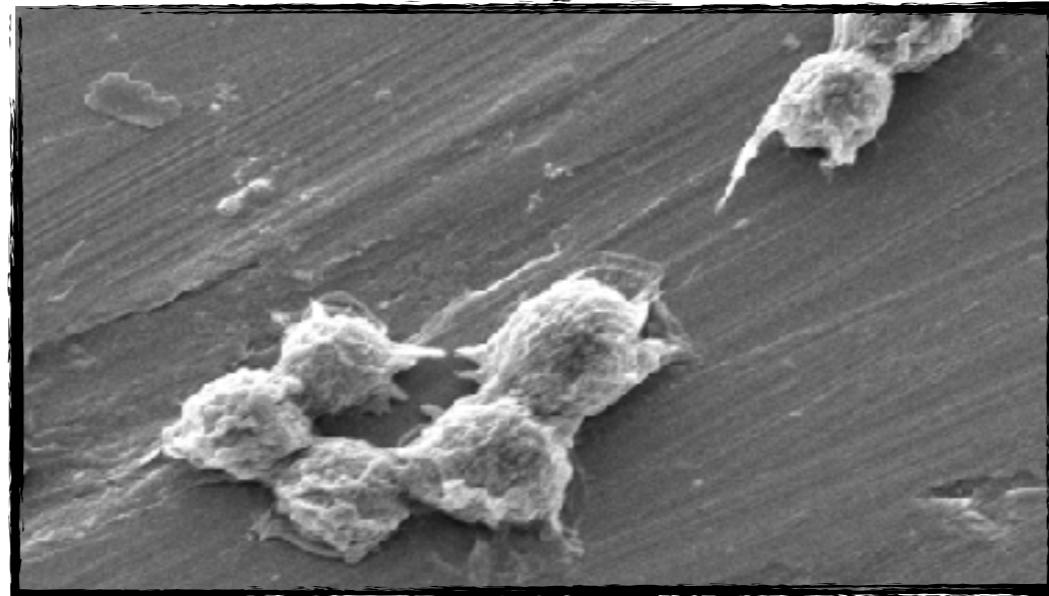


Social Amoeba *Dictyostelium discoideum* as an Inspiration for Swarm Robotics

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Prof. Giovanna Di Marzo Serugendo



**Cuso winter school 2018
Champéry**



**UNIVERSITÉ
DE GENÈVE**

CENTRE UNIVERSITAIRE
D'INFORMATIQUE



Collective Adaptive Systems

<https://iss.unige.ch/staff/research-teams/collective-adaptive-systems/>

What are we interested in ... ?

Understanding the different phases of *D. discoideum* behavior



Biology

Providing new agent-based models for collective behaviors

- First-order emergent behaviors
- Second-order emergent behaviors



Agent-based models

Integrate in artificial engineered systems such as swarms of robots

Swarm robotics

Social Amoebae *Dictyostelium discoideum*

**Soil-living amoeba, commonly referred to as slime mold
an ideal system for emergent phenomenon**

Shift between uni- and multicellularity

unicellularity

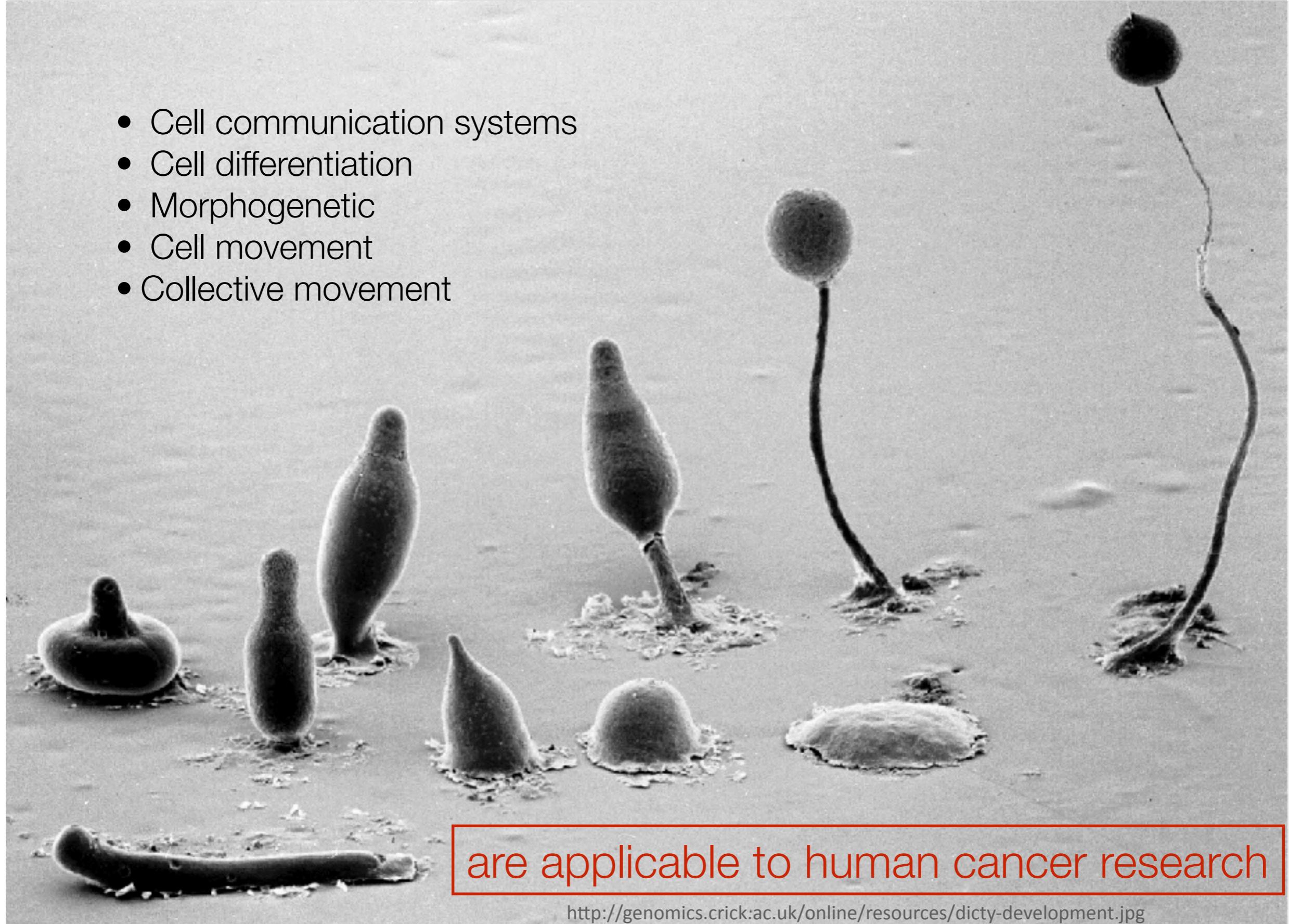


multicellularity

Food shortage: aggregation
fruiting bodies which consists of a stalk and spores bag

Social Amoebae *Dictyostelium*

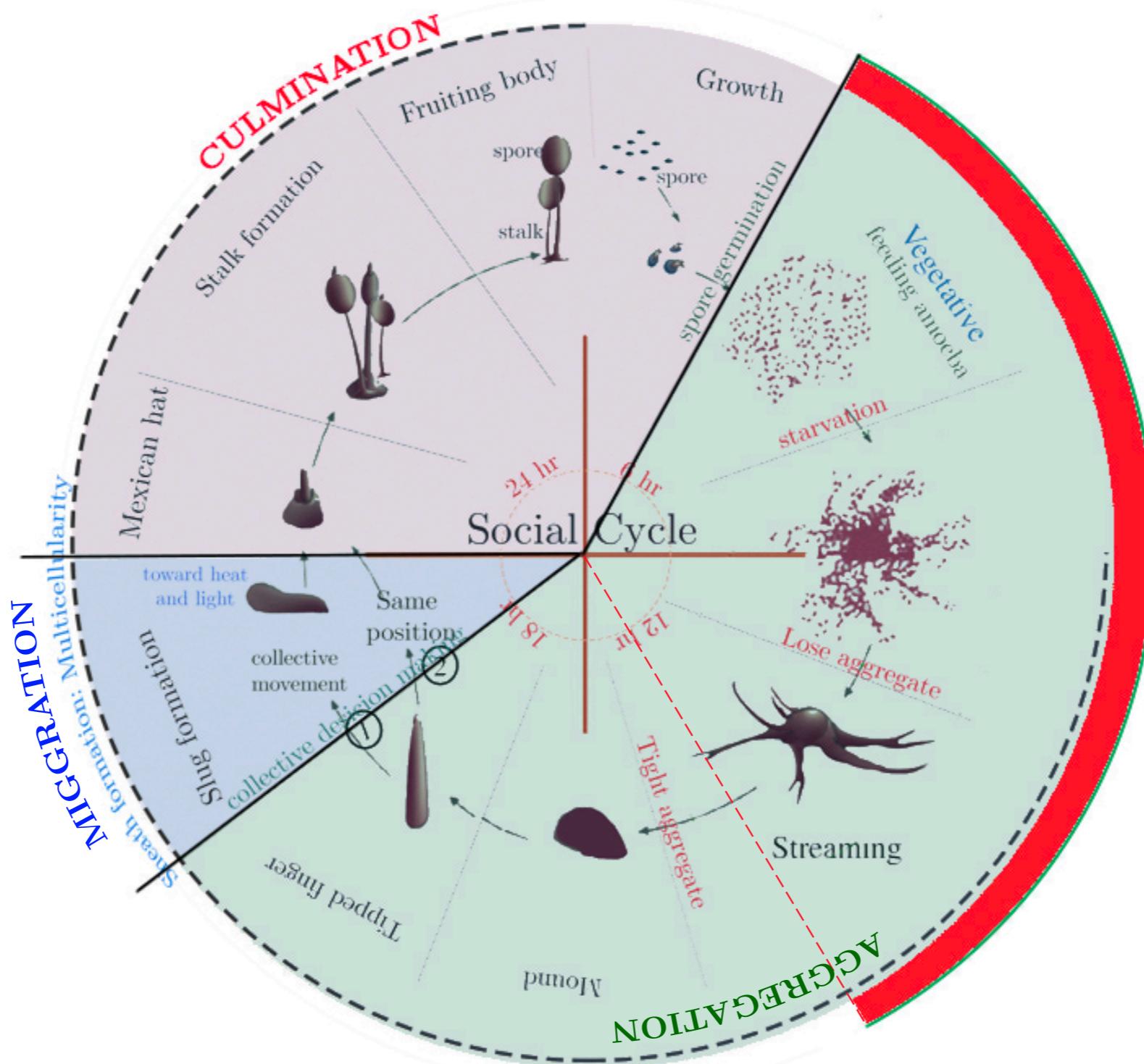
- Cell communication systems
- Cell differentiation
- Morphogenetic
- Cell movement
- Collective movement



are applicable to human cancer research

Life Cycle

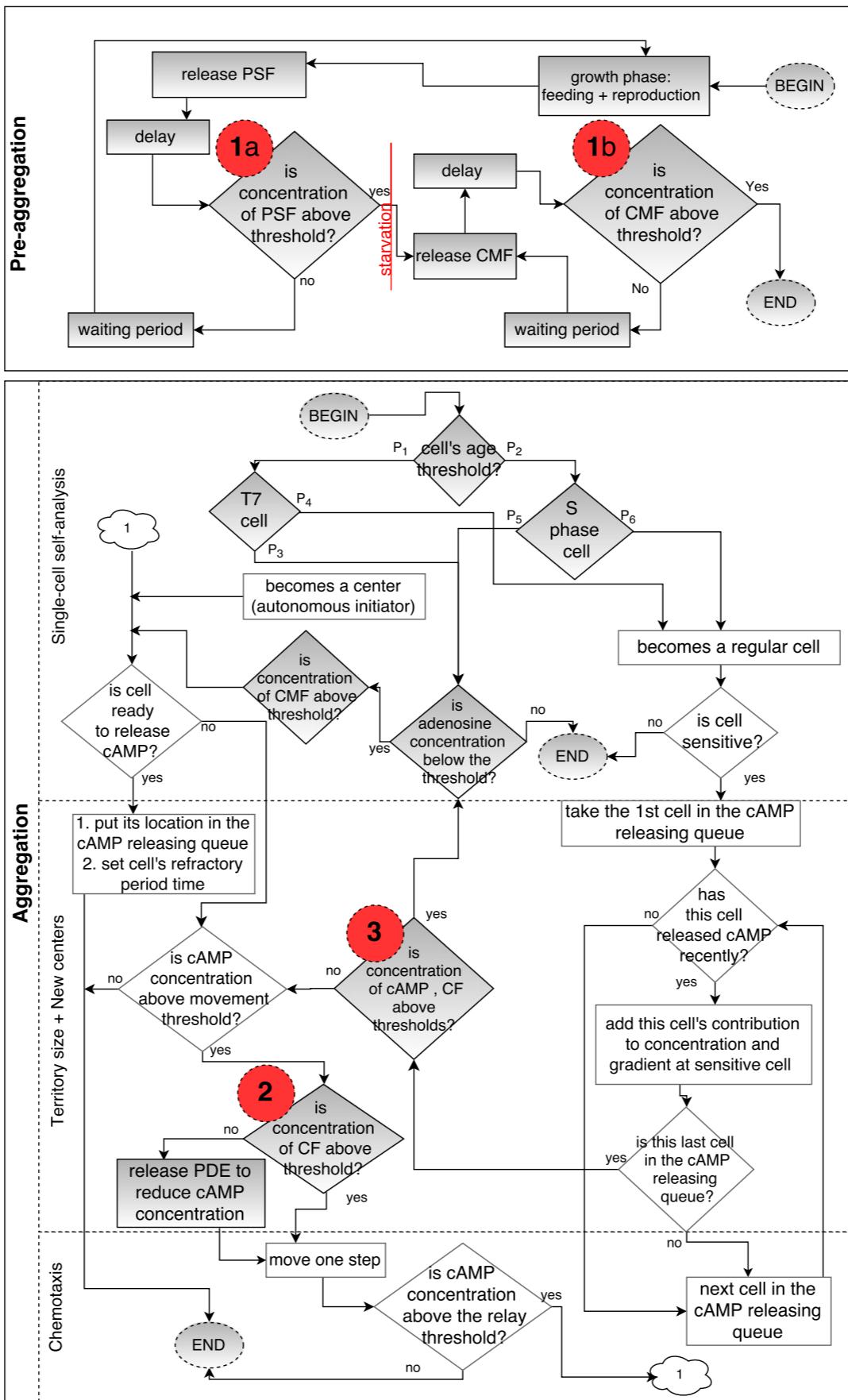
Morphogenesis: Aggregation Phase



- self-aggregation
- self-organizing
- self-regulation

....

self-*

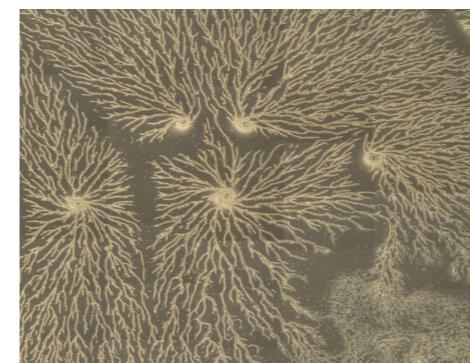


3 levels of quorum sensing + 6 chemical signals provide gradients for collective decentralized decisions

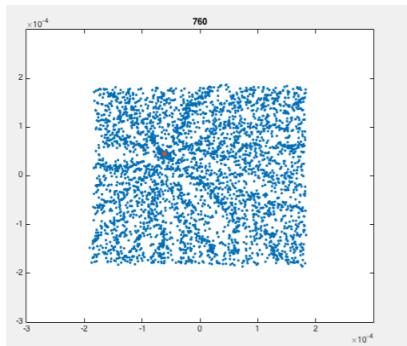
Results



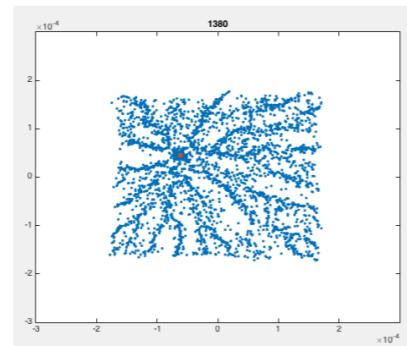
Ref: <https://www.wikipedia.org>



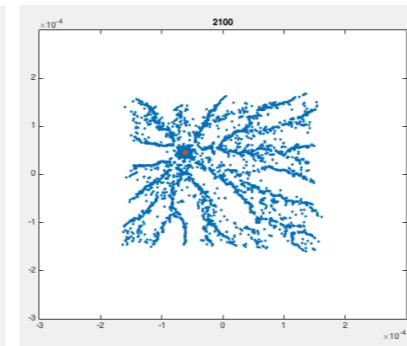
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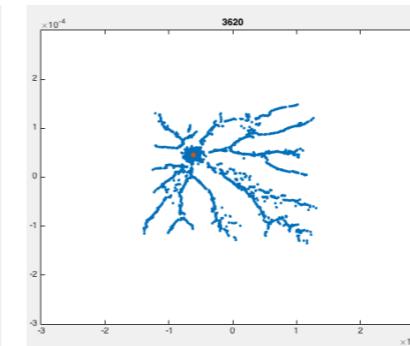
a.1



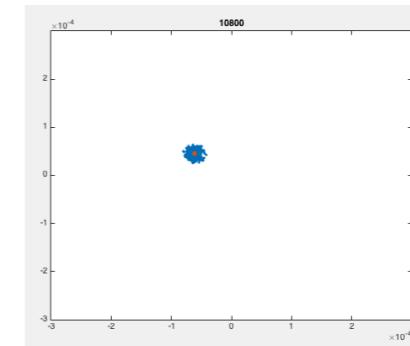
a.2



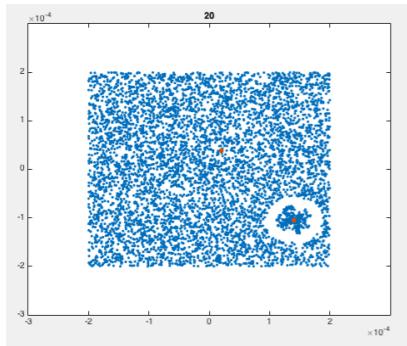
a.3



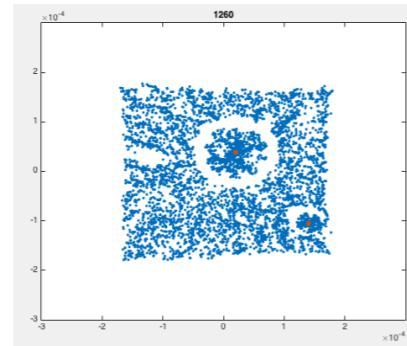
a.4



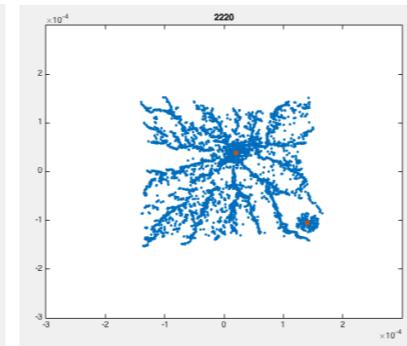
a.5



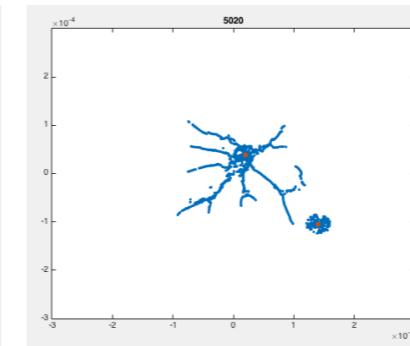
b.1



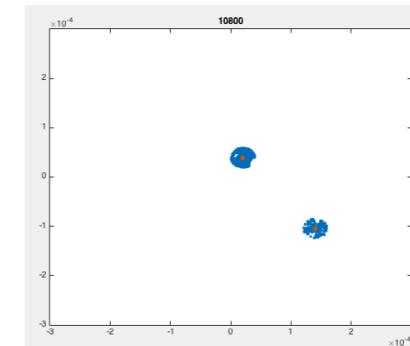
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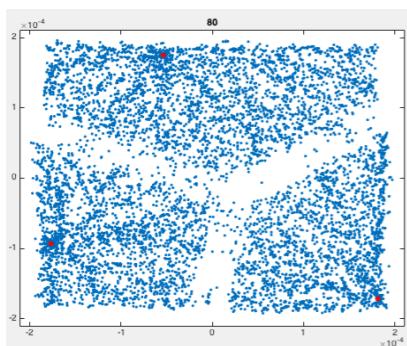
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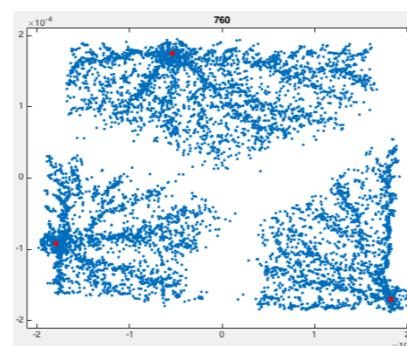
b.4



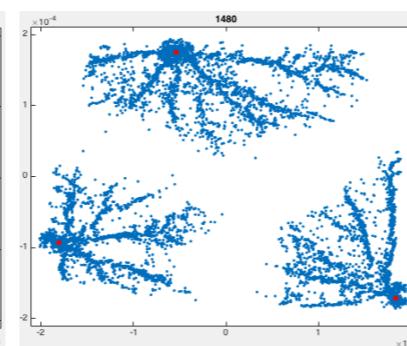
b.5



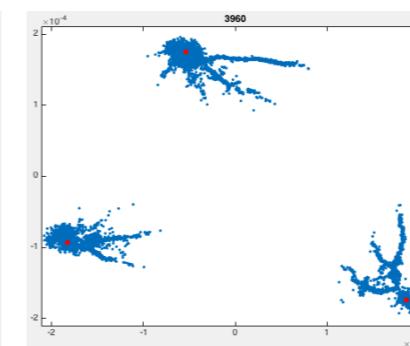
c.1



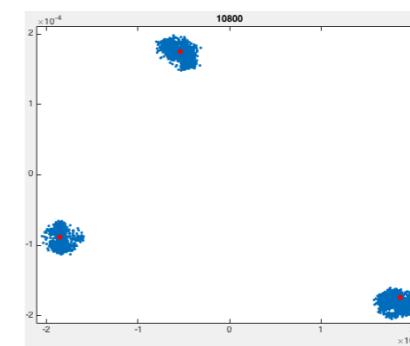
c.2



c.3



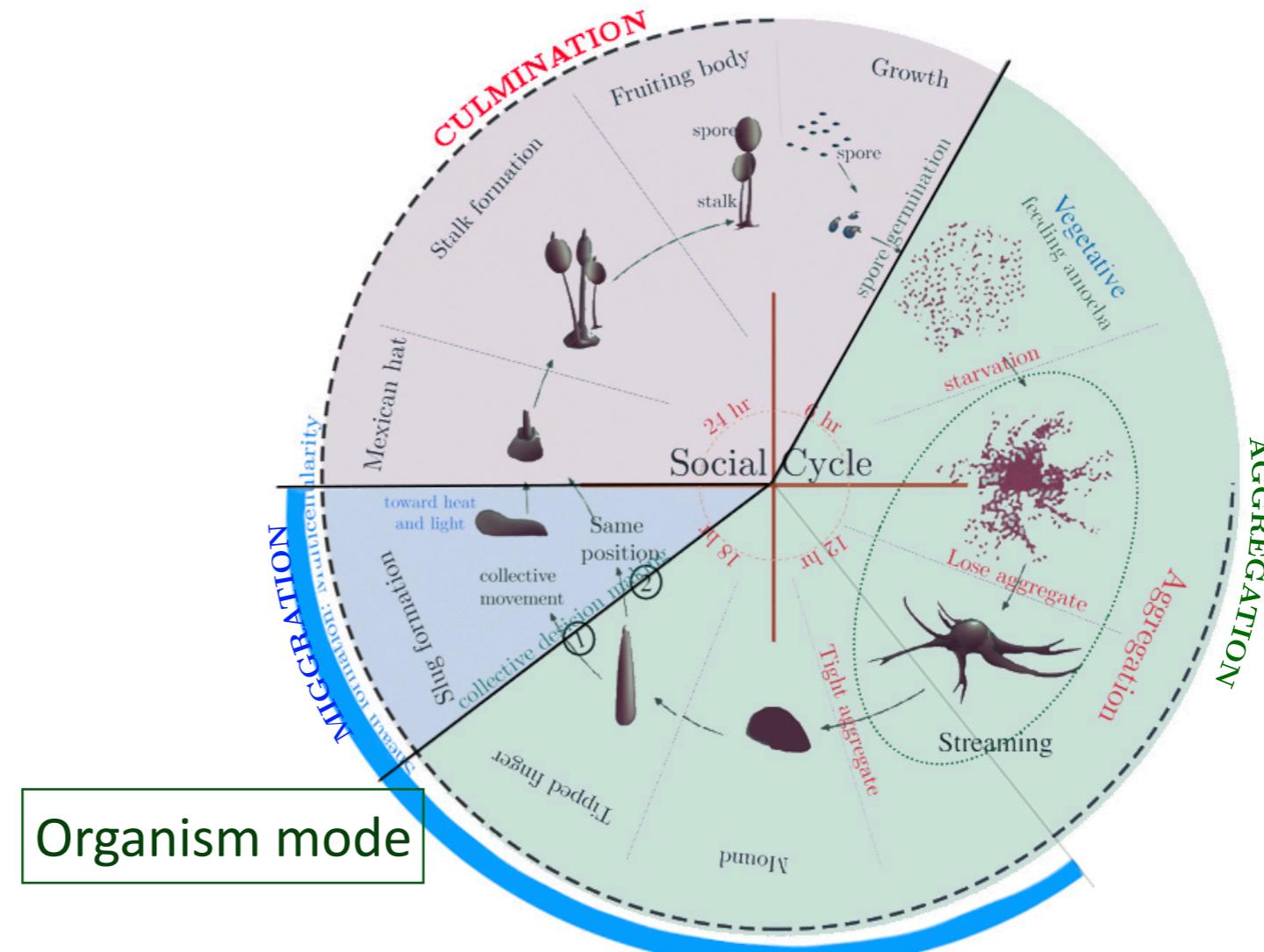
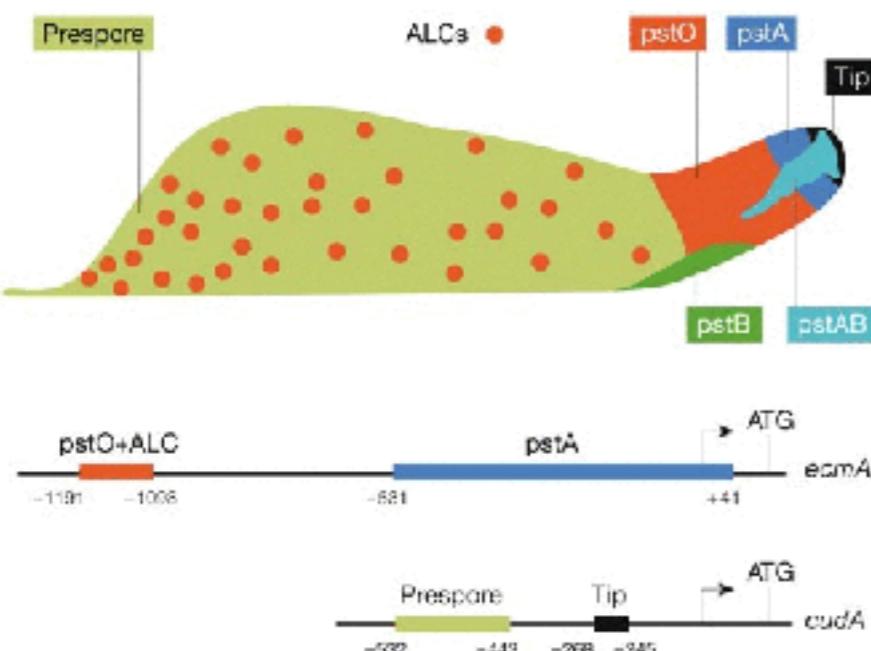
c.4



c.5

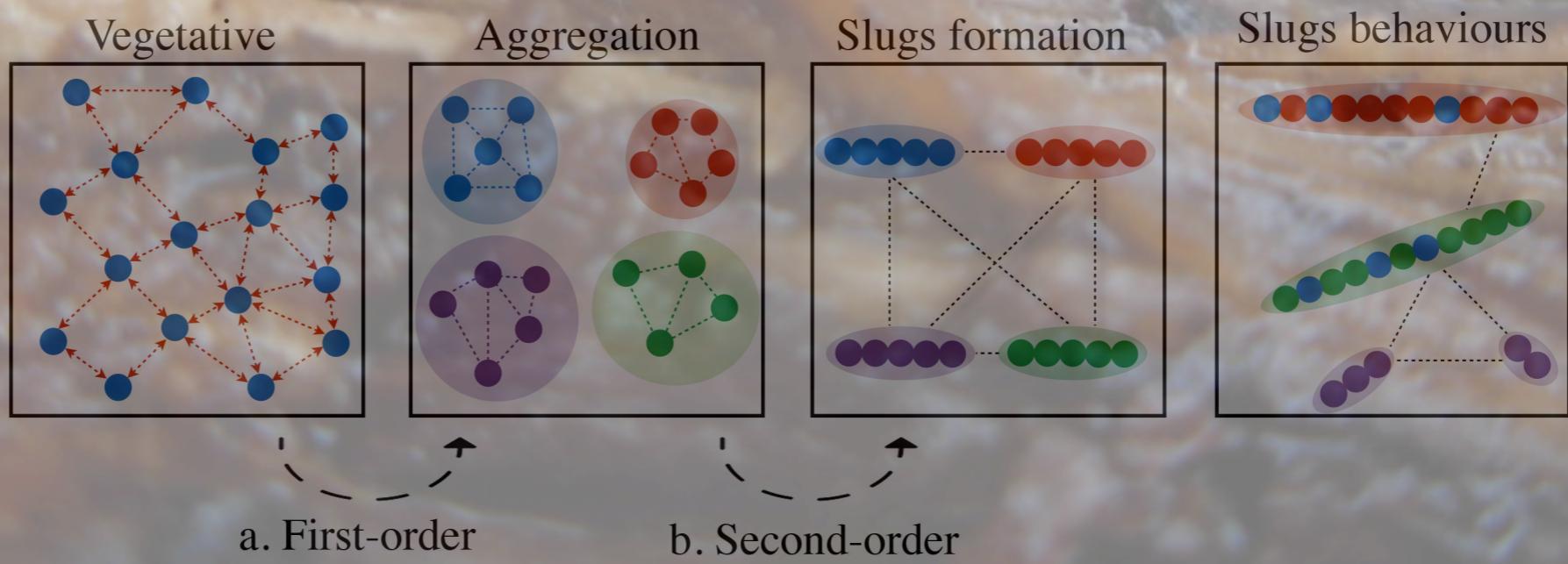
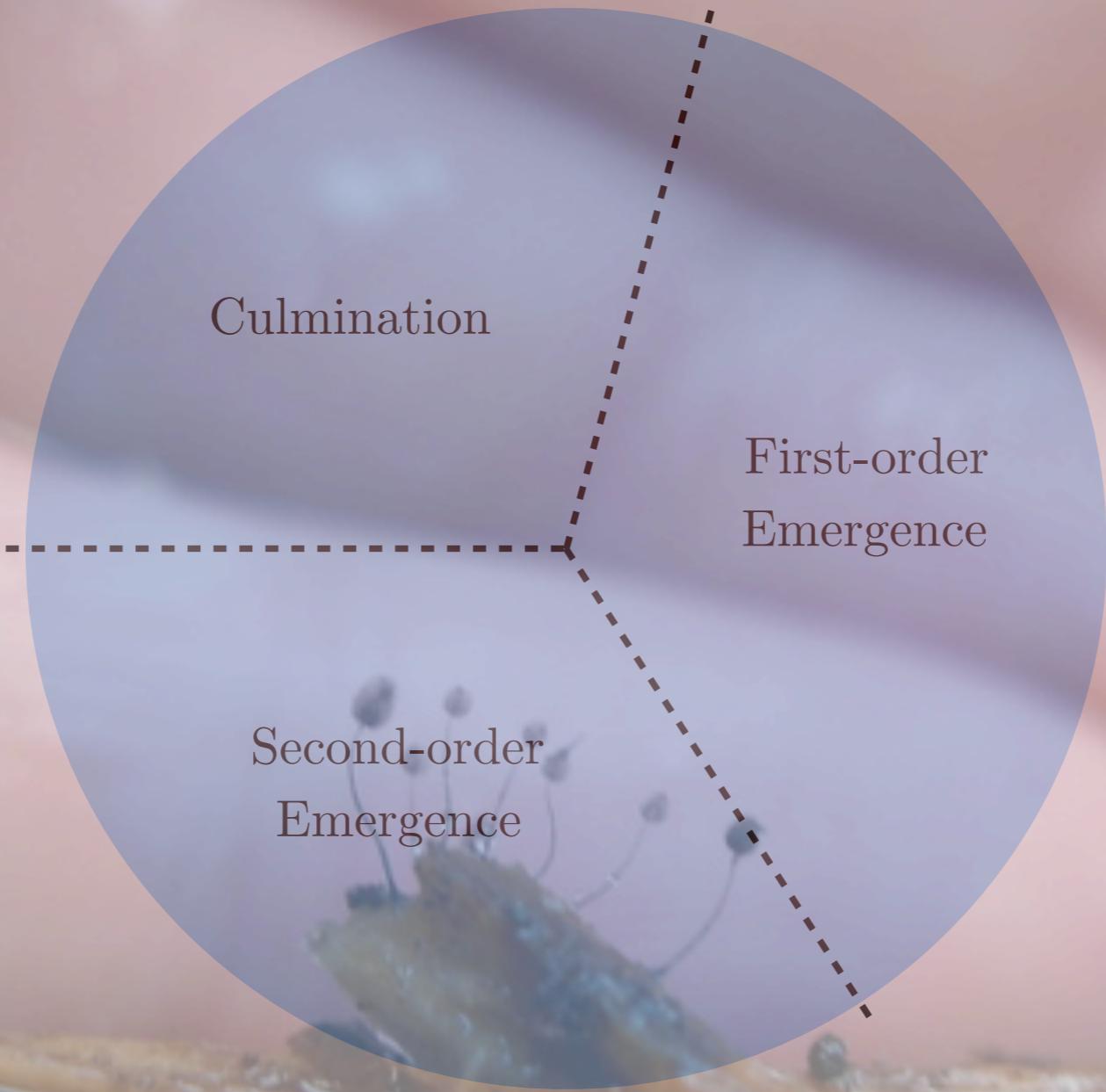
Life Cycle

Migration: Slug formation

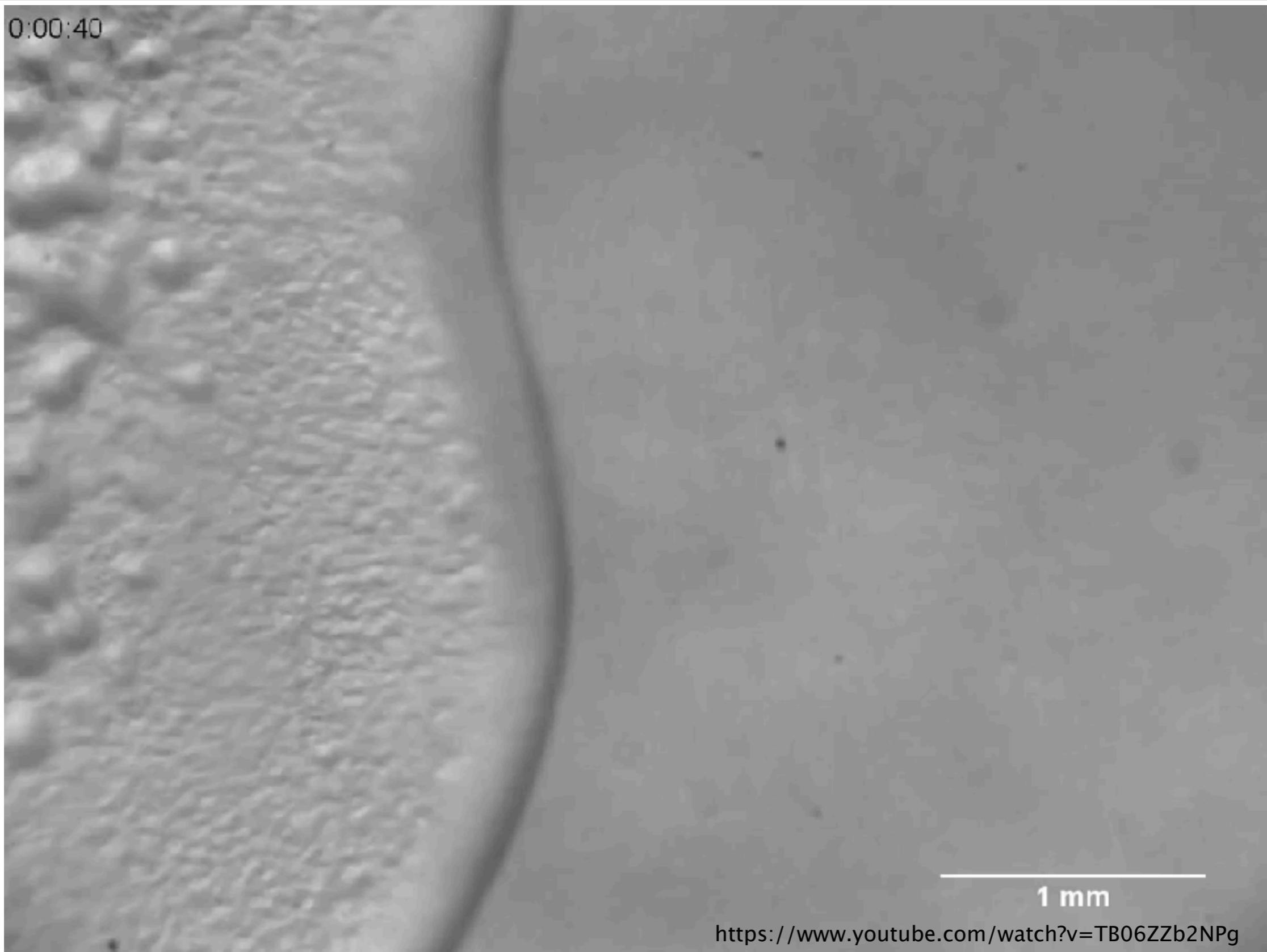


New behaviors: photo- and thermotactic sensitivities of the slug

<https://media.gettyimages.com/photos/the-cellular-slime-mold-slug-stage-lm-x30-picture-idvis311663?s=170667a>
<http://embor.embopress.org/content/embor/7/7/694/F1.medium.gif>



Dictyostelium



Future work: Kilobot



- Low-cost / developed in Harvard University
- Rechargeable lithium-ion battery / 3–12 hours
- 3 LED color for grouping
- Capabilities:
 - Forward movement (2 vibration motor)
 - Rotation
 - Communication with nearby units
(infrared up to 7cm)
 - Measure the distance between nearby units
 - Enough memory to run small code
 - The ability to measure ambient light levels
 - Allow for scalable operations

Validation

- + Team of biologists from the University of Geneva, to validate our simulation results.

Prof. Thierry Soldati

Thank You



Are there any questions?