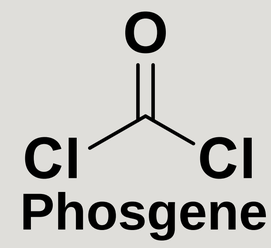
ORGANISATION FOR THE
PROHIBITION OF CHEMICAL WEAPONS

Working Together For a World Free of Chemical Weapons

Choking Agents and their Countermeasures

Chlorine

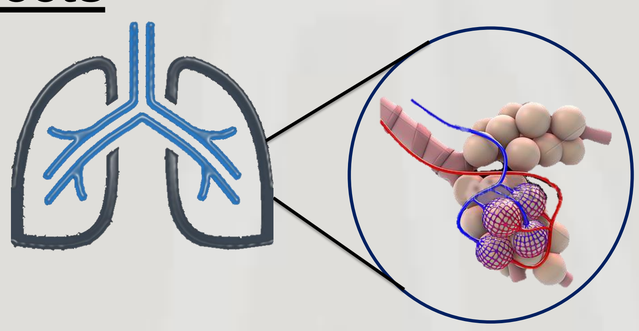
Chlorine is a yellow-green gas with a strong, bleach like odour. Soldiers describe its smell as a distinct mix of pepper and pineapple. Its density (3.21 kg/m^3) is about three times that of air.



Phosgene

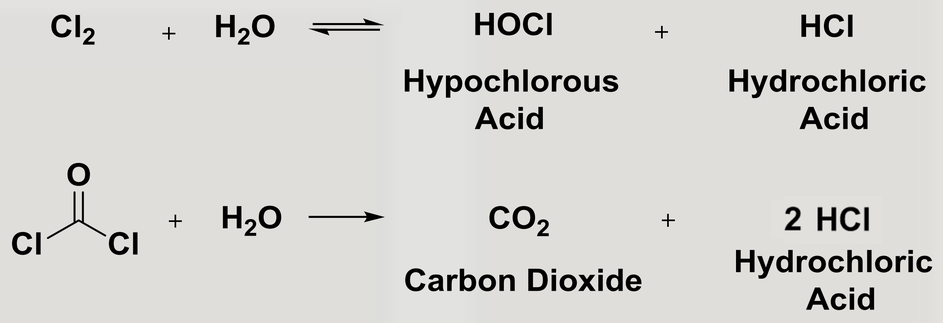
Phosgene is a colourless gas with a musty odour. Its density (4.25 kg/m^3) is about four times that of air.

Effects



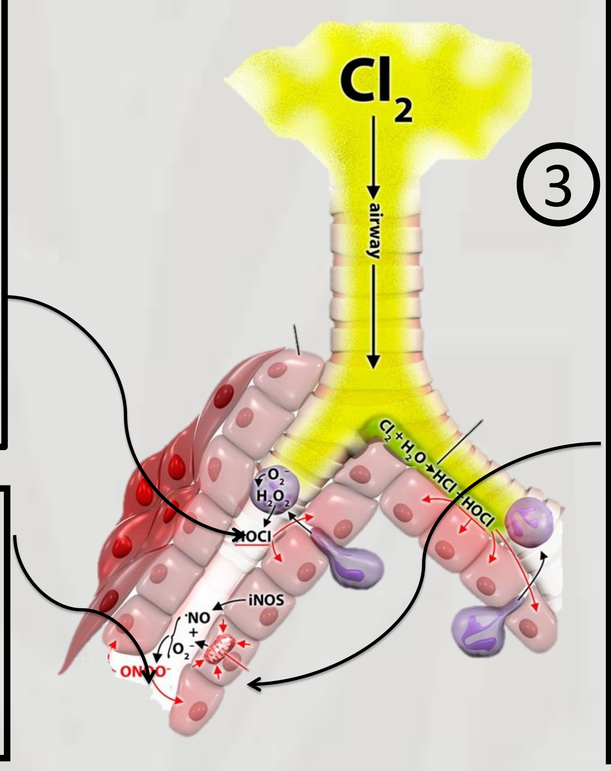
Choking agents react instantly with biological fluids, skin and eyes

- Chest Discomfort
- Shortness of breath
- Irritation of nose and throat
- Lachrymation



① Both **Cl_2** and HOCl react with airway lining constituent molecules. Reactive oxygen species (ROS) such as superoxide (O_2^-), hydrogen peroxide (H_2O_2) and hydroxy radicals (·OH) also form, and cause irreversible biochemical changes.

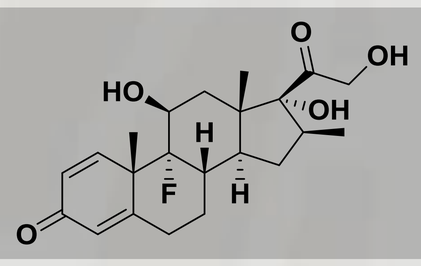
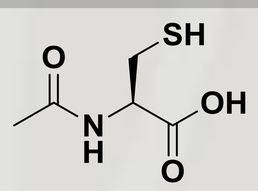
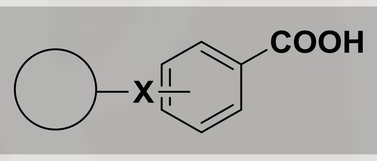
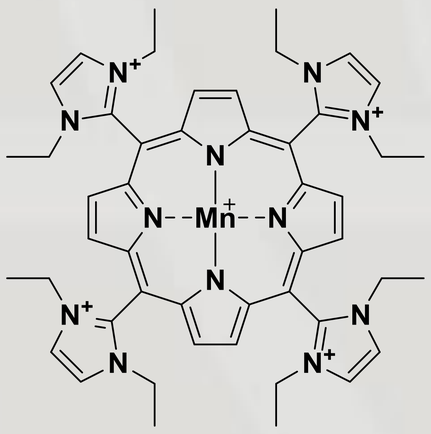
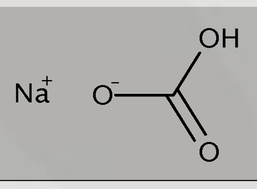
② Induction of nitric oxide synthase (iNOS) can lead to formation of nitric oxide (NO) and, secondarily, peroxynitrite ($ONOO^-$).



③ These reactive species damage DNA repair enzymes; activate some inflammatory cascades; and induce vascular dysfunction, oxidative stress, mitochondrial damage, and arterial plaque formation.

Bronchospasm, increased mucous production causes damage of alveoli-capillary membranes, in addition to a life-threatening build-up of fluid on the lungs (pulmonary edema).

Phosgene rapidly hydrolyses in water to form carbon dioxide and hydrochloric acid which produces ocular, naso-pharyngeal, and central airway irritation. The carbonyl group (C=O) of phosgene can undergo acylation reactions with amino (-NH_2), hydroxyl (-OH), and sulfhydryl (-SH) groups. These reactions account for the major pathophysiological effects of phosgene (severe dyspnoea and clinically evident pulmonary edema).

Countermeasures including supportive measures	Structure	Indication
Steroids (Inhaled or intravenous) e.g. Betamethasone (illustrated on the right)		Decrease respiratory complications by inhibiting inflammatory responses.
N-Acetyl cysteine (NAC)		Prevents cells from oxidative damage (anti-oxidant)
Non Steroidal Anti Inflammatory Drugs (NSAIDs)		Reduce pulmonary oedema
AEOL 10150 Newly available countermeasure *Curr Opin Investig Drugs. 2006 Jan;7(1):70-80*		This countermeasure has multiple mechanisms of action that include: anti-oxidant, anti-inflammatory and anti-angiogenic activity; and the catalytic consumption of reactive oxygen and nitrogen species (free radicals)
Nebulized Sodium Bicarbonate (is not generally recommended but there are reports of its use). *Inhal Toxicol. 2006 Oct;18(11):895-900*		Neutralization of the choking agent in the affected area.