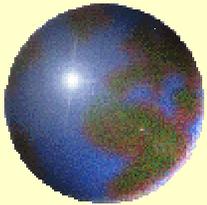


Bioterrorism, Biological Weapons and Anthrax

Part IV



Written by

Arthur H. Garrison

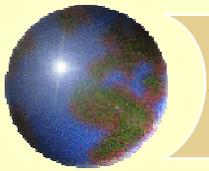
Criminal Justice Planning Coordinator

Delaware Criminal Justice Council



Bioterrorism and biological weapons

- ❖ The use of bio-terrorism and bio-warfare dates back to 6th century when the Assyrians poisoned the well water of their enemies.
- ❖ The goal of using biological weapons is to cause massive sickness or death in the intended target.



Bioterrorism and biological weapons

- ⊕ The U.S. took the threat of biological weapons attack seriously after Gulf War.
 - ⊕ Anthrax vaccinations of U.S. troops
 - ⊕ Investigating Iraq and its biological weapons capacity
 - ⊕ The Soviet Union manufactured various types of biological weapons during the 1980's
 - To be used after a nuclear exchange
 - Manufacturing new biological weapons
 - Gene engineering – creating new types of viruses/bacteria
 - Contagious viruses
 - Ebola, Marburg (Filoviruses)
 - Hemorrhagic fever diseases (vascular system dissolves)
 - Smallpox
 - ⊕ The spread of biological weapons after the fall of the Soviet Union
 - Material
 - Knowledge and expertise
 - Equipment



Bioterrorism and biological weapons

- There are two basic categories of biological warfare agents.

- **Microorganisms**

- *living organic germs*, such as anthrax (bacillus anthrax).
 - Bacteria
 - Viruses

- **Toxins**

- *By-products of living organisms* (natural poisons) such as botulism (botulinum toxin) which is a by-product of growing the microorganism clostridium botulinum



Bioterrorism and biological weapons

- The U.S. was a leader in the early research on biological weapons
 - Research on making weapons and delivery systems for them 1943-1969
 - Main research was conducted at Fort Detrick, Frederick, Maryland
 - More than 28 different viruses and bacteria were studied
 - Respiratory Anthrax (*Bacillus Anthracis*)



Bioterrorism and biological weapons

❖ Germ agents

❑ Unpredictable

- Not good tactically

❑ Cause epidemics

❑ Indiscriminate weapons

❑ Weapons of mass casualties

❖ Non-contagious weapons can be controlled because they can't be spread from person to person



Bioterrorism and biological weapons

✚ Issues in biological weapons

- ✚ Securing & using a virulent strain of bacteria or virus
- ✚ A stable electrical source
- ✚ High level of manufacturing knowledge and ability
- ✚ Having a controlled delivery system
- ✚ Removing electrostatic charge to make the biological weapon free-floating
- ✚ Creating primary and secondary aerosolization
- ✚ Have to be manufactured, clustered and aerosolized between 1 to 5 microns in size
 - Smaller microns (1.5 to 3 microns) remain in the air and spread easily
 - Create a cloud that could spread over a large area
 - Larger microns fall to the ground and spread less easily



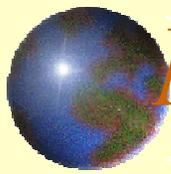
Bioterrorism and biological weapons

- In 1972, 103 nations signed the Biological Weapons Convention (a.k.a. *Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological and Toxin Weapons and on their Destruction*).
- On January 22, 1975 the U.S. signed the Convention.



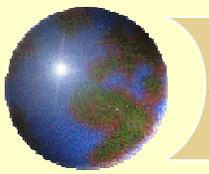
The nature of biological weapons

- ❖ Biological weapons don't need a highly sophisticated system of delivery to be effective.
- ❖ Biological weapons need a highly sophisticated system of manufacturing to be effective.
- ❖ Successful biological weapons have primary and secondary airborne capacity.
- ❖ The most dangerous biological weapons are those in which the particles are 1.5 to 3 microns long.
- ❖ Only virulent strains of bacteria, viruses and toxins can be turned into weapons.



Nations believed to have biological weapons

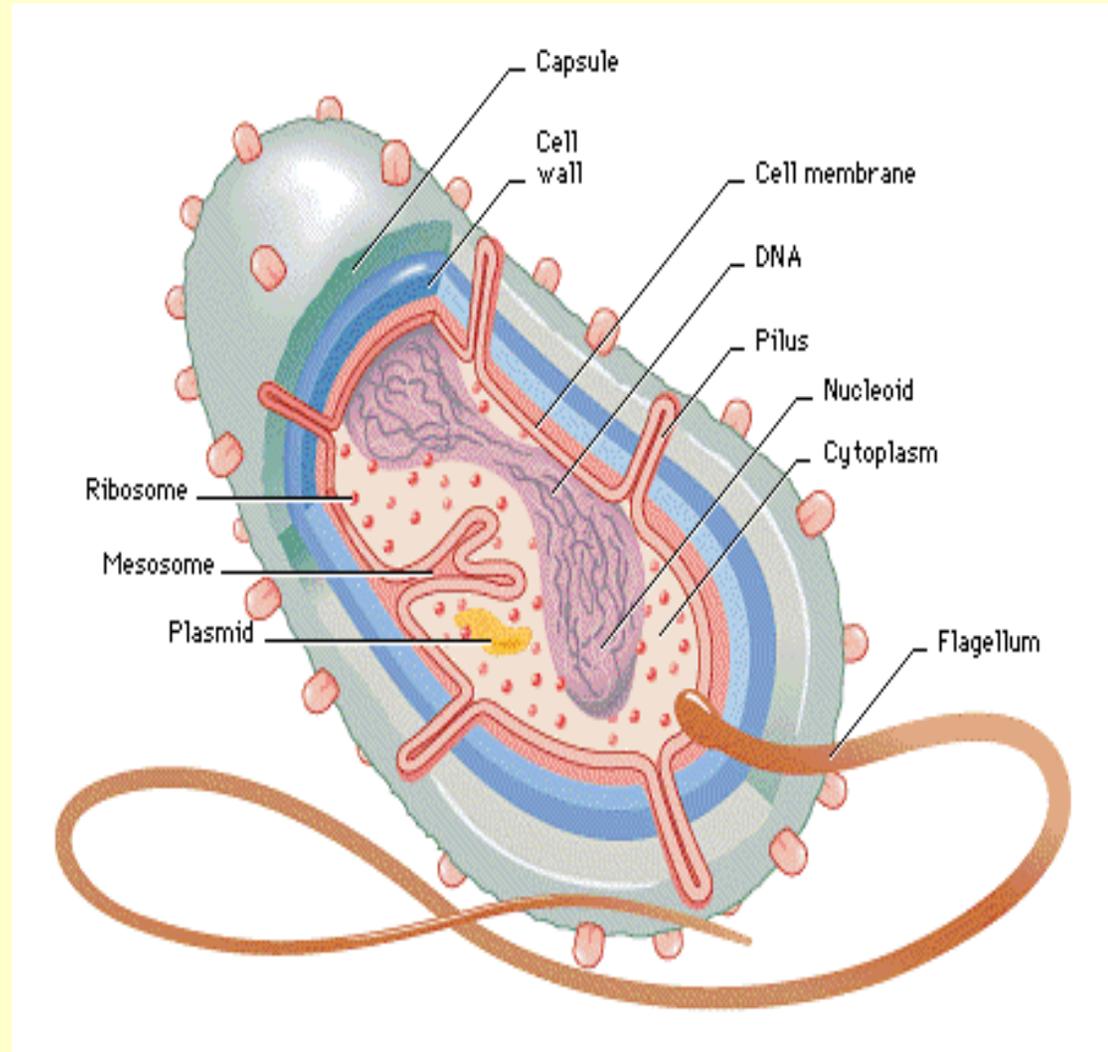
- Afghanistan
- Libya
- Iran
- Iraq
- Israel
- Russia
- China
- Vietnam
- Laos
- Cuba
- South Africa
- Pakistan
- India
- Syria
- North Korea
- Egypt
- Sudan
- Taiwan
- Bulgaria
- South Korea
- Romania
- Bulgaria



Sources of Biological Weapons: Bacteria

✚ Bacteria

- ✚ microorganisms that lack a nucleus and have a cell wall composed of peptidoglycan, a protein-sugar molecule.





Sources of Biological Weapons: Bacteria

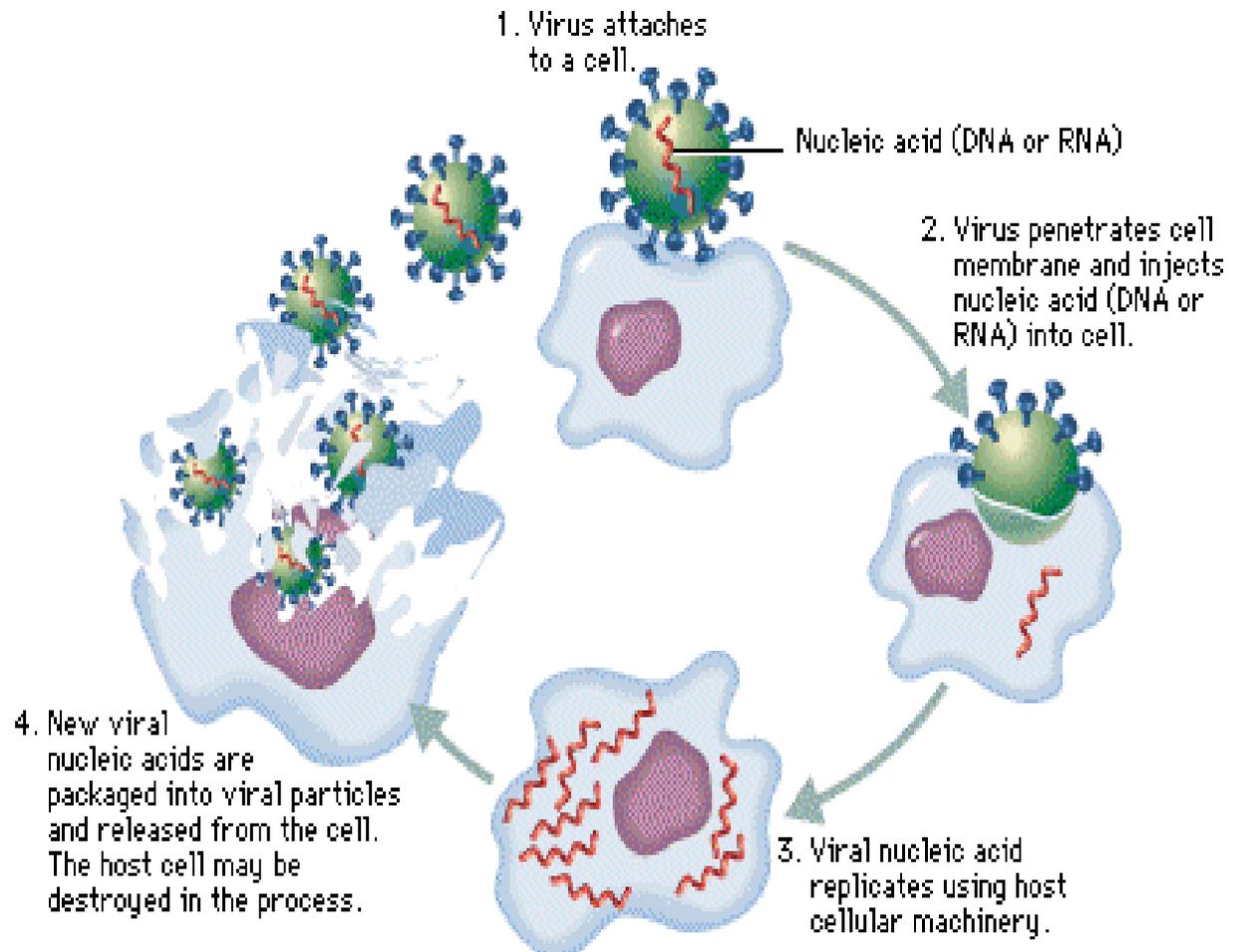
- ❑ Bacteria cause sickness
 - through the toxins they release.
 - because the body is overwhelmed by the fast reproduction of the bacteria.
- ❑ Cells divide to form two identical daughter cells which, approximately half of the original cell's mass, themselves begin to grow.
- ❑ A bacterium may divide as often as every six minutes.



Sources of Biological Weapons: Viruses

Virus

- a minute particle that lives as a parasite in plants, animals, and bacteria and consists of a nucleic acid core within a protein sheath. Viruses can only replicate within living cells and are not considered to be independent living organisms.

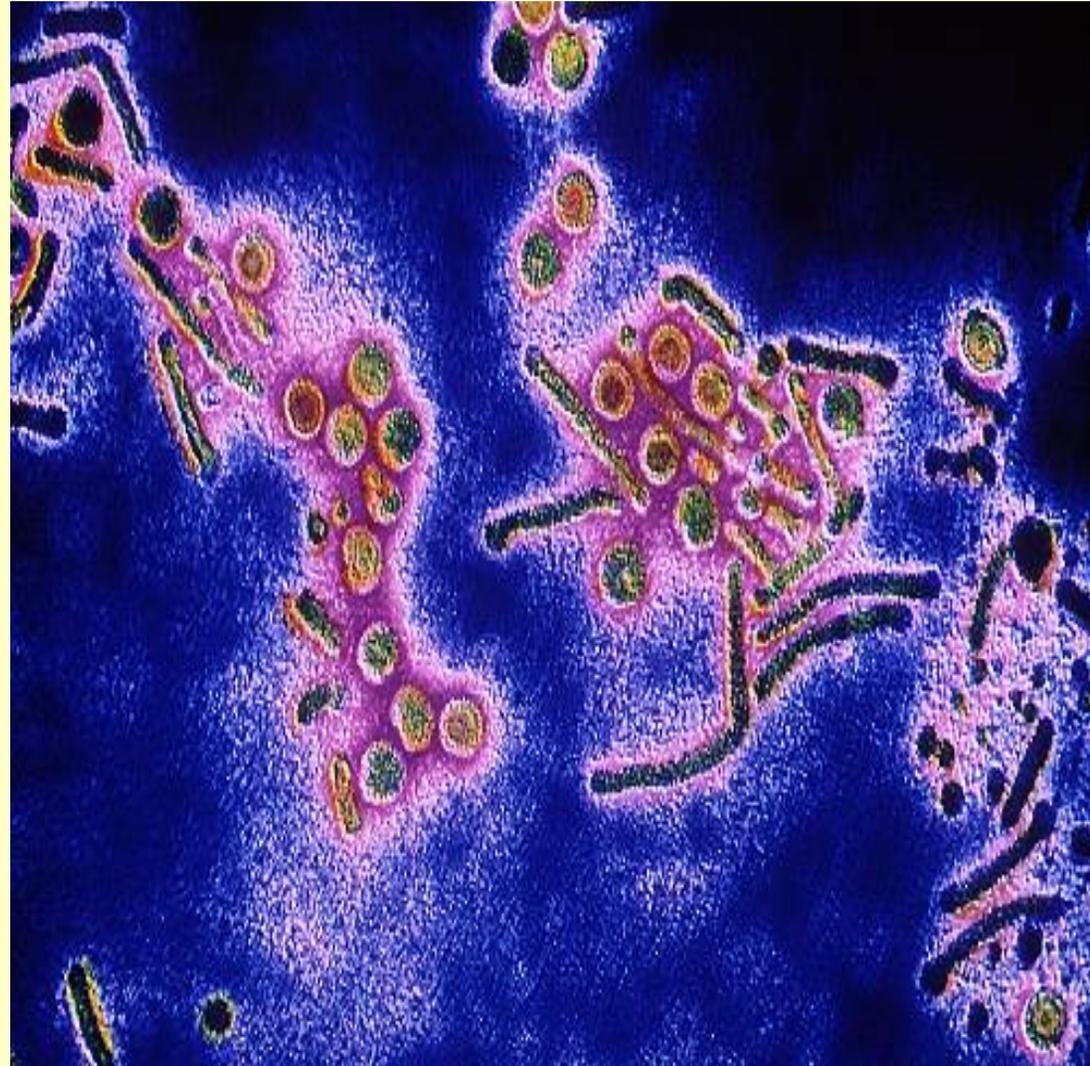


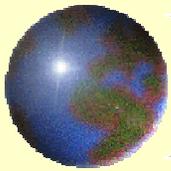


Sources of Biological Weapons: Toxins

✚ Toxins

- ▣ poisonous substance produced by the metabolic activities of certain living organisms.





Types of Biological Weapons

Bacteria

-  Anthrax
-  Plague
-  Tularema
-  Brucellosis
-  Salmonella

Viruses

-  Small Pox
-  Venezuelan Equine
Encephalitis VEE
-  Ebola

Toxins

-  Botulinum
-  Ricin



Types of Biological Weapons: Bacteria

	Anthrax	Plague
Incubation Period	1 to 6 days	2 to 3 days
Contagious	NO	YES (Pneumonic) NO (Bubonic)
Signs and symptoms	Chills, fever, nausea, swollen lymph nodes	Chills, high fever, headache, spitting up blood, shortness of breath
Mortality Rate	Inhalation Anthrax – 80 – 90%	90 – 100%



Types of Biological Weapons: Bacteria

- ❖ Anthrax occurs naturally in cattle, sheep, and other hoofed animals. It is normally transmitted to man through cuts or abrasions on the arms and hands.
- ❖ Plague or “black death” is transmitted to man from rats through the bite of infected fleas.
 - ❖ The bacteria can become air borne and be transmitted to man through the respiratory tract causing pneumonic plague (bleeding in the lungs).
 - ❖ Untreated plague has a mortality rate of 90 - 100%. It is a highly communicable biological warfare agent.

❖ Source: Perkins, M. (2001)



Types of Biological Weapons: Bacteria

	Tularemia	Brucellosis
Incubation Period	2 to 10 days	5 to 30 days
Contagious	NO	NO
Signs and Symptoms	Sudden onset of chills, fever, headache, general malaise	Variable: Acute form of flu-like symptoms Chronic form: chronic fatigue, depression, arthritis
Mortality Rate	30%	<2%

Source: Perkins, M. (2001), CDC (2001)



Types of Biological Weapons: Bacteria

- ❖ Tularemia occurs in many wild and domestic animals but the rabbit is most closely involved with disease outbreaks. Untreated cases can result in up to 30% fatalities.
- ❖ Brucellosis in the US transmission occurs more frequently by ingesting contaminated milk and dairy products.

❖ Source: Perkins, M. (2001)



Types of Biological Weapons: Viruses

	Small Pox	Venezuelan Equine Encephalitis VEE
Incubation Period	7 to 17 days	2 to 5 days
Contagious	YES	NO
Signs and Symptoms	Fever, rigors, vomiting, headache, pustules	Flu-like symptoms, high fever, headache
Mortality Rate	30%	5%

Source: Perkins, M. (2001)



Types of Biological Weapons: Viruses

- ❖ Small pox is the only virus that has been eradicated from the earth. It exists only in laboratories. The vaccine for smallpox is effective if given 2-4 days after exposure, but before illness.
- ❖ VEE or Venezuelan Equine Encephalitis is an alpha virus that primarily affects horses. It is spread to humans via mosquito bites. Mortality from this virus is 5% and nearly all deaths occur in children or those with compromised immune systems.

❖ Source: Perkins, M. (2001), Nova (2001)



Types of Biological Weapons: Viruses

	Ebola Virus
Incubation Period	Up to one week
Contagious	YES
Signs and Symptoms	<p>Early: Malaise, fatigue, headache, sore throat, backache (low), nausea, vomiting, diarrhea, and arthritis.</p> <p>Late: Conjunctivitis (eye inflammation), generalized rash, hemorrhagic, genital swelling (labia and scrotum), depression, increased sense of pain in skin, gastrointestinal bleeding (from mouth and rectum), bleeding from eyes, ears, and nose.</p>

Source: Medline (2001c)



Types of Biological Weapons: Viruses

● Ebola

- A severe disease transmitted to humans from infected animals and animal materials.
- Communicable between humans through human blood and human excretions.
- Virus kills 80 - 90% of those infected within a week.
- Outbreaks have been localized in Africa, which is where the virus originated.
- Aum Shinrikyo attempted to secure Ebola during the Ebola epidemic in Zaire in Oct. 1992.



Types of Biological Weapons: Toxins

	Botulinum	Ricin
Incubation Period	1 to 3 days	1 to 7 days
Contagious	NO	NO
Signs and Symptoms	Weakness, dizziness, dry mouth & throat, blurred vision, paralysis	Nausea, vomiting, bloody diarrhea, gastrointestinal cramps
Mortality Rate	5%	8%

Source: Perkins, M. (2001), CDC (2001), Thinkquest (2001)



Types of Biological Weapons: Toxins

- There are numerous naturally occurring toxins:
 - Neurotoxins which attack the central nervous system
 - Cytotoxins which are cell poisons.

- Botulinum
 - The principal reservoir of the bacteria that produces botulinum toxin is soil, but because they cannot grow in the presence of oxygen, natural exposures to the toxin occur via improperly preserved canned foods.
 - The toxin normally enters the body through the digestive system. Poisoning comes entirely from the toxin already formed in the ingested material. The toxin could also possibly enter the body through inhalation in a biological attack.



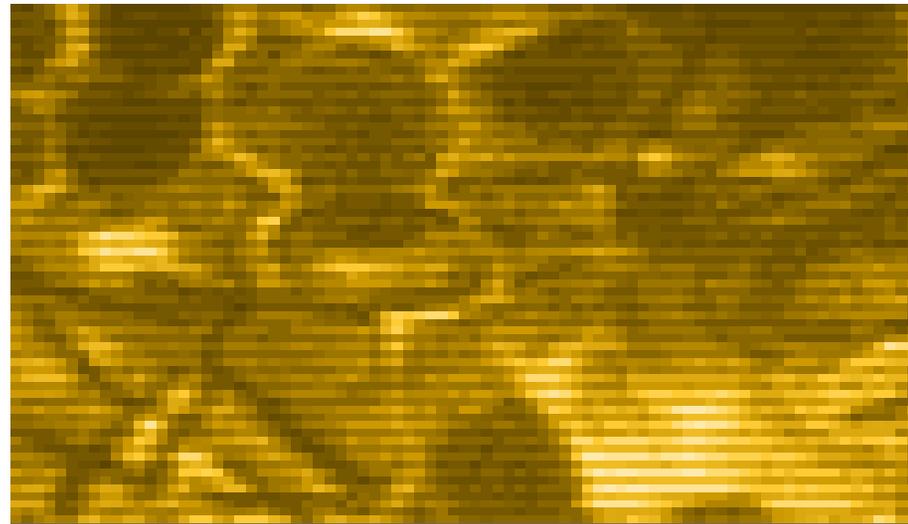
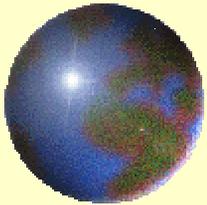
Types of Biological Weapons: Toxins

- There are numerous naturally occurring toxins:
 - Neurotoxins which attack the central nervous system
 - Cytotoxins which are cell poisons.

- Ricin
 - Comes from the seeds of the castor bean plant. It normally enters the body by ingestion, but can enter by inhalation if in aerosolized form.
 - Ricin is 6-9 times more toxic than sarin. If death has not occurred within 3-5 days, the victim will usually recover.
 - Ricin causes red blood cells to agglutinate (clump together) and burst by hemolysis (liberation of hemoglobin).
 - Only a small amount is needed to cause death. One milligram proved to be sufficient, as demonstrated in 1978, when Georgi Markov, a Bulgarian defector, was assassinated with ricin being injected into his leg from the tip of an umbrella.

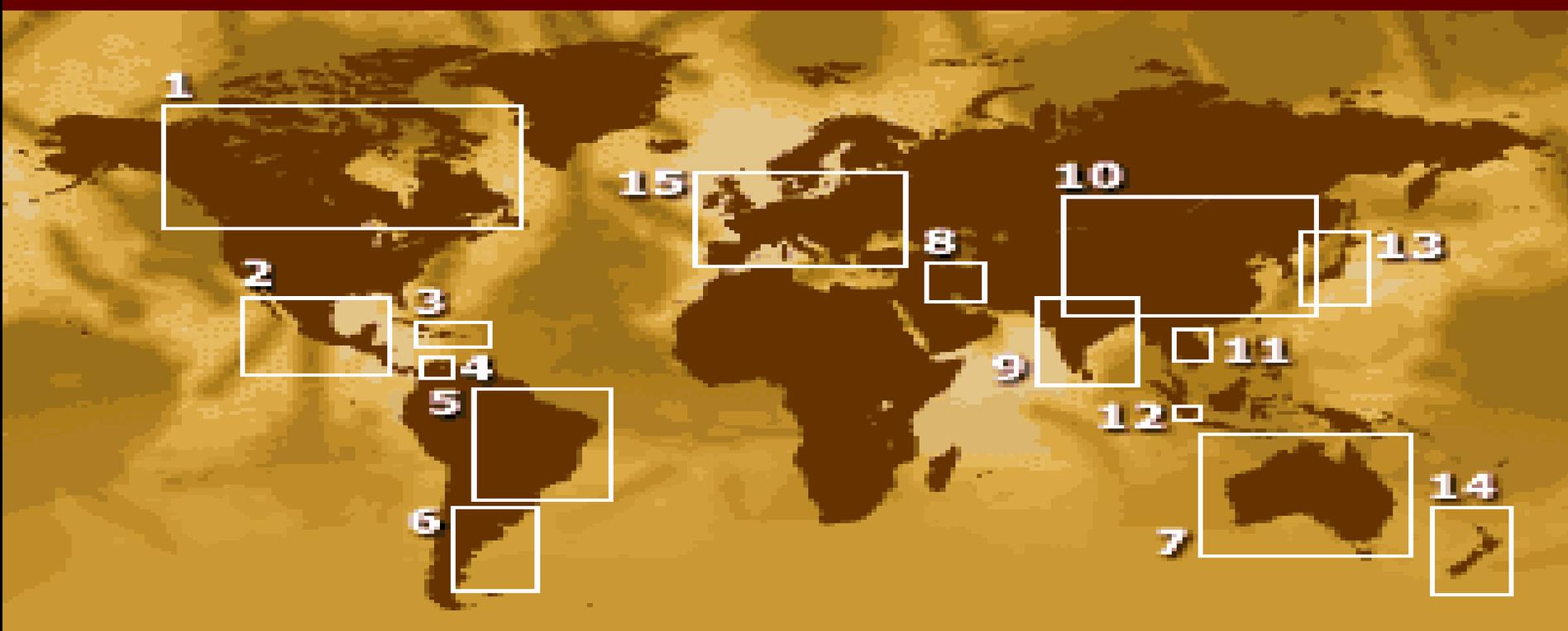


Bioterrorism



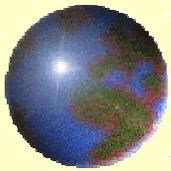
ANTHRAX

RESEARCH FACILITIES STORING ANTHRAX



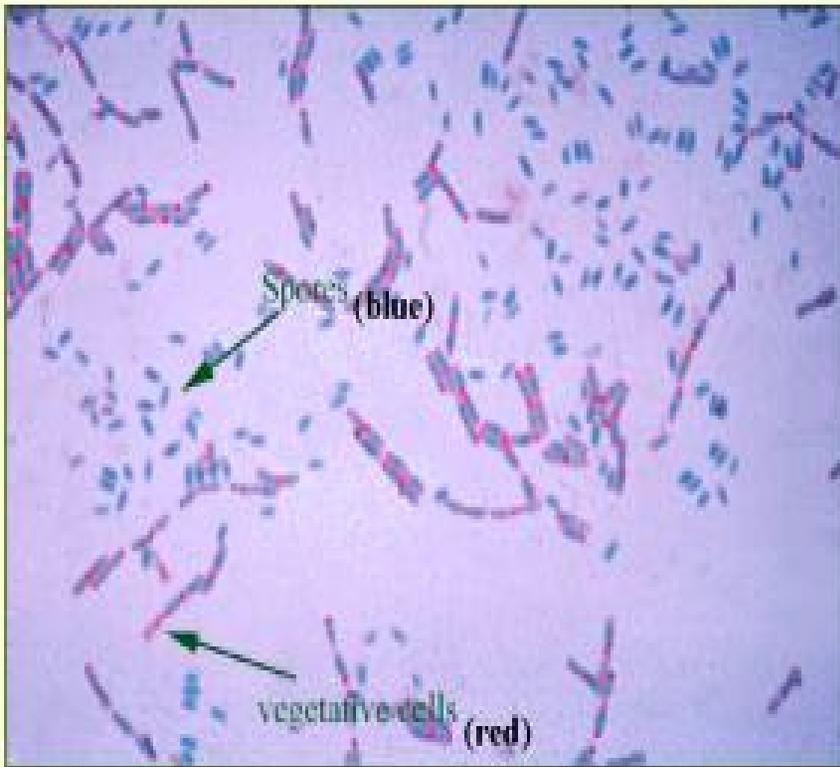
No. of stores

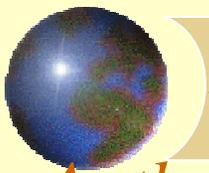
1	Canada	1	13	Japan	3
2	Mexico	3	14	New Zealand	1
3	Cuba	1	15	UK	2
4	Venezuela	1		France	1
5	Brazil	6		Switzerland	1
6	Argentina	3		Italy	1
7	Australia	5		Turkey	1
8	Iran	1		Czech Rep	2
9	India	2		Poland	1
10	China	2		Hungary	2
11	Thailand	3		Bulgaria	1
12	Singapore	1		Germany	1



The anthrax bacteria are very small and about 10,000 of the spores must be inhaled in order for the disease to manifest itself.

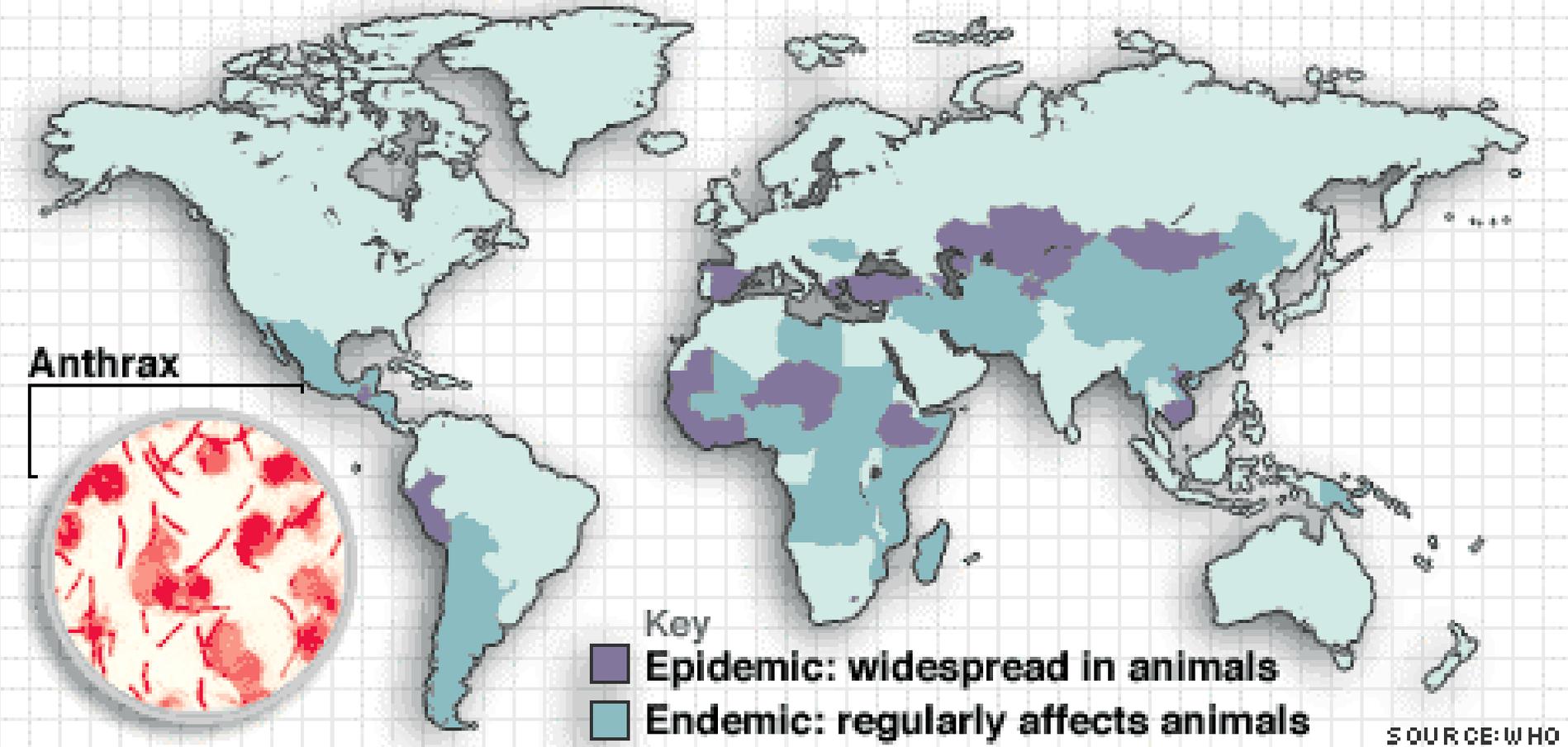
B. anthracis on Blood Agar

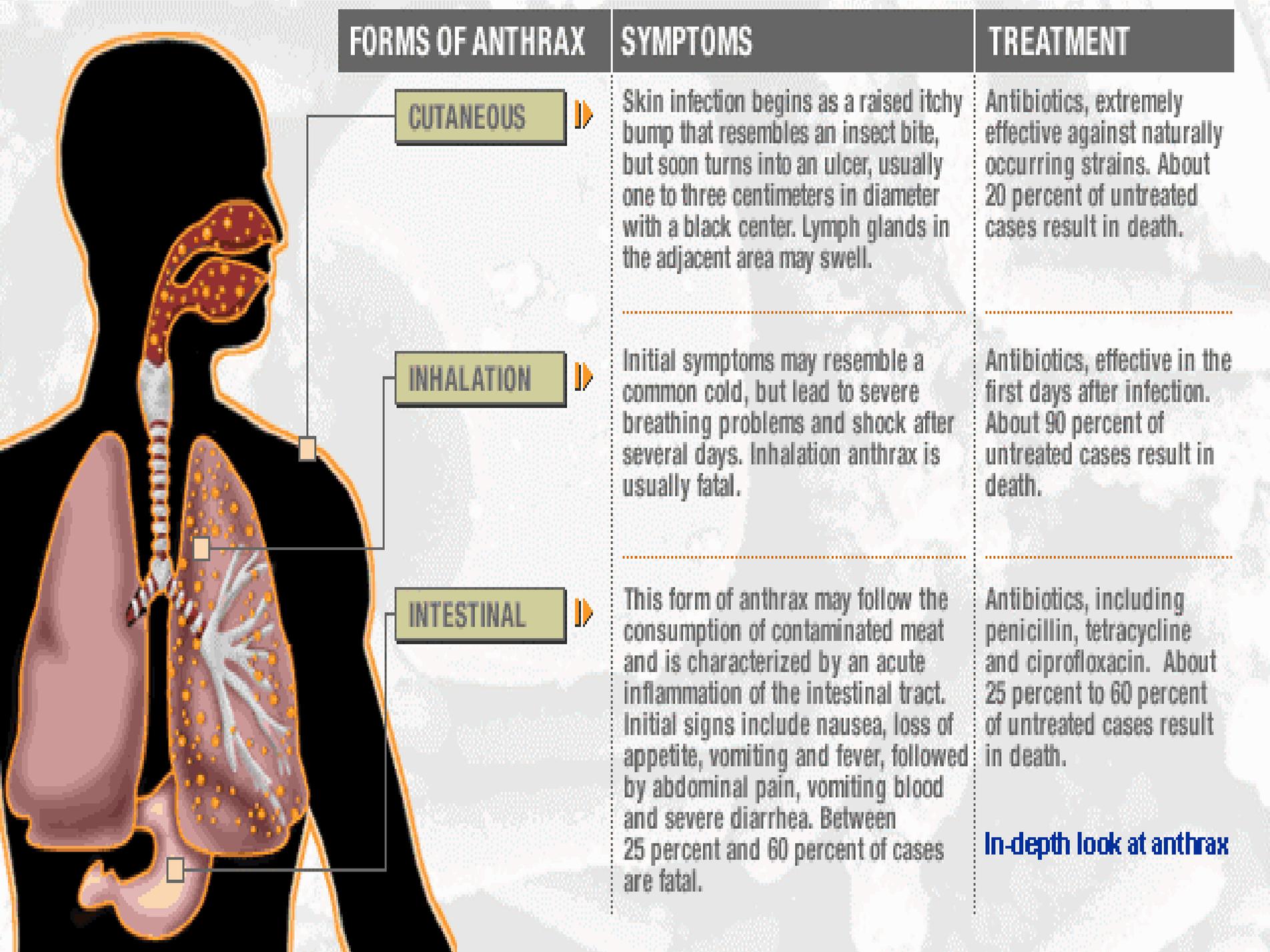




Anthrax occurs naturally in the environment and natural anthrax infection occurs through animals.

NATURALLY OCCURRING ANTHRAX CASES







Incidents of Anthrax in the U.S.

- **Anthrax attacks in the U.S. – Sept – November 2001**
 - **18 confirmed infections**
 - **Inhalation – 11**
 - **Cutaneous (skin) - 7**
 - **Significance:**
 - **1900 – 1978 only 18 cases of inhalation anthrax in the U.S.**
 - **1944 to 1994 224 cases of cutaneous anthrax in the U.S.**
 - **Year 2001: 5 deaths from inhalation anthrax (2 in Washington DC, 1 each in Florida and New York and 1 in Connecticut)**
 - **Source: CDC Update (Nov. 21, 2001), BBC (2001a)**



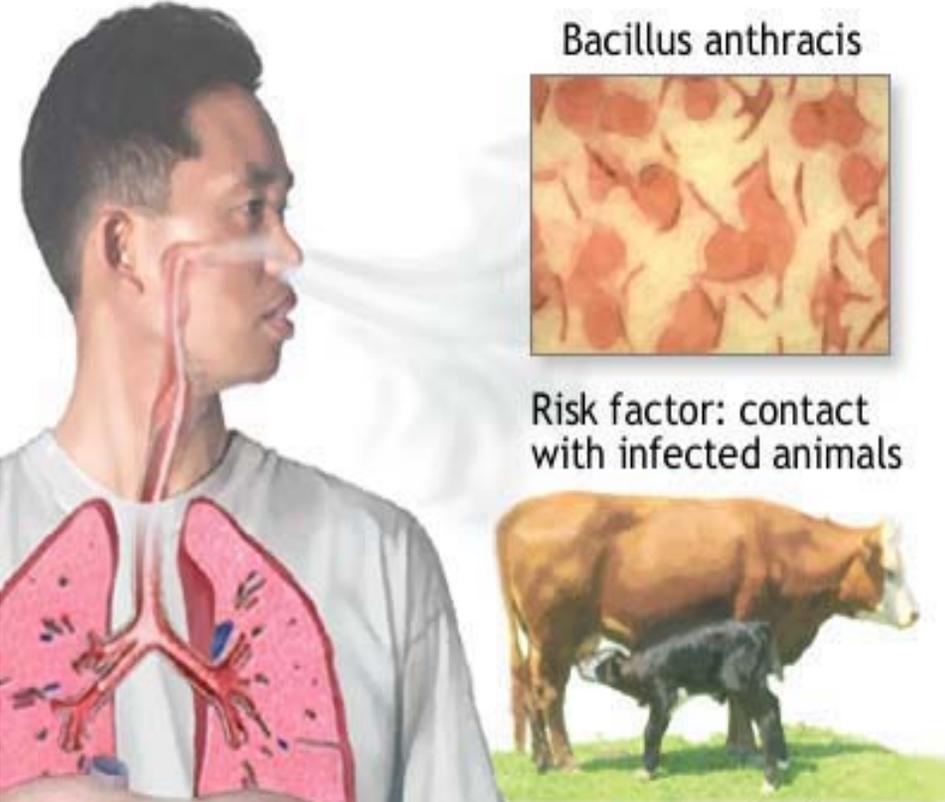
Anthrax

Anthrax occurs naturally in the environment and natural anthrax infection occurs through animals.

Bacillus anthracis



Risk factor: contact with infected animals



ADAM.

This panel illustrates the respiratory route of anthrax infection. On the left, a man's head and neck are shown in profile, with a diagram of his respiratory system (trachea and lungs) overlaid. On the right, a brown cow and her black calf are shown grazing in a field. A central inset shows a microscopic view of numerous orange, oval-shaped spores. The text 'Bacillus anthracis' is at the top, and 'Risk factor: contact with infected animals' is below the spore image. The ADAM logo is at the bottom right.

Bacillus anthracis

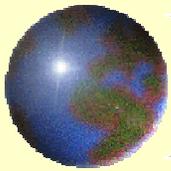


Bacillus anthracis infects mostly farm animals and is usually spread to humans through a break in the skin

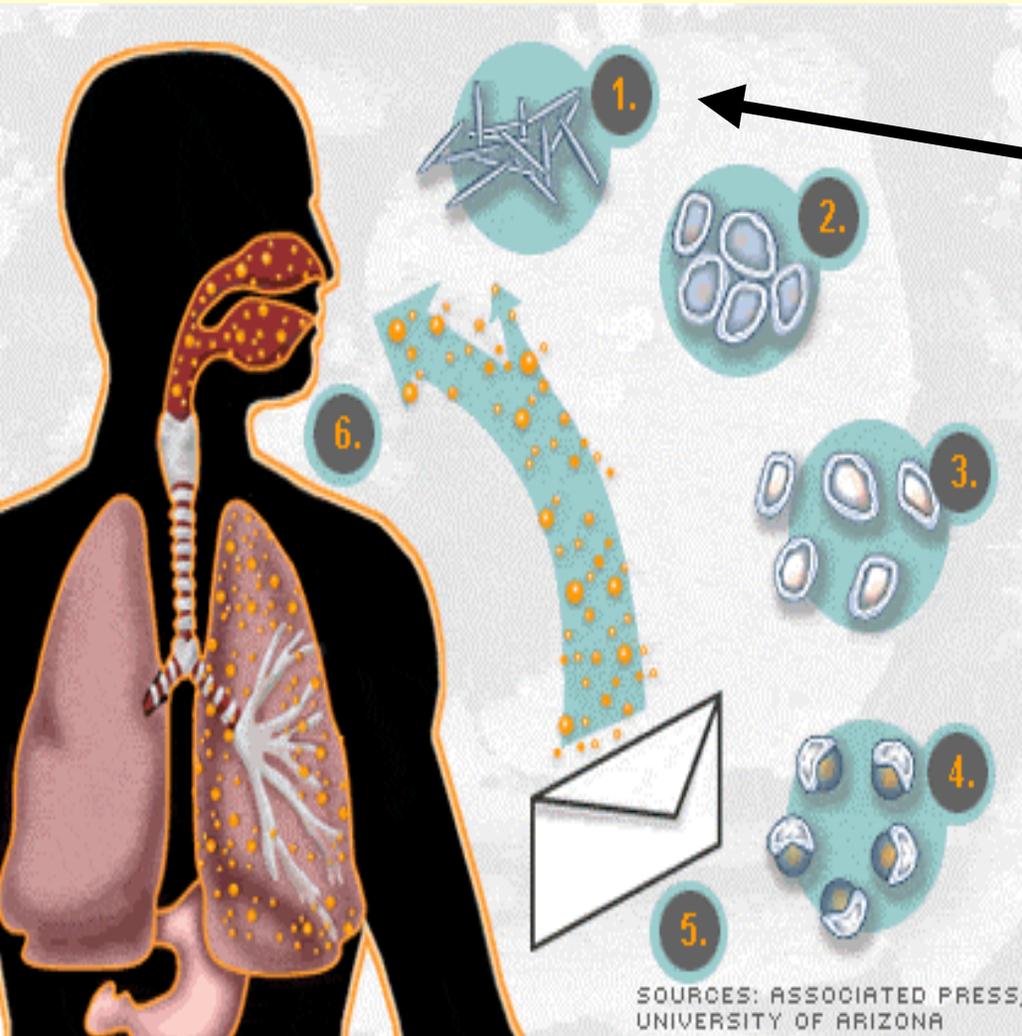


ADAM.

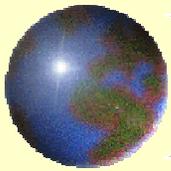
This panel illustrates the cutaneous route of anthrax infection. On the left, a group of farm animals (a cow, a sheep, and a pig) are grazing in a field. On the right, a human hand is shown with a needle puncturing the skin on the back of the hand. A central inset shows a microscopic view of numerous orange, oval-shaped spores. The text 'Bacillus anthracis' is at the top, and 'Bacillus anthracis infects mostly farm animals and is usually spread to humans through a break in the skin' is below the spore image. The ADAM logo is at the bottom right.



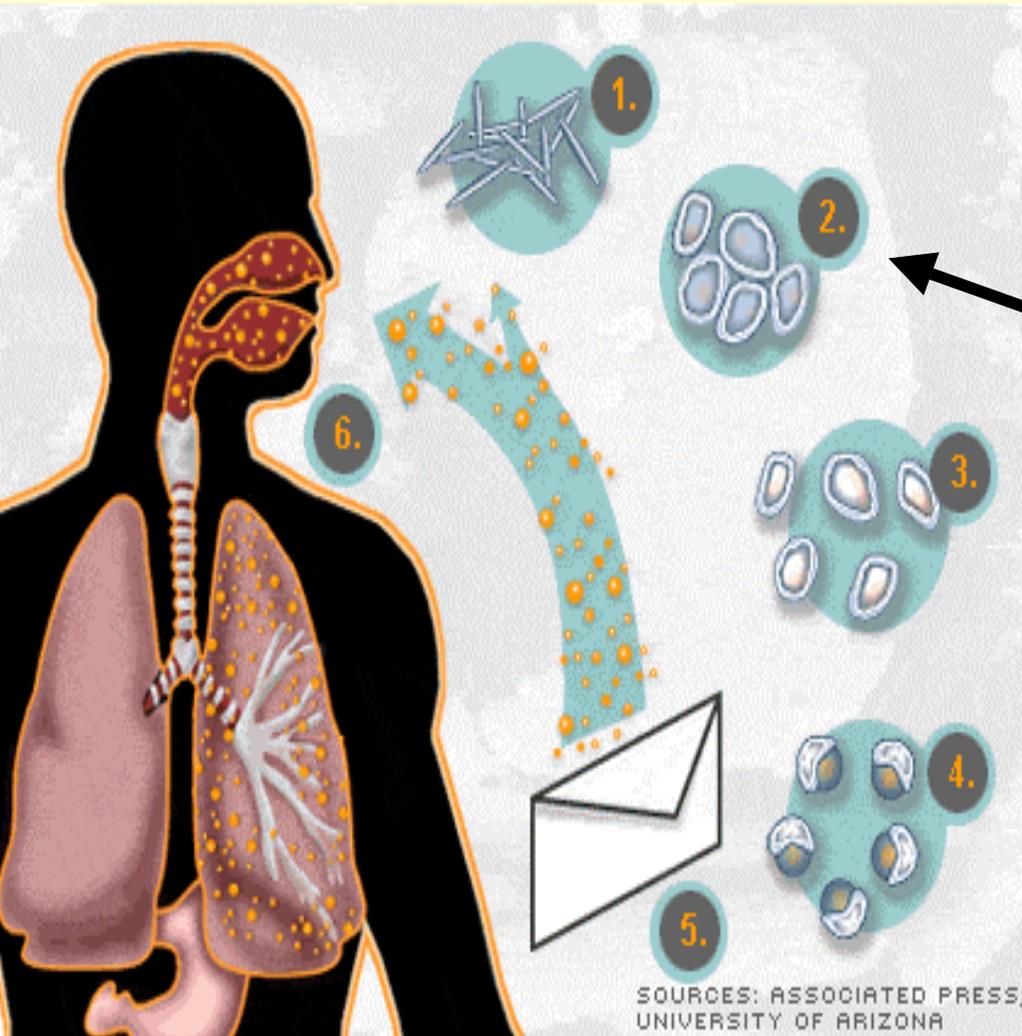
Weaponizing Anthrax



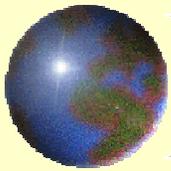
- 1. The organism, called *Bacillus anthracis*, is grown in the lab.



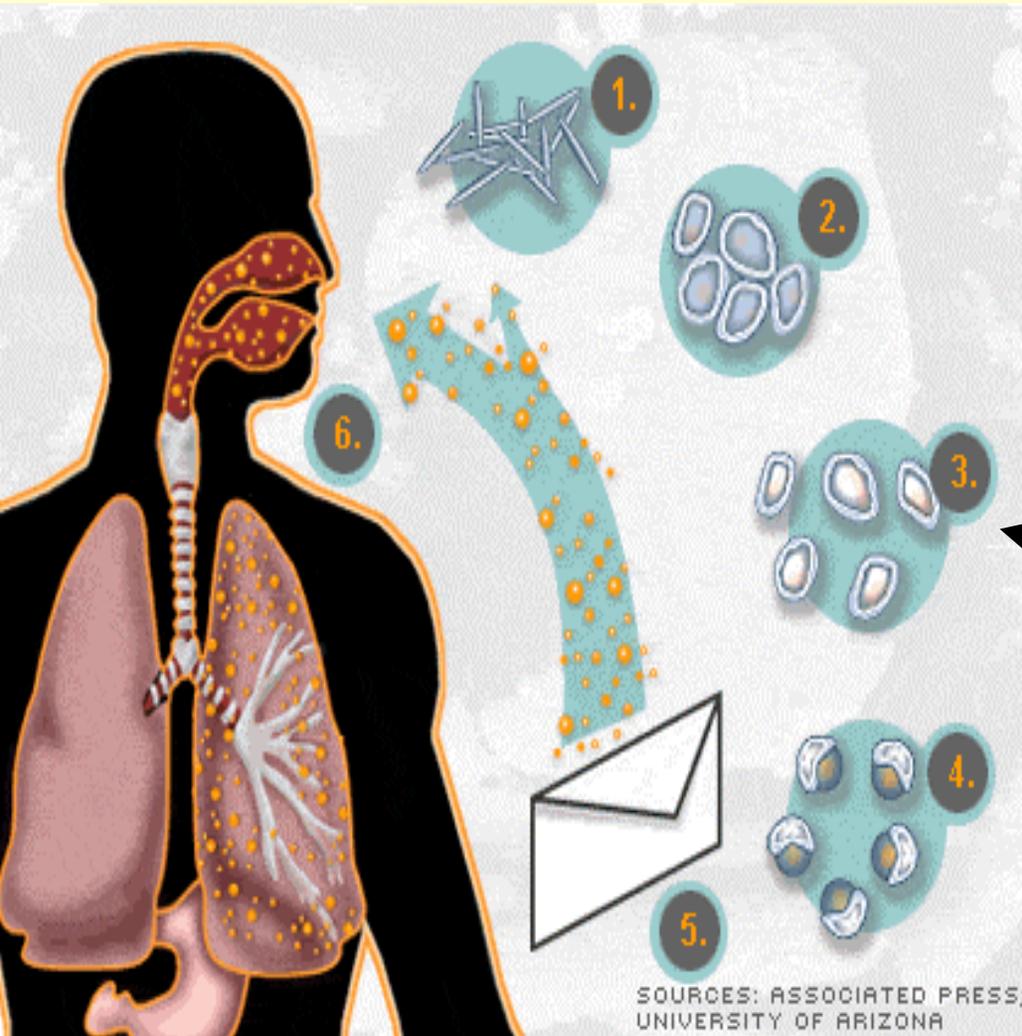
Weaponizing Anthrax



- 1. The organism, called *Bacillus anthracis*, is grown in the lab.
- 2. Removed from a nutrient-rich environment, the bacteria turns into spores. The spores are dried and then are ground down to one micron in length. The process adds a static electric charge that allows the spores to clump together.



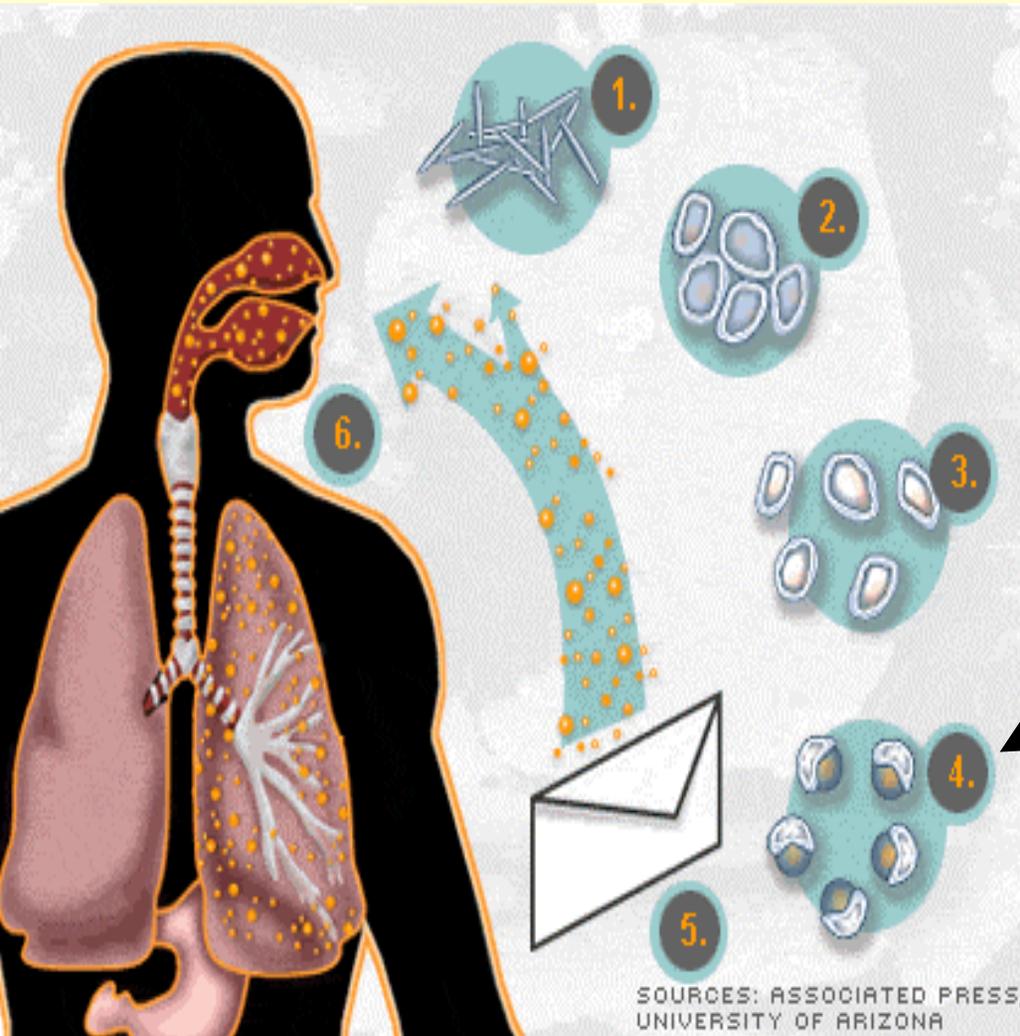
Weaponizing Anthrax



- 1. The organism, called *Bacillus anthracis*, is grown in the lab.
- 2. Removed from a nutrient-rich environment, the bacteria turns into spores, which naturally clump together.
- 3. **Spores are purified, separated and concentrated.** Remove the electrostatic charge.



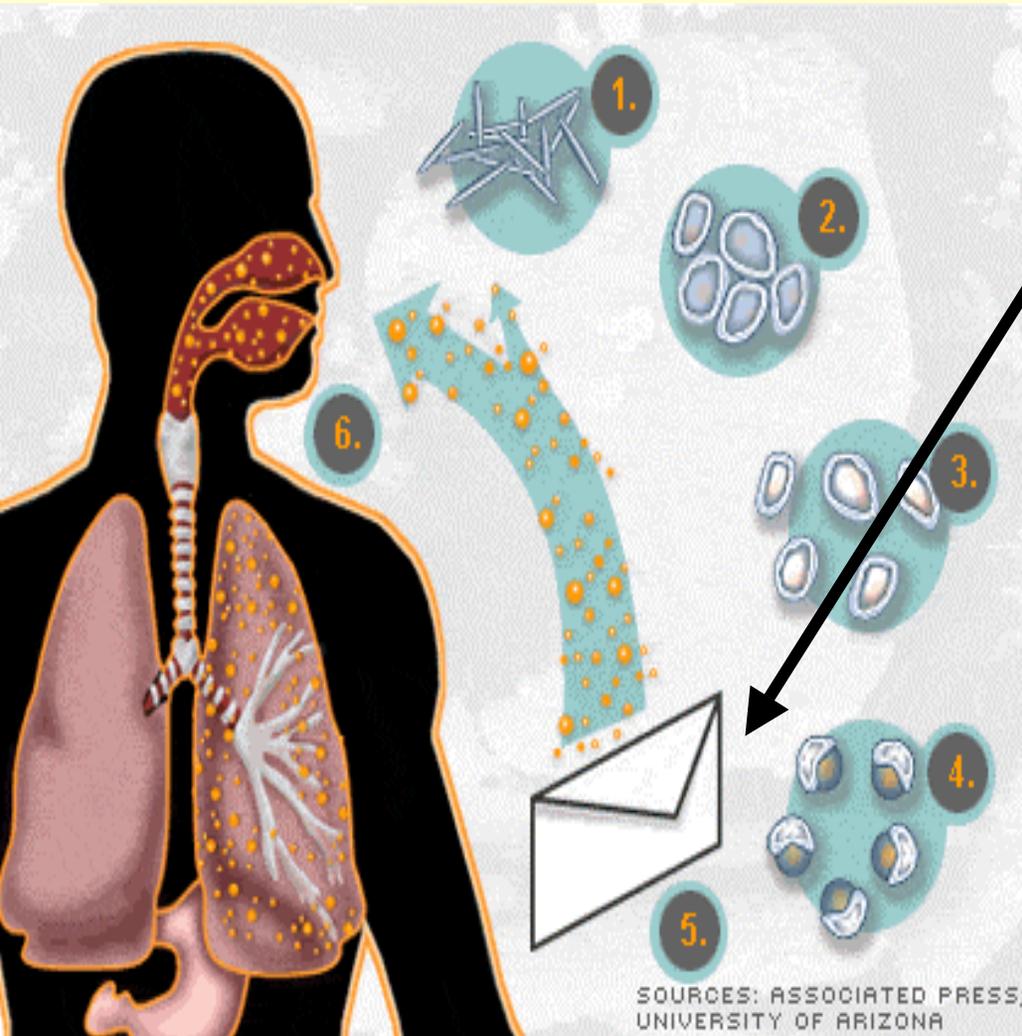
Weaponizing Anthrax



- 1. The organism, called *Bacillus anthracis*, is grown in the lab.
- 2. Removed from a nutrient-rich environment, the bacteria turns into spores, which naturally clump together.
- 3. Spores are purified, separated and concentrated.
- 4. Spores are combined with fine dust particles to maintain separation and increase time that they can suspend in air. The anthrax is made airborne.

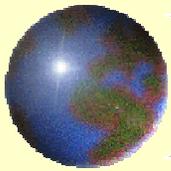


Weaponizing Anthrax

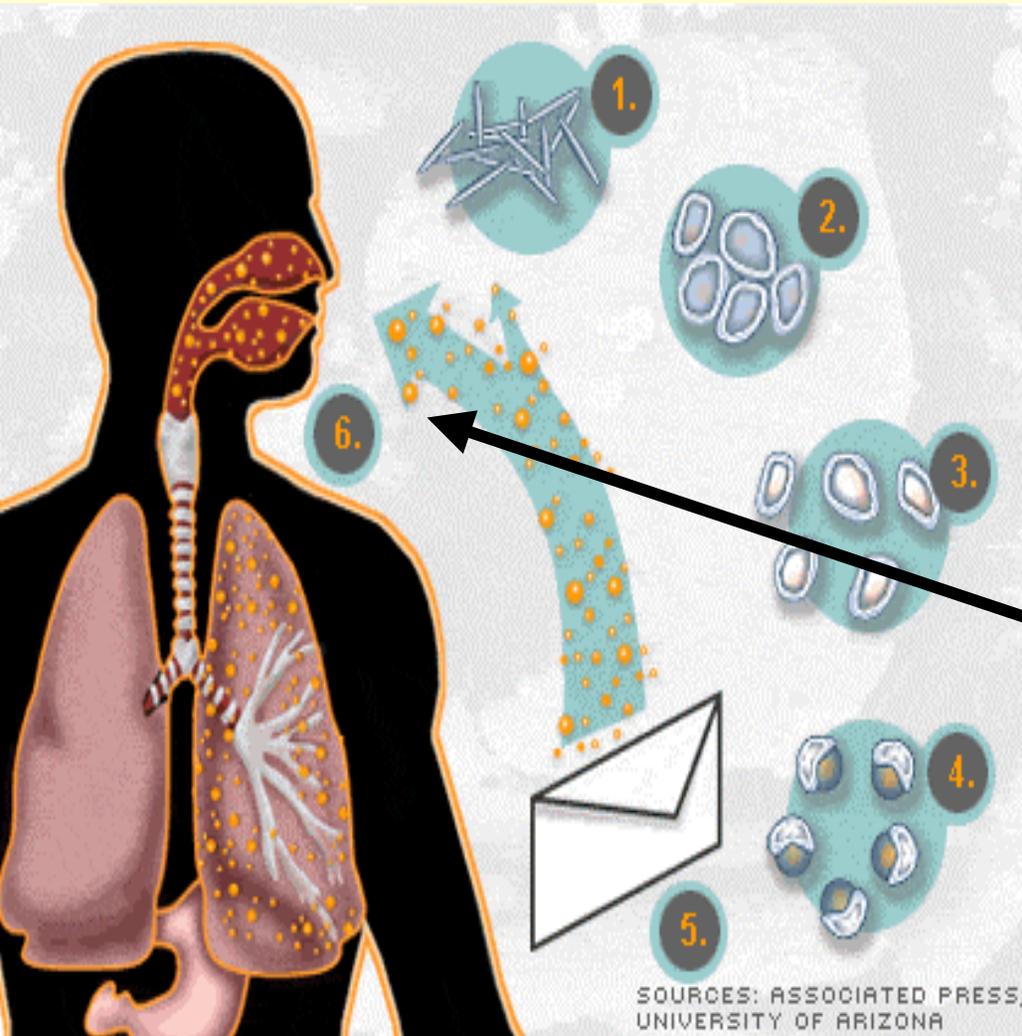


5. The powdery mixture is put into an envelope (or some other delivery system).

■ Note: Each spore is one micron across. Tissue paper is 25 microns thick.



Weaponizing Anthrax



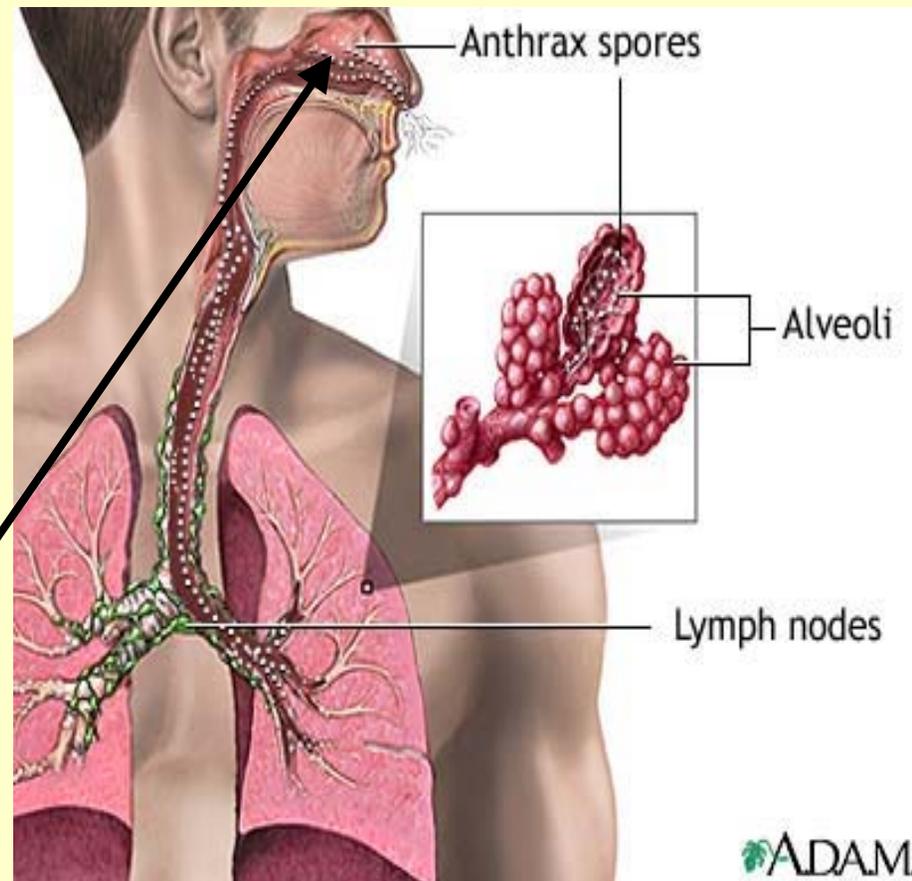
- 5. The powdery mixture is put into an envelope (or some other delivery system).
 - Note: Each spore is one micron across. Tissue paper is 25 microns thick.

- 6. When released into the air,
 - A high concentration of spores need to be drawn deep into the lungs.
 - The spores return to their bacteria state and a rapidly developing anthrax infection releases deadly toxins.



How anthrax works

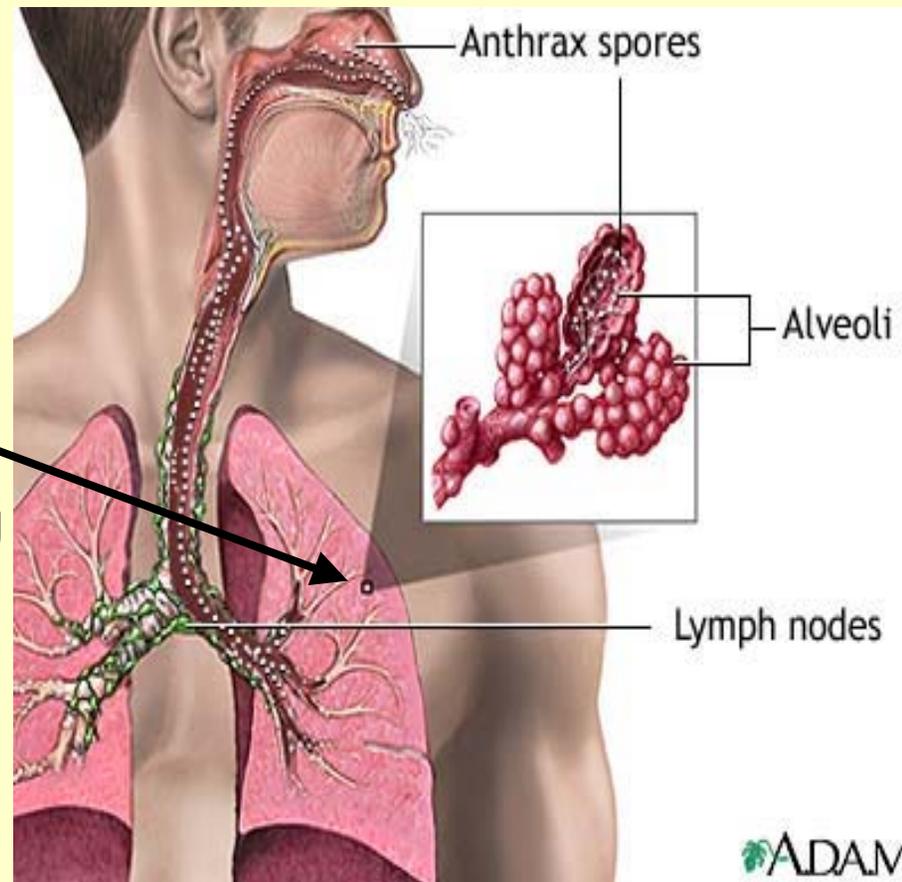
- ➊ **Inhaled anthrax** is particularly deadly. The spores are dormant when breathed in and germinate when exposed to a warm, moist environment, such as the lungs.
- ➋ Larger spores are caught in the nasal passages and don't pass into the lymph nodes.





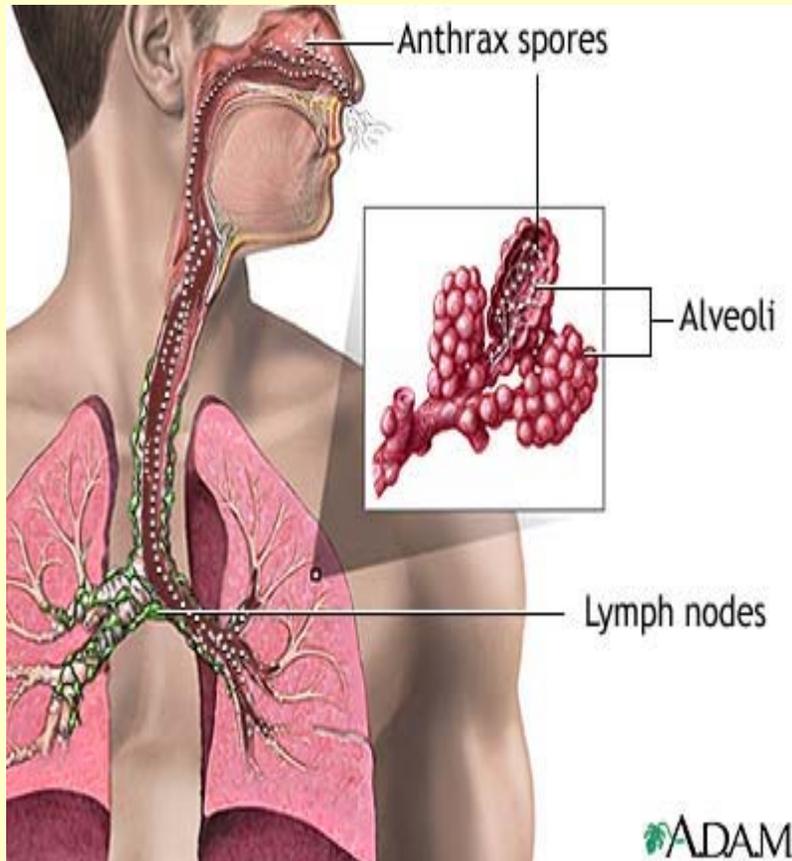
How anthrax works

- The spores (that are small enough)
 - move to the lymph nodes, and once they germinate
 - lead to the release of several toxic substances (toxins) in the lungs
 - This results in hemorrhage, swelling, and destruction of lung tissue.
- In order for a person to develop the actual disease, the spores must germinate -- a process which may take several days, or even up to 60 days to occur.

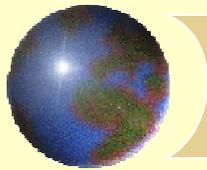




How anthrax works



- There are usually two stages of inhalation anthrax
 - The first stage can last from hours to a few days and is similar to a flu-like illness with fever, headache, cough, shortness of breath, and chest pain.
 - The second stage often develops suddenly and is notable for shortness of breath, fever, and shock. This second stage is highly fatal in up to 90% of individuals because of the build-up of toxins.



How anthrax works

- ✚ **Cutaneous anthrax** is an infection of the skin caused by the bacterium *Bacillus Anthracis*.
 - ✚ The bacteria causes disease when it comes into contact with non-intact skin.
- ✚ During an infection, an initial skin lesion forms then blisters. The blister breaks down into a black ulcer and nearby lymph nodes may become infected and painful. A scar is often formed which then dries and falls off within two weeks.
- ✚ In 20% of untreated individuals, the infection may spread to the bloodstream and become fatal. Although with proper treatment, **death is extremely rare.**





How anthrax works

Anthrax: *Cutaneous*



Day 2:

**Vesicle
Development**



Day 4



**Eschar
Formation**



Day 6

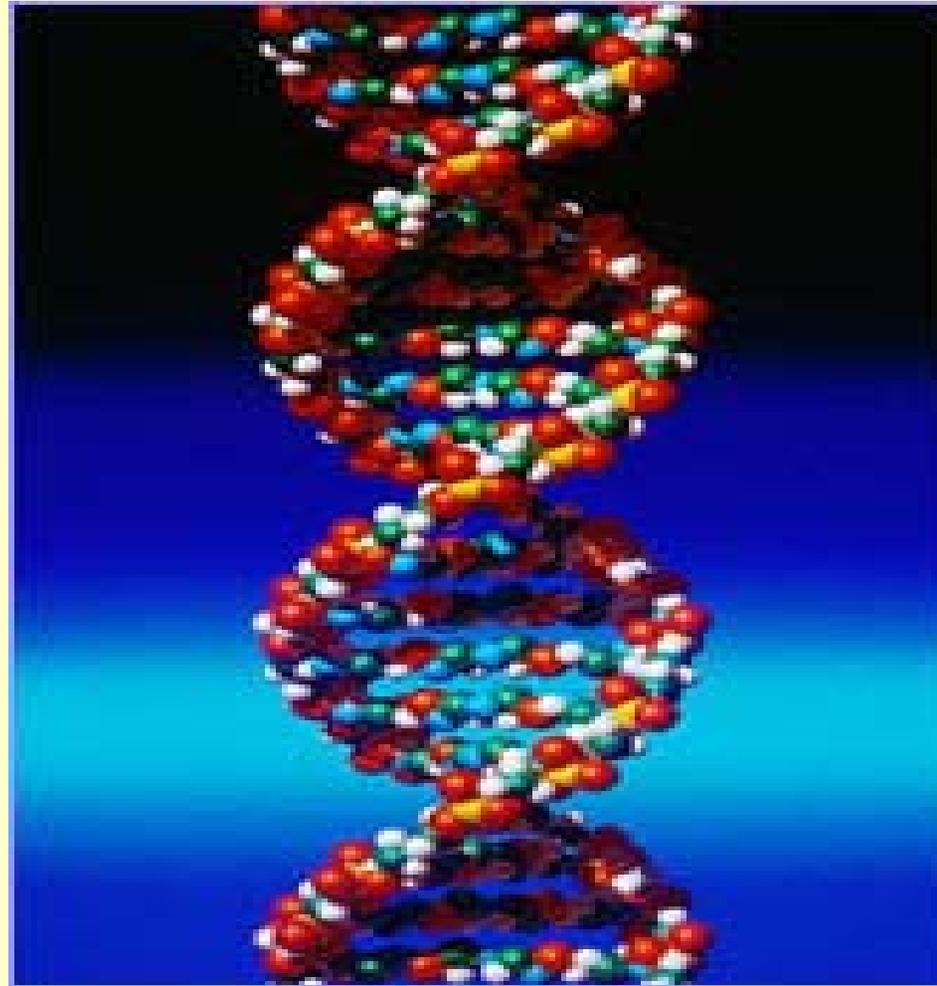


Day 10



Weaponized Anthrax

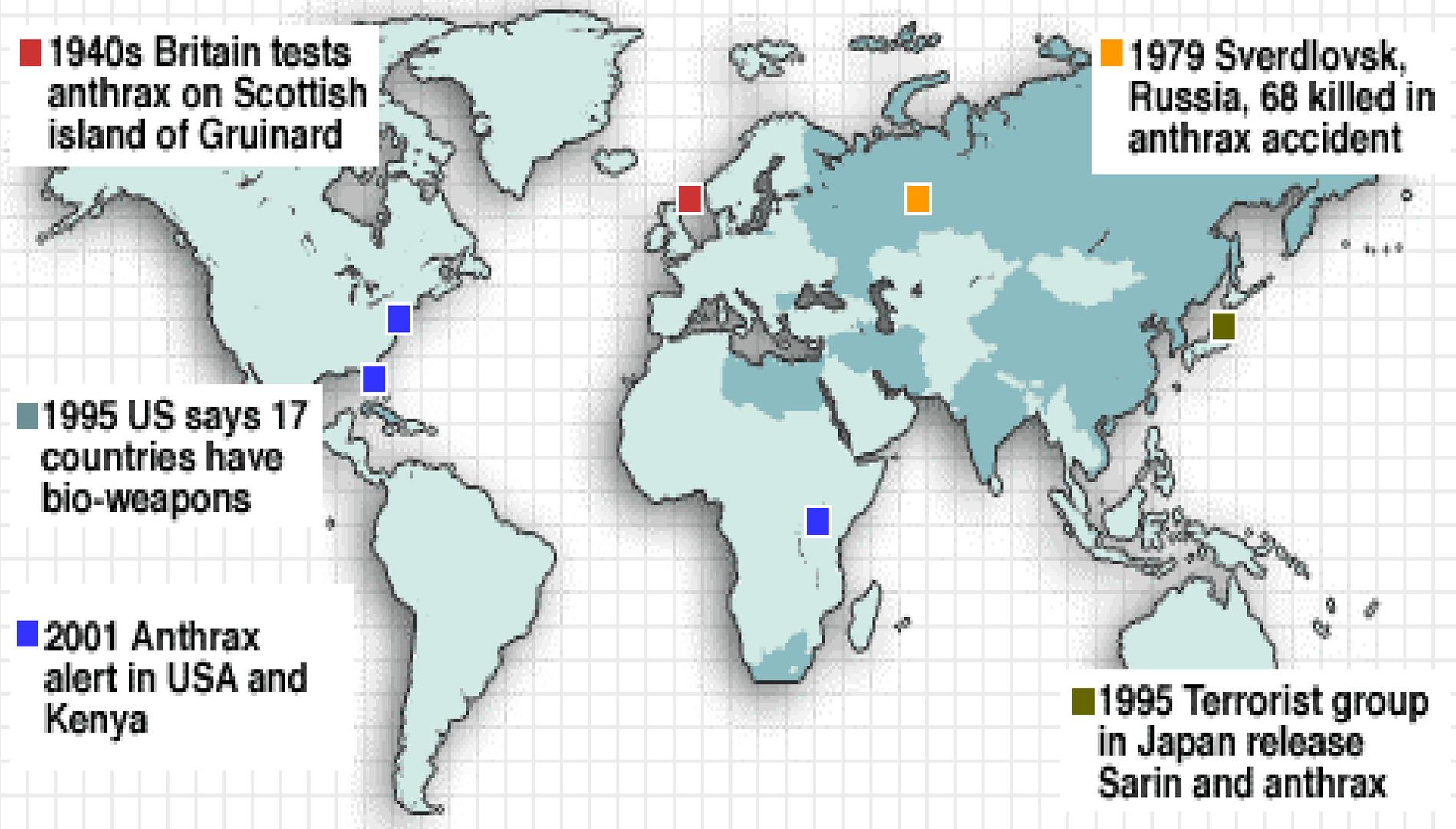
- ⊕ Weaponizing Anthrax is not a simple process
 - ⊕ Specific scientific knowledge and equipment are needed to create weapons grade anthrax
- ⊕ The delivery system for anthrax does not require either specific knowledge or equipment





Weaponized anthrax events

BIOLOGICAL WEAPONS AND ANTHRAX





Weaponized Anthrax

● Anthrax as a weapon

- Used by Germany in First World War Japanese said to experiment on Chinese prisoners during occupation
- 1972 International treaty signed banning use of anthrax and other biological weapons
- 1979 accident in Soviet Union kills 68
- 1995 Aum Shinrikyo group uses anthrax in Tokyo

■ Source: BBC (2001)



How biological weapons are dispersed

Food

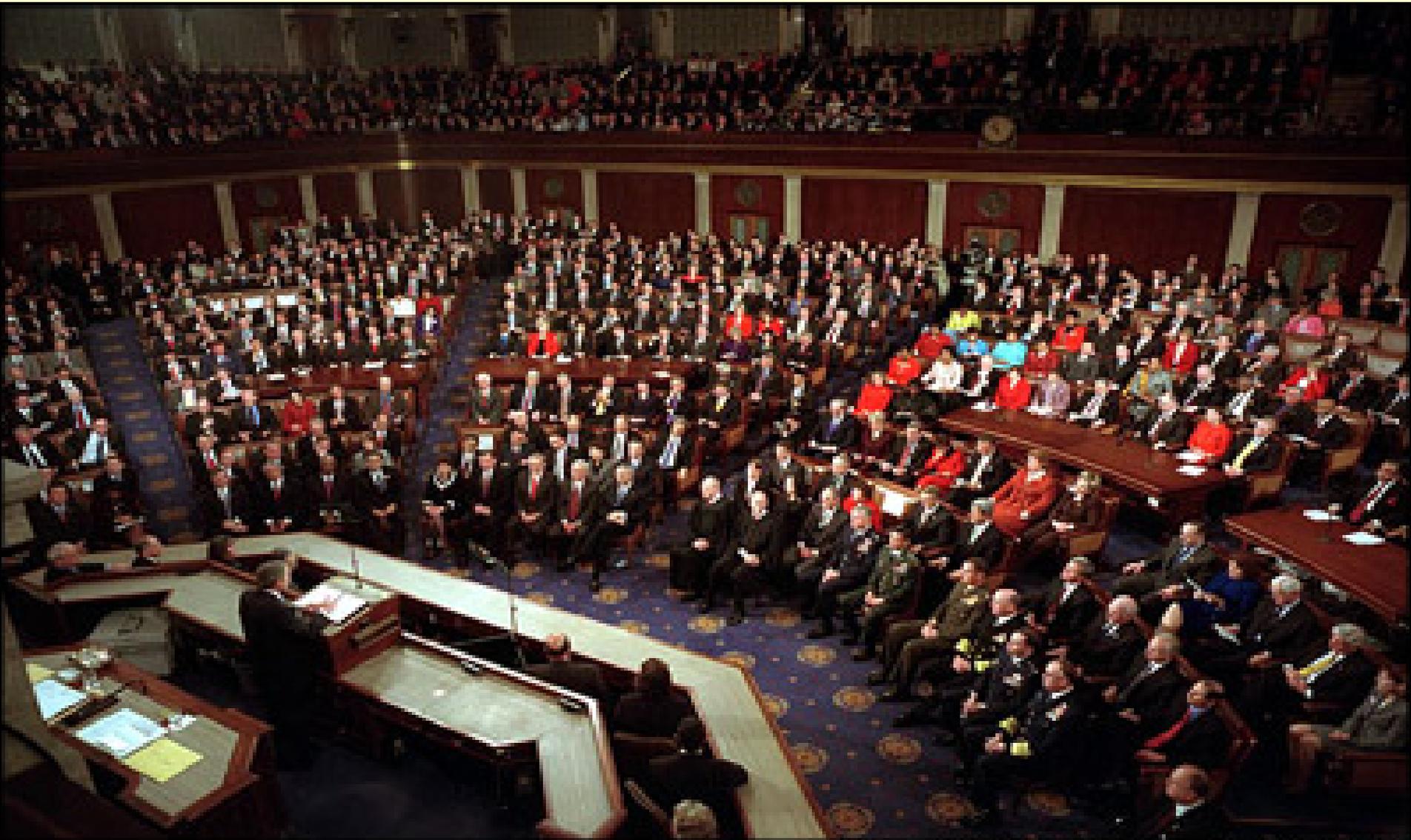
Water

Aerosol cans

Person to person

The Mail

How will we fight and win this war? We will direct every resource at our command – every means of diplomacy, every tool of intelligence, every instrument of law enforcement, every financial influence, and every necessary weapon of war – to the disruption and to the defeat of the global terror network.



White House photo by Paul Morse

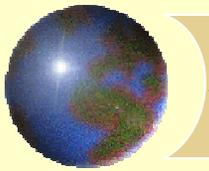


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