The Secrets of Smart Slime

Peering into the invisible

Strathcona

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Introduction

Physarum polycephalum is a slime mould. Despite its name, it lacks chitin or cellulose cell walls [9] (for most of its life cycle) and exhibits animal-like behaviours, placing it in the protist kingdom rather than among fungi or plants [7, 10, 11]. The most remarkable feature of P. polycephalum is its structure: a single cell containing millions of nuclei when mature [5]. Without a brain or the ability to photosynthesise, it has evolved highly sophisticated decentralised features to forage for food [1]. In accordance with my chosen topic of "Peering into the invisible" and this year's theme of "Seeds of science: Nurturing knowledge for all", this poster explores the invisible mechanisms used by the P. polycephalum and see how spores can grow into an incredible plasmodium that can help with the planning and development of cities that nurture billions of people.

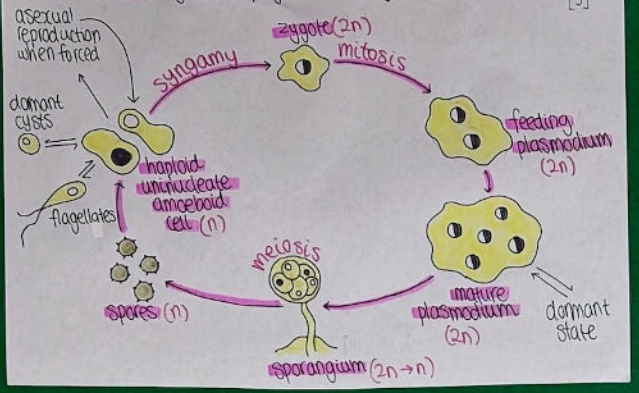
Explanation of Scientific & Technical Principles

The life cycle of P. polycephalum is like fungi, it begins as a spore that hatches into haploid ameboid cells. Compatible cells can fuse to become a zygote, entering the plasmodial phase. [5] Under lab conditions it can easily reach 14cm diameter in 2 to 3 days [4]. It is highly resilient, entering dormancy under suboptimal conditions as well as develop flagella in water (Diagram 1) [9, 2, 3]. P. polycephalum post-fusion in its plasmodial phase contains most standard eukaryotic organelles (labelled in diagram). However, some key differences are its multiple nuclei, lack of centrioles, its gel like ectoplasm and fluid endoplasm (Diagram 2) [10, 11]. P. polycephalum pulsates periodically (about every minute) moving towards food and away from harmful stimuli, like light and salt (Diagram 3) [8]. The peristaltic movement is driven by actin and myosin. The ectoplasm contains F-actin while the endoplasm contains G-actin. The ectoplasm is a gel substance which can contract and relax due to the presence of myosin interacting with the F-actin, like human muscles (Diagram 4) [12]. When growing P. polycephalum in a petri dish with oats (a food source) it initially spreads evenly, exploring the entire area. Over time, it strengthens optimum paths connecting the oats while ridding inefficient ones, leaving behind a slimy trail. This system allows the slime mould to remember and learn so it doesn't reexplore those paths. (Diagram 5) [6]

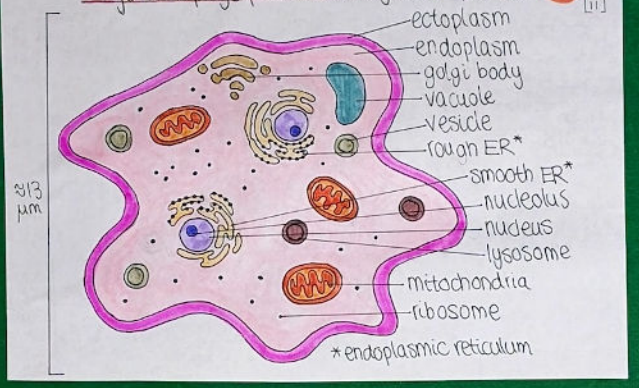
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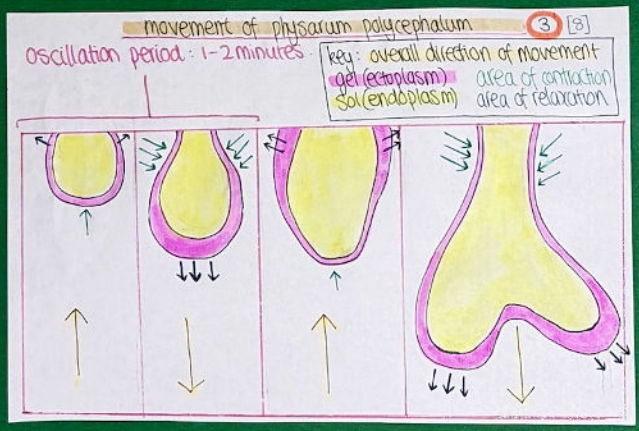
life cycle of physarum polycephalum (1) [9][2][3]



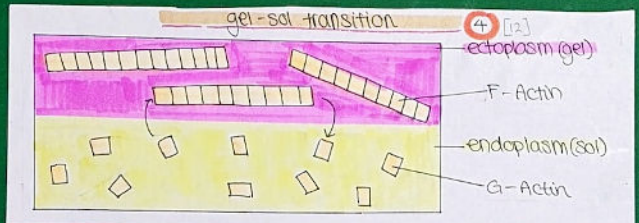
Physarum polycephalum (shortly after fusion) (2) [10][11]



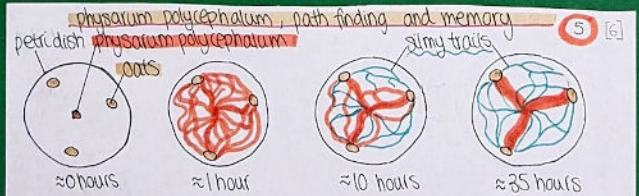
movement of physarum polycephalum (3) [8]



gel-sol transition (4) [12]



physarum polycephalum, path finding and memory (5) [6]



*this is a generalisation, not the results of any specific experiment

Significance & Impact

In real life, P. polycephalum has been used for network optimisation problems [1]. It can create connections between dozens of oats, minimising energy expenditure while maximising efficiency of nutrient transport [12]. In real life, this can translate to roads and railways connecting cities. When cities increase, optimising the routes of transport becomes exponentially more difficult using tradition calculation methods. However, the exploration time required for P. polycephalum increases linearly. Famously, researchers used P. polycephalum to create a near identical map of the Tokyo railway system. Other scientists have created computer algorithms inspired by P. polycephalum to solve some network optimisation problems [6]. As the demands for delivery and transport increases, slime mould inspired computer algorithms can help create infrastructure for new cities and optimise existing ones.

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AI	Gemini and Copilot were used to find sources of information, checking for spelling/grammar errors and help with citation format. I wrote and reviewed everything based on cited sources. Commands [find articles for Physarum polycephalum, check for spelling and grammar errors (first draft), how do I site this PDF (PDF link)]

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