Computer Modelling with Single Prompts (labs)

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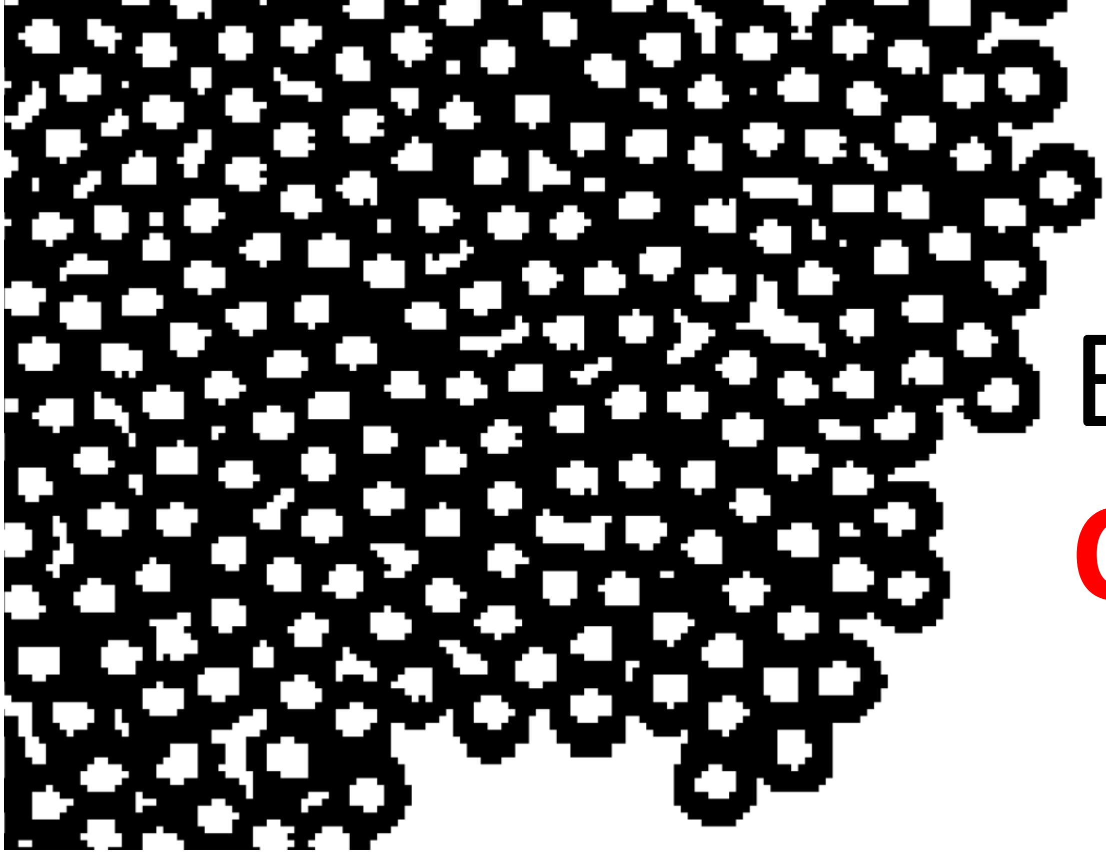
University of Warsaw, 2026-04-22/24



Phys. *A Math. Gen. 28 (1995) 2141-2147*

Bacterial **Clusters LLM**

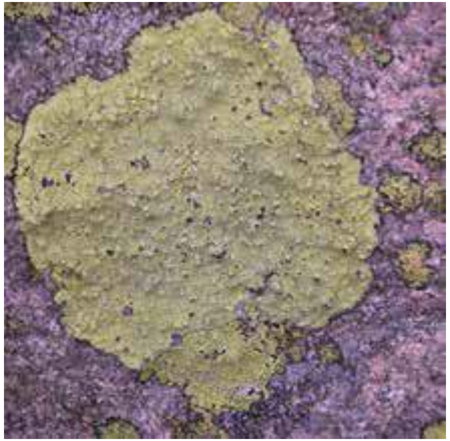
Maciej Matyka,
UW, 22/24.04.2026

Karkonosze

Misecznica murowa
Lecanora muralis

Stargard

Rozsypek srebrzysty
Phlyctis argena



Wzorzec alpejski
Rhizocarpon alpicola

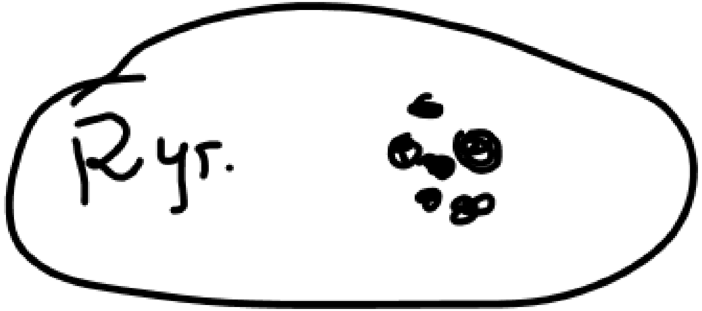
Rozsypek srebrzysty
Phlyctis argena

G. Grzejszczak, https://mycoportal.org/portal/collections/individual/index.php?occid=7025413

W. Fałtynowicz, Atlas porostów Karkonoszy, Jelenia Góra 2014

Eden's model (the simplest version)

1. Seed first bacteria.
2. Randomly select edge.
3. Insert a new bacteria.
4. Return to step 2.



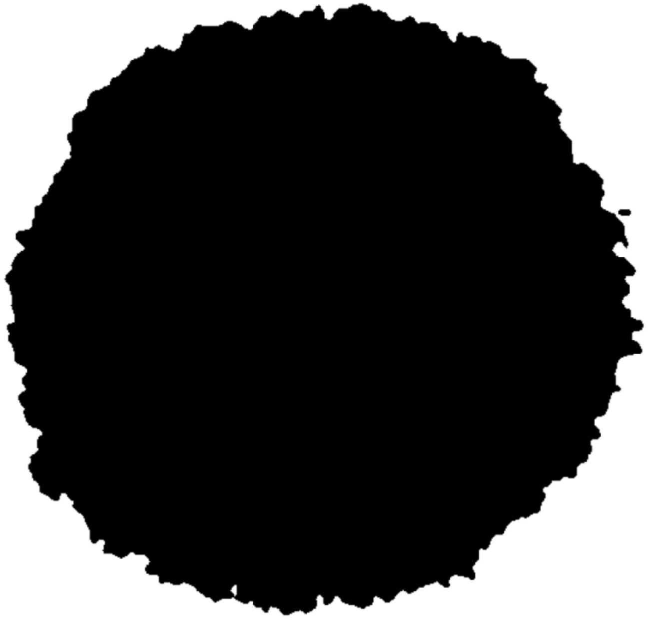
A two-dimensional growth process

[PDF] psu.edu

M Eden - Proceedings of the fourth Berkeley symposium on ..., 1961 - books.google.com

It is the purpose of this paper to examine certain of the properties of popula-tions of cells, in particular, properties relating to the architecture of cell colonies. We imagine that the underlying process in the growth of an organism begins with a single cell (perhaps derived ...

paper



A TWO-DIMENSIONAL GROWTH PROCESS

MURRAY EDEN
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

1. Introduction

It is the purpose of this paper to examine certain of the properties of populations of cells, in particular, properties relating to the architecture of cell colonies. We imagine that the underlying process in the growth of an organism begins with a single cell (perhaps derived from the fusion of two germ cells), and then continues by a process in which the initial cell divides into daughter cells. These in turn divide into other cells, these divide further, and so on. The rates of division, the rates of growth of the individual cells, the ultimate size of each cell, its life

Surface Thickness in the Eden Model

Link pdf

Plischke and Rácz (PR)[1] have recently studied the surface thickness of growing aggregates. They have found an unusual scaling, even for the Eden model.[2] Here, we consider three versions of this model and we show that the one used by PR exhibits strong finite-size effects. In a strip geometry, we find that the surface thickness simply grows as the square root of the cluster width.

In our simulations the aggregate grows on a square lattice, in a strip of width l, with periodic boundary conditions at the edges.[3] We start with all sites occupied up to $z=0$. Then new particles are added one by one. In version A (considered by PR), the new particle is added, equiprobably, on any *unoccupied* site adjacent to the surface. In version B (introduced by Eden himself[2]), an open bond is chosen equiprobably, and the new particle is added at the edge of this bond. In version C, an *occupied* site of the surface is first chosen equiprobably, and the new particle is added, equiprobably, at the edge of any open bond connected to this site. One can be convinced that these prescriptions give different results on short length scale. However, such differences must not affect the scaling behavior,

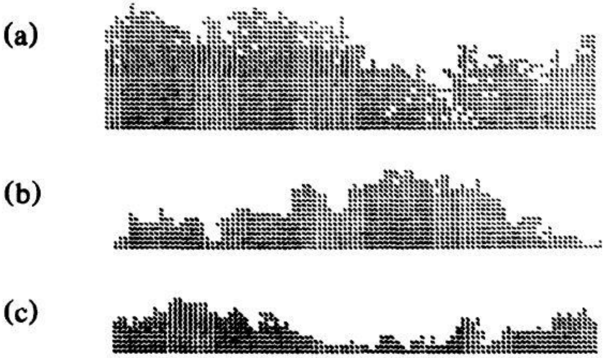


FIG. 2. Typical examples obtained for $l=96$. The figure only shows the last top rows, containing surface sites.

is nicely linear, leading to $\alpha=0.50\pm0.02$, the others exhibit an S shape. In case A the slope decreases first but, as expected, the curve cannot cross the others and, for larger sizes, the slope then increases, tending very slowly to $\alpha\sim0.5$. Striking differences between the three cases may also be seen in Fig. 2, where one observes many holes in case A. Finite-size effects also affect other quantities, such as the length n_s of the surface.[4] Many more results, with estimates of both α and γ and extensions to higher dimensions, will be

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Off-lattice Eden-C cluster growth model

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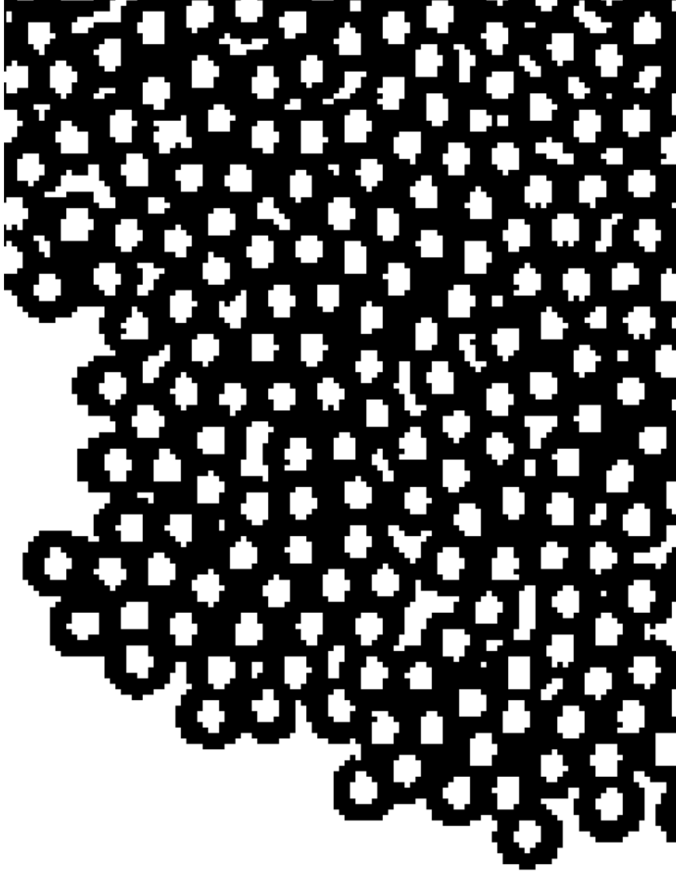
Abstract. A non-trivial cluster growth model, equivalent to the lattice-free Eden-C model, is proposed. The model is constructed by randomly adding contiguous circles without overlapping. Large-scale computer simulations show the interior density is constant at 0.650, while the boundary is fractal, with a thickness proportional to the 0.396 power of the mean radius.

1. Introduction

In 1961 Eden [1] introduced a stochastic growth model which may be used to study the propagation of epidemics, chemical reactions, tumour growths, forest fires and percolation theory. The algorithm is essentially as follows. On a square lattice a cell is labelled as 'infected'. Then any one of the four possible adjacent cells is randomly chosen to be infected. The pair now has six possible growth surfaces. The process continues until a cluster is formed [2, 3]. It is found that the cluster is compact [4], i.e. has a solid core. Three versions of the Eden model have been introduced [5]. In version A, a to-be-infected cell is chosen with same probability from all uninfected cells adjacent to the cluster. In version B,



(link to paper)

The cluster growth network

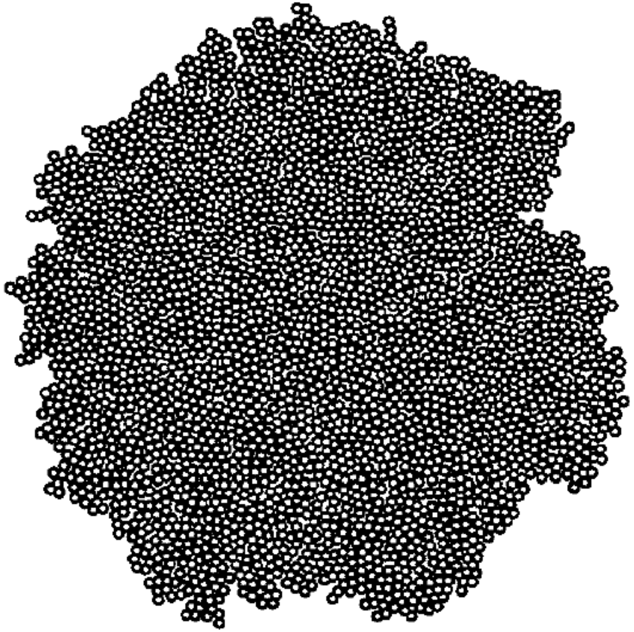


Figure 1. A cluster of 3000 cells.

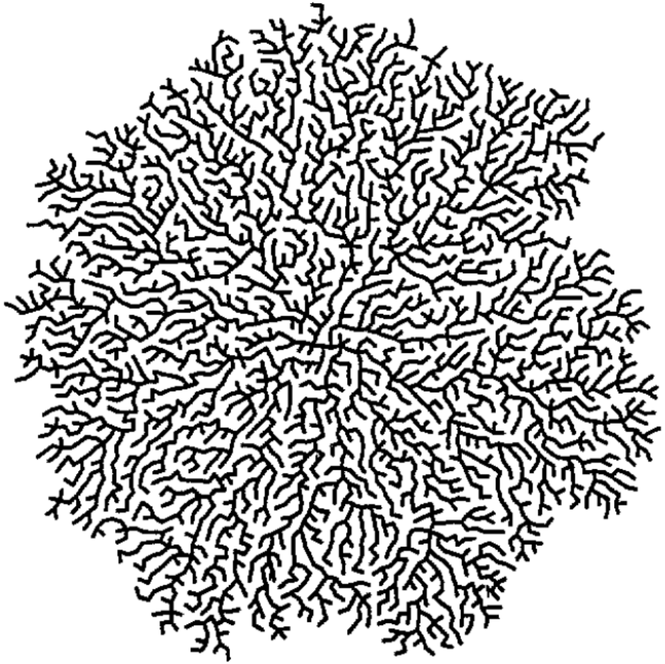


Figure 7. A growth network from figure 1.

The number of living cells in a cluster

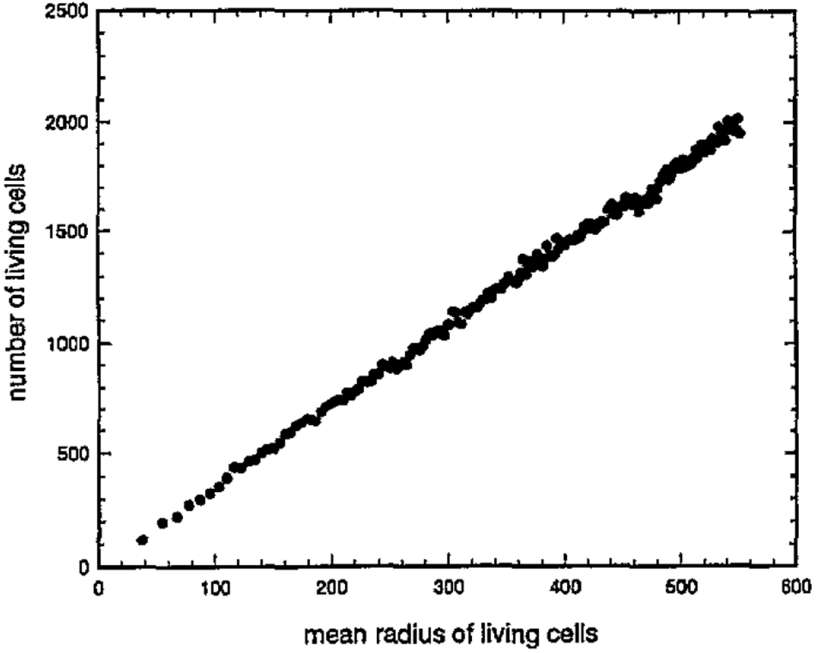


Figure 4. Number of living cells versus its mean radius (a typical sample).

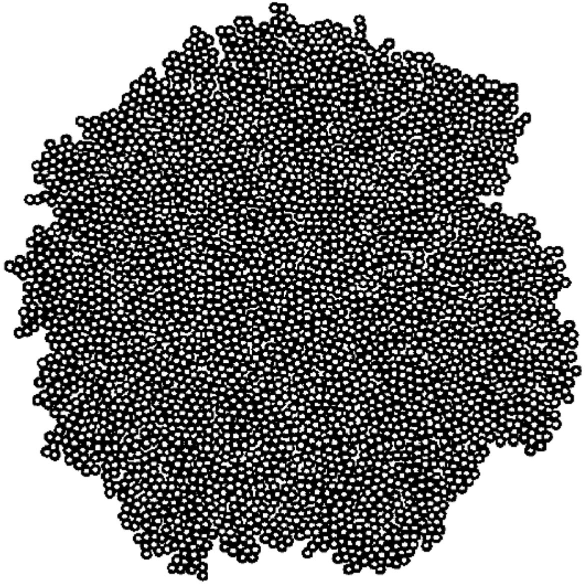
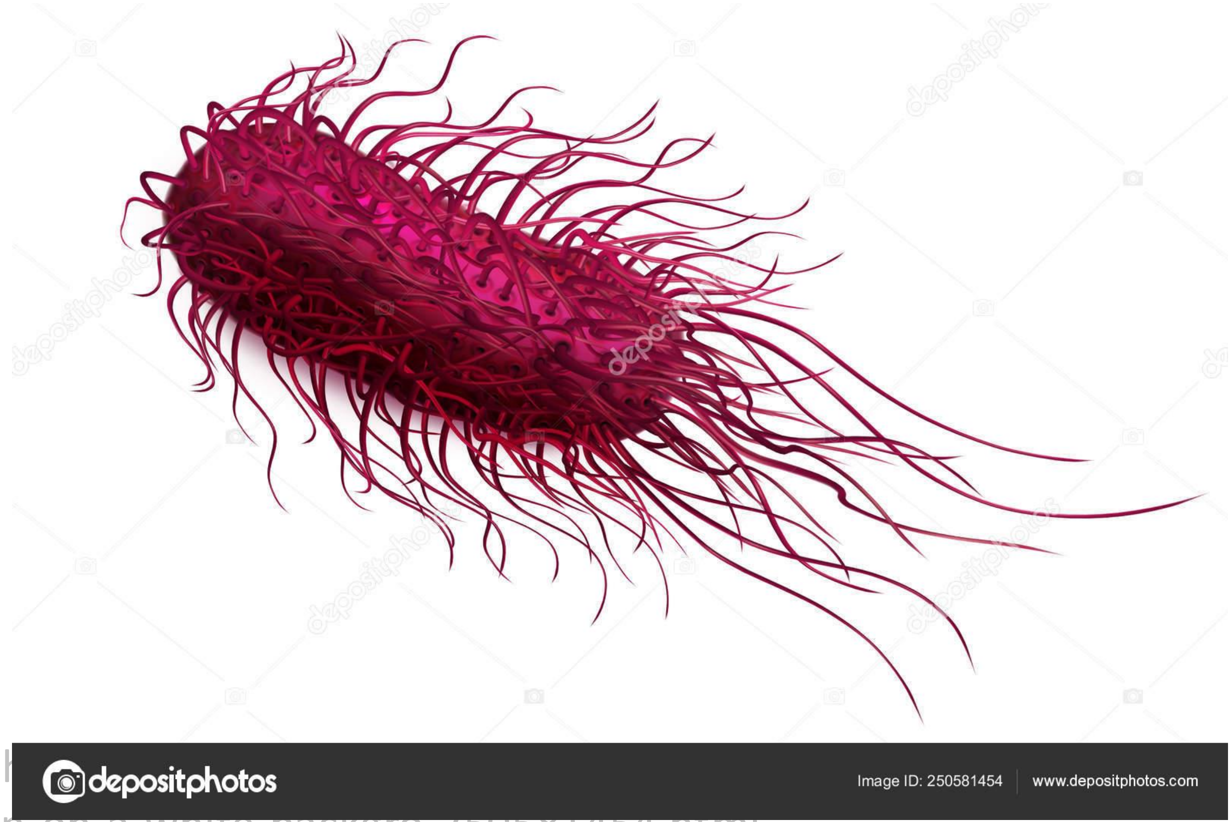


Figure 1. A cluster of 3000 cells.

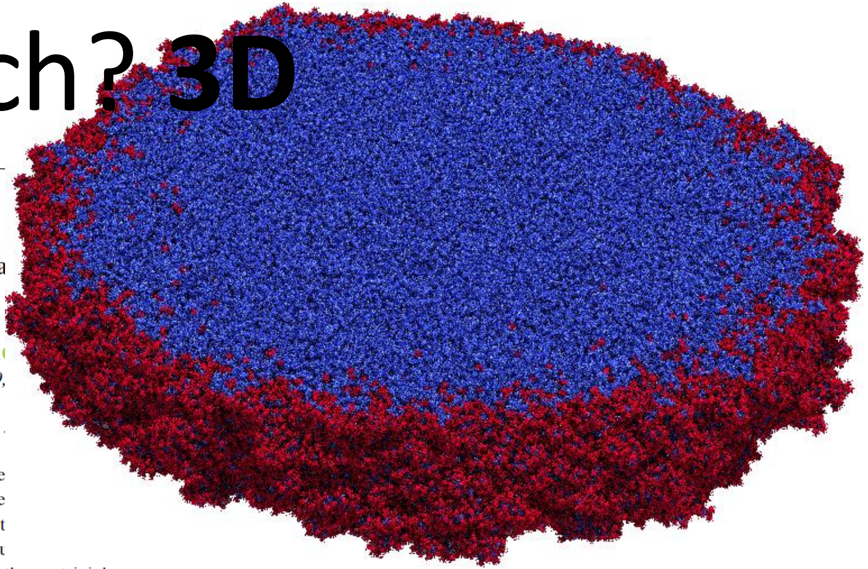
Research? **Elongated cells**



https://depositph
vector-illustration-on-a-white-backgro-250581454.html

Research? **3D**

PHYSICAL REVIEW E **111**, 014406 (2025)



Cauliflower shapes of bacterial clusters in the off-lattice Eden model for ba
in a Petri dish with an agar layer

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We develop the off-lattice Eden model to simulate the growth of bacterial colonies in the three geometry of a Petri dish. In contrast to its two-dimensional counterpart, our model takes a three set of possible growth directions and employs additional constraints on growth, which are limit to the nutrient layer. We rigorously test the basic off-lattice Eden implementation against literatu planar cluster. We then extend it to three-dimensional growth. Our model successfully demonstrates the nontrivial dependency of the cluster morphology, nonmonotonous dependency of the cluster density, and power law of the thickness of the boundary layer of clusters as a function of the nutrient layer's height. Moreover, we reveal the fractal nature of all the clusters by investigating their fractal dimensions. Our density results allow us to estimate the basic transport properties, namely, the permeability and tortuosity of the bacterial colonies.

DOI: 10.1103/PhysRevE.111.014406

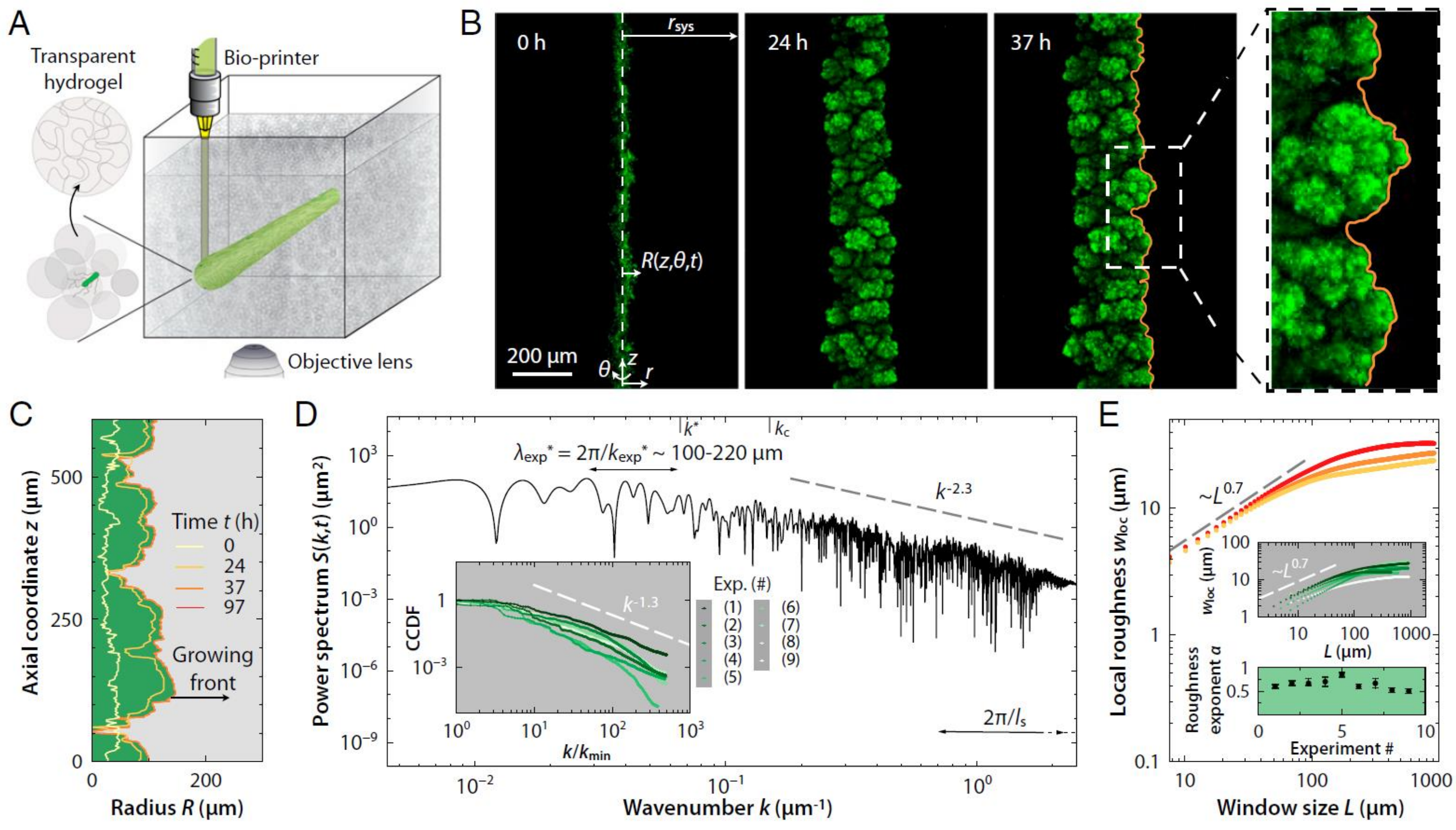
I. INTRODUCTION

Despite their microscopic size, bacteria play fundamental roles in many biological, ecological, and industrial processes. Their ability to grow and adapt rapidly makes them the

an experimental instrument that allows the growth and study of bacterial colony structures in the laboratory. It is a standard closed glass container that allows observation and control of bacterial growth under laboratory conditions.

In this study, we develop a simple model for the growth

https://journals.aps.org/pre/abstract/10.1103/PhysRevE.111.014406



A. Martínez-Calvo et al., Morphological instability and roughening of growing 3D bacterial colonies, Proc. Natl. Acad. Sci. USA 119, e2208019119 (2022)

Your task

Your task in the lab

Write a **single prompt** that implements program that produces **all results** from the paper:
CY Wang, PL Liu and JB Bassingthwaightes, Off-lattice Eden-C cluster growth model, Phys. *A Math. Gen. 28 (1995) 2141-2147* (link to paper)

Extra 1: Generalize to elongated bacteria shape (keep **single prompt**).

Extra 2: Generalize to 3D (keep **single prompt**).

Report: 1) single prompt, 2) output program, 3) results plots