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العنوان

Physiology and biology of bacterial Three modular unit



Bacterial metabolism: Basically the properties and processes of life essentially the same in all living things, whatever size or they are plants or animals. If an individual organism is to survive it must be able to react to changes on its environments it be able to **feed, respire** and it must be able **reproduce**. The essential condition for **growth** (mean= growth in size and growth in number {multiplication}).

1. **Nutrition.**
2. **Energy.**
3. **Oxygen (O₂)**
4. **Temperature (Temp.)**
5. **pH (acidity)**
6. **Pressure.**
7. **Osmotic pressure.**
8. **Moisture.**
9. **Light.**
10. **Radiation.**
11.**et.**

To obtain optimal bacterial growth, it is necessary to understand the metabolic role of nutrients. Metabolism: an interacting a set of chemical reaction of which very few occur spontaneously and most to be **catalyzed by specific proteins called Enzyme.**



There are two main types of metabolism reactions:

- **Catabolism reaction:** It is breakdown of molecules.
- **Anabolism reaction:** it is synthesis of molecules

The **energy** needed to drive the synthetic reaction comes from breakdown

Physical factors influencing for growth

reaction and the **enzymes** which may number about 1000 in single cells are involved in its transfer. The **action of enzymes** on their specific substrate is often used in the **identification of bacteria**

Nutrients:

A. **Water:** bacteria require water for the growth, dryness may kill most of bacteria, and 80-90% of bacteria dry weight is water.

B. **Minerals:** all bacteria must be supplied :

a- Inorganic elementary (salts) like: Na, P, Cl, Co, Cu, Zn, Fe, Ca, Mg, Mn, K, S

b- Organic source (C, O₂, H₂, and N₂).

i. **Carbon** source for carbohydrate metabolism.

ii. **Nitrogen** source for protein and nucleic metabolism.

Energy: from sunlight or catabolic molecules.



Bacteria can be divided into groups based on the nutritional requirements in two ways:

A. On how they obtain their energy.

B. On how they obtain carbon needed for synthesis of all organic molecules.

Groups of bacteria according Oxygen requirement:

1. **obligatory aerobic** bacteria ex. → *Pseudomonas*
2. **obligatory anaerobic** bacteria ex. → *Clostridium*
3. **facultative anaerobic** bacteria ex. → *E. coli*
4. **microaerophilic** bacteria ex. → *Neisseria*



Groups of bacteria according pH requirement:

- 1-**Neutrophilic** bacteria (optimal pH 6.8-7-7.2) ex. → *E. coli*
- 2-**Acidophilic** bacteria (optimal pH 0.2-2) ex. → *Lactobacillus*
- 3-**Basophilic** bacteria (optimal pH 8.9-9) ex. → *Vibrio*

Groups of bacteria according Temperature requirement:

1. **Thermophilic** bacteria (optimal temp. 55-75°C).
 2. **Mesophilic** bacteria (optimal temp. 30-45°C).
- [The optimal temperature for all medical bacteria is 37 °C]
3. **Psychophilic** bacteria (optimal temp. 0-10°C).



There are another physical factors or essential condition requirement for growth bacteria.

- 1- Pressure. 2- Radiation. 3- Osmotic pressure.
- 4- Light. 5-Moisture 6-Mechanical 7-sonication

Substances produced by bacteria:

1. Stains (pigments). (extracellular or intracellular)
2. Enzymes ex.→ (Haemolysin ...coagulase ..oxidase....)
3. Toxins (Exotoxin or Endotoxin)
4. Antibiotic
5. Acids

Nonspecific Immunity [barriers and inflammatory response]

Specific Immunity Passive and Active [humoral and cell-mediated]



GROWTH CURVE

When **organism** are **cultured** in appropriate broth media (**liquid medium**):

Counting of bacteria at different period after inoculation is represented one's graph which is called **growth curve**.



1- Lag Phase

During this phase:

1. Organism takes a little time to adjust itself (adaptation) in its new environment
2. Increase in size of cell without any multiplication.
3. Increase in metabolic rate

The length of lag phase depends upon:

1. Type of bacteria → *E. coli*, T.B.
2. Good and better medium, shorter this phase.
3. The phase of culture from which inoculation takes.
4. Size of inoculums.
5. Environmental factors like temp., pH, ...

2- Log phase (Logarithmic phase) .

The **organisms become to multiply by simple binary fission** there will be **increase in number of bacteria** to the extent that medium look turbid to the naked eye.

As multiplication is by **geometric progression**. **Logarithms of viable count plotting against time gives straight line**, during this period occurs. Bacteria have high rate of metabolism



1. Bacteria increase in number.
2. Bacteria will be more sensitive to antibiotics.
3. control of log phase is brought about by:

Nature of bacteria. .a

b. Environment of medium (temp.). .b

c. Concentration of material in media. .c

3- **stationary phase** .d

After sometime due to the exhaustion of nutritional factors of the medium and the accumulation of waste products, some bacteria die, and there is a balance of dead and living bacteria. This is the number of bacteria multiplying is equivalent (=) the number of bacteria dying. Production may occur during his stage .This is called stationary phase.

Quiz: In equal rate of multiplication and death, it may be due to:

- 1- Depletion of nutrient.
- 2- Accumulation of toxic products.



4- **Decline phase :**

In some bacteria after this short period of equilibrium **the number of dying is greater than the number of multiplying** and the stage is referred to as the decline phase. During this phase, **population decreases due to death of cells.**

Factors responsible for this phase are:

1. **Nutritional exhaustion.**
2. **Toxic accumulation.**
3. **Autolytic enzymes**



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