

# Modelling *Streptococcus mutans* invasion of an *in vitro* synthetic community of oral bacteria

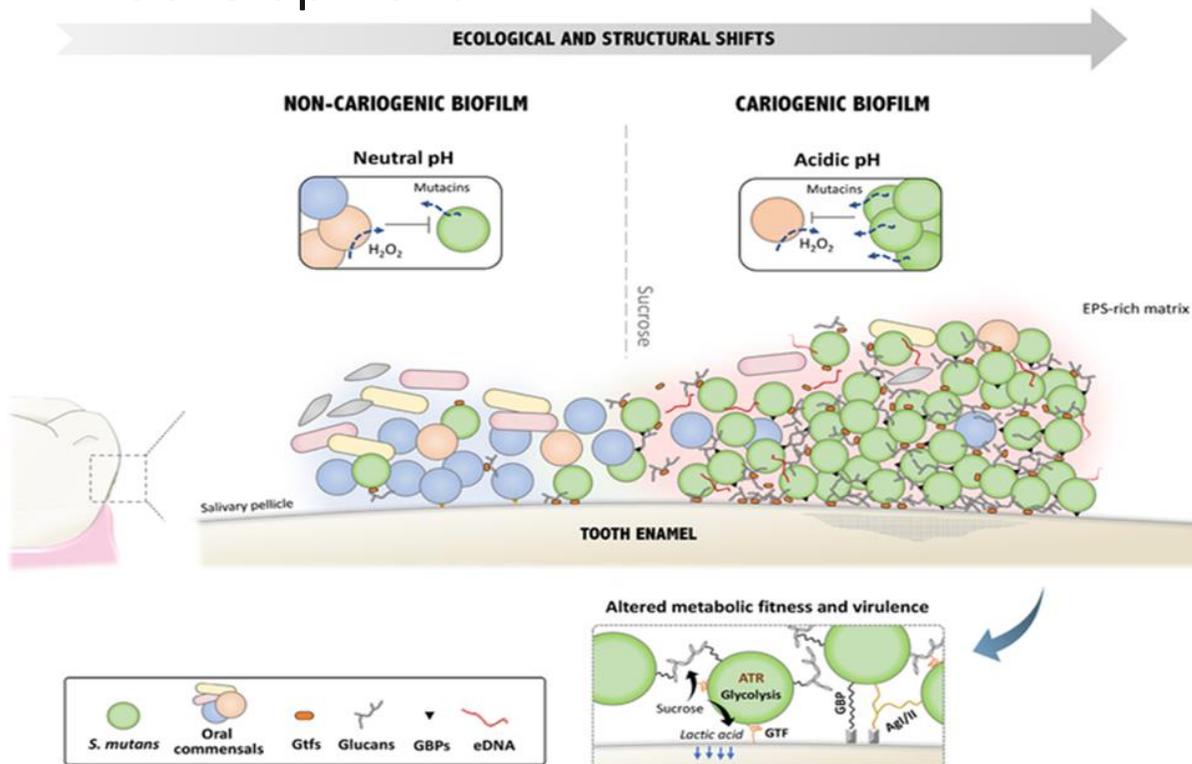
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Carious lesion

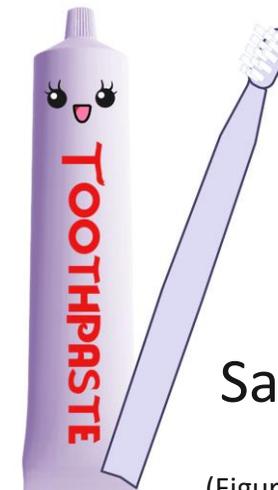


(Armstrong et al., 2005)

Cariogenic biofilm development



(Lemos et al., 2018)



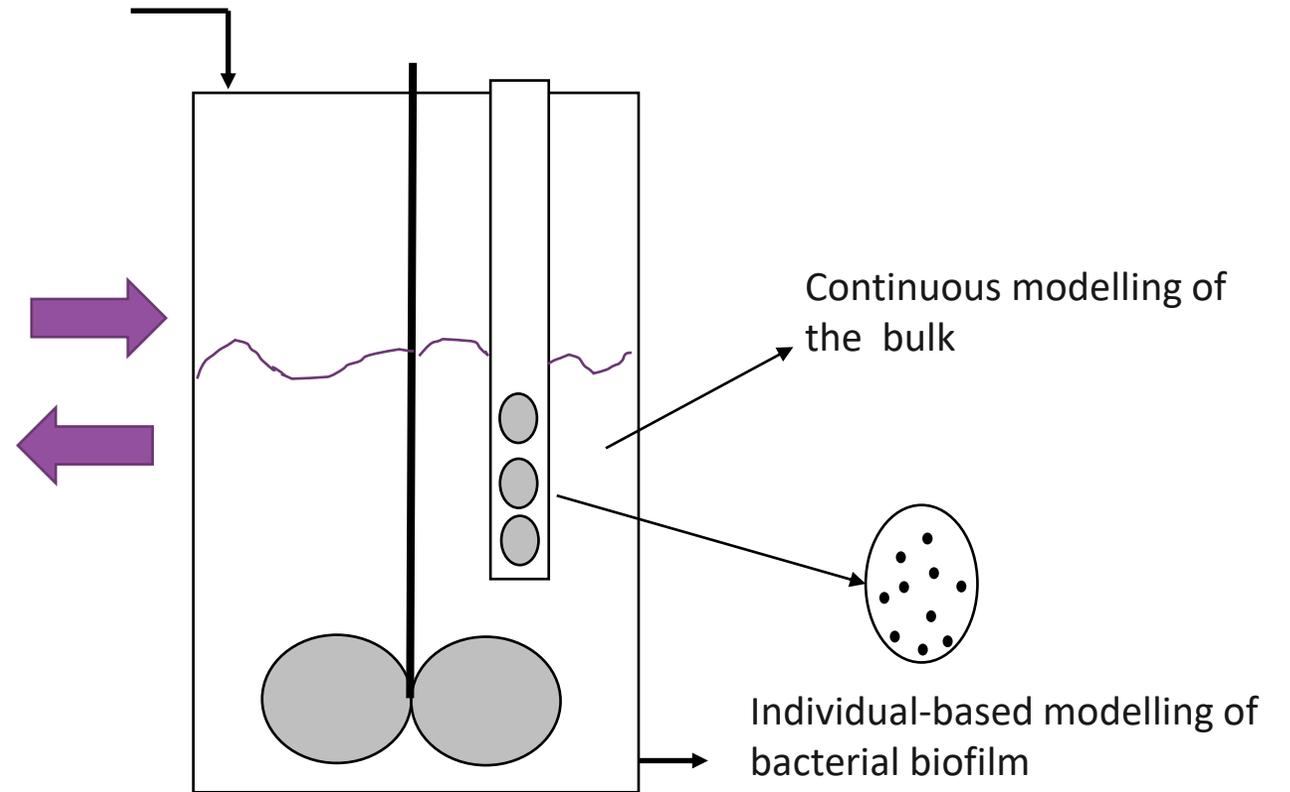
Safe products

(Figure created using [www.Biorender.com](http://www.Biorender.com))

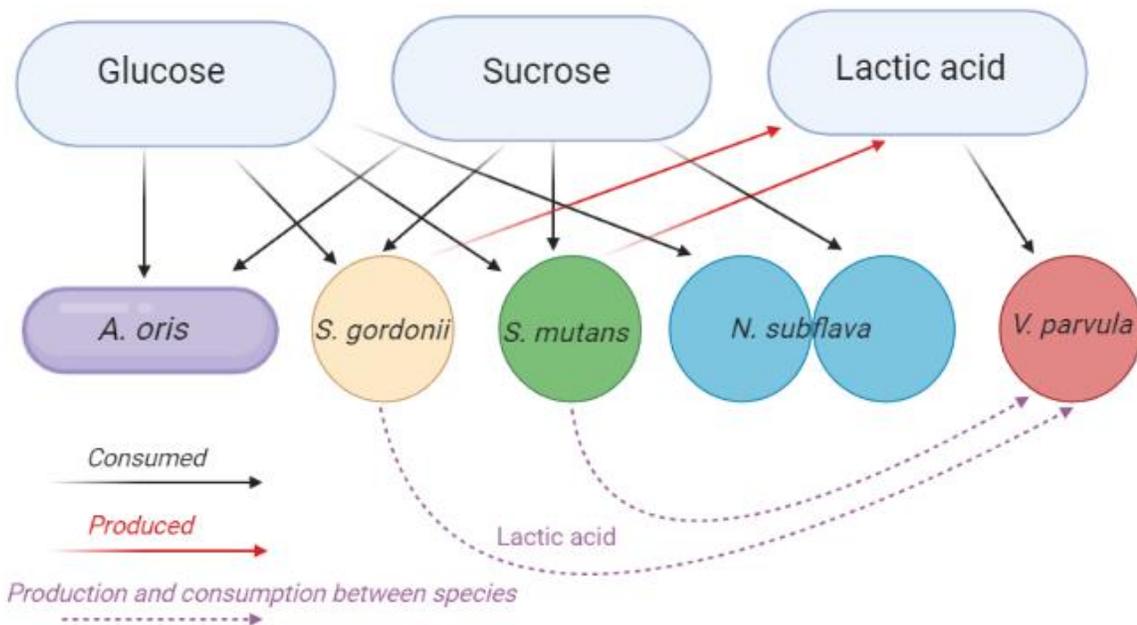
Develop modelling approaches to characterise *Streptococcus mutans* invasion to drive safe product development and risk assessment



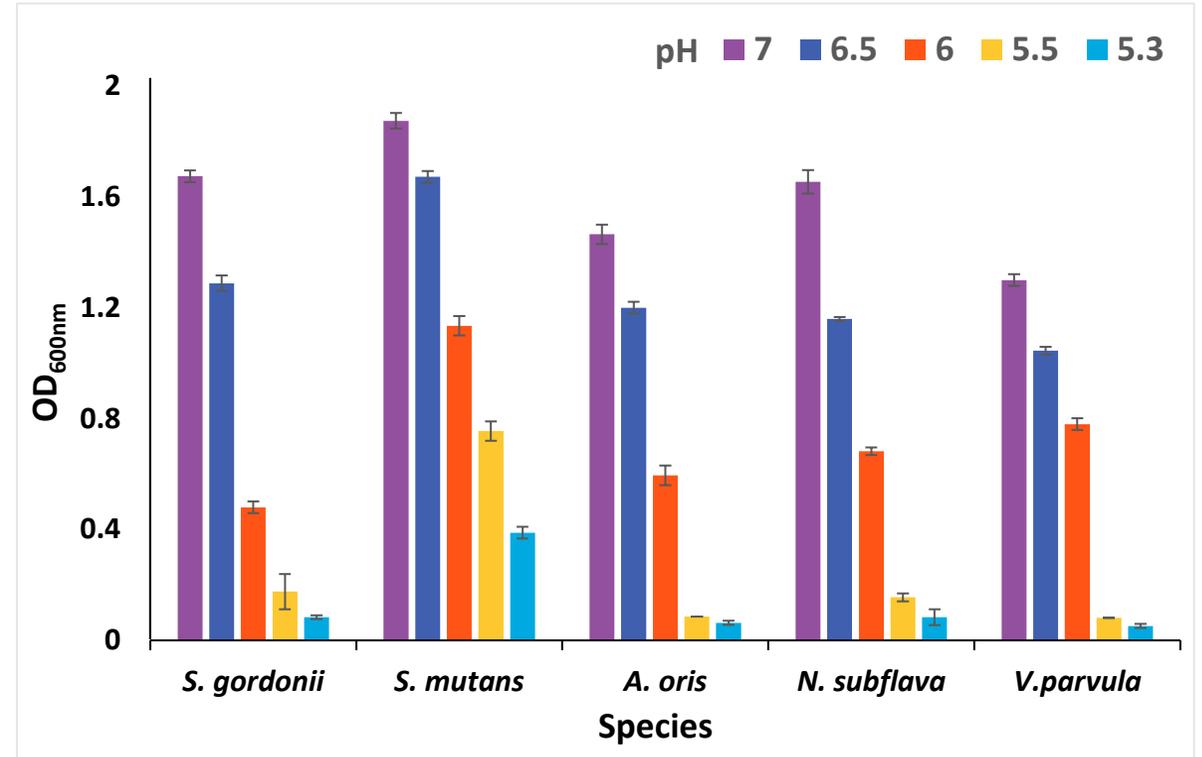
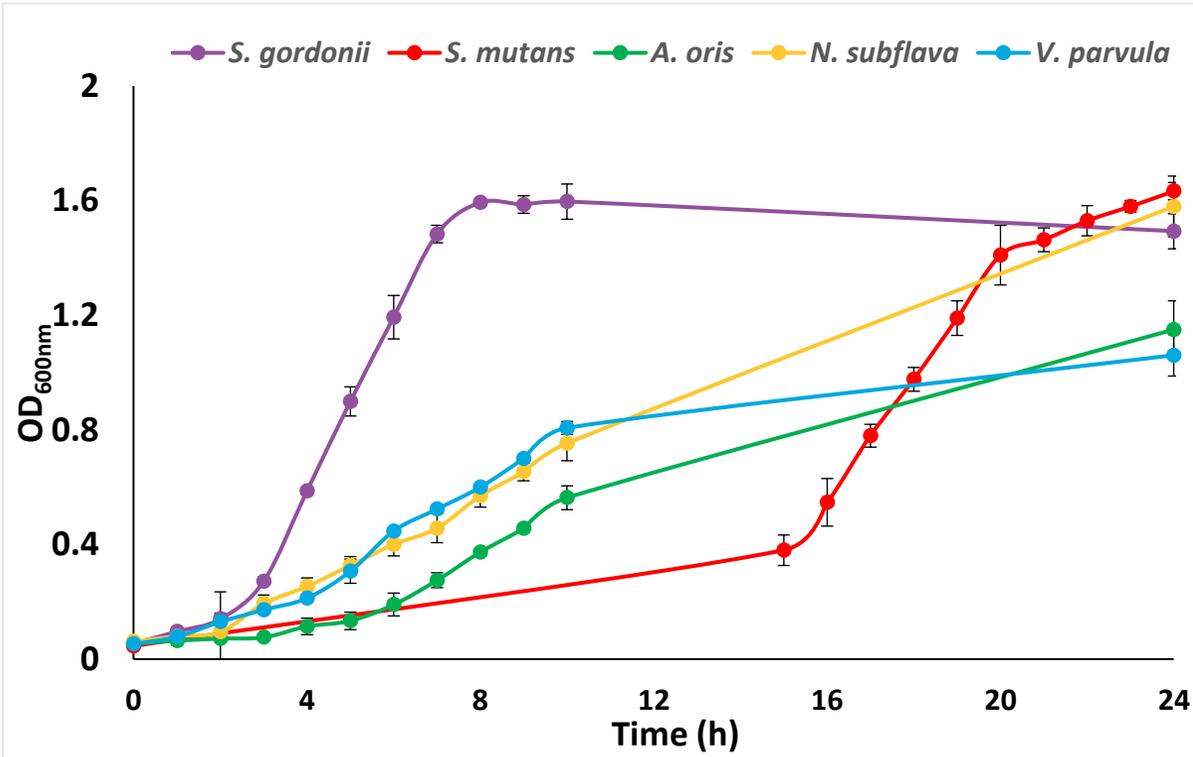
*In vitro* (CDC reactors)



*In silico*



Bacterial strain	Role in oral microbiome
<i>Streptococcus gordonii</i> DL1	Pioneering coloniser
<i>Veillonella parvula</i> DSM2008	Present in progression stages of oral biofilm development
<i>Actinomyces oris</i> MG1	Early coloniser of freshly cleaned teeth
<i>Neisseria subflava</i> DSM17610	Commensal, part of normal flora
<i>Streptococcus mutans</i> UA159	Cariogenic species, more abundant in caries progression



$\mu_{max}$ for synthetic community species ( $h^{-1}$ )				
<i>S. gordonii</i>	<i>S. mutans</i>	<i>A. oris</i>	<i>N. subflava</i>	<i>V. parvula</i>
0.492	0.406	0.227	0.261	0.246

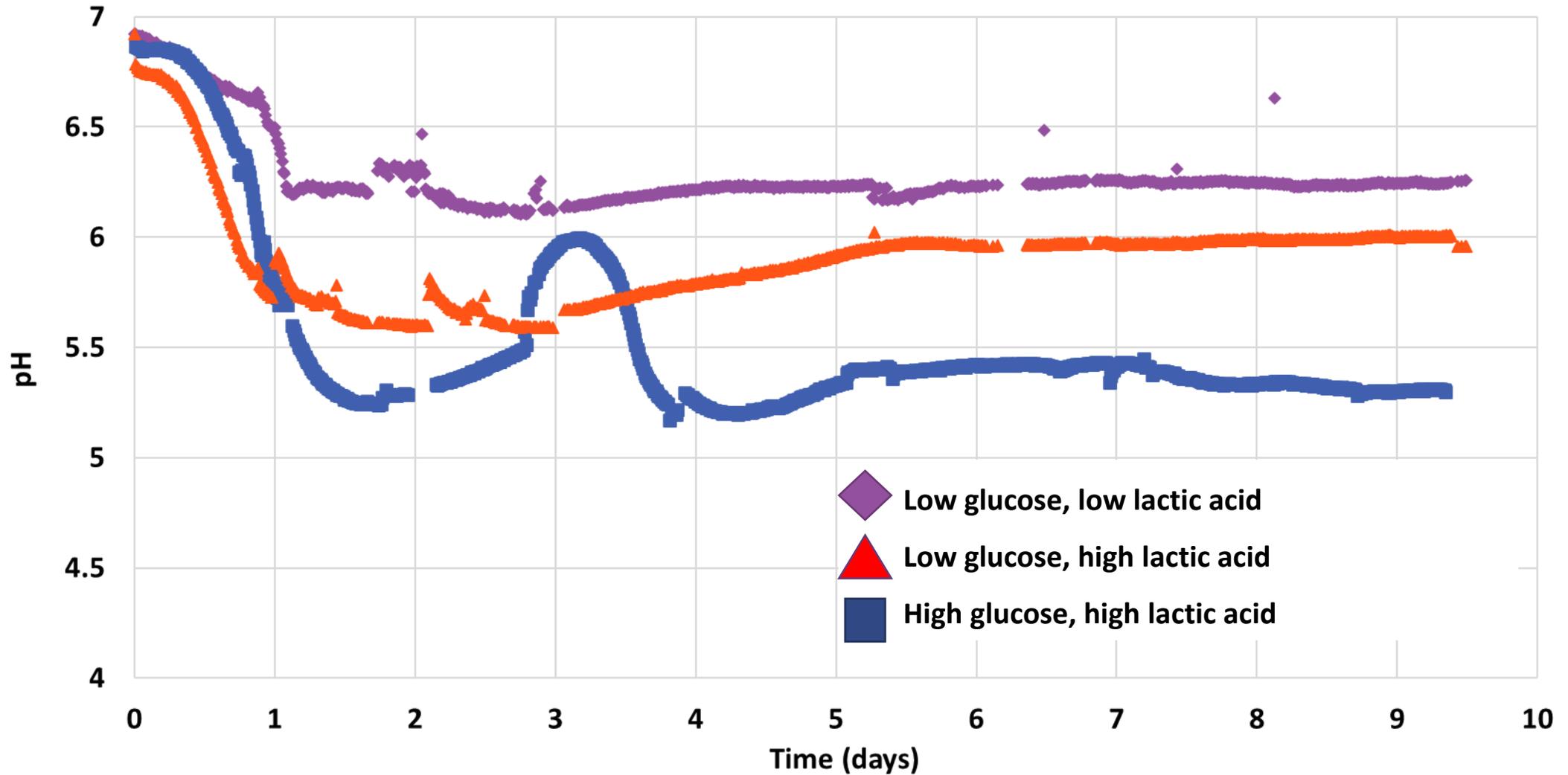
Ks values ( $mmol L^{-1}$ )				
<i>S. gordonii</i>	<i>S. mutans</i>	<i>A. oris</i>	<i>N. subflava</i>	<i>V. parvula</i>
6.60	5.55	7.78	5.55	26.90

Continuous flow of 0.4 mL min<sup>-1</sup>. Temperature maintained at 37 °C

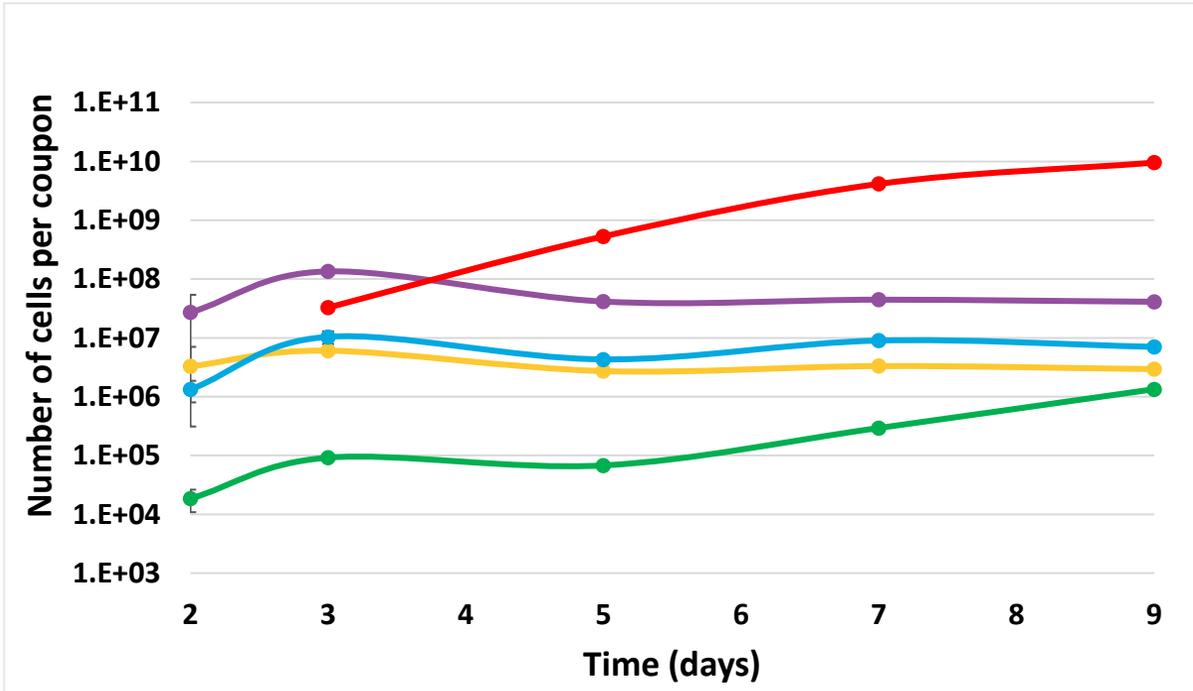
Inoculation (day)	Species
0	<i>Actinomyces oris</i>
1	<i>Streptococcus gordonii</i> <i>Neisseria subflava</i> <i>Veillonella parvula</i>
2	<i>Streptococcus mutans</i>



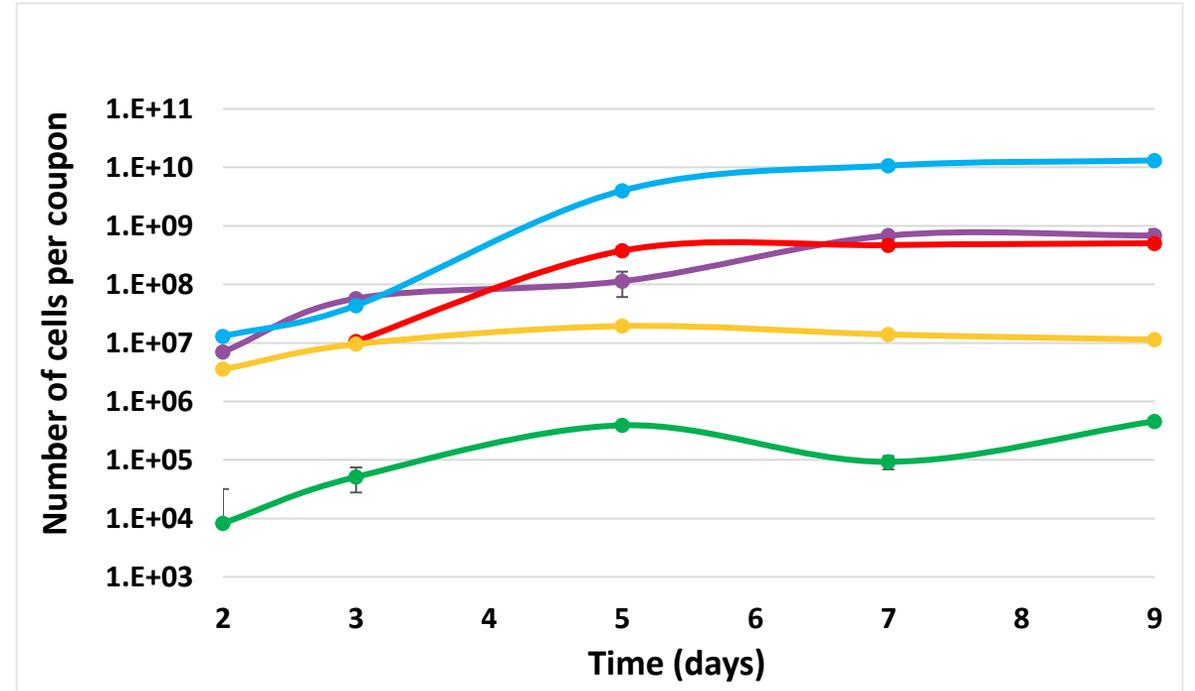
# pH variation in the bulk

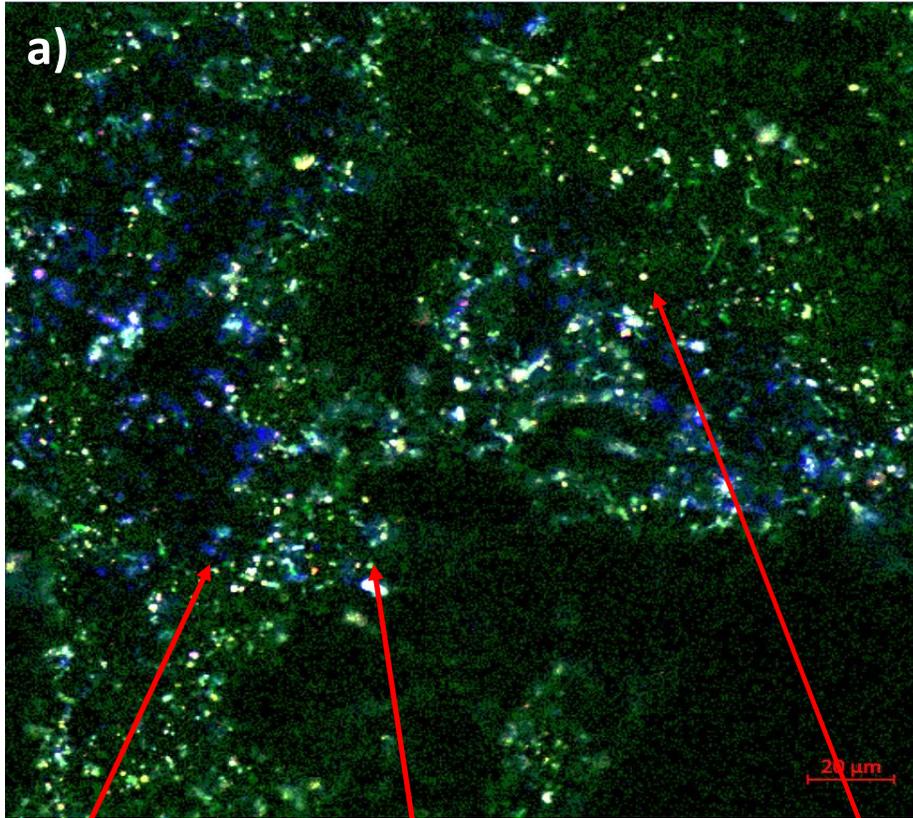


## High glucose



## Low glucose

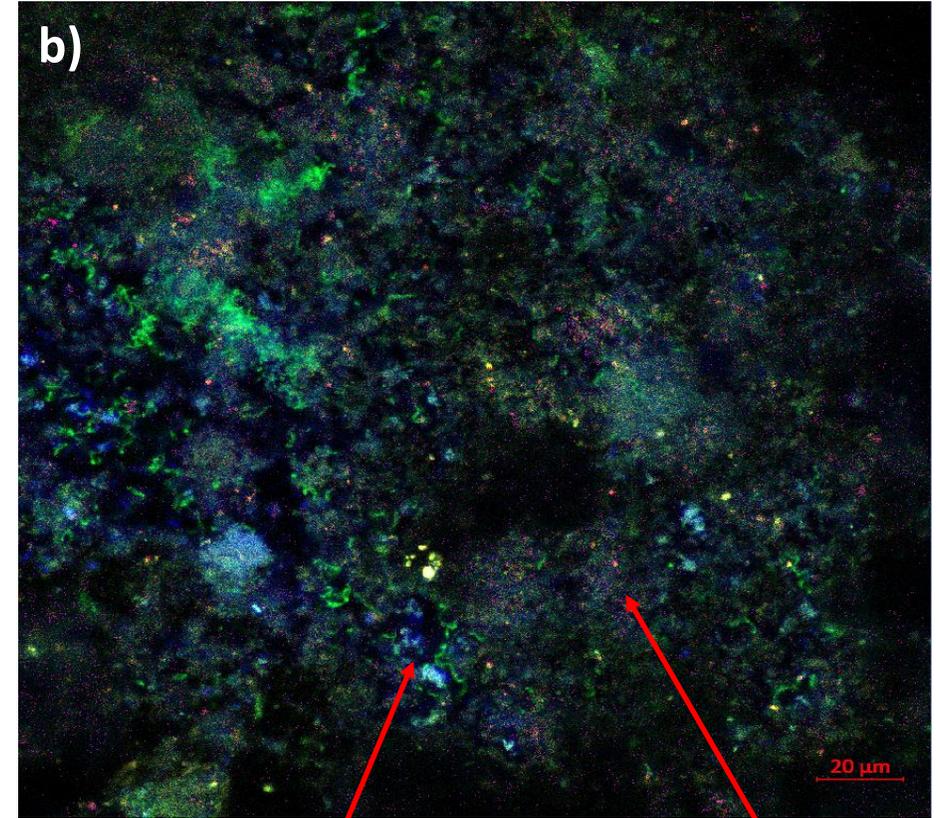




*S. gordonii*

*S. mutans*

*A. oris*



*N. subflava*

*V. parvula*

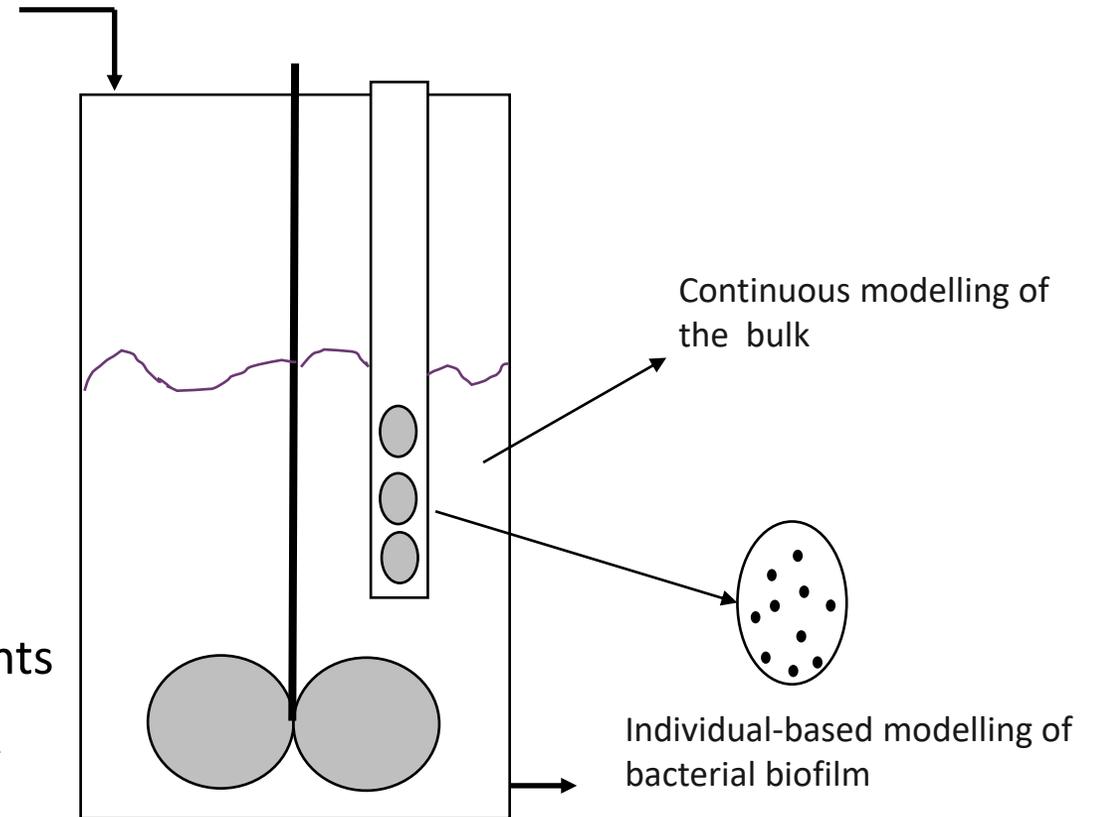
a) High glucose    b) Low glucose

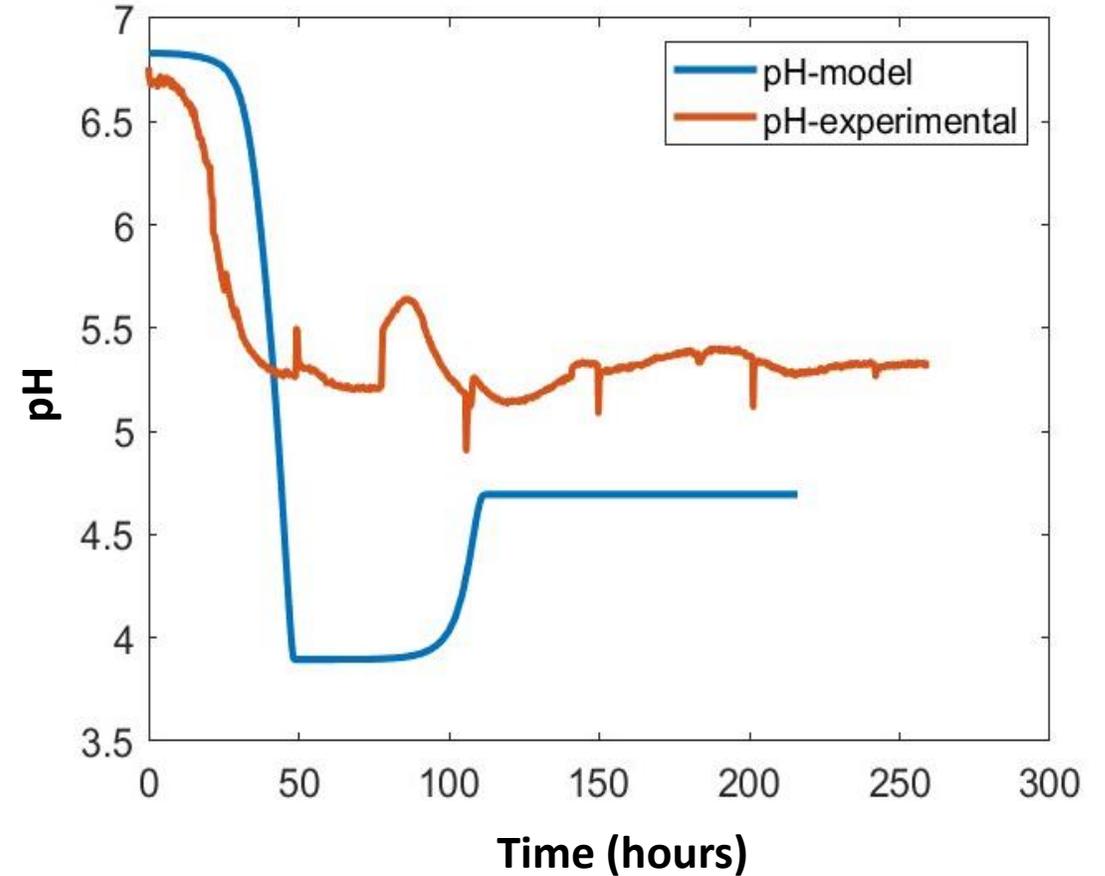
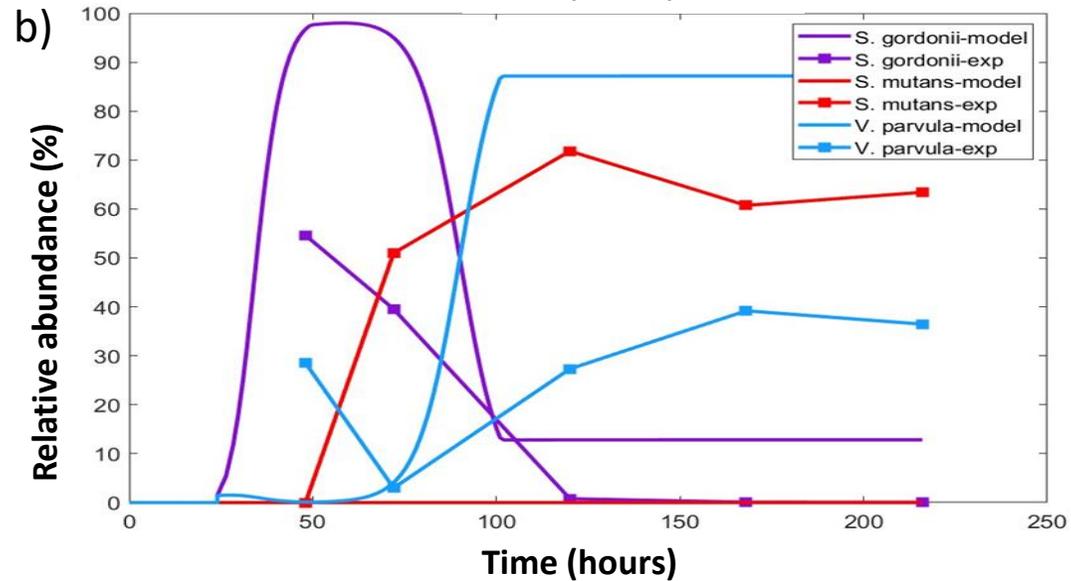
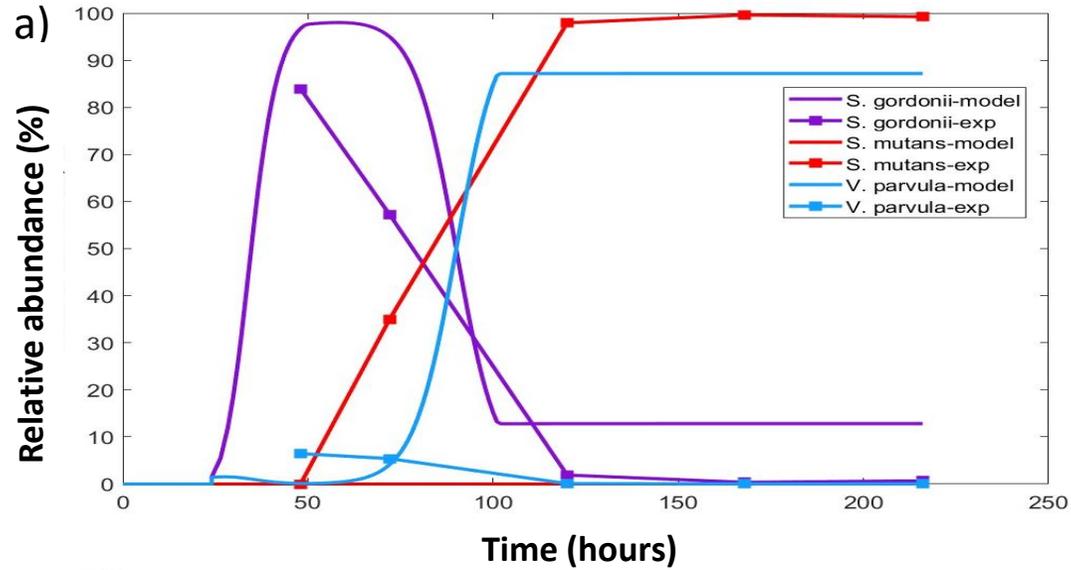
## The bulk:

- Continuous stirred-tank reactor model
- Yield calculated based on stoichiometry of bacterial species
- Comparison of the relative abundance and pH of bulk to that of *in vitro* model

## The biofilm:

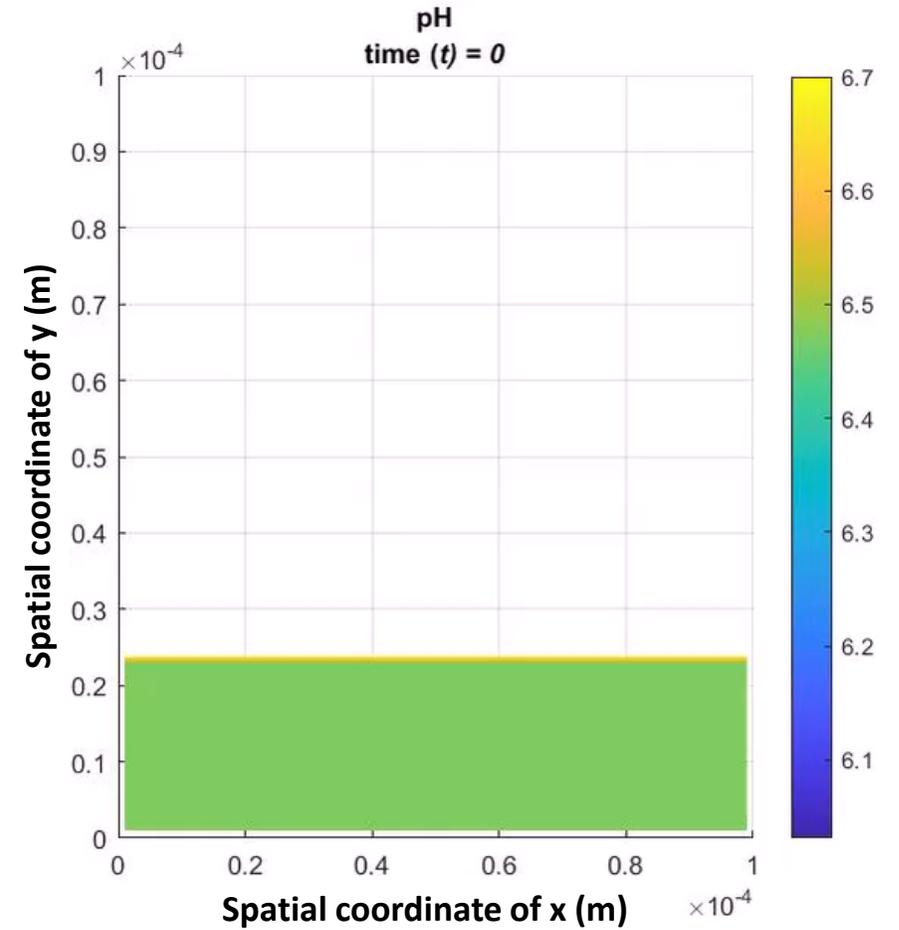
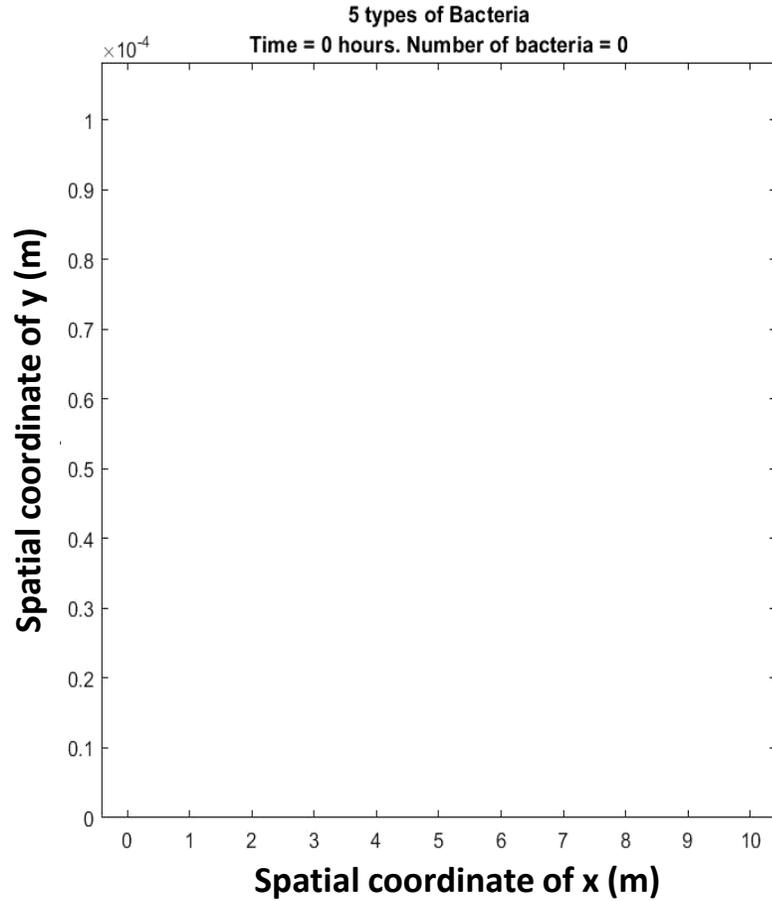
- Cells modelled as own agent
- Bacteria affected by local pH environment and nutrients
- Allows comparison of the relative abundance to qPCR results and simulates local pH environment



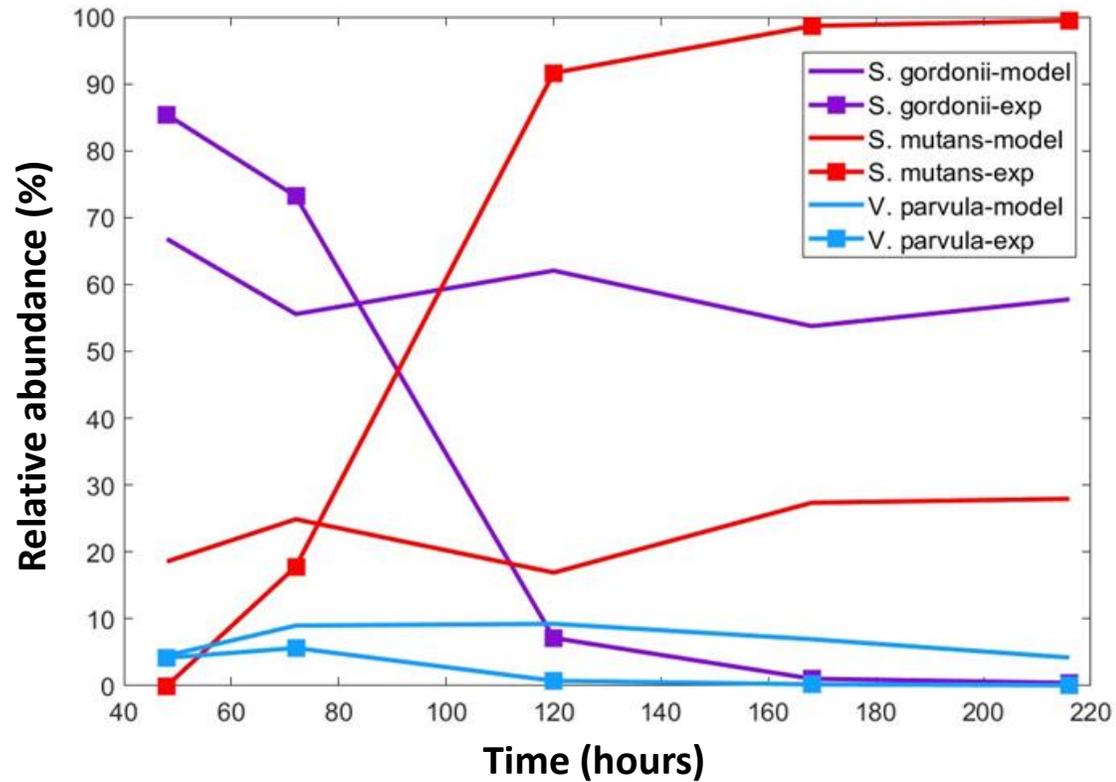


a) High glucose    b) Low glucose

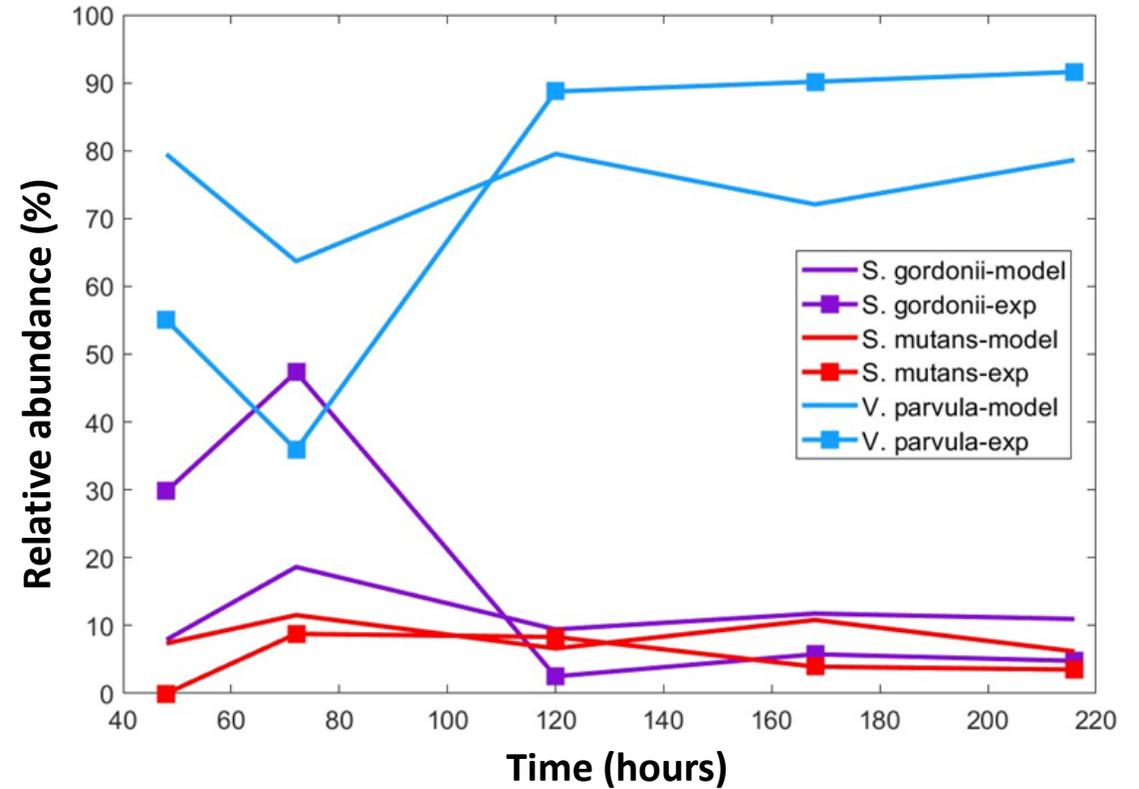
- *S. gordonii*
- *S. mutans*
- *A. oris*
- *N. subflava*
- *V. parvula*



## High glucose



## Low glucose

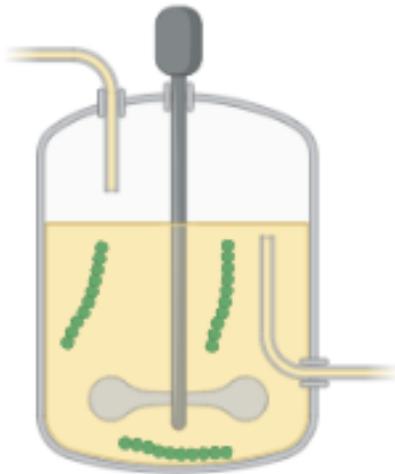


# Conclusions

High glucose



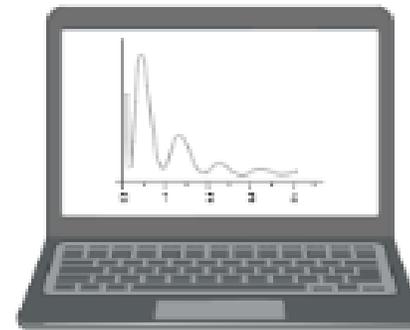
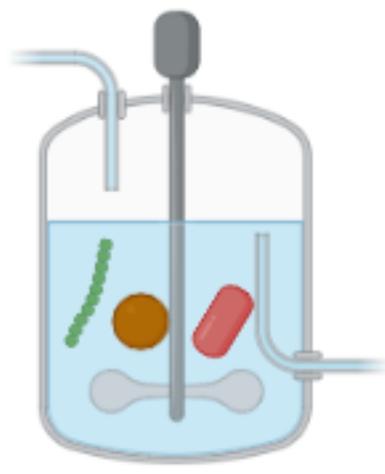
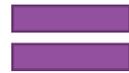
Low pH



Low glucose



High pH



(Figures created using [www.Biorender.com](http://www.Biorender.com))

# Future work



(Figures created using [www.Biorender.com](http://www.Biorender.com))

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