain aerosolized for less than an hour
 - >10 µm fall out of the air straight away

Ppe & decontamination

GTS/LTS

- Wet decontamination
- Contain water run-off
- Incinerate PPE
 - Ricin becomes inactive over 80°C
 - Can still be harmful even when dissolved in water

Splash suit/fire kit/coveralls

- Light spray/dampen PPE prior to safe undress



Chemical Warfare Agents

Chemical Warfare Agents

CW agents are extremely toxic synthetic chemicals that can be dispersed as a gas, liquid or aerosol or as agents adsorbed to particles to become a powder. These CW agents have either lethal or incapacitating effects on humans

Nerve agents

- VX
- Novichock

Vesicants (blistering agents)

- Mustard Gas

Bloods agents (cyanogenic agents)

- Cyanides

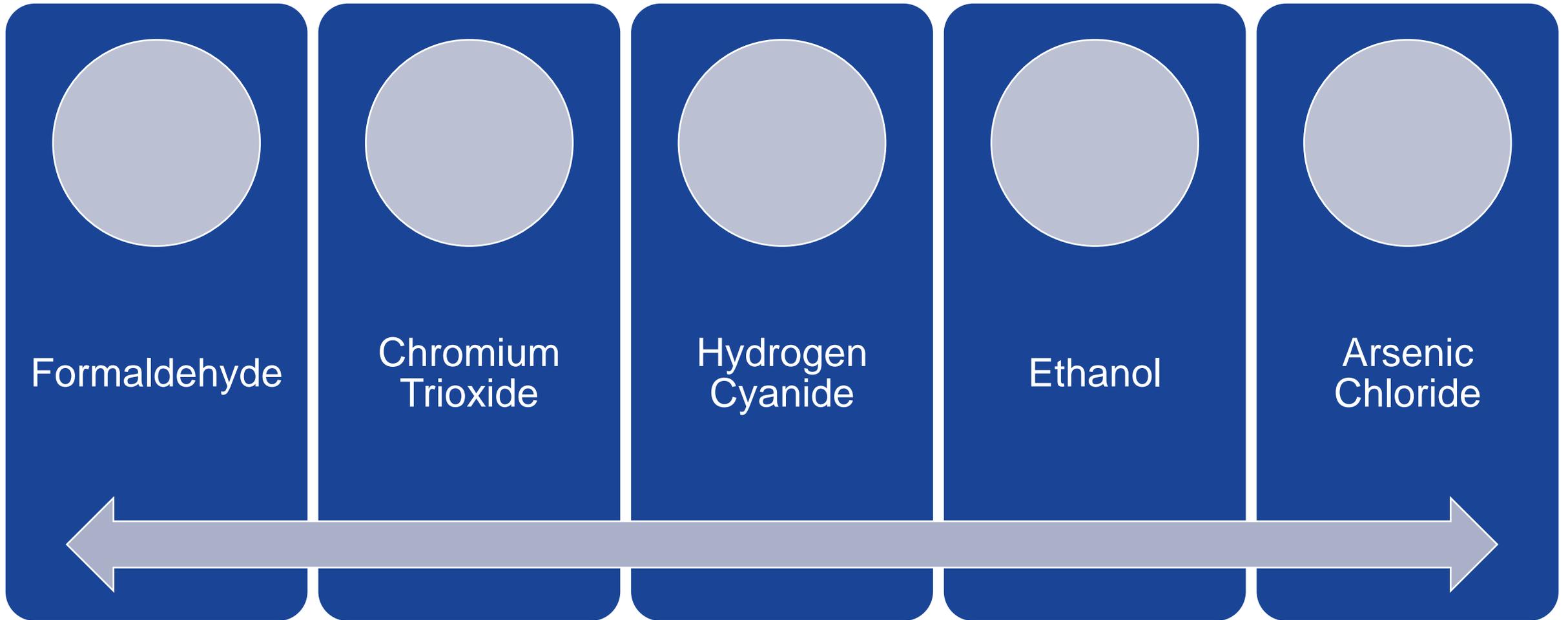
Choking agents (pulmonary agents)

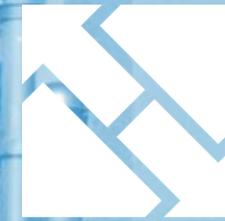
- Chlorine
- Ammonia

Riot-control agents (tear gases)

Exercise

How Toxic are they?





NCEC
HAZMAT
ACADEMY

Any Questions?