Stringy growth by Bacterial Species *Bacillus subtilis*

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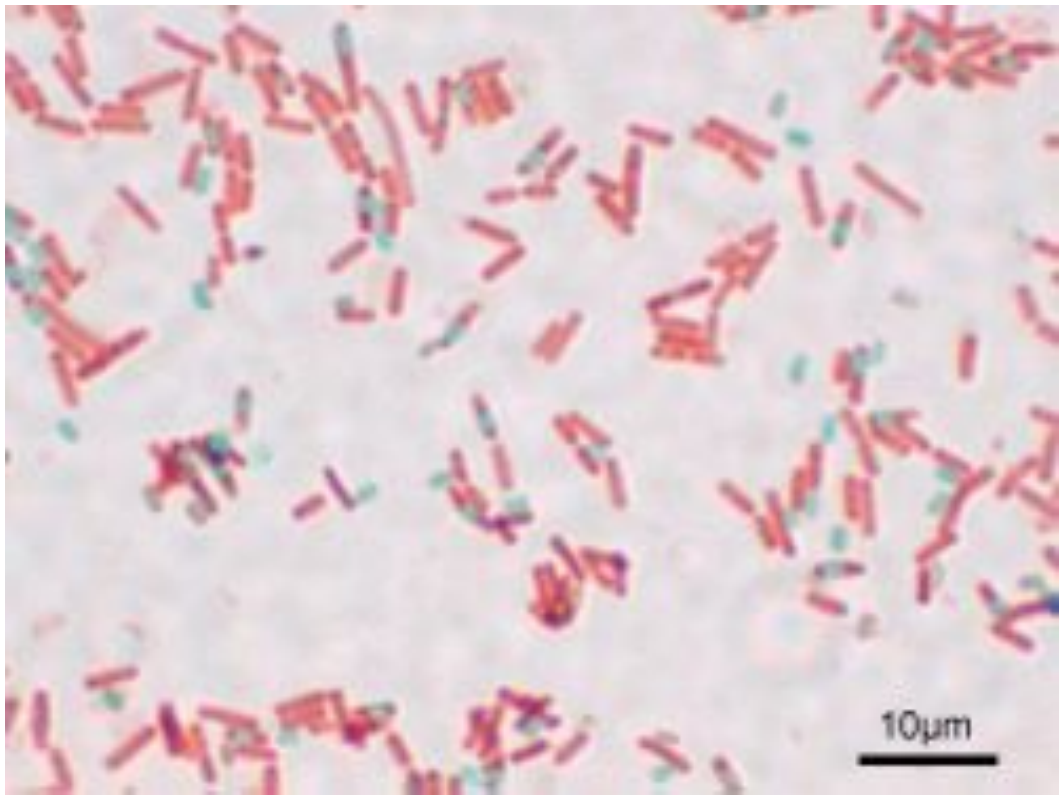
What is *Bacillus subtilis* ?

- The name of *"bacillus subtilis"* is derived from *Latin* , and the mean a narrow stick.



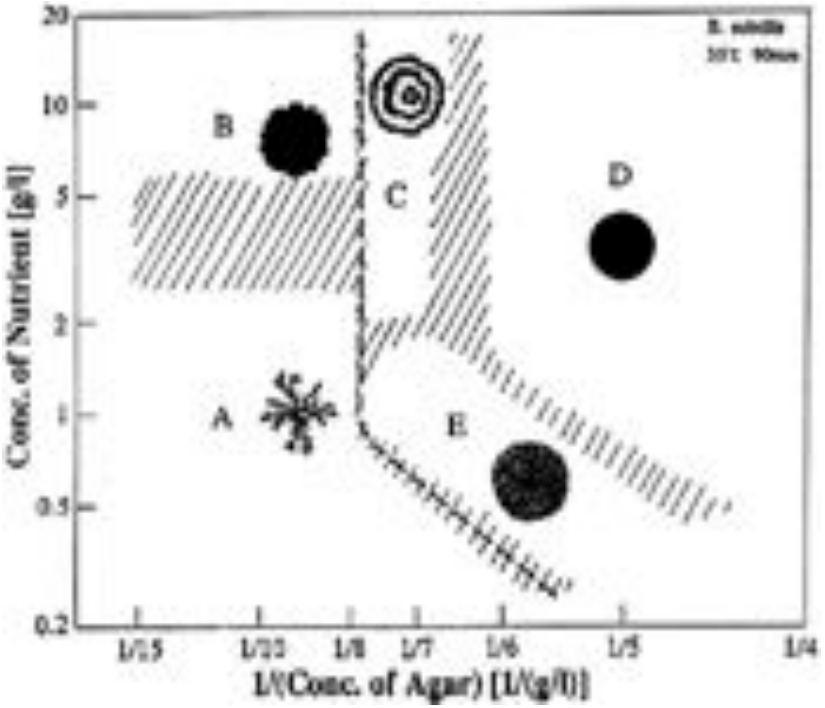
What is bacillus subtilis ?

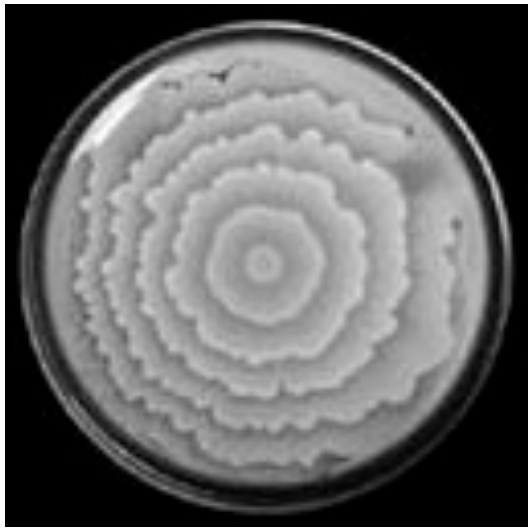
- 0.7-0.8 × 2-3 μm
- Aerobic
- Heat-resisting property
- Inhabiting a natto

Japanese food “natto”

Characteristics of bacteria

- Groups of some spiecies of bacteria form various colonies depending on both nutrient concentration C_n and agar concentration C_a.





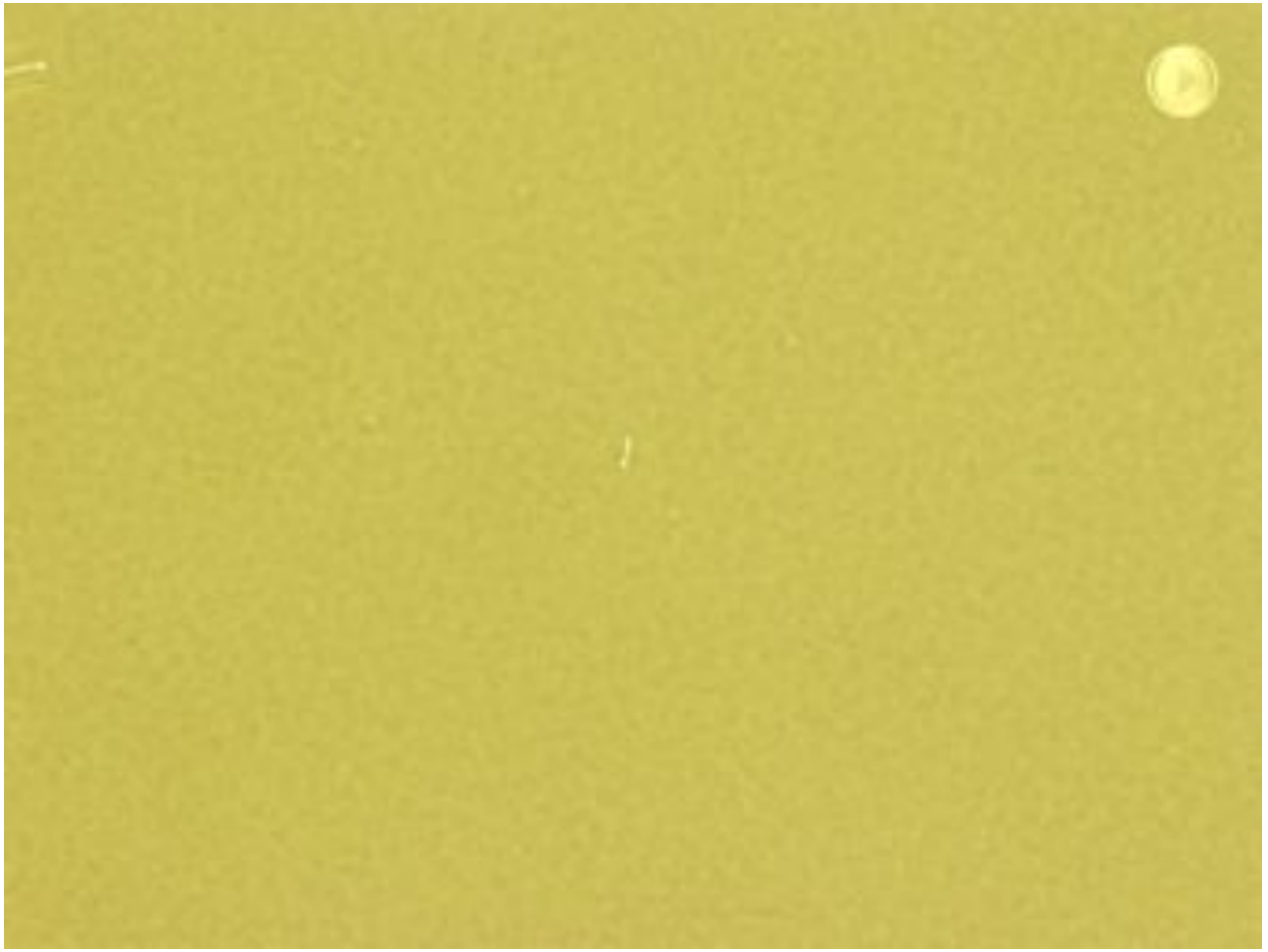
Interesting case

- There are lots of results of experiment of forming colonies as group behavior.
- what will becomes of growth starting at a bacteria? If I can observe it's characteristic growth, I want to make it modeling.

Experiment method

- I inoculated bacillus subtilis on the agar medium and attached it to microscope table keeping about 38 degrees.
- I photographed bacterial growth state with time-lapse mode.

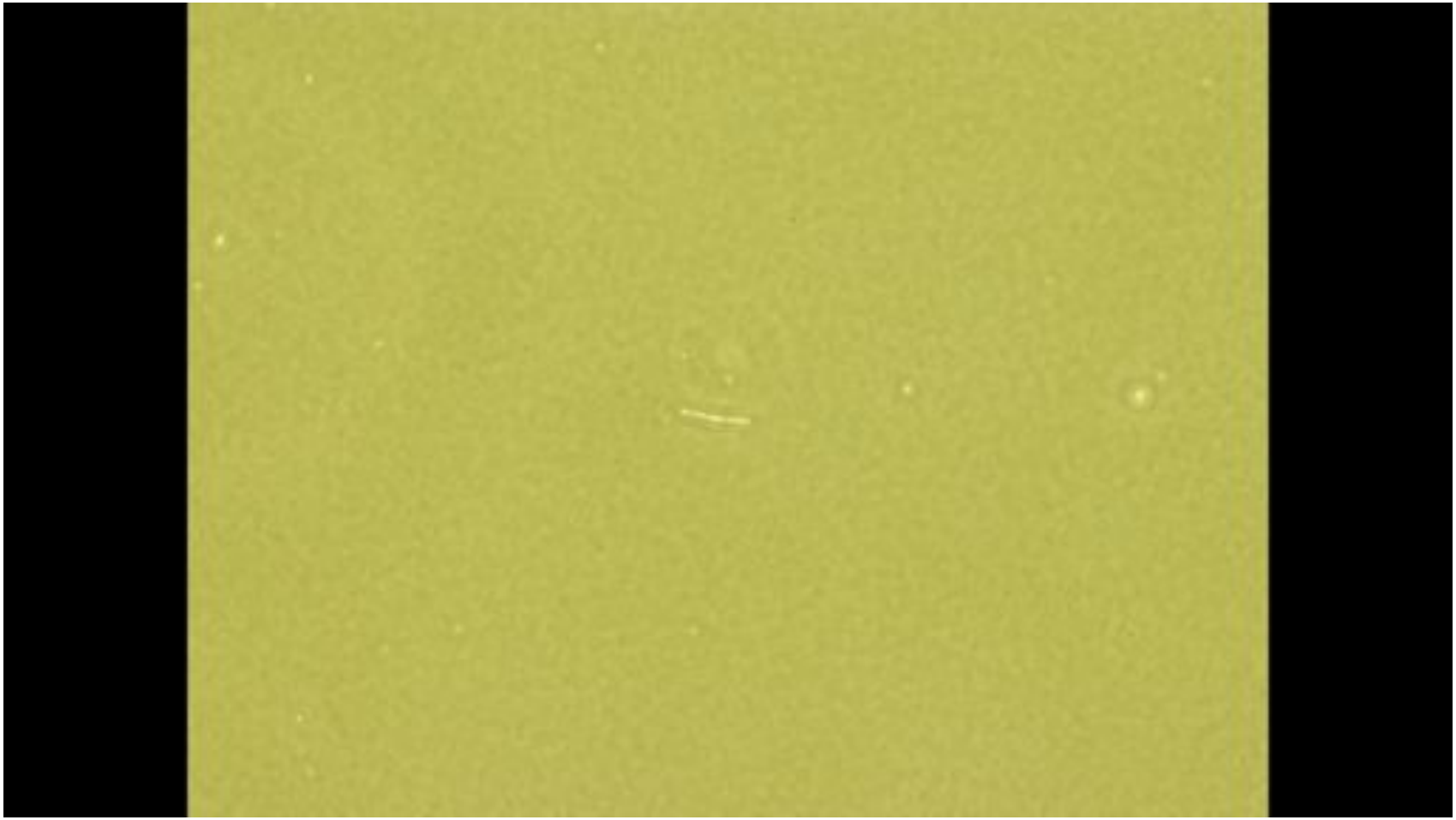
Movie 1



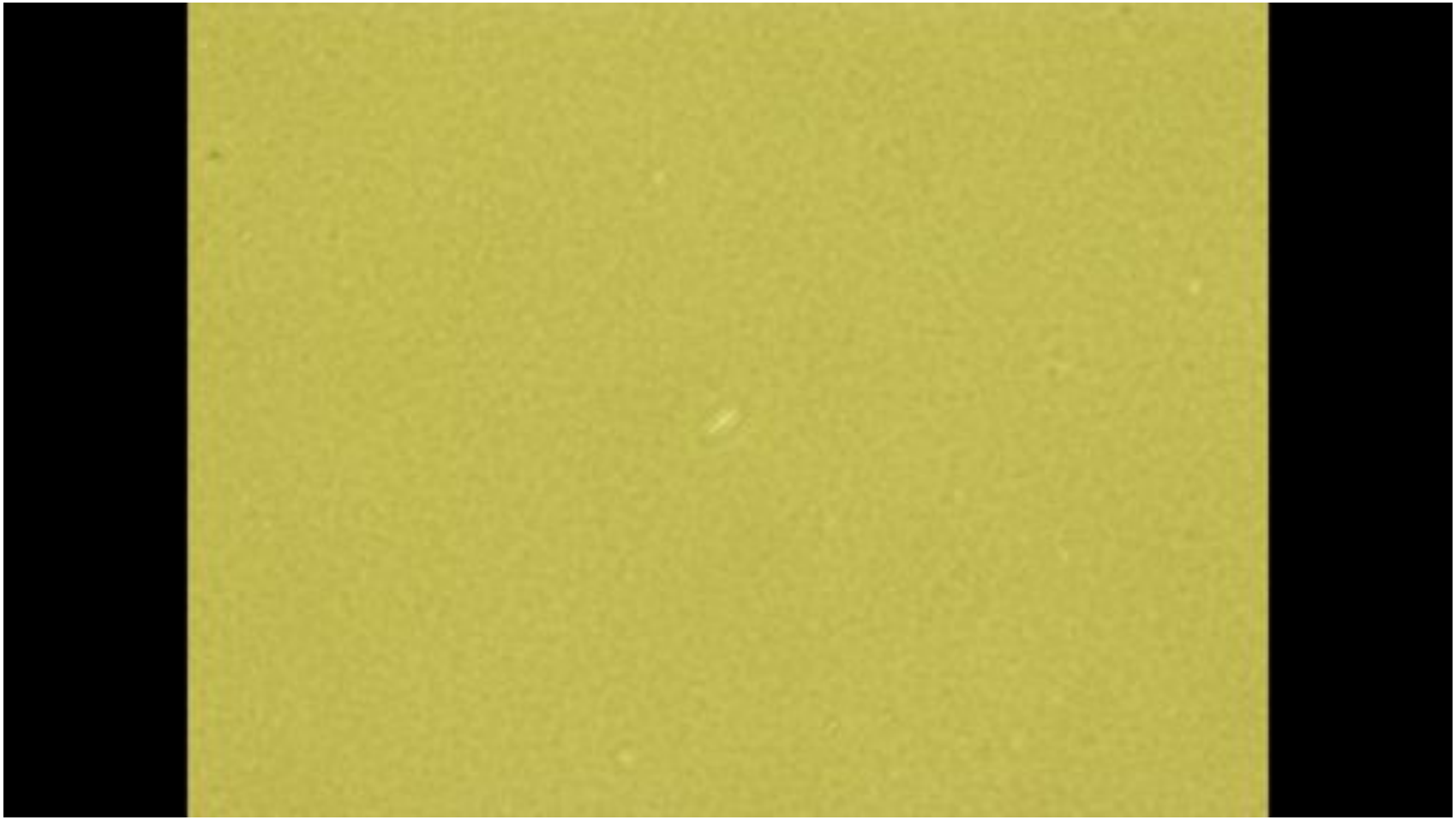
Illustrated in Movie 1

- Approximately, the process occurs in two steps.
- The first step is they are extended stringy without cutting off themselves and increase double line.
- The second step is a center of bacterial groups overlapping each other are expanded in a plane, as thrusting outward.

Movie 2

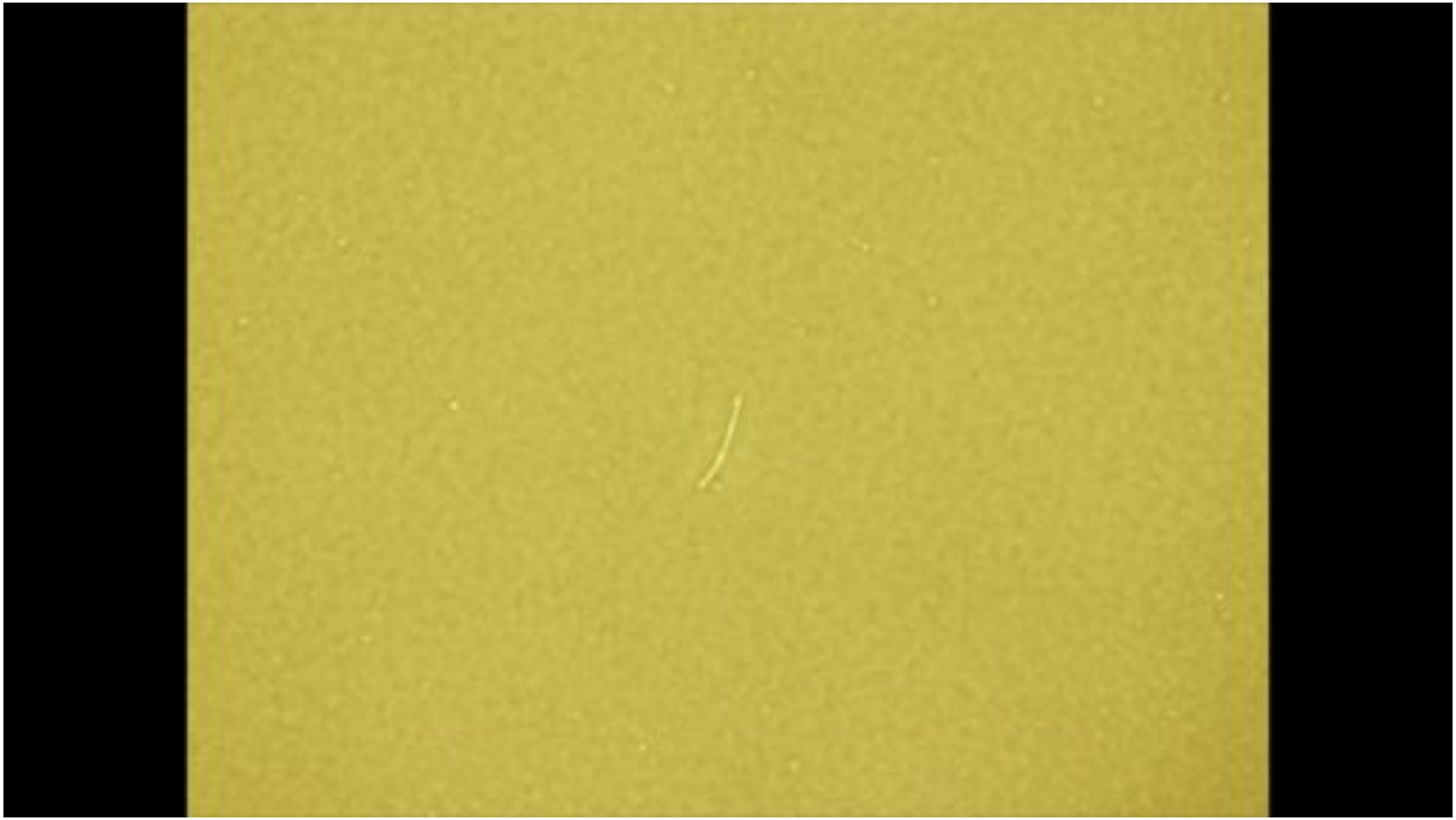


Movie 3



Movie 4

Movie 5



Simple model

- Step : t = 0,1,2, …
- Bacterial length : $l(t) = 2^t$
- Growing speed: $v(t) = \{ l(t) - l(t-1) \} / 2$

$$= (2^t - 2^{t-1}) / 2$$

$$= 2^{t-2}$$

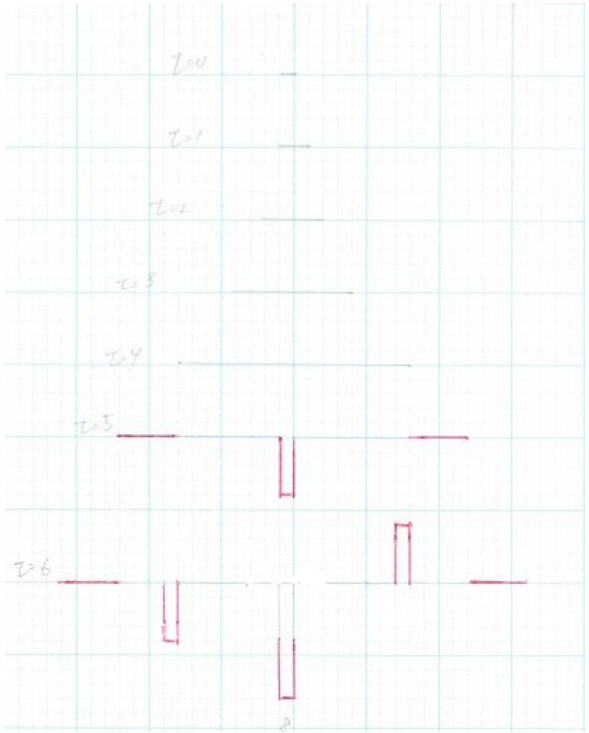
- Thresould value : $v_0 = 4$

Drowing pictures

- The point is two.

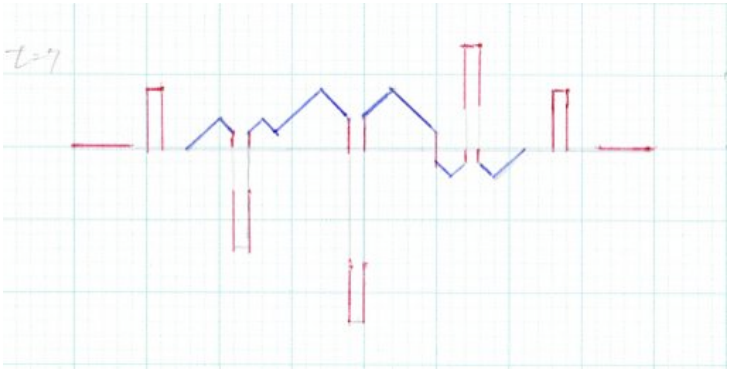
①l(t) is incresacing likely exponential function.

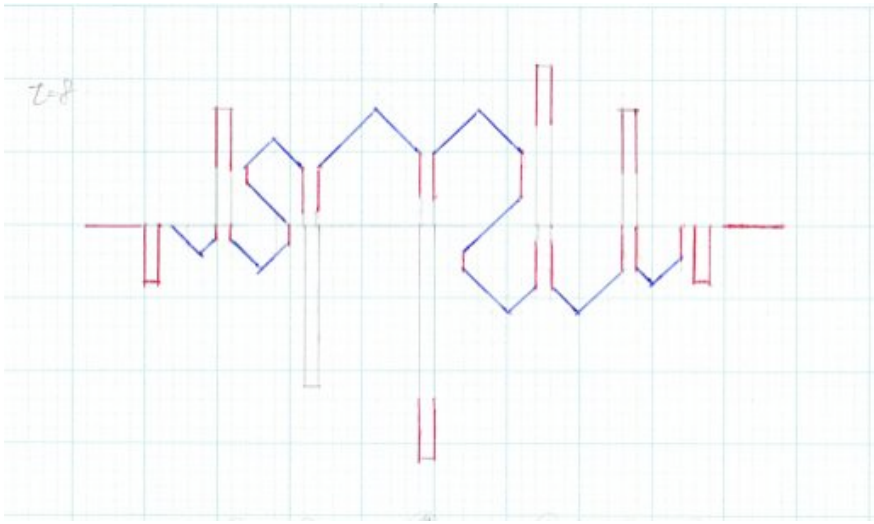
②v(t) is limited by resistance of agar medium.



Drawing pictures

- l(t=7),l(t=8) pictures
- l(t) is folded up and increase double lines.
- They are extended stringy without cutting off themselves.

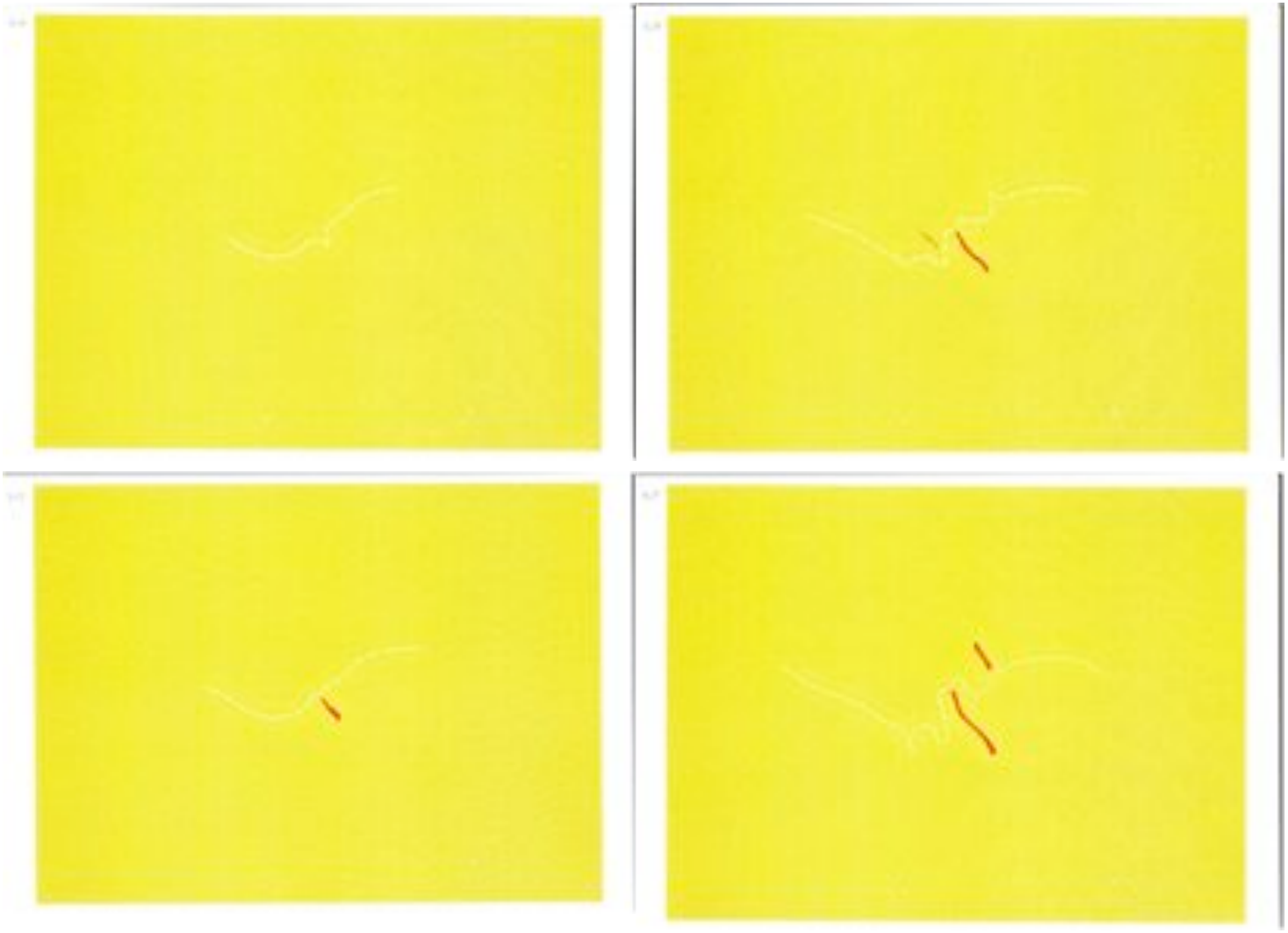




Consideration

- Now I have studied the first step.
- I think there are relation between the overall length of bacterial groups and the number of double line for time course.
- The second step is the interface growth and forming colonies, so it needs to other modeling.

Ovservation of double line



Observation of doubleline