Microbial Nutrition

Microorganisms requires about **10 elements** in large quantities, used to construct carbohydrates, lipids, proteins and nucleic acids. Several other factors are needed in very small amounts and are parts of enzymes and cofactors.

To obtain energy and construct new cellular components, organisms must have a supply of raw materials or nutrients. Nutrients are substances used in biosynthesis and energy release and therefore are required for microbial growth. Analysis of microbial cell composition shows that over **95% of cell dry weight** is made up of a few major elements; Carbon, Oxygen, Hydrogen, Nitrogen, Sulfur, Phosphorus, Potassium, Calcium, Magnesium and Iron which are called **macro-elements** or **macronutrients** because they are required by microorganisms in relatively large amounts. First six (C,O,H,N,S and P) are components of carbohydrates, lipids, proteins and nucleic acids while the remaining four macroelements exist in the cell as cations and play a variety of roles; **potassium (K^+)** is required for activity by number of enzymes, including some of those involved in protein synthesis.

Calcium (Ca^{+2}) contributes to the heat resistance of bacterial endospores. **Magnesium (Mg^{+2})** serves as a cofactor for many enzymes, complexes with ATP and stabilizes ribosomes and cell membranes. **Iron (Fe^{+2} and Fe^{+3})** is a part of cytochromes and a cofactor for enzymes and electron–carrying proteins.

All organisms including microorganisms (M.O) needs several micronutrients or trace elements; manganese, zinc, cobalt, molybdenum, nickel and copper. They are a part of enzymes and cofactors and they aids in the catalysis of reactions and maintenance of protein structure. **Zinc (Zn)** is present at the active site of some enzymes.

Requirements for Carbon, Hydrogen and Oxygen

Carbon requirements considers as a skeleton or backbone of all organic molecules. Molecules serving as carbon sources also contribute both oxygen and hydrogen atoms. M.O also needs a source of electron. The electron movement through electron transport chains and during other oxidation-reduction reactions can provides energy which can use in microbial activities. Electron also requires in the reduction reactions during biosynthesis. Carbon dioxide (CO_2) does not supply hydrogen or energy for the cell. All M.O can fix (CO_2) and reduce it to form organic molecules.

Bacterial Physiology Lec 2

Nutritional types of microorganisms

M.O can be classified into nutritional classes based on how they satisfy all their requirements (C, H, O, energy and electrons). There are two sources of energy available to M.O:

- **Light energy & Energy derived from oxidizing organic or inorganic molecules.**

1. Phototrophs: M.O that use light as their energy source.
2. Chemotrophs: M.O obtain energy from the oxidation of chemical compounds (organic & inorganic molecules).

Classification of M.O according to their source of electrons

1- Lithotrophs: reduced inorganic substances as their electron source.

2-Organotrophs: extract electrons from organic compounds.

According to carbon sources, M.O can be divided into two groups

1-Autotrophs; CO2 sole or principal biosynthetic carbon source.

2-Heterotrophs; Reduced, preformed, organic molecules are their carbon sources.

Major Nutritional Types

Most M.O may be placed in one of four nutritional classes based on their primary sources of carbon, energy, and electrons:

1-Photolithoautotrophy: L/E; Inorganic H/Electron donor; CO2.

2-Photoorganoheterotrophy: L/E; Organic H/Electron donor; O/ C source.

3-Chemolithoautotrophy: CH/E Inorganic; Inorganic H/Electron donor; CO2.

4-Chemoorganoheterotrophy: CH /E Organic; Organic H/Electron donor; O/ C source.

Mixotrophic: M.O that combine ch.li.au. tr. & heterotrophic metabolic processes.

Requirements for Nitrogen, Phosphorus and Sulfur

M.O must be able to incorporate large quantities of N, P & S in order to growth. Nitrogen requires for synthesis of amino acids, purines, pyrimidines, some carbohydrates, lipids, enzyme cofactors and other substances.

Phosphorus is present in nucleic acids, phospholipids, nucleotides like ATP, several cofactors, some proteins and other cell components. All M.O use inorganic phosphate as their phosphorus source.

Sulfur is needed for the synthesis of some amino acids like cysteine, methionine, some carbohydrates, biotin and thiamine. Most M.O use **sulphate** as a source of sulfur and reduce it by assimilatory sulfate reduction.

Growth factors: are an essential organic compounds required which are unable to synthesize by the organism. There are three major classes of growth factors:

1. Amino acids: require for protein synthesis.
1- Purines and pyrimidines: requires for nucleic acid synthesis.
2- Vitamins: small organic molecules that make up all or part of enzyme cofactors, only very small amounts sustain growth. Most common vitamins are Biotin, Folic acid and Riboflavin (B2).

References

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