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## Metabolic interactions in microbial communities

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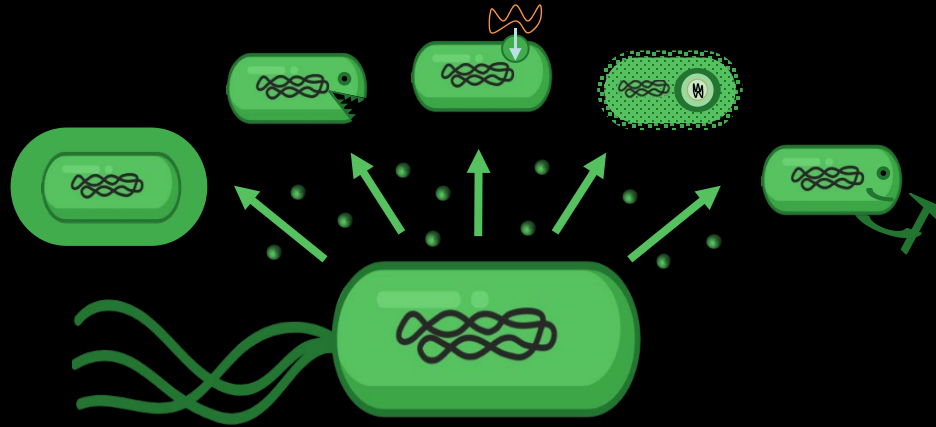
# Metabolic interactions in microbial communities

Elizabeth Shank

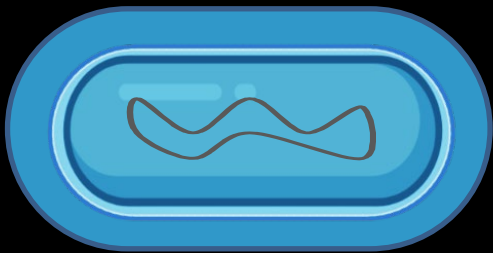
Program in Systems Biology  
Microbiology and Physiological Systems



# Cellular heterogeneity



**Bacterial differentiation**



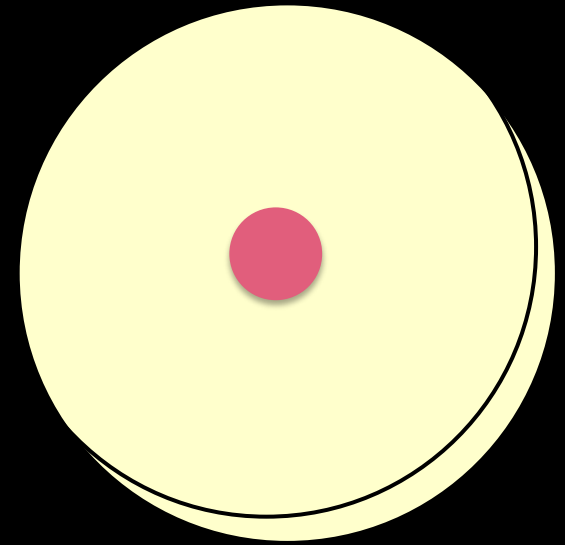
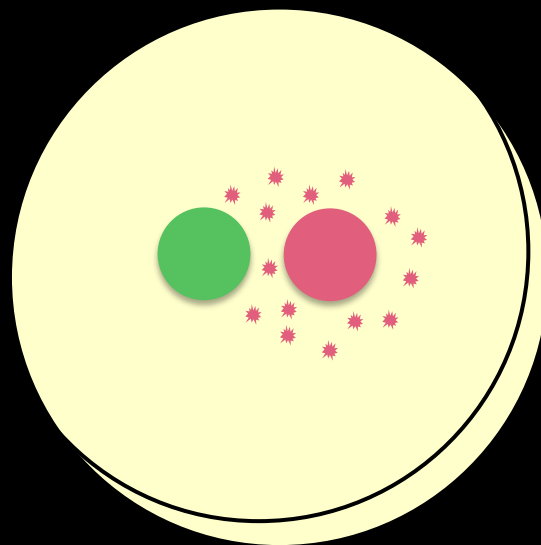
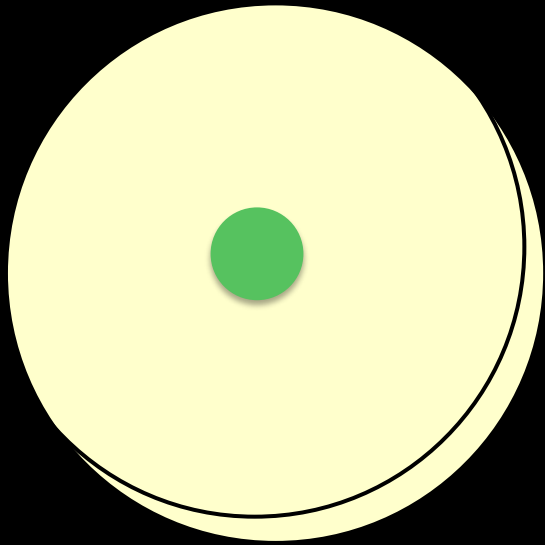
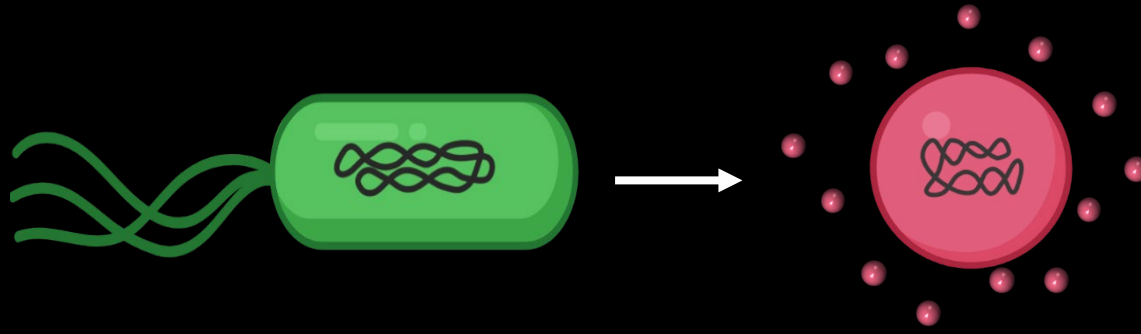
**Metabolite production**



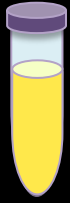




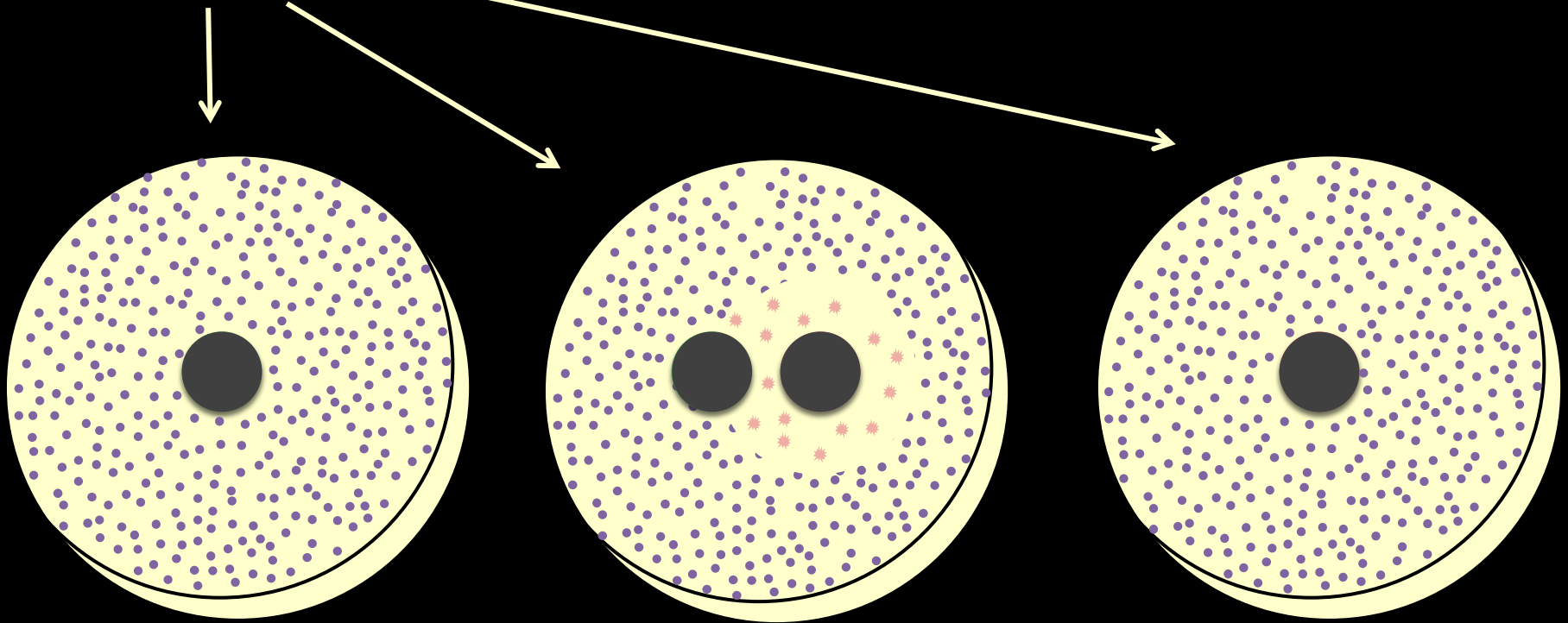
# Coculture antibiotic assay



# Coculture antibiotic assay



*Pathogen*



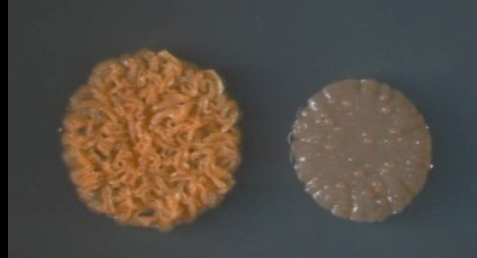


# Coculture promotes antibiotic production

*Microbispora* sp.  
Monoculture



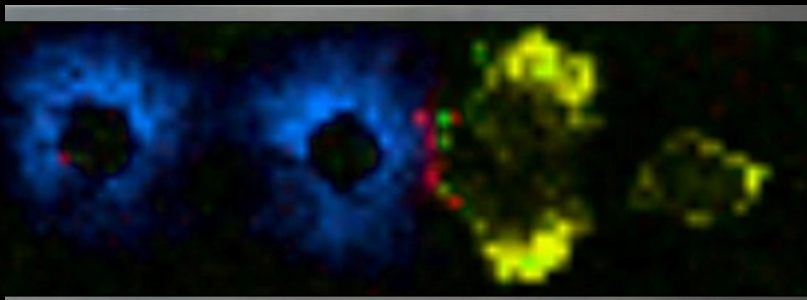
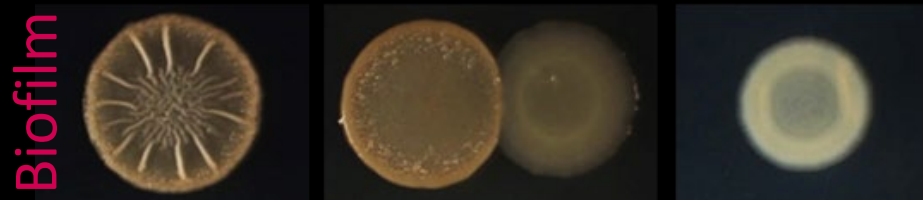
Coculture



*Microbispora* sp.  
Monoculture



# Coculture to identify cell-cell signals



Analyzed ~1,500  
genomes

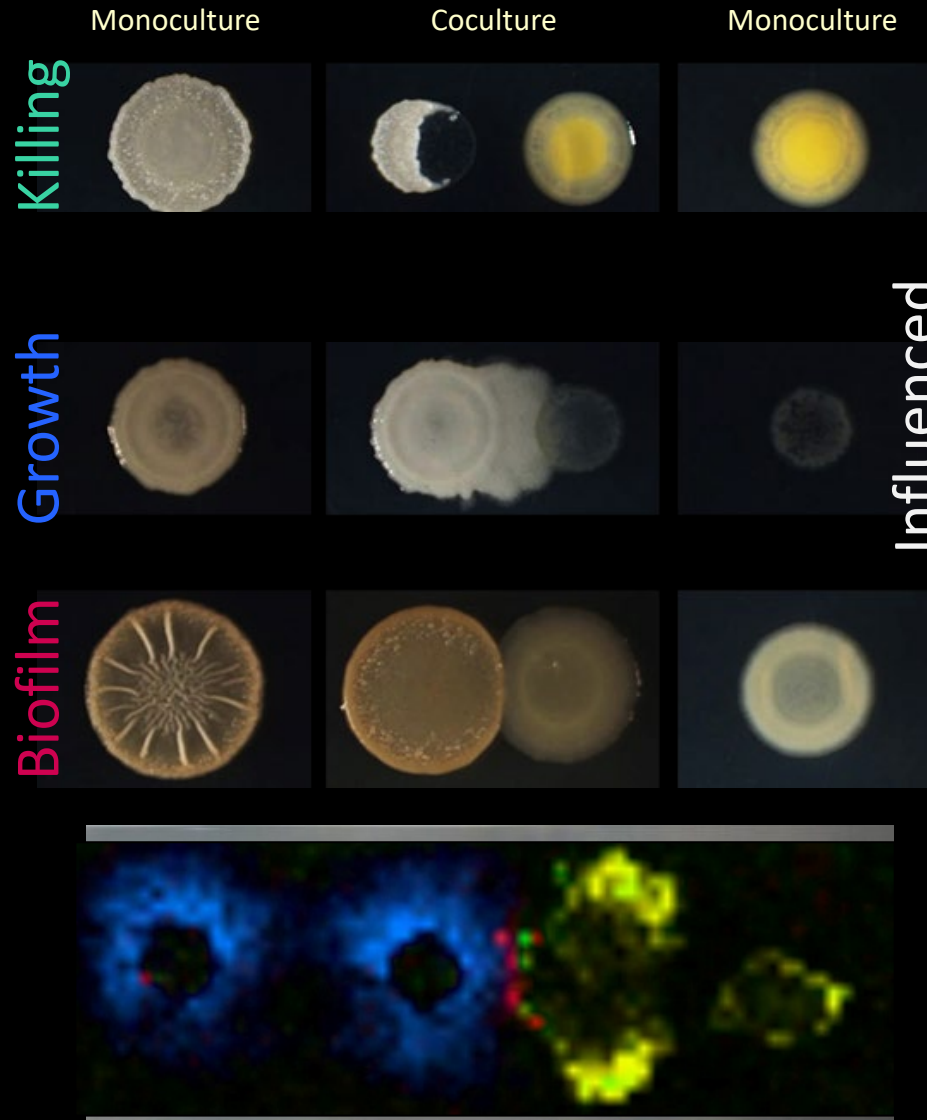
Identified those with  
**unusual biosynthetic  
gene clusters**

We selected 127  
strains

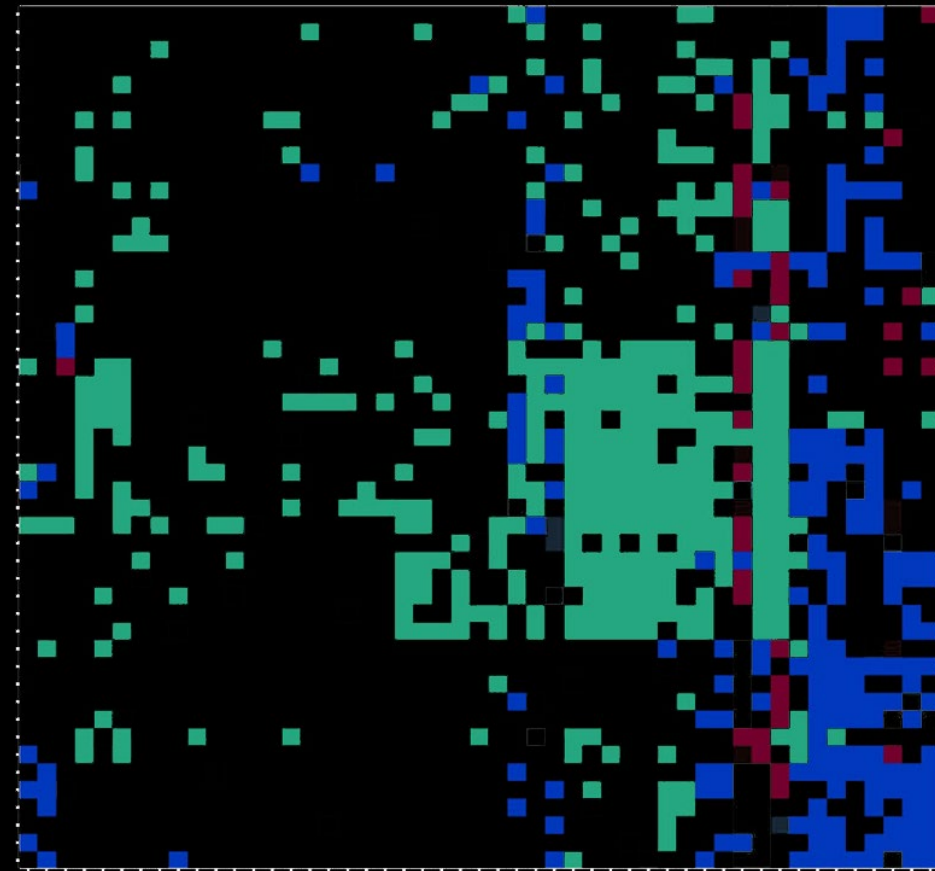
Performed > 5,000  
pairwise cocultures



# Coculture to identify cell-cell signals



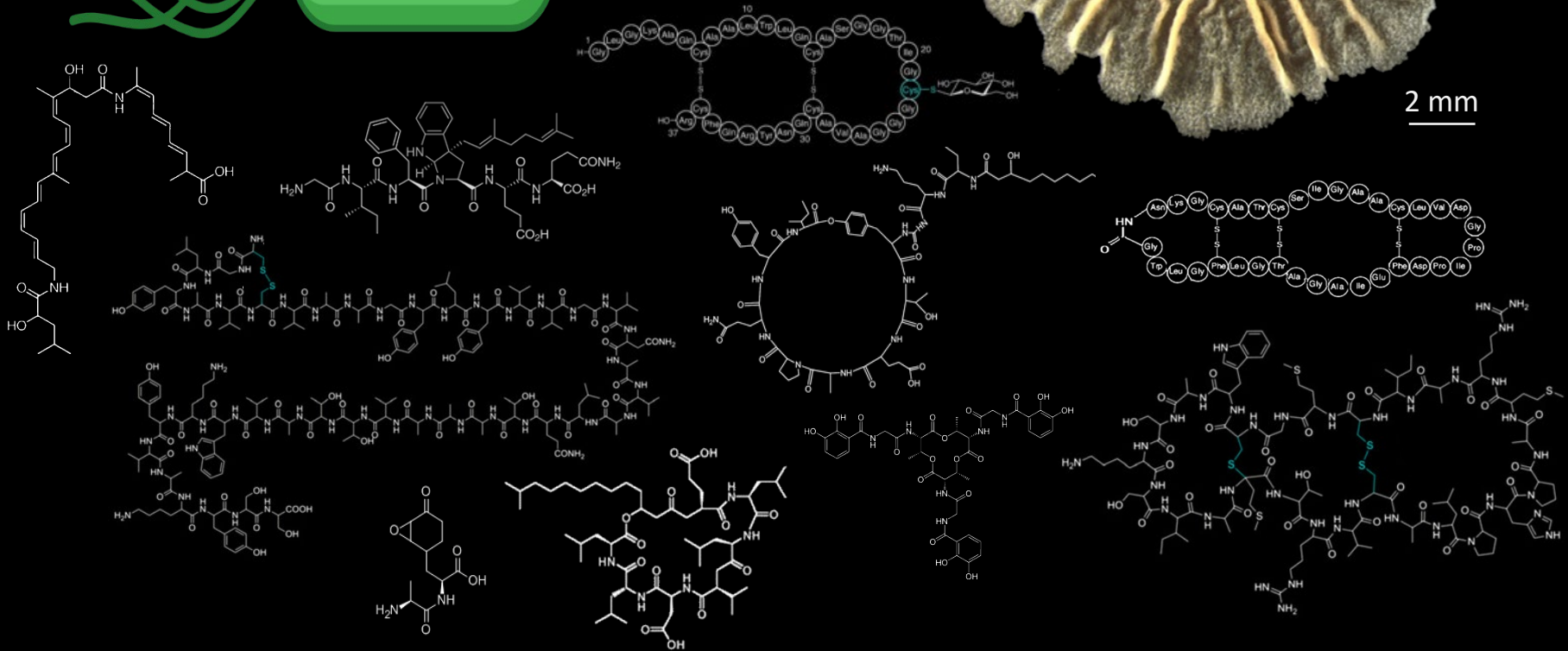
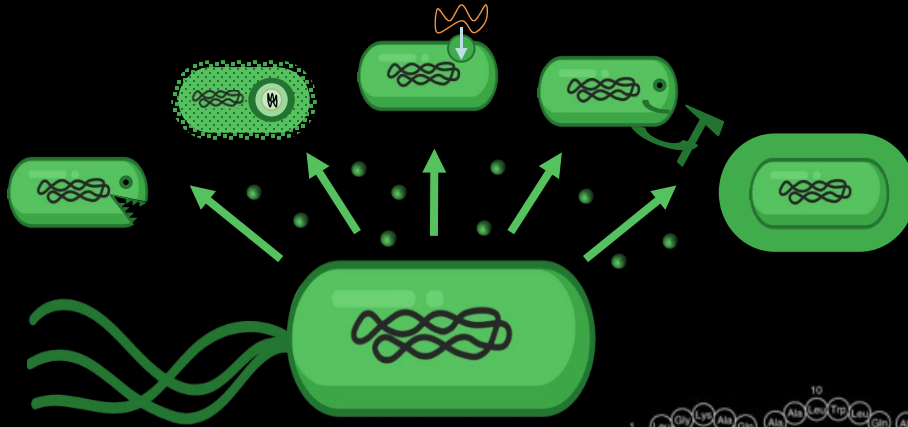
Influenced



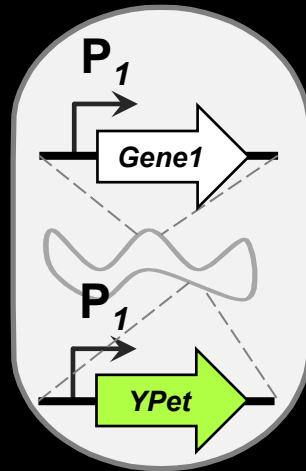
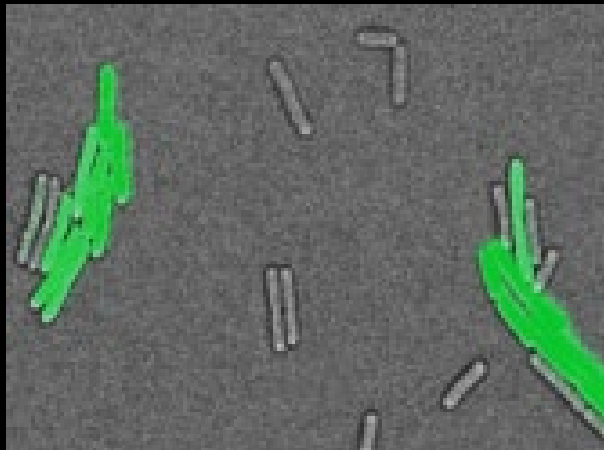
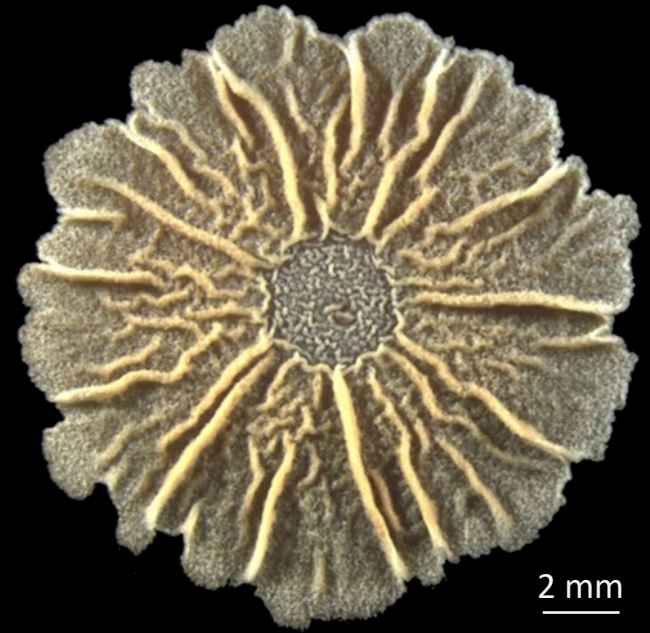
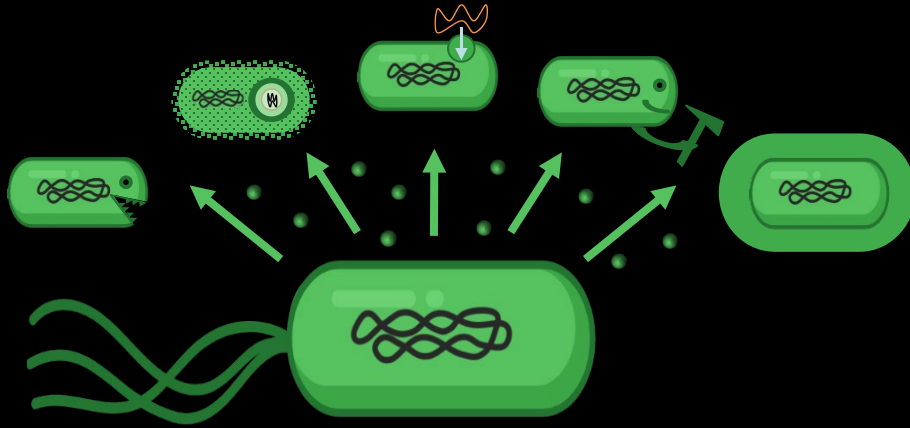
Influencer



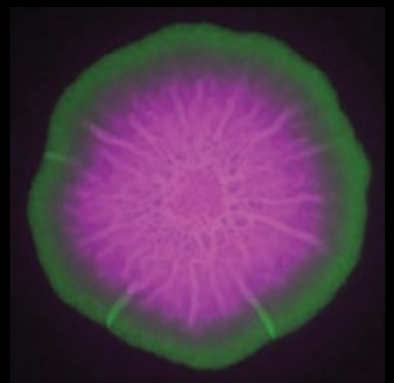
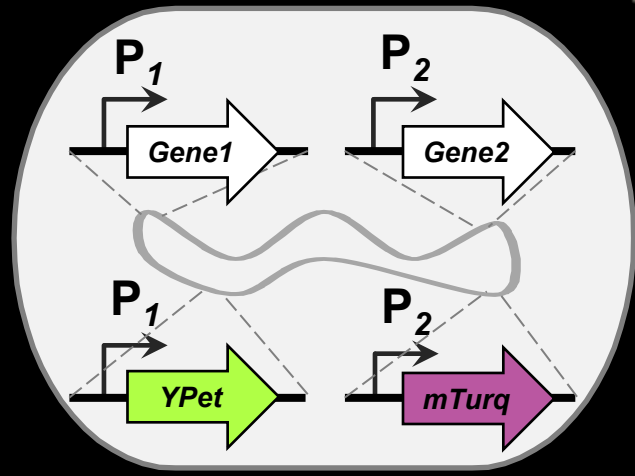
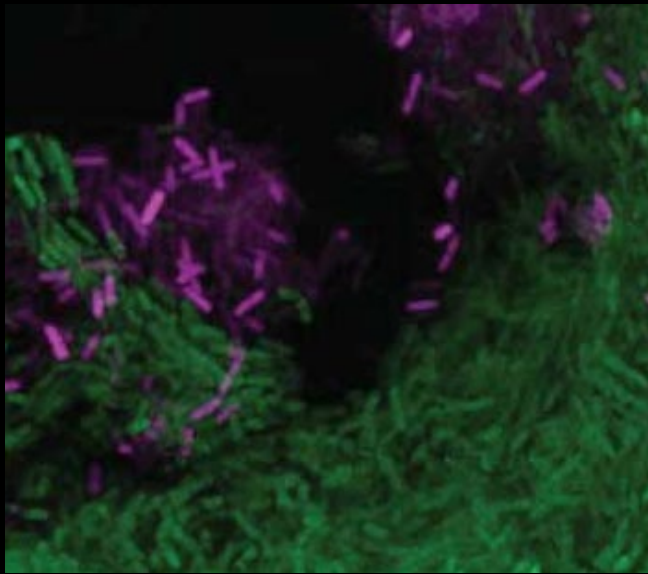
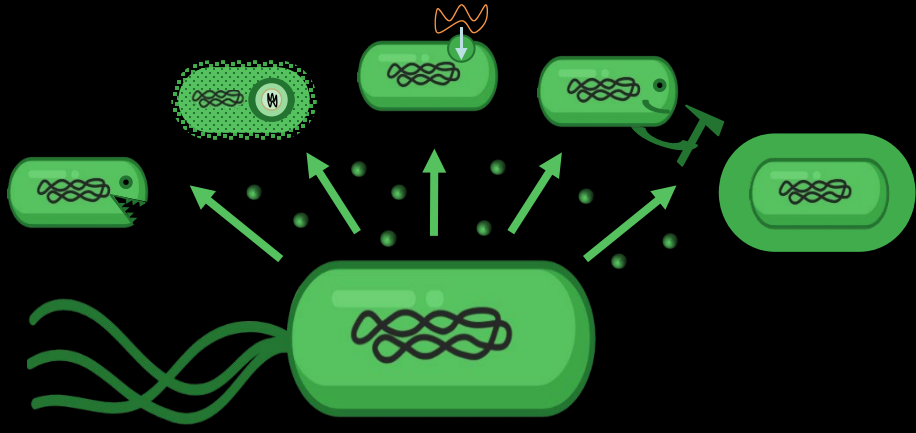
# Cellular heterogeneity



# Cellular heterogeneity

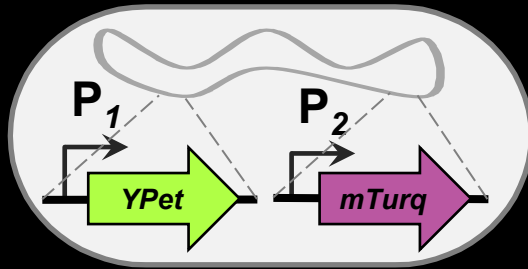


# Cellular heterogeneity

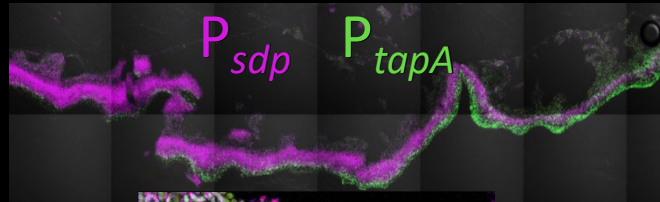


Selected 18 genes of interest  
(physiology and metabolites)

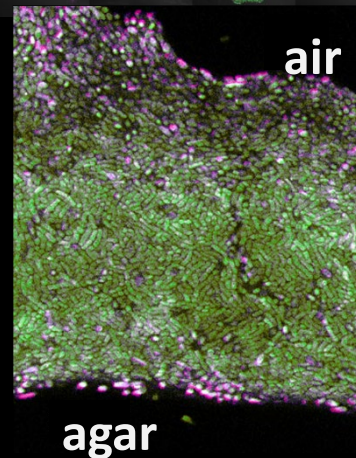
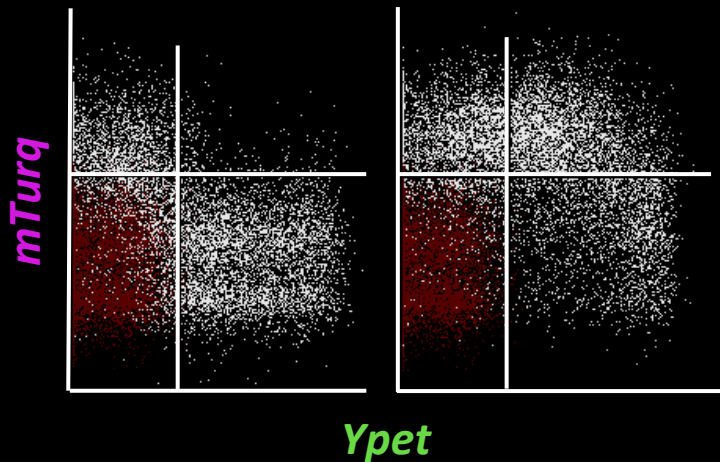
∴ Built 153 dual-labeled strains



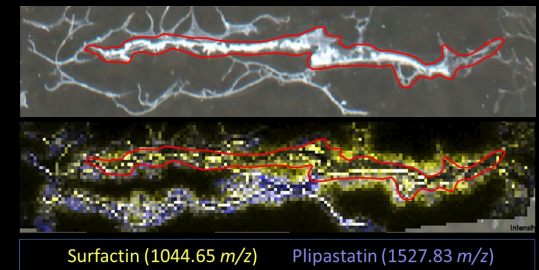
Microscopy



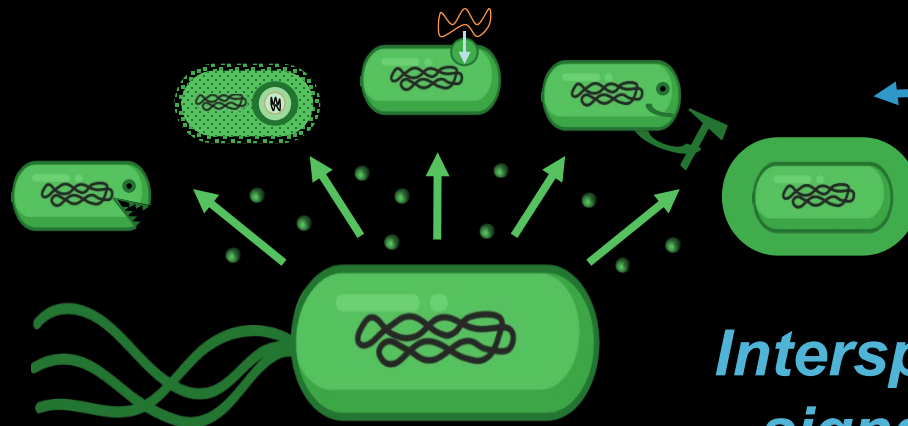
Flow cytometry



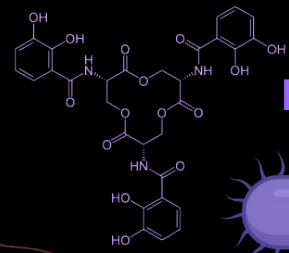
Imaging Mass Spectrometry



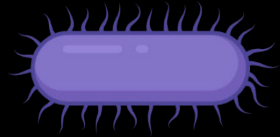
# Intraspecies signaling



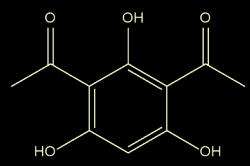
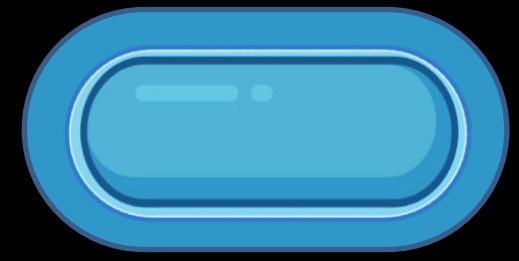
*B. cereus*  
Thiocillin



*E. coli*  
Enterobactin



# Interspecies signaling



DAPG



*P. protegens*

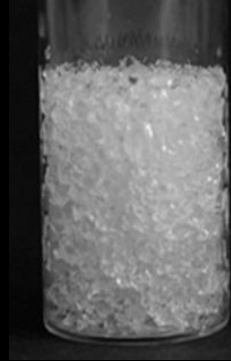
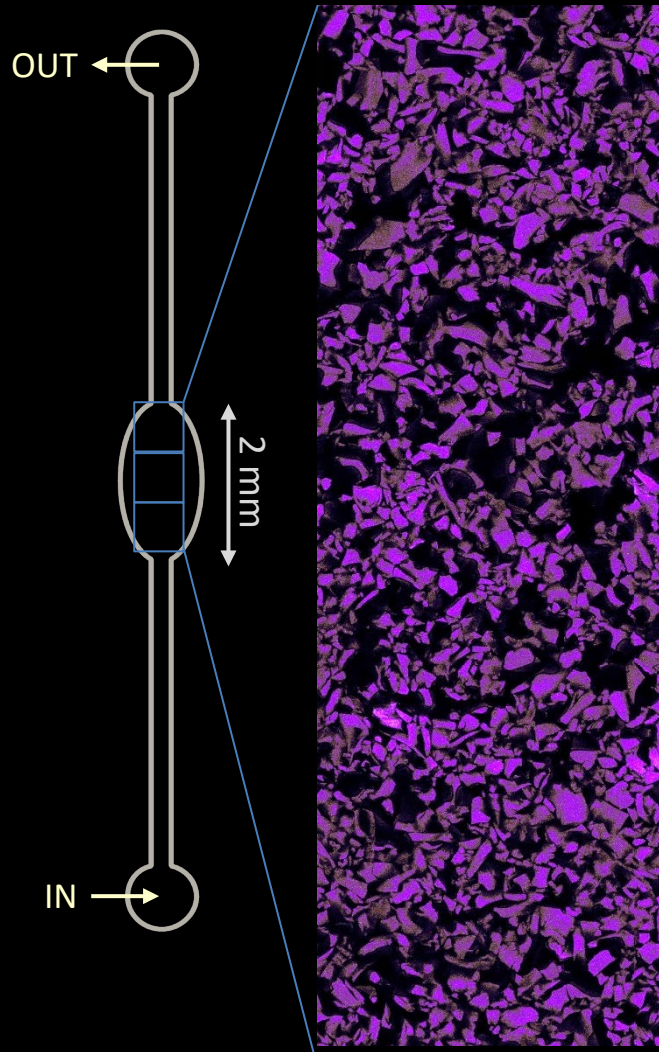
- 2011, *PNAS*, EA Shank et al.
- 2015, *PNAS*, R Bleich et al.
- 2015, *JBact*, M Powers et al.
- 2017, *AEM*, G Grandchamp et al.



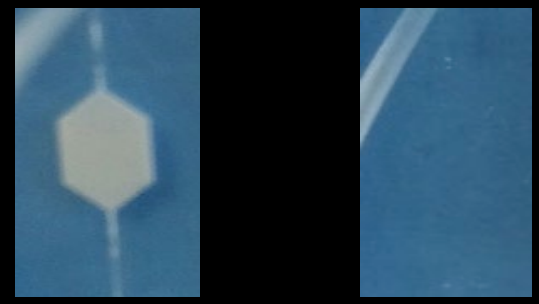
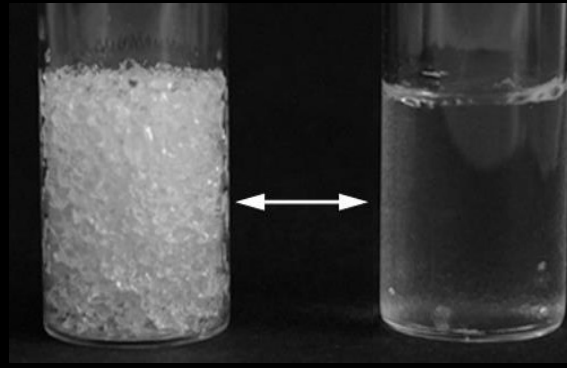
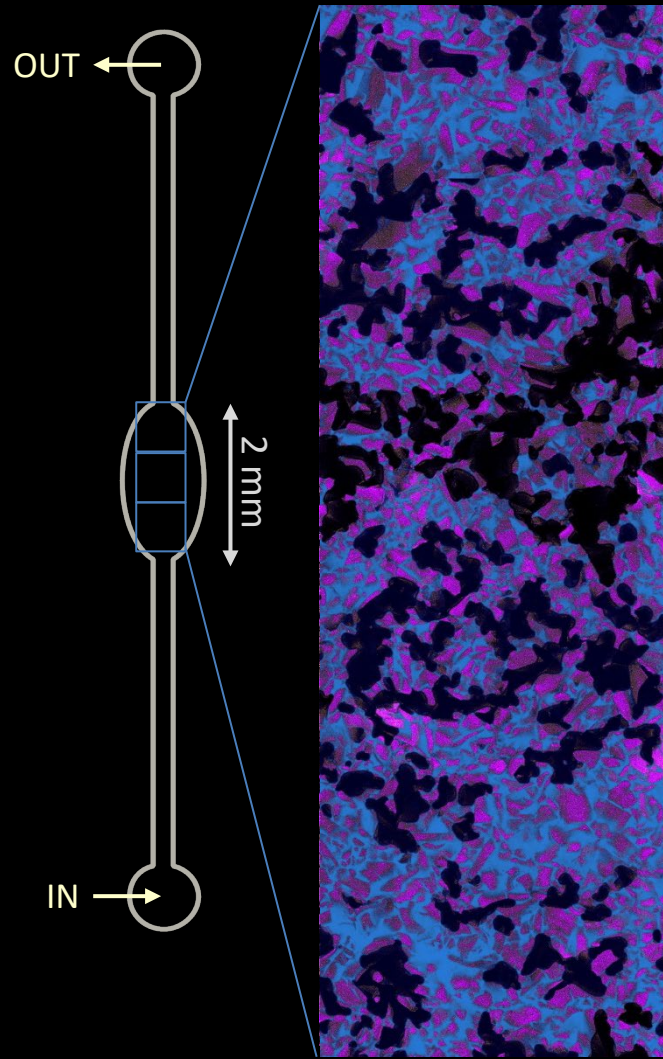


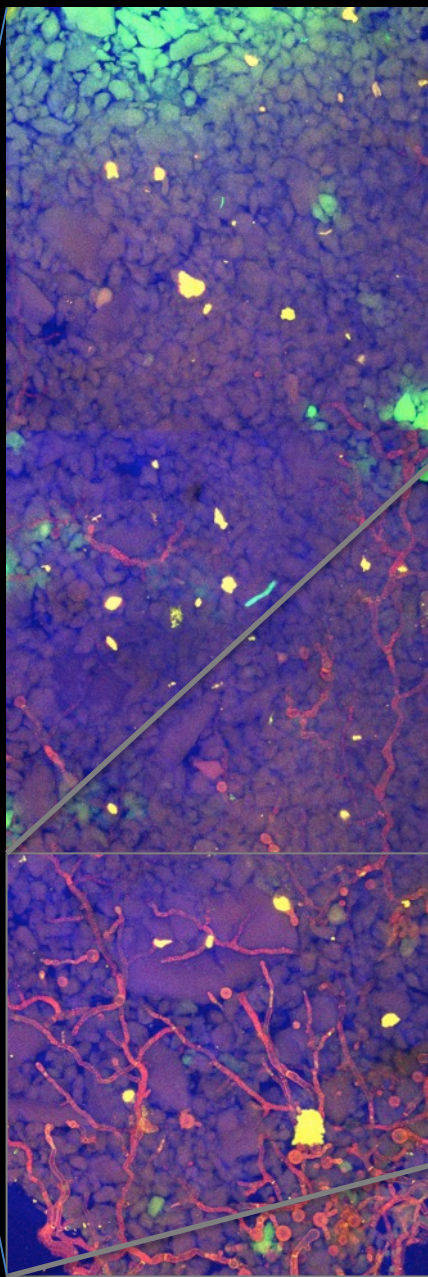
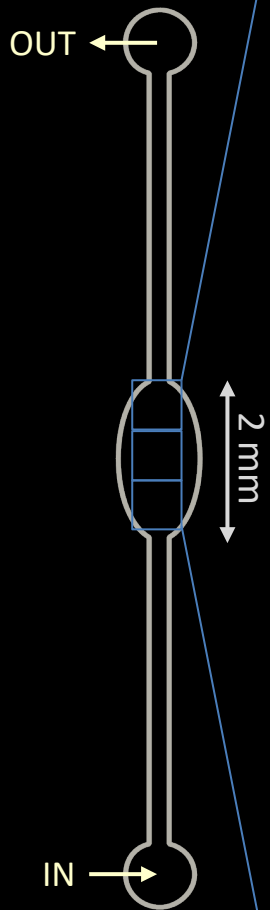
<http://bonnieplants.com/>

# Transparent Soil

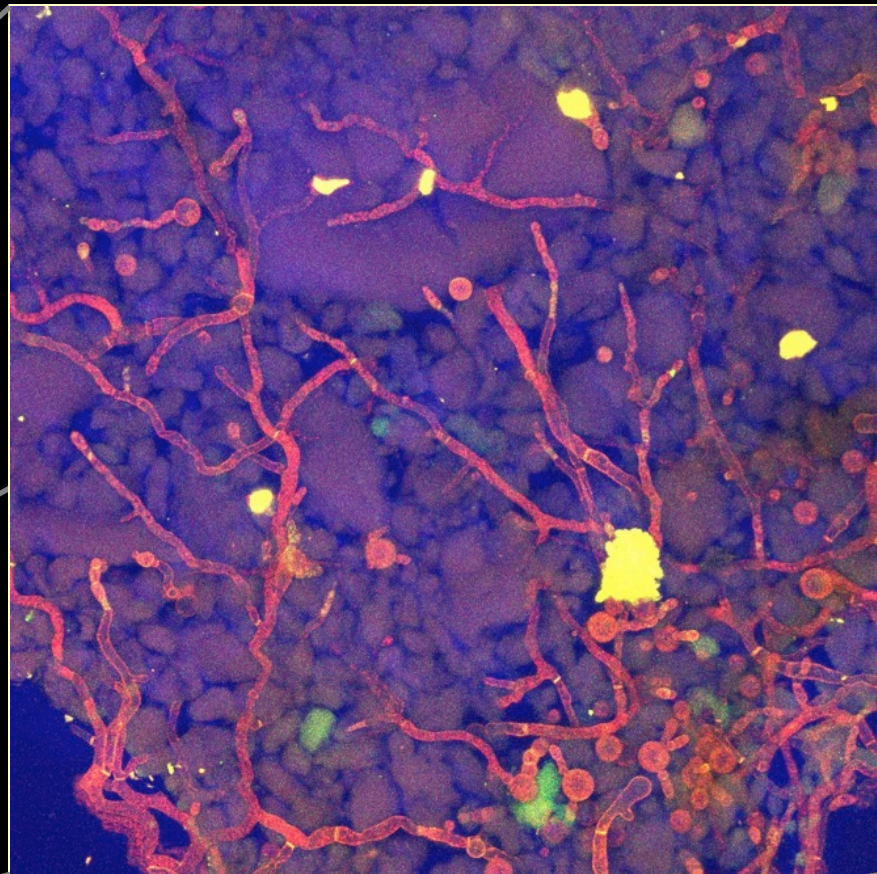


Transparent  
Soil      Liquid



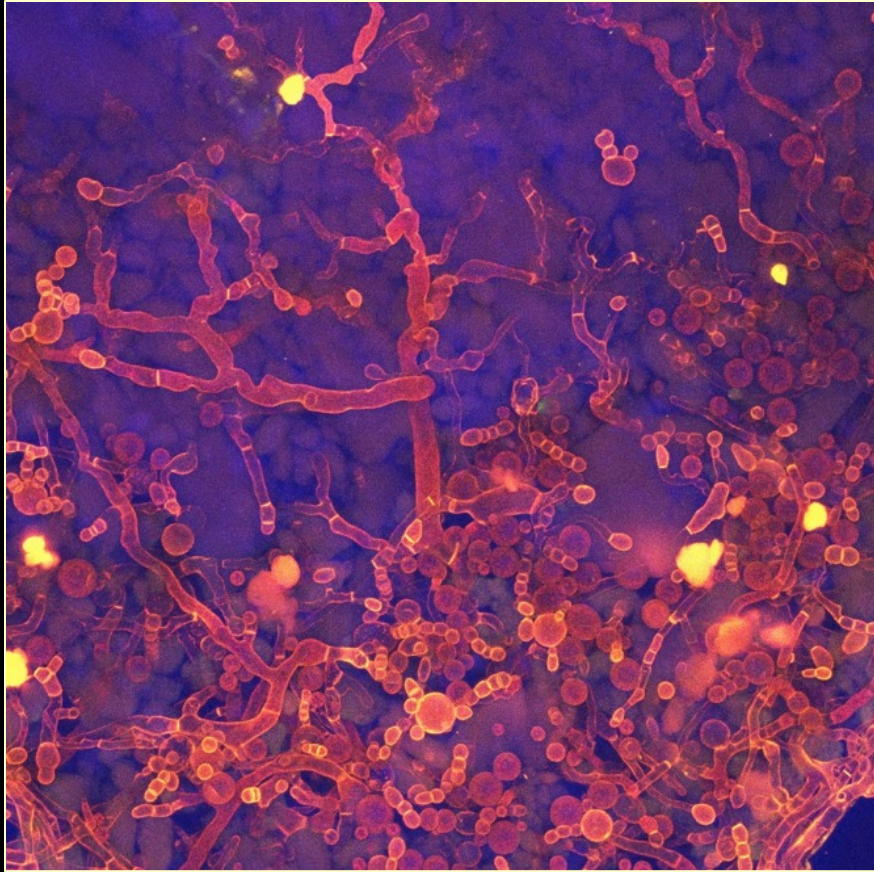


*Fungal hyphae*

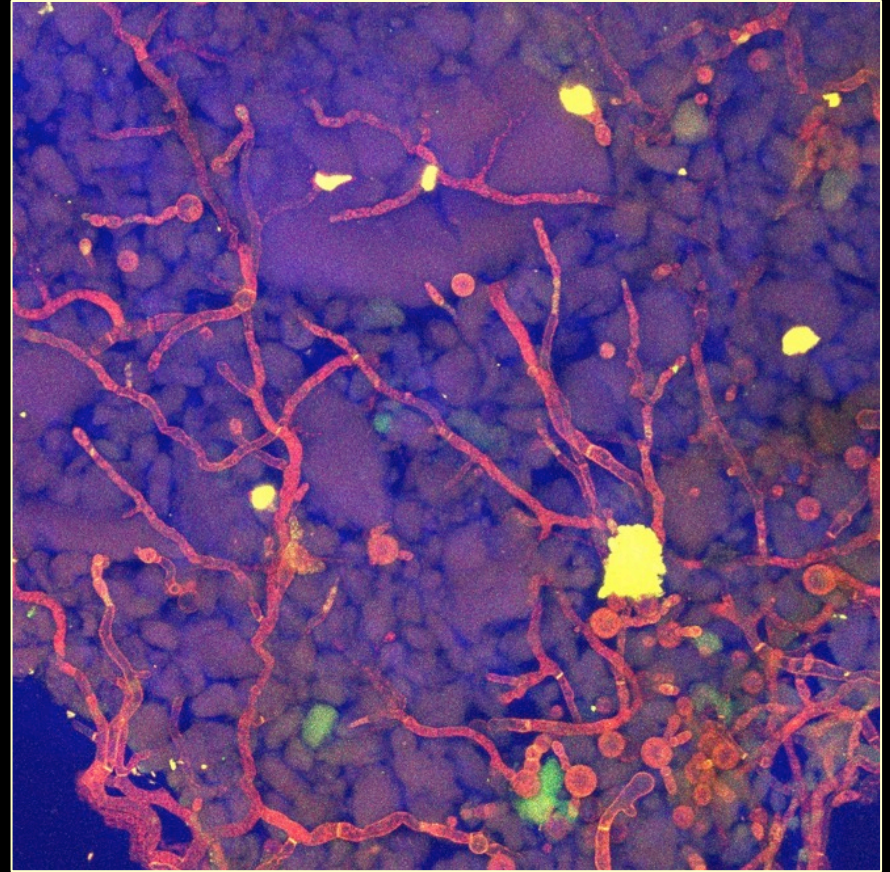


100  $\mu\text{m}$

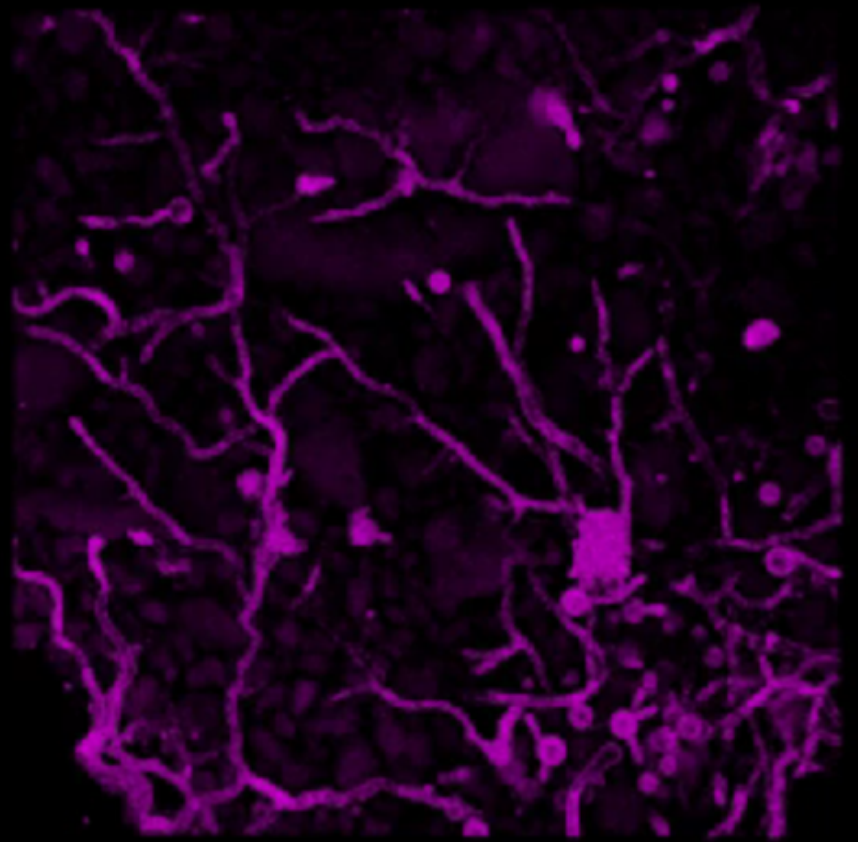
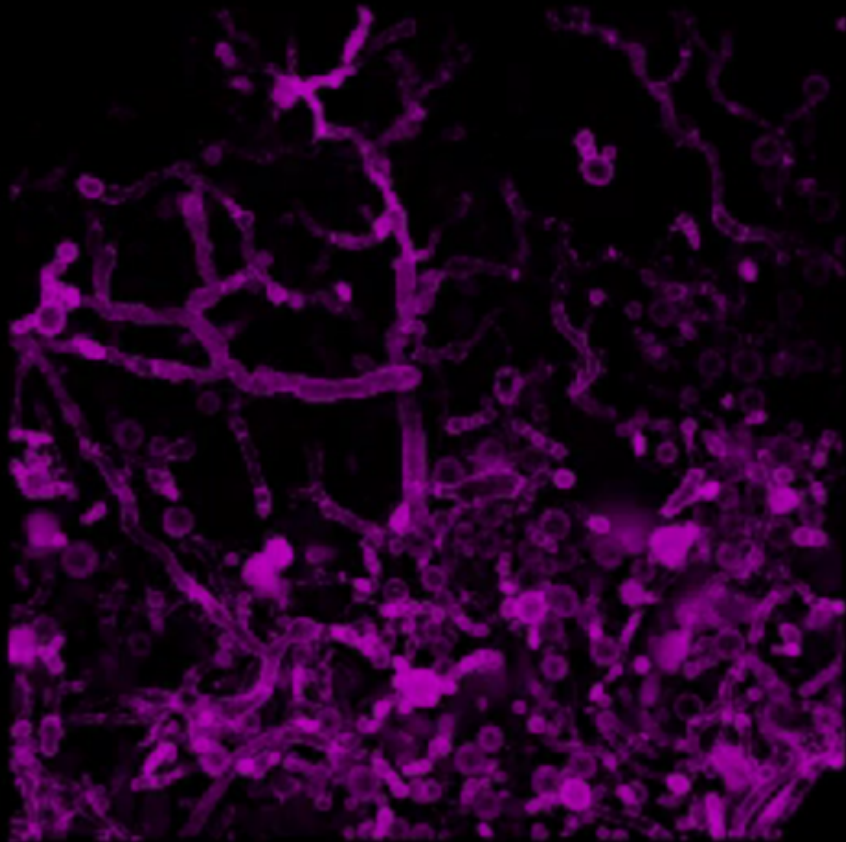
*Fungus + B. subtilis*



*Fungal hyphae*



100  $\mu\text{m}$



100  $\mu\text{m}$

# Shank Lab



PROGRAM IN  
SYSTEMS BIOLOGY



Sarah  
Yannarell



Alexi  
Schoenborn



Hunter  
Talley



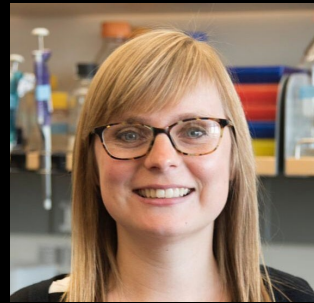
Noam  
Eckshtain-Levi

*We are  
recruiting!*

*Email me at  
Elizabeth.Shank  
@umassmed.edu*



Eric  
Beaudoin



Kasia  
Dubiel



Vanessa  
Nepomuceno



Chris  
Anderton



David  
Berry

## Collaborators



U.S. DEPARTMENT OF  
**ENERGY**

Office of Science



Will  
Chrisler



Galya  
Orr

A fluorescence micrograph showing a complex biological structure, possibly a developing embryo or a specialized cell. The structure is primarily orange and yellow, with numerous small, bright spots scattered throughout. It is surrounded by several circular, purple-stained cells. The background is dark blue. The text "Questions?" is overlaid in the upper right quadrant in a white, sans-serif font.

Questions?