

**SUBJECT:**

**INTRODUCTION TO PHYSIOLOGY OF CROP PLANT (AGR-301)**

**INSTRUCTOR:**

**DR. GHULAM HASSAN ABBASI**

**ACKNOWLEDGMENT:**

**SOIL SALINITY LABORATORY (SSL)**

**DEPARTMENT OF ENVIRONMENTAL SCIENCES**

**UNIVERSITY COLLEGE OF AGRICULTURE AND  
ENVIRONMENTAL SCIENCES**



**The Islamia University of Bahawalpur Pakistan**

**Crop Physiology:** The study of functions and internal processes within the community of plants is called crop physiology.

### **Concept and Significance of Crop Physiology:**

**Science:** It is the systematic study of any thing is called science. that is based upon observation and proved through experiments. Anything means living or non-living things.

**Biology:** The study of life is referred as Biology. It is further divided in Botany and Zoology.

- ❖ **Botany:** the study of structural, functional and evolution of plants is called botany.
- ❖ **Zoology:** the study of structural, functional and evolution of animals is called Zoology.
- **Morphology:** the study of external structural, functional and evolution of plants is called morphology.
- **Physiology:** the study of internal structural, functional and evolution of plants is called physiology.
- **Anatomy:** the study of internal structural of plants is called anatomy.
- **Cytology:** study of anatomy at cell level is called cytology.
- **Histology:** study of anatomy at tissue level is called histology.

Crops: the community of plants is called crop.

### **Difference Between Crop and Plant Physiology:**

Sr. No.	Crop Physiology	Plant Physiology
1.	It deals with the community of plants.	It deals with single plant.
2.	It is understanding the physiology processes to solve the problems.	That is the understanding the basic physiology processes within single plant, like photosynthesis, Respiration, Nutrients uptake and Translocation.
3.	In crop physiology more consideration to economic purpose of crop (production of crop).	In plant physiology economic purpose is less consideration.

### **Significance of Crop Physiology:**

- ❖ Understanding the basic physiology processes like photosynthesis, respiration.
- ❖ To study the integration (changes) of basic physiological processes e.g. photosynthesis with productivity.

- ❖ To study the influence of environment on the basic physiological processes.
  - ✓ In air environment: temperature, light, humidity, rainfall, wind velocity.
  - ✓ In soil environment: soil temperature, texture, nutrients etc.
- ❖ Effects of the various processes on the plant activity, growth and development.
- ❖ Sequence of events that results in plant growth and development. e.g. cell division, cell elongation.

### **Structure and Function of a Plant Living System:**

**System:** A group of things or parts working together is called system.

**Living System:** That is the plant or animal body including internal organs or process is termed as living system.

### **Plant body System:**

- At cell level
- At tissue level
- At organ level

### **Types of Cells:**

S.#	Types	Function	Location
1	<b>Meristematic Cell</b>	Production of new cells	Meristem
2	<b>Ground Cell</b>	Metabolic Processes e.g. Respiration	Throughout the body
3	<b>Parenchyma Cell</b>	Storage & Condition, Wound Healing & Regeneration	Cortex, as pith & pith rays, xylem, phloem
4	<b>Epidermis Cell</b>	Physical protection	Throughout the body
5	<b>Collenchyma Cell</b>	Support in primary plant body	Periphery of herbaceous stem & in petiole & ribs of leaves.
6	<b>Fiber Cell</b>	Strengthen the body Cell	Sometime in the cortex but mostly in the vascular tissues and associates with phloem
7	<b>Sclereids Cell</b>	Mechanical support	Throughout the body
8	<b>Xylem Cell</b>	Water & minerals transport	Vascular tissue
9	<b>Phloem Cell</b>	Transport of organic compounds	Vascular tissue
10	<b>Tracheid Cell</b>	Water & nutrients conduction	Xylem tissue
11	<b>Vessel Cell</b>	Connection for transports water b/w cells	

12	<b>Sieve Cell</b>	Food Production	Phloem Tissues
13	<b>Albuminous</b>	Into & out of sieve cells	
14	<b>Sieve tube Members Cell</b>	Food Conduction	
15	<b>Companion Cell</b>	Play role in movement of food into & out of sieve tube member.	

### **Tissue Level:**

**Tissue:** Aggregation of cells with a common function is called tissue.

### **Two Classes of Tissues:**

- ❖ Meristematic tissue: dividing tissue
- ❖ Non-meristematic tissue: non dividing or permanent tissue

**Meristematic Tissue:** A group of cells that under favorable conditions remain embryonic and retain their capability of cell division throughout the life.

### **Types of meristematic on the base of Location:**

- ❖ Apical meristematic tissue: which are located on the shoot apical (growth in length)
- ❖ Intercalary meristematic tissues: which are located at internodes (growth in length)
- ❖ Lateral meristematic tissue: which are located laterally, parallel to long plant body (growth in diagram)

### **Types on the Base of Origin:**

- ❖ Primary Meristematic tissue: these develops from embryonic cells.
- ❖ Secondary Meristematic tissue: these develop from mature cells.

**Non-Meristematic Tissues:** Simple permanent: which are containing structurally and functionally similar cells. E.g. dermal tissue, base or ground tissue, sclerenchyma, parenchyma, collenchyma's.

**Complex Permanent Tissues:** Which containing different types of cells. e.g. cork tissue (cork cells, cork cambium), xylem tissue (fibers, parenchyma, tracheid, vessels), phloem tissue (parenchyma, fiber, sieve tube, companion).

## **Basic Terminology Used in Crop Physiology**

- ✓ **Apoplast:** the continuum of cell walls throughout the plant, important in water movement.
- ✓ **Coleoptile:** A cylindrical sheath of tissue that encloses and protects young shoots of grasses and cereals during growth to the soil surface.
- ✓ **Cotyledon:** Embryonic leaf in seed plants that acts either as a storage organ or in absorbing food reserves from the **endosperm**. Dicotyledonous plants (such as broadleaf weeds) have two cotyledons and monocotyledonous plants (cereals and grasses) have one.
- ✓ **Cuticle:** A continuous waxy layer that covers the aerial parts of a plant to prevent excessive water loss.
- ✓ **Cutin:** A water - repellant waxy polymer that is a major component of the cuticle.
- ✓ **Differentiation:** A series of changes that occur in cells and tissues during development, resulting in their specialization.
- ✓ **Emergence:** The breaking through the soil surface by a seedling or an elongating shoot.
- ✓ **Ephemeral:** A plant with such a short life cycle that it may be completed many times in one growing season.
- ✓ **Epinasty:** Plant tissue movement to an external stimulus in which increased growth on one side of an organ causes bending of that organ. Commonly observed following application of auxins to young tissues.
- ✓ **Meristem:** A region containing actively dividing cells.
- ✓ **Metabolism:** The sum of the enzymatic reactions taking place in a cell, organ or organism.
- ✓ **Metabolite:** A product of **metabolism** within an organism.
- ✓ **Microtubule:** A cytoplasmic tubule composed of the protein tubulin.
- ✓ **Organelle:** A membrane - bound structure in the cytoplasm in which specific but essential processes take place.
- ✓ **Perennial:** A plant that lives for many years, surviving as either herbaceous perennials (with underground storage organs) or woody perennials (whose aerial stems persist above ground).
- ✓ **Photosynthate:** Organic products of photosynthetic carbon reduction.
- ✓ **Phytotoxicity:** Damage to plants.
- ✓ **Plasmid:** A non - chromosomal, circular, DNA molecule.
- ✓ **Plasmodesmata:** Cytoplasmic channels that span the plasma membrane and cell walls of plants, and form physiological connections between adjacent cells.
- ✓ **Plasticity:** The ability of an organism to change its form in response to varying environmental conditions.
- ✓ **Plastids:** Major organelles found in plant and algal cells.
- ✓ **Protoplast:** the part of the plant cell internal to the cell wall and bounded by the plasma membrane.
- ✓ **Stem cells:** Any cells that can proliferate in an undifferentiated state and can give rise to differentiated cells or tissues.
- ✓ **Stoma:** A moveable pore on aerial plant surfaces to allow gaseous exchange (pl. stomata).
- ✓ **Symplast:** the continuum of cytoplasm throughout the plant, linked by **plasmodesmata**.

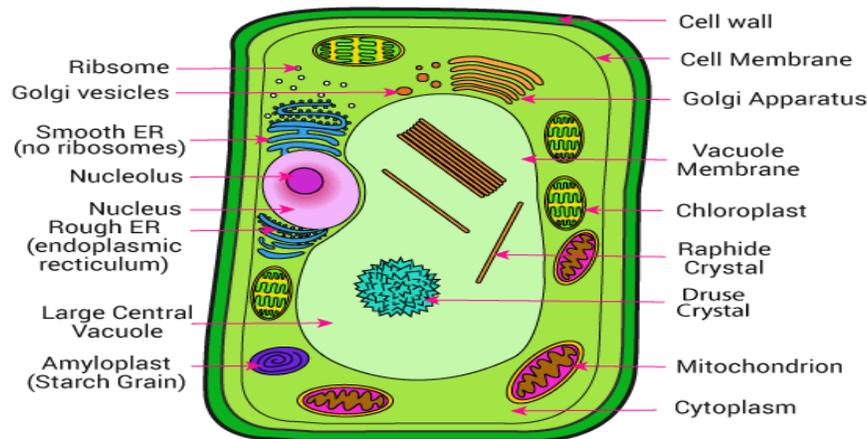
## **Cell Structure and Function**

## Plant Cell:

“Plant cells are eukaryotic cells with a true nucleus along with specialized structures called organelles that carry out certain specific functions.”

### Plant Cell

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## Plant Cell Structure:

- ✓ Cell Wall
- ✓ Cell Membrane
- ✓ Nucleus
- ✓ Plastids
- ✓ Leucoplasts
- ✓ Chloroplasts
- ✓ Chromoplasts
- ✓ Central Vacuole
- ✓ Golgi Apparatus
- ✓ Ribosomes
- ✓ Mitochondria
- ✓ Lysosome

### The Colloidal Systems:

The complex nature of the living substance in the cell, the protoplasm, is due to its physio-chemical properties. Protoplasm is predominantly composed of substances in the colloidal state and certainly it is to these colloidal systems that it owes much of its characteristic properties—variation in viscosity from values not greater than that of pure water to those of jellies, pronounced capacity for imbibition of water, though itself high in water content sometimes behaving as if immiscible with water, properties of irreversible coagulation at very high or low temperatures or at high concentration of salts, etc.

### **Adsorption:**

Adsorption is the condensation in the form of a film of molecules of a gas or of a solute or suspended particle upon the surface of a solid or liquid. Specially treated charcoal is one of the best adsorbents known for both gases and solutes. Gas masks which are used as a protection against poisonous gases in warfare owe their efficiency to the adsorptive capacity of charcoal present in the gas masks.

### **Imbibition:**

We have seen before that colloidal systems invariably take up a large amount of water from their surrounding medium and as a result swell up considerably. Many other substances such as proteins, gums, starch, cellulose, agar, gelatin, etc., show such hydrophilic properties when placed in contact with water or lose water and shrink when devoid of water.

### **Diffusion**

The movement of molecules or ions of a solute or solvent, be it a solid, liquid or gas from the region of its higher concentration/partial pressure / chemical potential to that of its lower concentration/ partial pressure/chemical potential.

The pressure exerted by the diffusing particles is called diffusion pressure and influenced by following factors:

1. Temperature
2. Density of diffusing substances
3. Medium in which diffusion occurs
4. Diffusion pressure gradient

### **Role of diffusion in plants:**

1. Exchange of gases during respiration and photosynthesis
2. Transpiration
3. Uptake of minerals
4. Translocation of substances

### **Osmosis:**

Diffusion of water/ solvent molecules from a dilute solution to the concentrated solution when the two are separated by a semipermeable membrane.

### **Osmosis Plays an Important Role in Plants as it Helps in:**

- Absorption of water by the plants
- Cell to cell movement of water
- Maintaining rigidity & shape of plant organs, leaves expand due to osmotic pressure, growing tips are able to penetrate the soil particles
- Opening and closing of stomata

### **Turgor Pressure (TP):**

It is the hydrostatic pressure generated by the protoplasm within the cell against cell wall as a result of osmotic entry of water into it. TP is always less than OP unless the cell is in water. Cell wall being rigid and elastic, exerts an equal and opposite pressure on expanding protoplasm, called wall pressure (WP).

### **Water Potential:**

The combination of solute concentration differences and physical pressure are incorporated into water potential, abbreviated with the Greek letter psi ( $\Psi$ ) Water will flow through a membrane from a solution of high-water potential to a solution of low water potential Water potential is measured in units of megapascals (MPa). Pure water has a water potential of 0 MPa (= 0 MPa)

### **Solute potential:**

Pure water is usually defined as having a solute potential ( $\Psi\pi$ ) of zero, and in this case, solute potential can never be positive. The relationship of solute concentration (in molarity) to solute potential is given by the van't-Hoff equation :

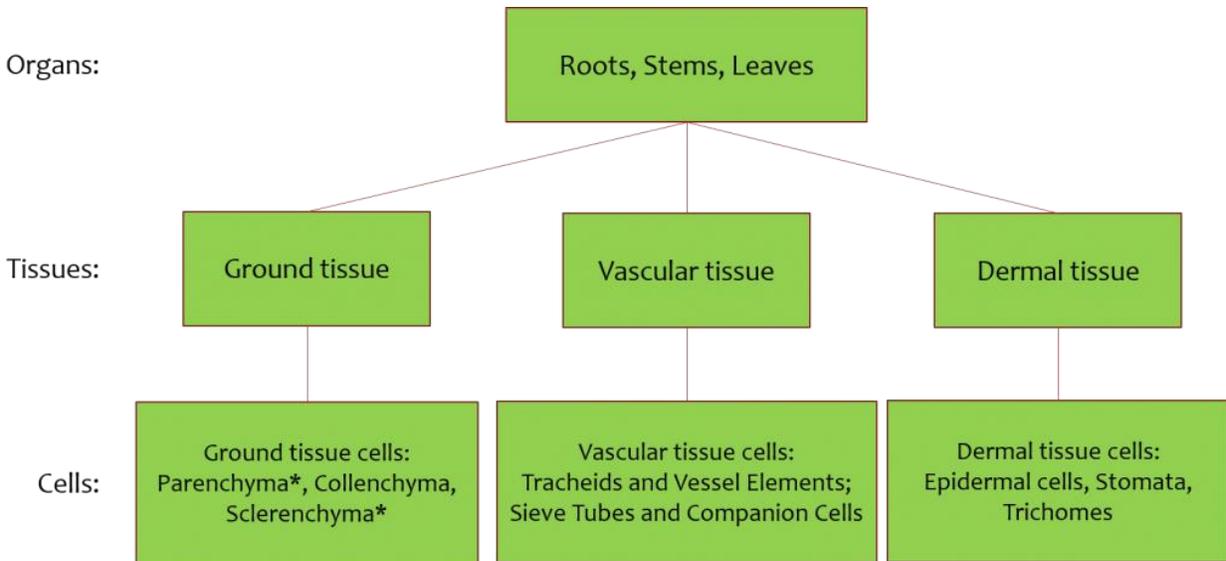
$\Psi$

$$\pi = - MiRT$$

where  $M$  is the concentration in molarity of the solute,  $i$  is the van't-Hoff factor , the ratio of amount of particles in solution to amount of formula units dissolved,  $R$  is the ideal gas constant, and  $T$  is the absolute temperature.

### **Plant Body Organization**

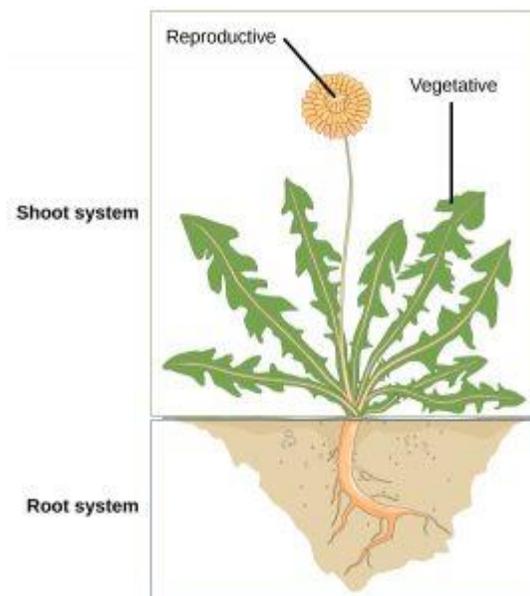
Like animals, plants are multicellular eukaryotes whose bodies are composed of organs, tissues, and cells with highly specialized functions. The relationships between plant organs, tissues, and cell types are illustrated below.



\*Parenchyma and sclerenchyma are also associated with xylem and phloem (vascular tissue)

### **Plant Organ Systems**

Vascular plants have two distinct organ systems: a shoot system, and a root system. The shoot system consists stems, leaves, and the reproductive parts of the plant (flowers and fruits). The shoot system generally grows above ground, where it absorbs the light needed for photosynthesis. The root system, which supports the plants and absorbs water and minerals, is usually underground. The organ systems of a typical plant are illustrated below.



The shoot system of a plant consists of leaves, stems, flowers, and fruits. The root system anchors the plant while absorbing water and minerals from the soil. Image credit: OpenStax Biology.

## **The Root System**

The roots of seed plants have three major functions: anchoring the plant to the soil, absorbing water and minerals and transporting them upwards, and storing the products of photosynthesis. Some roots are modified to absorb moisture and exchange gases. Most roots are underground. Some plants, however, also have adventitious roots, which emerge above the ground from the shoot.

### **Root systems are mainly of two types**

**Tap root systems** have a main root that grows down vertically, and from which many smaller lateral roots arise. Tap roots penetrate deep into the soil and are advantageous for plants growing in dry soils. Tap roots are typical of dicots such as dandelions.

**Fibrous root systems** are located closer to the surface and have a dense network of roots. Fibrous root systems can help prevent soil erosion. Fibrous roots are typical of monocots such as grasses.

### **Root structures are evolutionarily adapted for specific purposes:**

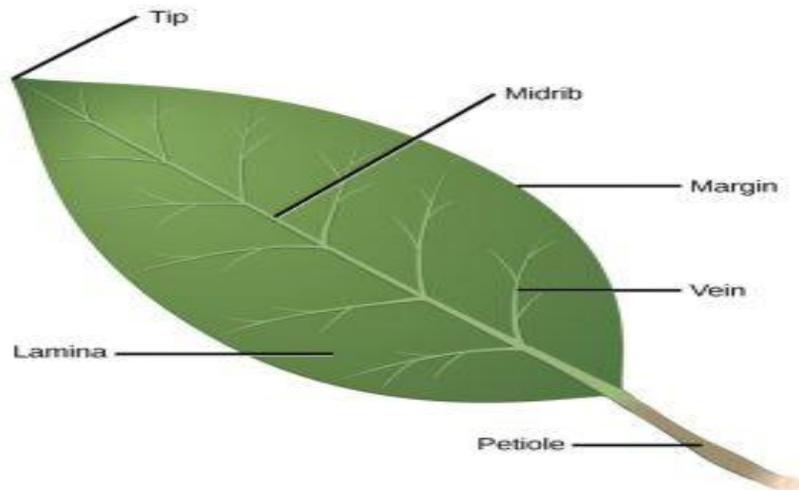
- Bulbous roots store starch.
- Aerial roots and prop roots are two forms of above-ground roots that provide additional support to anchor the plant.
- Some tap roots, such as carrots, turnips, and beets, are adapted for sugar/starch storage.
- Epiphytic roots enable a plant to grow on another plant

## **The shoot system: stems and leaves**

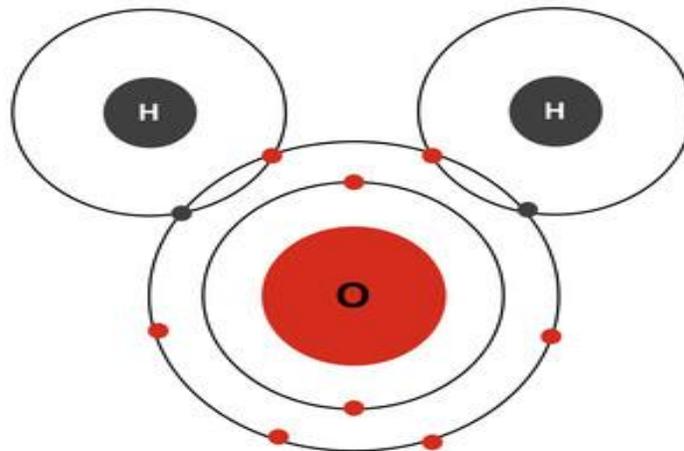
Stems are a part of the shoot system of a plant. Their main function is to provide support to the plant, holding leaves, flowers and buds.

- Stems can be of several different varieties:
- Herbaceous stems are soft and typically green
- Woody stems are hard and wooded
- Unbranched stems have a single stem
- Branched stems have divisions and side stems

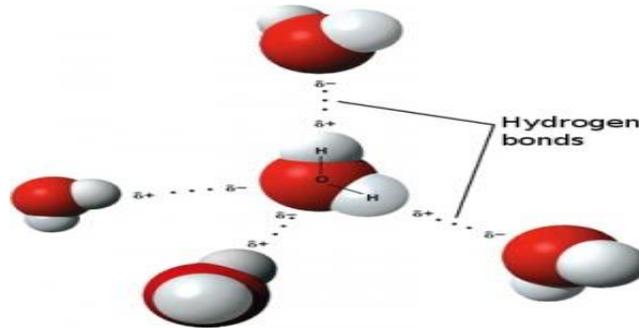
**Leaves** are the main sites for **photosynthesis**: the process by which plants synthesize food. Most leaves are usually green, due to the presence of chlorophyll in the leaf cells. However, some leaves may have different colors, caused by other plant pigments that mask the green chlorophyll.



### **The Structure of Water**



Water is a molecule ( $H_2O$ ) that contains two hydrogen atoms each sharing a pair of electrons with an oxygen atom. When atoms share electrons in this way, a covalent bond is created. These bonds are essential to living organisms.



## **Properties of water:**

### **Physical Properties:**

- Water is transparent material.
- Water is expanded on freezing
- Water molecule have cohesion and adhesion nature.
- Cohesion: force of attraction b/w similar molecules.
- Adhesion: force of attraction b/w dissimilar molecules.

### **Thermal Properties:**

- Temperature: it is liquid at normal temperature. Its boiling and melting points are higher than other molecules.
- Specific heat: amount of heat required to raise the temperate of 1g of water.
- Heat of fusion: amount of heat required to convert the 1 g of water in vapors.
- Thermal conductivity: it is the measure the ability of transfer the heat energy from one point to another point.

### **Chemical Properties:**

- Water in pure form  $H^+$  and  $OH^-$  in equal concentration of  $10^{-7}$  mol/liter.
- $H^+$  and  $OH^-$  ions produced when water react with weak acid and base.
- It reacts chemically with protein, CHO, lipids to produce the hydrolytic production.

## **Water Transport:**

The movement of plants from water to land has necessitated the development of internal mechanisms to supply all the parts of the plant. Water transport also occurs at the cellular level, as individual cells absorb and release water, and pass it along to neighboring cells. Water enters and leaves cells through osmosis, the passive diffusion of water across a membrane. In plants, water always moves from an area of higher water potential to an area of lower water potential.

**Active Absorption:** Active absorption refers to the absorption of water by roots with the help of adenosine triphosphate, generated by the root respiration: as the root cells actively take part in

the process, it is called active absorption. According to Renner, active absorption takes place in low transpiring and well-watered plants, and 4% of total water absorption is carried out in this process.

**Active Osmotic Water Absorption:** This theory was given by Atkins (1916) and Priestley (1923). According to this theory, the root cells behave as an ideal osmotic pressure system through which water moves up from the soil solution to the root xylem along an increasing gradient of D.P.D. (suction pressure, which is the real force for water absorption).

**Active Non-Osmotic Water Absorption:** This theory was given by Thimann (1951) and Kramer (1959). According to the theory, sometimes water is absorbed against a concentration gradient. This requires the expenditure of metabolic energy released from the respiration of root cells. There is no direct evidence, but some scientists suggest the involvement of energy from respiration.

**Passive Absorption of Water:** This mechanism is carried out without utilization of metabolic energy. Here, only the roots act as an organ of absorption or passage. Hence, sometimes it is called water absorption 'through roots', rather 'by' roots.

### **True Solution:**

A true solution is made up of at least two components, the dispersed (the solute) and the dispersion (the solvent).

Depending on the solvent whether it is liquid, solid or gas, following categories of solution may be formed.

(a)	solid—liquid	(b)	liquid—liquid	(c)	gas—liquid
	solid—solid		liquid—solid		gas—solid
	solid—gas		liquid—gas		gas—gas

### **Three types of solutions occur in the cells:**

- Solution of a gas in a liquid, carbon dioxide, nitrogen and oxygen are commonly found as gases in solution.
- Solution of liquids in liquids fall into two classes; those in which liquids are freely miscible in all proportions e.g., ethyl alcohol in water and secondly those in which two liquids are sparingly soluble e.g. ether, chloroform in water.
- Solution of a solid in a liquid is the common type of solution, e.g., solution of sucrose and common salt (NaCl) in water.

## **Suspension:**

In a suspension, the particles are greater than 1  $\mu\text{m}$  in size and the particles do not separate into molecules but are aggregates of molecules which can be seen with naked eye

## **Mineral Nutrition of Plants**

Criteria of nutrients to be essential

- It should be directly involved in plant nutrient
- A plant cannot, complete its life cycle without that nutrients
- The deficiency symptoms can only be recovered by addition of same nutrient which is deficient.

**Nutrient:** Chemical compound which are required by an organism for its growth and development.

**Mineral Nutrients:** Elements required primary in the form of inorganic ions from soil.

**Mineral Nutrition:** It is the study of how plant obtain and use the minerals nutrients.

**Plant nutrition:** Supply and absorption of chemical compounds required for growth and metabolism.

Out of the 102 nutrients only 19 are essential nutrients for plants. Which are found in soil.

## **Essential Nutrients:**

**Macronutrients:** Those nutrients which are required in large amount for plants are called macronutrients e.g., C, H, O (they are found in air), N, P, K, Ca, Mg, S (they are found in soil and inorganic fertilizer)

**Micronutrients:** Those nutrients which are required in small amount for plants are called micronutrients. e.g. Cu, Fe, Zn, Mn, Ni (Metals), Mo, B, Cl, Na (Non-Metals) the source of micronutrients is soil and fertilizer.

SN.	Groups	Uptake/ Available Form	Physical & Chemical Function
1	C, N, O, S	In Soil: C= CO <sub>2</sub> , HCO	Constituents of all organic compound Assimilation by oxidation & reduction process.
2		P= HPO <sub>4</sub> , H <sub>2</sub> PO <sub>4</sub> <sup>-</sup> , B= BO <sub>4</sub> , HBO K <sup>+</sup> Ca= Ca <sup>++</sup> , Mg= Mg <sup>++</sup> Mn= Mn <sup>++</sup> , Cl= Cl <sup>-</sup>	Esterification (bonding) with alcoholic group Sugar translocation Regulate the osmotic potential in cell Enzyme activation 'anion balance except Cl.

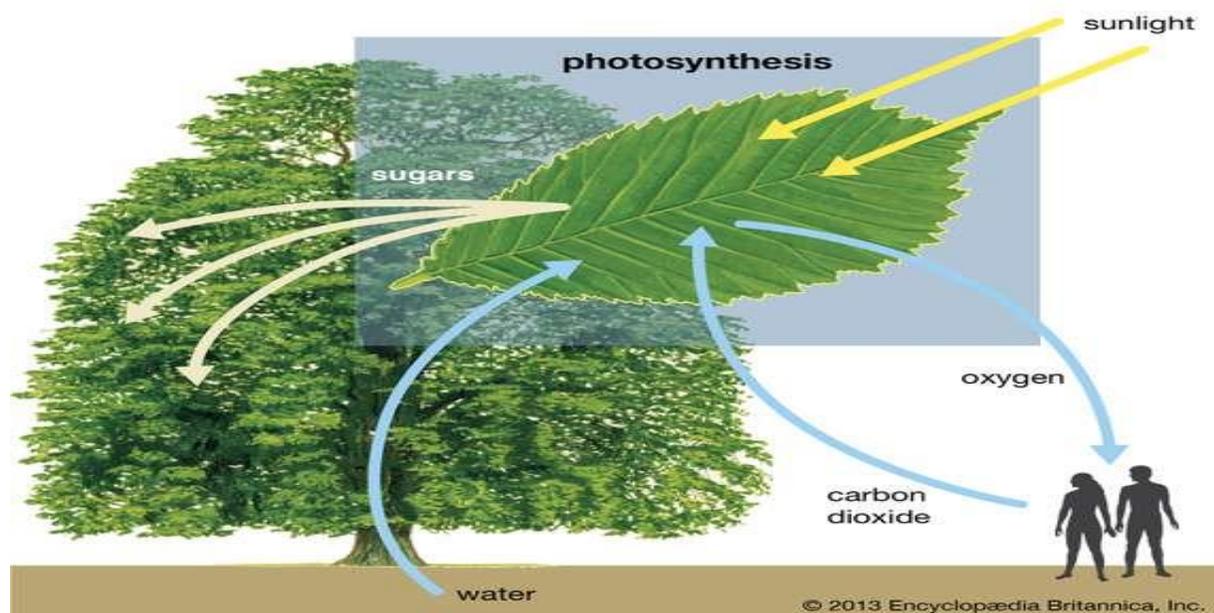
3	Cu, Fe, Zn, Mo	All are in ionic forms or chelating	It is involved in electron transport chain (ETC)
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## **Carbon Metabolism**

Carbon metabolism is the most basic aspect of life. This map presents an overall view of central carbon metabolism, where the number of carbons is shown for each compound denoted by a circle, excluding a cofactor (CoA, CoM, THF, or THMPT) that is replaced by an asterisk. One-carbon metabolism encompasses a broad range of biosynthetic reactions that occur in the cytoplasm and the mitochondria which are essential for maintaining cellular homeostasis.

## **Photosynthesis**

Photosynthesis, the process by which green plants and certain other organisms transform light energy into chemical energy. During photosynthesis in green plants, light energy is captured and used to convert water, carbon dioxide, and minerals into oxygen and energy-rich organic compounds.



## **Why Photosynthesis is Important?**

Photosynthesis is critical for the existence of the vast majority of life on Earth. It is the way in which virtually all energy in the biosphere becomes available to living things. As primary producers, photosynthetic organisms form the base of Earth's food webs and are consumed directly or indirectly by all higher life-forms. Additionally, almost all the oxygen in the atmosphere is due to the process of photosynthesis.

## **What is the Basic Formula for Photosynthesis?**

The process of photosynthesis is commonly written as:  $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$ . This means that the reactants, six carbon dioxide molecules and six water molecules, are converted by light energy captured by chlorophyll (implied by the arrow) into a sugar molecule and six oxygen molecules, the products. The sugar is used by the organism, and the oxygen is released as a by-product.

## **Respiration:**

The process of respiration in plants involves using the sugars produced during photosynthesis plus oxygen to produce energy for plant growth. Respiration takes place in the mitochondria of the cell in the presence of oxygen, which is called "aerobic respiration"

## **Seed Germination:**

Seed germination is the process of a fertilized plant ovary, or seed, developing into a mature plant. Seed germination starts with imbibition, when the seed takes in water from the soil. This triggers root growth to allow the seed to get more water.

## **Steps of Germination:**

Such five changes or steps occurring during seed germination are:

- Imbibition
- Respiration
- Effect of Light on Seed Germination
- Mobilization of Reserves during Seed Germination and Role of Growth Regulators and
- Development of Embryo Axis into Seedling.

## **Factors Effecting Germination:**

Environmental factors such as temperature, light, pH, and soil moisture are known to affect seed germination. Burial depth of seed also affects seed germination and seedling emergence.

## **Seed Dormancy:**

Seed dormancy is an evolutionary adaptation that prevents seeds from germinating during unsuitable ecological conditions that would typically lead to a low probability of seedling survival. Dormant seeds do not germinate in a specified period of time under a combination of environmental factors that are normally conducive to the germination of non-dormant seeds.

## **Types of Seed Dormancy:**

- ❖ **Physical Dormancy:** Dormancy caused by an impermeable seed coat is known as physical dormancy. Physical dormancy is the result of impermeable layer(s) that develops during maturation and drying of the seed or fruit.
- ❖ **Mechanical Dormancy:** Mechanical dormancy when seed coats or other coverings are too hard to allow the embryo to expand during germination.
- ❖ **Chemical Dormancy:** Includes growth regulators etc., that are present in the coverings around the embryo. They may be leached out of the tissues by washing or soaking the seed, or deactivated by other means.

*Some Other Types of Dormancy:*

- ✓ Endogenous Dormancy
- ✓ Physiological Dormancy
- ✓ Photo Dormancy
- ✓ Thermodormancy,
- ✓ Morpho-physiological Dormancy

### **Growth and Development:**

**Growth:** Growth is the irreversible change in size of cells and plant organs due to both cell division and enlargement.

**Development:** Development is the progression from earlier to later stages in maturation, e.g. a fertilized egg develops into a mature tree. It is the process whereby tissues, organs, and whole plants are produced.

### **Plant Growth Substances:**

Naturally occurring plant growth substances can be broadly categorized into two types. The first type includes growth substances such as auxins, gibberellins, cytokinin's, the inhibitor abscisic acid (ABA) and ethylene. These are commonly referred to as plant hormones.

#### **Auxins:**

- Primarily control growth through cell enlargement
- They may act as both stimulators and inhibitors of growth, and cause different plant parts (shoots, buds, and roots) to respond differently.
- Stimulate differentiation of cells and the formation of xylem and phloem tissues.

#### **Gibberellins:**

- Gibberellins control cell elongation and division in plant shoots
- They have been shown to stimulate ribonucleic acid and protein synthesis in plant cells

### **Cytokinins:**

- Act in cell division
- Promote cell enlargement
- Retard senescence
- And transport of amino acids in plants

### **Ethylene:**

- Inhibits the catalytic action of a specific enzyme.
- Since a plant cell may contain as many as 10,000 different enzymes, there are a wide variety of inhibitors acting inside the cell. Ethylene is internally produced by plants and has a multitude of effects on cell processes.
- It interacts with auxins to regulate many metabolic processes.

### **Plant Environment:**

Plant environment includes those biotic and abiotic factors that influence growth and development of forages. Plants rarely grow in ideal environments; instead they experience environmental fluctuations and stresses that modify morphology and rate of development, limit yield, and alter quality.

### **What is the Best Environment for Plants?**

- Light – Bright but not too bright
- Temperature – Comfortable for you, comfortable for your plants
- Air Circulation – Fresh air plus a gentle breeze
- Reflection – Cover your walls with a reflective material
- Humidity – Controlling humidity helps plants grow faster and can increase resin production

**Environmental Factors effecting Plant Growth:** The three most ecologically important environmental factors affecting rangeland plant growth are **light, temperature,** and water (precipitation). Plant growth and development are controlled by internal regulators that are modified according to environmental conditions.

### **What are Benefits of Plants?**

- Reducing carbon dioxide levels
- Increasing humidity
- Reducing levels of certain pollutants, such as benzene and nitrogen dioxide
- Reducing airborne dust levels
- Keeping air temperatures down

### **How do Crop Plant Affect Our Environment?**

Agriculture affects the environment in multiple ways. When we clear land for agriculture, we often lose some soil. The plant species originally on this land are gone, and what we replace those with may be plants that aren't as effective and retaining the soil and its nutrients. Thus, the soil degrades over time.