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Opinion Article

Biological Characteristics of Bacterial Respiratory Chain

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DESCRIPTION

The respiratory chain plays a central role in the energy and redox balance of aerobic bacteria. By manipulating respiration, it is possible to change the efficiency of energy production and intracellular redox states, thereby affecting the most important bioprocess parameters: cell yield, productivity and stress tolerance. Here we summarize the current approaches to metabolic engineering and synthetic biology for the respiratory metabolism of the bacterium, with a particular focus on the respiratory chain of the ethanol-producing bacterium *Zymomonas mobilis*. The electron transfer of *Z. mobilis* functions as a model system for bacterial respiration with low oxidative phosphorylation efficiency.

Bacterial cellular respiration

Bacteriostatic and bactericidal antibiotic treatment has two radically different phenotypic consequences-inhibition of bacterial growth, or cell death. Most antibiotics block processes that consume large amounts of cell energy output. This suggests that treatment with antibiotics may have important downstream effects on bacterial metabolism. We hypothesized 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 suppression of 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 discovery 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 the bactericidal antibiotics. This study identified by the association between antibiotic-induced cellular respiration and bactericidal lethality, and showed that bactericidal activity was stopped by suppressed respiration and enhanced by accelerated respiration.

The mechanism of bacterial respiration that involves in oxidative phosphorylation that link between redox reactions and ATP synthesis has been a hot topic. Today, many variations have been added to the three common models of energy coupling developed in the 1960s chemical theory, chemical penetration theory, microbial respiration and conformational theory. It is not intended here to delve into these various proposals or discuss their relative benefits. A distinguishing feature of chemiosmosis theory is the consideration of the asymmetric orientation of membrane-binding enzymes that catalyze the vector reactions that cause the movement of molecules, ions, and chemical groups across the respiratory membrane.

Dimeric mitochondrial ATP synthase

Mitochondrial ATP synthase has been shown to exist in a dimeric state in yeast, and dimeric forms are also found in mammalian mitochondria. However, the conditions for dimerization and the functional role of dimers are still controversial. In most cases, this dispute can be resolved by considering that ATP synthase is not a dimer in all species. Recent analyzes of *Paracoccus denitrificans*, *Acetobacter woodii*, and spinach chloroplasts show no evidence for dimeric ATP synthase in these organisms or organelles, and dimer complex V is mitochondrial-specific. It is suggested that microbial respiration is an important sink for reduction equivalents and an energy source for cell metabolism. However, if the target compound of the bioprocess is produced by a redox-balanced fermentation method, to give a typical example of the Pasteur effect, respiration is the yield of the product due to intervention in the redox and energy balance of the cells.

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