

Mechanisms of Bacterial Communication with Each Other and with the Host Organism and Their Application in Biotechnology

Vladislav Filozop

Faculty of Biotechnologies ITMO University, St. Petersburg, Russia

Tatiana Sall

Federal State Budgetary Scientific Institution 'Institute of Experimental Medicine' (FSBSI "IEM"), St. Petersburg, Russia

Ilia Kuzminov

Faculty of Biotechnologies ITMO University, St. Petersburg, Russia

Valeriy G. Zaitsev

Faculty of Biotechnologies ITMO University, St. Petersburg, Russia

Timur Ya. Vakhitov

Faculty of Biotechnologies ITMO University, St. Petersburg, Russia

Abstract

From a biotechnology perspective, microbial growth is a self-regulating process governed by autocatalytic and autoinhibitory mechanisms, resulting in the classic sigmoidal growth curve. Contrary to the traditional view of metabolic byproducts as mere waste, these substances serve vital signaling functions essential for sustaining culture growth, as demonstrated by dialysis and continuous-flow culture experiments. Leveraging these autoregulatory mechanisms can optimize biotechnological processes by accelerating microbial biomass production, increasing yield, and enhancing bacterial stress resistance. The most promising application of these signaling metabolites lies in modulating the composition and function of microbiota in the gastrointestinal tract and other host biotopes. This review discusses general approaches to studying bacterial metabolites' regulatory properties, developing drug formulations based on them (using the metabiotic Actoflor-S as an example), and evaluating their effects through preclinical and clinical studies.

Keywords

Bacterial communication; bacterial metabolites; signaling molecules; intermicrobial signaling; host-microbe interactions; microbial growth autoregulation; microbiome engineering; Actoflor-S.