**The Nucleus**:

The nucleus, a prominent structure in cells, stores genetic information Every cell in the body contains the same genes. Genes are segments of DNA that contain information for the production of specific proteins. Each type of cell has certain genes turned on and others turned off. DNA, with RNA acting as an intermediary, specifies the proteins in a cell. Proteins have many functions in cells, and they help determine a cell’s specificity.

**Chromatin** is the combination of DNA molecules and proteins that make up the chromosomes. Chromatin can coil tightly to form visible chromosomes during meiosis (**cell division that forms reproductive cells in humans**) and mitosis (**cell division that duplicates cells**). Most of the time, however, the chromatin is uncoiled. Individual chromosomes cannot be distinguished and the chromatin appears grainy in electron micrographs of the nucleus. Chromatin is immersed in a semi fluid medium called the nucleoplasm. A difference in pH suggests that nucleoplasm has a different composition from cytoplasm.

Micrographs of a nucleus do show one or more dark regions of the chromatin. These are nucleoli (sing., **nucleolus**), where ribosomal RNA (rRNA) is produced.

The nucleus is separated from the cytoplasm by a double membrane known as the nuclear **envelope**. This is continuous with the **endoplasmic reticulum (ER),** a membranous system of saccules and channels discussed in the next section. The nuclear envelope has **nuclear pores** of sufficient size to permit the passage of ribosomal subunits out of the nucleus and proteins into the nucleus.

**IV. MICROBIAL PHYSIOLOGY**

Environmental growth factors:  
**A-Nutrients:**

**Nutritional types:** Mos classified according to nutritional type in to:

**1. Autotrophs** use carbon dioxide as their sole or main carbon source.

**a. Photoautotrophs** use light as an energy source.

**b. Chemoautotrophs** oxidize organic or inorganic compounds to produce energy.

**2. Heterotrophs** use organic compounds as their main carbon source.

**a. Photoheterotrophs** use light as an energy source.

**b. Chemoheterotrophs** oxidize organic and inorganic compounds to produce energy.

**3. Prototrophs** are parent cells that have no special nutritional requirements. They require the same nutrients as the major number of the natural members of the species.

**4. Auxotrophs** are mutated so that they cannot synthesize the same essential nutrients (usually amino acids) as their parent cell.

**5. Subsets**

**a. Holophytic.** Organisms whose nutrients must be in a soluble, diffusible form.

**b. Holozoic.** Organisms that need complex nutrients, often solid materials that are ingested and then broken down.

**c.** **Saprophytic.** Organisms whose nutrients are obtained from dead or decaying organic matter.

**d. Parasitic.** Organisms whose nutrients are obtained from and at the expense of a living organism (human pathogens).

**Nutritional requirements.** Bacteria use a wide variety of nutrients to obtain energy and to construct new cellular components. The six elements used as the main components of carbohydrates, lipids, proteins, and nucleic acids are carbon, oxygen, hydrogen, nitrogen, phosphorus, and sulfur. Several minor and trace elements as well as cations play various roles in the microorganisms.

The following nutrients must be provided for any bacterial culture:  
1. Hydrogen donors and accepters.  
2. Carbon source.  
3. Minerals elements (sulfur and phosphorus).  
4. Growth factors (amino acid, pyrimidines and purins).  
**B-pH:**The bacteria can be classified according to pH rang:  
1. Neutrophiles: pH=6-8. most pathogenic bacteria.  
2. Acidophiles: pH=3. can grow at pH as low as 3.  
3. Alkaliphiles: pH=10.5. can grow at pH as high as 10.5.  
**C- Temperature:**The bacteria can be classified according to temperature:

**1. Psychrophile:** an organism that grows well at 0°C, has optimal growth at 15°C or less, and a maximum growth temperature of 20°C. (Psychophiles: grow best at15-20°C).

**2. Mesophile:** an organism with optimal growth at 20°-45°C, minimum growth temperatures between 15° and 20°C, and a maximum growth temperature of approximately 45°C (human pathogens).(Mesophiles: grow best at 30-37°C. most pathogenic bacteria).

**3. Thermophile:** an organism that can grow at 55°C or greater, with a minimum growth temperature of approximately 45°C.( Thermophiles: grow best at 50-60°C).

**D- Oxygen requirements:**

How organisms use oxygen can be a major factor in their classification.

**1. Aerobes** have the ability to grow in the presence of atmospheric oxygen.

**a. Obligate aerobes** depend completely on oxygen for growth. Oxygen serves as terminal electron acceptor in aerobic respiration.

**b. Facultative aerobes** have the ability to grow with or without molecular oxygen.

**2. Anaerobes** have the ability to grow without oxygen.

**a. Obligate anaerobes** do not tolerate oxygen at all and die in its presence. Many strains lack catalase and superoxide dismutase, which protect cells from the destructive oxidizing capabilities of hydrogen peroxide and superoxide ions, which are normally produced under aerobic conditions.

**b. Facultative anaerobes** do not require oxygen but grow better in its presence.

**3. Microaerophiles** require oxygen levels below normal atmospheric pressures for growth (e.g., *Helicobacter pylori*).

**4. Capnophiles** require higher levels of carbon dioxide than are found at normal atmospheric pressures for growth (e.g., *Neisseria* spp. and *Streptococcus* *pneumoniae*).

Bottom Line:

1. Obligate aerobes: need O2 as hydrogen accepter.  
2. Obligate anaerobes:- need substance other than O2 , and being sensitive to O2 inhibition   
3. Facultative:- able to live aerobically or an aerobically.

**E-Salt & Osmotic pressure:**   
-Halophiles: requiring high salt concentrations (marine bacteria).  
-Osmophiles: requiring high osmotic pressure.

**Bacterialgrowth:**  
Growth is the orderly increase in the sum of all the components of an organism. Cell multiplication is a consequence of growth, in unicellular organism, growth leads to an increase in the number of individuals making up a population. The bacterial growth can be measured by:

A: cell concentration: viable cell count.  
B: Bio mass density: by determining the dry weight of a microbial culture.

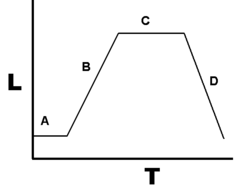
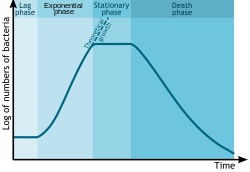
**Bacterial growth curve.** Bacterial growth is defined as an increase in the number of cells present. Because bacteria reproduce by **binary fission,** growth can be plotted as the log of the cell number versus time to produce a curve with four distinct phases.

**1. Lag phase.** Represents the period of adaptation to the new environment, enzymes and intermediates are formed.A transition period during which the bacteria are replicating DNA and the enzymes needed for the new environment are being induced. The cells are increasing in size but not in number. During this phase of growth, the cells are most permeable.

**2. Logarithmic (log) phase.** Division occurs at constant and maximal rate, and the number of cells increases in a geometric progression, the number of cells increase exponentially (one becomes 2, 2 becomes 4, 4 becomes 8...,etc), the time required for this doubling is called as generation time or doubling time. The generation time, which varies among species, is usually 15-20 minutes (*Escherichia*), but may be hours (*Mycobacterium*). Because the cell wall is being synthesized so rapidly, bacterial cells are most susceptible to cell wall inhibitors during this phase.

**3. Stationary phase.** The growth rate tapers off and growth and death rates are nearly equal. A fairly constant population of viable cells results. During this phase, cellular metabolites are polluting the environment.

**4. Death phase.** When the concentration of viable cells decreases because of the accumulation of toxic wastes and autolytic enzymes.

[](https://en.wikipedia.org/wiki/File:Bacterial_growth.png) [](https://en.wikipedia.org/wiki/File:Bacterial_growth_en.svg)

**Source of metabolic energy:**

Microorganisms derive energy from nutrients by a series of chemical reactions by which the energy stored in chemical bonds is transferred to newly formed chemical bonds to provide energy storage in a useful form, such as adenosine triphosphate (ATP).The three major mechanisms for generating metabolic energy are fermentation, aerobic respiration, and anaerobic respiration:-  
**1. Aerobic respiration:** is the metabolic process in which (O2) serves as the final electron acceptor for the electron transport chain. In this process O2 is reduced to water. This is the energy-generating used by all aerobic bacteria.   
**2. Anaerobic respiration:** is the metabolic process in which inorganic compounds other than O2 serve as the final acceptors, these acceptors can be (e.g., nitrate, sulfate or carbonate).

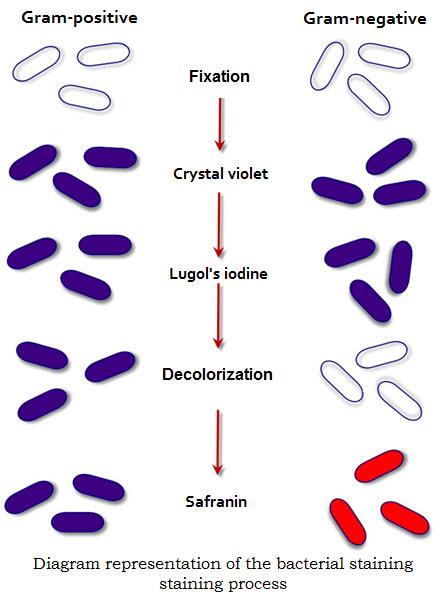
**3. Fermentation:** is an alternative aerobic process, by which an organic metabolic intermediate serves as the final electron transport, such as pyruvate, lactate, or ethanol which is released from glucose fermentation.  
In all pathways the energy represented by ATP is released and used in the biosynthesis of bacterial cell component (cell wall, capsule,…etc) the ATP yielded is much higher in respiration than fermentation.

**Microbiological culture media:**

The growth of MO depends on available nutrients and favorable growth environment. The cultures media differ depend on MO needing to nutrition.   
\*The media divided depending on their contents into:

1. Natural media.  
2. Synthetic media.   
3. Semi synthetic media.  
While the media can be divided depending physical state in to:1. Liquid media (broth).   
2. Solid media (agar).   
3. Semisolid media.  
Type of inoculation of media:   
1. Streaking plate.   
2. Spreading methods.   
3. Pour plate technique.   
4. Stapping methods.

**Stains:**Stains are chemical compounds with colored ions which react with the different constituents of the living cell to stain the transparent and minute cells of bacteria which are difficult to see by naked eyes.   
The stain may be classified into simple and differential, the simple stain colored all parts of the cell e.g. methylene blue while the differential stain are so selected that react with specific groups of the different parts of the cell or of different genera and species of bacteria for example Gram stain helps in the identification of bacteria G**+**ve and G**−**ve especially the pathogenic agents that causing disease in the lab. Many theories have been proposed to explain the observed difference in gram staining, one of the most common theory is that based on variation in the chemical composition of bacterial cell wall. G+ve bacteria contain magnesium-RNA-protein – carbohydrate complex which form an insoluble substance with the crystal violet and iodine , this complex is not washed with alcohol, while the lipid content of the cell wall being 10 times in G-ve as much as in G+ve ones, this lead to the solubility of lipids in alcohol and increase of cell wall porosity in G-ve and crystal violet iodine –complex can be extracted, so, G-ve cells become colorless after alcohol washing and take the another color safranin (cell turn pink) as shown in the below figure.

[](https://www.google.ca/url?sa=i&rct=j&q=&esrc=s&source=images&cd=&cad=rja&uact=8&ved=0CAcQjRxqFQoTCLXrv9jCysgCFSZwcgod4iMKqQ&url=https://www.studyblue.com/notes/note/n/lab-practical/deck/5955175&psig=AFQjCNEgmhYjfbUXWvvbWKtYsVL2ZOQZqg&ust=1445205782332028)