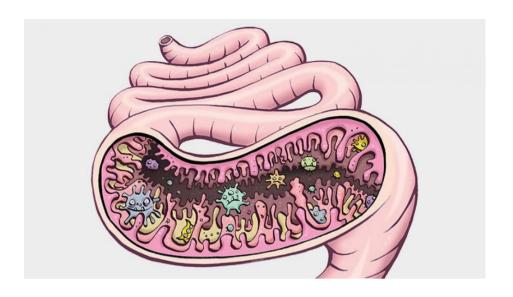
## Modelling Gut Micobiota In Petri nets With Snoopy

Leila Ghanbar

1 year PhD student in Computer Science and System
Biology

#### **Gut Microbiota**



Human body hosts symbiotic microorganisms on a massive scale.

Prokaryotic, fungi, archaea.

Affect health, behaviour & diseases in human

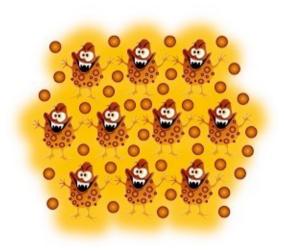
Each human ——— a unique microbiota universe

Modelling human-gut microbiota can play a crucial role in disease - personalized medicine health - personalized nutrition

# Quorum sensing: cell-cell communication in bacteria



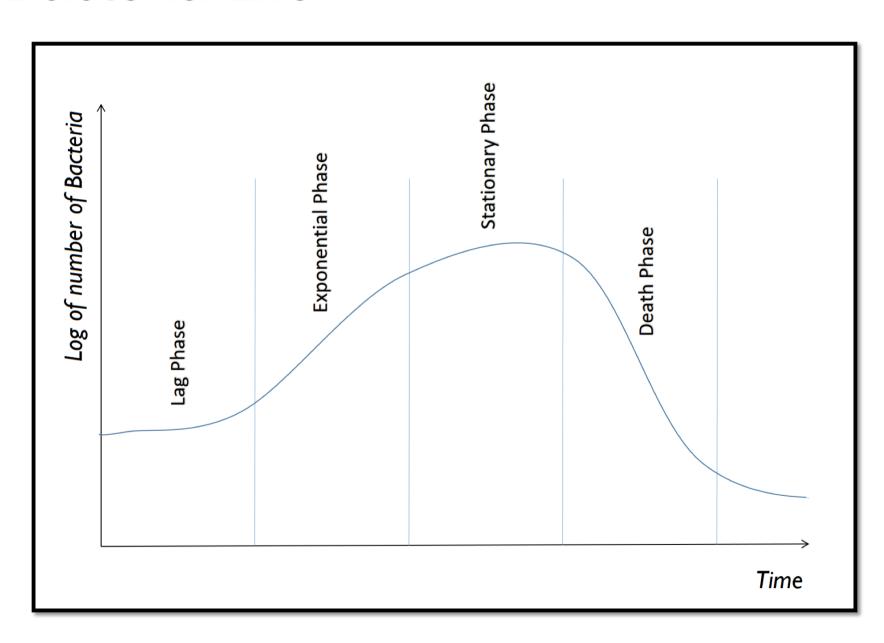
Low cell density: No Al-2 detection No changes in cell behaviour



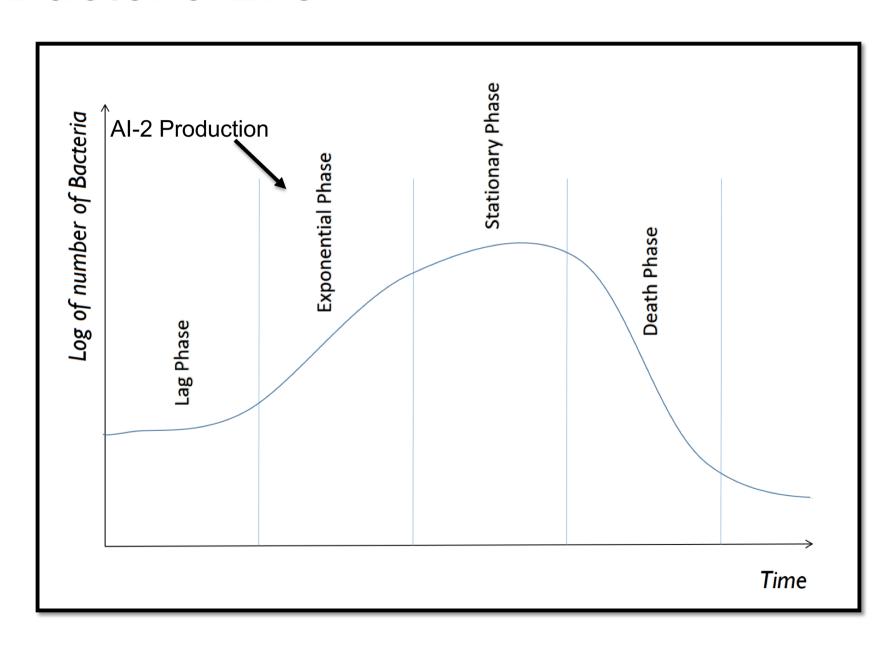
High cell density: Al-2 is detected Genes expression will change

One of the changes: BIOFILM FORMATION

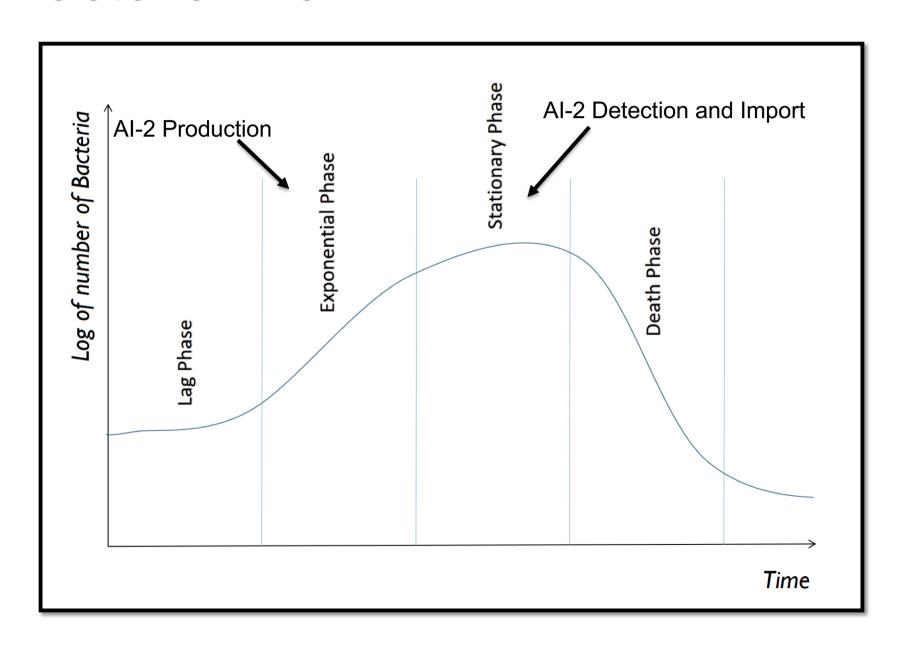
## **Bacteria Life**



## **Bacteria Life**



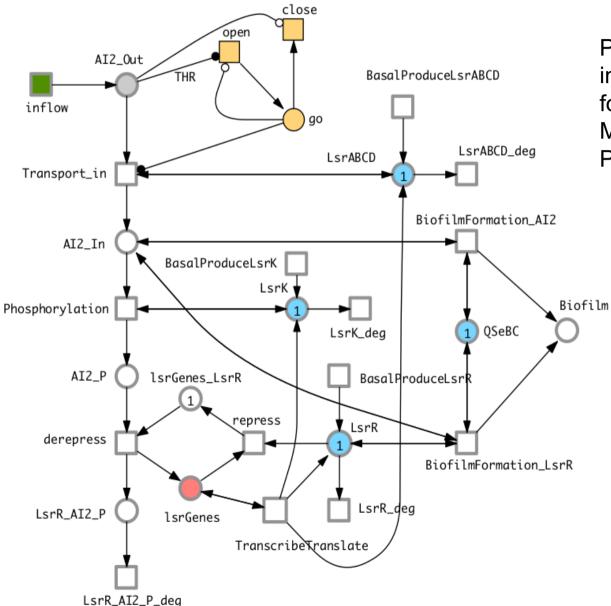
## **Bacteria Life**



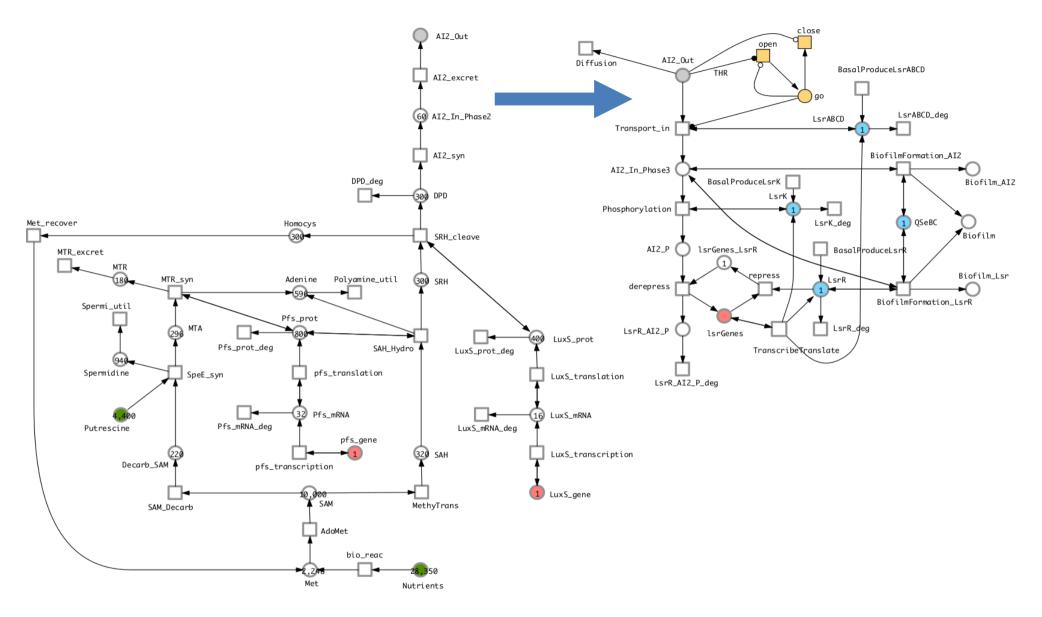
Phase 2 PAI\_2\_Out Phase 2 of bacterial 2 quorum, Li et al. 2006 growth: AI-2 production AI2\_excret AND excretion to the environment 60AI2\_intra AI2 syn DPD dea 00 DPD Met recover Homocys SRH cleave MTR excret Adenine Polyamine\_util \$00 SRH MTR syn Spermi util Pfs prot ATM 663 400 LuxS\_prot Pfs prot deg SAH Hydro LuxS\_prot\_deg pfs translation Spermidine SpeE syn LuxS translation 32)Pfs\_mRNA 16)LuxS\_mRNA Pfs mRNA deg Putrescine LuxS mRNA deg pfs gene \$20 SAH LuxS\_transcription Decarb SAM pfs\_transcription LuxS gene SAM MethyTrans SAM Decarb AdoMet bio reac Met Nutrients

Reference: A stochastic model of Escherichia coli Al-

#### Phase 3



Phase 3 of bacterial growth: importing AI-2 AND biofilm formation regulated by AI-2 Modelled by Leila Ghanbar and Professor Monika Heiner

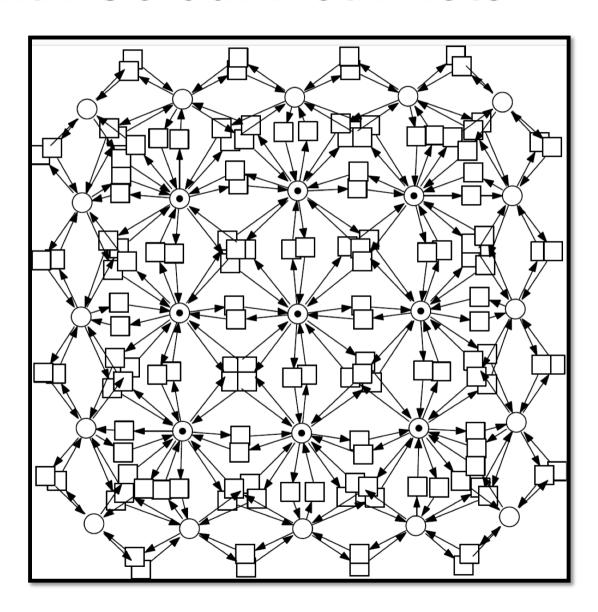


Combining the models

Reference: Spatial quorum sensing modelling using coloured hybrid Petri nets and simulative model checking, David Gilbert, Monika Heiner, Leila Ghanbar, Jacek Chodak (2018)

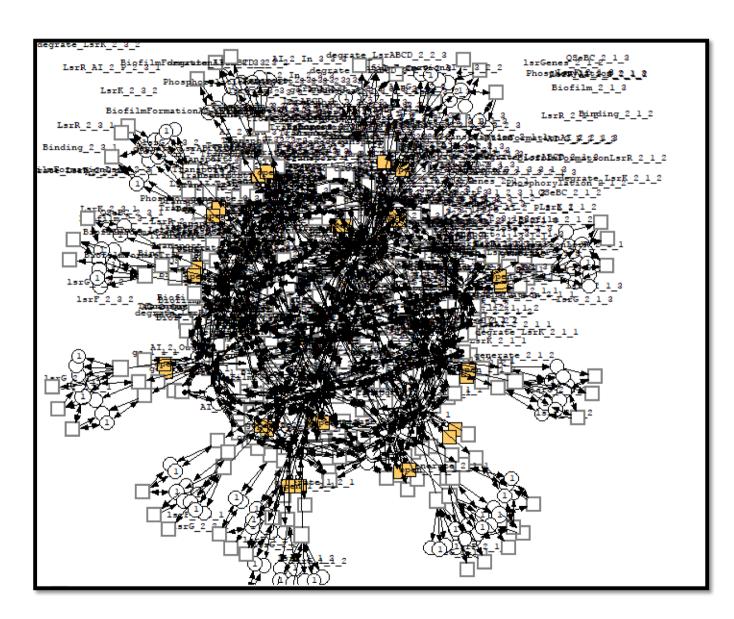
### 3D Models with Colour Petri nets

3D model of Diffusion



## 3D Models with Colour Petri nets

3D model of Biofilm Formation

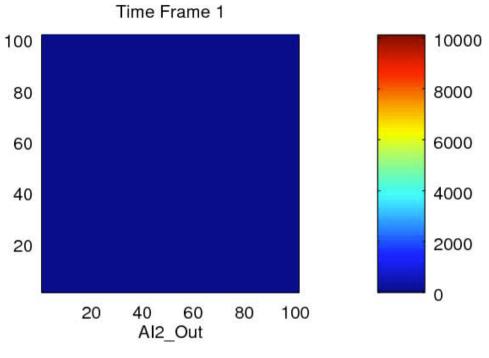


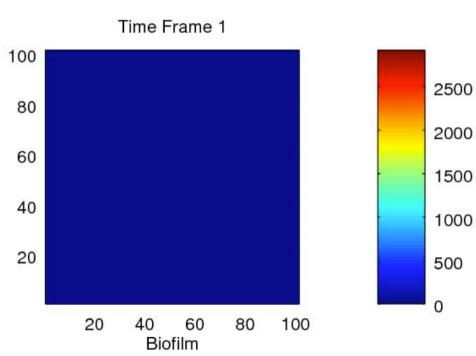
#### Results

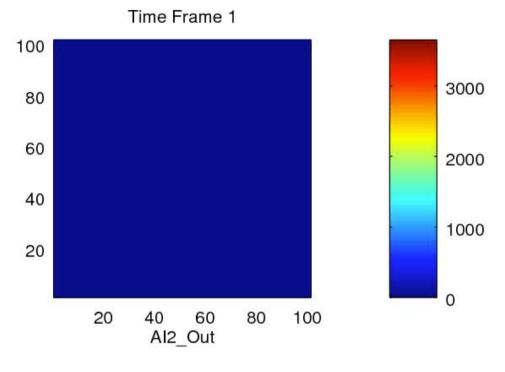
| Colony | Al2_Out    | Biofilm   |
|--------|------------|-----------|
| R0     | 13,374.49  | 0.68      |
| R2     | 308,478.60 | 55,468.61 |
| R5     | 326,647.00 | 637.79    |
| R7     | 341,143.57 | 35.14     |

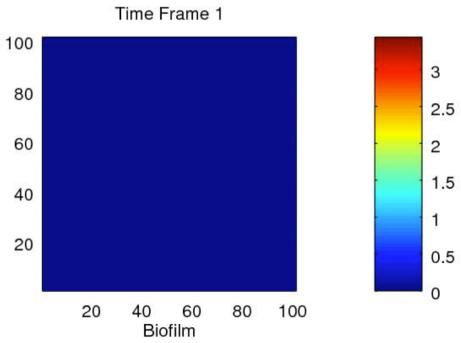
When there is only one bacteria (R0) biofilm formation is so low When there is a compact colony (R2) biofilm formation is noticeably high As the colony is sparser, the biofilm formation decreases.

Reference: Spatial quorum sensing modelling using coloured hybrid Petri nets and simulative model checking by: David Gilbert, Monika Heiner, Leila Ghanbar, Jacek Chodak









#### What is NEXT...

- Adding more details to the model
- Adding human cell interaction to the model
- Studying the connection between these two types of cells
- Studying them in a populated environment