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The Cytoskeleton of the System

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ABSTRACT

Cytoskeleton is a skeletal network structure that consists of protein and protein, including cytoplasmic skeleton and nucleus skeleton. The main role of the cytoskeleton system is to maintain a certain shape of the cells, so that cells can live and work. The cytoskeleton also acts as a communicating artery for intracellular transport of substances and organelles; the cytoskeleton also localizes the intracellular matrix; in addition, the cytoskeleton also has the function of helping the cells move. The cytoskeleton consists of a structural system called 'cytoskeletal system', with intracellular genetic systems, biofilm systems, and called 'intracellular three systems'. Initially, there is no visible structure in the cytoplasm, but many life phenomena, such as cell movement and cell shape maintenance, is difficult to be explained. In 1928, the original concept of cytoskeleton was proposed. In 1954, under electron microscopy for the first time to see the cells in the microtubules, but at this time, electron microscopy can only use osmium acid or potassium permanganate in low temperature conditions to fix, under such conditions often occur in the cytoskeleton Phenomenon, and thus be destroyed. In 1963, the use of glutaraldehyde fixed at room temperature, only widely observed the existence of species-like cytoskeleton, and officially named as an organelle. The role of cytoskeleton in cell life activity is omni-directional, and its research will give rise to a new understanding of the basic unit of cell life - the structure and function of cells.

KEYWORDS: cytoskeleton system dynamics protein fiber molecular biology has a wide range of roles

1. Introduction

The narrow cytoskeleton concept refers to the structure of the protein fibers in eukaryotic cells. Until the 20th century, 60 years later, the use of glutaraldehyde at room temperature, only to gradually recognize the objective existence of the cytoskeleton. Eukaryotic cells, by virtue of maintaining an important structure of their basic form, are vaguely called cytoskeleton, which is also generally considered to be a broad organelle.

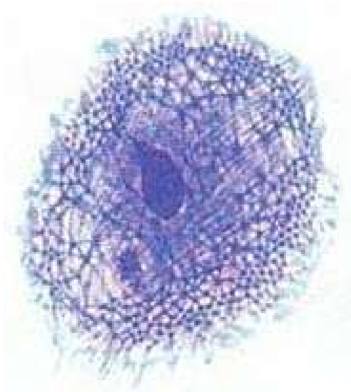
The generalized cytoskeleton concept is the presence of nuclear skeletons in the nucleus - the nucleus layer system. The nuclear skeleton, the core layer and the intermediate fiber are structurally connected to each other and run through the network of the nucleus and cytoplasm.

The cytoskeleton is divided into cytoplasmic skeleton and nucleus skeleton. The cytoplasmic skeleton is a network of three fibrous structures composed of microfilament, microtubule and intermediate filament (IF). The nucleus skeleton includes the nuclear matrix, the nucleolus, the nucleolus skeleton and the chromosomal skeleton. The generalized cytoskeleton also includes the cell membrane skeleton and the extracellular matrix.

The cytoskeleton plays an important role not only in maintaining cell morphology, subjecting to external forces, maintaining the orderly structure of the internal structure of the cells, but also in many important life activities such as cytoskeletal traction chromosome separation in cell division , In the muscle cells, the cytoskeleton and its binding protein constitute the power system; in the white blood cell (white blood cell) migration, spermatozoa swimming, nerve cell axons and trees Sudden extension and other aspects are related to the cytoskeleton. In addition, cytoskeleton in plant cells guides the synthesis of cell walls.

Cytoskeleton system: cytoskeleton is the protein and protein from the skeleton of the network structure, including the cytoplasm skeleton and the nuclear skeleton. The main role of the cytoskeleton system is to maintain a certain shape of the cells, so that cells can live and work. The cytoskeleton also acts as a communicating artery for intracellular transport of substances and organelles; the cytoskeleton also localizes the intracellular matrix; in addition, the cytoskeleton also has the function of helping the cells move. The main components of the cytoskeleton are microtubules, microfilaments and intermediate fibers.

Here I will be discussing about the microfilament, microtubules, middle silk, nuclear skeleton of these three aspects to do a detailed description:

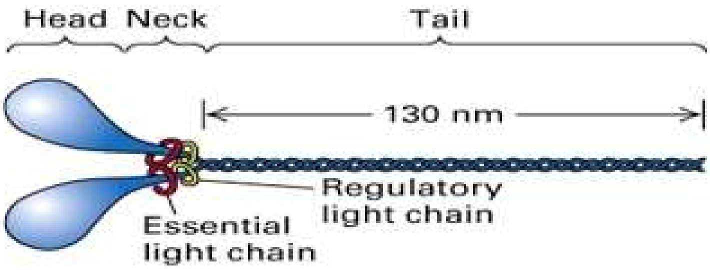


2. Microfilament

2.1. Morphology of microfilaments

Microfilaments A fiber that is spirally aggregated by an actin molecule, also known as actin filament, one of the major components of the cytoskeleton.

Microfilaments are proteins of about 42 kDa in all eukaryotic cells and are highly conserved proteins that do not exceed 20% due to species differences (eg algae and humans). The actin filament of actin filaments, also known as actin filament, is one of the main components of the cytoskeleton. Its diameter is about 7 nanometers. Microfilaments and its association protion and myosin constitute a chemical mechanical system that utilizes chemical energy to produce mechanical motions. The microfilament formed by the microfilament is called the stress fiber and often runs through the long axis of the cell. Vertebrate actin is divided into α, β and γ, α type is distributed in myocardium and striated muscle cells. A and γ are distributed in smooth muscle cells. B and γ are distributed in non-muscle cells.



2.2. The chemical composition of microfilaments

The actin monomer (also known as G-Actin, all called globular actin, Globular Actin, hereinafter referred to as G-actin) is spherical and has an ATP binding site on its surface. Actin monomer one by one into a string of actin chains, two strings of such actin chains twisted together into a microfilament. This actin multimer is also known as F-Actin (Fibrous Actin).

The assembly of microfilaments is divided into three stages: the nucleation phase, the growth phase or the extension, and the equilibrium. The nucleation period is the rate limiting process of microfilm assembly, which takes some time, so it is called delay period. At this time, myosin begins to polymerize, its dimer is unstable and easy to hydrolyze, and only the formation of trimer is stable. That is, the core formation. Once the core is formed, globular myosin is rapidly aggregated at both ends of the core to enter the growing season. The assembly speed of both ends of the microfilament is different, the assembly speed of the positive end is obviously faster than the negative end, about 10 times more than the negative end. When the microfilament is extended to a certain period of time, the velocity of actin incorporation into the microfilaments is balanced with the rate of dissociation from the negative end of the microfilaments. At this time, the length of the microfilament is almost constant, and the length of the filament is longer than that of the negative of the length, and still carried out polymerization and dissociation activities.

The assembly of microfilaments can be explained by the treadmiling model and the unsteady dynamic model, but the latter is more reasonable. ATP is the main factor in regulating the dynamic instability behavior of microfilaments. In addition, actin-binding protein (ABP) also regulates the assembly of microfilaments.

2.3. Microfilament function

Microfilaments in addition to participate in the formation of myofibrils also has the following functions:

1 The formation of stress fibers (stress fibers): non-muscle cells in the stress fibers and myofibrils have many similarities: all contain myosin II, myosin, filamin and α-actinin. Cultured fibroblasts are rich in stress fibers and are immobilized on the substrate by adhesive spots. Stress fibers in the body make the cells resistant to shear

2 Forming microvilli

3 Cell deformation movement: divided into four steps:

(1): microfilament fiber growth, the cell surface prominent, the formation of tablets (lamellipodium).

(2): in the foot and the matrix in contact with the location of the formation of adhesive spots.

(3): in the role of myosin microfilament fibers slide, so that the main body of the cell forward.

(4): release the cell behind the sticky point. So the cycle, the cells move forward. Amebic protozoa, white blood cells, fibroblasts can move in this way.

4 Cytoplasmic splitting: At the end of mitosis, two adjacent subcells produce contraction loops, and the contraction loop consists of parallel aligned microfilaments and myosin II. With the contraction of the shrinkage ring, the cytoplasmic separation of the two daughter cells, in the presence of cytochalasin, cannot form a cytoplasmic cleavage ring, thus the formation of binucleated cells.

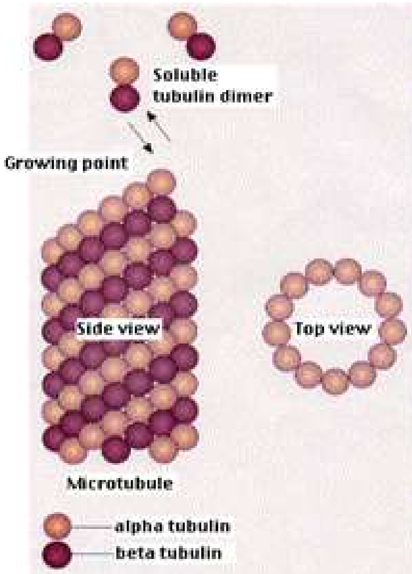
5 Acrosome reaction: in the sperm and egg combination, the microfilament to the top of the body protruding into the gums of the egg, the accumulation of fertilized egg cell surface area increased, the formation of microvilli, microfilaments involved in the formation of microvilli, is conducive to absorption of nutrients.

6 Other functions: such as organelles movement, plasma membrane fluidity, cytoplasmic circulation are related to the activities of microfilaments, inhibition of microfilament drugs (cytochalasin) can enhance membrane flow, destruction of cytoplasmic circulation.

3. Microtubules

3.1. Microtubules of the morphological structure

A non - branched hollow tubular structure consisting of tubulin filaments. A diameter of about 25 nm, is a cytoskeletal component that is involved in cell support and exercise. Spindle, eukaryotic cell cilia and centrioles. are composed of microtubules organelles.



In each microtubule tubulin dimer head and tail to form an elongated protofil (protofilament), 13 of these fibrils arranged in a vertical arrangement of microtubules wall. The microtubes are hollow cylinders of 24-26 nm in diameter. The outer diameter is an average of 24 nm and an inner diameter of 15 nm. Microtubules are approximately 5 nm thick and the microtubules are usually straight but sometimes curved. The intracellular microtubules are coiled and bundled and can be assembled with other proteins, which can be assembled into single tubes, double tubes (cilia and flagellum), triple tubes (centrioles and matrix), spindle, axons, nerve tube and other structures. It is composed of 13 protils (protofilament) composed of hollow tubular structure, diameter 22-25 nm.

3.2. Chemical composition of microtubules

Microtubules are a polar cytoskeleton. Microtubules are composed of α, β two types of tubulin subunits formed tubulin dimer, composed of tubulin dimer long tubular organelles structure. Microtubules are composed of tubulin heterodimers as the basic members, and helical coiled to form the walls of the microtubules.

Purification of tubulin from various tissues can be found to have some other protein components (5% -20%), called microtube associated proteins (microtube associated stories MAPs). These proteins have tissue specificity and show that microtubules formed from the same αβ dimer polymerization have unique properties. Various alpha and beta tubulin proteins have been found from different human tissues and the microtubule gene has been tracked Gene family, some genes are thought to be encoded by unique tubulin.

At least two apparently differentiated alpha-tubulin and three distinctly differentiated beta-microtubule genes are found in humans, which produce tubulin mRNA with specific functions. Since these codes are very similar to protein molecules in the constituent components, the number of specific subtypes of differentially expressed tubulin proteins in different tissues is yet to be studied.

In addition to α-β-tubulin has a similar variation of different types, in recent years has also found a variety of new differences in the code of the new tubulin, the formation of different gene family. Where the gamma-tubulin is located in the cell's microtubule organizing center (MTOC) and is the starting core used to provide alpha and beta tubulin for polymerization to form microtubules. And δ and ε are considered to be related to the structure and formation of the central particles. There are many variants such as η, ζ and θ, but there are usually only a few eukaryotic single cell organisms such as protozoa or ciliates, which may be related to the unique structure and physiological habits of these organisms. Further details are still to be studied.

3.3. Microtubule function

(1) Maintain cell shape, from the role of stent. (Such as spindle-shaped cells)

(2) Participate in cell wall formation and growth.

(3) Guide the polysaccharide containing Golgi vesicles, equatorial plane, cell plate;

(4) Arranged in the plasma membrane, determine the direction of deposition of cellulose microfilament;

(5) Microtubule concentration, secondary wall thickening.

(6) Organelles and cell movement is closely related

(7) Constitute the mitosis and meiosis of the spindle wire

(8) CS movement by the control of the spindle wire

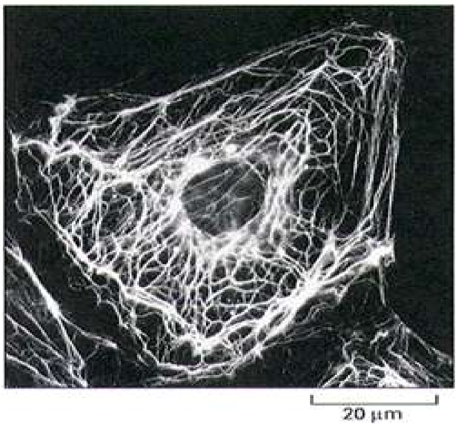
(9) Provide transport trajectories for intracellular material movement

(10) Combined with microfilament to provide transport power

4. Middle silk

4.1. Mesh shape structure

Intermediate filament, also known as intermediate filament (IF) diameter of about 10nm, between the microfilaments and microtubules. Unlike microtubules, intermediate fibers are the most stable cytoskeletal component, and it acts primarily as a support. The intermediate fibers are distributed around the nucleus in the cells, bundled into the network, and extended to the cytoplasmic membrane, connected with the plasma membrane. , Originally in the smooth muscle cells found in the diameter of 10nm rope-like structure. Because of its thickness between the muscle cells and fine filaments between, so named as the middle silk. The middle filaments are present in the vast majority of animal cells, and the cytoplasmic intermediate filaments are usually assembled around the nucleus and extend to the cell edge to connect with the cytoplasmic membrane on the cell membrane, such as desmosomes, half desmosomes. Through the cell connection, the middle silk will be adjacent cells into one. In the nucleus, a class of special intermediate silk protein family members of the nuclear layer is distributed in the form of orthogonal network, close to the inside of the nuclear membrane.



4.2. Chemical composition of intermediate filaments

The chemical composition of the middle silk is more complicated. Constitute its protein up to 5, common with vimentin (vimentin), keratin (keratin), desmin, neuronal fibers and glial fibers. In different cells, the composition changes greatly. The intermediate fibers make the cells have tension and shear resistance. Intermediate fibers have a common basic structure, that is, to build a central α-spiral rod-shaped area, both sides of the size and chemical composition of different end areas. The diversity of the end regions determines the difference and specificity of the shape and properties of the intermediate fibers.

These structural units are not immutable, but with the cell life activities and a high degree of dynamic, they are by the monomer protein to a weak non-covalent bond together to form a fiber-type polymer, it is easy to assemble and disassemble, which is necessary to achieve its function.

In the animal cells, maize, tobacco and other plants also found that the middle silk can be divided into six types according to the amino acid sequence, gene structure, assembly characteristics and tissue-specific expression pattern of the middle silk protein.

Type I (acidic) keratin

Type II (neutral and alkaline) keratin. Type I and type II keratin are involved in the assembly of the intermediate filaments in epithelial cells in a heterogeneous and specific form.

(Vimentin, also known as corrugated silk protein), desmin / glial filamentic acid prot-ein (GFAP, also known as glial fibrin) and peripheral protein (Peripherin).

(NF-L; NF-H) and α-internonin (NF-L) were detected by immunohistochemistry Began to express, and added to the cell within the middle of the network.

Type V intermediate filament protein includes nucleus nuclear laminin A and its cleavage laminin C and laminin B1 and B2.

VI type intermediate silk protein includes nestin, microtubule curl protein and desmuslin.

4.3. Function of the middle silk

(1) Stent effect

(2) Pass information

(3) The transport of mRNA

(4) The relationship with cell differentiation

5. Nuclear skeleton

5.1. Nuclear matrix

Nuclear matrix (nuclear matrix) also known as nuclear skeleton. There are two concepts: broad sense and narrow sense. The broad concept is that the nuclear matrix includes the nuclear matrix - the nuclear layer - the nuclear pore complex structure system; the narrow concept is the nucleus to remove the nuclear membrane, nucleus, chromatin, nucleolus exists outside of a fibrin Grid system. At present more use of narrow concept. The network-like nuclear matrix fibers are filled with nuclear space, connected with the core layer and the nuclear pore complex, and the nucleolus is networked in the grid of the nuclear matrix fiber. The nuclear matrix, the core layer and the medium fiber form a unified grid structure system that runs through the nucleus.

Nuclear matrix is closely related to DNA activity, RNA transcription and processing, chromosome assembly and viral replication and other life activities.

The composition of the nuclear matrix is more complex, the main components are three categories: non-histone fibrin, molecular weight 40-60KD, accounting for more than 96%, of which a considerable part of the sulfur-containing protein, the disulfide bond has to maintain nuclear skeleton structural integrity In addition to fibrin, there are more than 10 kinds of secondary proteins, including actin and vimentin, which constitute the core skeleton of the cover; nuclear skeleton fragments there are three kinds of scaffold proteins (scaffold proteins, SC, SC, SCIII), SCII, function is not clear, SCI is DNA topoisomerase. A small amount of RNA and DNA, RNA is necessary to maintain the three-dimensional structure of the nucleus skeleton, and DNA is called a matrix or scaffold region (MAR or SAR), usually an AT-rich region. a small amount of phospholipids (1.6%) and carbohydrates (0.9%).

Nuclear skeleton fiber thickness ranging from 3 to 30nm in diameter, the formation of three-dimensional network structure and the core layer, and the nuclear pore complex phase, the chromatin and nucleolus network in which. Nuclear skeleton - nuclear fiber layer - the middle of the three fibers connected to form a through the nuclear, mass unified network system. This system has a higher stability than microtubes and microfilaments.

5.2. Core layer

The core layer is widely found in the higher eukaryotic cells, is the inner layer of nuclear membrane fibrin layer, the fiber diameter of about 10 nanometers, the fibers arranged in a vertical and horizontal fibers were network-like. The core layer is connected with the nuclear matrix in the nucleus and is connected with the medium fiber outside the nucleus to form a unified grid structure system that runs through the nucleus and cytoplasm. It is located between the inner nuclear membrane and the chromatin, and the nuclear membrane, chromatin and nuclear pore complex in the structure are closely linked to the nuclear layer of protein and the inner nuclear membrane of the protein binding, inward and dyeing Qualitative combination of specific sections. The thickness varies with different cells, ranging from 30 to 100 nanometers.

5.3. Chromosome skeleton

Chromosome skeleton (scaffold), in the chromosome packaging, for the chromatin to provide anchoring sites of non-histone. In order to demonstrate the presence of the chromosomal skeleton, the chromosomes before mitosis were isolated, followed by dissolution of the histones and most of the major non-histones with reagents, followed by a complete chromosomal framework or scaffold under electron microscopy. In the interval, the chromosome scaffold disintegrated, and the protein that forms the scaffold acts as a component of the nuclear matrix.

Conclusion

(20 ~ 25nm), microfilament (5 ~ 6nm), intermediate fiber (7 ~ 11nm) and micro-beam network (3 ~ 6nm) according to the size of the fiber. These fibers form a cytoplasmic skeleton system. In recent years, it has been found in the nucleus there are protein-based, with a small amount of RNA fine mesh system of the nucleus skeleton.

The cytoskeleton is not static, but is in a highly dynamic, interconnected and bound to the nucleus and other membrane-bound organelles, closely related to cell activity.

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