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## Anthrax<sup>1</sup>

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### Introduction

Anthrax is mainly a disease of sheep, horses, cattle, and other herbivorous animals. Historically, the disease in humans has been restricted mainly to people who work with animals, or animal products. However recent episodes have brought attention to the causative agent of anthrax, *Bacillus anthracis*. This pathogenic organism produces spores when environmentally stressed. These spores, which contain the genetic material of the bacteria, encased in a tough coat, are highly resistant to harsh environmental conditions such as drying, heat, starvation, etc. There are reports of anthrax spores remaining viable for over 50 years in soil. Spores can germinate and form the vegetative, disease-producing form when environmental conditions are favorable. The spore-forming characteristic, and the fact that the bacteria, unlike most spore-forming pathogenic bacteria, can readily grow in the presence of oxygen, has made *Bacillus anthracis* one of the top choices as a biological warfare agent.

### Forms of Anthrax

*Bacillus anthracis* causes three different kinds of disease. The most common is cutaneous anthrax. The organisms enter the body through skin abrasions, and a localized lesion develops at the site of entry. The

first sign of disease is a small inflamed elevation of the skin which later fills with pus, and eventually becomes an open ulcer. In severe cases, the bacteria may invade the blood stream, and cause death. Ingestion of *Bacillus anthracis*, or its spores, can result in intestinal anthrax; the form most commonly seen in animals. The clinical signs are pain, vomiting, and bloody diarrhea. This form of the disease has a 25% to 50% fatality rate. The pulmonary form of anthrax, due to inhalation of spores, is the most dangerous manifestation of the disease. Pneumonia-like symptoms develop, and the organisms may invade the bloodstream and even the brain. The fatality rate is greater than 90%. Under usual circumstances, pulmonary anthrax is rare, found mainly among people who work with wool or fleeces.

Viable, vegetative forms of *Bacillus anthracis*, although microscopic, are too large to readily enter the alveoli (air sacs) of the human lung. However, the spores are much smaller, and can gain entry to the alveoli, germinate, produce toxic substances, and cause disease. This characteristic of *Bacillus anthracis* spores, plus the high resistance to environmental stress, makes these bacteria ideal agents for biological warfare. Large-scale production and dispersal of *Bacillus anthracis* spores has the

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potential for causing high mortality in a target population. On the positive side, however, is the fact that dispersal of spores can be difficult, and it takes about 10,000 spores to initiate an infection. This latter fact may contribute to the fact that anthrax is not considered to be communicable.

will minimize their effects on the civilian and military populations.

## Treatment and Vaccination

Field isolates of *Bacillus anthracis* are susceptible to penicillin, streptomycin, tetracycline, doxycycline, erythromycin, and ciprofloxacin. The FDA has approved doxycycline and ciprofloxacin for treatment of human anthrax. A human vaccine exists but it has been primarily used for military personnel in the United States. There have been reports of undesirable side effects associated with the anthrax vaccine; the nature of these has not yet been elucidated. Vaccination has proved to be an effective means of prevention of anthrax in animals.

## Preventive Measures

Protective clothing and protective masks should be worn in areas where *Bacillus anthracis* contamination is suspected. In general, trained experts should clean up contaminated areas. In emergency situations, or when otherwise appropriate, disinfectants such as liquid formaldehyde, and liquid glutaraldehyde will kill both spores and vegetative bacteria. However, the compounds are toxic, and their fumes are noxious. A new foaming disinfectant has been developed and seems to be effective in killing anthrax spores. This product is being used to clean up areas that have recently been deliberately contaminated with *Bacillus anthracis* spores.

## Research

A great deal of research relative to combating bioterrorism has been carried out, and is ongoing. The projects include development of new environmentally friendly disinfectants, protective clothing, respirators, air filters, improved vaccines, detection systems, etc. Public health officials will evaluate the impact of the bioterrorism attack that was recently launched against the United States, and will try to develop strategies and resources which will allow effective responses to any future attacks, and