## Chapter 6 Microbial nutrition and medium

Fresh microbial cells are mainly made of water (more than 90% of cell weight).

95% or more of cell dry weight is made up of a few major elements: carbon, oxygen, hydrogen, nitrogen, sulfur, phosphorus( C, H, O, N, P and S) , which are components of carbonhadrates, lipids, proteins and nucleic acids .

- Mineral elements are divided into two groups: macronutrients(phosphorus, potassium, magnesium, calcium, sulphur, sodium) ;
- trace elements( iron, copper, molybdenum,boron, colbalt and zinc).

### Section 1 Types and function of nutrients

1 Carbon source

There 2 kinds of carbons and they are organic carbon(sugar, starch, cellulose ) and inorganic carbon($CO_2$, $CaCO_3$).

The function of carbon is to provide energy for the metabolism of the cells and to provide building blocks for the synthesis of macromolecules of the cells.

2 Nitrogen source

There 2 kinds of nitrgens and they are organic nitrogen( protein, peptide and amino acid) and inorganic nitrogen(mainly element nitrogen).

The function of the nitrogen is that they are the building blocks of protein and nucleic acid, which are essential to life.

3 Minerals

Macroelements are with the concentraton of $10^{-3}$---$10^{-4}$mol/L, such as , P, S, K, Mg, Na, Fe.

Microelements are with the concetration of $10^{-6}$---$10^{-8}$mol/L, such as, Cu, Zn, Mn, Mo, Co, Ni, Se, Sn.

The chemicals used frequently are $K_2HPO_4$and $MgSO_4$, for they can provide 4 of the macroelements at the same time.

Function of minerals: they are essential for some physiological processes and for the activity of enzyme.

4 Growth Factors

Growth factors are essential for growth of cell, yet only tiny amount of them are needed and they are organic matters.

General growth factors include vitamin, amino acid, purine and pyrimidines. Special growth factors mean only vitamins.

5 Water

Water is essential for transportation of nutrients, biochemical process and the adjustment of temperature in cell.

### Section 2 Nutritional types of microorganisms

Based on the properties of carbon source, microbes can be divided into two groups,

Autotroph needs simple nutrients.

Heterotroph needs complex nutrients.

Based on the properties of energy, microbes can be divided into another two groups,

Phototroph needs light.

Chemotroph needs chemicals.

Based on the properties of both carbon source and energy source, microbes could be classified as follows into four groups,

| Major nutritional type | Energy source/ hydrogen (H/e-) donor /carbon source | Representative microorganisms |
|---|---|---|
| Photoautotroph (Photolithotroph) | Light / inorganic matter / CO2 | Algae, Purple and green bacteria, Cyanobacteria |
| Photoheterotroph (Photoorganotroph) | Light / organic matter / CO2 and organic matter | Purple nonsulfur bacteria, Green sulfur bacteria |
| Chemoautotroph (Chemolithotroph) | Inorganic matter/ inorganic matter / CO2 | Sulfur-oxdizing bacteria, Hydrogen bacteria, Nitrifying bacteria |
| Chemoheterotroph (Chenoorganotroph) | Organic matter / organic matter / organic matter | Most bacteria, fungi, protozoa |

## Section 3 Culture media

1 Types of media

Culture media is substrate in which microbes grow.

Based on the state of medium, culture media can be divided into Liquid media, Solid media, Semi-solid media and Dehydrated media.

Based on chemical composition, culture media can be divided into Complex media, Undefined media (only natural substrate or materials) and Chemical defined media (containing only chemicals) and Semi-defined media(containing natural substrate and chemicals).

Based on the function, culture media can be divided into Selected media(only special microbes can grow in it), Enriched selected media(containing special nutrient), Inhibited selected media(certain microbes are inhibited in it ) and Differential media(special microbes will be recognized in it, for example, E.coli. forms green metal-colored colony on Eosin Methylene Blue, EMB)

2 principle for preparing media

1) Complete nutrition. C：N=6：1。

2) Proper osmotic pressure

3) Proper pH and redox potential

4) Lower cost.

## Section 4 Absorption of nutrients

Most microorganisms obtain nutrients by permeabile absorption except that protozoa by phagocytosis.

Nutrients have to cross selectively permeable plasma membranes before they enter the cell. There are four ways for the nutrient to pass the plasma membrane.

### 1 Passive diffusion

Passive diffusion is the process in which molecules move from a region of higher concentration to one of lower concentration as a result of random thermal agitation.

A few substances, such as water,$CO_2$, $O_2$ , glycerol and some ions, can cross the plasma membrane by passive diffusion.

### 2 Facilitated diffusion

The diffusion process is aided by a carrier, which is called facilitated diffusion.

The rate of diffusion across selectively permeable membranes is greatly increased by the aid of carrier proteins, sometimes called permeases, which are embedded in the plasina membrane.

A model of facilitated diffusion

The membrane carrier can change conformation after binding an external molecule and subsequently release the molecule on the cell interior. It then returns to the outward oriented position and is ready to bind another molecule.

Because there is no energy input, molecules will continue to enter only as long as their concentration is greater on the outside.

### 3 Active transport

Active transport is aided by carrier proteins, in which the solute molecules are transported from lower concetrations to higher concentrations, with the use of metabolic energy input.

There are two ways to obtain the energy needed. They are proton-motive force and ATP.

### 4 Group translocation

Group transtlocation is a kind of active transport in which the molecules transported have changed chemically after they pass the membrane.

The best-known group translocation system is the phosphoenolpyruvate/sugar phosphotransferase system (PTS), which transports a variety of sugars into procaryotic cells while simultaneously phosphorylating them using phosphoenolpyruvate (PEP) as the phosphate donor.

PEP + sugar (outside) ------- pyruvate + sugar-P (inside)

The following is phosphoenolpyruvate: sugar phosphotransferase system of E. coli.

PEP+Enz Ⅰ -------- Enz Ⅰ-P

Enz Ⅰ-P+HPr-------HPr-P（Enz,Ⅰ,PHPr）

HPr-P +Enz Ⅲ ------- Enz Ⅲ -P

Glucose+ Enz Ⅲ -P（ Enz Ⅱ ） -------- Glucose-P