



**Department of biology**

**MICROBIOLOGY**

**BY Dr. ASEEL HASHIM RADHI**

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**Lecture 7**

**(Nutritional Types of Microorganisms)**

# The Ways of Food Entrance to Organisms

- Entrance of food substances into all plant cells, and most animal cells, is by passage through the cell membrane and cell wall if present of nutrients in an aqueous solution by the processes of diffusion and osmosis. This type of nutrition is to be **osmotrophic**.

# The Ways of Food Entrance to Organisms

- **Phagotrophic cells**

Animal cells are typically without cell walls, have the ability to ingest solid particles of food by drawing them into the cell through the cell membrane by the process called **phagocytosis**. Phagocytic cells are said to have a phagotrophic type of nutrition.

# The Ways of Food Entrance to Organisms

- **Pinocytosis:**
- Many kinds of animal cells, though lacking cell walls, are not phagocytes. However, they can engulf fluids, and possibly pass minute particles inward through the cell membrane by a process called pinocytosis.
- **A similar process called endocytosis**, large, complex molecules such as proteins, nucleic acids, some phages, and possibly colloids like sulfur, taken into the mammalian cell via minute invaginations of the cytoplasmic membrane.

# Requirements of nitrogen, phosphorus, and sulfur

- **Carbon:** The sole inorganic source of carbon is  $\text{CO}_2$  (M.O called autotrophs) while glucose and amino acids are the sole source of organic carbon, which is needed for anabolism and release energy and M.O called heterotroph.
- **Nitrogen:** Is needed for the synthesis of amino acids, purine, pyrimidine, nucleic acids, enzymes, and vitamins.

# Requirements of nitrogen, phosphorus, and sulfur

- **Phosphorus:** Is present in nucleic acids, phospholipids, nucleotides like ATP, several cofactors, some proteins, and other cell components.
- **Sulfur:** Is needed for the synthesis of substances like amino acids (cysteine, and methionine), thiamine, biotin, and some carbohydrate

# Nutritional types of microorganisms

- There are two sources of energy available to organisms:
- 1-Light energy
- 2-The energy derived from oxidizing organic or inorganic molecules.
- Some of nutrients transport method need energy such as in anaerobic bacteria, while the other doesn't need it like in aerobic bacteria.

# Nutritional types of microorganisms

- Let us focus on carbon first. All organisms are carbon-based with macromolecules – proteins, carbohydrates, lipids, nucleic acid – having a fundamental core of carbon.
- On one hand, organisms can use reduced, preformed organic substances as a carbon source. These are the **heterotrophs or “other eaters.”**
- Alternatively, they can rely on carbon dioxide (CO<sub>2</sub>) as a carbon source, reducing or “fixing” it this inorganic form of carbon into an organic molecule. These are the **autotrophs or “self-feeders.”**



# Nutritional types of microorganisms

- For energy, there are two possibilities as well: light energy or chemical energy. Light energy comes from the sun, while chemical energy can come from either organic or inorganic chemicals.
- Those organisms that use light energy are called **phototrophs** (“light eaters”), while those that use chemical energy are called **chemotrophs** (“chemical eaters”).
- Chemical energy can come from inorganic sources or organic sources. An organism that uses inorganic sources is known as a **lithotroph** (“rock eater”), while an organism that uses organic sources is called an **organotroph** (“organic eater”). These terms can all be combined, to derive a single term that gives you an idea of what an organism is using to meet its basic needs for energy, electrons, and carbon.

# Nutritional types of microorganisms

- **Phototrophs:** Microorganisms use light as an energy source, such as Chlorobium
- **Chemotrophs:** Microorganisms obtain energy from the oxidation of chemical compounds.
- **Lithotrophs:** Microorganisms use reduced inorganic substances as an electron source.
- **Organotrophs:** Microorganisms extract electrons or hydrogen from organic compounds.
- **Mixotrophs:** Bacteria that depending on inorganic energy sources and organic carbon sources.

## The common nutrients requirements:

- Analysis of microbial cell composition shows that 95% or more of cell dry weight is made up few major elements (carbon, oxygen, hydrogen, nitrogen, sulfur, phosphorus, potassium, calcium, magnesium and iron).
- These are referred to as macronutrients or macro elements because M.O require them in large amounts. The first six are components of carbohydrates, lipids, proteins, and nucleic acids. The remaining four exist in the cell as cations and play a variety of roles.

# The common nutrients requirements:

- **Potassium ( $K^+$ )**: It is required for activity by a number of enzymes including some of those involved in proteins synthesis.
- **Calcium ( $Ca^{++}$ )**: It has many functions and the most important one is the contribution to heat resistance of bacterial end spore formation.
- **Magnesium ( $Mg^+$ )**: It serves as a cofactor for many enzymes also makes a complex with ATP, stabilizes ribosome and cell membrane.
- **Iron ( $Fe^{++}$  or  $Fe^{+++}$ )**: It is involved in synthesis of cytochromes, as a cofactor for enzymes and electron carrying proteins.

## Growth factors:

- An autotroph or a heterotroph, may require small amounts of certain organic compounds for growth because they are essential substances that the organism is unable to synthesize from available nutrients. Such compounds are called growth factors.

# Growth factors:

- Growth factors are organized into three categories:
- **1-Purines and pyrimidines**: Required for synthesis of nucleic acids (DNA and RNA).
- **2-Amino acids**: Required for the synthesis of proteins.
- **3-Vitamins**: Needed as coenzymes and functional groups of certain enzymes.

## Growth factors:

- The growth factors are not metabolized directly as sources of carbon or energy; rather they are assimilated by cells to fulfill their specific role in metabolism.
- **Mutant strains** of bacteria that require some growth factor not needed by the wild type (parent) strain are referred to as **auxotroph**. Thus, a strain of E. coli that requires the amino acid tryptophan in order to grow would be called a tryptophan auxotroph.

## Growth factors:

- Some vitamins that are frequently required by certain bacteria as some of growth factors are listed in the following:
- 1- Folic acid: synthesis of thymine, purine bases, serine, methionine .
- 2- Biotin: Biosynthetic reactions that require CO<sub>2</sub> fixation
- 3- Pyridoxine (B6): decarboxylation and recreation of amino acids.
- 4- Vitamin K: electron transport processes.



## Growth factors:

- **Mineral salts:** Microorganisms need mineral salts in a small quantity of inorganic ions (cations and anions) such as:
- **1-Macronutrients elements:** They are needed for activation of enzymes, enzymes cofactor, and controlling the osmotic pressure inside the cell. They including  $Mg^{+2}$ ,  $Ca^{+2}$ ,  $Na^{+}$ , and  $Cl^{-}$ .
- **2-Micronutrients elements:** They are required in low concentration.

## Growth factors:

- There is a group of M.O, which needed  $\text{Na}^+$  and  $\text{Cl}^-$  in high concentration Called Halophiles that can be classified into:
- **1-Slightly halophiles:** Those who needed a small quantity of NaCl (2-5%), including most of marine bacteria.
- **2-Moderately halophiles:** NaCl is needed in a range about (5-10%) such as Pseudomonas, Lactobacillus.
- **3-Extremely halophiles:** NaCl is needed in a range about (20-30%) such as Halobacterium and Micrococcus. NaCl is necessary to stabilize the binding of cell wall proteins to each other

## The effect of oxygen:

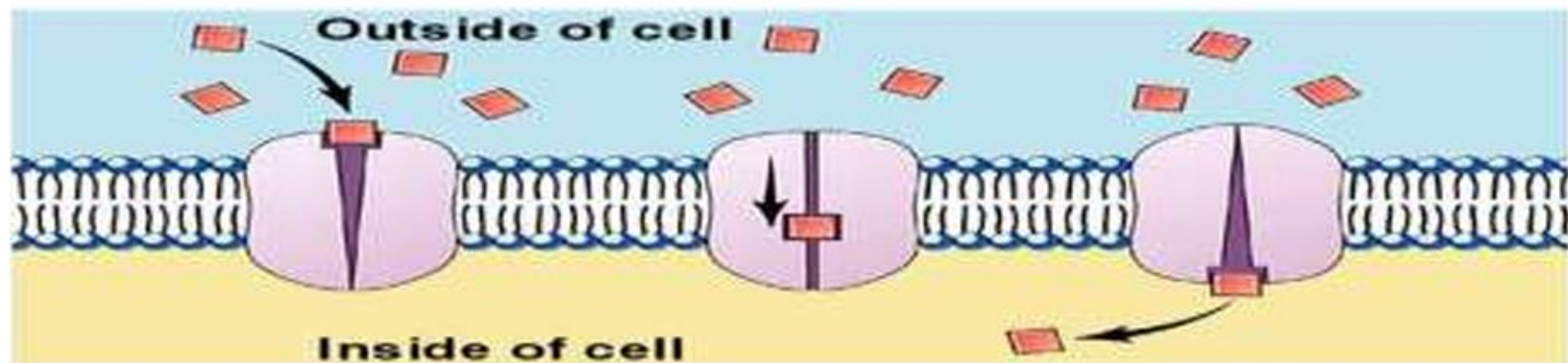
- Oxygen is a universal component of cells and is always provided in large amounts by H<sub>2</sub>O. Prokaryotes display a wide range of responses to molecular O<sub>2</sub>. (Table 1)

Group	Aerobic	Anaerobic	O <sub>2</sub> effect
<b>Obligate aerobe</b>	Growth	No growth	Required (utilized for aerobic respiration)
<b>Microaerophile</b>	Growth if level not too high	No growth	Required but at levels below 0.2 atm
<b>Obligate anaerobe</b>	No growth	Growth	
<b>Facultative anaerobe</b>  (Facultative aerobe)	Growth	Growth	Not required for growth but utilized when available
<b>Aerotolerant anaerobe</b>	Growth	Growth	Not required and not utilized

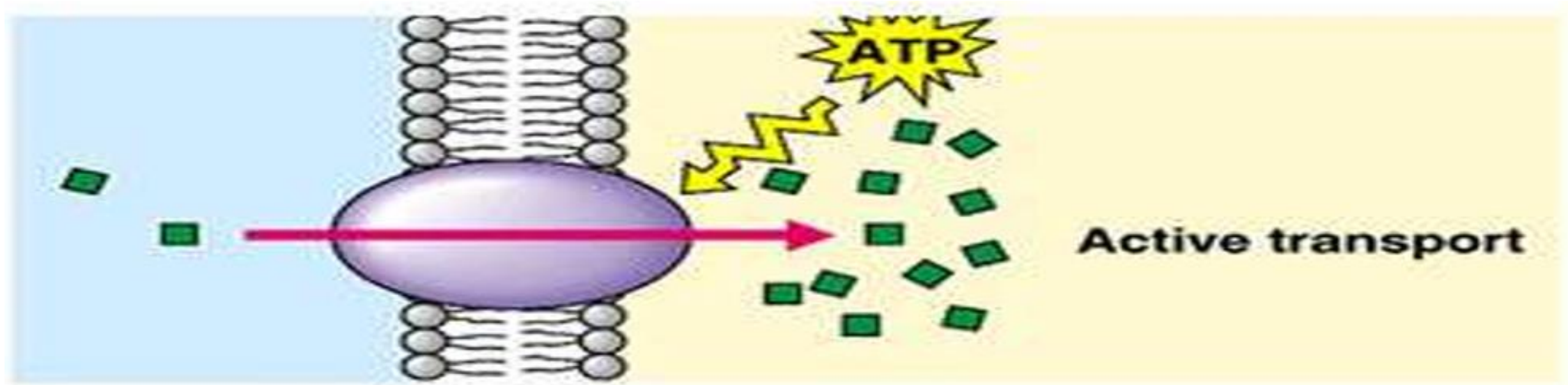
# Uptake of Nutrients

- In order to support its' activities, a cell must bring in nutrients from the external environment across the cell membrane. In bacteria and archaea, several different transport mechanisms exist., the most important of them:
- **1-Facilitated diffusion:** A few substances can cross the cytoplasm membrane by **passive diffusion**. In this process molecules move from a region of **higher** concentration to one of **lower** concentration.

## Facilitated Diffusion

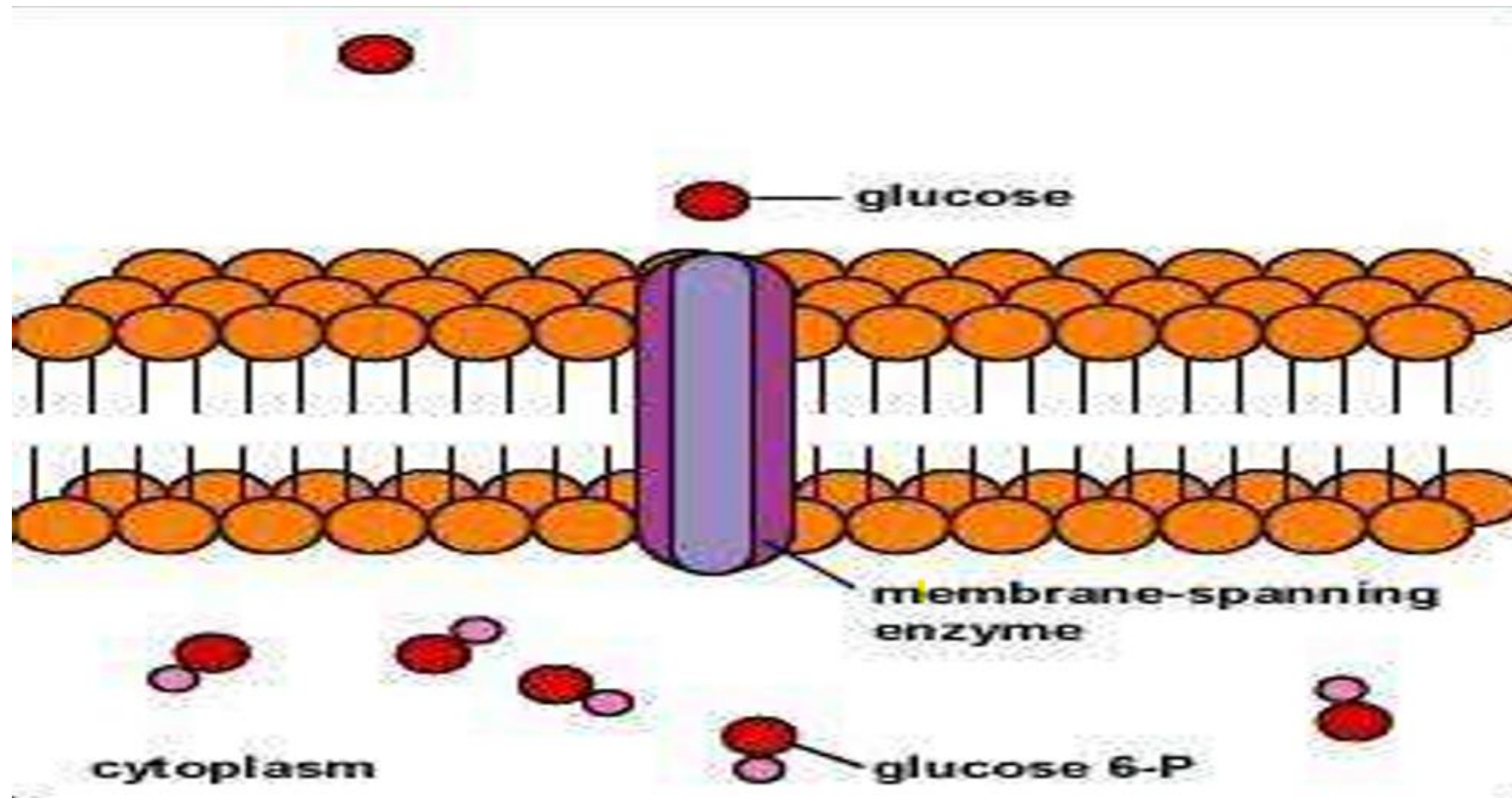


**2-Active transport:** It is transport of solute to higher concentration or against the concentration gradient with the use of metabolic energy in input.





**3-Group translocation:** A substrate is becoming phosphorylated during the transport process.





*Thank  
you*

