

Foundations in Microbiology

Fifth Edition

Talaro

Chapter

7



Elements of Microbial Nutrition, Ecology and Growth

Chapter 7

Environmental influences on microbial growth

- temperature
- oxygen requirements
- pH
- electromagnetic radiation
- barometric pressure

3 cardinal temperatures

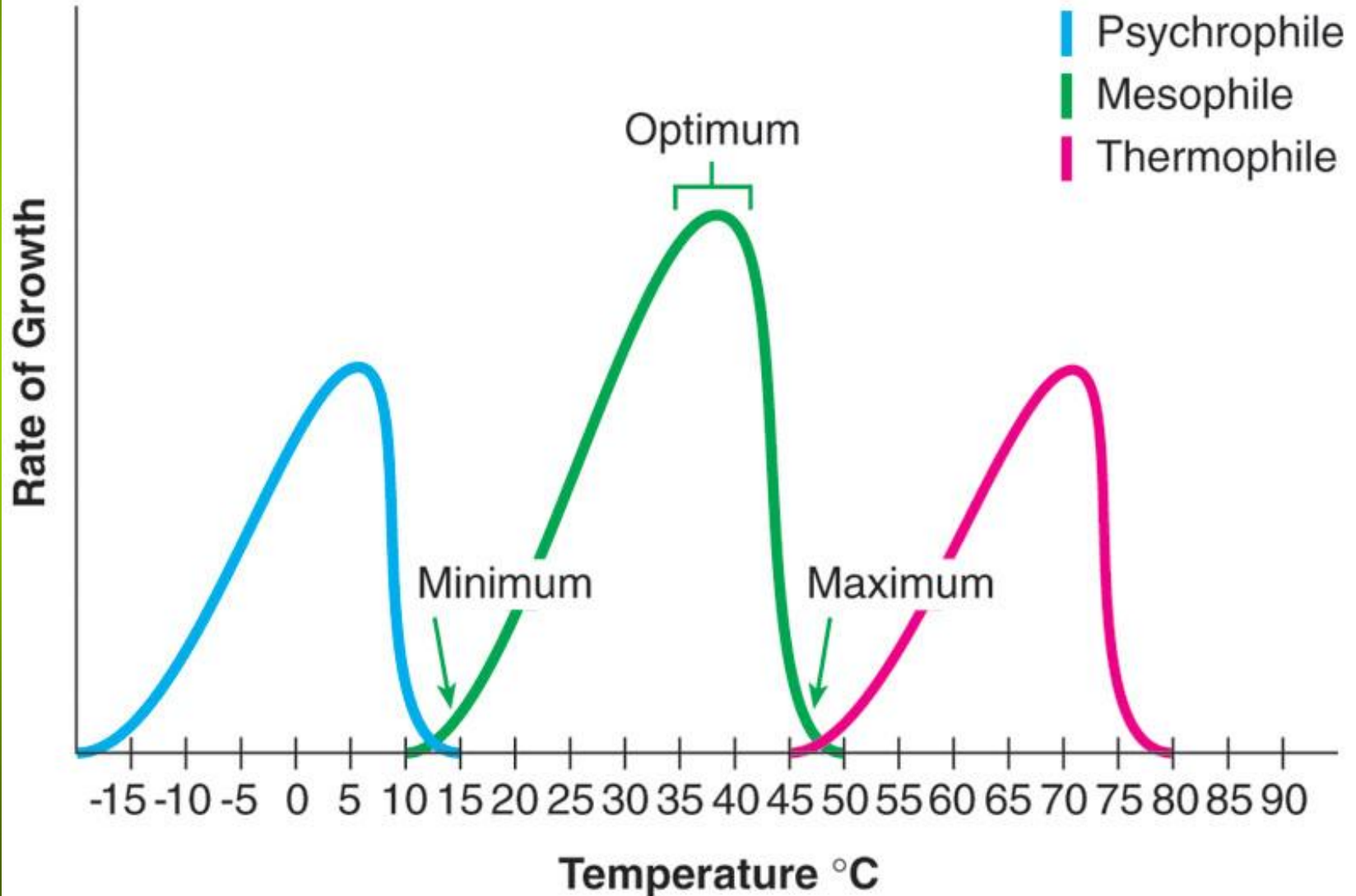
- **Minimum temperature** – lowest temperature that permits a microbe's growth and metabolism
- **Maximum temperature** – highest temperature that permits a microbe's growth and metabolism
- **Optimum temperature** – promotes the fastest rate of growth and metabolism

3 temperature adaptation groups

1. **Psychrophiles** – optimum temperature below 15°C, capable of growth at 0°C
2. **Mesophiles** – optimum temperature 20°-40°C, most human pathogens
3. **Thermophiles** – optimum temperature greater than 45°C

3 temperature adaptation groups

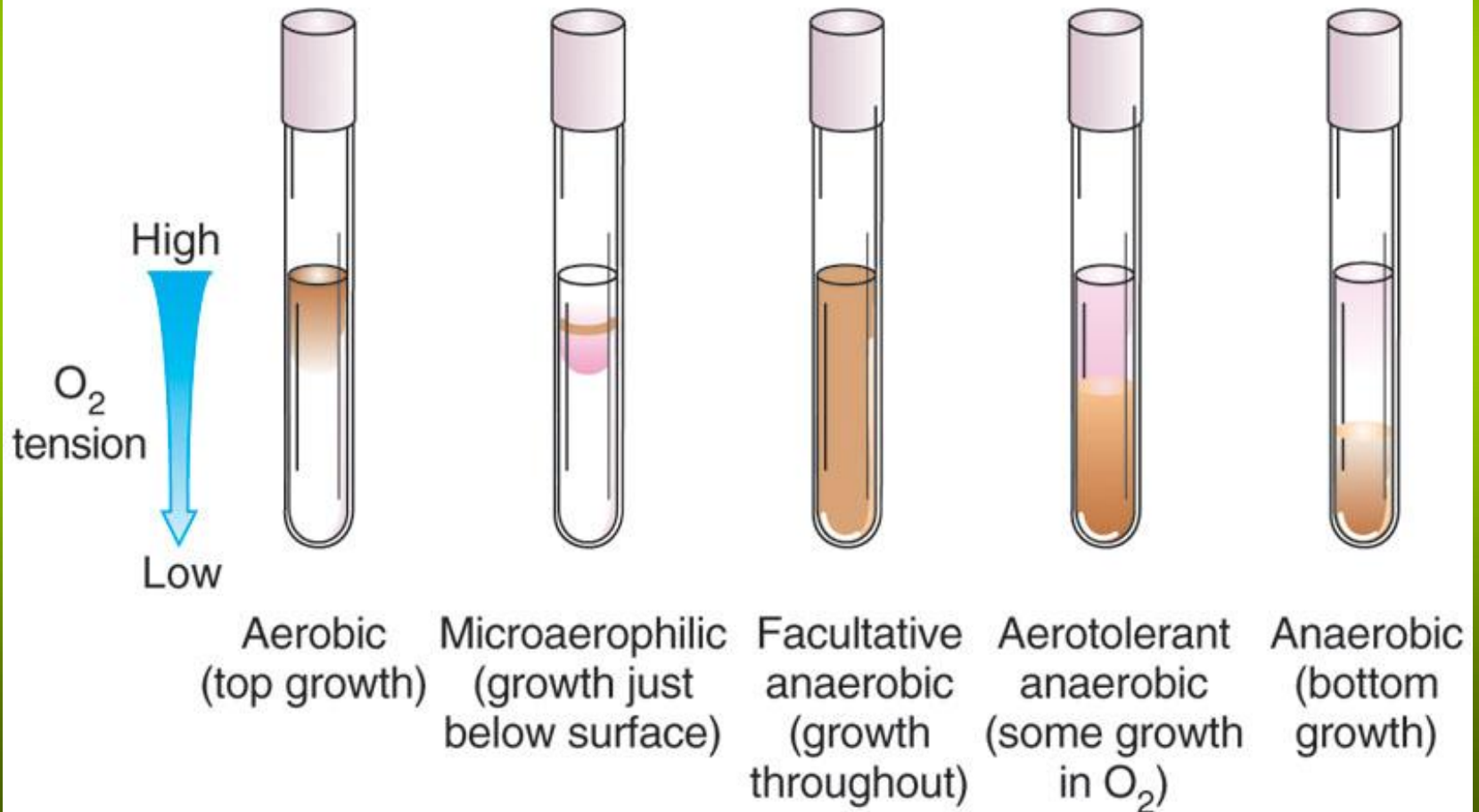
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Oxygen requirements

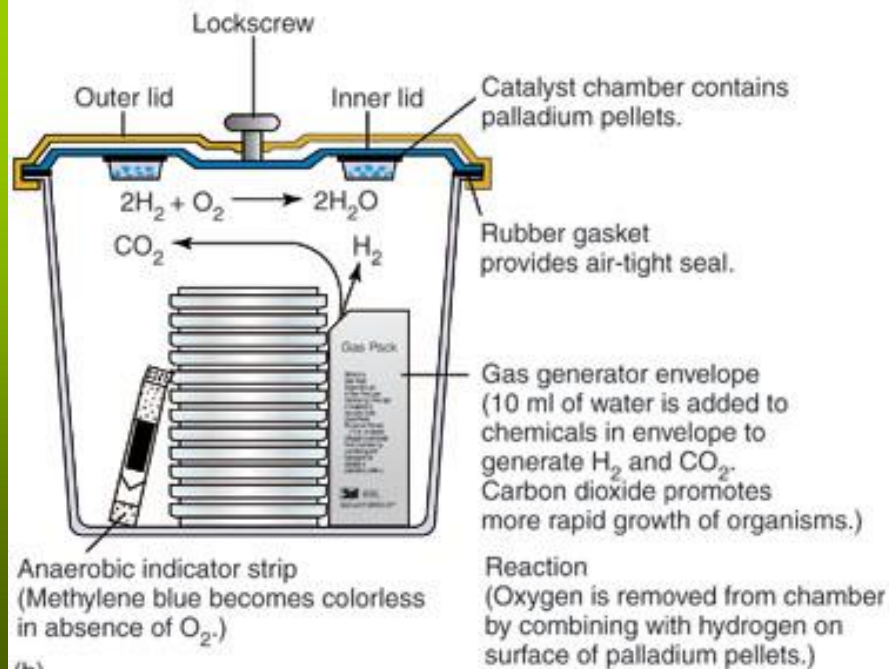
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Demonstration of Oxygen Requirements





(a)



(b)

Microbial associations

- Symbiotic – organisms live in close nutritional relationships; required by one or both members
 - **Mutualism** – obligatory, dependent; both members benefit
 - **Commensalism** – commensal member benefits, other member not harmed
 - **Parasitism** – parasite is dependent and benefits; host is harmed

Microbial associations

- Non-symbiotic – organisms are free-living; relationships not required for survival
 - **Synergism** – members cooperate and share nutrients
 - **Antagonism** – some member are inhibited or destroyed by others

Binary Fission

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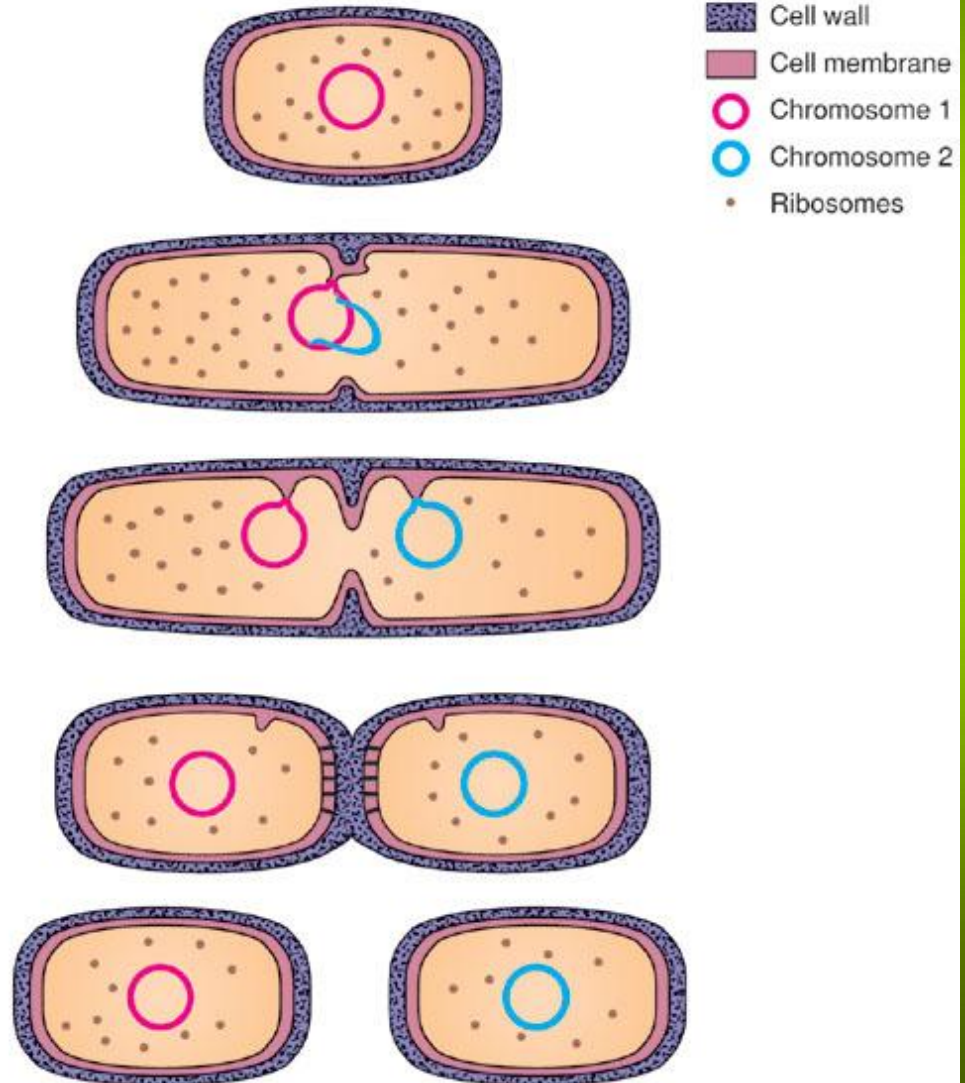
(a) A young cell at early phase of cycle.

(b) A parent cell prepares for division by enlarging its cell wall, cell membrane, and overall volume. Midway in the cell, the wall develops notches that will eventually form the transverse septum, and the duplicated chromosome becomes affixed to a special membrane site.

(c) The septum wall grows inward, and the chromosomes are pulled toward opposite cell ends as the membrane enlarges. Other cytoplasmic components are distributed (randomly) to the two developing cells.

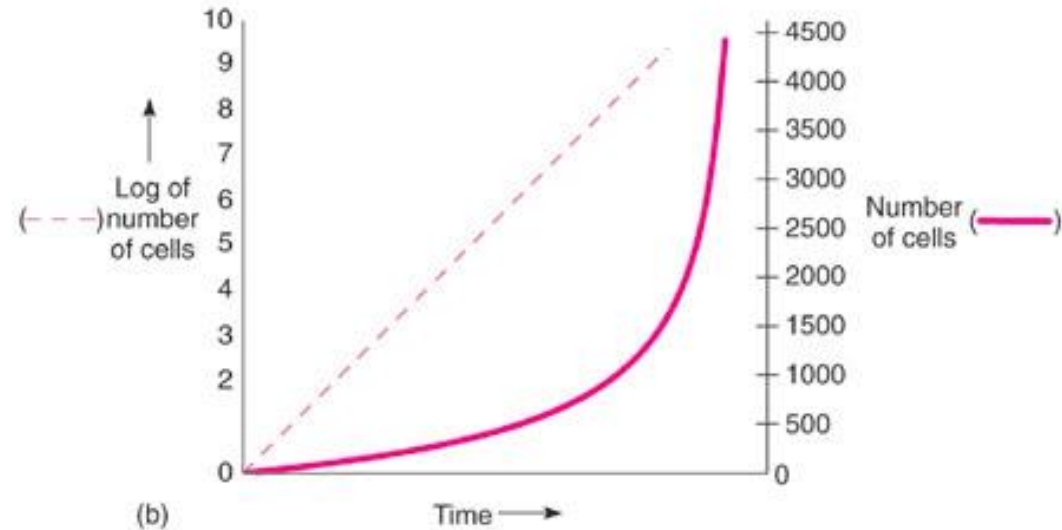
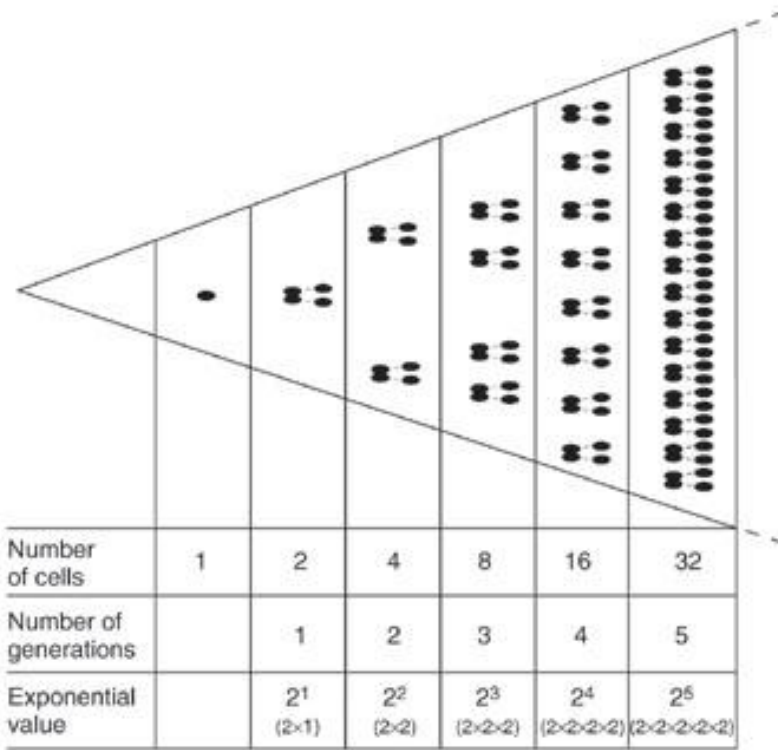
(d) The septum is synthesized completely through the cell center, and the cell membrane patches itself so that there are two separate cell chambers.

(e) At this point, the daughter cells are divided. Some species will separate completely as shown here, while others will remain attached.



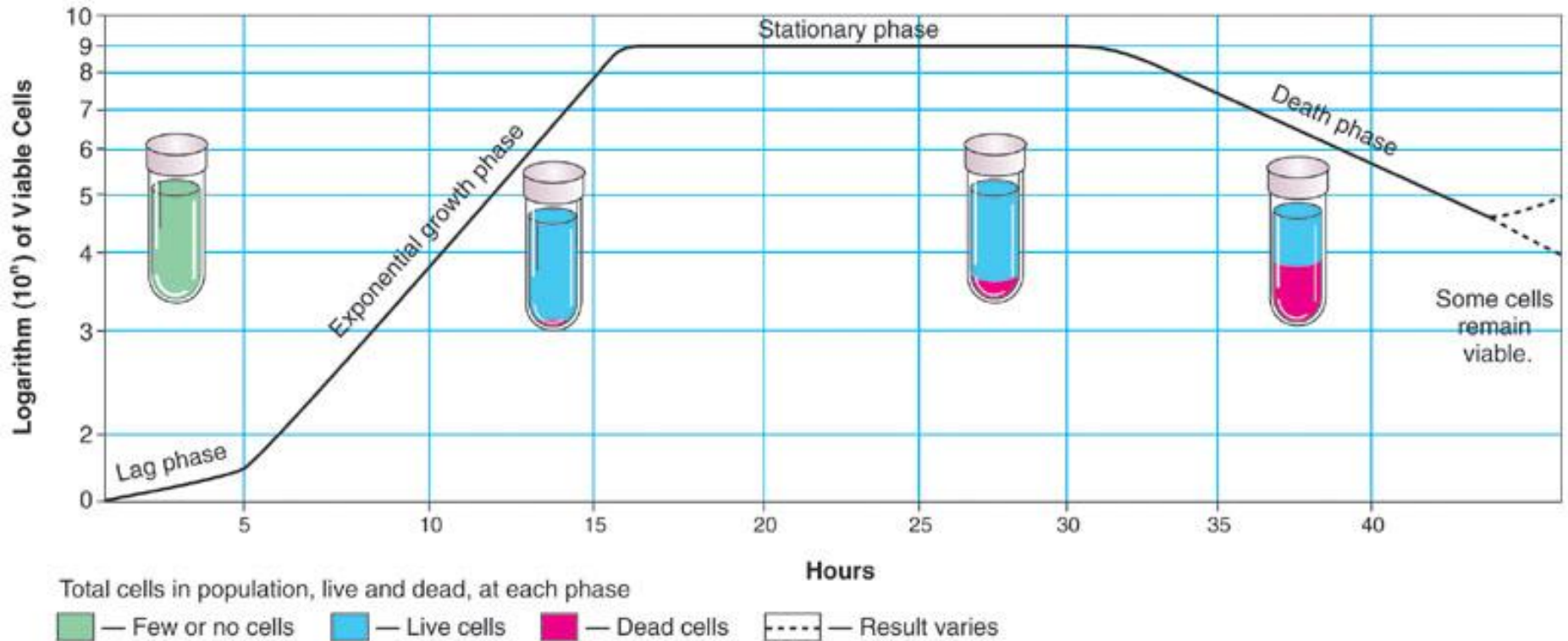
Population growth

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Growth curve

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Growth curve

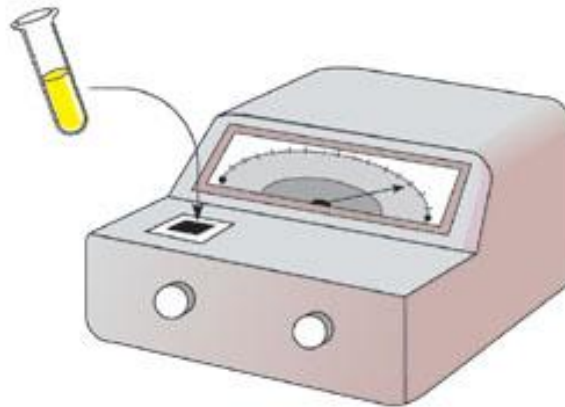
1. **Lag phase** – “flat” period of adjustment, enlargement; little growth
2. **Exponential growth phase** – a period of maximum growth will continue as long as cells have adequate nutrients & a favorable environment
3. **Stationary phase** – rate of cell growth equals rate of cell death cause by depleted nutrients & O₂, excretion of organic acids & pollutants
4. **Death phase** – as limiting factors intensify, cells die exponentially in their own wastes

Turbidity

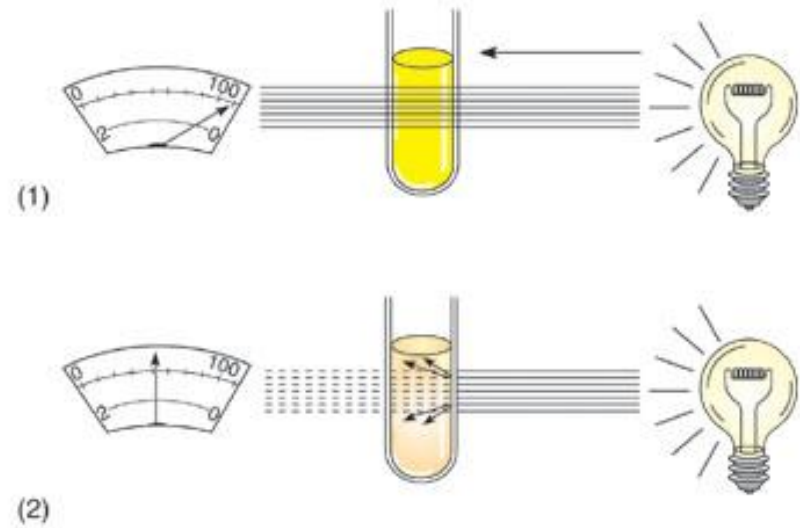
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(a)

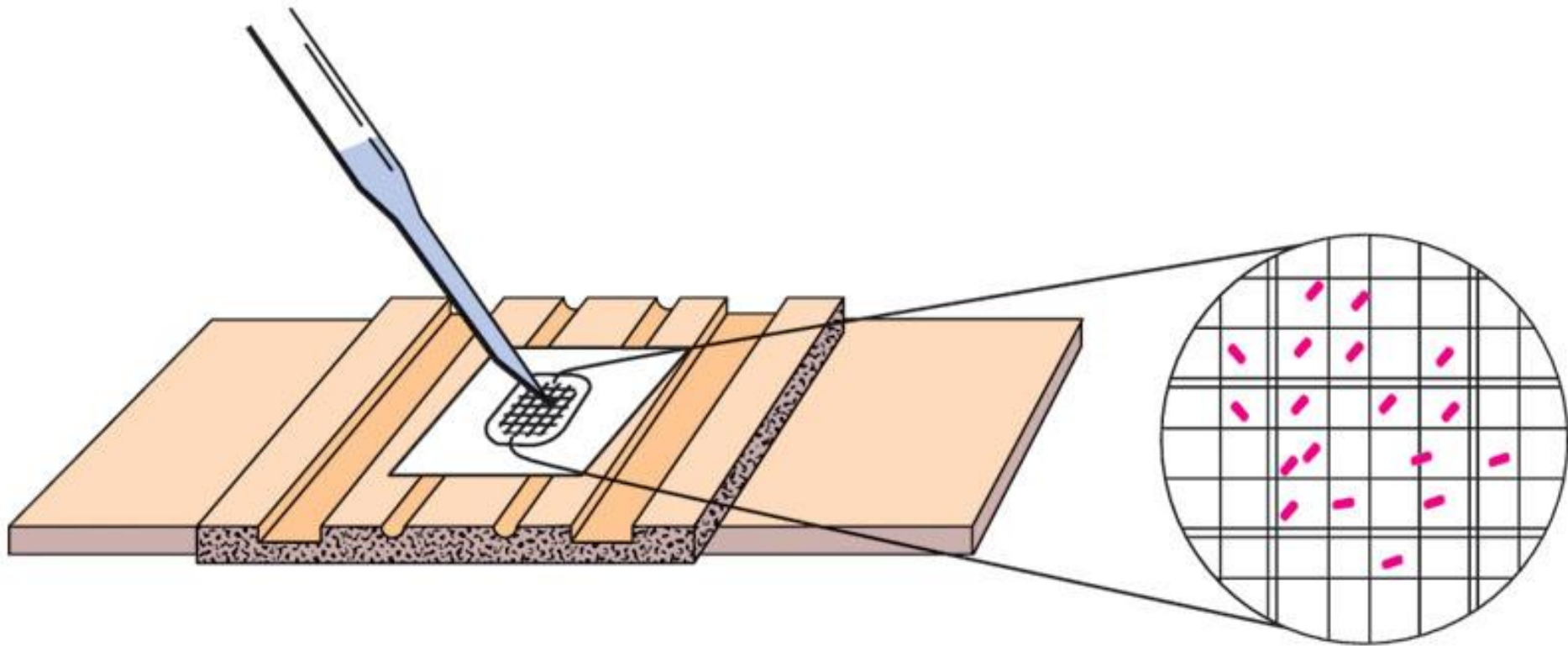


(b)



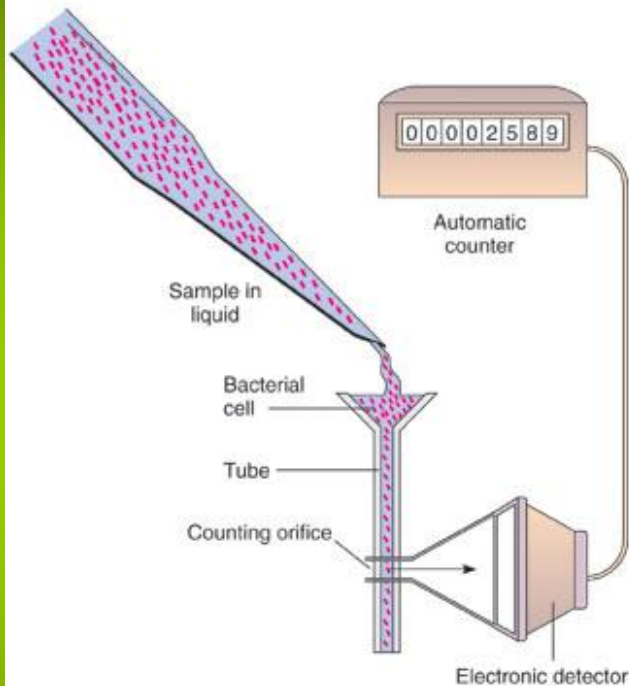
Direct microscopic count

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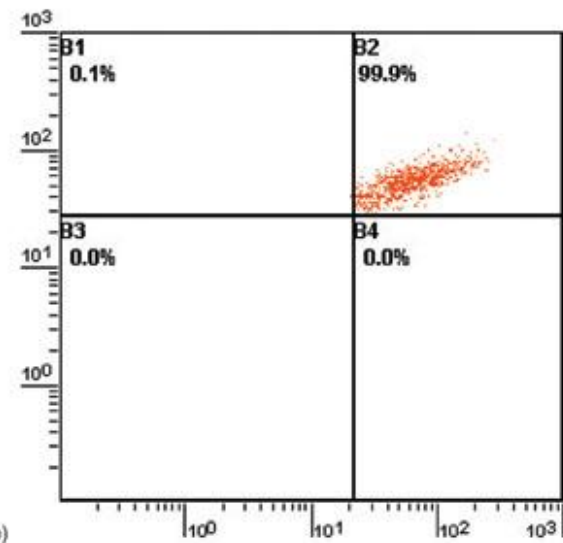
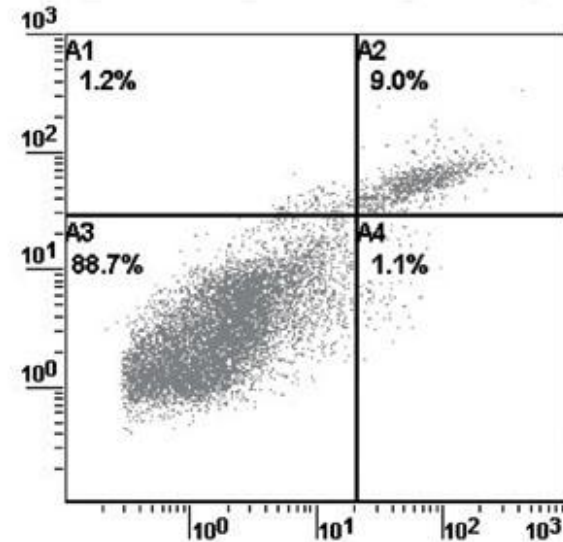
Electronic counting

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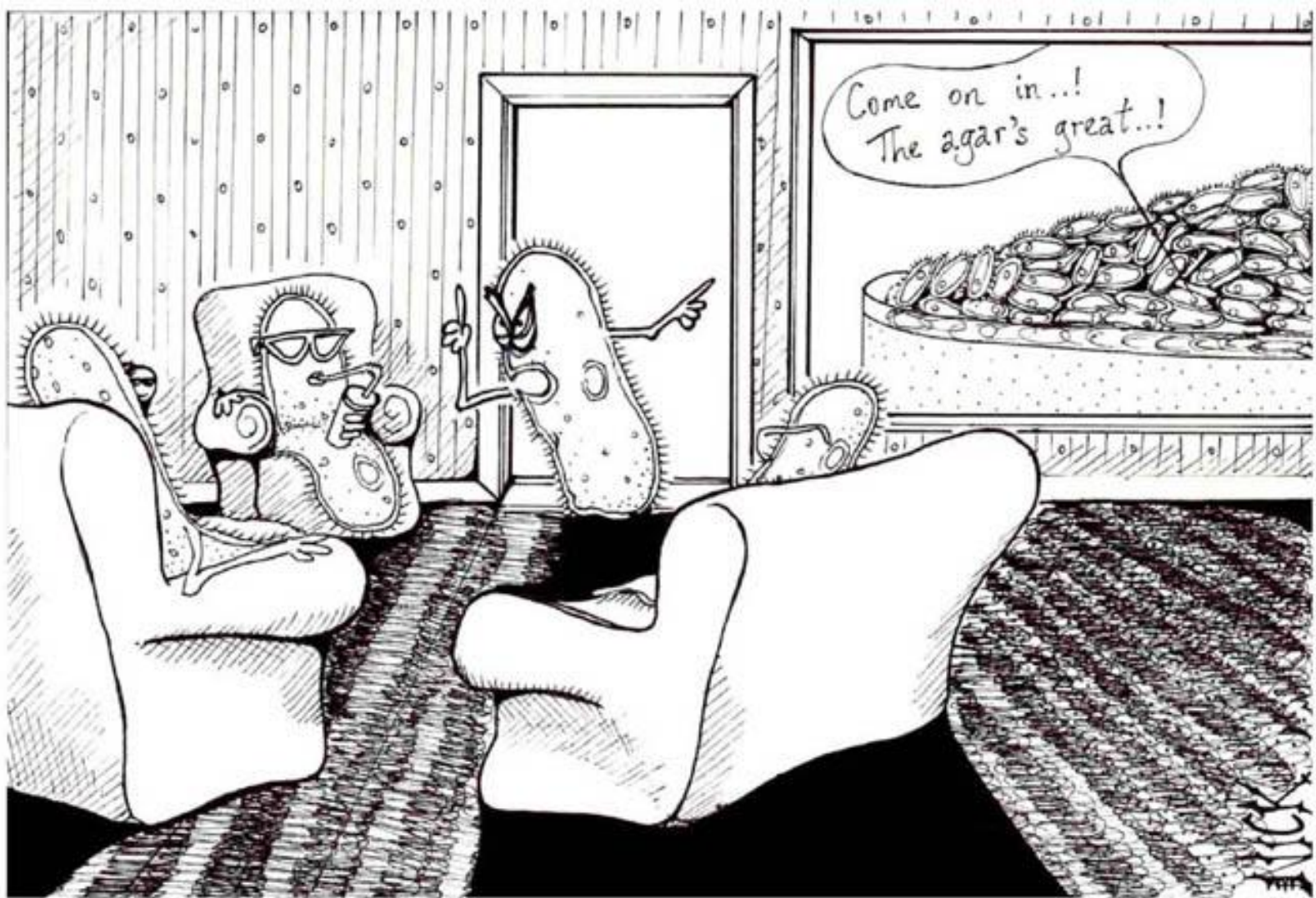


(a) **Coulter counter.** As cells pass through this device, they trigger an electronic sensor that tallies their numbers.

(b) **Flow cytometry.** A variation on the Coulter counter is used to detect, count, and sort the cells in a sample and display a plot of the results. In one version of this procedure, zoospores of the toxic algae *Pfiesteria* (B_2) have been separated from a mixed sample (A_3). The method is so accurate and precise that the sorted sample is a pure culture of the zoospores.



(b)



"I wish you'd learn to put the lid on your Petri dish, Harry! We came here with four kids, and now it looks like we've got twenty million...!!"