CYTOSKELETON

NAME OF TEACHER	**DR ROLEE SHARMA**
EMAIL ID	**roleesharma@csjmu.ac.in, roleesh@gmail.com**
DESIGNATION	**Professor**
UNIVERSITY NAME	**C.S.J.M. University, Kanpur**
COLLEGE NAME	**C.S.J.M. University, Kanpur**
STREAM NAME	**BIOLOGY**
FACULTY NAME	**SCIENCE**
DEPARTMENT NAME	**BIOSCIENCES**
SUBJECT NAME	**CELL BIOLOGY**
COURSE	**M.Sc. BIOCHEMISTRY / LIFE SCIENCE**
COURSE DURATION	**2 Years**
SUBTOPIC NAME	**Cytoskeleton - basics**
CONTENT TYPE	**PDF**
SEARCH KEYWORD	**Cytoskeleton**

THE CYTOSKELETON OF CELLS

Cytoskeleton : A network of protein fibres in the cytoplasm that gives shape to a cell, holds and moves organelles, and is typically involved in cell movement.

The cytoskeleton is a dynamic three-dynamic structure that fills the cytoplasm. When you think of cytoskeleton, think of pillars of a building. This structure acts as both muscle and skeleton, for movement and stability. It is a **dynamic structure** of protein fibres floating around in cytoplasm that serve functions as:

- **maintains cell shape**
- **protect the cell** providing mechanical strength
- enables some cell **motion** (using structures such as flagella and cilia)
- **chromosome separation** in mitosis and meiosis
- **Intra-cellular transport** of organelles (the movement of vesicles and organelles)

Eukaryotic cells are given shape and organized by the cytoskeleton, which is made up of three kinds of protein filaments:

- Actin filaments (also called microfilaments)
- Intermediate filaments and
- Microtubules

The long fibres of the cytoskeleton are polymers of subunits.

Microfilaments/Actin filaments are fine, twisted **thread-like** double strand actin **protein fibres** consisting of a string of proteins, from **7 nm diameter** to several cm long. Its function helps **muscle contraction, cell shape, and movement in cytoplasm.**

They are mostly concentrated (form a band) just beneath the plasma membrane, as they -
keep cellular shape (provide mechanical strength to cell), generate cytoplasmic streaming in some cells, form cytoplasmatic protuberances (like pseudopodia and microvilli), and generate locomotion in some cells as WBCs and amoeba.

They participate in some cell-to-cell or cell-to-matrix **junctions** and in the **transduction of signals**. They link transmembrane protein (as cell surface receptors) to cytoplasmic proteins.

They are also imp. for **cytokinesis** and, along with protein myosin, **muscular contraction.**

Intermediate filaments are made up of **eight subunits in rope-strands**. The protein structure varies with different tissue types. This component helps **maintain shape, support nerve cell extensions**, and **attach cells together**.

Intermediate filaments – **10 nm diameter** and provide tensile strength for the cell. They **organize the internal 3-dimensional structure of the cell** (they are structural components of the nuclear envelope or the sarcomeres for example). They may stabilize organelles like the nucleus, and also participate in some cell-cell and cell-matrix junctions. Different intermediate filaments are:

- made of vimentins, being the common structural support of many cells.
- made of keratin, found in skin epithelial cells, hair and nails
- neurofilaments of neural cells that strengthen the long axons of neurons
- made of lamin, giving structure support to the nuclear envelope

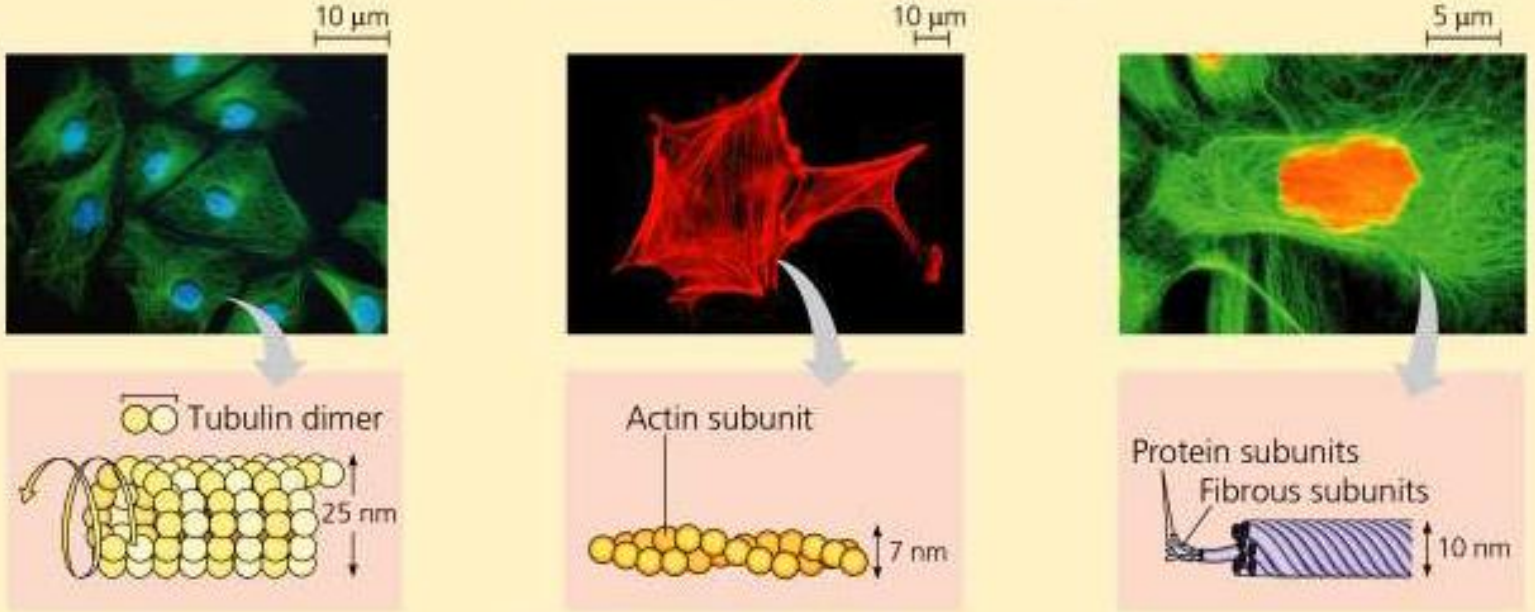
- Despite their chemical diversity, Intermediate filaments play similar roles in the cell, providing supporting framework within cells. The nucleus in epithelial cells is held within cell by a basketlike network of Intermediate filaments made of keratin.

Microtubules are tubes made up of **spiraling, two-part subunits**, made of tubulin. It aids in **chromosome movement, movement of organelles, and the movement of cilia and flagella**. Microtubules are hollow cylindrical tubes of **20-25 nm** in diameter. They are comprised of a ring of 13 protofilaments , that are linear rows (polymers) of alpha- and beta- **tubulin** dimers. They show dynamic behaviour, binding GTP for polymerization. They are organized by the centrosome.

- Microtubules act as a scaffold to determine cell shape, and **provide a set of tracks for cell organelles and vesicles to move** on (they transport organelles like mitochondria or vesicles)
- Microtubules also form the **spindle fibres for separating chromosomes during mitosis**.
- When arranged in geometric patterns inside **flagella and cilia**, they are used for **locomotion.**
- **Synthesis of** the **cell wall** in plants.

Table 7.2 The Structure and Function of the Cytoskeleton

Property	Microtubules	Microfilaments (Actin Filaments)	Intermediate Filaments
Structure	Hollow tubes; wall consists of 13 columns of tubulin molecules	Two intertwined strands of actin	Fibrous proteins supercoiled into thicker cables
Diameter	25 nm with 15-nm lumen	7 nm	8–12 nm
Protein subunits	Tubulin, consisting of α-tubulin and β-tubulin	Actin	One of several different proteins of the keratin family, depending on cell type
Main functions	Maintenance of cell shape (compression-resisting "girders") Cell motility (as in cilia or flagella) Chromosome movements in cell division Organelle movements	Maintenance of cell shape (tension-bearing elements) Changes in cell shape Muscle contraction Cytoplasmic streaming Cell motility (as in pseudopodia) Cell division (cleavage furrow formation)	Maintenance of cell shape (tension-bearing elements) Anchorage of nucleus and certain other organelles Formation of nuclear lamina



SOURCE: Adapted from W. M. Becker, L. J. Kleinsmith, and J. Hardin, *The World of the Cell*, 4th ed. (San Francisco, CA: Benjamin Cummings, 2000), p. 753.

Prokaryotic cytoskeletal system

Like eukaryotes cytoskeletal elements are also characteristics of prokaryotes. Bacteria generally employ the tubulin ortholog FtsZ instead of tubulin of eukaryotes for cell division. Tubulin in eukaryotes form microtubules that provide cellular tracks for organelle transport and that form the mitotic spindle apparatus, among other functions. Some plasmids also encode a partitioning system that involves an actin-like protein ParM. Filaments of ParM exhibit dynamic instability, and may partition plasmid DNA into the dividing daughter cells by a mechanism analogous to that used by microtubules during eukaryotic mitosis. Two bacterial genes MreB and Mbl code for actin like proteins which form filamentous helical structures underneath the cell membrane, MreB filaments control the width of the cell, whereas Mbl filaments control the longitudinal axis of the cell. Recent research has showed that *Caulobacter crescentus* cells are vibrio-shaped, due to the action of CreS protein which is a homolog of eukaryotic proteins that form intermediate filaments.