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Perspective

Inhibition of Bacterial Cellular Respiration and Metabolic Effects in Bactericidal Antibiotics

Barton Hugenholtz*

Department of Biochemistry and Microbiology, University of New Jersey, New Jersey, USA

DESCRIPTION

Bacteria can obtain the energy required for growth from so many different and diverse reactions, and the particular reaction used by a particular organism depends on the growth conditions used. However, from an operational point of view, these different responses can only be seen as examples of two common energy-saving techniques. The first of these is the formation of Adenosine -5- Triphosphate (ATP) by phosphorylation at the substrate level, which can distinguish between two different classes of reactions. A distinguishing feature of the chemiosmosis theory is the consideration of the asymmetric orientation of the membrane-binding enzymes that catalyze the vector reactions that cause the movement of molecules, ions, and chemical groups across the membrane. In addition, some of these reactions result in the separation of charges within and across the membrane, and their recombination is affected by the performance of osmotic, chemical, and mechanical work. They oxidize food materials present in the cytoplasm to obtain energy. Most bacteria make use of the free oxygen of the atmosphere or oxygen dissolved in the liquid environment. The free oxygen diffuses in through the bacterial cell wall and oxidizes the food materials present in the cytoplasm. The reaction takes place in two steps. The first step is to oxidize the food material and remove the hydrogen atom pairs. The second step involves the oxidation of hydrogen atoms by oxygen with the release of energy. The released energy is taken up by Adenosine Diphosphate (ADP) and Adenosine Triphosphate (ATP) formed from phosphoric acid.

Inhibition of bacterial cellular respiration

Bacteriostatic and bactericidal antibiotic treatment has two radically different phenotypic consequences-inhibition of bacterial growth, or cell death. Most antibiotics inhibit processes that consume large amounts of cell energy output. This suggests that treatment with antibiotics may have important downstream effects on bacterial metabolism. It was assumed that the specific metabolic effects of bacteriostatic and bactericidal antibiotics contribute to their overall effectiveness. We used a combination of contrasting phenotypes of bacteriostatic and fungicides to study their activity. Growth inhibition by bacteriostatic antibiotics was associated with suppressed cellular respiration, whereas cell death by most bactericidal antibiotics was associated with accelerated respiration. In combination, suppression of cellular respiration by bacteriostatic antibiotics was the dominant effect and prevented bactericidal death. Global metabolic profiling of bacteriostatic antibiotic treatment reveals that the accumulation of metabolites involved in the activity of specific drug targets is associated with the accumulation of energy metabolites that fuel the electron transport chain. Inhibition of cellular respiration by cytochrome oxidase knockout is sufficient to reduce bactericidal lethality, and accelerated basal respiration by genetically disconnecting ATP synthesis from electron transport enhances the killing effect of bactericidal antibiotics. This study identified an association between antibiotic-induced cellular respiration and bactericidal lethality, and showed that bactericidal activity was stopped by suppressed respiration and enhanced by accelerated respiration. Overall, our data shows that antibiotics disrupt the metabolic state of the bacterium, which affects the effectiveness of the antibiotic.

Anaerobic bacterial respiration

There are quite a few bacteria that can live and grow without free oxygen. In fact, they die in the presence of free oxygen. These unique bacteria acquire the oxygen needed to breathe from organic compounds such as sugar. They are called anaerobic or anaerobic bacteria. A good example of this type is a bacterium that breaks down glucose into alcohol and carbon dioxide. Anaerobic respiration is achieved by the secretion of certain oxidases. The latter causes the breakdown of food. The rearrangement of atoms in the organic molecule follows. Certain groups of molecules absorb the oxygen they contain from other groups. The amount of energy available for this type of breathing is much less than when using free oxygen. Examples of the ecological importance of anaerobic respiration are the use of nitrates as terminal electron acceptors, or catabolicdenitrification, which is the main pathway for solid nitrogen to be returned to the atmosphere as molecular nitrogen gas.

Correspondence to: Barton Hugenholtz, Department of Biochemistry and Microbiology, University of New Jersey, New Jersey, USA, E-mail: Hugenholtz_b@edu.com

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