CYTOSKELETON

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A network of protein filaments that extends throughout the cytoplasm of eukaryotic cells. It provides the structural framework of the cell and is responsible for cell movements.

The **cytoskeleton** is a structure that helps cells maintain their shape and internal organization

It also provides mechanical support that enables cells to carry out essential functions like division and movement.

There is no single cytoskeletal component. Rather, several different components work together to form the cytoskeleton.

Cytoskeleton consist of three fibres or filaments

MICROTUBULES
MICROFILAMENTS
INTERMIDIATE FILAMENT

MICROTUBULES

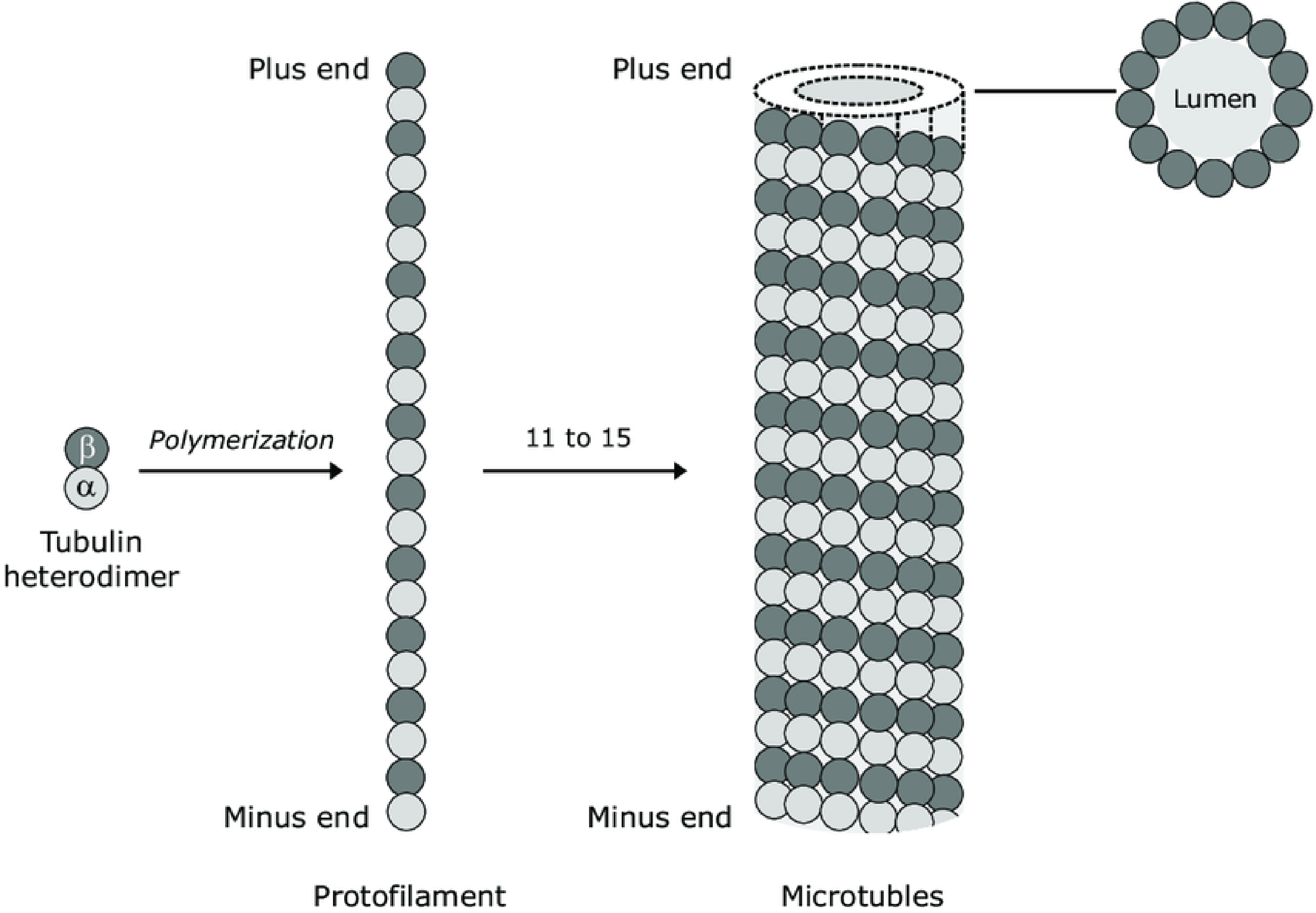
Microtubules are major components of the cytoskeleton. They are found in all eukaryotic cells, and they are involved in mitosis, cell motility, intracellular transport, and maintenance of cell shape.

Microtubules are composed of **alpha- and beta-tubulin** subunits assembled into linear protofilaments.

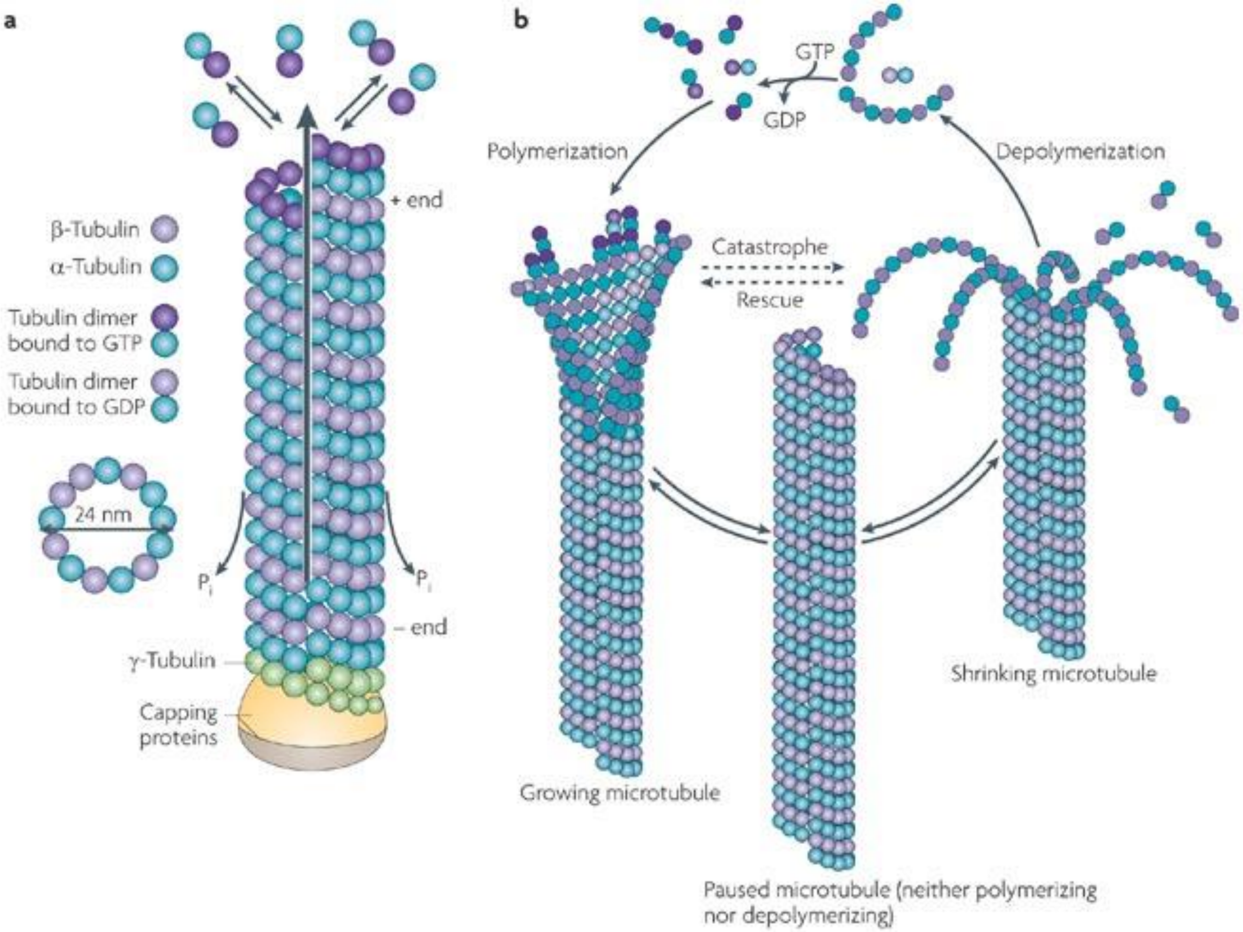
A single microtubule contains **10 to 15 protofilaments (13 in mammalian cells)** that wind together to form a 24 nm wide hollow cylinder.

Microtubules are structures that can rapidly grow (via polymerization) or shrink (via depolymerization) in size, depending on how many tubulin molecules they contain.

In addition, a third type of tubulin **(γ-tubulin)** is specifically localized to the centrosome, where it plays a critical role in initiating microtubule assembly



Plus end
Plus end
Lumen
β
α
Polymerization
11 to 15
Tubulin
heterodimer
Minus end
Minus end
Protofilament
Microtubles



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Tubulin dimers polymerize to form microtubules, which generally consist of **13 linear protofilaments** assembled around a hollow core.

The protofilaments, which are composed of head-to-tail arrays of **tubulin dimers**, are arranged in parallel.

Microtubules are polar structures with two distinct ends: a **fast-growing plus end and a slow-growing minus end.**

This polarity is an important consideration in determining the direction of movement along microtubules.

Tubulin dimers can depolymerize as well as polymerize, and microtubules can undergo rapid cycles of assembly and disassembly.

Both α- and β-tubulin bind GTP, which functions analogously to the ATP bound to actin to regulate polymerization.

The GTP bound to β-tubulin is hydrolyzed to GDP during or shortly after polymerization.

This GTP hydrolysis weakens the binding affinity of tubulin for adjacent molecules, thereby favoring depolymerization and resulting in the dynamic behavior of microtubules.

The Centrosome and Microtubule Organization (MTOC)

The microtubules in most cells extend outward from a microtubule-organizing center, in which the minus ends of microtubules are anchored.
In animal cells, the major microtubule-organizing center is the centrosome, which is located adjacent to the nucleus near the center of interphase (nondividing) cells.

During mitosis, microtubules similarly extend outward from duplicated centrosomes to form the mitotic spindle, which is responsible for the separation and distribution of chromosomes to daughter cells.

The centrosome thus plays a key role in determining the intracellular organization of microtubules

Stabilization of Microtubules and Cell Polarity

Because of the inherent dynamic instability, most microtubules are frequently disassembled within the cell.

This dynamic behavior can be modified by the interactions of microtubules with other proteins. Some cellular proteins act to disassemble microtubules, either by severing microtubules or by increasing the rate of tubulin depolymerization from microtubule ends.

Other proteins (called **microtubule-associated proteins** or **MAPs**) bind to microtubules and increase their stability. Such interactions allow the cell to stabilize microtubules in particular locations and provide an important mechanism for determining cell shape and polarity.

A large number of MAPs have been identified, and they vary depending on the type of cell.

The best-characterized are **MAP-1, MAP-2, and tau**, isolated from neuronal cells, and **MAP-4**, which is present in all non-neuronal vertebrate cell types.

The tau protein has been extensively studied because it is the main component of the characteristic lesions found in the brains of Alzheimer patients. The activity of MAPs is regulated by phosphorylation, allowing the cell to control microtubule stability.