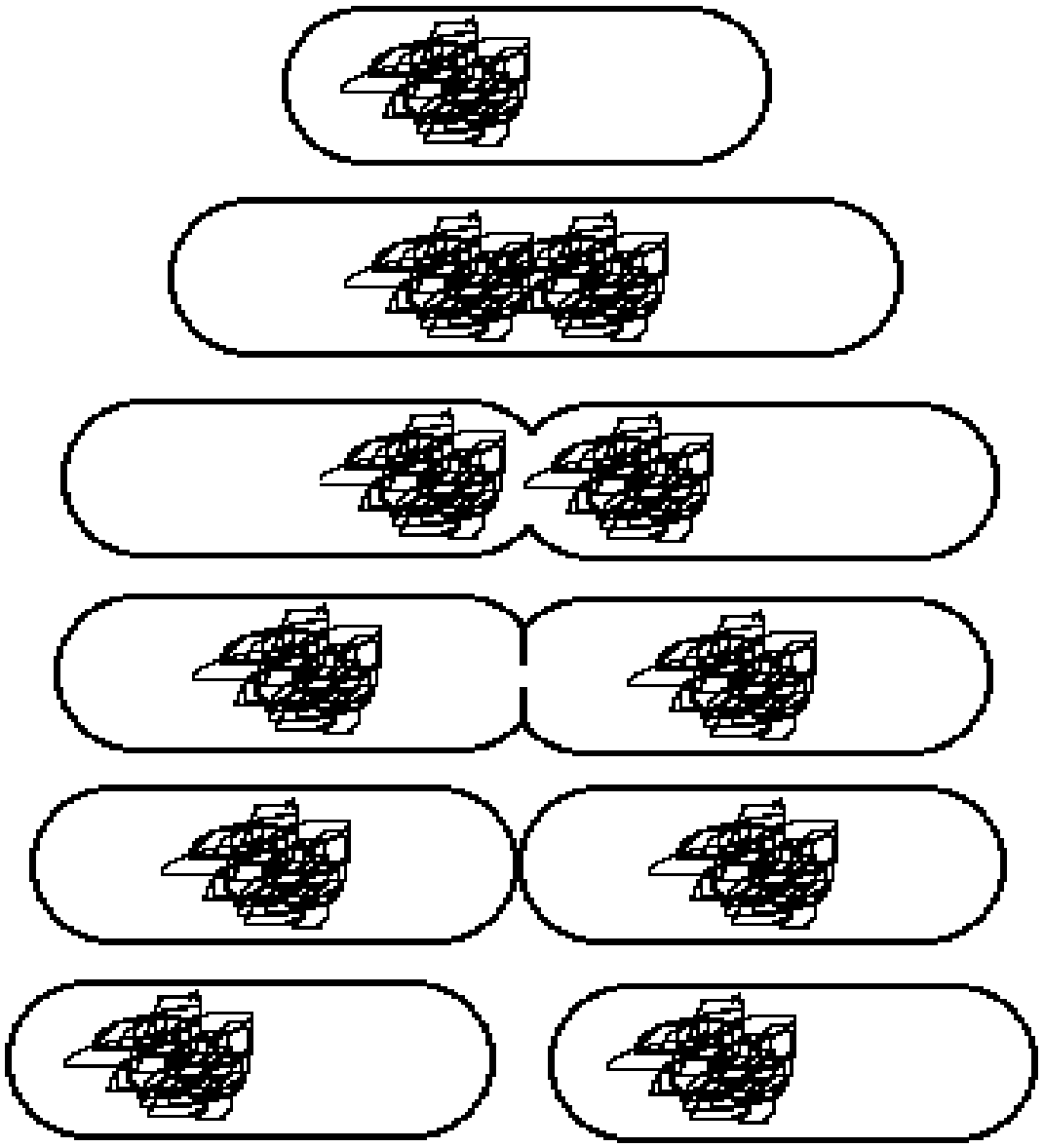
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Bacterial growth

Bacterial growth

- Growth in microbes refers to the increase in the number of cells rather than the increase in the cell's size.
- An increase in the number of microbes from a single parent cell gives rise to a single ***colony*** of cells.
- Common reproduction in bacteria Binary fission

Binary Fission



bacilli following division

chromosome division,
cell growth by lengthening

chromosome divided,
cell fully lengthened,
ingrowth of envelope,
chromosomes segregated

cross wall completed

daughter cells separate

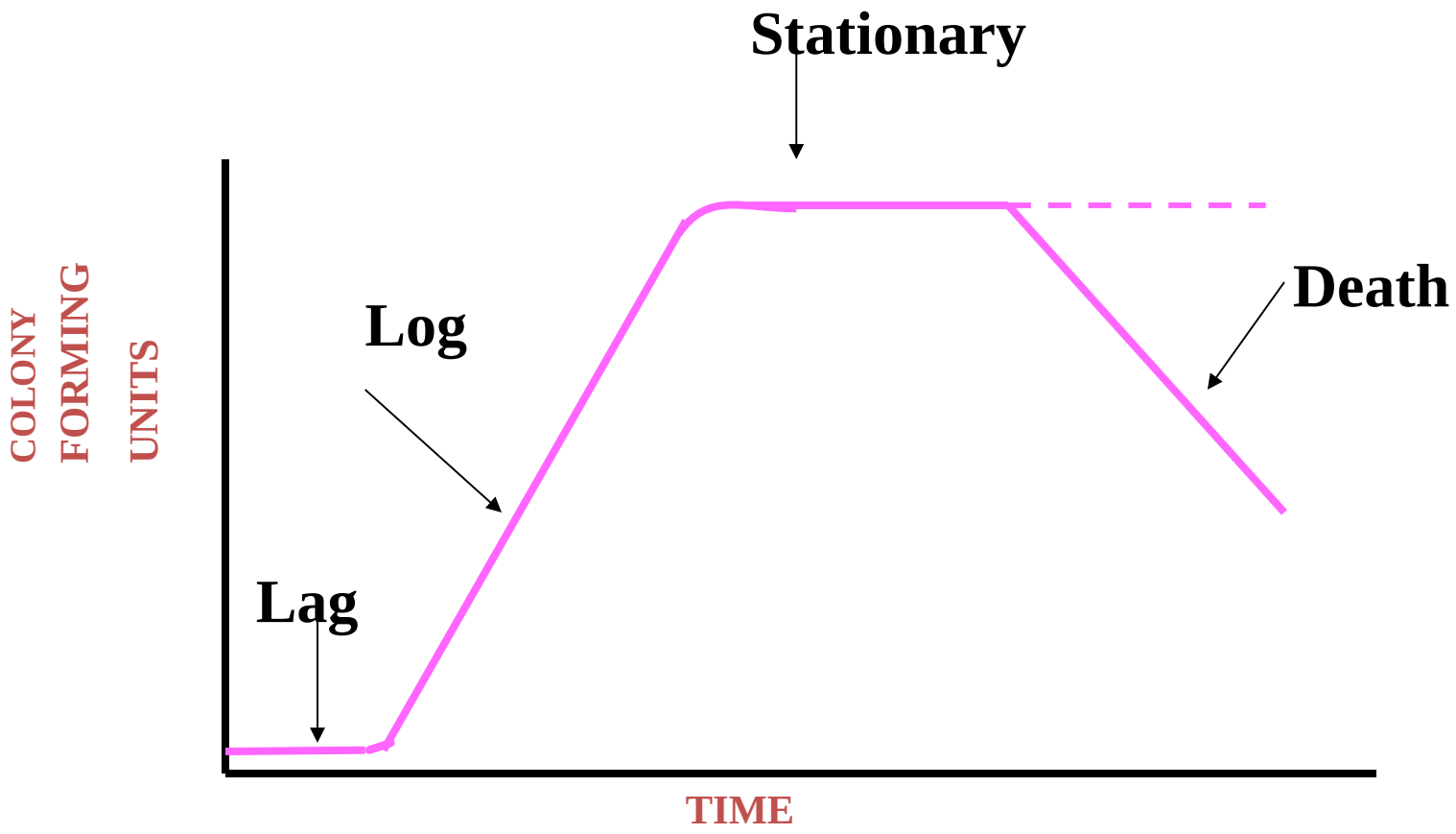
- If the environment is optimum the two daughter cells may divide into four in 20 minutes ⇒ 1, 2, 4, 8, 16, 32, 64... Or 2^0,2^1, 2^2, 2^3, 2^4, 2^5, …2^n, exponential growth

Mathematically this can be expressed : $N=No*2^n$,

=>Number at any time = Number at time zero

times 2 to the n^{th} power, where "n" = number of generations

Growth Curve



Phases of growth

1. Lag phase

- The cells are adapting to their new niche, usually a broth.
- Cell reproduction is not immediate.
- Enzymes are ***synthesized*** to utilize broth nutrients.
- The bacterial cells are ***Metabolically*** **active**.
- According to the bacteria being grown, this phase can take from less than an hour to several days.

2. log/exponential phase

- The necessary chemicals are synthesized for metabolism.
- There is a *rapid replication* of genetic material as well as reproduction of new daughter cells.
- There is logarithmic growth.
- The bacteria are dividing at their greatest rate.
- ***Metabolic activity has peaked.***
- These new cells are young, delicate and ***immature***.
- These cells are ***sensitive*** **to antibiotics** and **UV radiation**.
- The cells can be ***Gram stained the best*** during this phase.

3. Stationary phase

- The growth ***rate slows***.
- This is a phase of equilibrium, because the number of cells being ***replicated equals*** the number of cells ***dying***.
- Nutrients are depleted.
- Waste products are building up, causing an acidic pH level.
- Metabolic activity is greatly reduced.

- They **increase *peptidoglycan cross-linking*** and cell wall strength.
- The starved cells become harder to kill and more resistant to starvation itself, damaging temperature changes, oxidative and osmotic damage, and toxic chemicals such as chlorine.
- There is even evidence that *Salmonella typhimurium* and some other bacterial pathogens become *more virulent* when starved.

4. Death/decline phase

- All nutrients are ***totally depleted***.
- A tremendous buildup of metabolic waste products.
- Cells are dying faster than they are being replicated.
- Cell death is occurring at negative logarithmic rate.
- Gram stain reaction is ***Gram variable***.
- The number of ***endospore*** cells exceeds ***vegetative*** cells in G+ cells.
- Total death will occur if this culture is not transferred to a new broth tube.

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Thank you