Microbiology

Bacterial Growth and Nutrition

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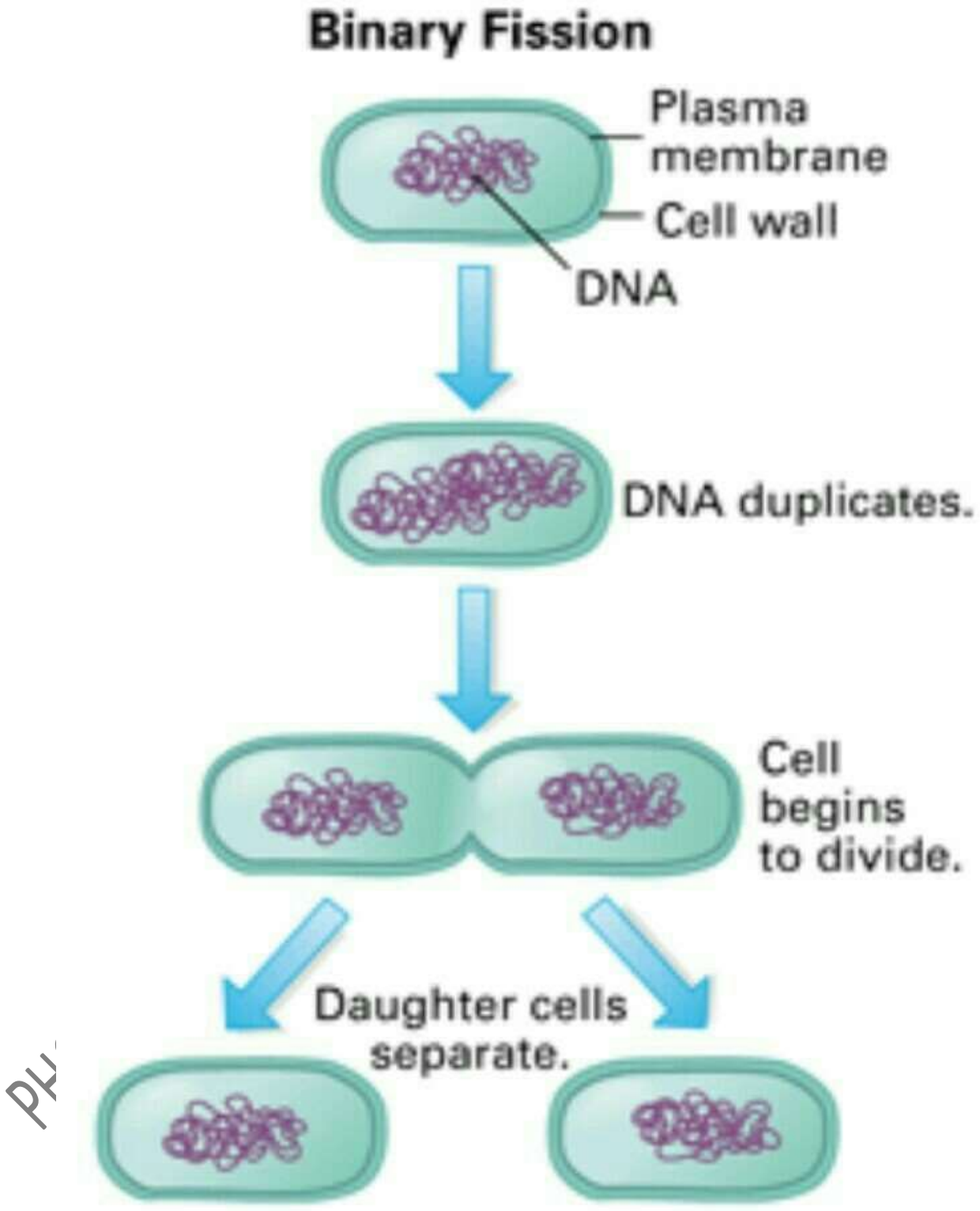
GROWTH OF BACTERIA

Bacterial growth is an orderly increase in the quantity of cellular constituents (i.e, cell mass) and cell number.It is the ability of cell to form new protoplasm from nutrients available in the environment.

The increase in cell number occurs by cell division which is known as BINARY FISSION.

In binary Fission

- DNA replicates
- 2replicated DNA's seperate
- Plasma membrane invaginate (grows inward) and split into 2 daughter cells through the process known as CYTOKINESIS.



BINARY FISSION

A method of asexual reproduction in which cell divides into 2 nearly identical daughter cells. The genetic material is equally partitioned, therefore the daughter cells are genetically identical.

PHASES OF GROWTH

A. FRESH CULTURE has 3 phases of growth.

1. Growth Phase

2. Stationary Phase

3. Death Phase

B. CLOSED CULTURE (BATCH CULTURE) has 4 phases of growth.

1. Lag Phase

2.Log Phase (Exponential Phase)

3.Stationary Phase

4.Death Phase (Decline Phase)

1. LAG PHASE

In this phase only the cell mass increases but there is no increase in cell number.It is the period of adaptation of cells to new environment .It depends on characteristics of bacterial species and by conditions in media.

2.LOG (EXPONENTIAL) PHASE

It is a pattern of balanced growth where in all the cells are dividing regularly by binary fission and are growing by geometric progression(1,2,4,8..... or 2^0,2^1 ,2^2,2^3.....2^n).This growth is known as Exponential growth. The cells divide at constant rate .

GENERATION TIME OR DOUBLING TIME:

The rate of exponential growth of bacterial culture is expressed as generation time or doubling time of bacterial population. The generation time is the time interval required for the cells to divide.

Generation time = t / n

where t ⟹ time in minutes / hours

n ⟹ number of generation

3. STATIONARY PHASE

Exponential growth can't be continued forever in a batch culture (e.g; closed system).In this phase, the cell growth has levelled off and become constant. The no. of cells multiplying equals the no. of cells dying.

The population growth is limited by one of the 3 factors :

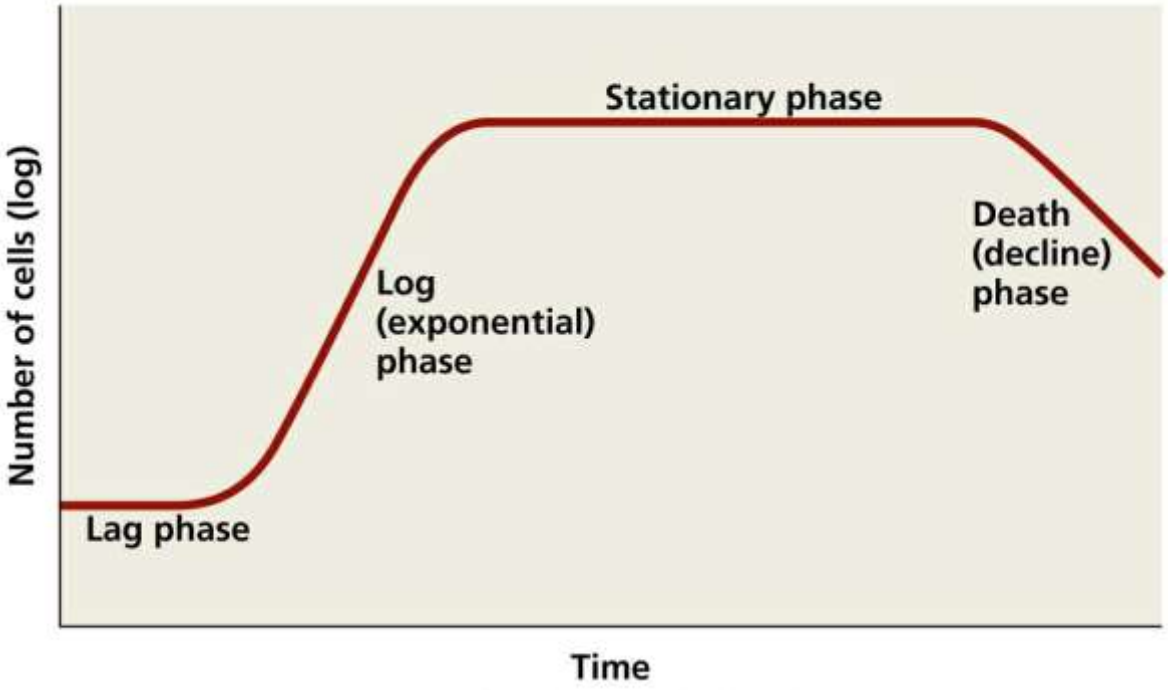
1.Exuastion of available nutrients .

2.Accumulation of inhibitory metabolites / end products.

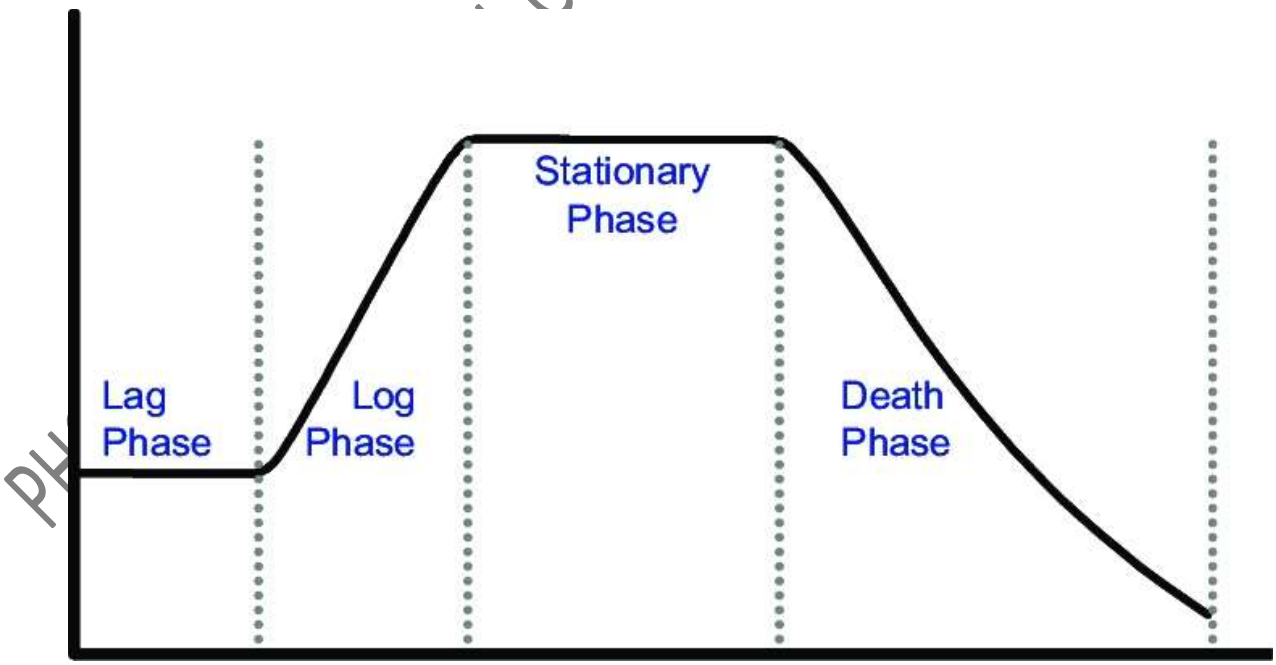
3.Exaustion of space (lack of biological space).

4. DEATH PHASE

In this phase viable cell population declines. The decrease in viable cells is exponential which essentially is reverse of growth during log phase.


Number of cells (log)
Stationary phase
Death (decline) phase
Log (exponential) phase
Lag phase
Time

OR


Stationary Phase
Lag Phase
Log Phase
Death Phase

NUMERICAL

Q : What is the doubling time for a bacterium which reaches to its 5th generation in 2 hours ?

Sol : Generation time = t/n { t= 2 hrs .....given

G.T =120/5 t = 2 (60) minutes

G.T = 24 minutes t = 120 minutes}

BACTERIAL NUTRITION

Nutrients are substances used in biosynthesis and energy production and therefore required for bacterial growth.

All bacteria require several macro_ and micro _ nutrients.

1. Macro nutrients:

These are required in relatively large quantities. These include carbon, hydrogen, nitrogen, oxygen, sulpher, phosphorus, potassium, calcium, magnisium and iron.

2.Micro nutients:

These are required in very small amounts. These include manganese, molybdenum, zinc, nickel, copper and cobalt.

In addition to the need for carbon, hydrogen and oxygen, all organisms require source of energy and electrons for growth to take place.

On the basis of carbon, energy and hydrogen /e⁻s bacteria can be categorized into following types:

- ***BASED ON CARBON SOURCES:***

1.AUTOTROPHS:

Bacteria that use CO_2 as a sole source of carbon for growth are known as autotrophs.

example:

- Purple and Green sulphur bacteria
- Blue - Green bacteria.

2.HETEROTROPHS:

Bacteria that use organic carbon are known as heterotrophs.

example:

- Purple and Green non - sulpher bacteria.

- ***BASED ON ENERGY SOURCE:***

1. PHOTOTROPHS:

Bacteria that use light as their energy source are known as Phototrophs.

example:

- Purple Sulphur bacteria
- Green Sulphur bacteria

2. CHEMOTROPHS:

Bacteria that obtain energy from oxidation of chemical compounds (either organic or inorganic) are known as chemotrophs.

example:

Sulphur oxidizing bacteria.

➢ *BASED ON HYDROGEN OR ELECTRON SOURCE:*

1. LITHOTROPHS:

They use reduced inorganic substances as their electron source.

example:

- Nitrifying bacteria(Nitromonas europea)
- Hydrogen bacteria
- Sulphur bacteria

2. ORGANOTROPHS:

They extract electrons from organic compounds.

example:

- Most non - photosynthetic bacteria