

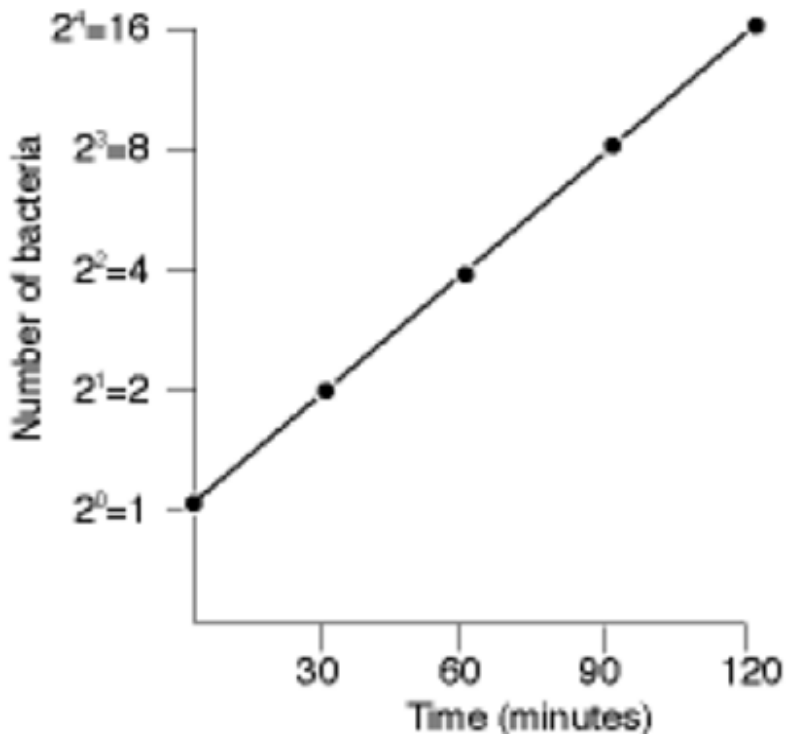
# فسيولوجيا الأحياء الدقيقة Microbial Physiology

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مكتب ٢ ب ٤٥

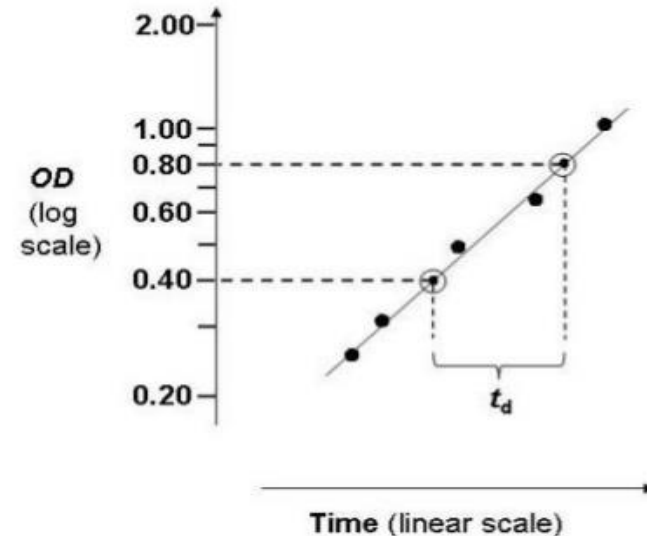
**Bacterial Growth**  
**L8**

# Growth Rate (k)

❖ *The generation time* (time needed for the cell to divide into two-**Doubled**) differs according to species and prevailing conditions. For example, a bacterium that divides every 30 min has a generation time of 30 min.

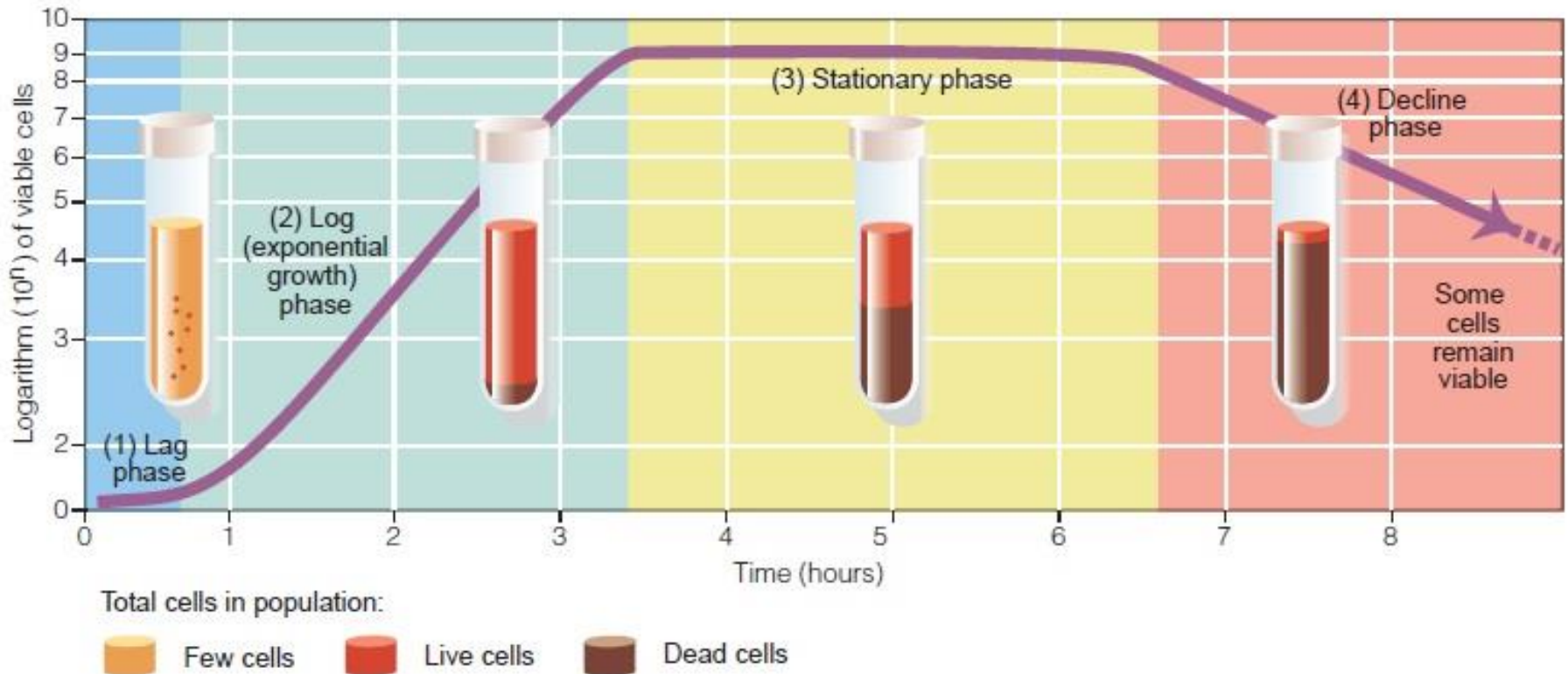


Calculating doubling (generation) time from an OD measurement (indirect method):



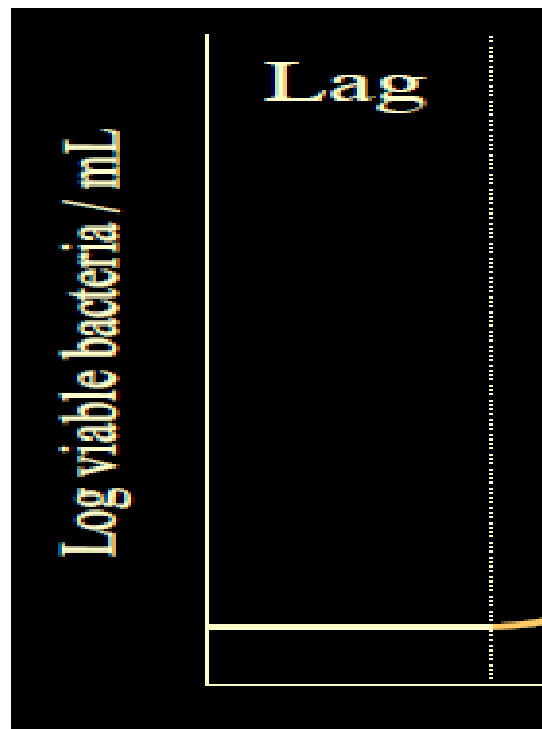
# Population Growth Phases

- ❖ Bacterial growth over time can be graphed as cell number versus time = growth curve.
- ❖ The growth of populations of bacteria tends to follow a typical pathway in an appropriate media.
- ❖ It is characterised by four stages of growth:



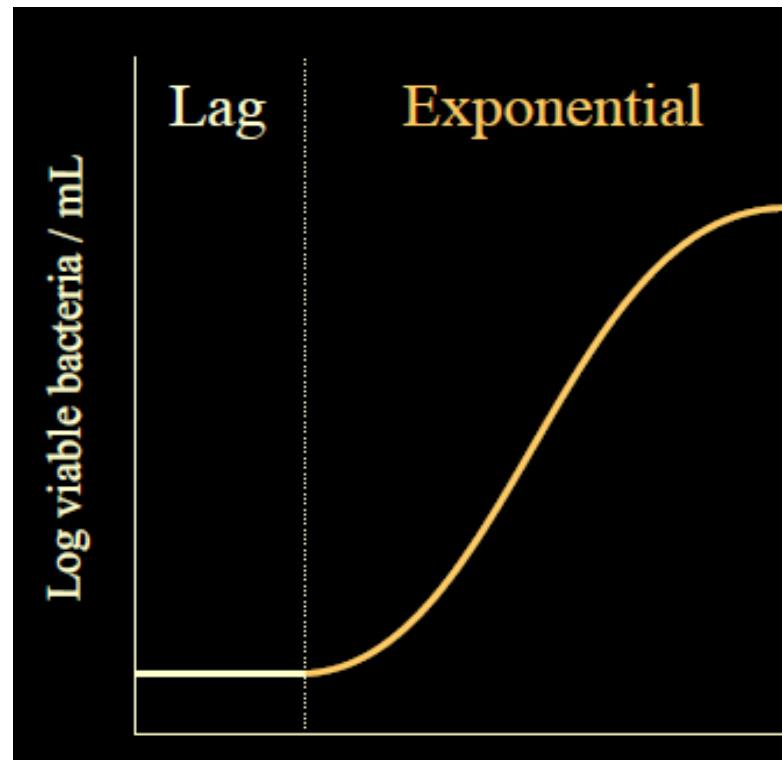
# Population Growth Phases

- ❖ **The lag phase:** describes the beginning of growth after inoculation.
- ❖ The cells adjust to its environment and start to produce required cell constituents to adapt properly.
- ❖ This period is unbalanced and generally unrestricted.



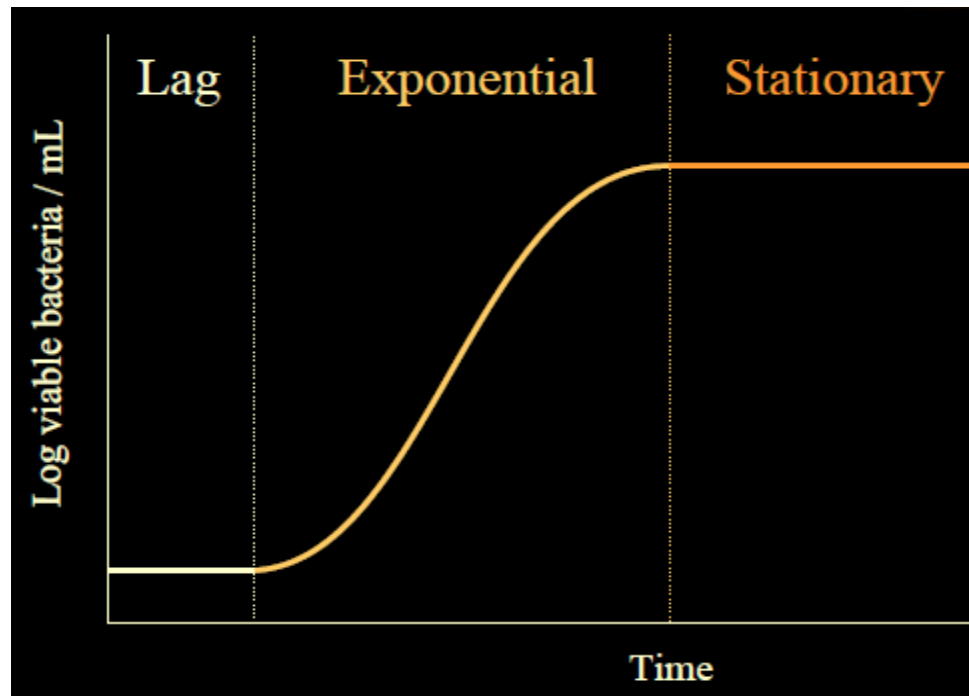
# Population Growth Phases

- ❖ After the initial period of adaptation, the cell begins to replicate in a binary fashion.
- ❖ This period is called the **log or exponential phase** due to the relative increase in cell numbers.
- ❖ This period is still unrestricted, but balanced.



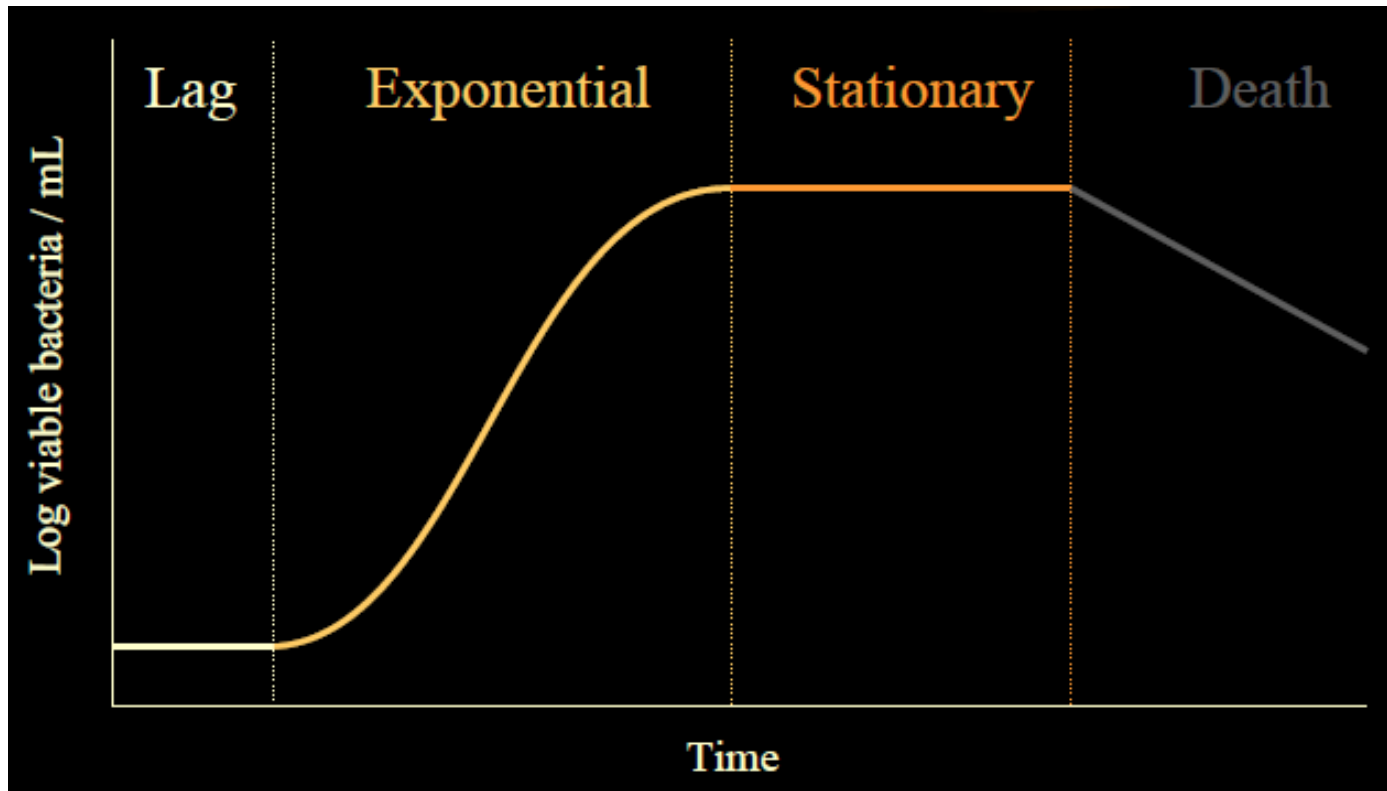
# Population Growth Phases

- ❖ As nutrients start to diminish, and toxic waste product build up, growth becomes restricted.
- ❖ This is called the **stationary phase**.
- ❖ Cells adapt to lower levels of nutrients, and higher levels of toxins, causing the growth to start off unbalanced, but once adapted, become balanced.
- ❖ The numbers of new cells match the numbers of dying cells.



# Population Growth Phases

- ❖ When the toxins or waste products reach a threshold concentration, the cells enter the **death phase**.
- ❖ This phase is restricted and unbalanced, as the cells cannot obtain all their requirements to grow or replicate.



# Temperature as an Influential factor

- ❖ An important factor that influences bacterial growth.
- ❖ The temperature at which they are able to grow and replicate can aid in describing bacteria.
- ❖ Above optimum temperatures, growth rate rapidly decreases.
- ❖ The growth rate does not simply diminish with the decrease in temperature.



# Effect of Temperature on Cell Physiology

- ❖ An important factor that influences bacterial growth.
- ❖ The temperature at which they are able to grow and replicate can aid in describing bacteria.
- ❖ Above optimum temperatures, growth rate rapidly decreases.
- ❖ The growth rate does not simply diminish with the decrease in temperature.
- ❖ If we change the temperature the bacterial cells change their growth rate immediately to that of the new temperature. For example, *E. coli* from 20°C to 37°C.
- ❖ However, the cell pauses in its growth cycle, before starting to grow again. When we change *E. coli* culture from 37°C to 12°C causes a 4 hour stop in its growth cycle.

# Why does the cell pause mid-cycle?

- ❖ The bacterial cell needs to adjust its physiological composition before it can function properly at the new temperature.
- ❖ When the temperature changes within the normal range, the cell reactions remain coordinated.
- ❖ With large changes in temperature, the metabolism becomes unbalanced, and the cell needs to adapt a new strategy in coping with the new temperature.
- ❖ For *E. coli*, when the temperature is increased above the normal range, some proteins increase in levels by up 100 times.
- ❖ Proteins that are induced by an increase in temperature are repressed by a decrease in temperature.

# Why does the cell pause mid-cycle?

- ❖ The fatty acid composition also changes.
- ❖ With an increase in temperature the phospholipid bilayer of the membrane becomes more fluid, allowing leakage to occur more easily.
- ❖ To stop this happening, the fatty acids become more saturated, allowing to retain their fluidity.
- ❖ A decrease in temperature sees the increase of chain branching and more double bonds, stopping the phospholipids forming a crystalline structure.

# QUESTIONS??

