

Engineered bidirectional communication mediates a consensus in a microbial biofilm consortium

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PNAS **104**, 44, 17300-17304 (2007)

Presented by Shlomiya Bar-Yam
May 9, 2012

Background

- Biofilms common
- Complex, interacting communities
- Work just beginning

Accomplishments

- Populations communicate, come to consensus, respond to each others' presence
- Characterized in liquid, solid, biofilm

The MCC “Signaling Network”

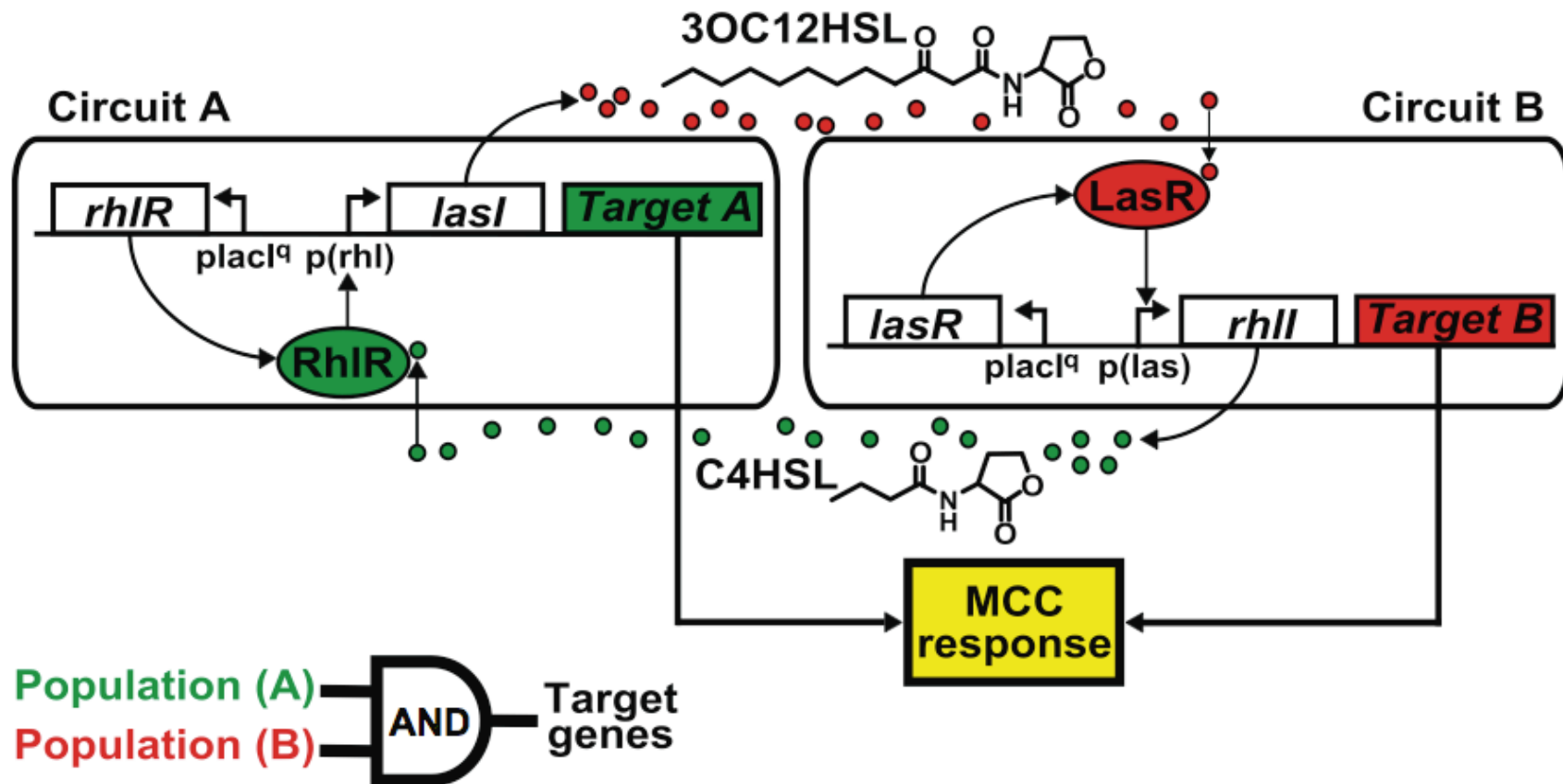
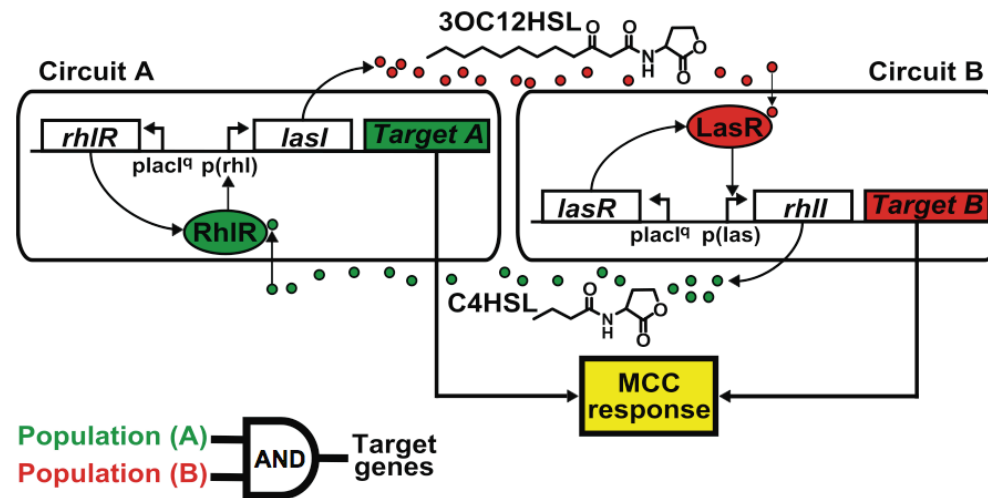


Figure 1

Modeling to Minimize Crosstalk

- Minimize densities for consensus activation, maximize densities for isolation activation
- Positive feedback loop
- Need C4HSL for LasI and 3OC12HSL; need 3OC12HSL for RhII and C4HSL (minimize crosstalk signal)



Liquid Culture

- GFP in both
- Separate chambers with passage of small molecules
- Responses over 100-fold greater with communication

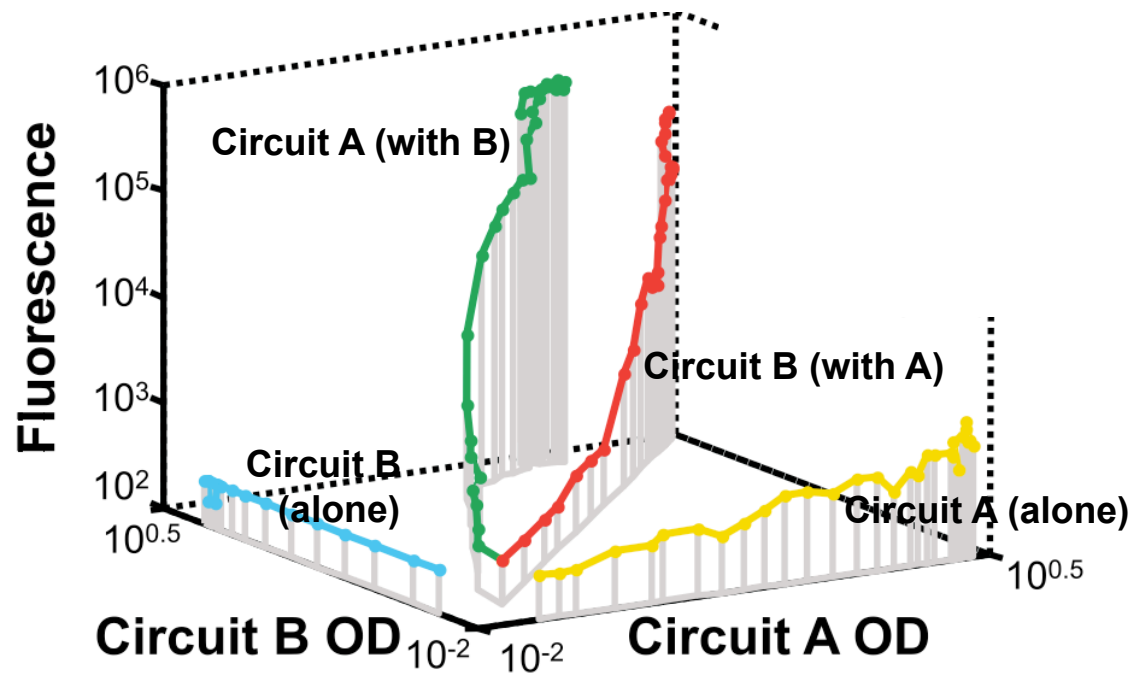


Figure 2B, modified

Solid Culture

- Cell types embedded separately in solid medium
- Media placed in contact
- Fluorescence decreases with distance from interface
- Circuit A slower growth

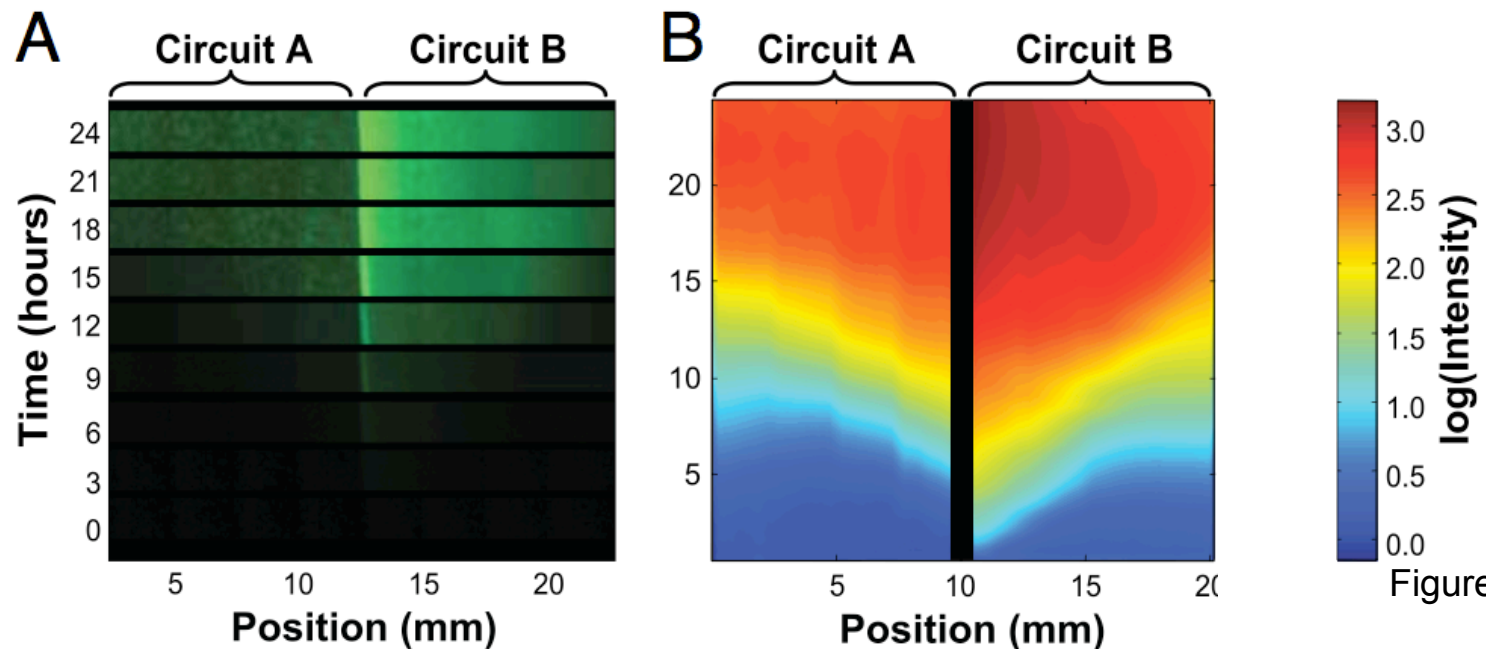


Figure 3

Biofilms (consortium)

- Circuit A – green (yellow); Circuit B – red (cyan)
- Grow together and display MCC function (≥ 6 dys)
- No significant fluorescence separately

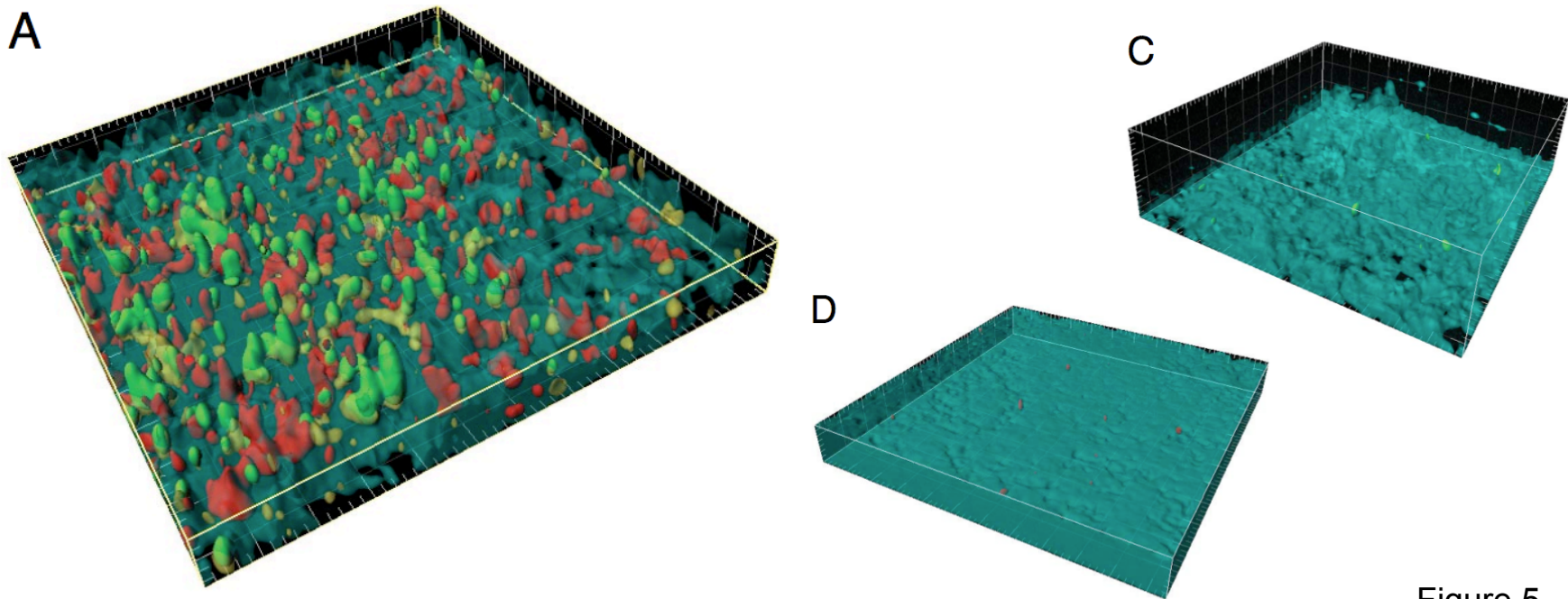


Figure 5

Biofilm Communication in Nature

- Quorum sensing to coordinate biofilm formation
- Biofilm disruption

Fundamental Applications

- Integrate cells sensing different stimuli (temp, pH, ...)
- More communication partners
- Communication other than quorum

Applied Applications

- Mixed-culture batch reactors require quorum of each
- Disrupt pathogenic biofilms
- Enzyme-prodrug pair; inactive toxin fragments
- Materials synthesis
- Surveillance for environmental changes
 - Epidemiology, material degradation

Discussion

- Paper is early (2007); later developments?
- How special is this “AND gate” in relation to one-cell circuits?

See this paper for insight on biofilms:

R.M. Donlan, J.W. Costerton. Biofilms: Survival mechanisms of clinically relevant microorganisms. *Clin. Microbiol. Rev.* **15**, 2, 167-193 (2002). <http://cmr.asm.org/content/15/2/167.full>

Increasing fluorescence from increasing concentration of signaling molecule

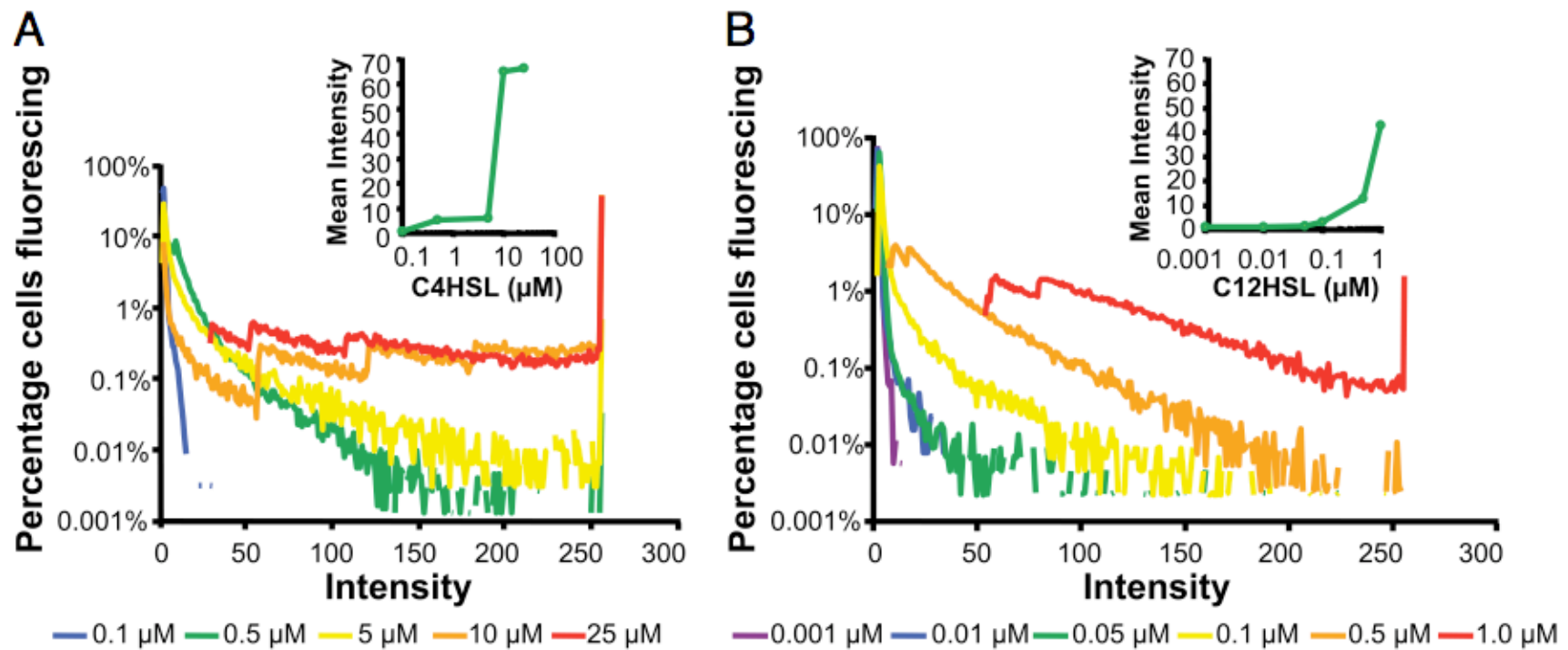


Figure 4