

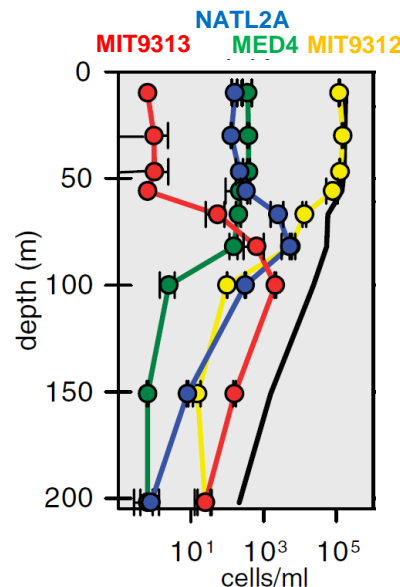
# ***Modeling the Evolution of Light Adaption in Marine Viruses using Systems BioEcology***

by  
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# *Prochlorococcus*

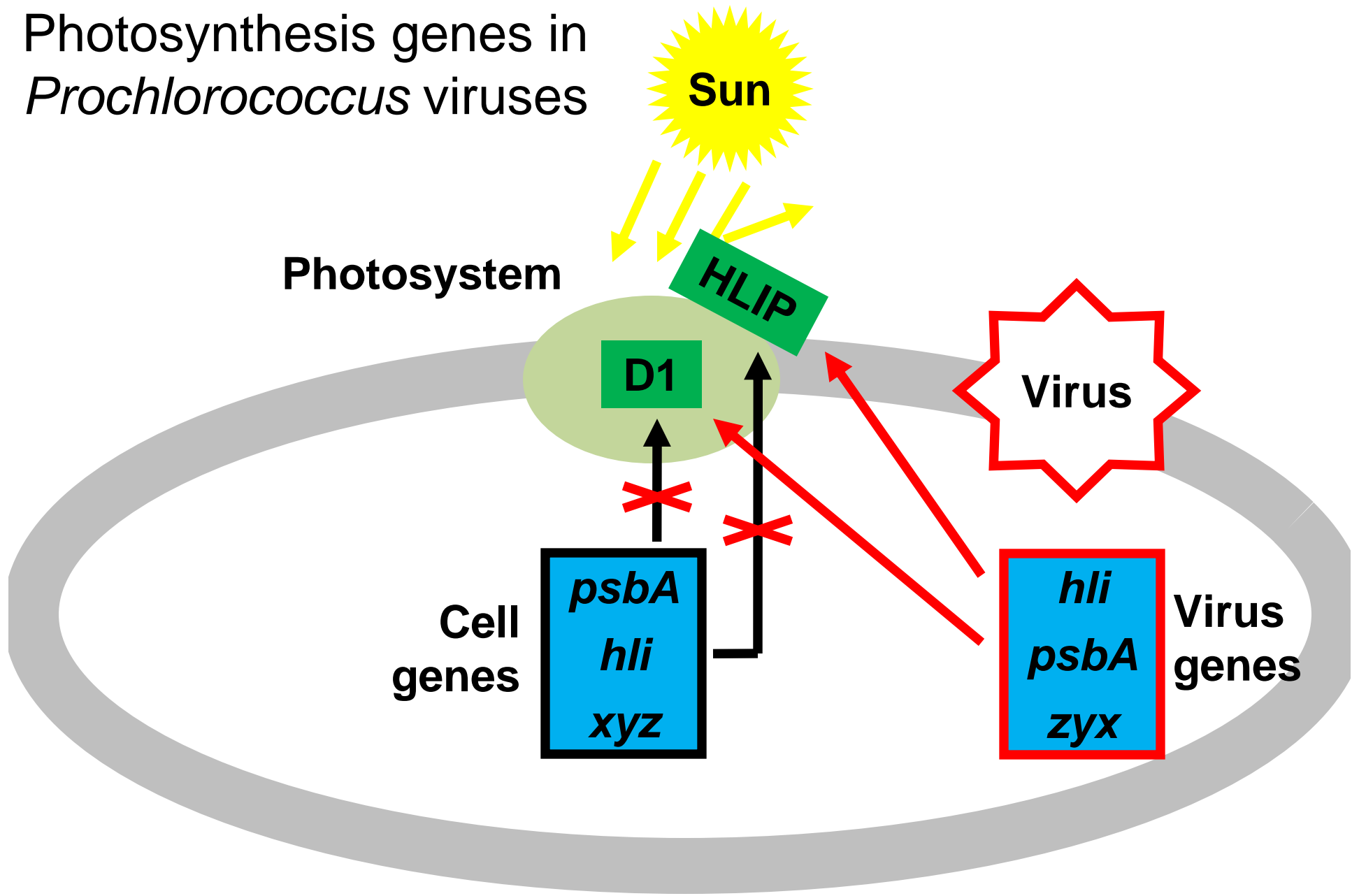
- Marine cyanobacteria (blue-green algae)
- In oligotrophic ocean:
  - Numerically dominant phytoplankton species
  - 21 to 43% of the photosynthetic biomass
  - 13 to 48% of the net primary production

- Different “ecotypes”:
  - Nutrient
  - Temperature
  - Light



Different combinations of photosynthesis genes (e.g. *psbA*, *hli*).

# Photosynthesis genes in *Prochlorococcus* viruses



# Ecological Fitness

## Fitness benefit:

- Increased energy > speeds up virus prod.
  - > allows for reduced latent period

## Fitness costs:

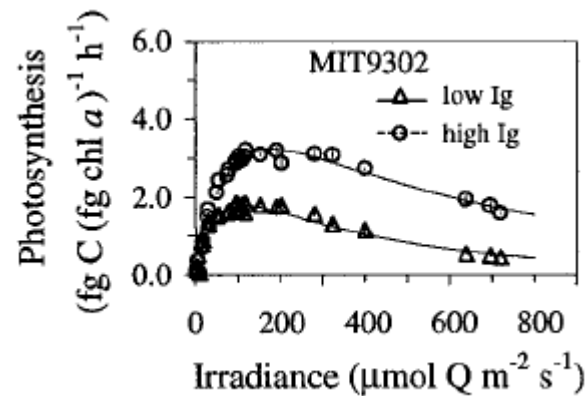
- Larger DNA > takes longer to inject, transcribe and copy DNA
  - > increased latent period
- Larger DNA > Reduces max. burst size

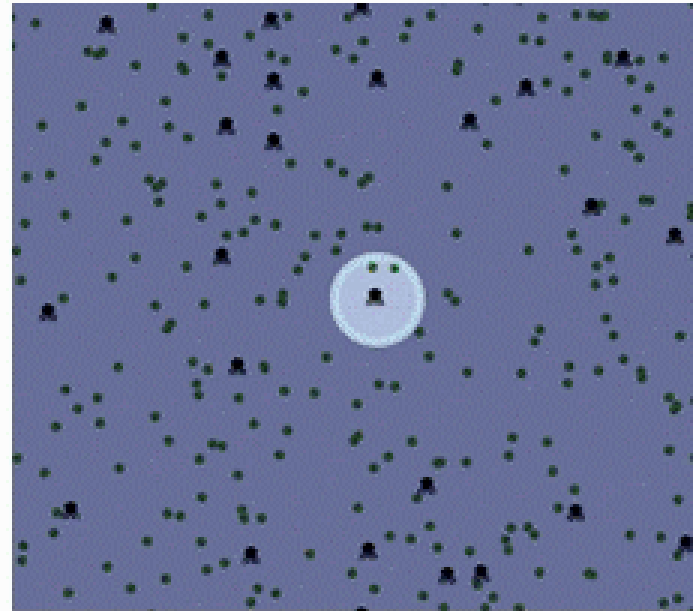
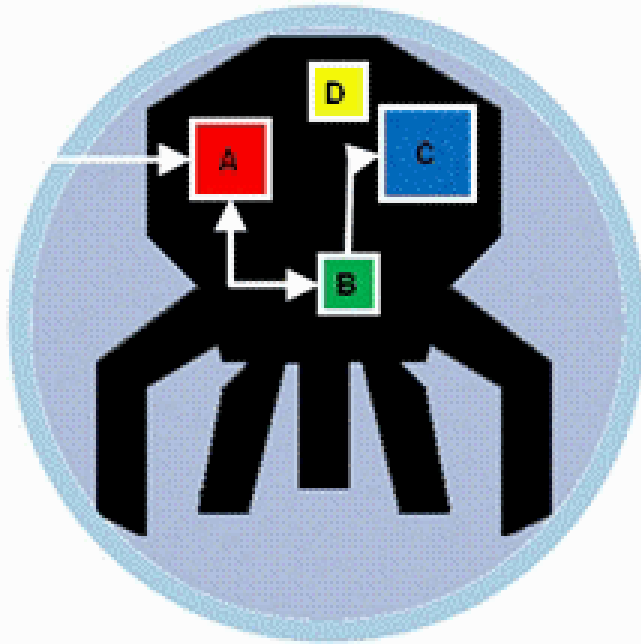
**What is the net fitness benefit?**

# Modeling Approach

## Conventional Model

$$P = P_m \tanh(\alpha I / P_m)$$





**Systems  
Biology**

(2,980,000 Google hits)

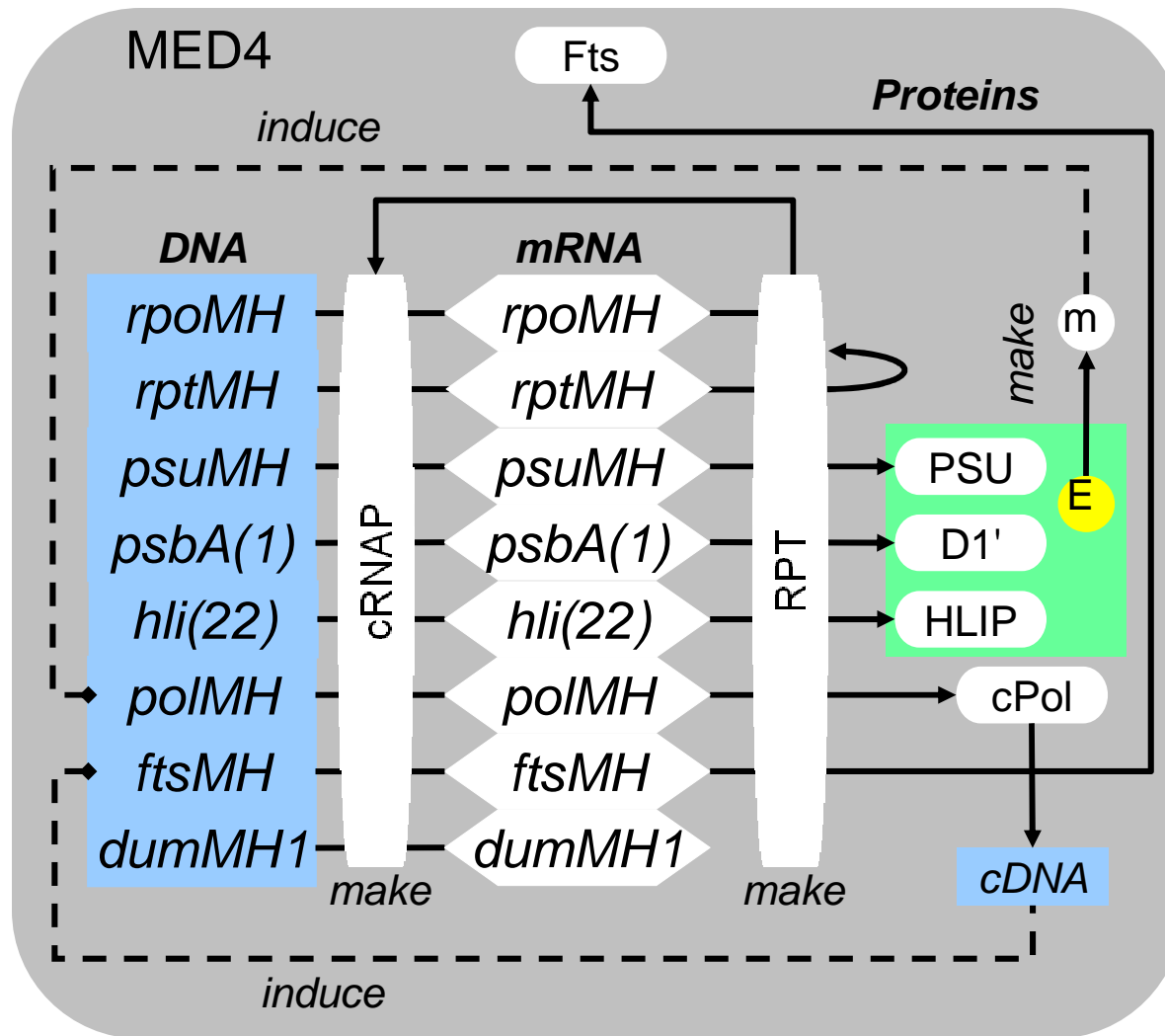
+

**Systems**

**BioEcology**

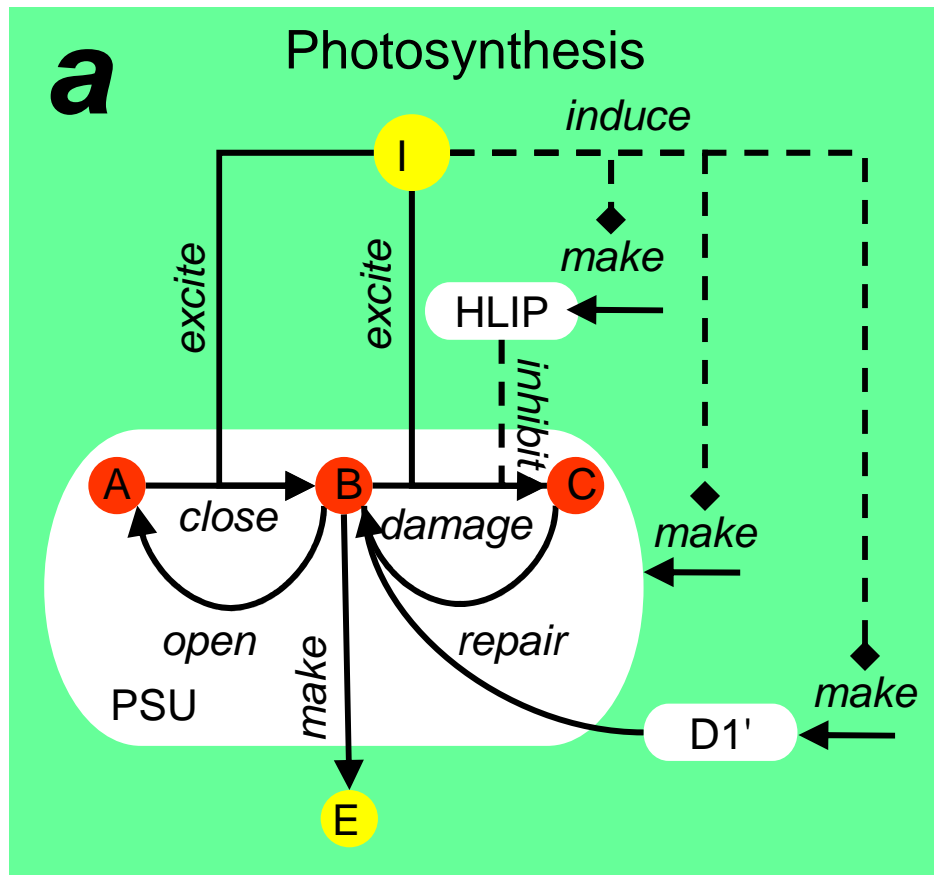
(No Google hits)

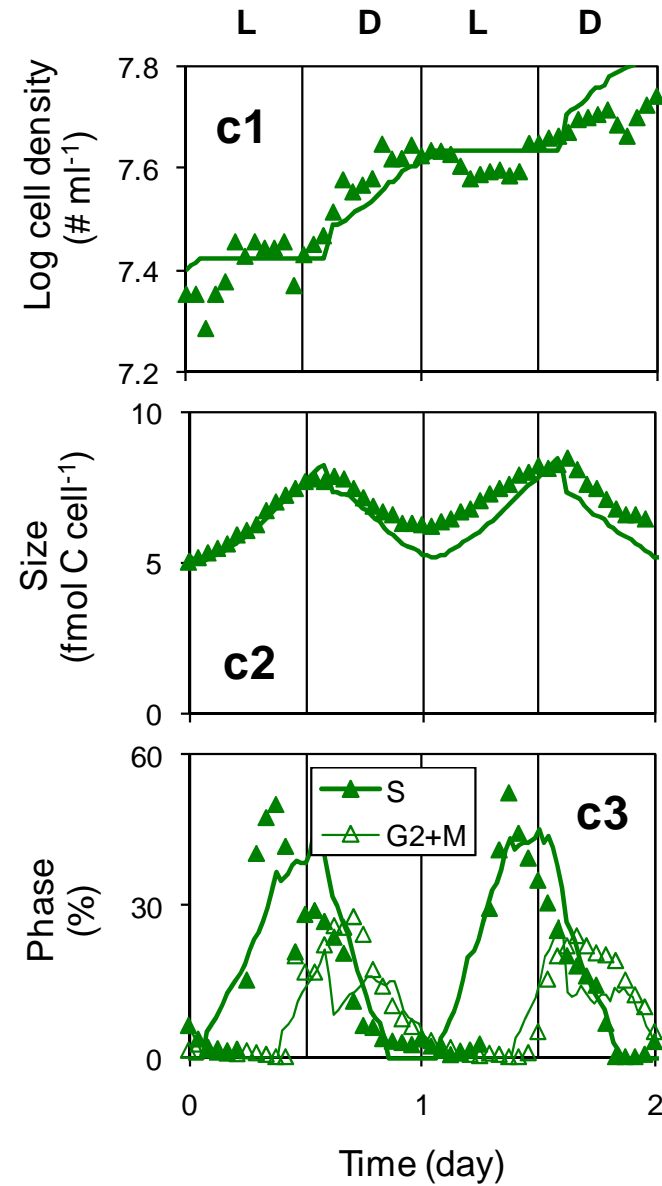
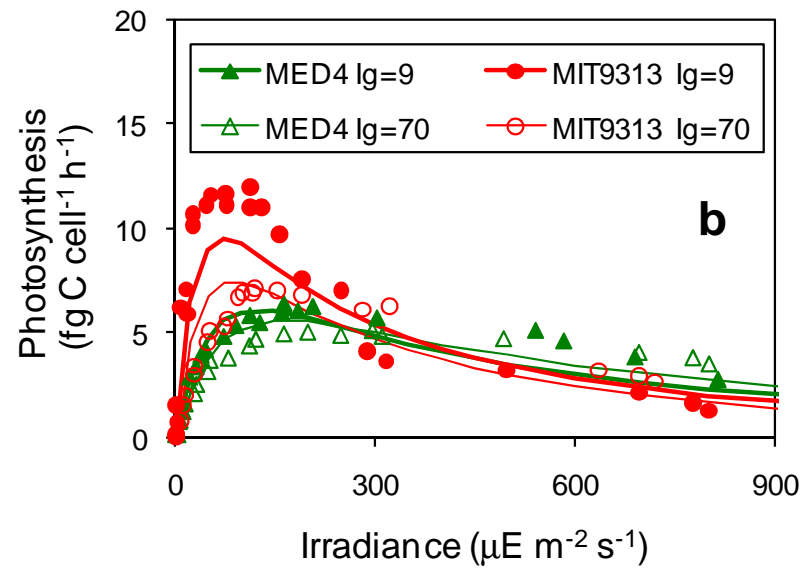
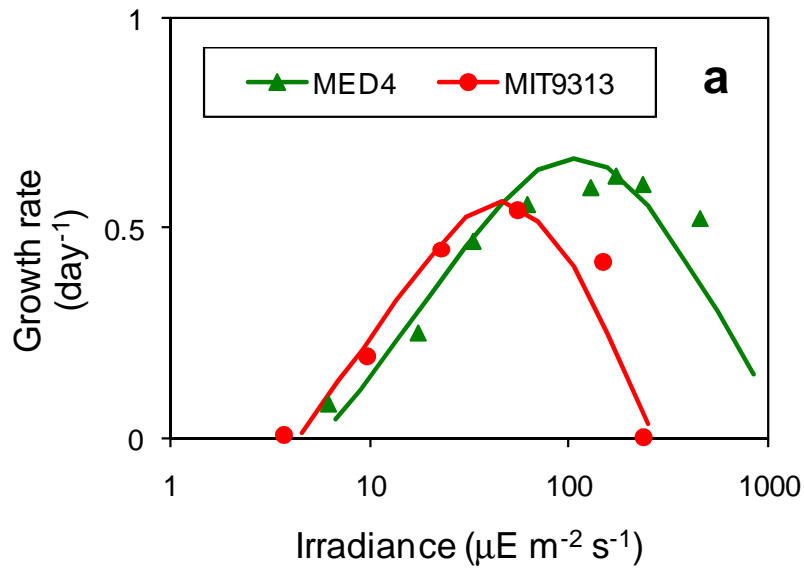
**“From genes to ecosystems in one shot”**





- Based on Han (*J. theor. Biol.*, 2002).
- Added D1' & HLIP
- Added photoacclimation

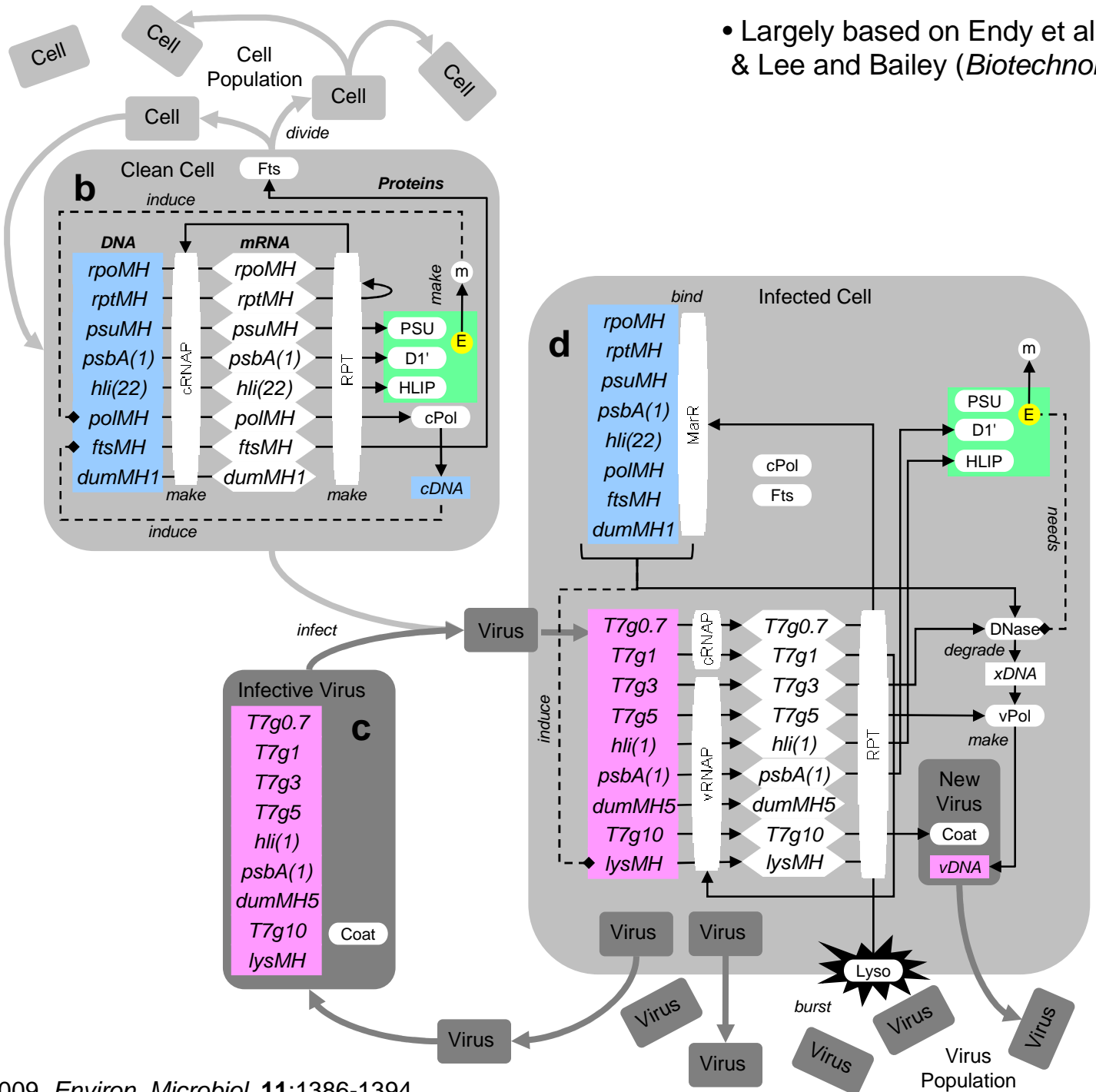




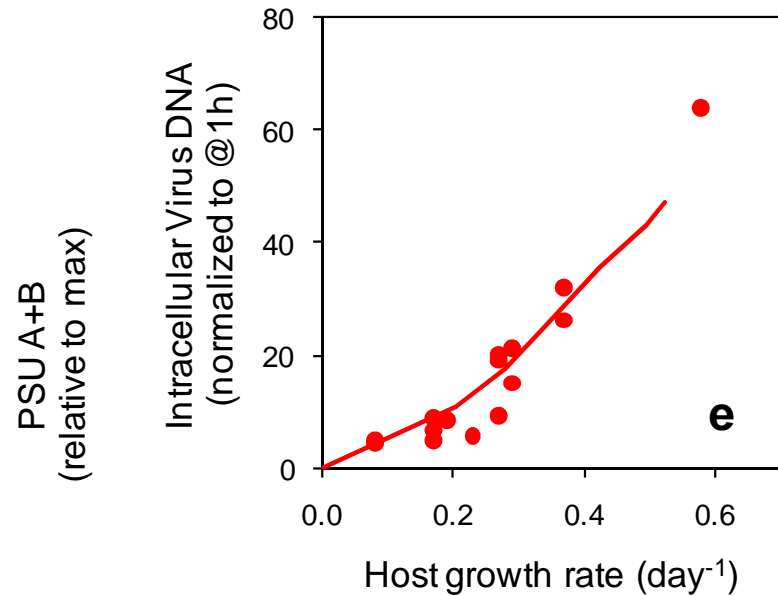
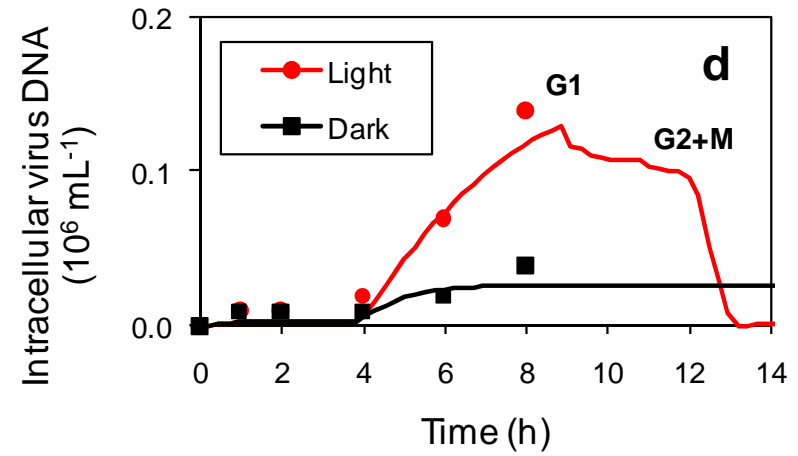
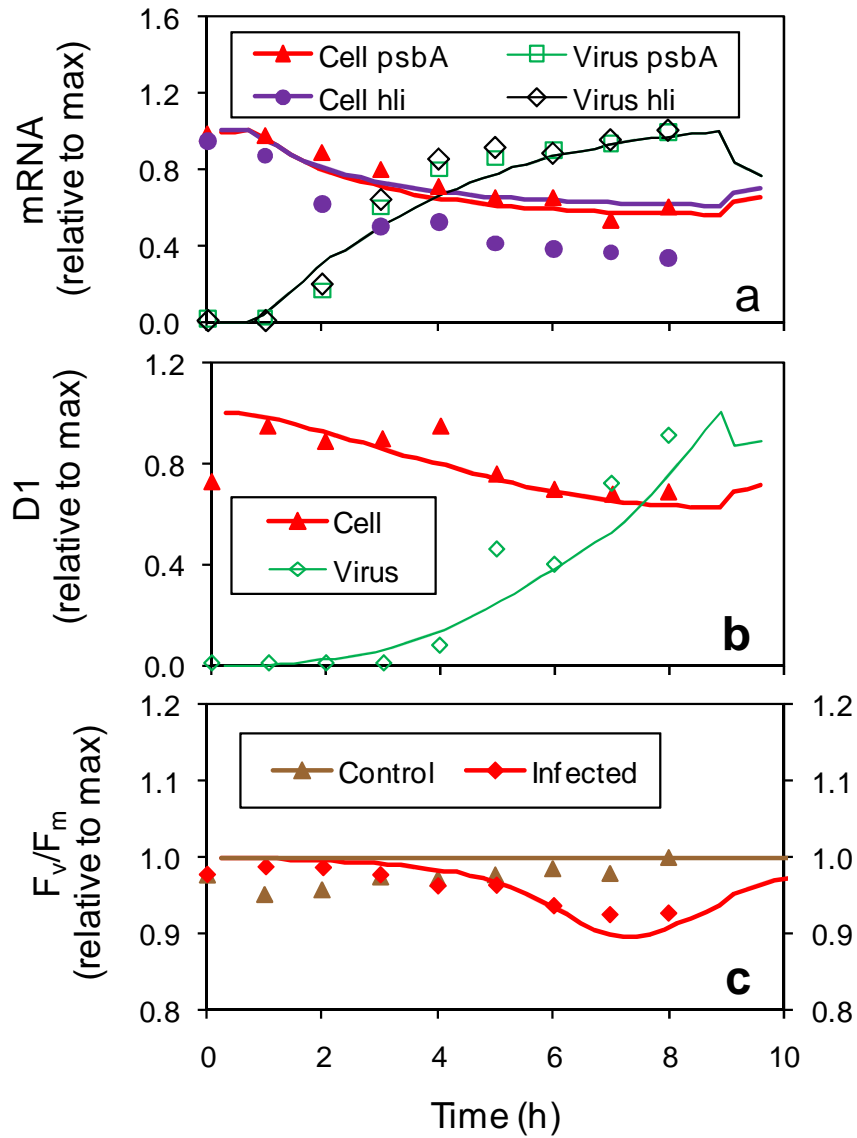
Hellweger, 2009, *Environ. Microbiol.* **11**:1386-1394.

Data are from Moore et al. (1995), Moore and Chisholm (1999) and Jacquet et al. (2001).

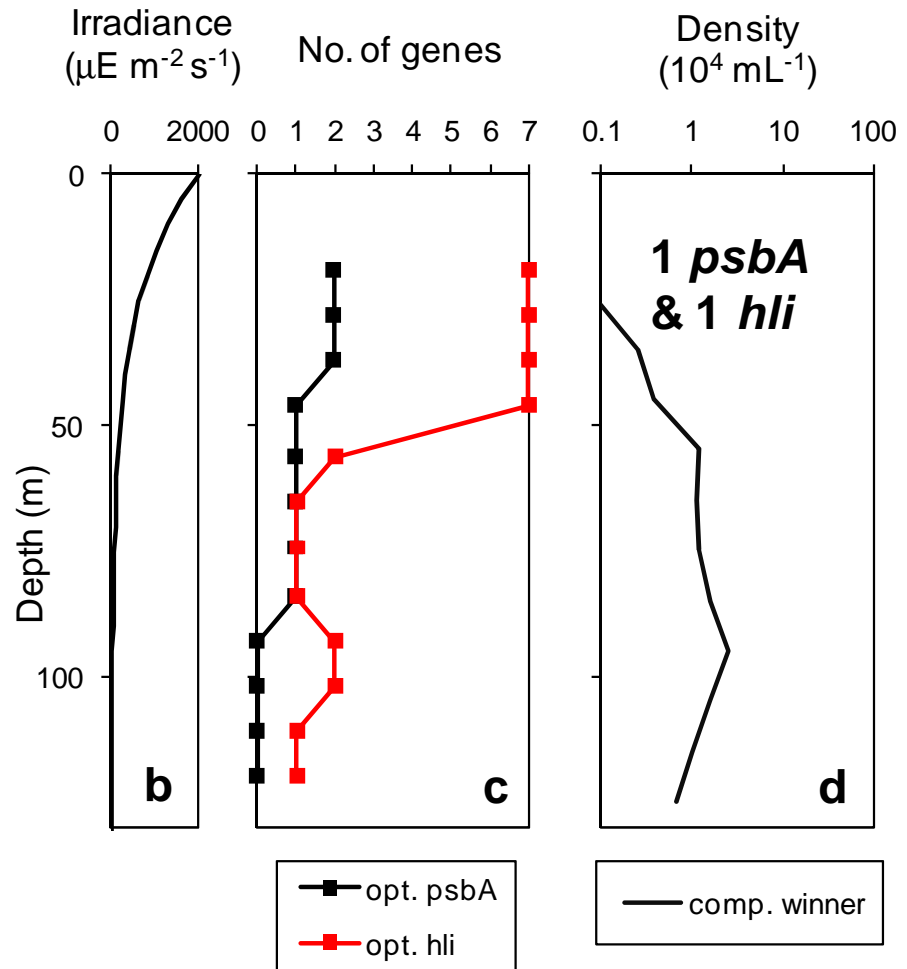
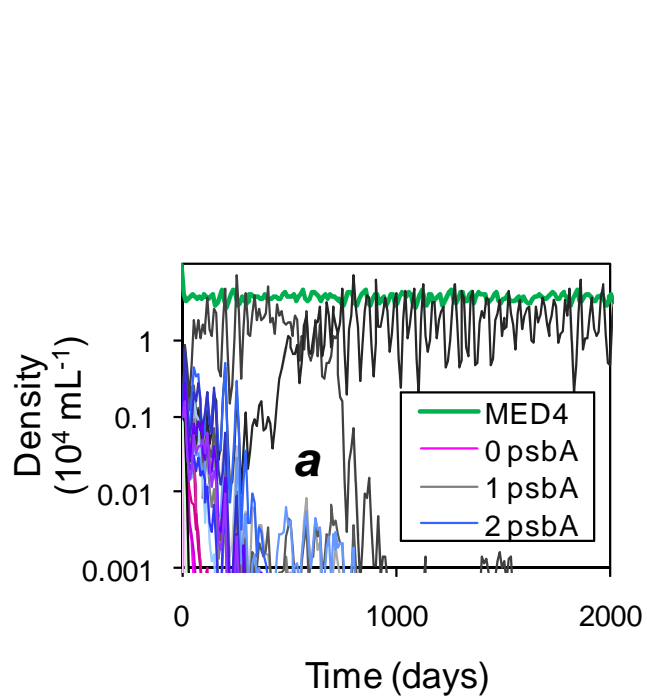
- Largely based on Endy et al. (*PNAS*, 2000) & Lee and Bailey (*Biotechnol. Bioeng.*, 1984).

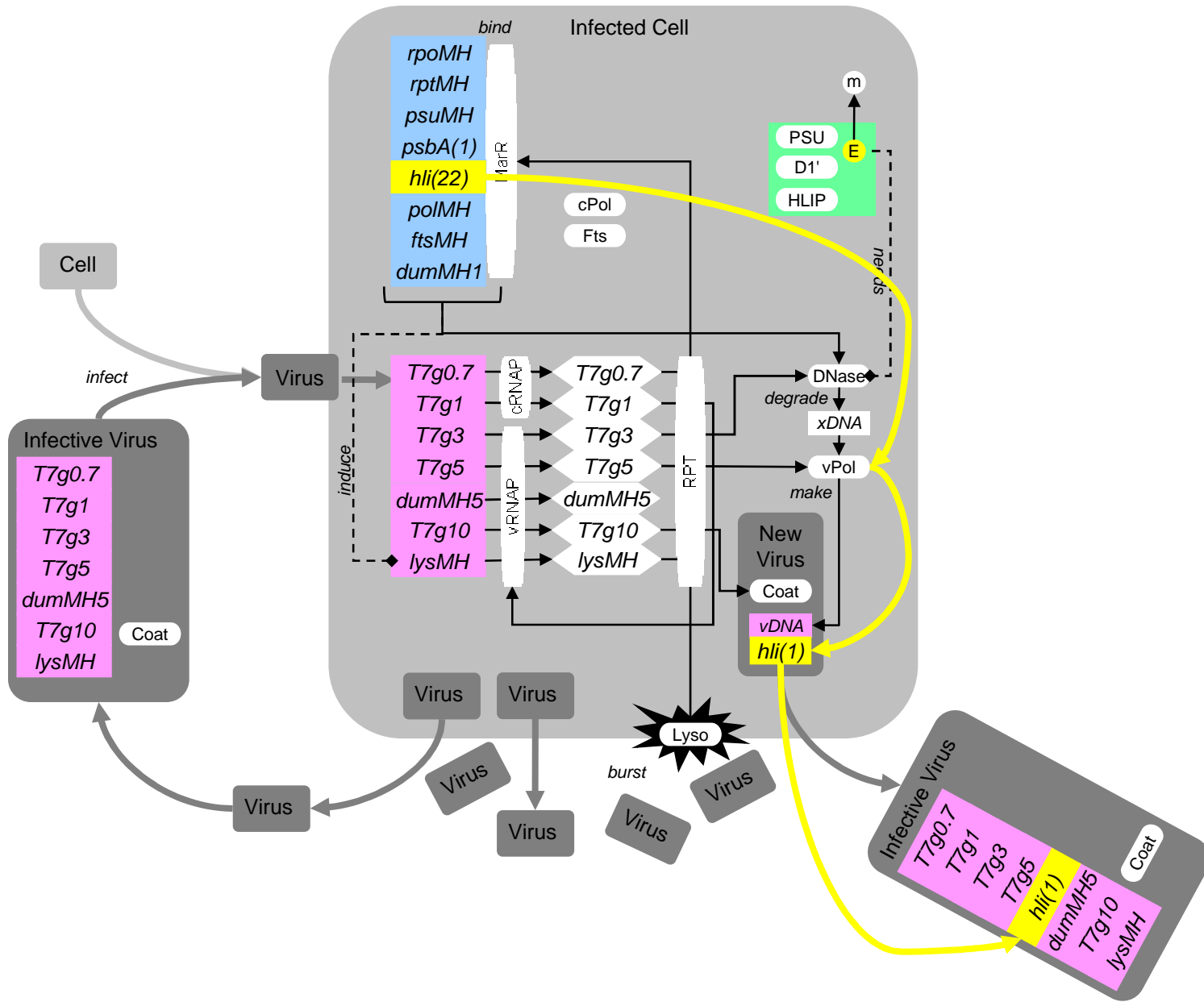


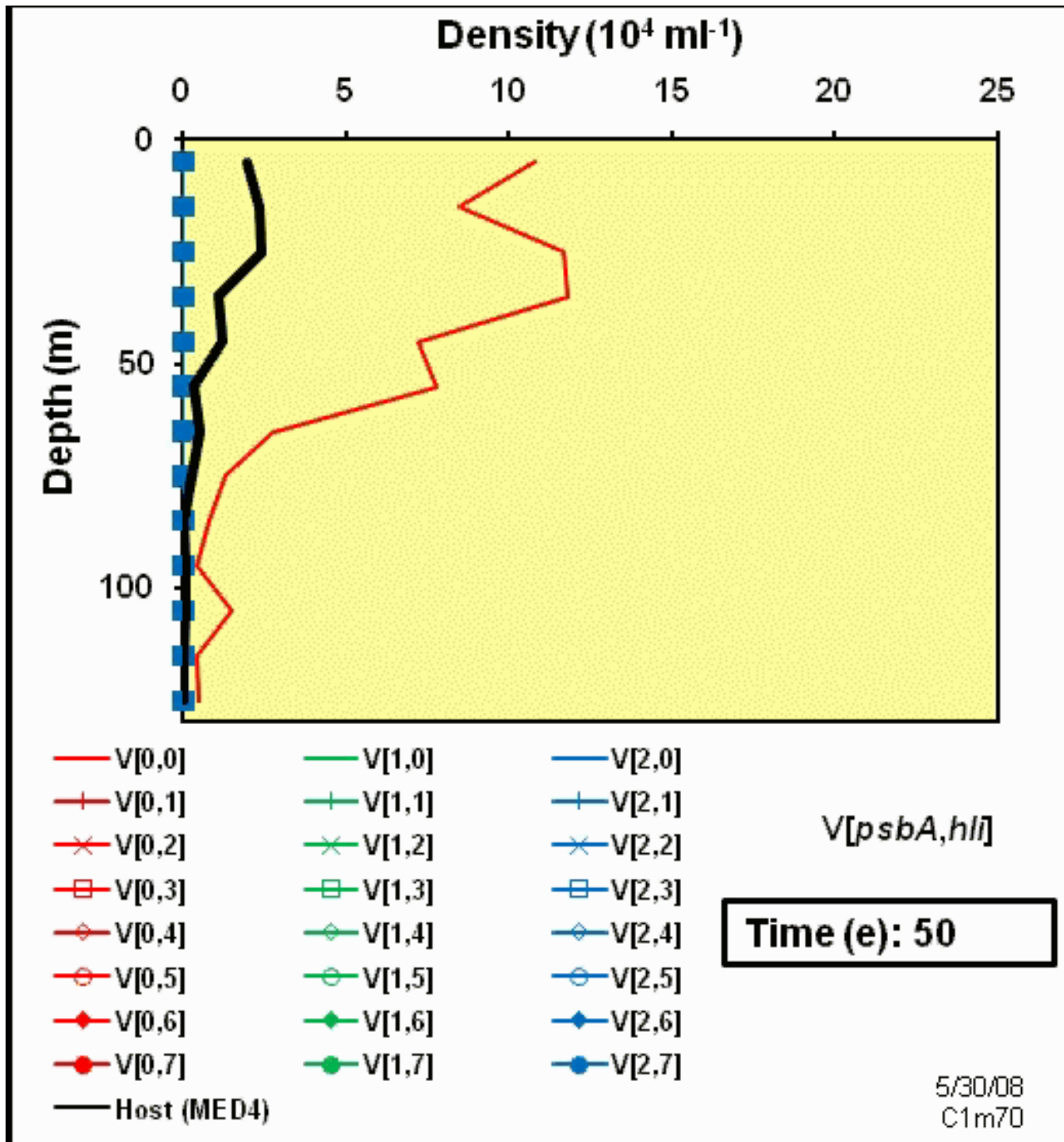
Hellweger, 2009, *Environ. Microbiol.* 11:1386-1394.



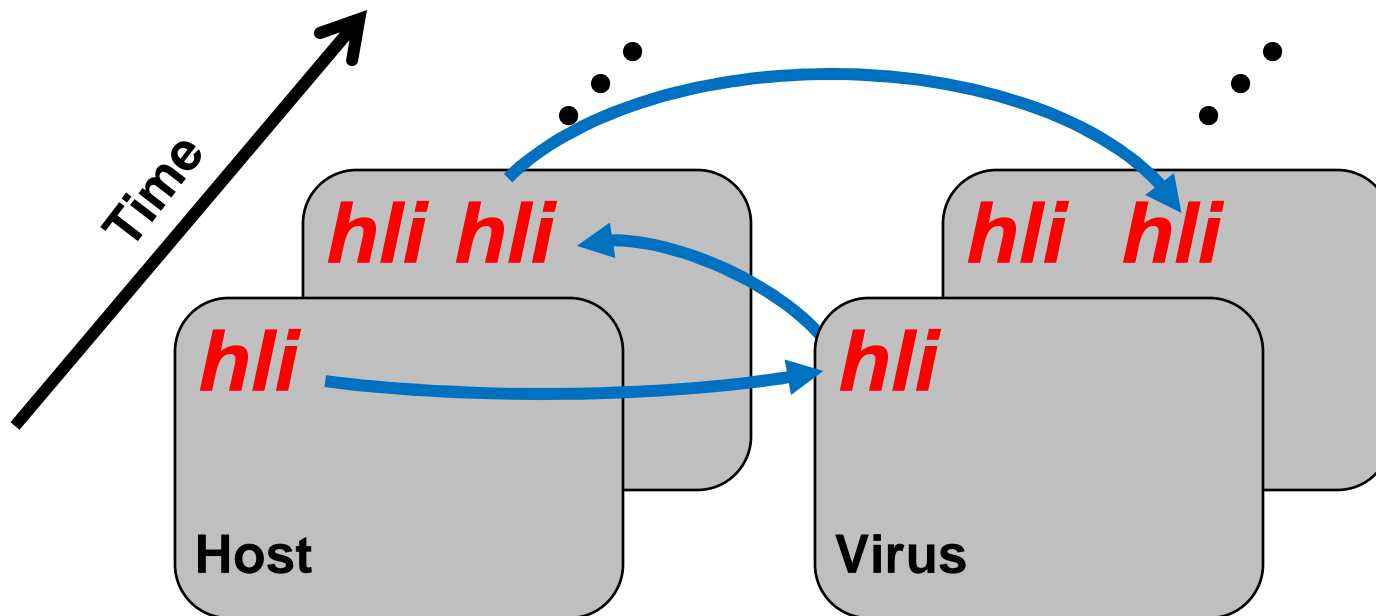
Hellweger, 2009, *Environ. Microbiol.* **11**:1386-1394.  
 Data are from Lindell et al. (2005, 2007).





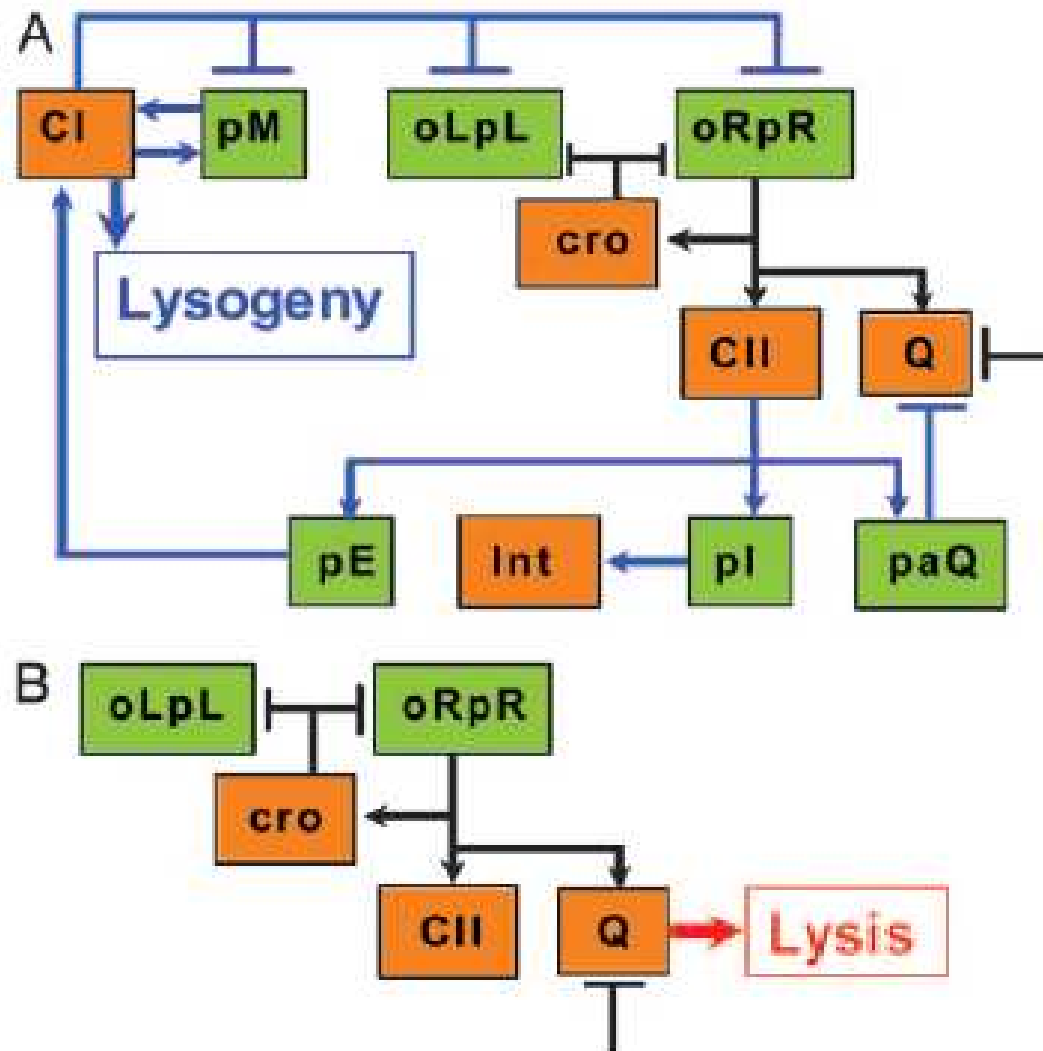


# Next Steps: Model Co-Evolution

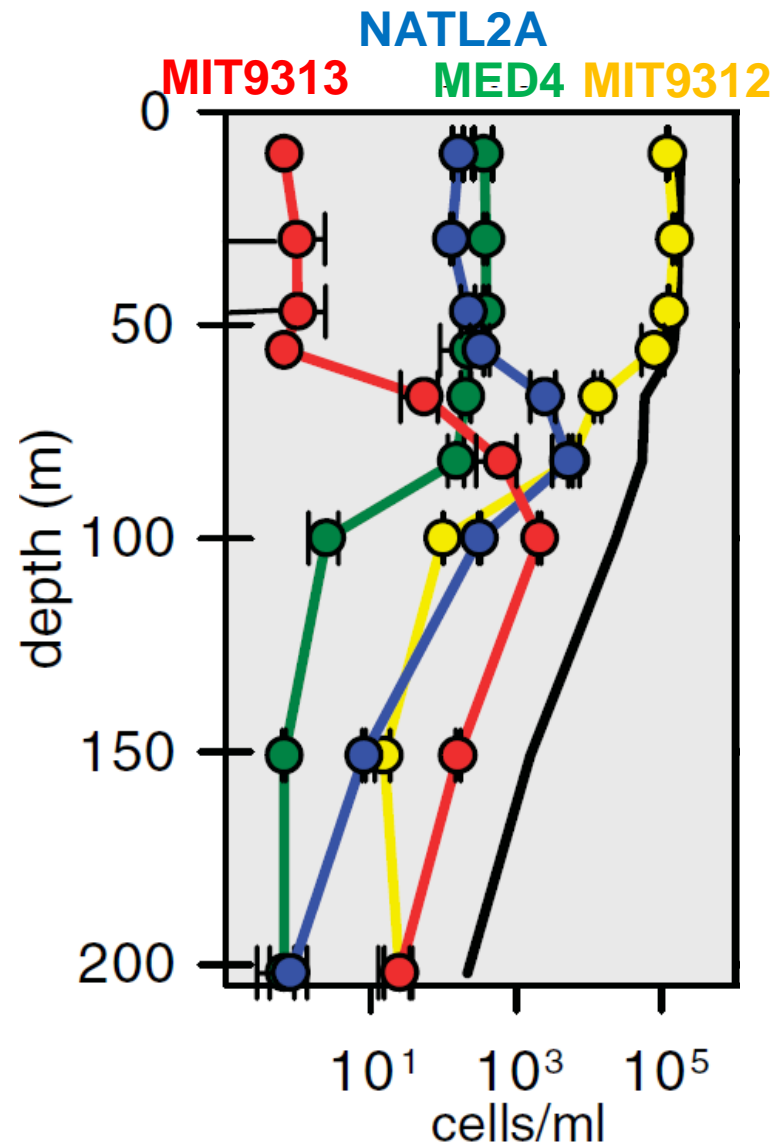


# Approach: Add Lysogenic Route & Stranding

## Lambda Model



# Approach: Model-Data Comparison



Thank you!  
Next time let's meet in...

A photograph of the Boston skyline across a body of water. The skyline includes several prominent skyscrapers, such as the Prudential Tower and the Hancock Tower. In the foreground, numerous sailboats with white sails are scattered across the dark blue water. The sky is a clear, light blue.

**Boston**