Microorganisms and Nutrition

1. Microorganisms :Tiny Powerhouses of Life

- **Microscopic Size**: Invisible to the naked eye; require a microscope to be seen.
- **Diverse Forms**: Includes bacteria, viruses, fungi, protozoa, and algae.
- **Reproduction**: Rapid reproduction through binary fission, budding, or spore formation.
- **Ubiquitous Presence**: Found in various environments, including extreme conditions.
- **Metabolic Diversity**: Utilize different energy sources like light, chemicals, or organic matter.

2. Classification of Microorganisms

➢ **Bacteria :**

- **Discovered by**: Antony Van Leeuwenhoek
- **Unicellular and Prokaryotic**: Single-celled organisms without a true nucleus.
- **Cell Structure**: Cell wall made of peptidoglycan; may have flagella.
- **Reproduction**: Binary fission; can exchange genetic material.
- **Roles**: Aid in digestion, nitrogen fixation, and antibiotic production.
- Examples: Rhizobium, Azotobacter, Lactobacillus.

➢ **Fungi :**

- **Cell Structure**: Can be unicellular or multicellular; cell wall made of chitin.
- **Heterotrophic**: Depend on external sources for nutrients.
- **Decomposers**: Break down dead organic matter.
- Examples: Yeasts, molds, mushrooms.
- **Applications**: Useful (e.g., yeast, penicillin) and harmful (e.g., ringworm).

➢ **Viruses :**

- **Discovered by**: Dmitri Ivanovsky
- **Non-Cellular**: Composed of proteins, nucleic acids, and lipids.
- **Reproduction**: Only active within host cells.
- Examples: Influenza virus (flu), HIV/AIDS.

➢ **Protists** :

- **Unicellular and Microscopic**: Single-celled organisms, distinct from plants and animals.
- **Nutritional Modes**: Autotrophic (photosynthesis) or heterotrophic.
- **Reproduction**: Primarily through binary fission or budding.
- Examples: Amoeba, diatoms, slime molds.
- **Ecological Role**: Oxygen production, nutrient recycling.

➢ **Algae :**

- **Study:** Phycology
- **Autotrophic**: Can be unicellular or colonial; photosynthetic.
- **Uses:** Food (e.g., Ulva), manure, medicine (e.g., laminaria for iodine).
- **Harmful Effects**: Water bloom, red tide.

3. Diseases Caused by Microorganisms

- **Bacterial Diseases**: Tuberculosis, Cholera, Typhoid, Botulism, Pneumonia, Meningitis.
- **Viral Diseases**: HIV/AIDS, Common Cold, Hepatitis B, Chickenpox, Measles, Rabies, COVID-19.
- **Protist Diseases**: Malaria, Sleeping Sickness, Kala Azar.
- **Fungal Diseases**: Ringworm, Athlete's Foot, Asthma.

4. Importance of Microorganisms

- **Nutrient Cycling**: Decompose organic matter (e.g., Nitrosomonas in nitrogen cycle).
- **Soil Fertility**: Enhance nutrient uptake (e.g., Glomus fungi in roots).
- **Disease Prevention**: Maintain gut health (e.g., Lactobacillus).
- **Bioremediation**: Clean up pollutants (e.g., Pseudomonas).
- **Food Production**: Fermentation (e.g., yeast in bread).
- **Medicine Production**: Antibiotics (e.g., Penicillium notatum).
- **Agricultural Benefits**: Nitrogen fixation (e.g., Rhizobium).
- **Biogas Production**: Methane generation from anaerobic bacteria.
- **Climate Regulation**: Affect CO2 levels (e.g., marine phytoplankton).

5. Nutrition in Plants, Animals, and Humans

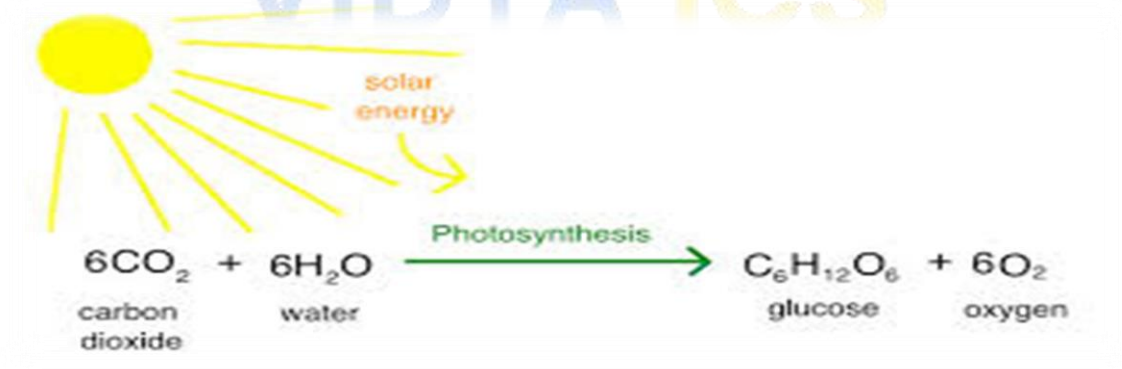
Nutrition Overview:

- **Definition**: Process of obtaining and utilizing food for growth, maintenance, and health.
- **Categories**: Autotrophic (self-feeding) and heterotrophic (feeding on others).

Nutrition in Plants: Photosynthesis

Photosynthesis is a biological process used by plants, algae, and some bacteria to convert light energy, usually from the sun, into chemical energy stored in molecules of glucose.

This process is fundamental to life on Earth, as it provides the primary source of organic matter for almost all organisms and releases oxygen into the atmosphere.



- CO_2: Carbon dioxide absorbed from the atmosphere.
- H_2O: Water absorbed from the soil.
- $C_6H_{12}O_6$: Glucose (a type of sugar used for energy and growth).
- O_2: Oxygen released as a byproduct.

Sites of Photosynthesis :

Chloroplasts: Photosynthesis occurs in the chloroplasts of plant cells. Chloroplasts are specialized organelles that contain chlorophyll and other pigments necessary for capturing light energy.

- Structure :
  - **Double Membrane**: Outer and inner membranes surround the chloroplast.
  - **Thylakoids**: Membrane-bound sacs within the chloroplast. Thylakoids are organized into stacks called granum.
  - **Stroma**: Fluid-filled space surrounding the thylakoids.

Steps of Photosynthesis :

Light-Dependent Reactions (Occur in Thylakoid Membranes):

1. **Photon Absorption**: Chlorophyll and other pigments in the thylakoid membranes absorb light energy.
2. **Water Splitting**: Light energy is used to split water molecules (H_2O) into oxygen (O_2), protons (H^+), and electrons.
3. **Electron Transport Chain** (ETC): Excited electrons travel through a series of proteins embedded in the thylakoid membrane, creating a flow of energy.
4. **ATP and NADPH Formation**: The energy from the electron transport chain is used to convert ADP and inorganic phosphate (Pi) into ATP and to reduce $NADP^+$ to NADPH.
   - **ATP**: Adenosine Triphosphate, an energy carrier.
   - **NADPH**: Nicotinamide Adenine Dinucleotide Phosphate, a reducing agent.

Light-Independent Reactions (Calvin Cycle, Occur in the Stroma):

1. **Carbon Fixation**: CO_2 is fixed into a 5-carbon sugar molecule (ribulose bisphosphate, RuBP) by the enzyme RuBisCO.
2. **Reduction Phase**: ATP and NADPH from the light-dependent reactions are used to convert into a sugar molecule.

Factors Affecting Photosynthesis :

- **Light Intensity**: Affects the rate of photosynthesis up to a certain point; too much light can damage the chlorophyll.
- **Carbon Dioxide Concentration**: Increased CO_2 levels generally increase the rate of photosynthesis.
- **Water Availability**: Essential for the light-dependent reactions; water stress can limit photosynthesis.
- **Temperature**: Affects enzyme activity; too high or too low temperatures can reduce the efficiency of photosynthesis.
- **Pigments**: Chlorophyll a is the primary pigment, but chlorophyll b and carotenoids also play roles in capturing light energy.

Significance of Photosynthesis

- **Foundation of Life**: Provides the base of the food chain for most ecosystems by converting solar energy into chemical energy.
- **Oxygen Production**: Supplies oxygen necessary for respiration in animals and other aerobic organisms.
- **Carbon Cycle**: Plays a crucial role in regulating atmospheric CO_2 levels and thus impacts global climate.

Additional Concepts :

- **Photorespiration:** A process where RuBisCO fixes oxygen instead of carbon dioxide, which can decrease the efficiency of photosynthesis.
- **C4 Photosynthesis**: A variant of photosynthesis found in some plants (e.g., maize, sugarcane) that is adapted to high temperatures and low CO_2 concentrations.
- **CAM Photosynthesis**: Found in succulents and other desert plants; opens stomata at night to reduce water loss and fixes CO_2 into organic acids.
- **Photosynthesis**: Plants produce food using sunlight, CO_2, and water.
- **Site**: Chloroplasts (Thylakoids and Stroma).
- **Key Factors**: Sunlight, CO_2, water, pigments, RuBisCO enzyme, temperature.

Nutrient Absorption in Plants :

- **Macronutrients**: Needed in large quantities (e.g., Nitrogen, Phosphorus).
- **Micronutrients:** Needed in smaller amounts (e.g., Iron, Zinc).

Significance of Photosynthesis :

- **Foundation of Life**: Provides food, regulates carbon cycle, and produces oxygen.

Nutrition in Animals :

- **Ingestion**: Intake of food.
- **Digestion**: Breakdown of food into smaller, absorbable components.
- **Absorption:** Nutrients absorbed into the bloodstream.
- **Assimilation**: Utilization of nutrients.
- **Egestion**: Elimination of waste.

Types of Nutrition in Animals

- **Filter Feeding**: Nutrients from suspended particles (e.g., fish).
- **Deposit Feeding**: Nutrients from soil particles (e.g., earthworms).
- **Fluid Feeding**: Consumes fluids (e.g., mosquitoes).
- **Bulk Feeding**: Eats whole organisms (e.g., humans, lions).

Nutrition in Amoeba :

- Ingestion: Uses pseudopodia to engulf food.
- Digestion: Occurs inside food vacuoles.
- Absorption: Nutrients diffuse into the cytoplasm.
- Egestion: Waste expelled through the cell membrane.