Control of Anthrax Toxin Gene Expression by the Transition State Regulator \textit{abrB}

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Anthrax in the News
HOW ANTHRAX ATTACKS

Anthrax is a naturally occurring bacterium that plagues farm animals and, occasionally, agricultural workers. An airborne form of the disease, however, can be harnessed as a potent biological weapon.

1. Sneaking in
   Anthrax spores are inhaled and swept into the lungs.

2. Beating the defense
   White blood cells attack the spores, killing only a few.

3. Growing
   Spores collect in the lymph nodes and develop. The immune system of vaccinated people can defeat the infection at this point.

4. Striking
   Toxins released by the bacteria spread via the lymphatic system. The poison causes internal bleeding and severe damage to the tissue of major organs. Once the poison has circulated, antibiotics will not save the victim.

Source: “The World’s Best Anatomical Charts”; “Zoology”; Anthrax Vaccine Immunization Program; Journal of the American Medical Association

ADRIAN HOLOVATY/Missourian
Sporulation

- Vegetative cell splits off. A layer of protein and polysaccharide is made encapsulating the chromosome. The cell lyses and the protection spore is formed.

- Environmental stressors include: Starvation, Temperature, pH, cell crowding, antibiotic exposure.
Cell Signaling in *B. subtilis*
AbrB

Spo0 phosphorelay

Spo0A-P

abrB

Ribose transport
Arginine metabolism
Motility
Antibiotics
Genetic competence
Sporulation
Degradative enzymes
Oxidative stress response
Phosphate metabolism
B. anthracis genome

Chromosome

Virulence plasmids

pXO1
182kb

pXO2
95kb
Anthrax Toxins on pXO1

*lef*: lethal factor: LF
*pagA*: protective antigen: PA
*atxA*: anthrax toxin activator
*cya*: edema factor: EF
Hypothesis

• Timing of the toxin gene expression by *B. anthracis* is controlled by a transition state regulator, such as *AbrB* of *B. subtilis*.
Figure 1: Protein sequence alignment of **AbrB**

**B. subtilis**

**B. anthracis**

**B. halodurans**

**B. stearothermophilus**

**B. cereus**

**B. anthracis pXO1**

* Denote essential amino acids in mutational studies.
Figure 2: Knockout of *abrB* in *B. anthracis*
Growth Curve and _β_-galactosidase activity \textit{pagA::lacZ}

Early-exp: 0.08-0.2
Mid-exp: 0.5-0.7
Stationary: 1.3-1.5

- parent strain
- \textit{abrB} mutant
- abrB complement
- *control
Growth Curve and _-galactosidase activity *lef::lacZ* and *cya::lacZ*

**lef::lacZ**

**cya::lacZ**

- Parent strain
- *abrB* mutant
- Closed symbols: growth curves
- Open symbols: _-galactosidase activity
Western blot looking at *abrB* control of toxin production

- **AbrB complimented**
- **AbrB mutant**
- **pXO1-**

**UM44**
- **PA**
- **LF**
- **EF**

**UT166**
- **UT166(pUTE448)**

**UT166(pUTE29)**

**UM44-1C9**

Parent
Growth Curve and \(-\)-galactosidase activity \textit{abrB::lacZ} and \textit{atxA::lacZ}

\textit{abrB::lacZ}

\textit{atxA::lacZ}

Open symbols: growth curves
Closed symbols: \(-\)-galactosidase
Growth Curve and α-galactosidase activity \( abrB::lacZ \) in \( Spo0A \) null mutant

Open symbols: growth curves
Closed symbols: α-galactosidase
Detection of AbrB in *B. anthracis* cell extracts from different growth stages
• AbrB negatively regulates expression of toxin genes in *B. anthracis*?

• AbrB is negatively regulated by Spo0A in *B. anthracis*