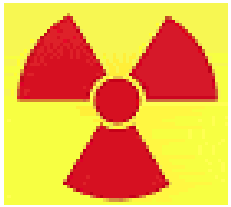

بسم الله الرحمن الرحیم

RISK!!

LOW → HIGH



Nuclear

Biological

Chemical

HIGH ← LOW

TECHNICAL COMPLEXITY

Chemical: low complexity, high probability

Chemical agent Overview

Types of Chem-Agents

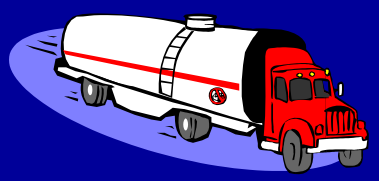
Some chem-agents are persistent, many are not persistent

Persistent chemicals

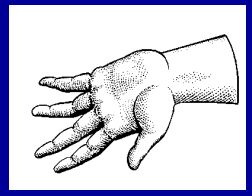
- Remain on surfaces without evaporating or breaking down for more than 24 hours
- can remain for days to weeks

Non-persistent chemicals

- Quickly evaporate and break down
- carried in bulk on commercial carriers



Chemical Agent Detection

- Some can be seen 
- Some can be smelled 
- Some can be tasted 
- Most can be felt (e.g. burning sensation, choking) 
- *All can be detected by appropriate instruments* 

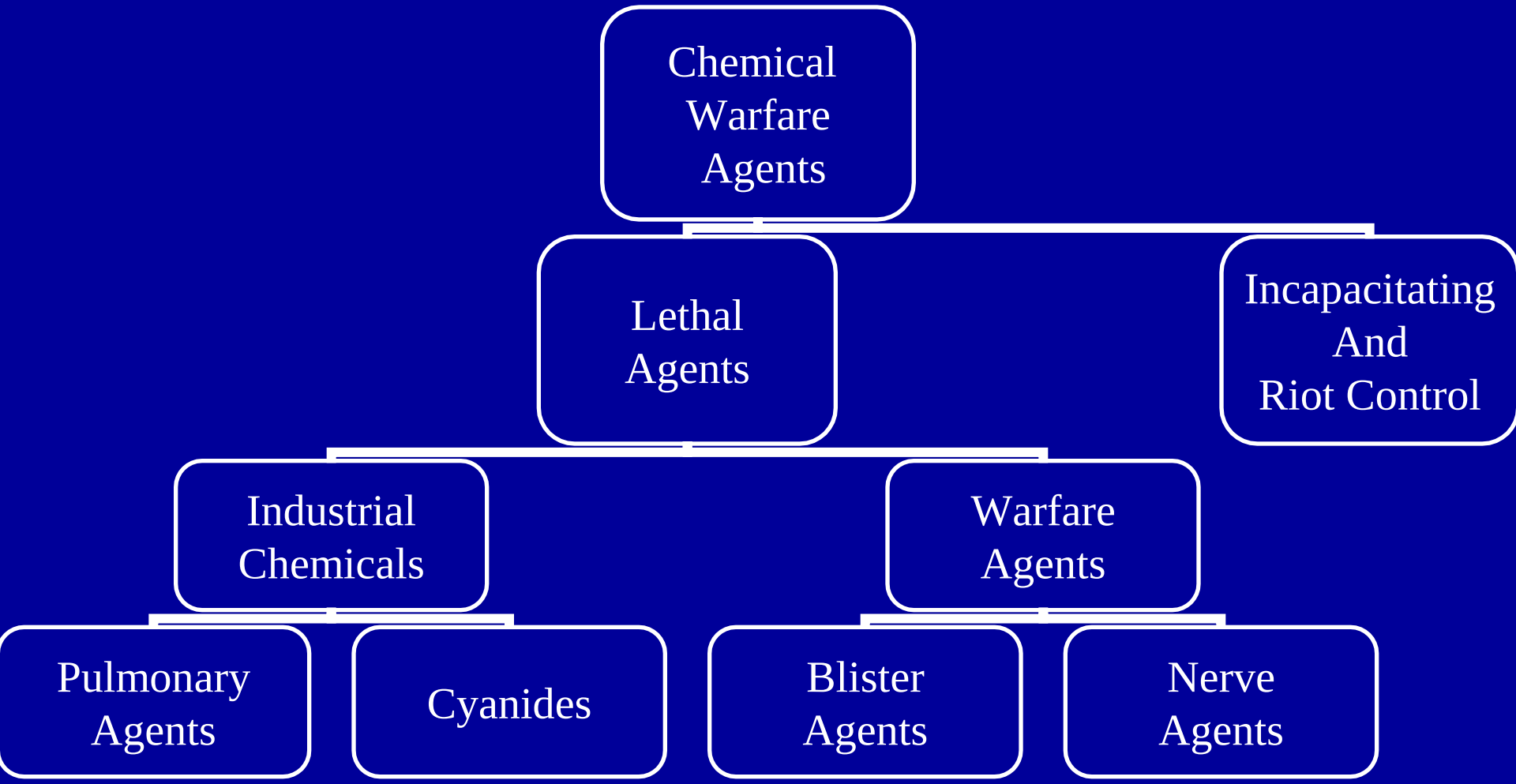
Chemical Agent Effects and Treatment

Chemical agents may be solid, liquid, or gas.

HEALTH EFFECTS	MITIGATION
• Disorientation • Dizziness • Nausea • Blindness • Serious Injury • Immobilization • Death	1. Minimize exposure: Avoid chemical cloud Cover face to filter breathing 2. Get medical attention: Skin decontamination Antidote

Some have no antidote!

Classes of Chemical Agents



Chemical Agents: Summary

Agent - Prototype	**Effects**	**Onset**	**Treatment**
Cyanide - H_2 cyanide	Loss of consciousness, convulsions, apnea	Seconds to minutes	Sodium nitrite or amyl nitrite, sodium thiosulfate
Nerve agents - Sarin	Miosis, rhinorrhea, N/V, convulsions, apnea	Minutes	Atropine, pralidoxime, valium
Pulmonary agents - Phosgene	Eye/airway irritation, dyspnea, delayed pulmonary edema	Hours	Fresh air, supportive care, enforced rest
Vesicants - Sulfur mustard	Asymptomatic period, erythema, blisters, eye irritation, cough	Hours to days	Decontamination, supportive care

Chemical Warfare: Iran-Iraq War

Iran-Iraq War: 1980-88

- Iraq: Chemical weapons
  - Widespread use
- Blistering agent: Lewisite
- Nerve agent: Tabun
  - Heavy Iranian casualties, deaths

Chemical Terrorism: Iraqi Kurds

- 1988: Iraq bombed their Kurds with mustard, nerve and cyanide gas
- Over 5,000 died
75% women and children

1- Pulmonary Agents

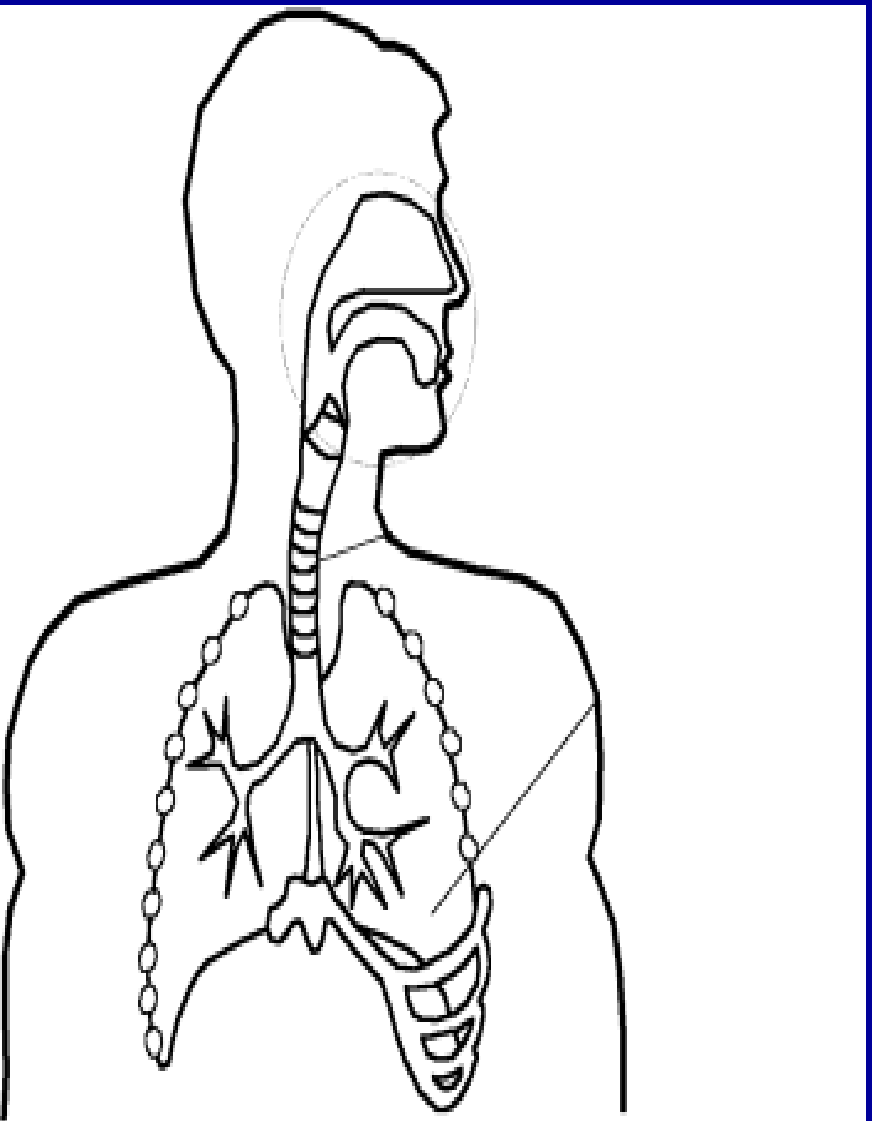
Choking or Lung Agents

- Phosgene (CG)
- Chlorine (CL)
- Ammonia
- Chloropicrine
- Chlortrifluoride

فسژن

- يا كربنيل كلرايد
- يك گاز بيرنگ
- با نقطه جوش۸/۲ درجه سانتيگراد، و نقطه ذوب ۱۱۸- سانتيگراد
- با بوئي مشابه يونجه تازه چيده شده (علف كپك زده)
- ناپايداروبسيار فرار است
- از هوا سنگين تر است(تجمع در سطح زمين،زيرزمين وسنگرها)

Pulmonary Agents: Toxicity



Upper Airway Irritation

Water Solubility

HIGH

LOW

Hydrochloric Acid
Ammonia
Mustard Gas

Chlorine

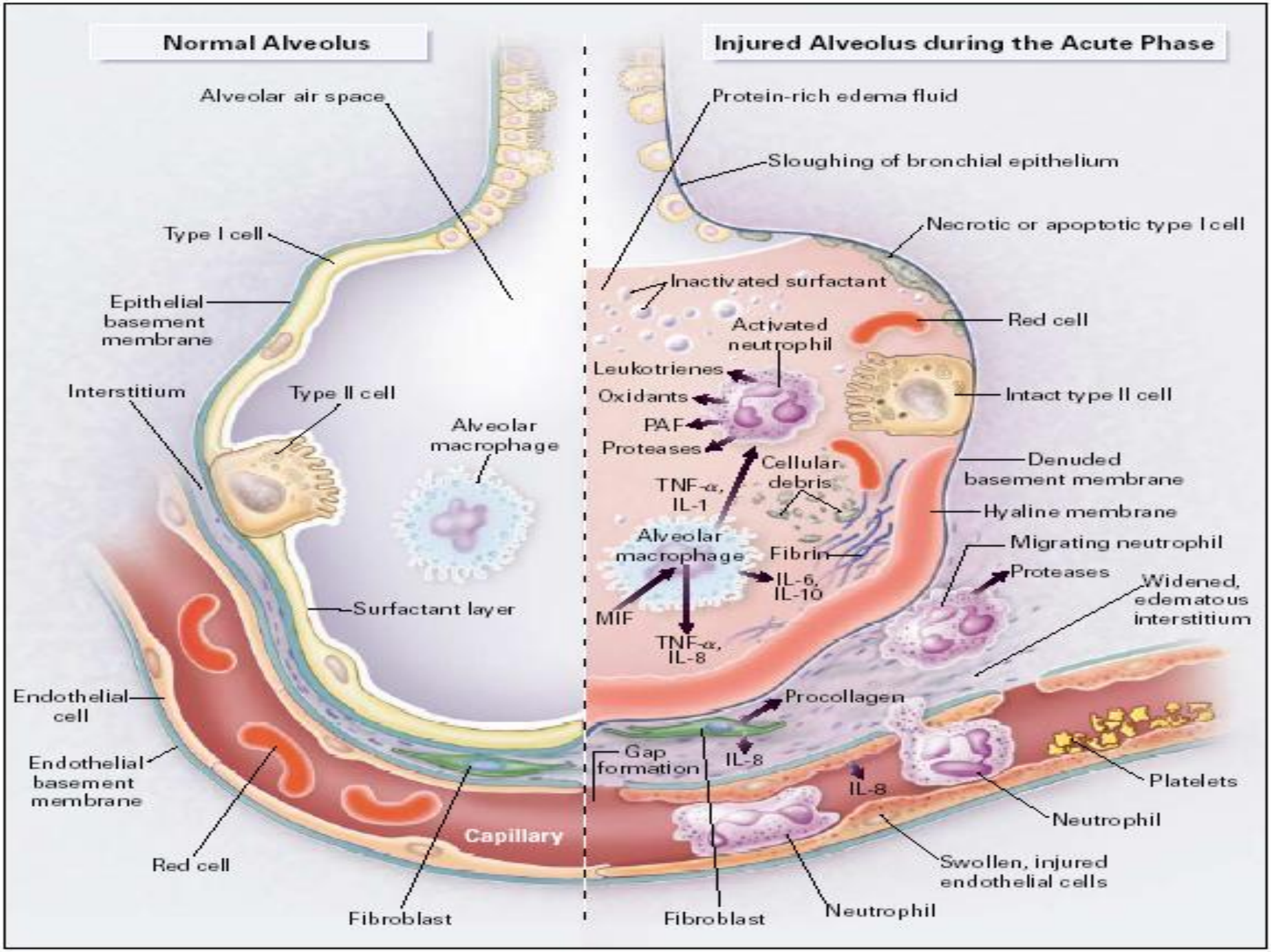
Phosgene

Nitrogen Oxides

Pulmonary Irritation

Pulmonary Agents: Toxicity

- Pulmonary agents
  - Absorbed by inhalation
  - Readily penetrates respiratory system
  - Mucous membrane irritation
    - Immediate eye, nose, airway irritation
- Direct alveolar toxicity:
  - Capillary permeability
  - Leukotriene synthesis
    - **Pulmonary edema after latent period 12-48 hours**
      - **Reaction increased with physical activity, exertion**


Normal Alveolus
Injured Alveolus during the Acute Phase
Alveolar air space
Type I cell
Epithelial basement membrane
Interstitium
Type II cell
Alveolar macrophage
Surfactant layer
Endothelial cell
Endothelial basement membrane
Red cell
Capillary
Fibroblast
Protein-rich edema fluid
Sloughing of bronchial epithelium
Necrotic or apoptotic type I cell
Inactivated surfactant
Activated neutrophil
Red cell
Leukotrienes
Oxidants
PAF
Proteases
Intact type II cell
Cellular debris
Denuded basement membrane
TNF-α, IL-1
Hyaline membrane
Alveolar macrophage
Fibrin
Migrating neutrophil
Proteases
IL-6, IL-10
MIF
TNF-α, IL-8
Widened, edematous interstitium
Procollagen
Gap formation
IL-8
IL-8
Platelets
Neutrophil
Swollen, injured endothelial cells
Fibroblast
Neutrophil

Latent symptoms: (latent period 12-48 h)

- Gradually progressive over hours ⇨ ARDS
- Rapid, shallow resp.
- Painful cough
- Cyanosis
- Frothy sputum
- Clammy skin
- Rapid, feeble pulse
- Low blood pressure
- Shock may develop
- Death

Signs

- Coarse crackles in all lung fields
- ↓ Respiratory sounds

Extra pulmonary symptoms

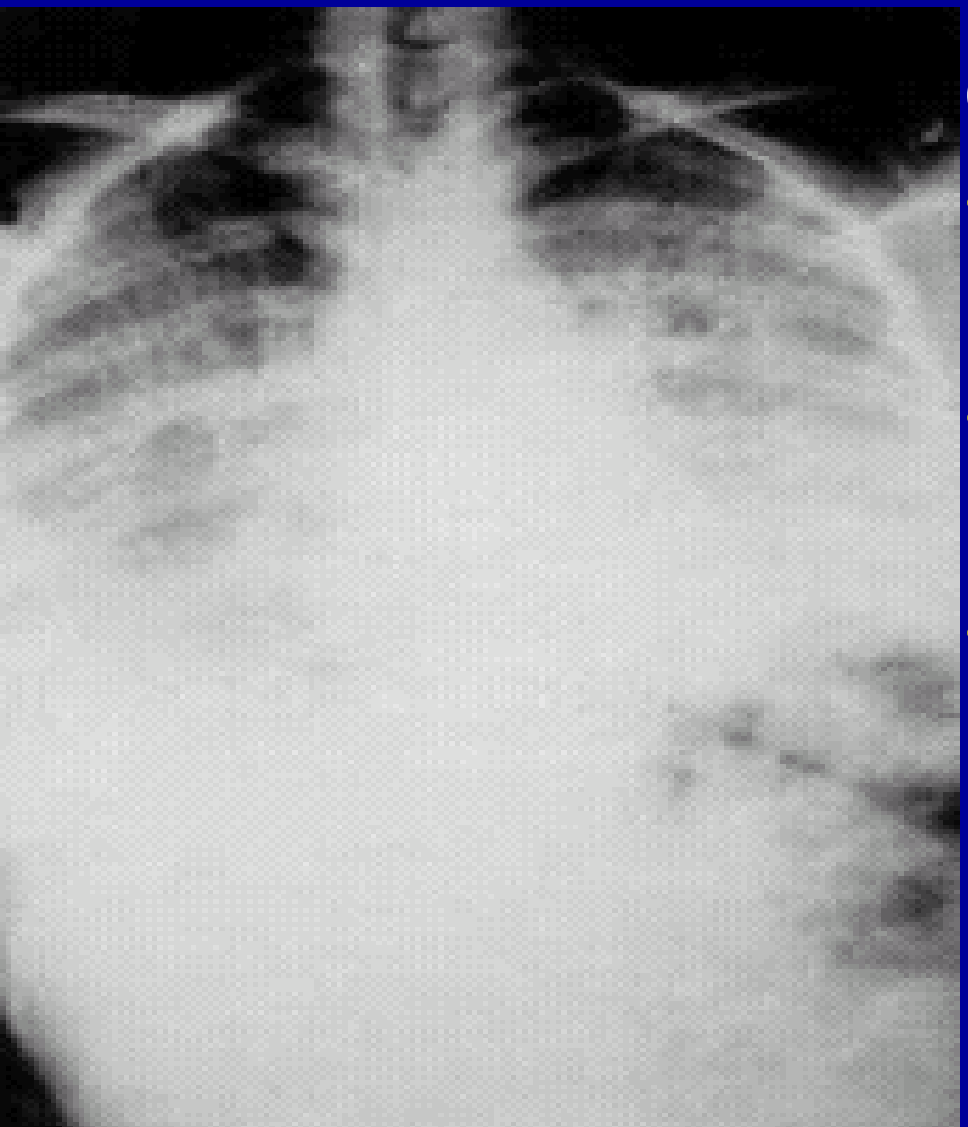
- Eye irritation
- Watering of the eyes
- Nose irritation

Pulmonary Agents: Laboratory:

- Laboratory:
  - –ABG:

    Decreased arterial oxygen and CO_2
    - Can be warning of increased interstitial fluid

Pulmonary Agents: CXR Findings



CXR:

- Normal for several hours
- Early changes by 8 hours
- Late:
  - Hyperinflation
  - Pulmonary edema
  - No cardiomegaly
  - No vascular redistribution

ARDS

Pulmonary Agents: Treatment

- Treatment is supportive:

1. Remove patient to fresh air
2. Decontaminate if any liquid exposure
3. Enforced rest
   - Activity increases capillary reaction
   - Monitor for 12-48 hours

Treatment

4.Stiroid therapy:
Methylprednisolone for bronchospasm
5.Anti tussive agents:
Codeine sulphate:30-60 mg
6.Oxygen
6. Antibiotic
7. IV fluids for hypotension
8.Hexa-methyline-tetramine(HMT)
9.Aminophyline,Dopamine,
10.Phosgene Antiserum

2- Blistering Agents

Blister Agents

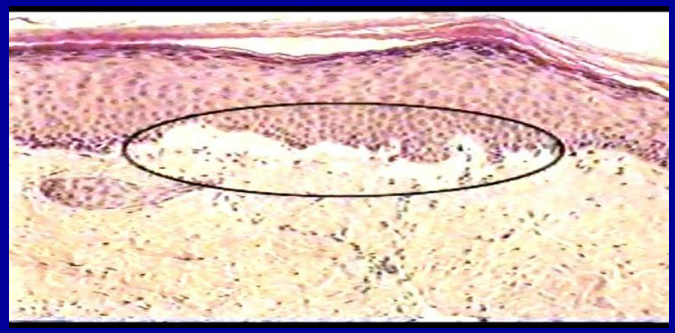
- Mustard (HD) – Has a garlic smell
- Nitrogen Mustard (HN) – fishy odor
- Lewisite (L) – geranium or fruity odor
- Phosgene Oxime (CX) – Disagreeable odor

Blistering Agents : Overview

- Blistering agents:
  - Sulfur mustard, phosgene oxime, lewisite
    - Nitrogen mustard:
      - Past used for chemotherapy (high toxicity)
    - Smell : mustard, garlic, geraniums
  - Oily liquid, evaporates slowly
    - Persistence hazard
    - Vapor hazard increases with heat
  - Erythema , blisters, bone marrow suppression
    - Injury similar to radiation

Blistering Agents: Toxicity

- Local damage:
  - Easily enters skin, eyes, respiratory tract
    - Enhanced: moisture, heat, thin skin
  - Protease digestion in skin
    - Erythema, vesicles, bullae
      - Dermal-epidermal junction
      - May be delayed 1-2 days



Sulfur Mustard: Skin Toxicity

Sulfur Mustard: Eye Signs

Eyes: most sensitive organ

- Symptoms soon after exposure

Conjunctivitis, photophobia

Corneal epithelium

- Swelling and scarring
- Resolves over weeks
- Scarring increases risk glaucoma

Sulfur Mustard: Pulmonary Toxicity

Pulmonary damage:

- Necrosis and destruction of lung mucosa
- Pseudomembrane formation
  - Upper and lower airways
- Pulmonary edema can occur
  - Only when damage severe

Respiratory failure

- Most common cause death with sulfur mustard

عوارض زودرس تنفسي گاز خردل

- ۱-عوارض زودرس:

- تجمع ترشحات در مجاري هوايي
- اختلال تهويه و پرفيوژن
- خونريزي مجاري هوايي
- اختلال بيوشيميايي ريه
- آسيب عروقي ريه
- اختلال در سلولهاي دفاعي ريه

تجمع ترشحات در مجاري هوايي

- ايجاد نكروز در لايه سطحي تماس وآسيب اپيتليوم سطحي برونشها

- آسيب به سلولهاي مژكدار & خاصيت كولينرژيكي گاز خردل سبب افزليش توليد موسين از GC

- انسداد برونشيولها وبرونشها

- بروز آتلكتازي

اختلال تهويه و پرفيوژن

- تجمع ترشحات در مجاري

- انسداد مجاري تنفسي

- بروز سندرم هايپوونتيلاسيون

- بروز خفگي در فاز حاد تماس با گاز

خونريزي مجاري هوايي

- آسيب شديد ناشي از خاصيت تاولزايي گاز خردل
- التهاب توام با خونريزي
- خفگي مصدوم

اختلال بيوشيميايي ريه

درمايع BALمدلهاي حيواني:

- آسيب اپيتليالي سبب افزايش فعاليت گاما گلوتاميل ترانسفراز(GGT

- افزايش فعاليت سيتوتوكسيكي ريه ها سبب:
  - افزايش غلظت پروتئين
  - افزايش فعاليت LDH

آسيب عروقي ريه

بروز مرگ سلولي (Apoptosis) و نكروز سلولهاي آندوتليال شريان ريوي

افزايش فشار شريان ريوي و فيبروز

اختلال در سلولهاي دفاعي ريه

گاز موستارد با ايجاد تغييرات ژنتيكي در سلولها

بروز اختلال در عملكرد آنها

عوارض ديررس تنفسي گاز خردل

- برونشيت مزمن
- فيبروز ريه
- آسم
- برونشكتازي
- تنگي موضعي در تراشه وبرونش هاي اصلي
- كانسر ريه

برونشیت مزمن

- شایعترین تابلو بالینی CB
- سرفه ،تنگي نفس ،دفع خلط
- با درجات مختلف (GOLD Class.)

فيبروز ريه

- در صورت تماس طولاني مدت با مقادير كم گاز خردل
- سالها بعد به صورت تنگي نفس فعاليتي وسرفه هاي تحريكي
- درPFTبا نماي تحديدي وكاهش DLCO
- در HRCT
- تشخيص قطعي بابيوپسي باز ريه ويا TBLB (DIP,UIP...)

درمان

- برونکودیلا تورها:

۱-آگونیستهاي بتا

۲-متیل گزانتینها

۳-داروهاي آنتي کولینرژیك

۴-کرومولین سدیم

3-Nerve Agents

Nerve Agents

1. Tabun (GA)

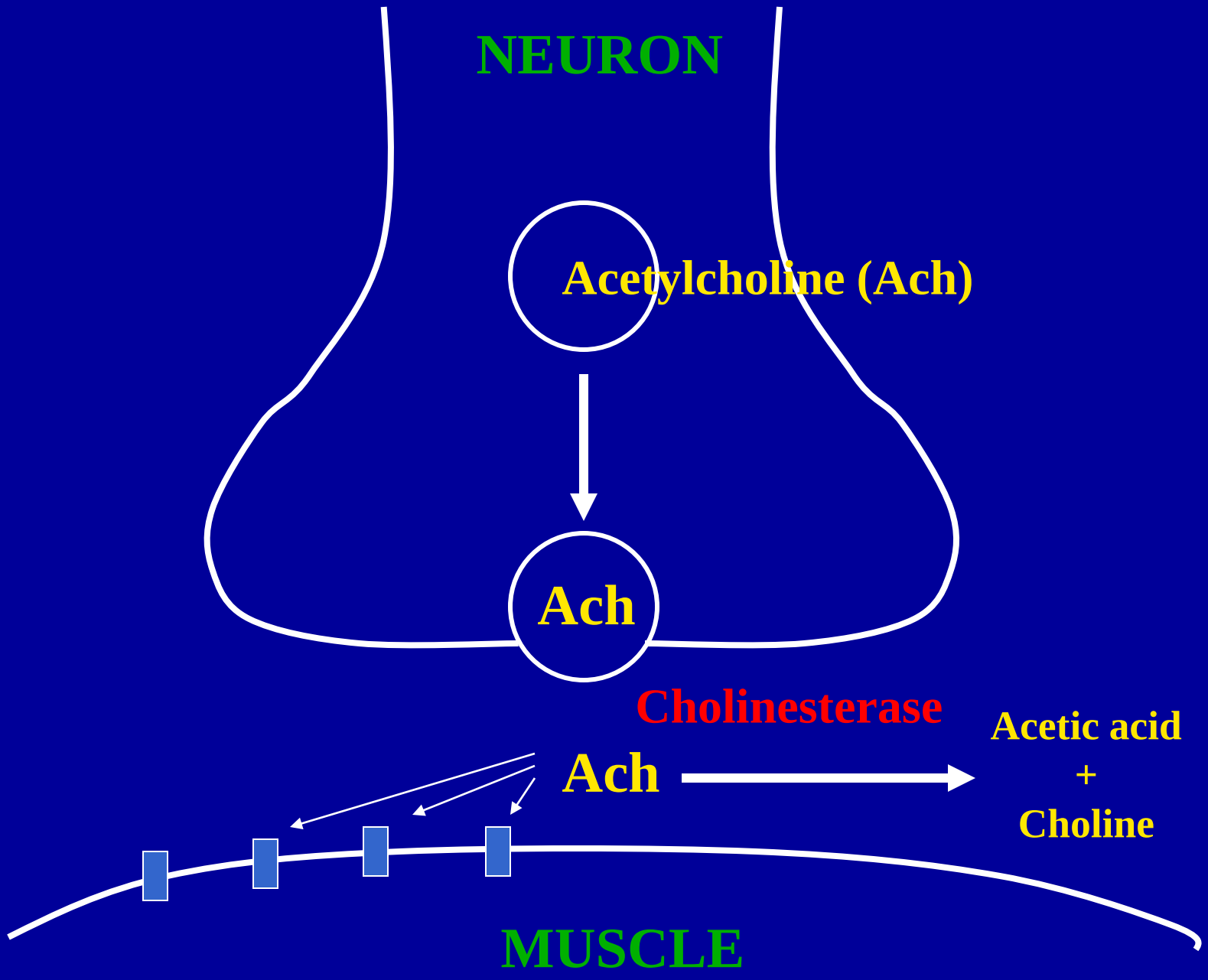
2. Sarin (GB)

3. Soman (GD)

4. VX

آثار اصلي عوامل عصبي درنقاط مختلف بدن

گيرنده	اندام متاثر	علائم ونشانه ها
مركزي	**سيستم اعصاب مركزي**	گيجي،اضطراب ،بيقراري،سردرد،رعشه،عدم تمركز،تشنج،نارسايي تنفسي
موسكارييني	**غدد** غشاءمخاط بيني غشاءمخاط نايژه ها عرق اشكي بزاقي **عضلات صاف** عنبيه عضله مژگاني لوله گوارشي برونشها مثانه **قلب**	آبريزش بيني ترشح زياد مخاط نايژه تعريق اشك ريزش ترشح بزاق تنگي مردمك ضعف تطابق كرامپ شكمي واسهال برونكواسپاسم وتنگي نفس تكرر و دفع غير ارادي ادرار كاهش ضربان
نيكوتيني	**عقده هاي خودكار** **عضلات اسكلتي**	**آثار سمپاتيك:**رنگ پريدگي، تاكيكاردي، افزايش فشار خون ضعف و انقباض غيرارادي


NEURON
Acetylcholine (Ach)
Ach
Cholinesterase
Ach
Acetic acid
+
Choline
MUSCLE

Nerve Agents: Toxicity

- Nerve agents:
  - Absorbed through eyes, skin, respiratory tract
- Mechanism of action:
  - Bind and inhibit acetylcholinesterase
    - Cholinergic overactivity
    - Nicotinic: sweating, fasciculations, paralysis
    - Muscarinic: pupil constriction, secretions, vomiting, diarrhea
    - Central: confusion, convulsions, respiratory depression

Nerve Agents: Treatment

Atropine:

- Blocks muscarinic receptors
  - Dries secretions, relaxes smooth muscle
- No effect on nicotinic receptors
  - Twitching, paralysis

Pralidoxime:

- Removes agent from esterase
- Only affects nicotinic system
  - Should be given before aging occurs

Nerve Agents: Treatment

- Nerve agent antidote kit:
  - Atropine, titrate until secretions dried
    - 2 mg IV/IM every 3-5 minutes
  - Pralidoxime chloride (2-PAM)
    - 1-2 gm IV/IM, repeat every hour as needed
  - Diazepam for seizures
    - 5-10 mg IV every 5-10 minutes

- Supportive care
  - Decontamination, if liquid exposure expected
  - Tropicamide eye drops for eye pain, constriction

4-Cyanide

Cyanide: Overview

- Cyanide:
  - High volatility:
    - Needs high concentrations, closed space
    - Smell: bitter almonds (60% can smell)
  - Sudden loss of consciousness, seizures, death
    - Used in Nazi concentration camps
  - Ubiquitous in all living things
    - Pits of peaches, almonds: ingestion has caused death
  - Industrial: US uses > 300,000 tons/year
    - Electroplating, dyeing, printing, photography

Cyanide: Toxicity

- Cyanide gas inhalation:
  - Rapidly distributed to all organs, tissues
  - Reacts with metals in body: iron
    - Reaction reversible
      - Prevents intracellular O_2 utilization in mitochondria
      - Anaerobic metabolism: results in lactic acidosis
  - Reacts with sulfur-contained compounds
    - Reaction irreversible
      - Sodium thiosulfate
      - Product less toxic, excreted in urine

Cyanide: Signs and Symptoms

- Signs and symptoms:
  - Central nervous system:
    - Dizziness, headache, nausea, vomiting, seizures
  - Respiratory: shortness of breath, chest tightness
  - Skin and eyes: “Cherry red” venous blood
    - Cyanosis occurs only after cardiovascular collapse
- Laboratory:
  - Lactic acidosis
  - Arterial oxygen normal, venous oxygen high

Cyanide: Treatment

- Cyanide antidote kit
  - Nitrites:
    - Reaction couples with cyanide: less toxic
    - Amyl nitrite perle in mask while preparing sodium nitrite
    - Sodium nitrite 3%: 10mL over > 5 minutes (hypotension)
  - Thiosulfate
    - Sulfur donor: excreted in urine
    - Sodium thiosulfate 25%: 50 mL over 10-20 minutes
- Supportive care
  - Intubation, 100% oxygen

Decontamination/Treatment

Chemical Agents: Decontamination

- Decontamination:
  - Wash with large amount water and soap
    - Especially important for liquid hazards
  - Household bleach: use to clean solid surfaces
    - Diluted in water (1:10)
    - Avoid in human decontamination (toxic)
  - First responders:
    - May need to use personal protective equipment
    - Remove patient to fresh air, remove clothing

Chemical Agents: Personal Protective Equipment

Personal Protective Equipment

- Full face piece
- Breathing apparatus
- Gloves, boots
  - Butyl rubber
- PPE suit

Chemical and Radiological Agents: Summary

1. Effects from chemical agents occur rapidly
   - Early decontamination is important
2. Clothing removal is 80-90% of decon
   - May be all that is needed in a gas/vapor event
3. Appropriate use of PPE
   - Important for chemicals, especially liquids
4. Antidotes are available for some agents
   - Give early to be effective

Chemical and Radiological Agents: Summary

5. Dirty bomb: more likely than nuclear blast
   - Unlikely to cause much radiation
   - Risk mostly fear and panic
6. With standard precautions
   - Risk from radiation-contaminated patients to healthcare workers is minimal
7. Care of burn/blast injuries
   - Takes precedent over radiation decon