

# **Can you have memories without a brain?**

# Readings for today

- Suda, H., Mano, H., Toyota, M., Fukushima, K., Mimura, T., Tsutsui, I., ... & Hasebe, M. (2020). Calcium dynamics during trap closure visualized in transgenic Venus flytrap. *Nature Plants*, 6(10), 1219-1224.
- Reid, C. R., Latty, T., Dussutour, A., & Beekman, M. (2012). Slime mold uses an externalized spatial “memory” to navigate in complex environments. *Proceedings of the National Academy of Sciences*, 109(43), 17490-17494.

# Topics

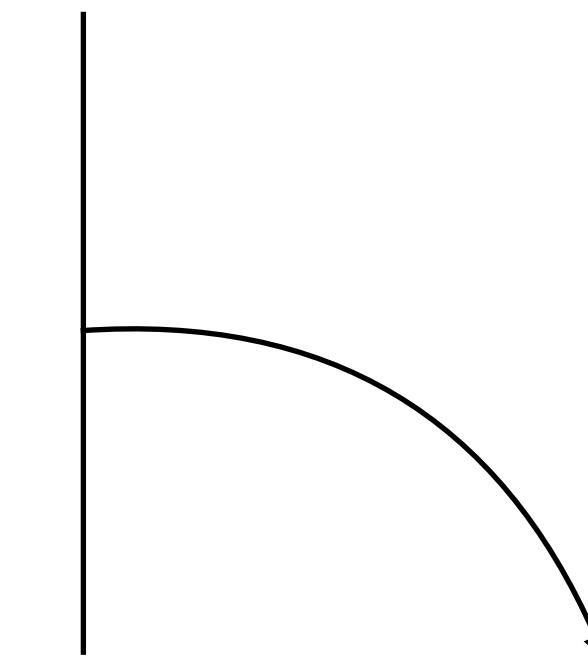
- Brainless working memory
- Brainless longterm memory

# **Brainless working memory**

# Why do we care about memory?

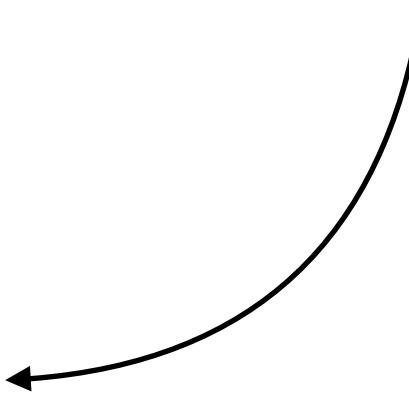
## Two components of directed exploration:

- **Decision-making**: The ability to use prior knowledge to select an action.
- **Learning**: The ability to change a system so that past experiences guide future actions.



Both require a system with a memory.

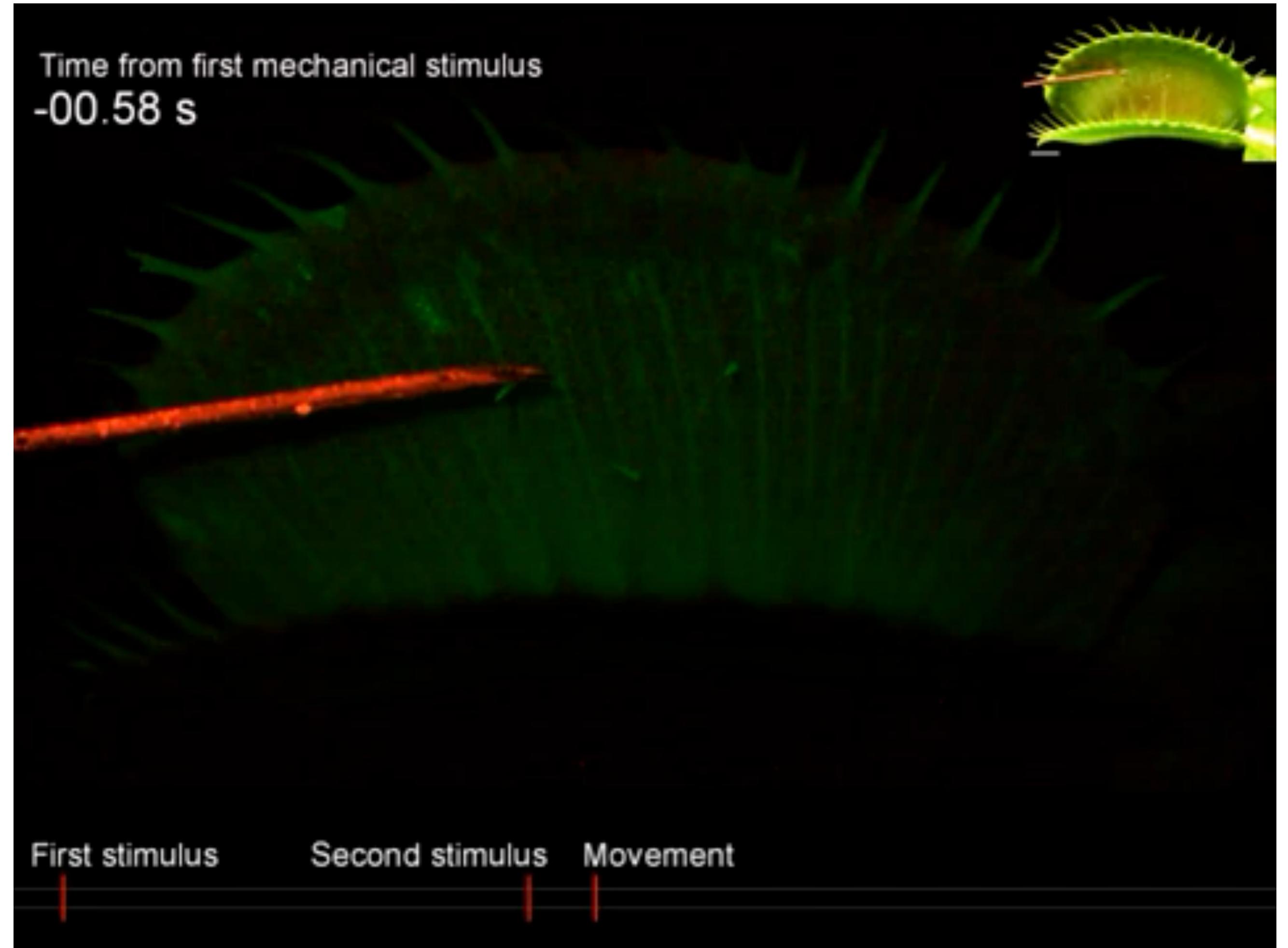
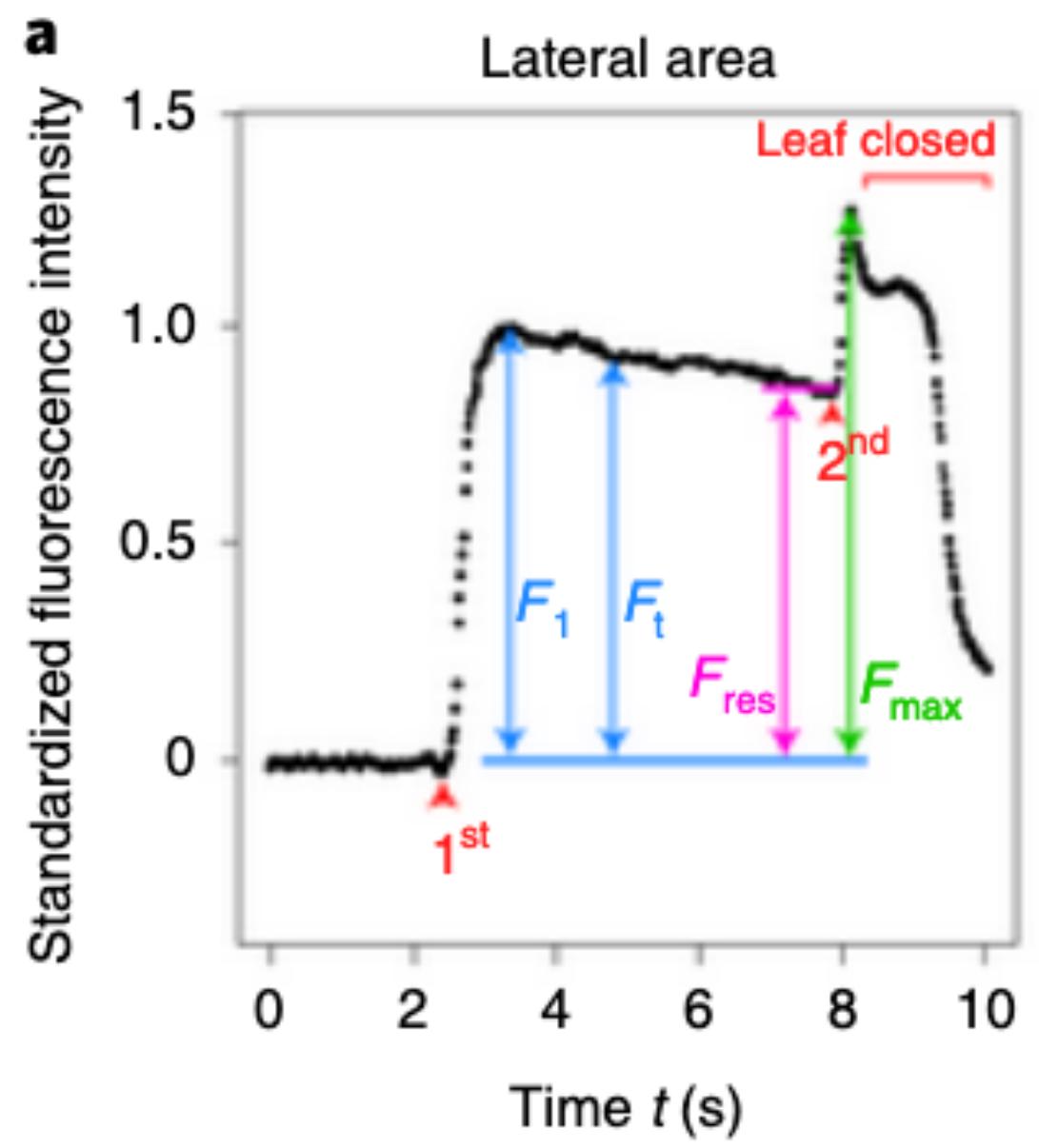
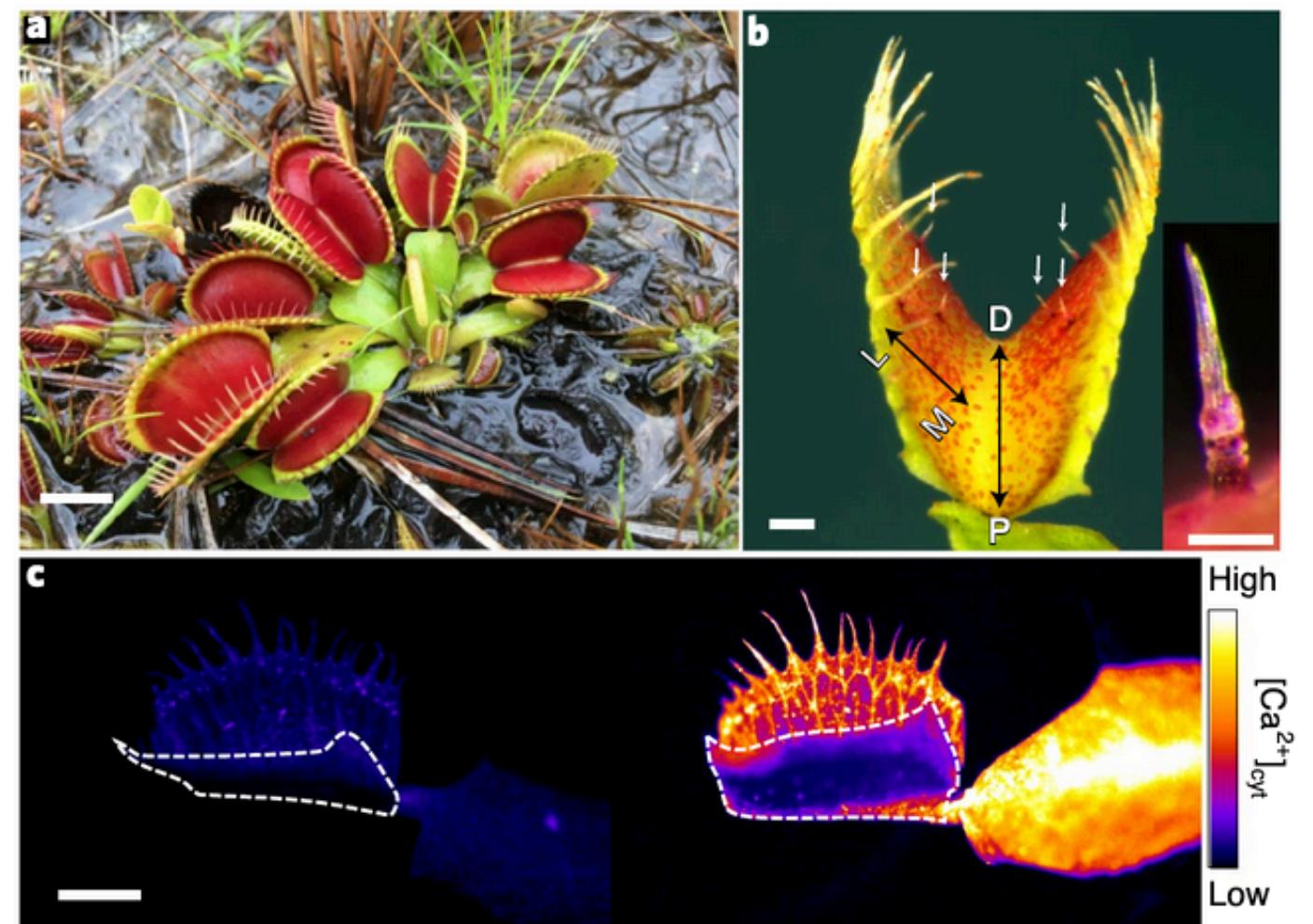
Is a brain necessary for this?



# How to remember without a brain

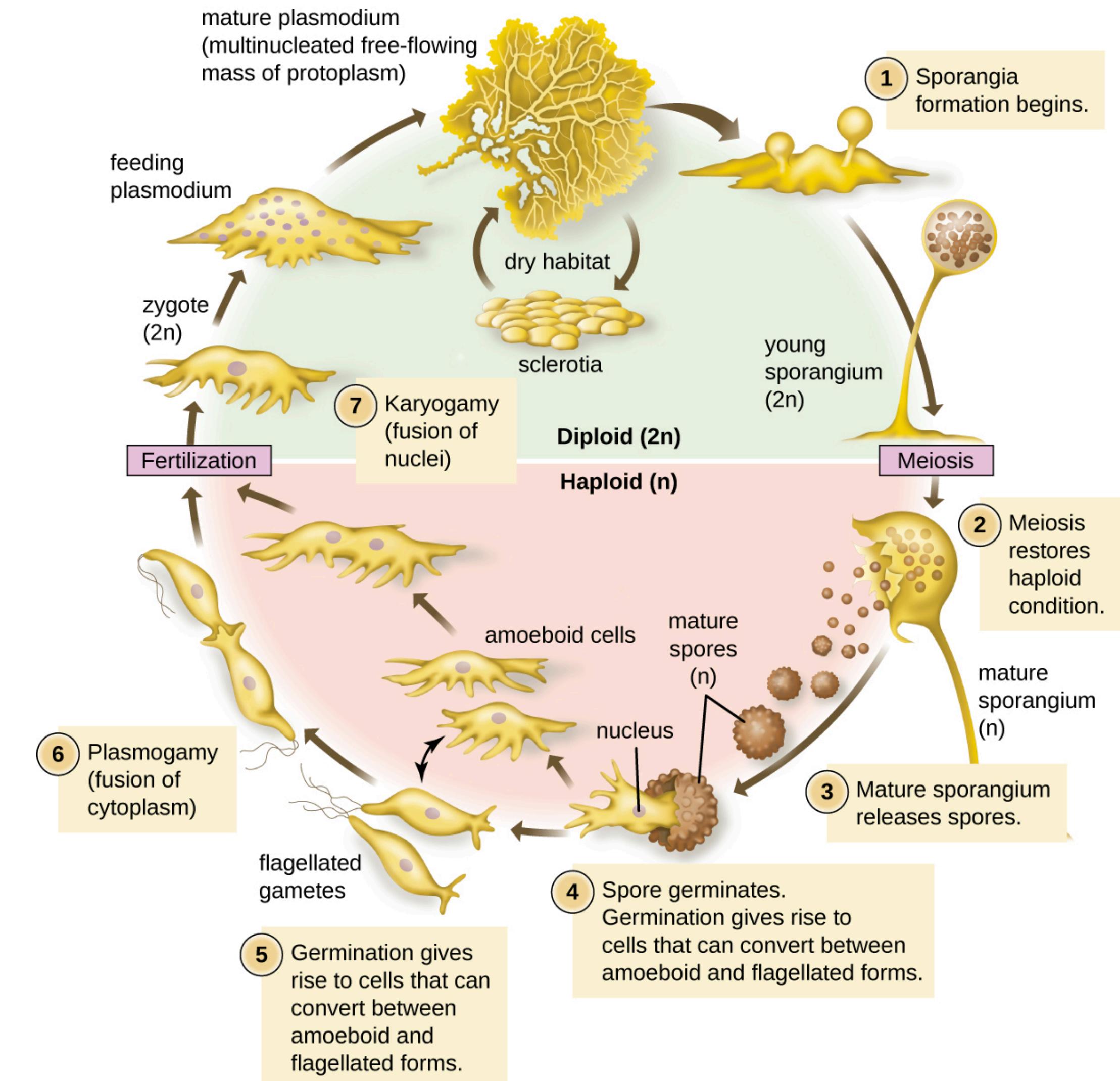


# Brainless working memory

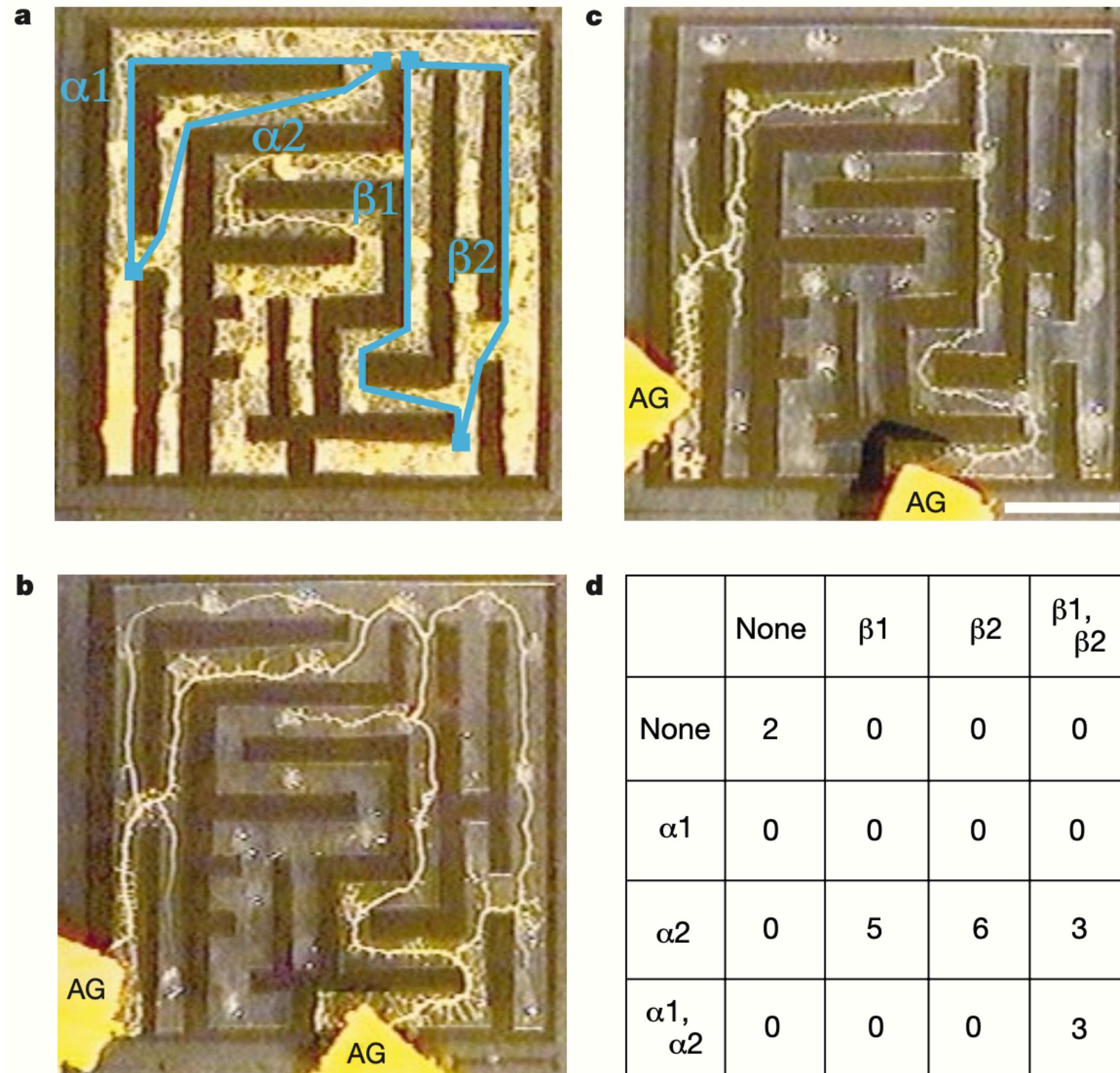


# **Brainless long term memory**

# Slime mold

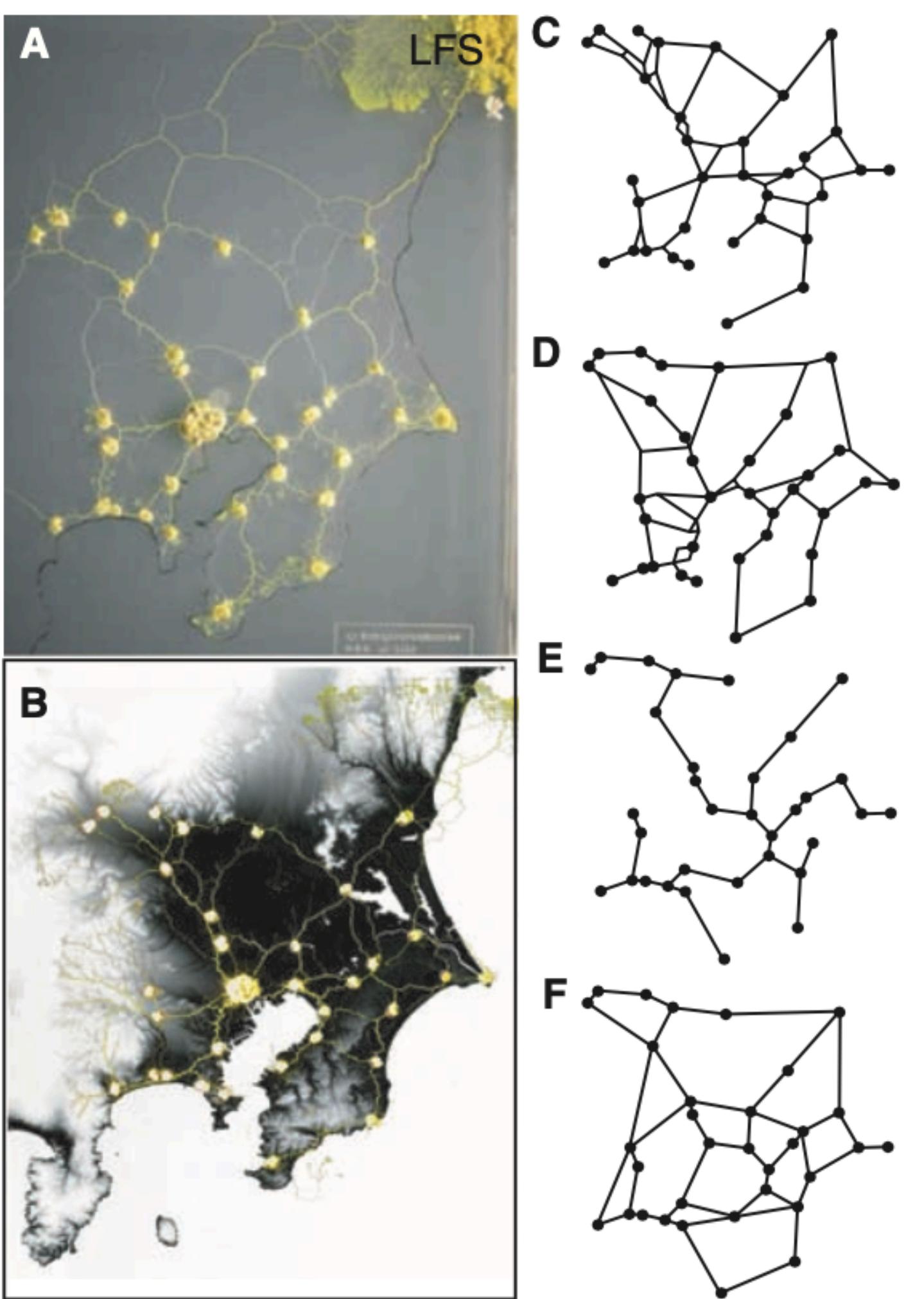


# Slime mold navigation

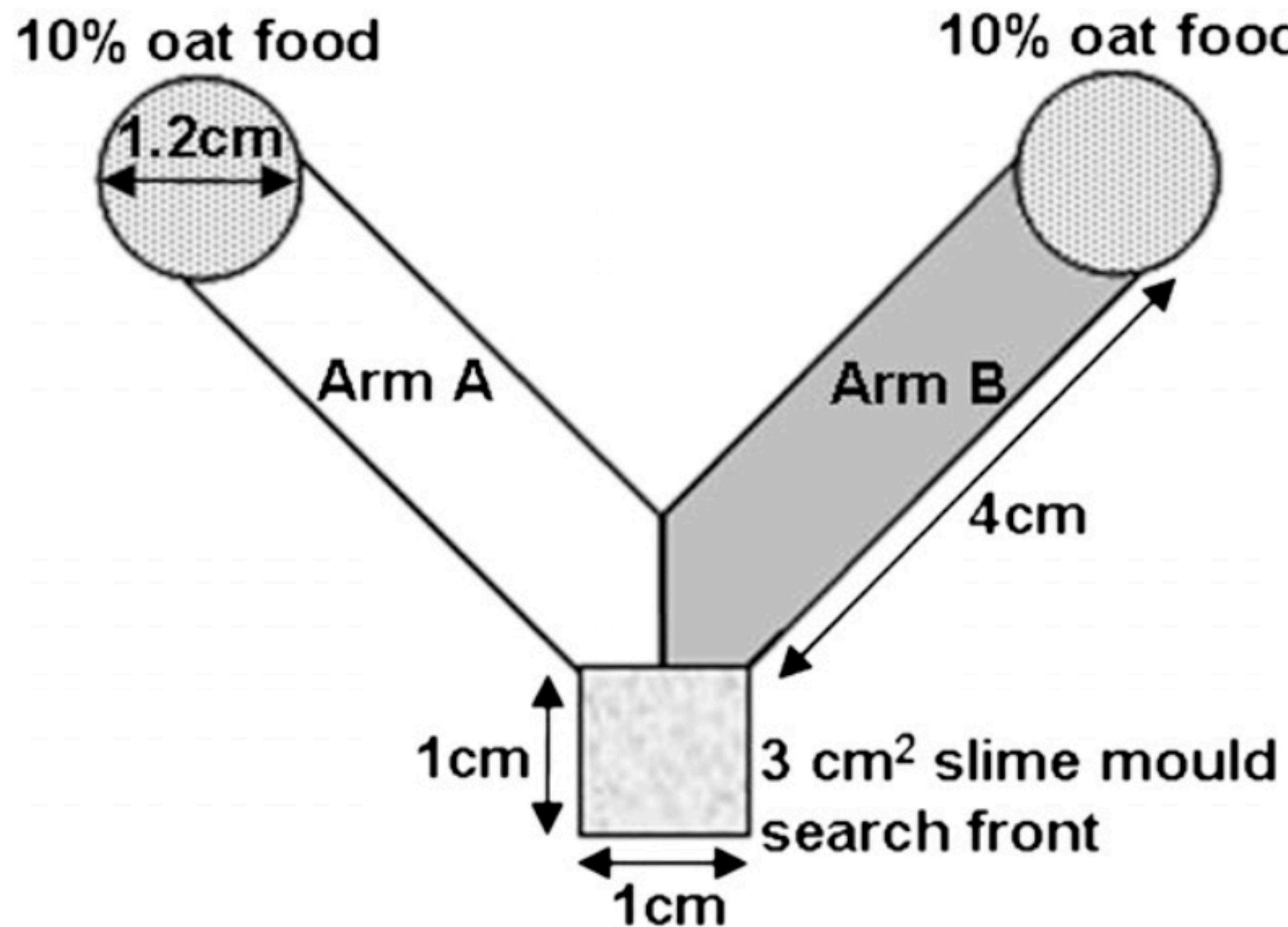


Slime molds can find optimal foraging routes through nutrients (and obstacles)

# Path minimization

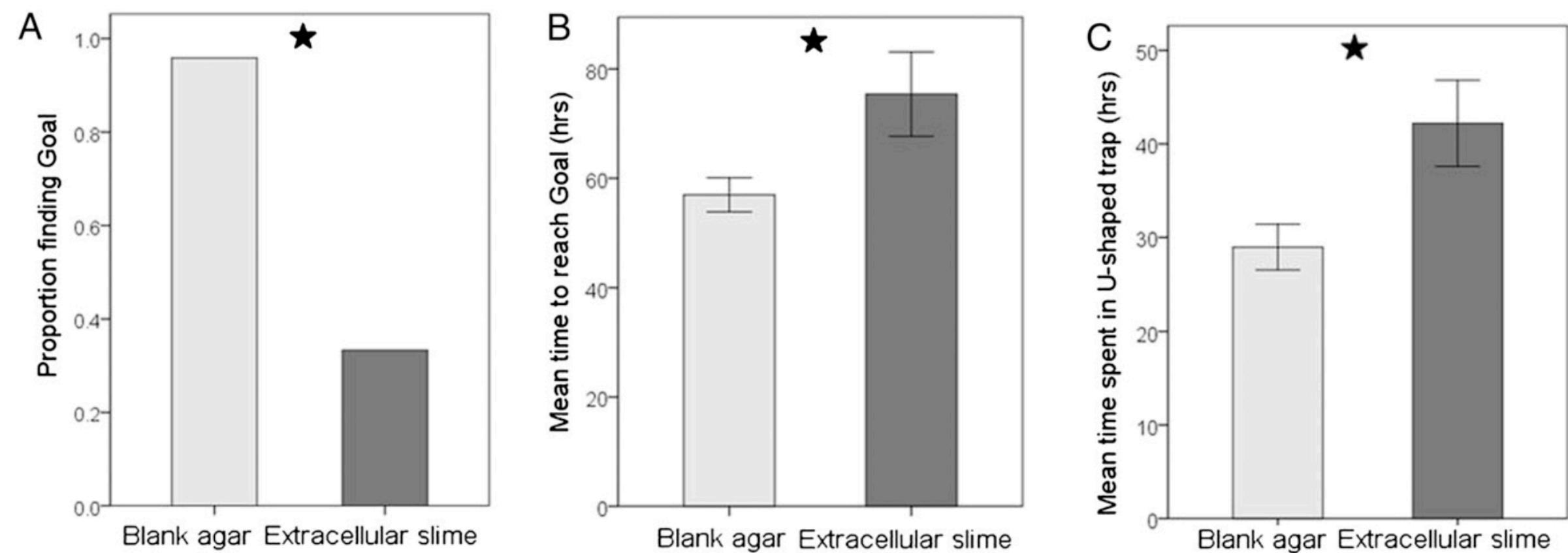
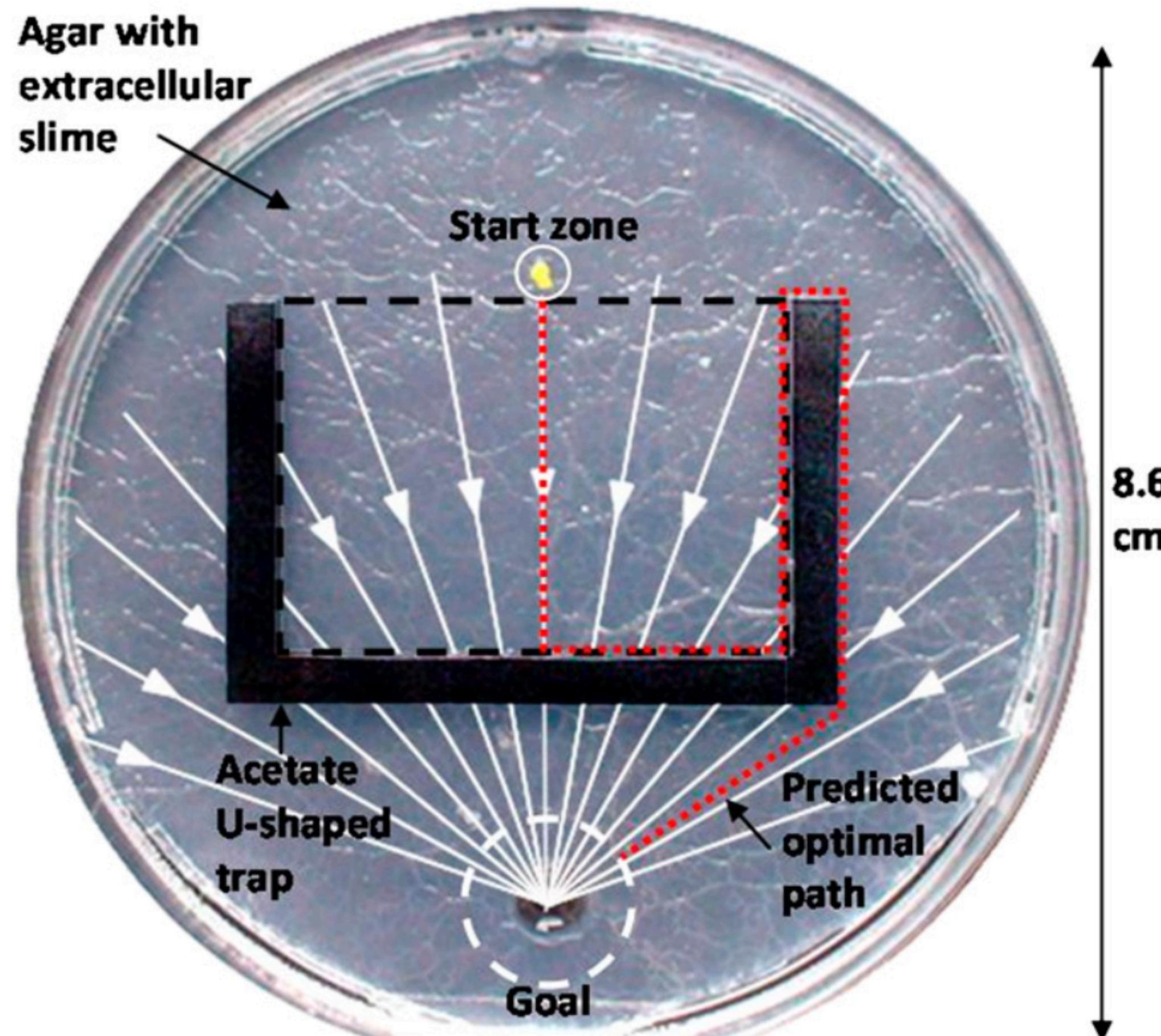


# Making choices



- Arm B contained extracellular slime (naturally secreted by slime molds).
- 39/40 molds chose arm without slime mold.
- Indicates it has been there before.

# Spatial memory



- Presence of extracellular slime impaired slime mold's ability to “solve” the maze.
- Chemical “I've been here” trail.

# Take home message

- Brains are not necessary for memories
- Flytraps can implement a simple working memory using calcium diffusion.
- Slime molds can externalize their memory to find the optimal (i.e., shortest) paths through the environment (slime mold).

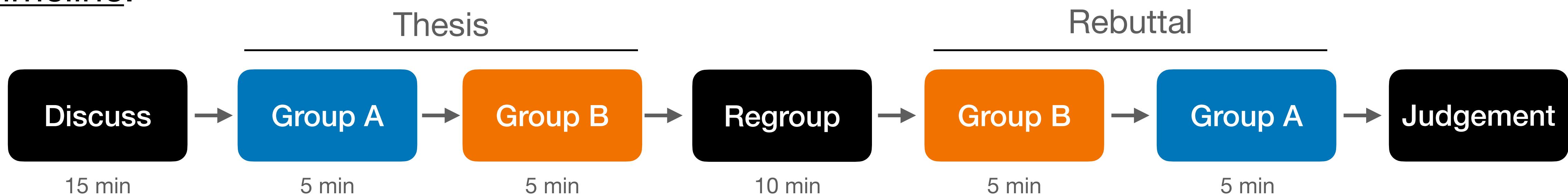
# Debate time!

Prompt: If organisms without brains can implement basic memories that facilitate exploration, then what value does the brain add to exploration?

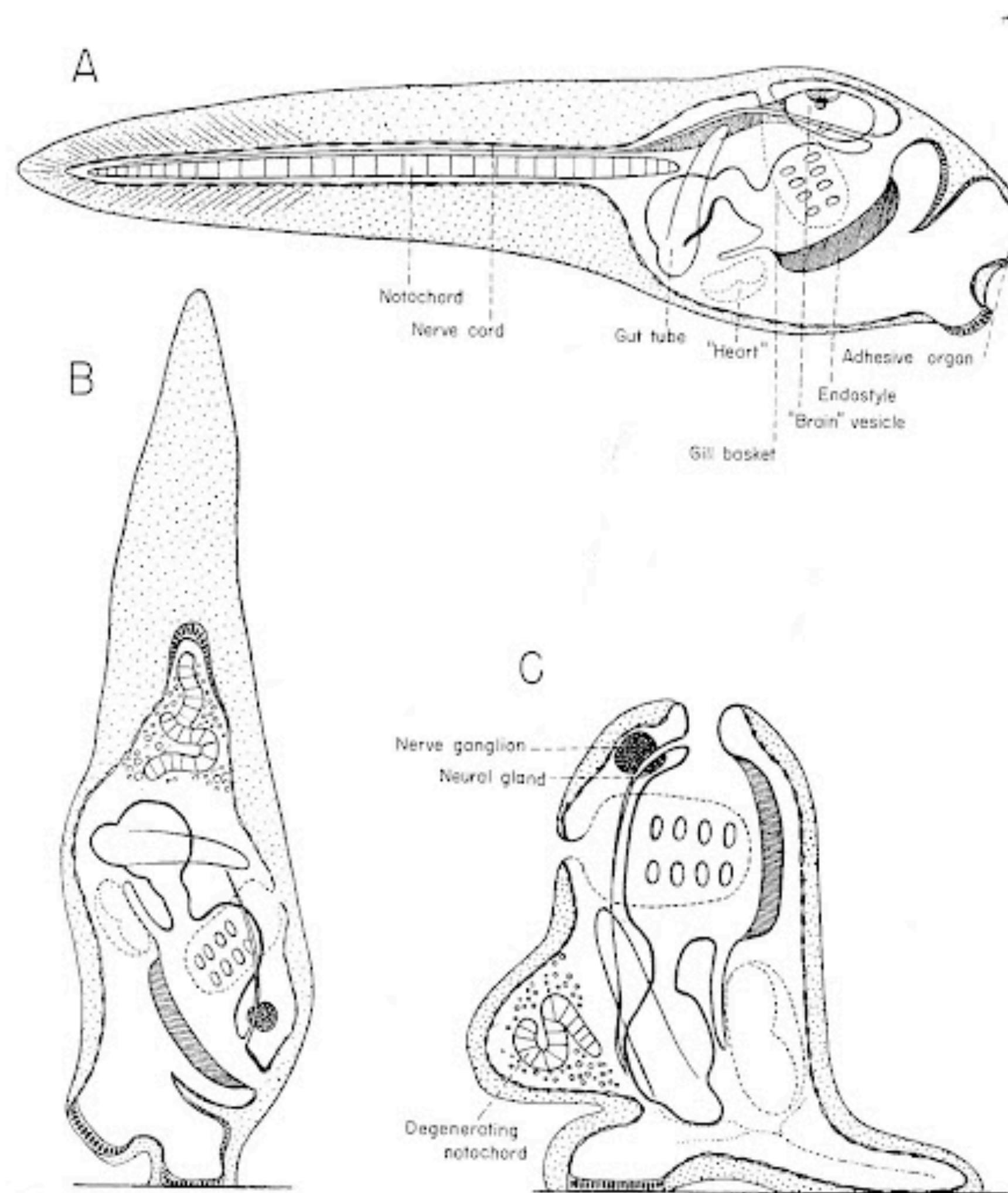
**Group A:** Defend the brain.

**Group B:** Reject the brain.

Timeline:



# Use it or lose it: the sea squirt story



- As a juvenile the sea squirt has a brain.
- Once attached to a surface, it digests the brain as it matures into the adult phase (passive feeding)