بكتـــريـــا طبيـــة 1

Microbial Growth and Metabolism

Sawa University — جامعـــــــة ســـــــــاوة الاهلية

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Second Stage — المرحلـــــــــــــة / الثانيـــة

SAWA UNIVERSITY

محاضرة رقم: 3

Lecture No. 3

الجانب النظري

Theoretical

تدريسي المادة : دكتـــور معيـــن حســـن

(INTRODUCTION)

- **Microbial Growth**
- **Metabolism**

❖ Microbial Growth and Metabolism

- The division of a bacterial cell occurs mainly through **binary**, or **transverse fission**.
- Binary means that one cell becomes two, and transverse refers to the division plane forming across the width of the cell.
- During binary fission, the **parent cell enlarges**, duplicates its **chromosome**, and **forms a central transverse septum** that divides the cell **into two daughter cells**.
- This process is repeated at intervals by each new daughter cell in turn, and with each successive round of division, the population increases in size, number, and mass.

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.

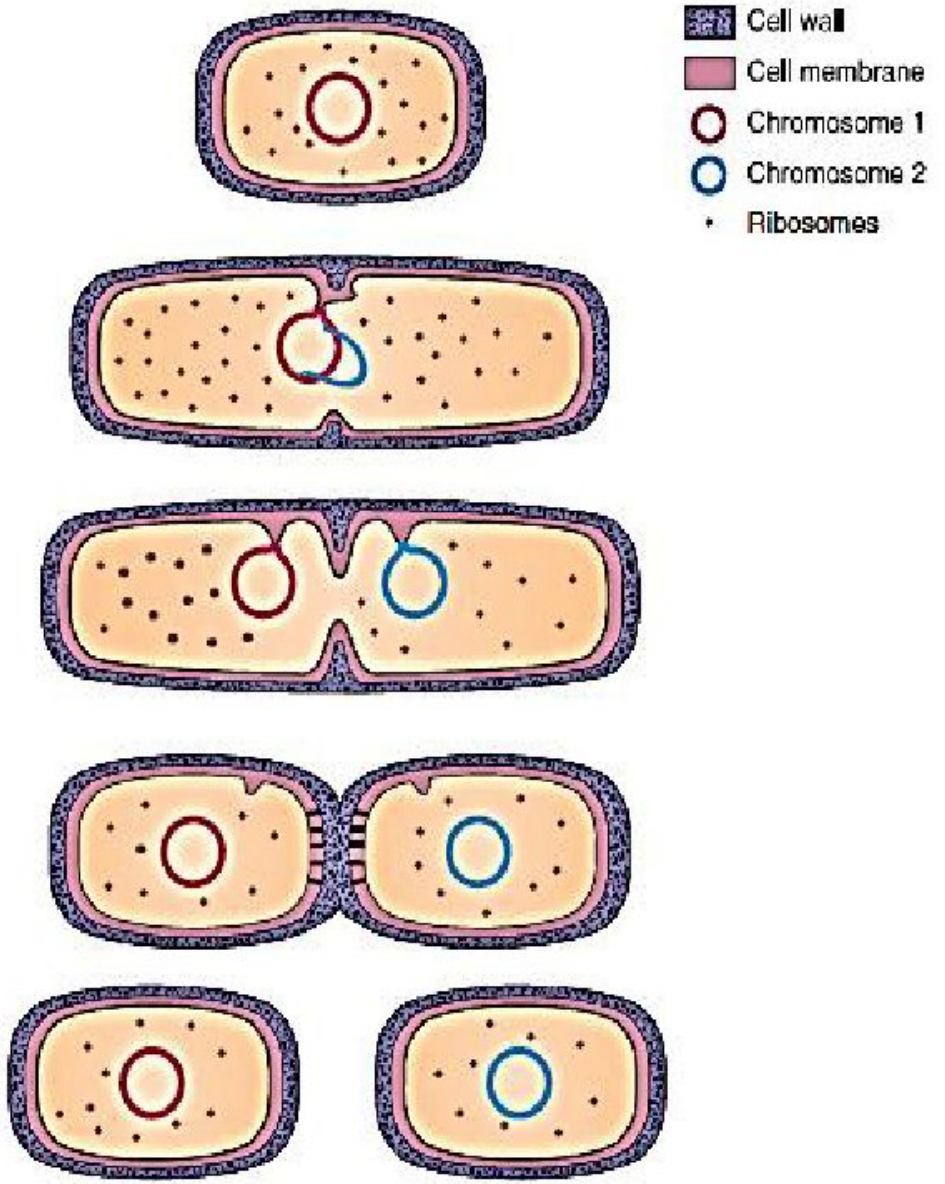
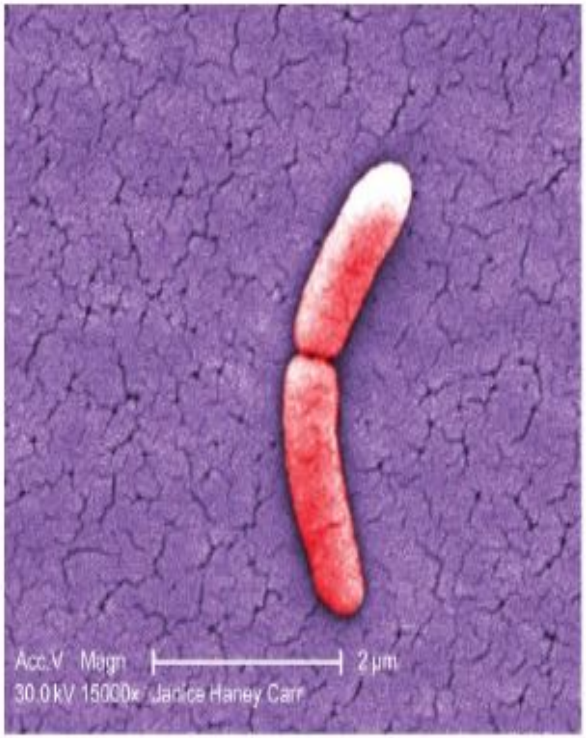
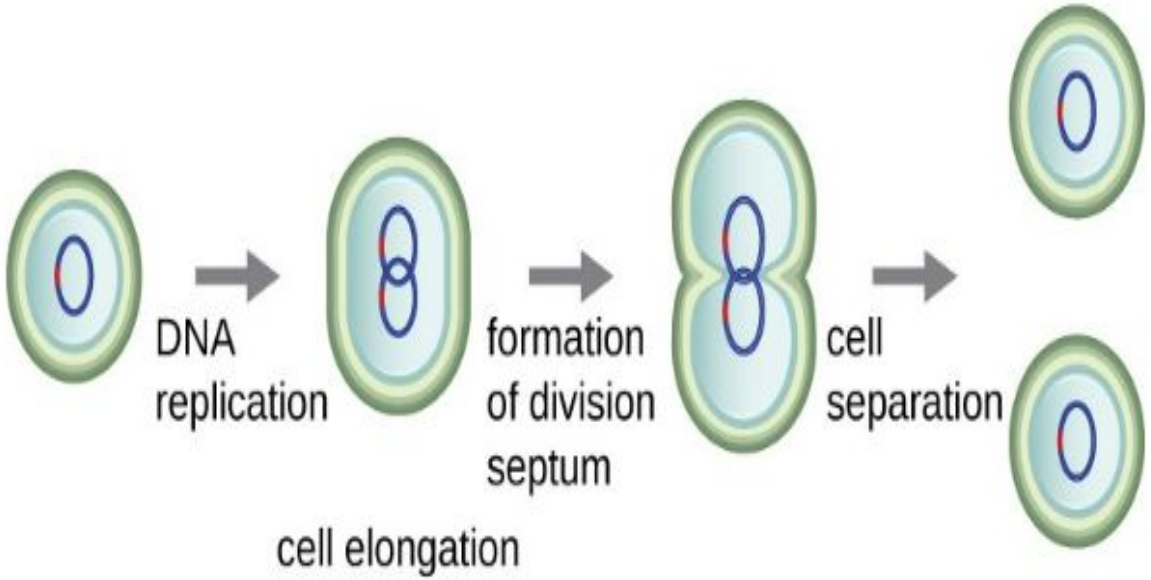


FIGURE 7.14

Steps in binary fission of a rod-shaped bacterium.


Acc.V Magn
2 µm
30.0 kV 15000x Janice Haney Carr


DNA replication
formation of division septum
cell separation
cell elongation

❖ STAGES IN THE NORMAL GROWTH CURVE

- The system of batch culturing described as closed, meaning that nutrients and space are finite and there is no mechanism for the removal of waste products.
- Data from an entire growth period of 3 to 4 days typically produce a curve with a series of phases termed:

1. The Lag phase.

2. The Exponential growth (log) phase.

3. The Stationary phase.

4. The Death phase.

1. The Lag Phase:

- Is a relatively "**flat**" period on the graph when the population appears not to be growing or is growing at less than the exponential rate.
- Growth lags primarily **because**:
- **(A)** The newly inoculated cells require a period of adjustment, enlargement, and synthesis.
- **(B)** the cells are not yet multiplying at their maximum rate.
- **(C)** the population of cells is so sparse or dilute that the sampling misses them.
- The length of the lag period varies somewhat from one population to another.

2. Exponential Growth (Log) Phase:

- A period during which the **curve increases geometrically**.
- This phase will continue as long as cells have adequate nutrients and the environment is favorable.

3. Stationary Growth Phase:

- The population enters **a survival mode** in which cells **stop growing** or **grow slowly**.
- The curve levels **off** because the rate of cell inhibition or death balances out the rate of multiplication.

- The decline in the growth rate is caused by **depleted nutrients** and **oxygen**, excretion of organic acids and other biochemical pollutants into the growth medium, and an **increased density of cells**.
- As the limiting factors intensify, cells begin to die in exponential numbers and they are unable to multiply.

4. Death Phase:

- The curve now **dips downward** as the **death**.
- The speed with which death occurs **depends on** the relative resistance of the species and how toxic the conditions are, but it is usually slower than the exponential growth phase.

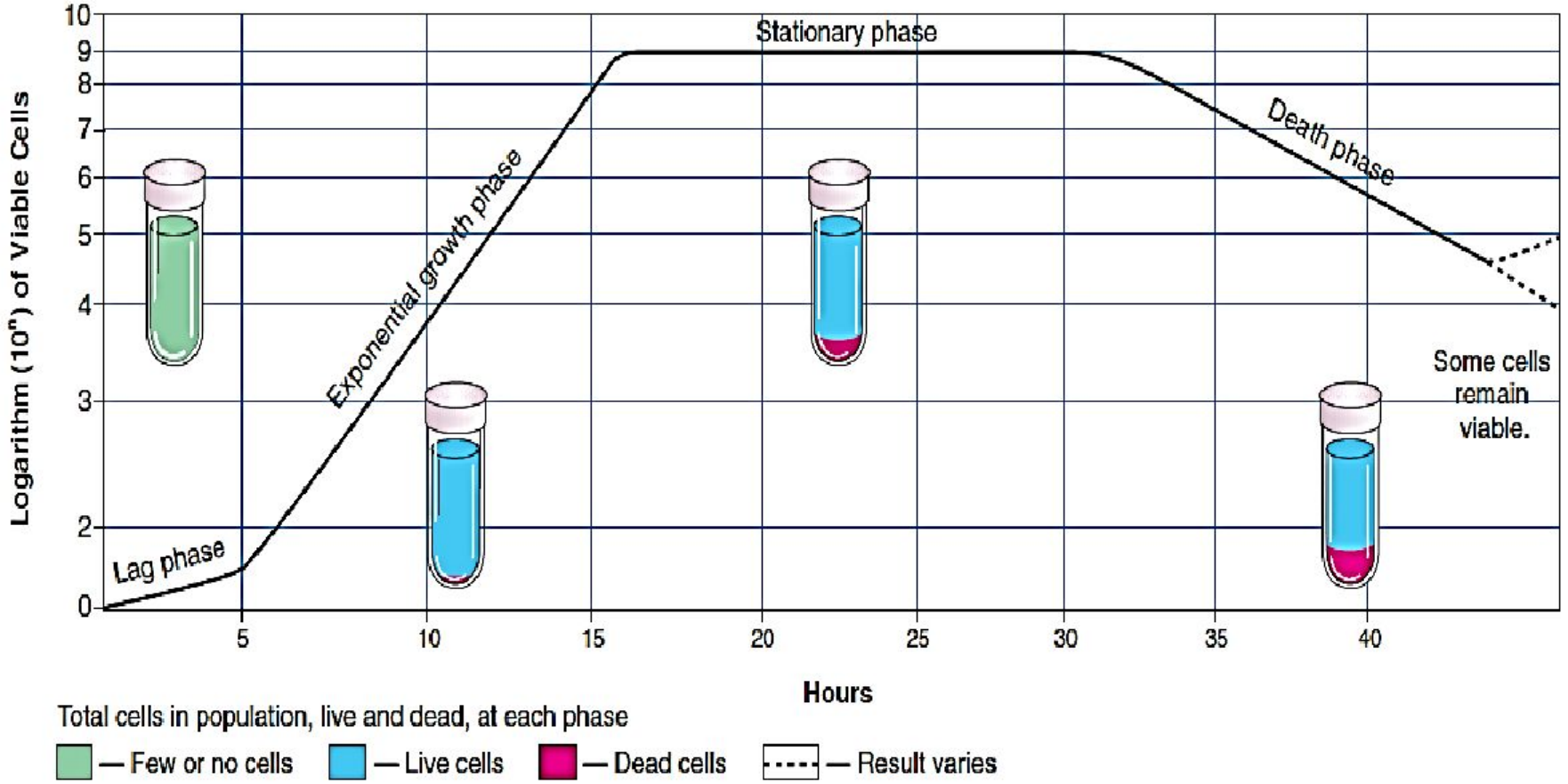
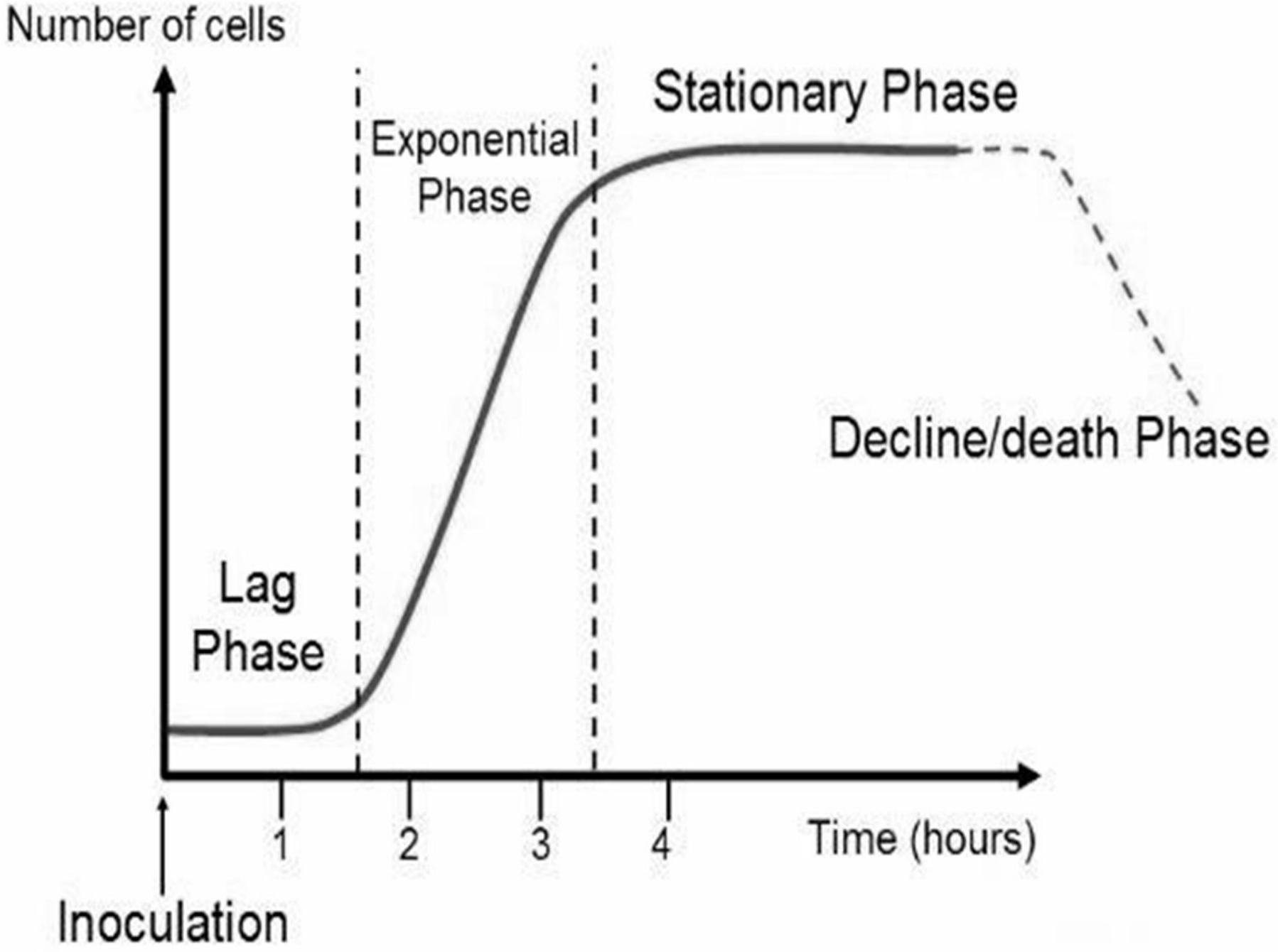


FIGURE 7.16

The growth curve in a bacterial culture. On this graph, the number of viable cells expressed as a logarithm (log) is plotted against time. See text for discussion of the various phases. Note that with a generation time of 30 minutes, the population has risen from 10 (10^1) cells to 1,000,000,000 (10^9) cells in only 16 hours.


Number of cells
Stationary Phase
Exponential Phase
Decline/death Phase
Lag Phase
1
2
3
4
Time (hours)
Inoculation

❖ Surface Growth

- If a single bacterial cell is placed on a solid nutrient agar surface progressive of this cell remain close to the site of deposition and eventually form a compact macroscopic mass of cells called colony.
- For rapidly growing species over night incubation at **30 C° to 37 C°** is sufficient to produce **millions of cells**.
- The colonies morphology include **color**, **shape**, **adherence**, **smell**, and **surface texture** can used guide for identification of the bacterial species.

Cell numbers can be counted directly by:

1. A microscope counting chamber.

2. Coulter counter or flow cytometer.

3. Cell growth can also be determined by turbidometry.

4. Total cell count.

❖ The Meaning of Bacterial Death

- For a microbial cell, **death means <u>the irreversible loss of the ability to reproduce (grow and divide).</u>**
- The **empirical test** of death is culture of cells on solid media:
- A cell is **considered dead** if it **<u>fails to give rise to a colony on appropriate medium</u>**.
- Obviously, then, the reliability of the test **<u>depends on</u>** the choice of medium and conditions: For example, a culture in which 99% of the cells appear "dead" in terms of the ability to form colonies on one medium may prove to be 100% viable if tested on another medium.
- Furthermore, the detection of a few viable cells in a large clinical

- In such cases, the sample may have to be diluted first into liquid medium, permitting the outgrowth of viable cells before plating.
- The conditions of incubation in the first hour after treatment are also critical in the determination of "**killing**." For example, if bacterial cells are irradiated with ultraviolet light and plated immediately on any medium, it may appear that 99.99% of the cells have been killed.
- If such irradiated cells are first incubated in a suitable medium for 20 minutes, plating may indicate only 10% killing.
- In other words, irradiation determines that a cell will "**die**" if plated immediately but will live if allowed to repair radiation damage before plating.

- A microbial cell that is not physically disrupted is thus "dead" only in

QUIZ

Q1/ ENUMERATE FACTORS EFFECTING IN BACTERIAL GROWTH?

Q2/ ENUMERATE STEPS OF BINARY FISSION OF A ROD SHAPED BACTERIUM?

Q3/ ENUMERATE STEPS OF GROWTH CURVE?

Any questions?