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Chapter 1 : How a molecular traffic jam impacts cell division

This volume attempts to describe the purification and assay of the diverse group of proteins involved in otoplasmic organization. Some of the more promising attempts to apply techniques of molecular biology, genetics, and molecular cytochemistry to these proteins are discussed.

Septin Septins are a group of the highly conserved GTP binding proteins found in eukaryotes. Different septins form protein complexes with each other. These can assemble to filaments and rings. Therefore, septins can be considered part of the cytoskeleton. Recent research in human cells suggests that septins build cages around bacterial pathogens, immobilizing the harmful microbes and preventing them from invading other cells. Spectrin Spectrin is a cytoskeletal protein that lines the intracellular side of the plasma membrane in eukaryotic cells. Spectrin forms pentagonal or hexagonal arrangements, forming a scaffolding and playing an important role in maintenance of plasma membrane integrity and cytoskeletal structure. Yeast In budding yeast an important model organism , actin forms cortical patches, actin cables, and a cytokinetic ring and the cap. Cortical patches are discrete actin bodies on the membrane and are vital for endocytosis , especially the recycling of glucan synthase which is important for cell wall synthesis. Actin cables are bundles of actin filaments and are involved in the transport of vesicles towards the cap which contains a number of different proteins to polarize cell growth and in the positioning of mitochondria. The cytokinetic ring forms and constricts around the site of cell division. Prokaryotic cytoskeleton Prior to the work of Jones et al. When studied, many misshapen bacteria were found to have mutations linked to development of a cell envelope. Like tubulin, FtsZ forms filaments in the presence of guanosine triphosphate GTP , but these filaments do not group into tubules. During cell division , FtsZ is the first protein to move to the division site, and is essential for recruiting other proteins that synthesize the new cell wall between the dividing cells. All non-spherical bacteria have genes encoding actin-like proteins, and these proteins form a helical network beneath the cell membrane that guides the proteins involved in cell wall biosynthesis. 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. Crescentin is also involved in maintaining cell shape, such as helical and vibrioid forms of bacteria, but the mechanism by which it does this is currently unclear. These filament forming proteins have been classified into 4 classes. Actin-like proteins are actin in eukaryotes and MreB , FtsA in prokaryotes. Examples for intermediate filaments, which have almost exclusively been found in animals i. The same holds true for the actin-like proteins and their structure and ATP binding domain. Which proteins fulfill which task is very different. For example, DNA segregation in all eukaryotes happens through use of tubulin, but in prokaryotes either WACA proteins, actin-like or tubulin-like proteins can be used. Cell division is mediated in eukaryotes by actin, but in prokaryotes usually by tubulin-like often FtsZ-ring proteins and sometimes Crenarchaeota ESCRT-III, which in eukaryotes still has a role in the last step of division. While mainly seen in plants, all cell types use this process for transportation of waste, nutrients, and organelles to other parts of the cell.

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Chapter 2 : Cytoskeleton - Wikipedia

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How a molecular traffic jam impacts cell division November 7, , Ludwig-Maximilians-Universitat Munchen Interdisciplinary research between biology and physics aims to understand the cell and how it organizes internally. The mechanisms inside the cell are very complicated. The professor for statistical and biological physics and his team, Louis Reese and Anna Melbinger, investigate the interplay of so-called molecular motors with the skeleton of the cell, the cytoskeleton. The cytoskeleton consists of many fiber-like structures called microtubules. Molecular motors move along these filaments and transport large macromolecules. Furthermore, these motors are necessary for cell signaling and microtubule regulation at the tip of these filaments. Frey and his coworkers investigate molecular motors which are of particular interest for the regulation of the length of microtubules during cell division. Without these motors, cells are not able to divide properly. How does the lack of one single molecule, the molecular motor, have such tremendous impact on cellular behavior? The biophysicists confronted this question and studied the detailed functioning of the molecule and its potential regulatory mechanisms during cell division. They focused on the interplay of microtubules and motors that shorten depolymerize the filaments. Frey and his colleagues used a theoretical model which correctly accounts for the "traffic jam" phenomenon. Using this model, the biophysicists were able to show that a traffic jam of motor molecules on the microtubule alters the shortening behavior of the filament significantly. The number of motors present in the surrounding solution i. At a specific critical concentration of motors, traffic jams form at the tip of the microtubule. As soon as a motor has finished its severing activity, it diffuses with the microtubule-brick into solution. However, due to the traffic jam of motor proteins, a fresh supply is already present. Hence, the rate of microtubule shortening is directly connected to the speed at which the single molecular motor depolymerizes the microtubule. The situation changes dramatically if there are significantly less motor proteins in solution. In this case, the supply of motor proteins becomes the limiting factor. The disassembly speed is now governed by the quantity of motors arriving at the microtubule tip. Consequently the disassembly mechanism differs significantly from the one for higher motor concentrations. In particular, the depolymerization speed becomes length dependent. With their calculations, the physicists from Munich contribute to a better understanding of existing experiments on microtubule disassembly. For example, a phenomenon discussed among scientists is that the speed at which microtubules are depolymerized by motors depends on the microtubule length: Their theoretical model explains these basic functional properties of this system and in this vein it puts the existing experimental results into a larger context. On this track the cell plays a central role with its multifarious building blocks and functions. To understand these effects in the living cell is a declared aim of biology and biophysics".

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