Department of biology

2025-2026

((MICROBIOLOGY))

Stage (2)

LEC- ((7))

Nutritional Types of Microorganisms

By

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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.

- 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.

  - **Pinocytosis:**

  Many kinds of animas cell, though lacking cell walls, are not phagocyte. 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 cytoplasm membrane.

Requirements of nitrogen, phosphorus, and sulfur

- Carbon: The sole inorganic source of carbon is Co2 (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. Generation time varies with:
- 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.
- 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_2) as a carbon source, reducing or "fixing" it this inorganic form of carbon into an organic molecule. These are the autotrophs or "self-feeders."
- 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.
- Phototrophs: Microorganismsuse light as an energy source, such as Chlorobium
- Chemotrophs: Microorganisms obtain energy from the oxidation of chemical compounds.
- Lithtrophs: 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 of a 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.
- 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 issued 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 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.
- 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 factors 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.
- 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 CO2 fixation
3. Pyridoxine (B6): decarboxylation and recreation of amino acids.
4. Vitamin K: electron transport processes.

- 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.
- There is a group of M.O, which needed Na+ and 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:

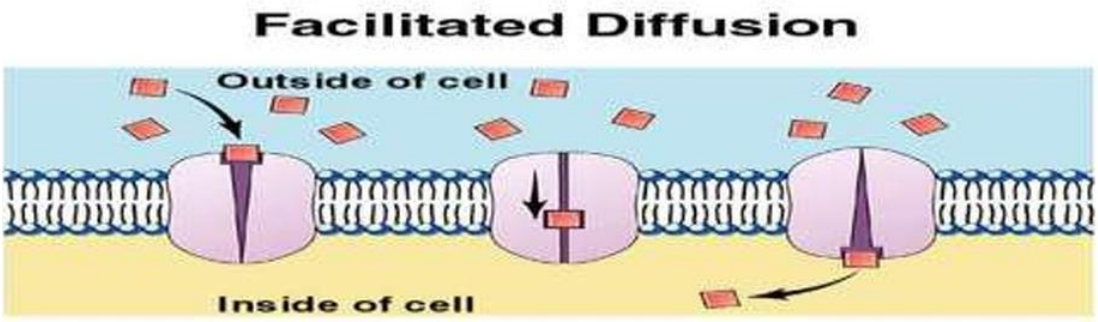
- Oxygen is a universal component of cells and is always provided in large amounts by H2O. Procaryotes display a wide range of responses to molecular O2.

Group	Aerobic	Anaerobic	O_2 effect
Obligate aerobe	Growth	No growth	Required (utilized for aerobic respiration)
Microaerophile	Growth if level not too high	No growth	Required but at levels below 0.2 atm
Obligate anaerobe	No growth	Growth	
Facultative anaerobe **(Facultative aerobe)**	Growth	Growth	Not required for growth but utilized when available
Aerotolerant anaerobe	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.



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.