

Course: General Microbiology

**Introduction to Binomial nomenclature,
Bacterial growth & Growth curve**

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Binomial nomenclature of microbes

- Nomenclature – The system of naming organisms or things
- Binomial – Two names

- Classification system of all the living organisms began in the eighteenth (1735) century by Carolus Linneaus, a Swedish physician and botanist.
- He developed the two part binomial naming system are
 - A) **Genus** (Plural - Genera) – always capitalized
 - B) **Species** epithet (Species name) –not capitalized

Bacteria and archaea, like other organisms are referred to by their unique binomial name, consisting of the **genus** and **species** names of each organism.

The names are given in Latin, since **Latin was the classical language of science.**

When **typed or handwritten**, genus and species names are **underlined** to indicate that they are in Latin. In print, the genus and species names are italicized. **The first letter of genus name is capitalized and the species name is written in all the lowercase letters.**

- The rules of nomenclature for micro organisms are established by international committees.
- Different codes of international are used for different microbial groups.
- The code of nomenclature of bacteria applies to all bacteria, fungi, algae are covered by the botanical code.
- Scientific names describe an organism, honor a researcher or identify the habitat of species.
- Eg. *Staphylococcus aureus* - commonly found in skin.

Staphylo – Clustered arrangement of the cells

coccus – sphere or round shape

aureus – golden color colonies

Escherichia coli – this is named from a scientist Escherich

coli – colon region, the habitat of this organism

- Rules for naming newly classified bacteria and for assigning bacteria to taxa are established by the International Committee on Systematic Bacteriology and are published in the Bacteriological code.

Microbial Taxonomy

- A) **Species** –a single organism
- B) **Genus** – many number of species
- C) **Family** – related genera (genetically similar to maximum extent)
- D) **Order** –a group of families
- E) **Class** – group of similar orders
- F) **Division** – related classes
- G) **Kingdom** – related divisions
- H) **Domain** - related kingdom
- I) **Sub species** – variant of a species

In general species are the basic taxonomic units and divided into sub species or types based on genetic variability of micro organisms that describe the specific clone of the cells. The sub species or type may differ in the following characters.

- A) **Biovar or Biotypes** – Physiologically different within the same species.

Eg. *Vibrio parahaemolyticus* kanagawa positive
kanagawa negative

Kanagawa positive – Positive for hemolysin production in blood agar plates by *V. parahaemolyticus* (virulent strains)

Kanagawa negative – Negative for hemolysin production in blood agar plates by *V. parahaemolyticus* (non virulent strains)

- B) **Morphovar**– Morphologically different species.

Eg. *Vibrio cholerae* and *V. vulnifus*

Vibrio cholerae – in Thiosuiphate Citrate Bile Salt Sucrose (TCBS) agar medium, it appears as yellow thin colony, 2-3 mm diameter and umbonate at the center.

V. vulnifus – in TCBS plates it looks yellow big colony, 5mm diameter and concave on surface

- C) **Serovar or Serotypes** – Based on the presence of antigens, species are differentiated.

Eg. *Vibrio cholerae*, *E. coli*, *Salmonella* etc.,

Vibrio cholerae O1 – it has 'O' type antigen, virulent species

V. cholerae Non- O1 – No 'O' type antigen, a less virulent species

Classical approaches to microbial classification

- Normally, classification systems of micro organisms were assigned to groups based on morphology, staining properties, pigmentation, the presence or absence of spores, nutritional requirements, the capacity to produce acid from sugars and the ability to grow in the presence of inhibitory compounds.
- This classical approach supported the needs of many microbiologists, such as those clinical laboratories. Some of the important characteristics used for the classical approach are....

- 1) **Cellular characteristics**
 - a) Morphology – cell shape, size , arrangement of cells and flagella, capsule and endospore.
 - b) Staining reactions - Gram's and Acid fast stain reaction.
- 2) **Growth and Nutritional characteristics**

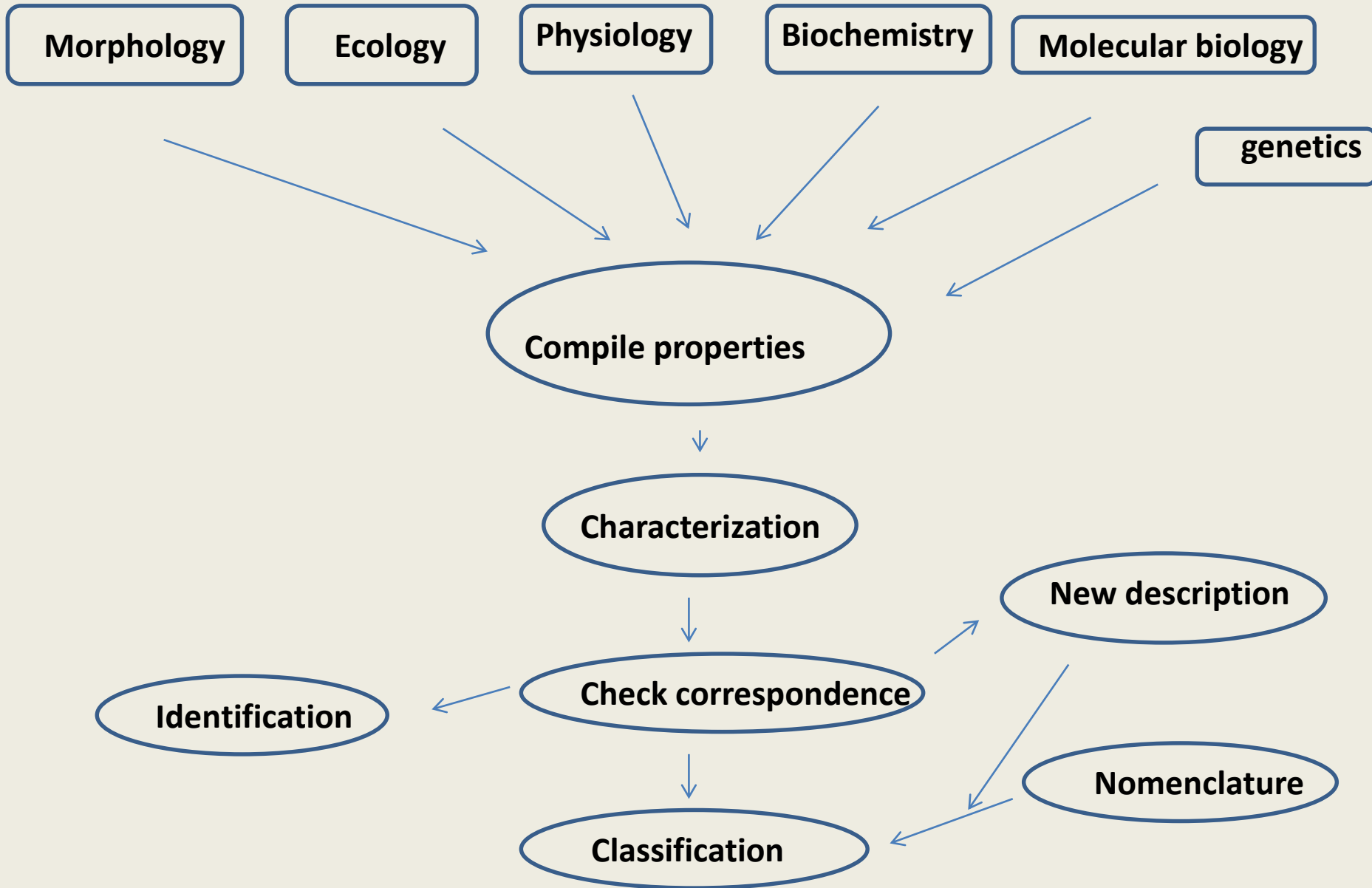
Colony morphology, pigmentation, energy sources, carbon sources, appearance in liquid culture, modes of metabolism etc.,
- 3) **Biochemical characteristics**

Cell wall constituents, pigment, biochemical, antigens, RNA molecules and storage inclusions(metachromatic granules)
- 4) **Physiological characteristics**

Temperature range, pH tolerance range, Osmotic tolerance, Salt requirement and tolerance and antibiotic sensitivity.
- 5) **Ecological characters**

Habitat, symbiotic relationship

CLASSIFICATION



Bacterial growth (Growth of Bacteria)

- What is bacterial growth?
 - Growth of bacteria is defined as a steady increase in all of the chemical components (DNA, enzymes) and the size of the cell, finally increase in cell number or population.
- What is growth curve?
 - If an old culture of bacteria is inoculated or added to a fresh medium and the cell concentration (growth) is periodically measured. A graph may be plotted by using cell concentration and time and curve is obtained. This is called growth curve.

Bacterial division or Binary fission

Bacteria normally reproduce or divide by binary fission.

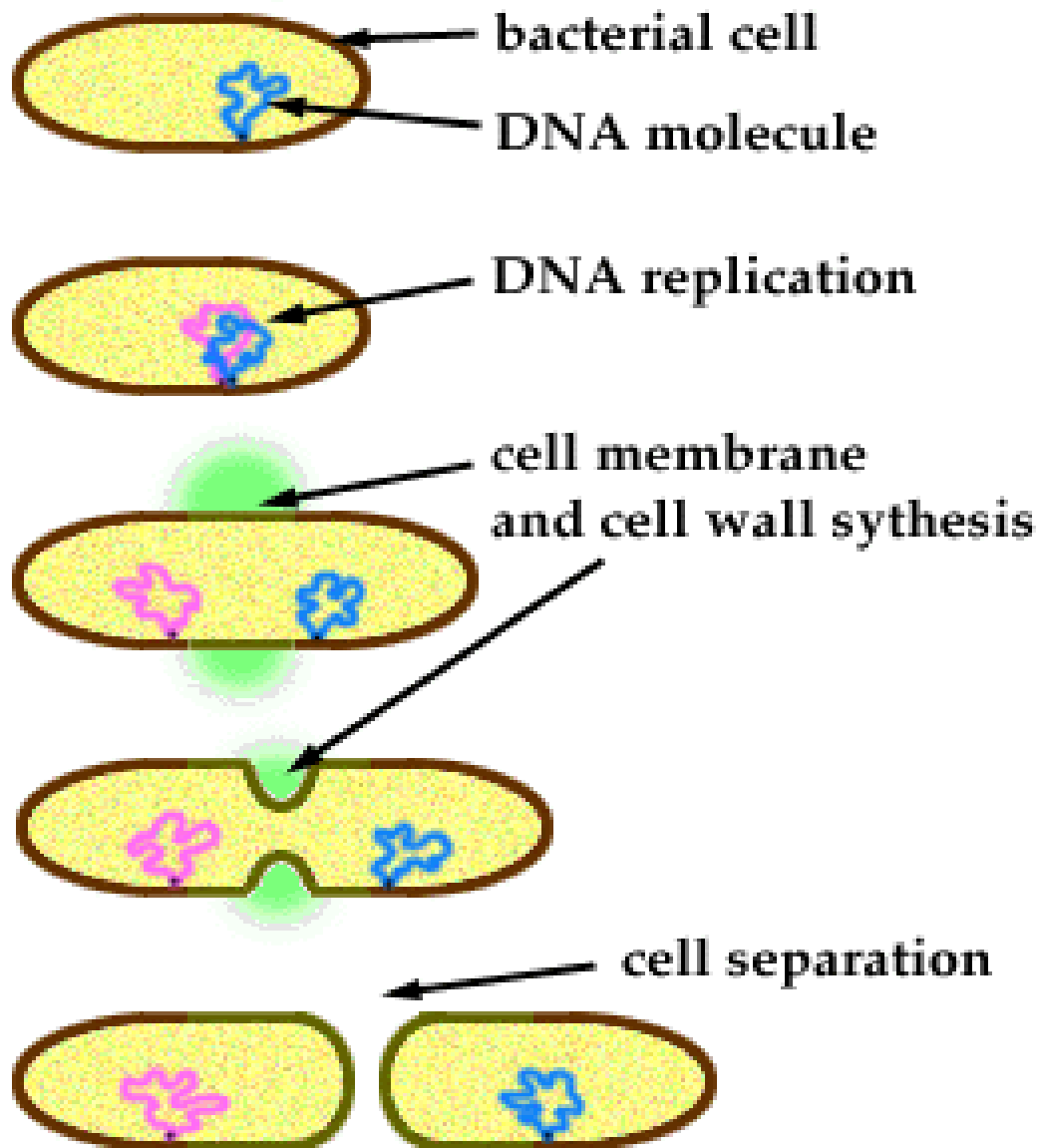
The steps are

- a. Cell elongation and replication of the chromosomal DNA
- b. The cell wall and cell membrane then begin to grow inward from all sides at a point between the two regions of chromosomal DNA.
- c. Eventually, the in growing cell walls meet, forming a cross wall called **septum**
- d. Two individual cells are formed, which is identical to the parent cell.

Generation time:

The time required for a cell to divide (population to double) is called generation time. Most bacteria have a generation time of 1-3 hours.

Bacterial cell: Binary Fission



The phases of bacterial growth

- LAG phase
 - Transportation of nutrients to the cell from the medium
 - DNA and enzyme synthesis
 - DNA multiplication

The phases of bacterial growth

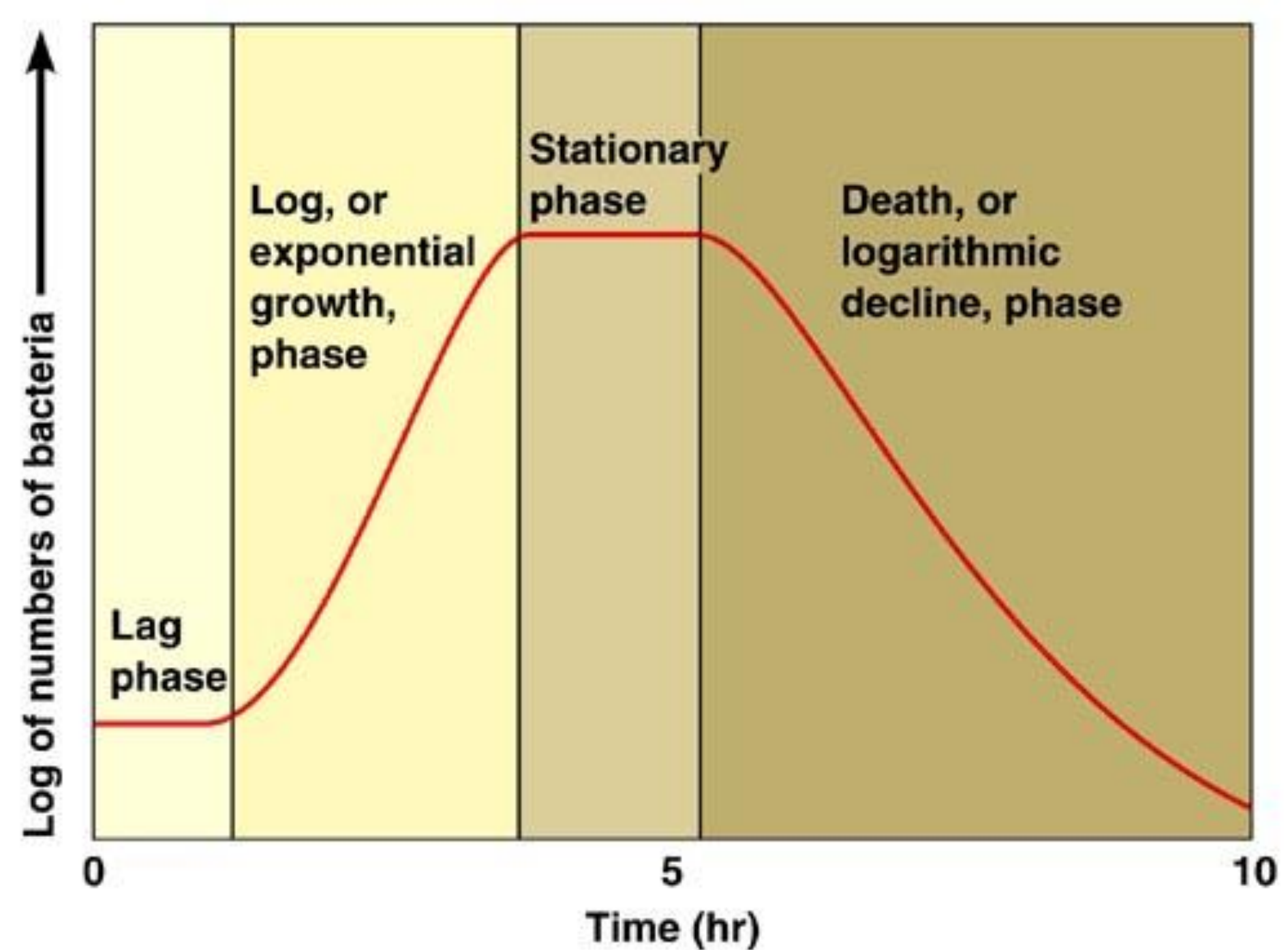
- LOG or EXPONENTIAL or GROWTH phase
 - One mother cell divides to form two daughter cells
 - The two daughter cells again divides and form four cell.
 - This process is continued and population increased

The phases of bacterial growth

- **STATIONARY phase**
 - The depletion or exhaustion of nutrients
 - Accumulation of waste products in the medium
 - Harmful changes in pH

The phases of bacterial growth

- DEATH or DECLINE phase
 - The number of deaths eventually exceeds the number of new cells formed.
 - No further net increase in bacterial cell numbers and gradually population dies and enters death phase
 - This phenomenon is called death phase
 - This phase continues until the population completely dies.



Growth of bacterial cultures

- In laboratory and natural situations, some environmental parameter or interaction of environmental parameters controls a given bacterial growth rate.
- In nature, where conditions cannot be controlled to achieve optimal bacterial growth rate.
- However, in laboratory , it is possible to adjust conditions to achieve optimal growth rates for a given organisms (bacterial species).
- There are 3 process to achieve the optimal growth.

Batch culture

- The normal bacterial growth curve is characteristic of bacteria in batch culture.
- That is a fresh medium is simply inoculated with a bacterium and grown under the required conditions.
- In batch culture growth, nutrients are expended and metabolic products accumulate in the closed environment

Continuous culture

- In continuous culture systems, fresh medium replaces some of the spent medium enable bacteria to grow continuously (growth phase).
- This is accomplish 2 process
 - A. Turbidostat
 - B. Chemostat

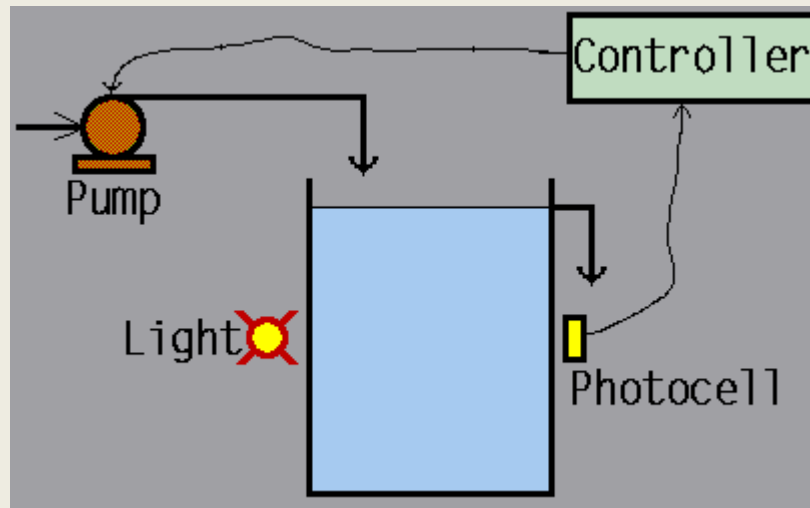
Turbidostat

- In this process, the system includes an **optical sensing device that measures the turbidity** of the culture in the growth vessel.
- It also generates an electrical signal which is used to regulate the flow of fresh medium into the vessel and the flow of spent medium and cells out of it.

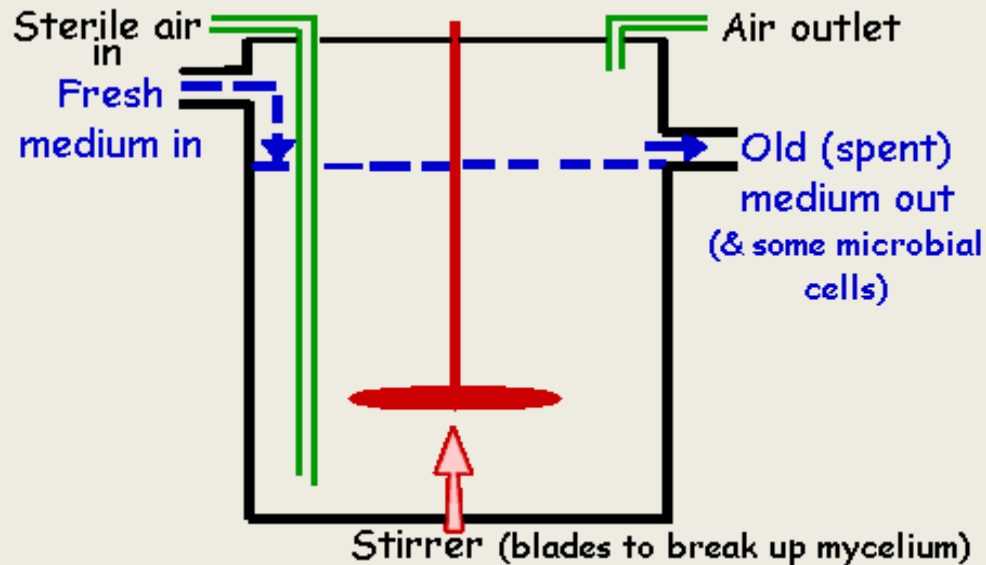
Chemostat

- In this process, the flow rate from a reservoir of a growth medium is set at a particular value and growth rate of the culture adjusts to this flow rate
- Bacteria grown in a chemostat, in which nutrients are supplied and end products (waste material) continuously removed.
- Thus, continuous growth of bacteria is accomplished in this device by continuously feeding a liquid medium into the bacterial culture.

Turbidostat



Chemostat



Synchronous culture

- Synchronous growth of bacteria occurs when all cells divide at the same time.
- This can be achieved by adjusting environmental conditions.
- For example, by repeatedly changing the temperature or by adding fresh nutrients to culture.

THANK
YOU