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*“I, at any rate, am convinced that He does not play dice.”*

Albert Einstein

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- Four examples from *B. subtilis***
- Growth versus competence
  - Swimming versus chaining
  - Eating versus being eaten
  - Community versus individuality

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### 1. Growth versus Competence

*B. subtilis* enters a state of “competence” in which it can take up DNA.

Entry into competence is controlled by **ComK**, whose synthesis is governed by a noise-driven stochastic switch.

*David Dubnau and others*

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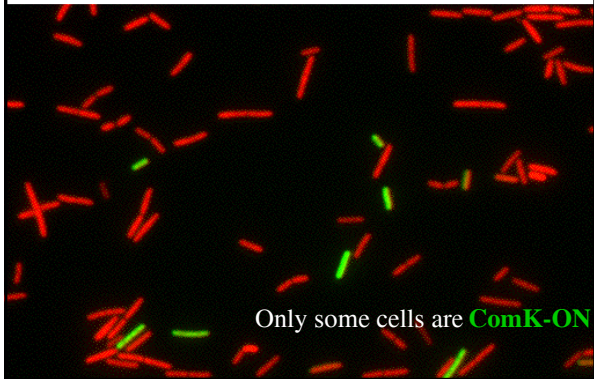
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Cells with **GFP** fused to a **ComK**-controlled promoter



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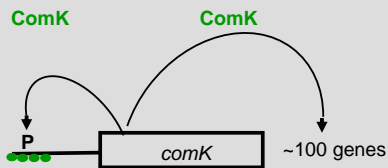
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*comK* is controlled by a positive feedback loop in which **ComK** stimulates transcription of its own gene.

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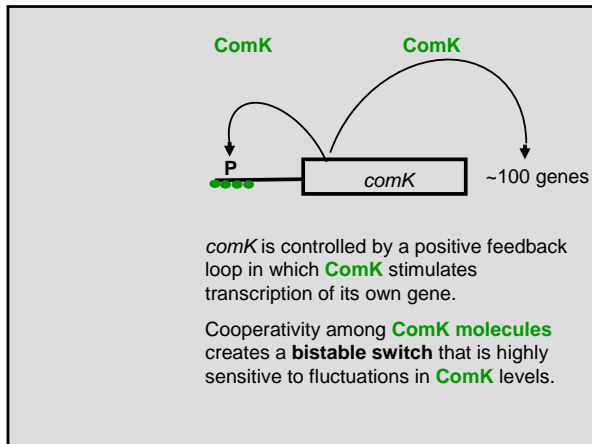
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## 2. Motility versus chaining

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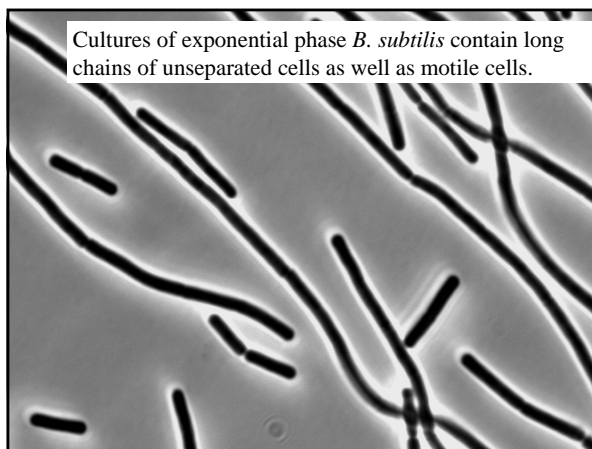
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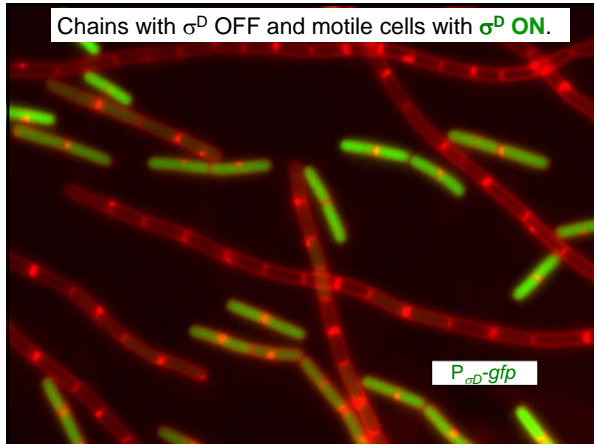
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### 3. Eating versus being eaten

When starved for nutrients, *B. subtilis* enters the pathway to sporulate.

Entry is governed by a master regulatory protein called **Spo0A**.

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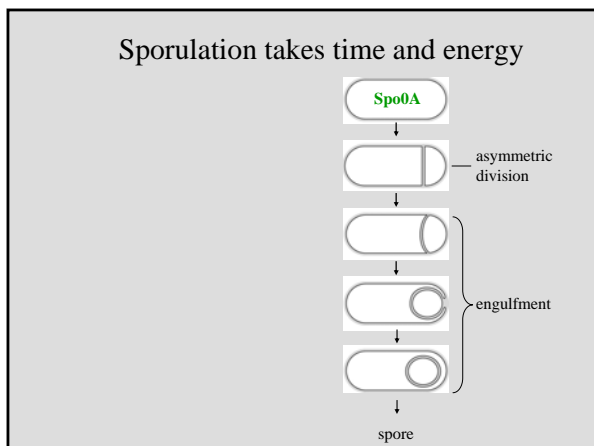
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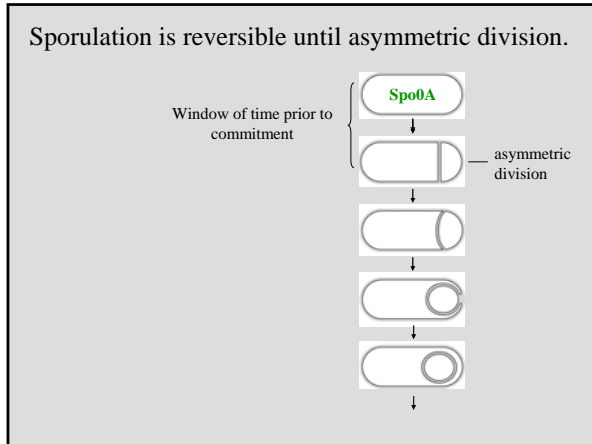
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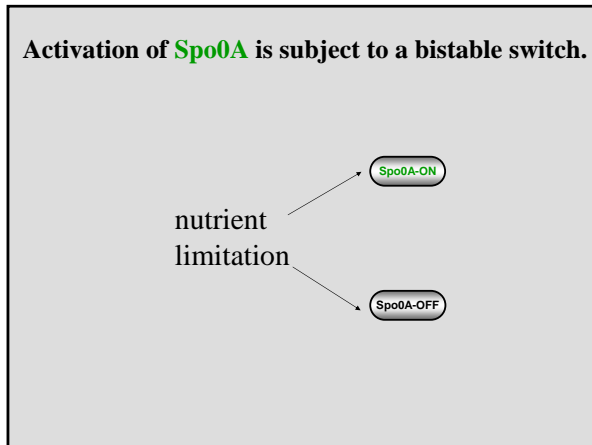
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Why is Spo0A subject to a bistable switch?

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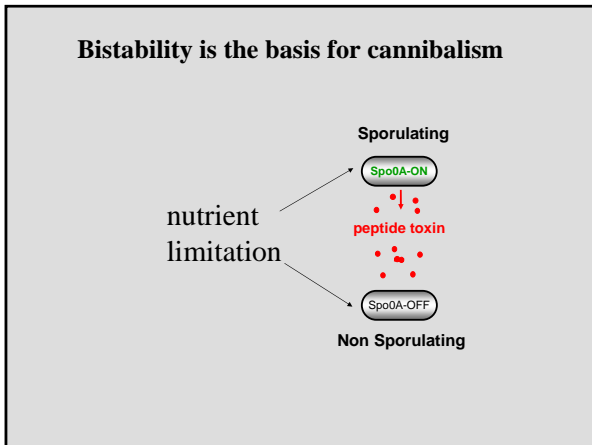
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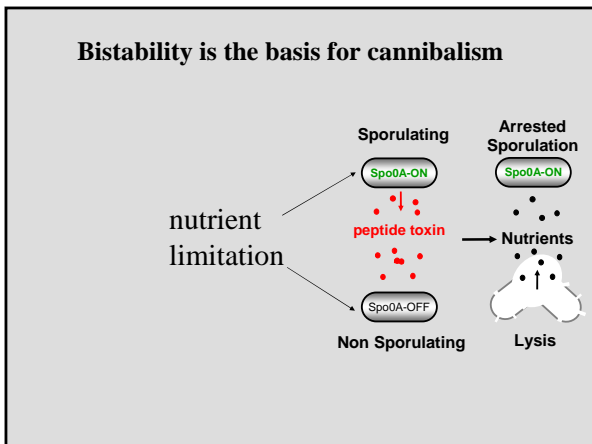
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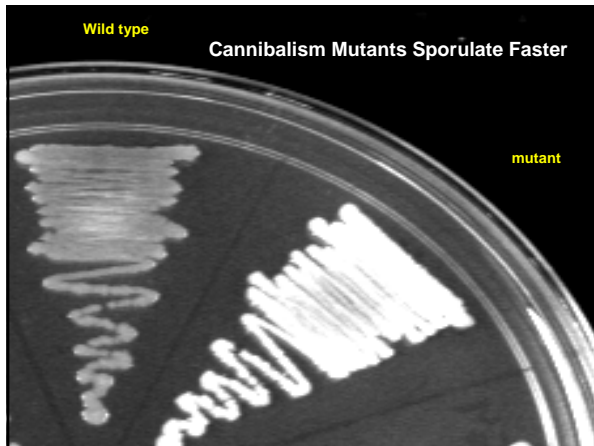
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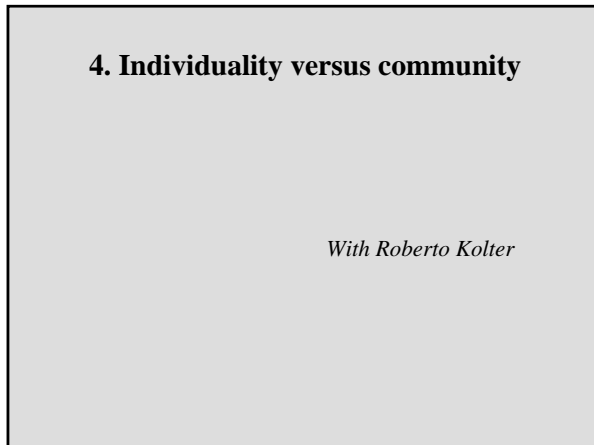
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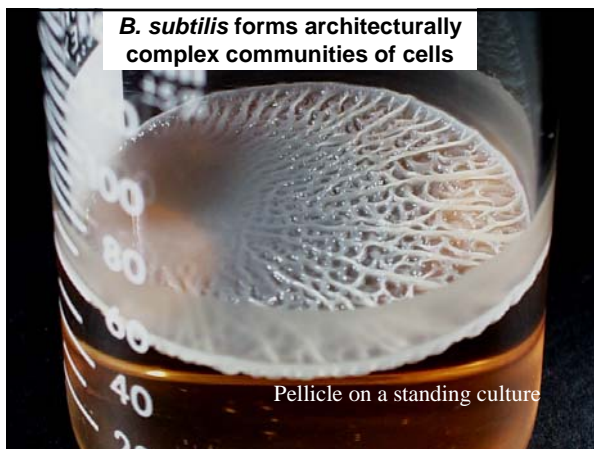
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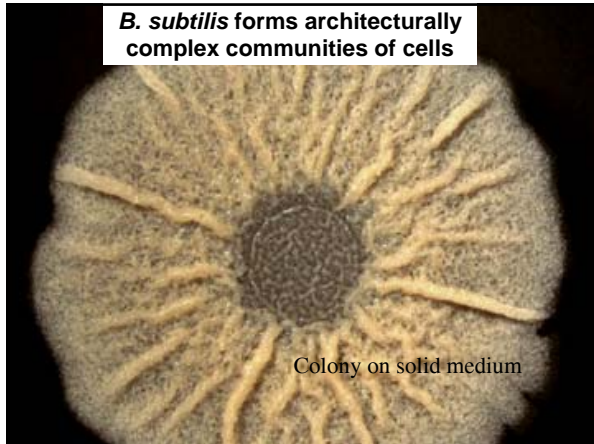
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Cells in the biofilm are held together by an **extracellular matrix**.

The matrix consists of **polysaccharide** and **protein**.

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Matrix production is controlled by **Spo0A!**

**Spo0A** → anti-repressor → repressor → matrix

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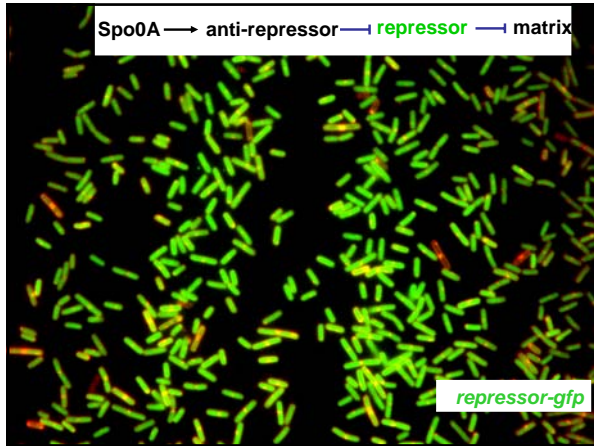
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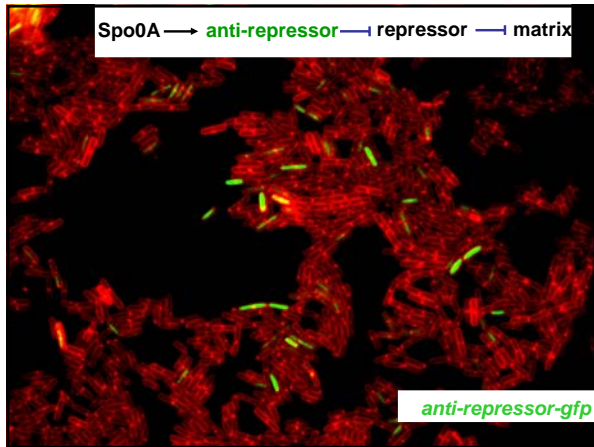
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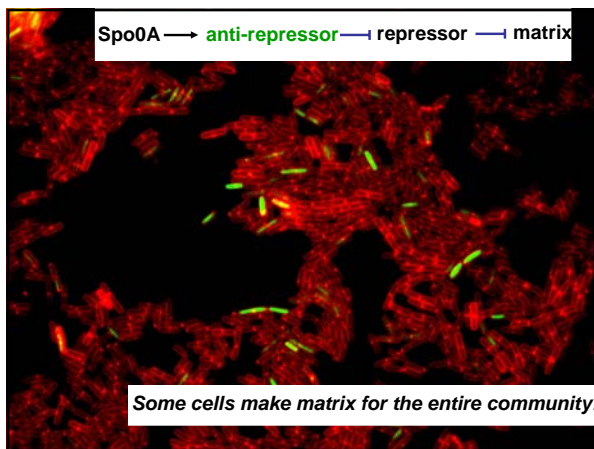
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Stochasticity is not unique to bacteria.

Consider the mouse olfactory neuron and the eye of the fly!

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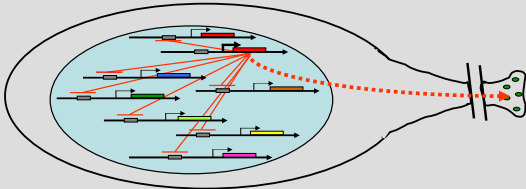
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Mouse olfactory neuron



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The eye of the fly consists of many clusters of light-sensitive cells called ommatidia.

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The eye of the fly consists of many clusters of light-sensitive cells called ommatidia.

Ommatidia produce either of two color-sensitive rhodopsins, **rh5** or **rh6**.

The choice is stochastic!

*The work of Claude Desplan*

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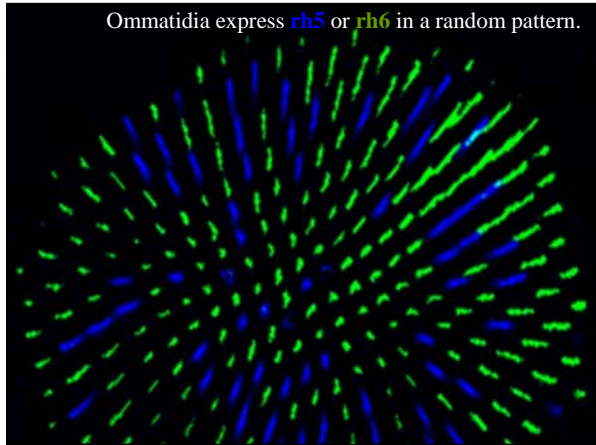
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Nature knows how to make deterministic decisions, but, in contrast to Einstein's view of the universe, she also knows how to leave certain decisions to a roll of the dice.

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