Growth Requirements

Microbiologists use the term *growth* to indicate an increase in a *population* of microbes rather than an increase in size. Microbial growth depends on the metabolism of nutrients, and results in the formation of a discrete **colony,** an aggregation of cells arising from a single parent cell. A **nutrient** is any chemical required for growth of microbial populations , or are substances used in biosynthesis and energy production , therefore are required for microbial growth . The most important of these are compounds containing carbon, oxygen, nitrogen, and/or hydrogen.

Nutrients: Chemical and Energy Requirements

All cells require three things to conduct metabolism: a carbon source, a source of energy, and a source of electrons or hydrogen atoms.

Sources of Carbon, Energy, and Electrons

Organisms can be categorized into one of four groups based on their source of carbon and their use of either chemicals or light as a source of energy:

Photoautotrophs use carbon dioxide as a carbon source and light energy from the environment to make their own food.

Chemoautotrophs use carbon dioxide as a carbon source but catabolize organic molecules for energy.

Photoheterotrophs are photosynthetic organisms that acquire energy from light and acquire nutrients via catabolism of organic compounds.

Chemoheterotrophs use organic compounds for both energy and carbon.

In addition, **organotrophs** acquire electrons from organic sources, whereas **Iithotrophs** acquire electrons from inorganic sources.

Common nutrient requirements

Microbial cell require a basic nutrient elements for growth and replication as fallow :

1- Microbial cell composition is made up of few major elements like carbon , oxygen , hydrogen, nitrogen , sulfur , phosphorus , potassium , calcium, magnesium and iron are called **macro elements** because they are required in large amounts as components of carbohydrate , lipid , protein , nucleic acids synthesis.

2- Microorganisms require several **micronutrients** like manganese , zinc , cobalt , nickel and copper are available in nature , have many roles in the cells as a part of enzymes , cofactors that make to catalysis of reaction and maintenance of protein structure .

3- **Growth factors** are organic compounds require as an essential cell components and can not synthesis by M.O. There are three major classes of growth factor :

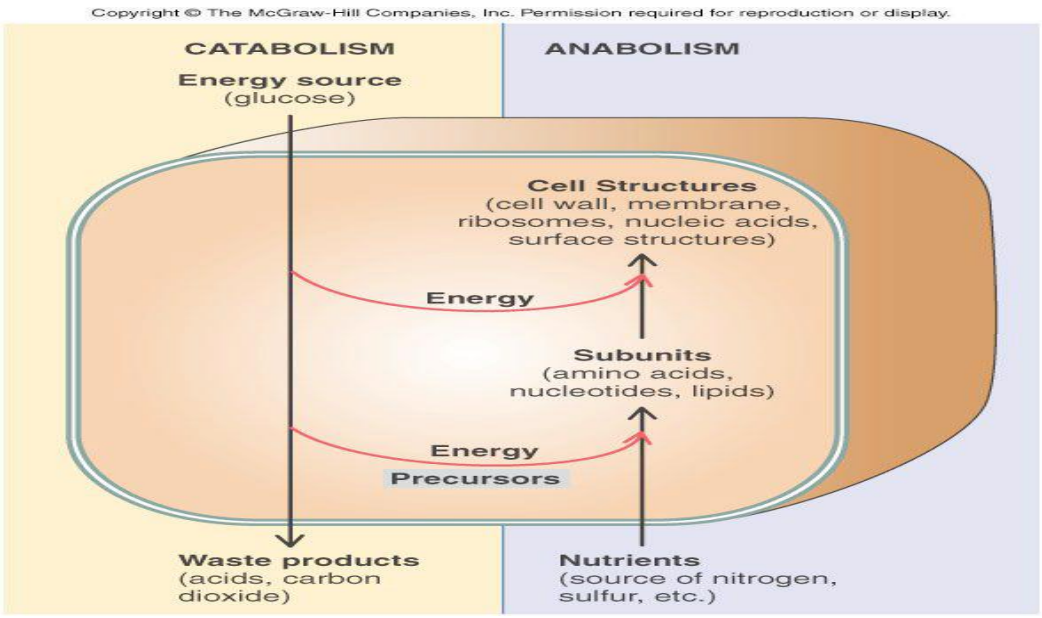
a- purines and pyrimidines for nucleic acid synthesis .

b- amino acids are needed for protein synthesis .

c- vitamins are small organic molecules that usually make –up all or part enzymes and cofactors that are needing in very small amounts to sustain growth such as folic acid , biotin , vitamins B12 and K etc .

Some bacteria for ex. *E. coli* do not require any growth factors , they can synthesize all essential purines, pyrimidines, amino acids and vitamins, starting with their carbon source, as part of their own intermediary metabolism, while other bacteria like *Lactobacillus* requires purines,

pyrimidines, vitamins and several amino acids in order to grow.



Overview of Metabolism

Oxygen Requirements

Obligate aerobes require oxygen as the final electron acceptor of the electron transport chain, whereas obligate anaerobes cannot tolerate oxygen and use an electron acceptor other than oxygen. Toxic forms of oxygen are highly reactive and cause a chain of vigorous oxidation. Four forms of oxygen are toxic:

Singlet oxygen (02)
Supcroxide radicals (02)
Peroxide anion (02^{2}-)
Hydroxyl radicals (OH')

Not all organisms are either strict aerobes or anaerobes. **Facultative anaerobes** can maintain life via fermentation or anaerobic respiration,

though their metabolic efficiency is often reduced in the absence of oxygen. **Aerotolerant anaerobes** prefer anaerobic conditions, but can tolerate oxygen because they have some form of the enzymes that detoxify oxygen's poisonous forms. **Microaerophiles** require low levels of oxygen. **Capnophiles** grow best with high carbon dioxide levels in addition to low oxygen levels.

Nitrogen Requirements

Nitrogen is a growth-limiting nutrient for many microorganisms, which acquire it from organic and inorganic nutrients. Though nitrogen constitutes about 79% of the atmosphere, relatively few organisms can utilize nitrogen gas. A few bacteria reduce nitrogen gas to ammonia via a process called **nitrogen fixation,** which is essential to life on Earth.

Physical Requirements

In addition to chemical nutrients, organisms have physical requirements for growth, including specific conditions of temperature, pH, osmolarity, and pressure.