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# Cytosol (Cell Biology-BBT-1002)

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## Learning Outcomes

- Learner will be able to define cytosol and cytoplasm.
- Learner will get an insight to chemical composition of cytosol.
- Learner will be able to appreciate the function of each constituent of cytosol.

## Cytosol

- The cytosol is a semi-fluid substance filling the interior of the cell and embedding the other organelles and subcellular compartments.
- The cytosol itself is enclosed by the cell membrane and the membranes of different organelles, thus making up a separate cellular compartment.
- Together, the cytosol and all organelles, except for the nucleus, make up the cytoplasm.

## Chemical Composition of Cytosol

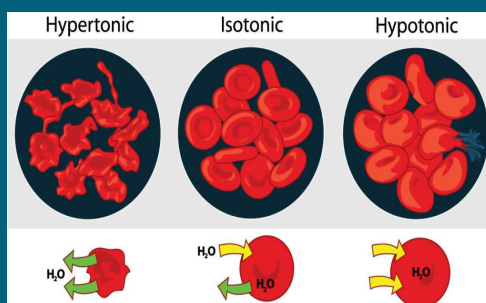
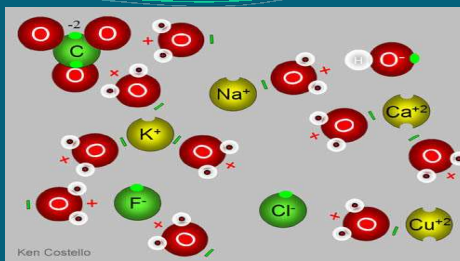
- The cytosol makes up about 70% of the total volume of cells, and is highly crowded and complex.
- The cytosol is mainly composed of water (approximately 70% of the volume) and proteins (20-30% of the volume).
- Rather than a liquid, it is often described as a hydrophilic jelly-like matrix that allows for free movement of ions, hydrophilic molecules and proteins, but also larger structures such as protein complexes and vesicles, across the cell.
- Ions such as potassium, sodium, bicarbonate, chloride, calcium, magnesium and amino acids are also important constituents of the cytosol. The differences in concentration of these ions between the cytosol and the extracellular fluid or cytoplasmic organelles are essential for many cellular functions, for example to enable cell-to-cell communication at the synapses of nerve cells.
- Human cytosolic pH ranges between 7.0 - 7.4 and is usually higher if the cell is growing.

## Water

- Found as free(30%) and bound water( 70%).
- Major part of cellular water used as solvent.
- The attractive forces between water molecules and the slight tendency of water to ionize are of crucial importance to the structure and function of biomolecules.
- The noncovalent interactions responsible for the strength and specificity of “recognition” among biomolecules are decisively influenced by the solvent properties of water, including its ability to form hydrogen bonds with itself and with solutes.
- Bound water remains loosely linked to protein molecules by hydrogen bonds.
- High surface tension due to cohesive nature of water molecules maintains protoplasm structure and movement.

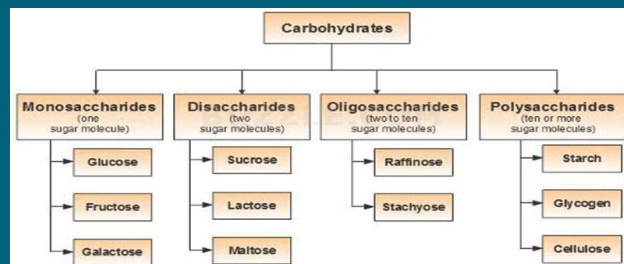
## Ions

- Maintain osmotic pressure
- Acid base balance of cell maintained
- Inflow of water in cells is prevented
- $\text{Cl}^-$ ,  $\text{K}^+$ ,  $\text{Mg}^{2+}$ ,  $\text{CO}_3^{2-}$ ,  $\text{HCO}_3^-$

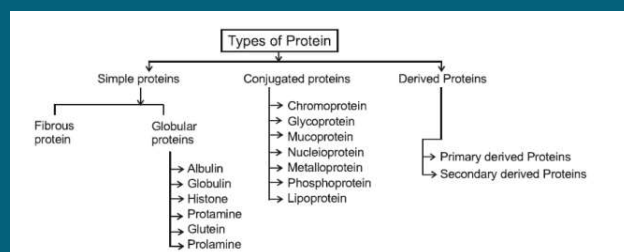


Cytosol has a high concentration of potassium ions and a low concentration of sodium ions. The reason for these specific sodium and potassium ion concentrations are  $\text{Na}^+/\text{K}^+$  ATPase pumps that facilitate the active transport of these ions. These pumps transport ions against their concentration gradients to maintain the cytosol fluid composition of the ions.

# Macromolecules



Carbohydrates provide the energy for the most functions of cells



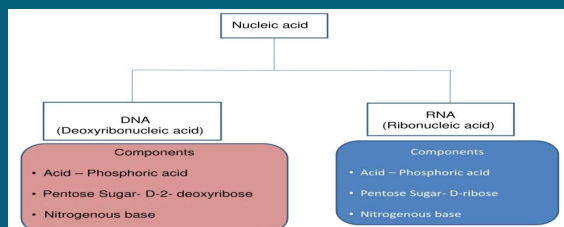
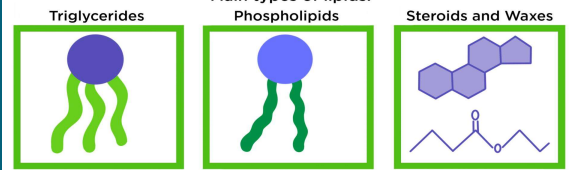
Proteins are required for the structure, function, and regulation of the cells.

# Macromolecules (contd.)

## What are Lipids?

Lipids are macromolecules made of fatty acid monomers. Functions of lipids include structural support for the cell, energy storage, and cell signaling. Lipids are typically nonpolar in nature and do not interact with water, though some exceptions exist.

### Main types of lipids:



DNA provides the code for the cell's activities, while RNA converts that code into proteins to carry out cellular functions.

## Functions of Cytosol

- Role in providing structural support for other organelles and in allowing transport of molecules across the cell. For example, metabolites often need to be transported across the cytosol from the area of their production to the site where they are needed, and various signals need to be transduced from the cell membrane to target compartments.
- Many important cellular processes and reactions, especially of metabolic character, occur in the cytosol. These processes include protein synthesis through translation, the first stage of cellular respiration through glycolysis, and cell division through mitosis and meiosis.
- The cytosol also plays a pivotal role in maintaining gradients across the membranes, which is important for cell signalling, osmosis and cellular excitability.

## References and Further Readings

- Luby-Phelps K., **The physical chemistry of cytoplasm and its influence on cell function: an update.** *Mol Biol Cell.* (2013)
- [https://www.proteinatlas.org/humanproteome/subcellular/cytosol#composition\\_of\\_the\\_cytosol](https://www.proteinatlas.org/humanproteome/subcellular/cytosol#composition_of_the_cytosol)