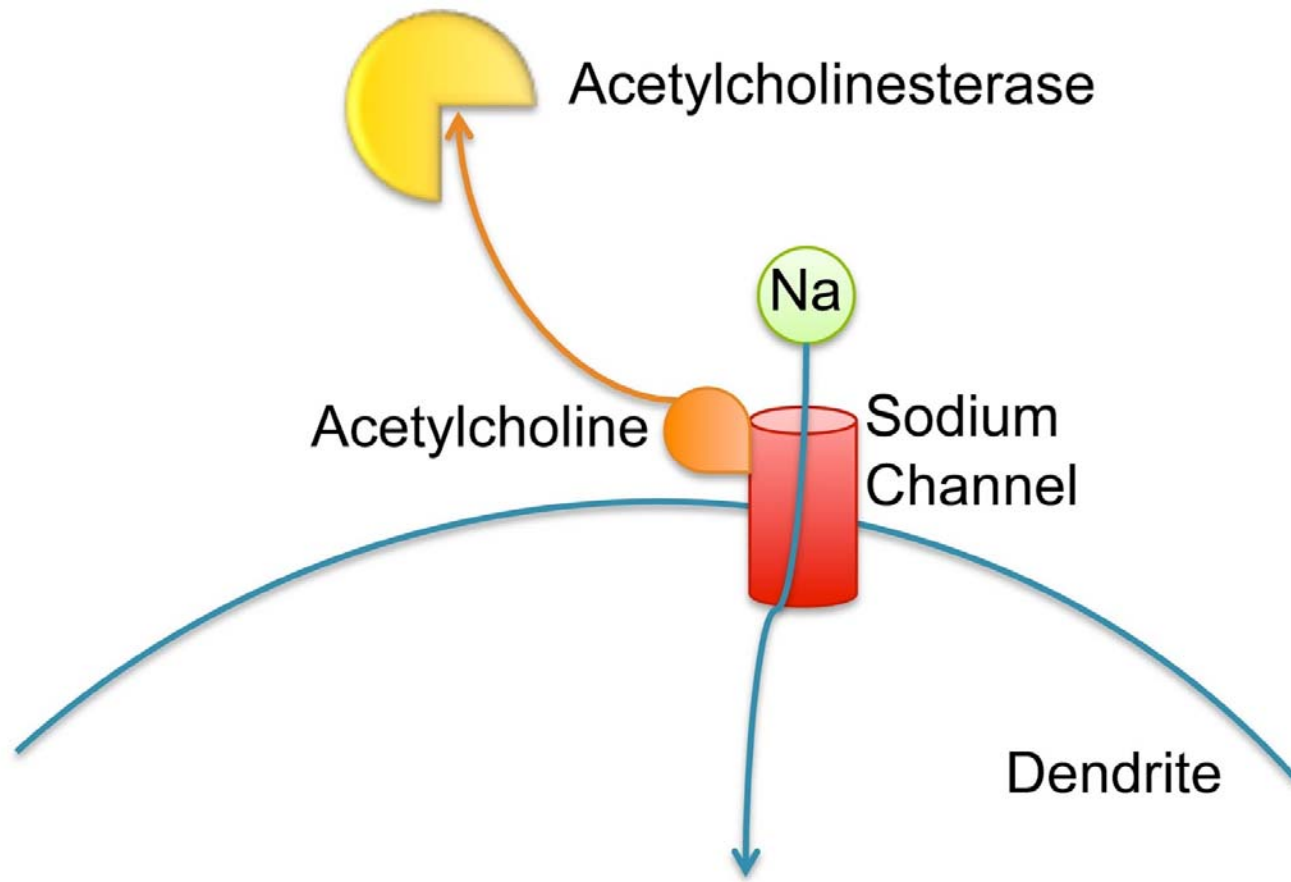


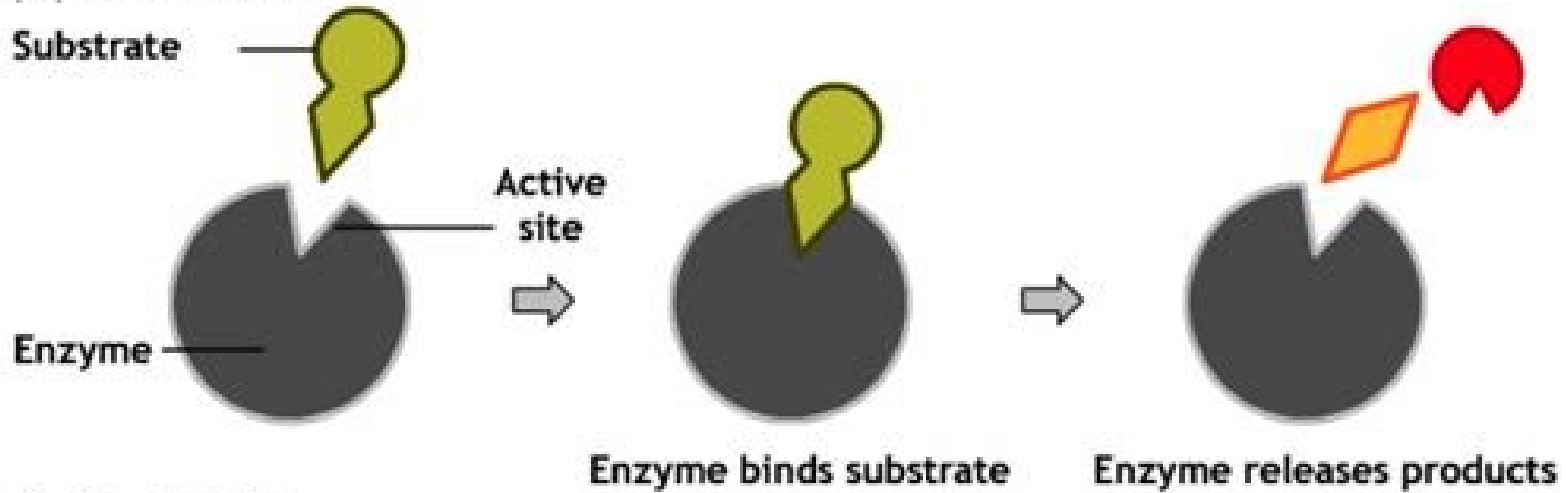
**1** Acetylcholine (ACh) is made from choline and acetyl CoA.

**2** In the synaptic cleft ACh is rapidly broken down by the enzyme **acetylcholinesterase**.

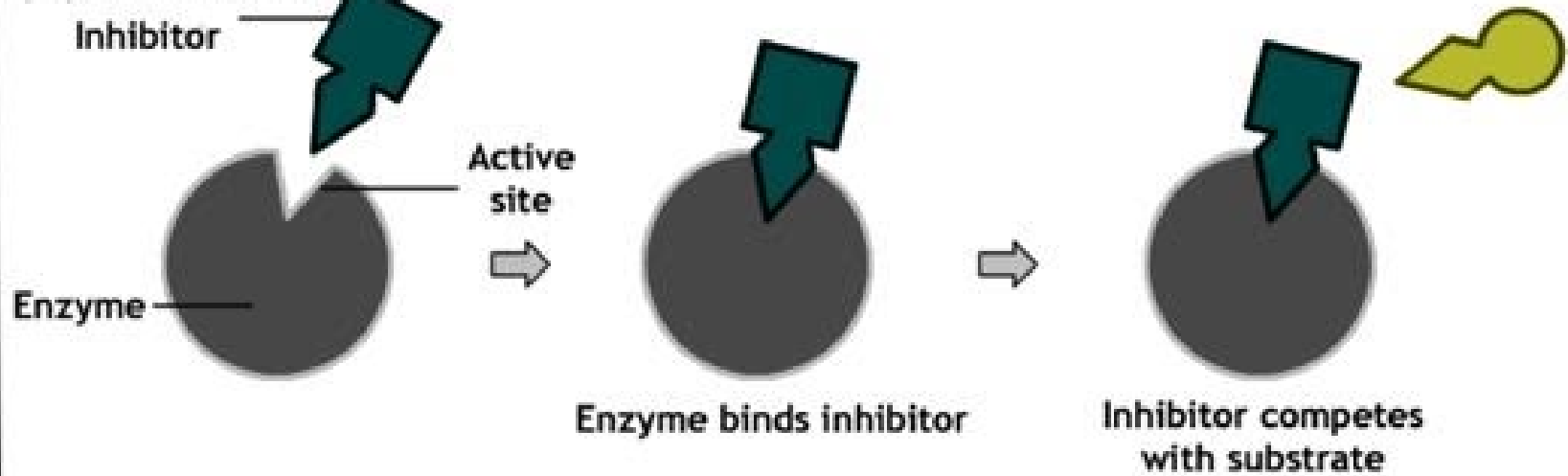
**3** Choline is transported back into the axon terminal and is used to make more ACh.



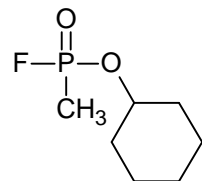
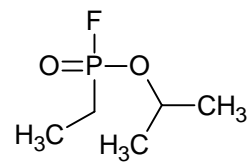
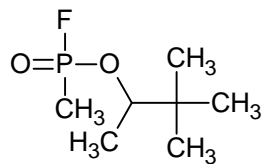
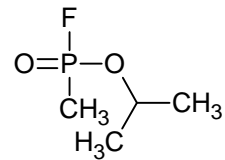
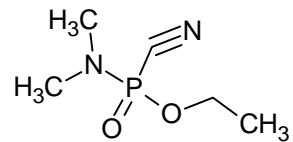
### (a) Reaction



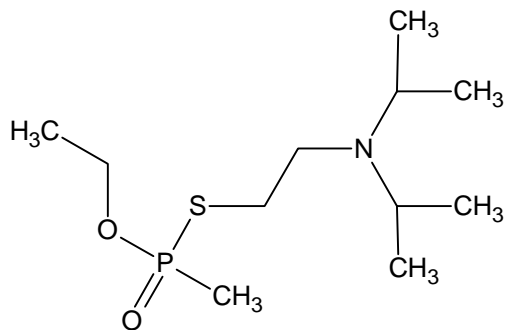
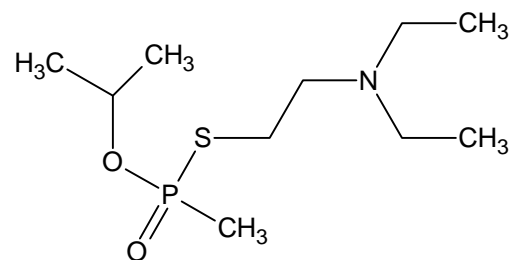
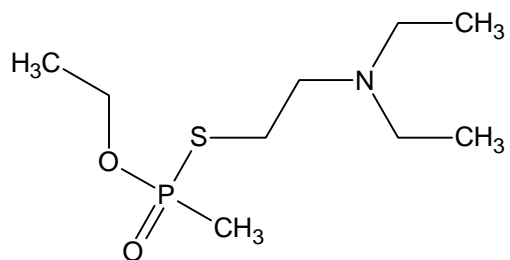
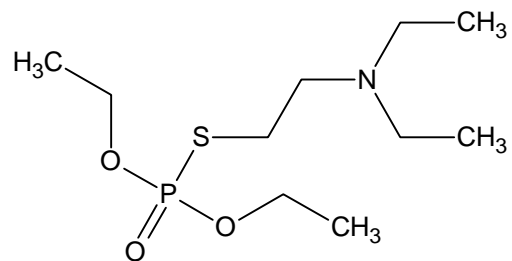
### (b) Inhibition

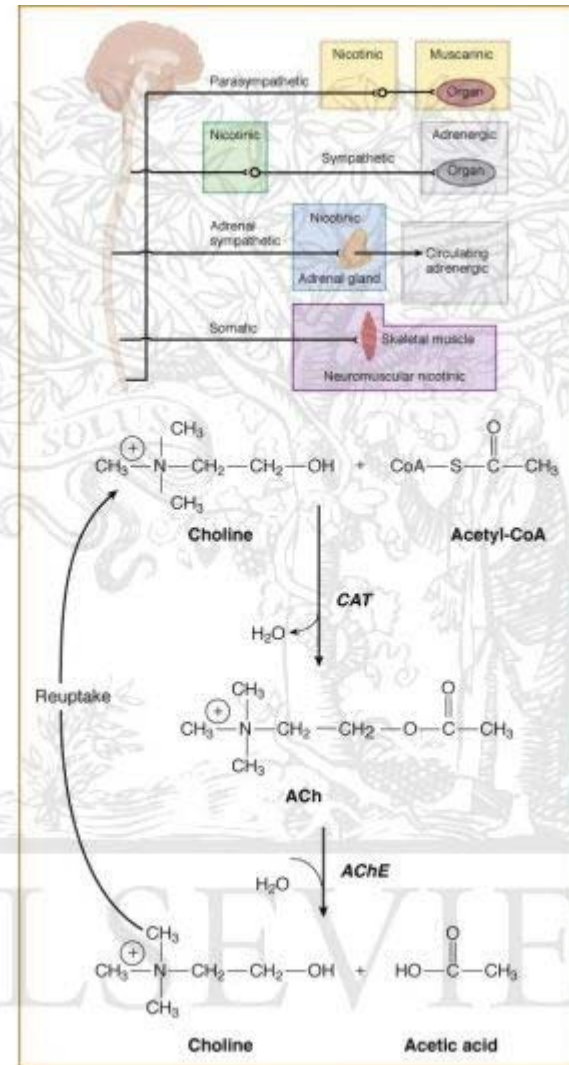
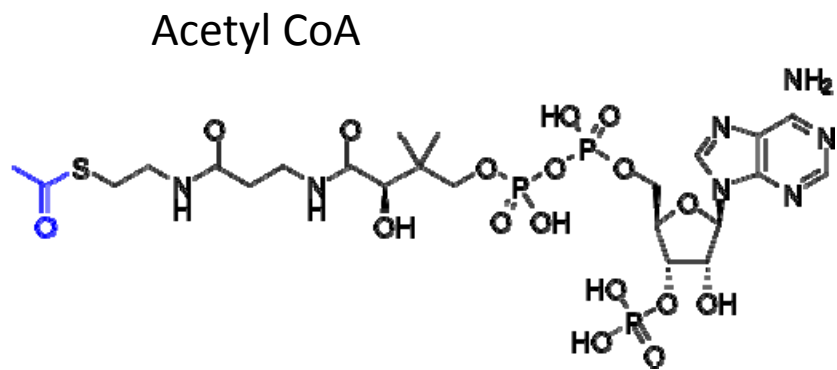
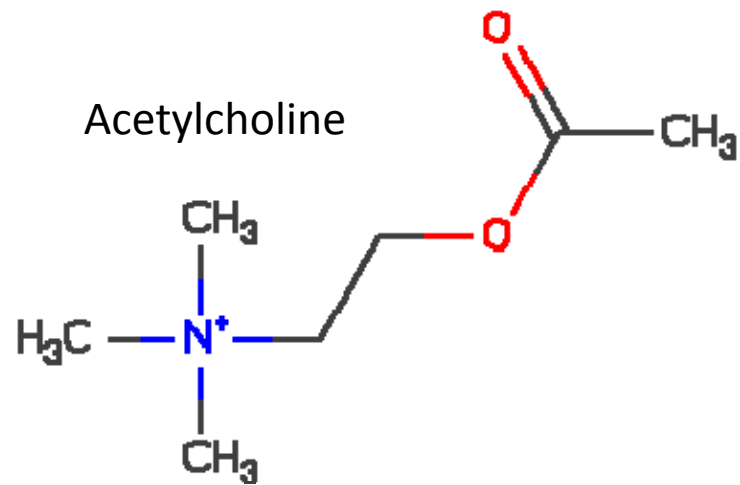


## G-Series

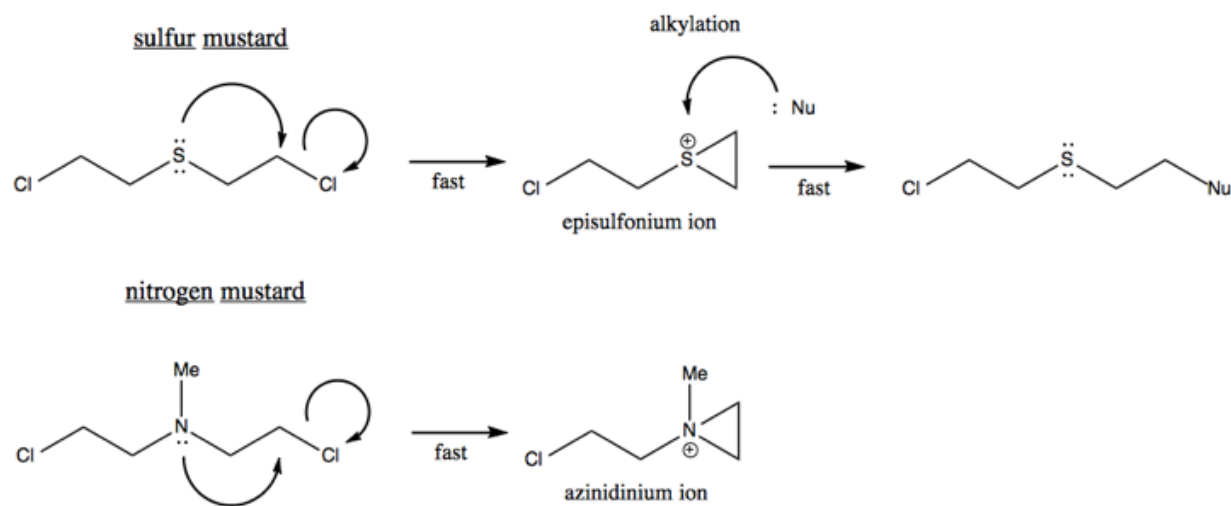


## V-Series



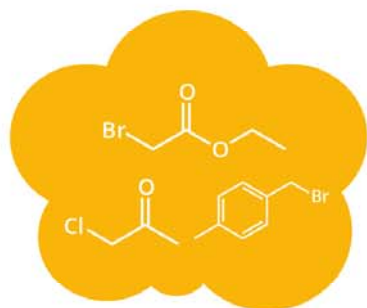


The toxic effects of mustard agent depend on its ability to covalently bind to other substances. The chlorine atom is spiked off the ethyl group and the mustard agent is transferred to a reactive sulphonium ion. This ion can bind to a large number of different biological molecules. Most of all it binds to nucleophiles such as nitrogen in the base components of nucleic acids and sulphur in SH-groups in proteins and peptides. Since mustard agent contains two "reactive groups", it can also form a bridge between or within molecules. Mustard agent can destroy a large number of different substances in the cell by means of alkylation and thereby influence numerous processes in living tissue.



# CHEMICAL WARFARE WORLD WAR I

WORLD WAR I IS SEEN AS THE DAWN OF MODERN CHEMICAL WARFARE, WITH A VARIETY OF DIFFERENT CHEMICAL AGENTS BEING EMPLOYED ON A LARGE SCALE, RESULTING IN APPROXIMATELY 1,240,000 NON-FATAL CASUALTIES, AND 91,000 FATALITIES. A VARIETY OF POISONOUS GASES WERE USED THROUGHOUT THE CONFLICT, WITH EACH HAVING DIFFERING EFFECTS UPON VICTIMS.



## TEAR GASES

(ethyl bromoacetate, chloroacetone & xylol bromide)

### SMELL & APPEARANCE

Both ethyl bromoacetate and chloroacetone are colourless to light yellow liquids with fruity, pungent odours. Xylol bromide is a colourless liquid with a pleasant, aromatic odour.

### EFFECTS

Tear gases are what is known as 'lachrymatory agents' - they irritate mucous membranes in the eyes, mouth, throat & lungs, leading to crying, coughing, breathing difficulties, and temporary blindness.

### FIRST USED

**1914** In August 1914, the French forces used tear gas grenades against the German army, to little effect.

### ESTIMATED CASUALTIES

**0** fatal These gases were used to incapacitate enemies rather than to kill; symptoms commonly resolved within 30 minutes of leaving the affected area.



## CHLORINE

### SMELL & APPEARANCE

Chlorine is a yellow-green gas with a strong, bleach-like odour. Soldiers described its smell as 'a distinct mix of pepper and pineapple'.

### EFFECTS

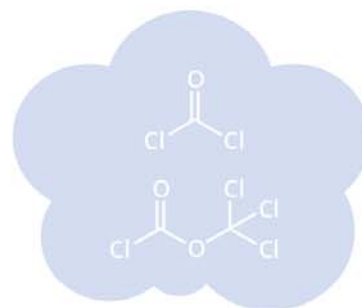
Chlorine reacts with water in the lungs, forming hydrochloric acid. It can cause coughing, vomiting, and irritation to the eyes at low concentrations, and rapid death at concentrations of 1000 parts per million.

### FIRST USED

**1915** Used by German forces at Ypres in April 1915. British forces used it for the first time at Loos in September.

### ESTIMATED CASUALTIES

**>1,100** number of fatalities in first use of chlorine at Ypres Chlorine was devastating as troops were initially unequipped to deal with it. Later, gas masks limited its effectiveness.



## PHOSGENE & DIPHOSGENE

(carbonyl dichloride & trichloromethane chloroformate)

### SMELL & APPEARANCE

Phosgene is a colourless gas with a musty odour comparable to that of newly mown hay or grass. Diposgene is a colourless, oily liquid.

### EFFECTS

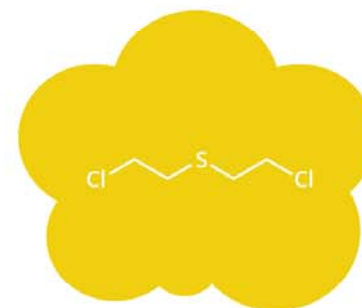
React with proteins in lung alveoli, causing suffocation. Cause coughing, difficulty breathing and irritation to the throat & eyes. Can cause delayed effects, not evident for 48hrs, including fluid in the lungs & death.

### FIRST USED

**1915** In December 1915, the German forces used phosgene against the British at Ypres.

### ESTIMATED CASUALTIES

**85%** of all gas-related fatalities in WWI It's estimated 85% of all gas-related fatalities in World War I resulted from phosgene and diposgene, which were both used to fill artillery shells.



## MUSTARD GAS

(bis(2-chloroethyl) sulfide)

### SMELL & APPEARANCE

When pure, mustard gas is a colourless and odourless liquid, but it's used as a chemical agent in impure form. These are yellow-brown in colour and have an odour resembling garlic or horseradish.

### EFFECTS

Powerful irritant and vesicant (blistering agent) that can damage the eyes, skin, & respiratory tract. Causes chemical burns on contact with skin. Forms intermediates that react with DNA leading to cell death.

### FIRST USED

**1917** On 12<sup>th</sup> July 1917, German forces used mustard gas against the British at Ypres.

### ESTIMATED CASUALTIES

**2-3%** mortality rate of mustard gas casualties The mortality rate of mustard gas casualties was low, but its effects were debilitating, and patients required elaborate care.



**Category A Agents**

	<b>Incubation Period</b>	<b>Communicability</b>	<b>Symptoms</b>	<b>Treatment</b>
<b>Anthrax</b> ( <i>Bacillus anthracis</i> )	1 to 7 days, although there are rare cases of 60 days.	Person-to-person contact is very rare. It has not been reported for inhalation or gastrointestinal anthrax. Contact with tissue or livestock and an exposed area or lesion, inhalation of spores.	3 kinds of illness: cutaneous (blisters/bumps), inhalation (fever, SOB, cough, etc.), and gastrointestinal (fever, chills, diarrhea, swelling of abdomen).	IV antibiotics and antitoxins. Timing and treatment are crucial for survival of inhalation.
<b>Botulism</b> ( <i>Clostridium botulinum</i> )	12 to 36 hours	Consumption of food that contains toxin (common outbreaks associated with improperly canned food).	4 kinds: foodborne, wound (via contamination), infant (colonization of intestines in an infant), and adult intestinal toxemia. Symptoms: blurred vision, drooping eyes, muscle weakness, muscle paralysis, etc.	Ventilator if respiratory failure occurs. Antitoxins are also available.
<b>Plague</b> ( <i>Yersinia pestis</i> )	1 to 7 days	Flea bites (infected fleas), contact with contaminated fluid or tissue, and infectious droplets (cough via pneumonic cases)	3 kinds: bubonic (fever, chills, weakness, and swollen lymph nodes), septicemic (fever, chills, shock, bleeding into skin and organs), and pneumonic plague (fever, rapid pneumonia, cough, etc.	Doxycycline, ciprofloxacin, and gentamicin (common antibiotics)
<b>Smallpox</b> ( <i>Variola minor, major</i> )	7 to 19 days	Droplet spread via saliva droplets.	Prodromal rash, high fever, headache, malaise, etc.	No known treatment, but vaccination within 3-4 days of exposure can reduce severity of illness.
<b>Tularemia</b> ( <i>Francisella tularensis</i> )	3 to 5 days with a range of 1-14.	Arthropod bites (infected ticks), contact of infected tissue with mucous membranes or ingestion of infected meat.	Depends on exposure route, but general symptoms are fever, swelling of lymph glands, difficulty breathing, chest pain, etc.	Antibiotics such as streptomycin, gentamicin, doxycycline, and ciprofloxacin.
<b>Viral Hemorrhagic Fevers</b> Zoonotic viruses from 4 families (arenaviruses, filoviruses, bunyaviruses, and flaviviruses)	2 to 21 days	Where animal or insects are natural reservoirs. Person-to-person transmission through close contact with infected persons noted in Ebola, Marburg, Lassa, and Crimean-Congo hemorrhagic fever.	Fever, dizziness, muscle aches, exhaustion, bleeding under the skin and in internal organs or from orifices and eyes, shock, nervous system malfunction, delirium, and seizures.	No established treatments. Ribavirin has been show to be beneficial for Lassa fever, but supportive care is standard practice.

# Ricin poisoning

## WHAT IT DOES

Inactivates ribosomes in cells, which prevents the body from creating proteins. This can cause widespread organ damage that can lead to pulmonary, liver, renal, and immunological failure

## PRODUCTION

Can be made from waste "mash" produced when oil is extracted from castor beans



## DELIVERY

Can be introduced in liquid, aerosol, powder, or pellet form

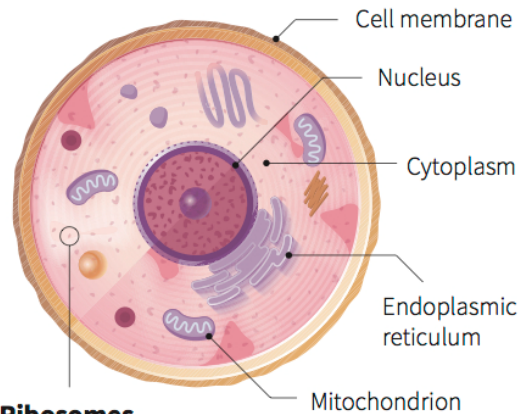
## EFFECTS AFTER EXPOSURE

**Within 8 hours** - Pathological changes

**36-72 hours** - Acute respiratory failure

If exposure does not prove fatal within 3-5 days, the victim will usually recover

## HUMAN CELL STRUCTURE

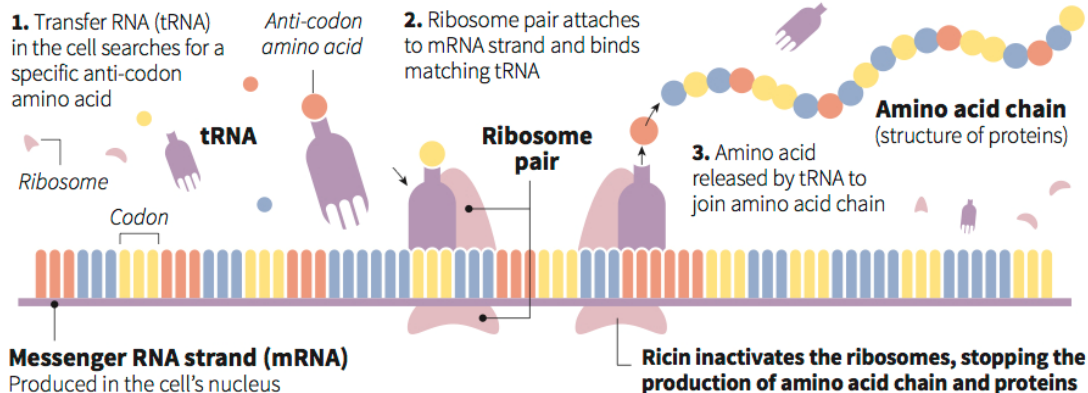


### Ribosomes

- ▶ Can be found in the cytoplasm or the endoplasmic reticulum
- ▶ Bind one amino acid at a time to build chains of proteins which the body uses to perform biological functions

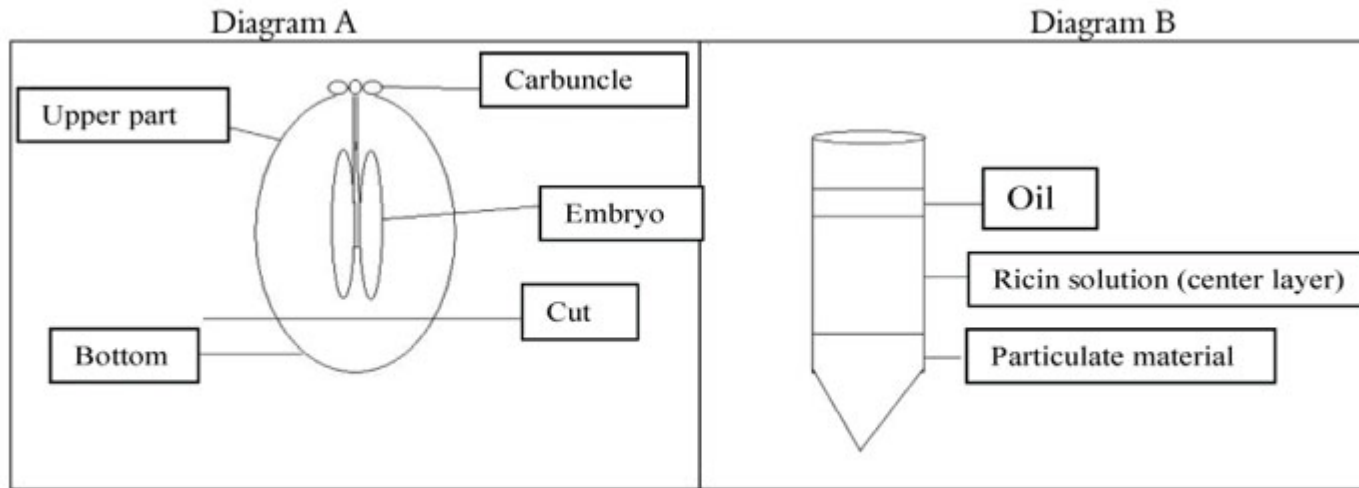
## HOW RICIN AFFECTS PROTEIN SYNTHESIS

*Note: Diagram is schematic*



Sources: Reuters; How Stuff Works; Federation of American Scientists

RNA - Ribonucleic acid



**Figure 1.** Diagrams (A) of the castor bean seed showing the part that was removed and (B) of the centrifuge tube showing the suspension separated into three layers.

22ug/kg body mass

Injested 1mg/kg – stomach kills most.

The whole seed contains about 45 to 50% oil,  
 12 to 16% protein (~ 1% of which  
 is ricin), 3 to 7% carbohydrates, 23 to 27% fiber  
 and 2% ash.

If Ricin extracted per g of seed = 7 mg