Cytoskeleton

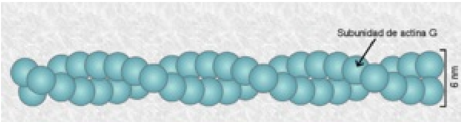
The **Cytoskeleton** is a three-dimensional network in the cytoplasm of eukaryotic cell. It mechanically stabilizes the cell, enables its movement and participates in intracellular transport.

The main structural component is the protein filament – a polymeric dynamic structure. We distinguish three types of filaments:

- **actin filaments'** (diameter about 7 nm),
- **intermediate filaments'** (diameter about 10 nm),
- **microtubules** (about 25 nm in diameter).

Another part of the cytoskeleton are '*accompanying proteins*. They regulate the construction and dismantling of filaments, connect them to each other and connect them to other, e.g., membrane proteins.

Actin filaments − microfilaments

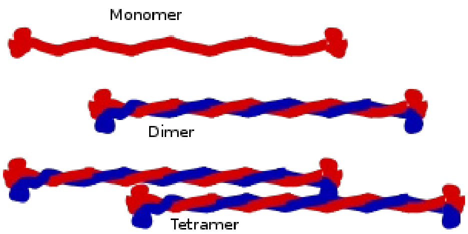


Actin filament

The basic unit is globular G-actin (globular monomer) and fibrillar F-actin (polymerizing into an asymmetric double helix). Actin occurs in three isoforms – α (muscle contractile apparatus), β and γ. They are a component of all cells. Most of them are found in muscle, where they make up 50% of total proteins. They form a terminal network (a three-dimensional network in cells), microvilli, stereocilia, pseudopodia, lamellipodia, filopodia and zonulae adhaerentes.

Muscle tissue contains *muscle actin (5-7 nm)*. It is structurally stable. Together with *myosin filaments* (15-16 nm) they form a molecular motor. The proteins that accompany actin are: tropomyosin (stabilizes filaments), fimbrin, villin, espin, α-actinin (forms bundles of filaments), filamin (forms a network in the cortical cytoplasm), vinculin, talin (anchors filaments).

Intermediate filaments



Intermediate filament

These are mechanically resistant fibers with a diameter of 10–12 nm. Thanks to their stability, they equalize the pressures acting on the cell and give it strength. The structure of intermediate filaments is complex. Protein monomers intertwine into pairs (dimers), which in turn form further pairs (tetramers). Parallel arranged tetramers form the typical helical structure of intermediate filaments.

Individual types of intermediate filaments are found in different types of cells.

Filamentary protein	Typical location
keratins	all epithelial cells
vimentin	cells of mesenchymal origin (connective cells, endothelium, vascular smooth muscle cells)
desmin	smooth muscle cells, cardiomyocytes, skeletal muscle fibers
glial fibrillary acidic protein (GFAP)	glial cells – mainly astrocytes
neurofilament proteins	nerve cells
nest	neural stem cells
laminae A, B, C	the *lamina fibrosa* of the cell nucleus

Microtubules

Microtubules are the thickest filaments of the cytoskeleton (25 nm in diameter). They mainly serve for intracellular transport, they also enable the movement of chromosomes and also participate in maintaining the shape of the cell and its changes. These are unbranched tubules with a solid wall (5 nm thick) composed of tubulin proteins. The stabilization of microtubules is ensured by the so-called ``accompanying proteins *(proteins associated with microtubules, also ``MAPs*) by regulating polymerization and depolymerization.

Microtubules consist of centrioless, mitotic spindles, kinocilia and flagella (*flagella*).

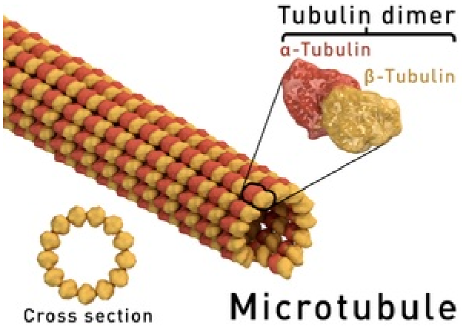
Structure

The basic building block of microtubules is a heterodimer consisting of **α-** and **β-tubulin**. Polymerization of these dimer molecules (with the participation of GTP) creates spirally arranged **protofilaments**, on which we distinguish (+) and (−) ends. During polymerization, the dimers are organized in such a way that α-tubulin is always adjacent to β-tubulin. A microtubule is formed by a circular assembly of thirteen protofilaments.

Microtubule growth

It proceeds from the so-called **microtubule organizing center'** (*MTOC*) by adding additional tubulin subunits to the (+) end of the microtubule; The (−) end anchors the microtubule in the microtubule-organizing center and growth does not occur on it.

The **Centrosome** and the basal bodies of the cilia (*kinetosome*) represent the microtubules organizing the centers.



Microtubule

Protein Biological Motors

Protein biological motors are proteins associated with the cytoskeleton. It can convert the energy of chemical bonds into mechanical energy. The ATPase activity of the protein motor molecule allows it to change its conformation and move along the cytoskeletal filament. Motors are mainly responsible for intracellular transport, cell movement, its contractility or shape changes. We distinguish between actin and microtubular protein motors:

- protein motors of the actin system - '*myosins*. They move towards the (+) end of the actin filament;
- protein motors of the microtubule system – '*kinesins and dyneins*. Kinesins move towards the (+) end of the microtubule, mainly following β-tubulins. Dyneins move to the (−) end of the microtubule, following both α- and β-tubulins.

Links

- ws:Cyroskeleton

Related Articles

- Locomotor apparatus of the cell
- Cytoskeleton from the point of view of biophysics
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- ŠTEFÁNEK, George. *Medicine, diseases, studies at the 1st Faculty of Medicine, UK* [online]. [cit. 11/02/2010]. <https://www.stefajir.cz/>.

External links

- Cytoskeleton (Czech Wikipedia)
- Cytoskeleton (English Wikipedia)

References

- LANGMEIER, Miloš, et al. *Fundamentals of Medical Physiology.* 1. edition. Prague : Grada Publishing, a.s, 2009. 320 pp. ISBN 978-80-247-2526-0.