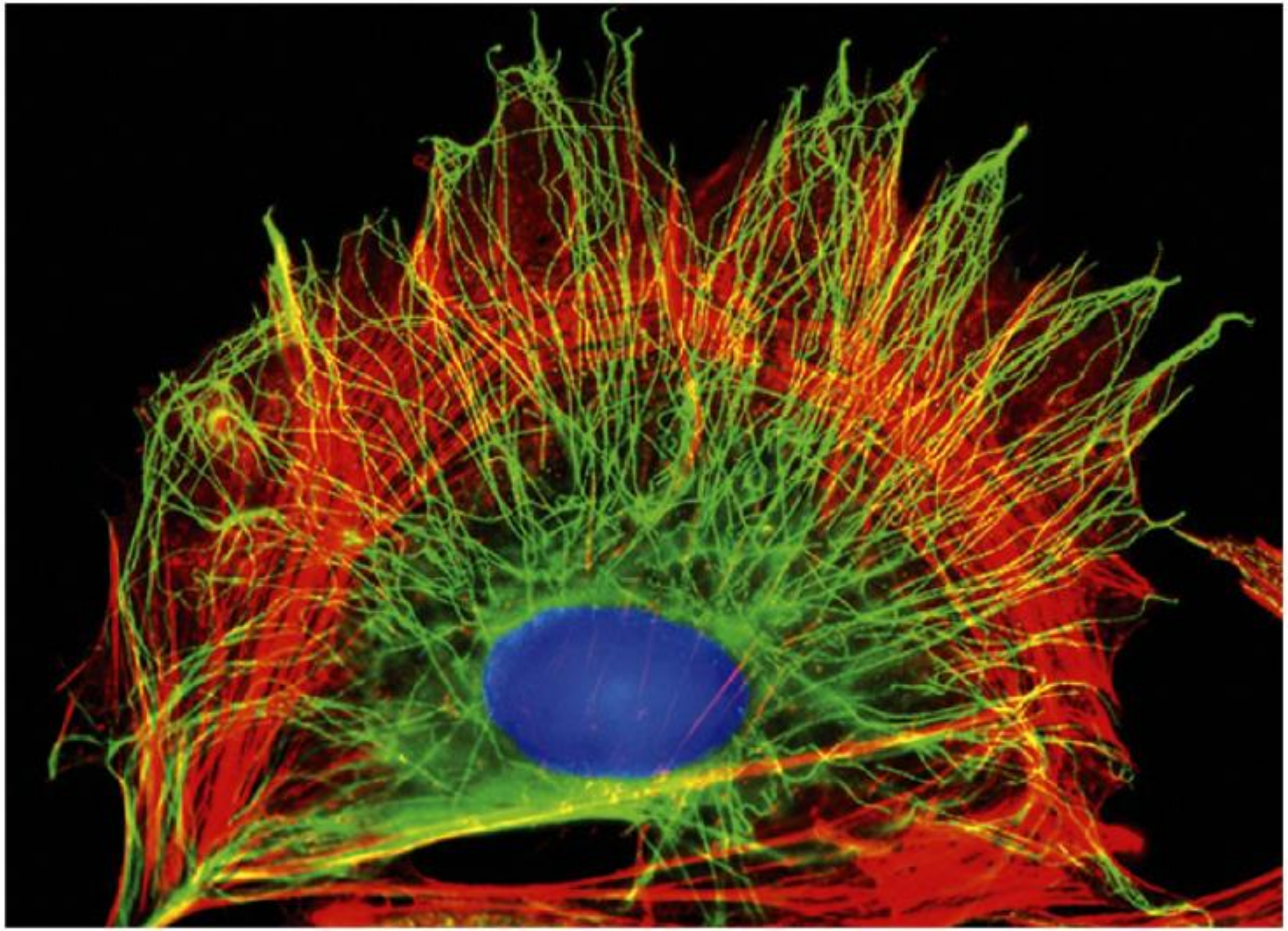
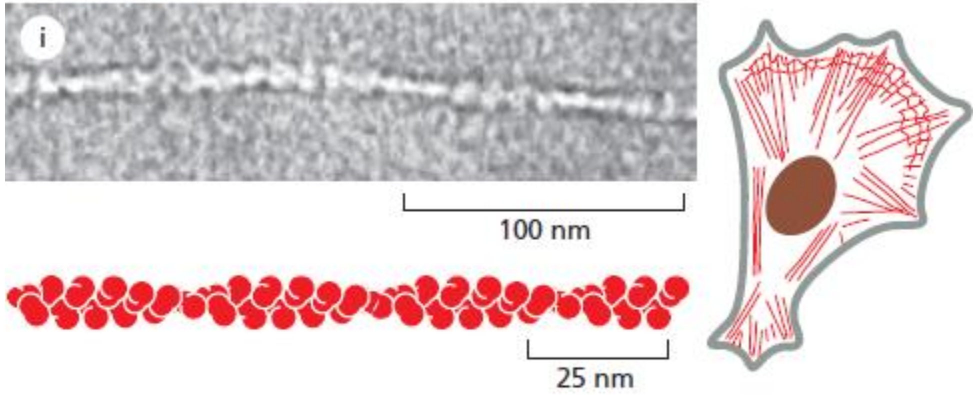
El Citoesqueleto - II



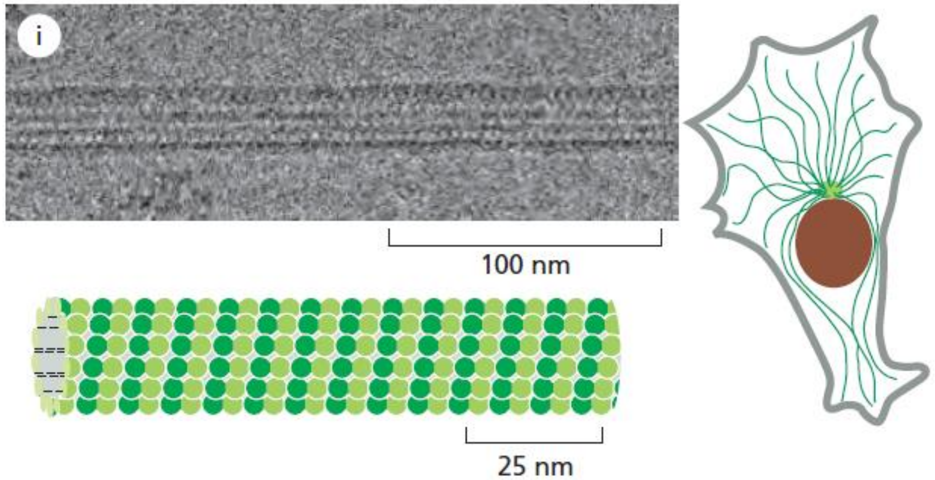
Uriel Koziol – ukoziol@fcien.edu.uy

ACTIN FILAMENTS



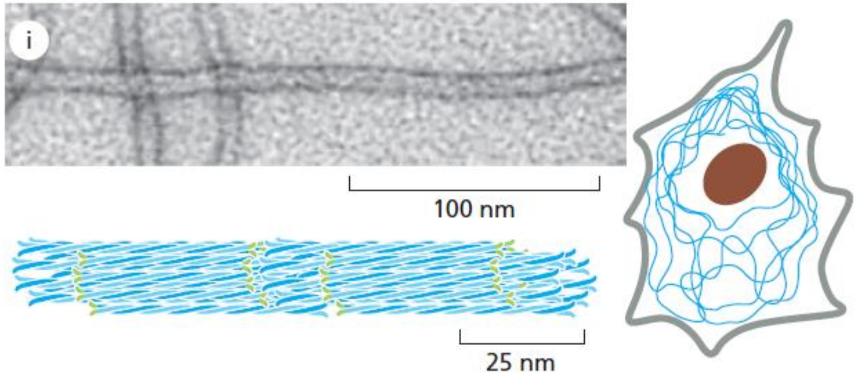
Actin filaments (also known as *microfilaments*) are helical polymers of the protein actin. They are flexible structures with a diameter of 8 nm that organize into a variety of linear bundles, two-dimensional networks, and three-dimensional gels. Although actin filaments are dispersed throughout the cell, they are most highly concentrated in the *cortex*, just beneath the plasma membrane.

MICROTUBULES



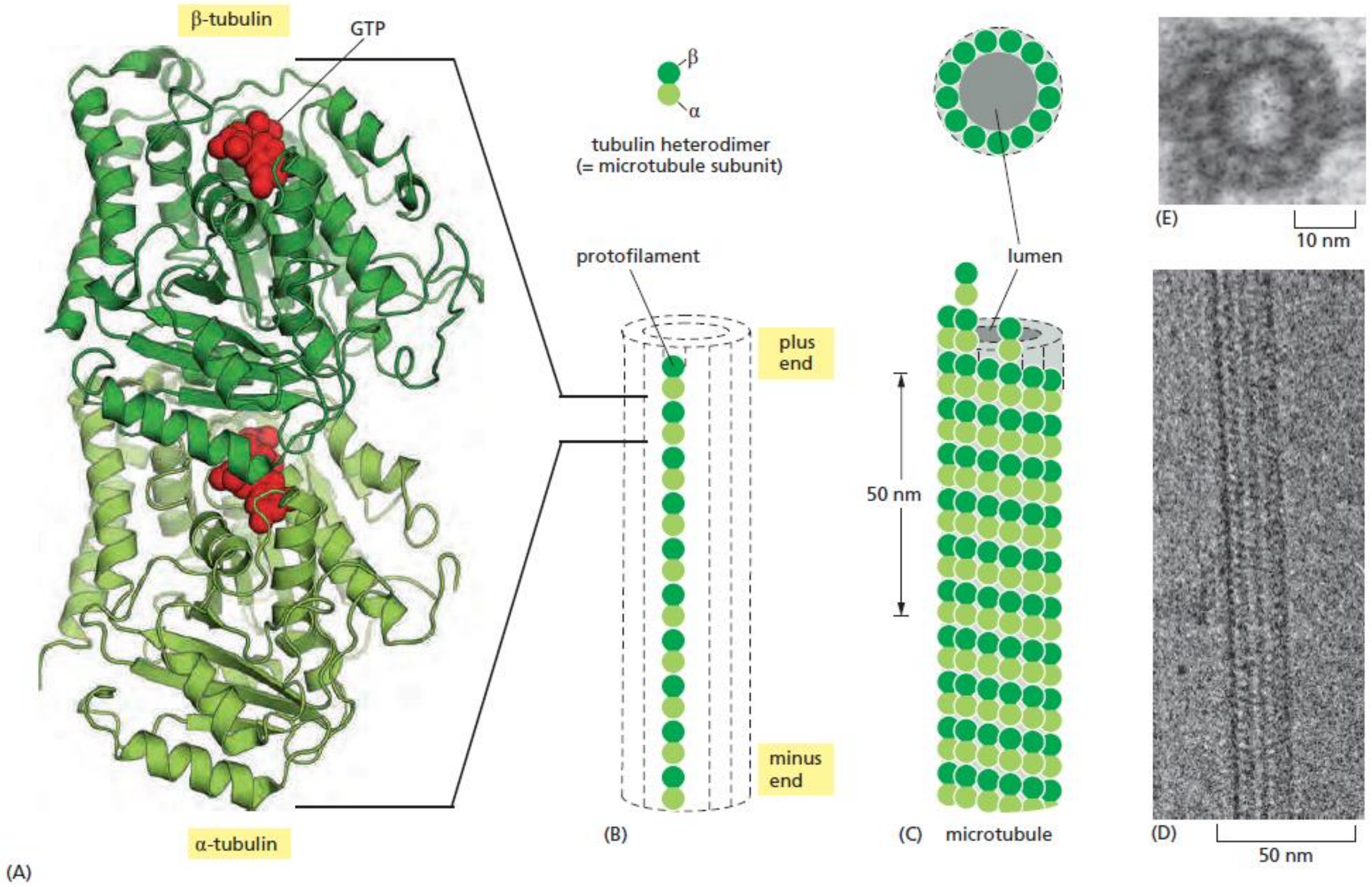
Microtubules are long, hollow cylinders made of the protein tubulin. With an outer diameter of 25 nm, they are much more rigid than actin filaments. Microtubules are long and straight and frequently have one end attached to a microtubule-organizing center (MTOC) called a *centrosome*.

INTERMEDIATE FILAMENTS



Intermediate filaments are ropelike fibers with a diameter of about 10 nm; they are made of intermediate filament proteins, which constitute a large and heterogeneous family. One type of intermediate filament forms a meshwork called the nuclear lamina just beneath the inner nuclear membrane. Other types extend across the cytoplasm, giving cells mechanical strength. In an epithelial tissue, they span the cytoplasm from one cell–cell junction to another, thereby strengthening the entire epithelium.

Microtúbulos



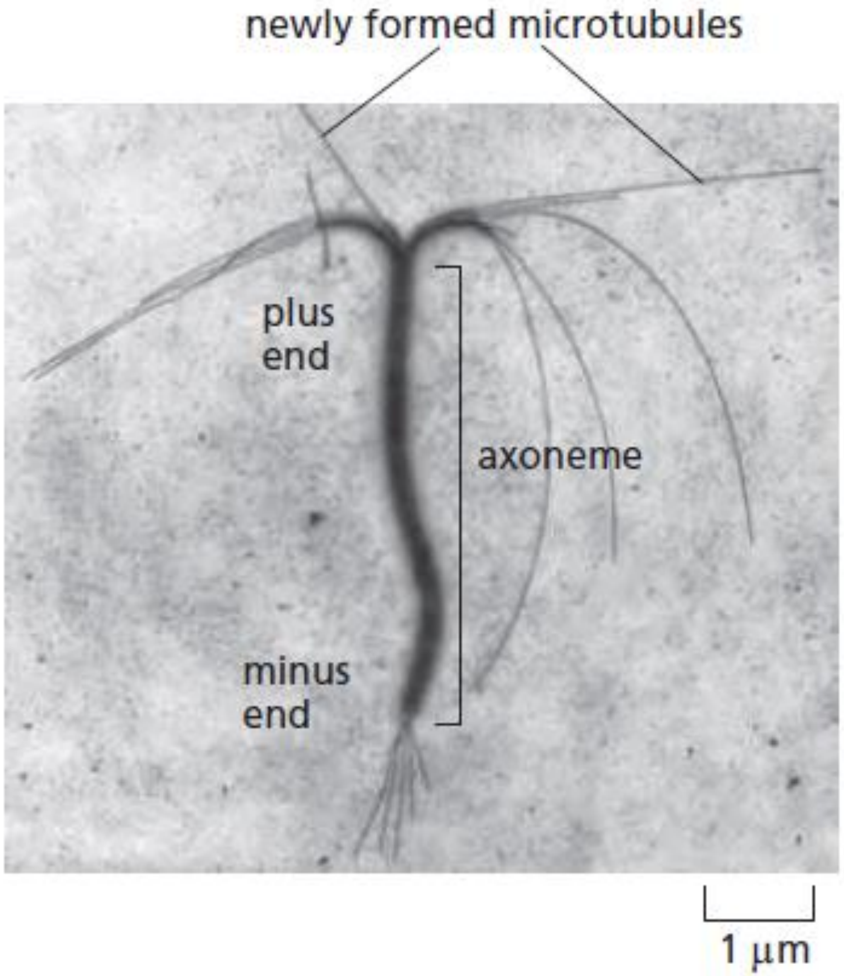
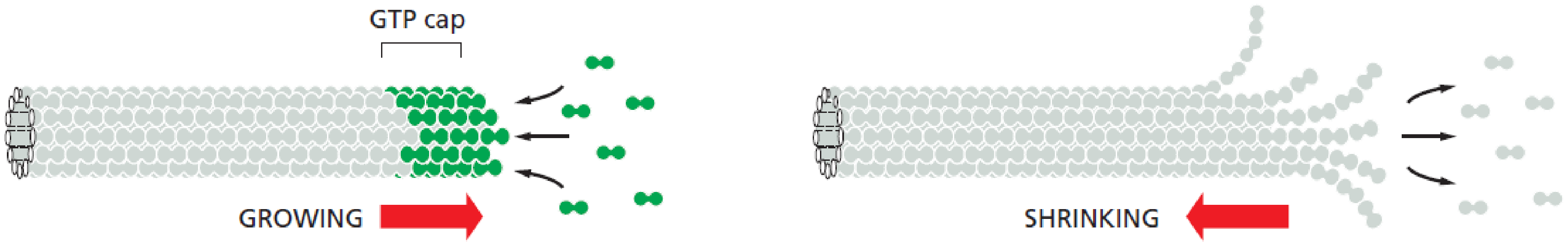


Figure 16–43 The preferential growth of microtubules at the plus end. Microtubules grow faster at one end than at the other. A stable bundle of microtubules obtained from the core of a cilium (called an axoneme) was incubated for a short time with tubulin subunits under polymerizing conditions. Microtubules grew fastest from the plus end of the microtubule bundle, the end at the *top* in this micrograph. (Courtesy of Gary Borisy.)

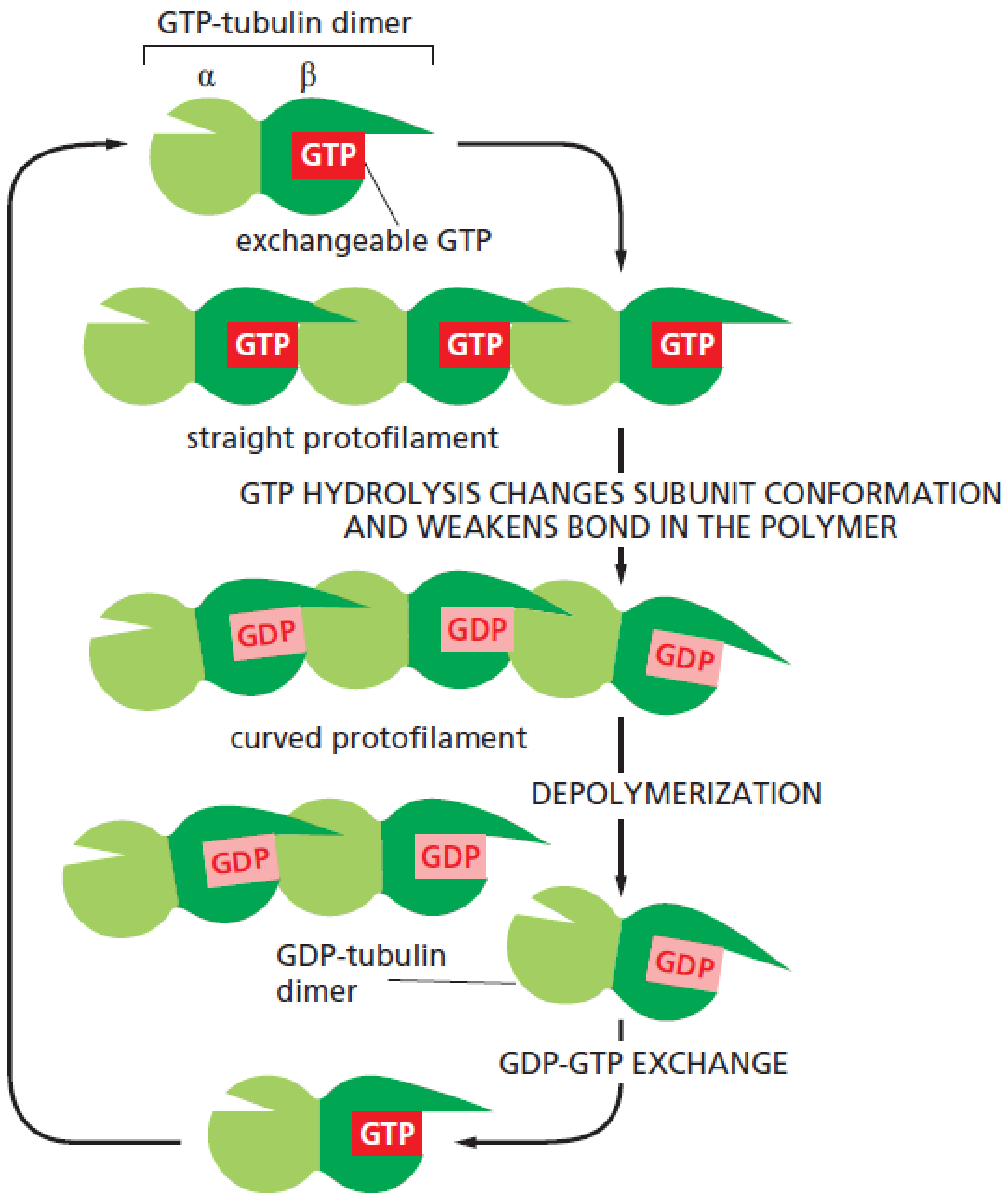
Inestabilidad dinámica

DYNAMIC INSTABILITY

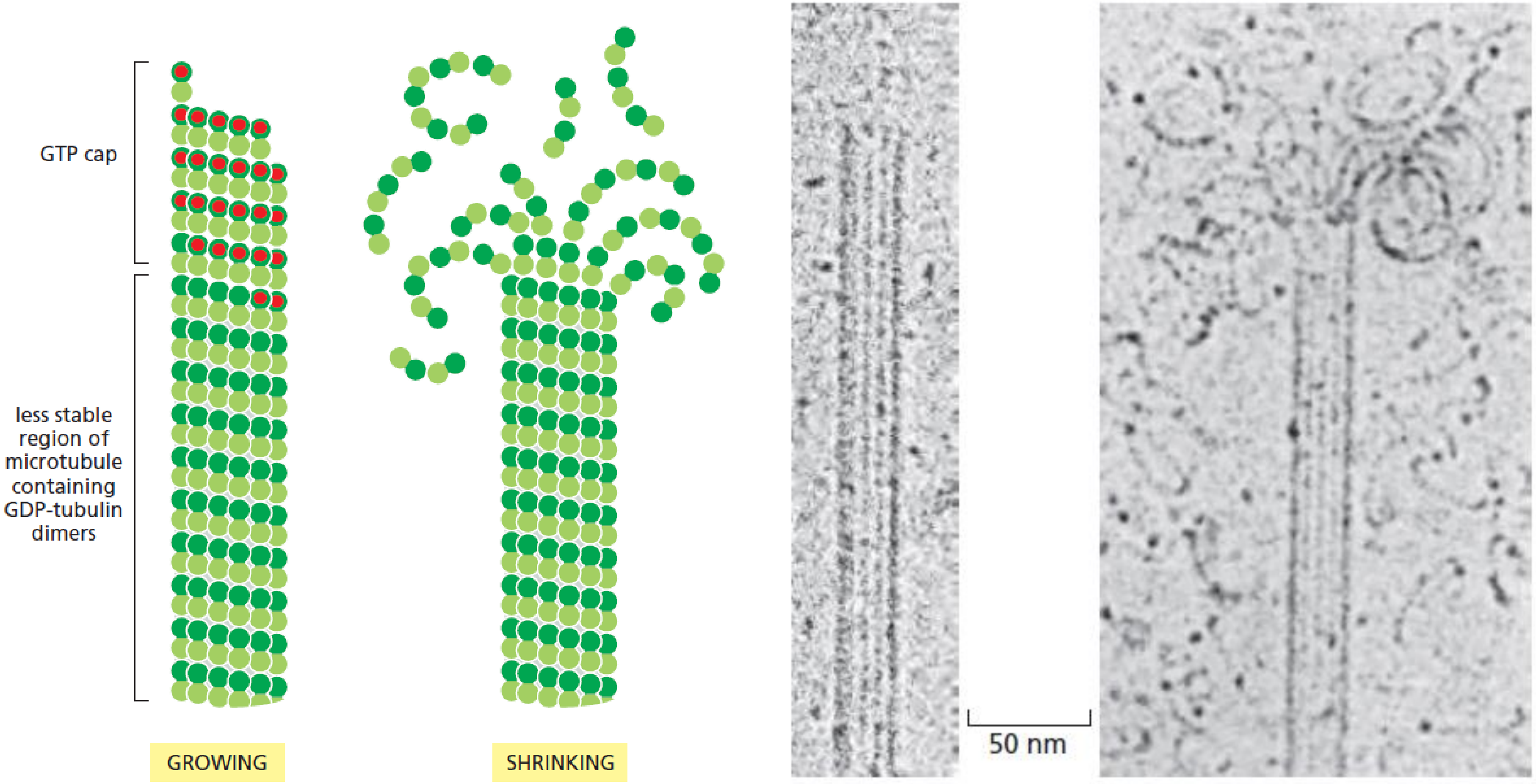
Microtubules depolymerize about 100 times faster from an end containing GDP-tubulin than from one containing GTP-tubulin. A GTP cap favors growth, but if it is lost, then depolymerization ensues.



Individual microtubules can therefore alternate between a period of slow growth and a period of rapid disassembly, a phenomenon called dynamic instability.


GTP-tubulin dimer
α
β
GTP
exchangeable GTP
GTP
GTP
GTP
straight protofilament
GTP HYDROLYSIS CHANGES SUBUNIT CONFORMATION AND WEAKENS BOND IN THE POLYMER
GDP
GDP
GDP
curved protofilament
DEPOLYMERIZATION
GDP
GDP
GDP-tubulin dimer
GDP
GDP-GTP EXCHANGE
GTP

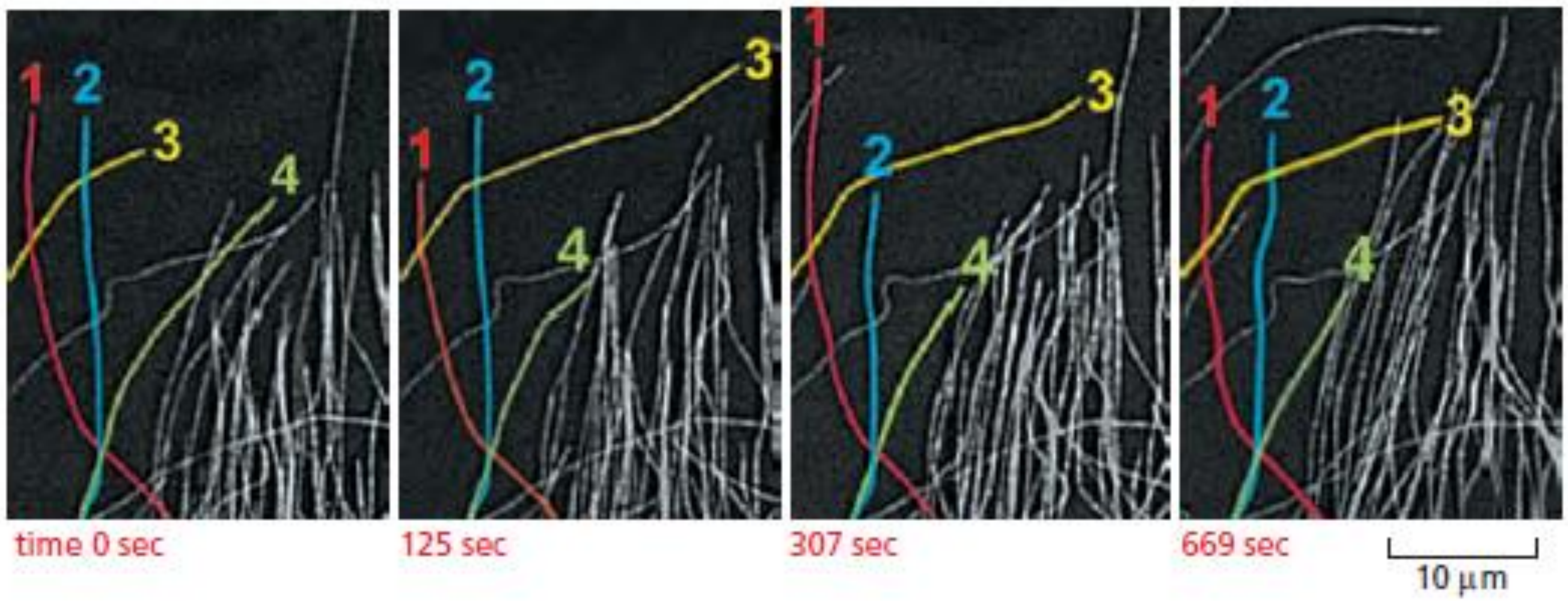
(B)

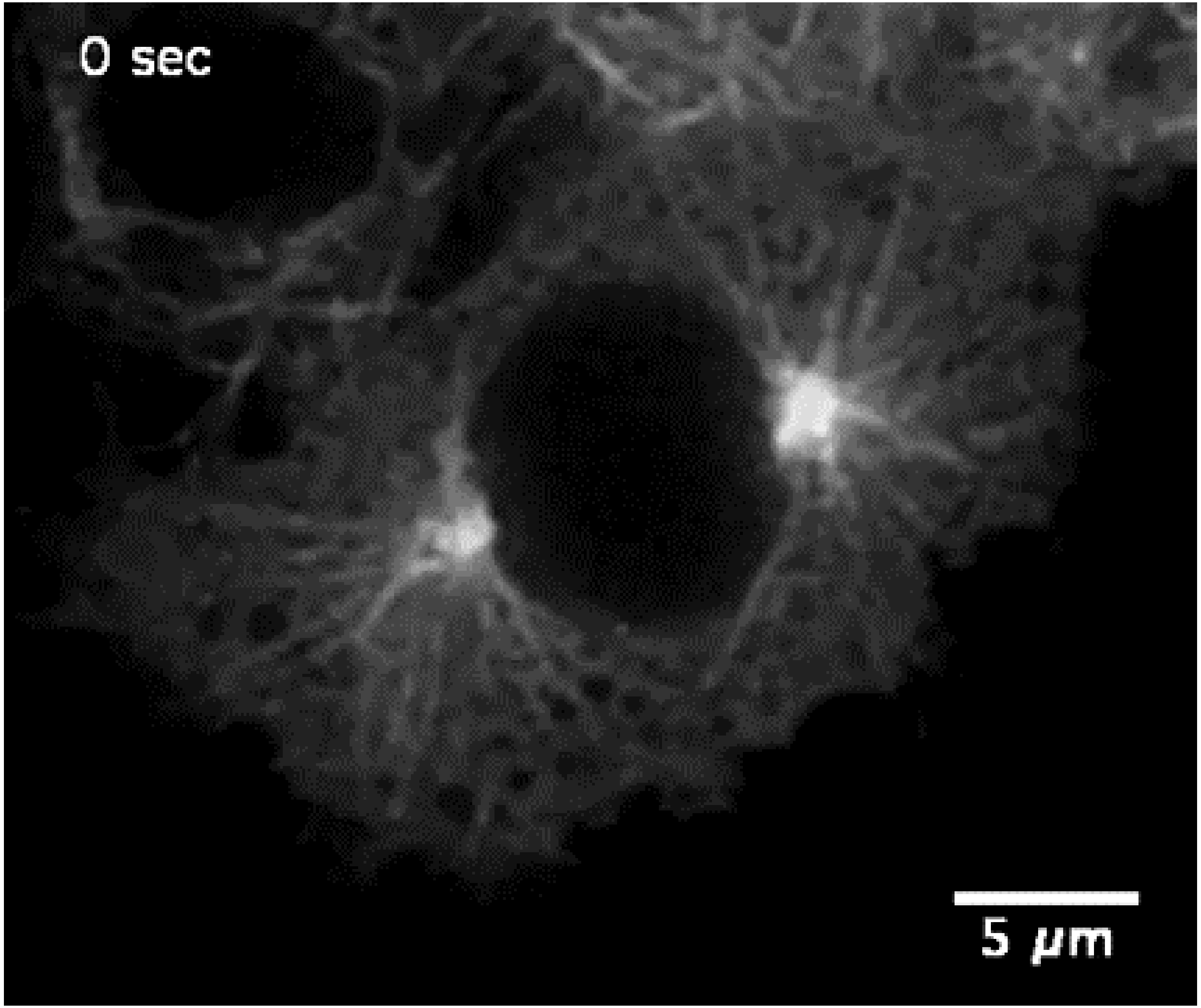


GTP cap
less stable region of microtubule containing GDP-tubulin dimers
GROWING
SHRINKING
50 nm

(C)

¿Cómo podemos ver la dinámica de los microtúbulos en una célula viva?





https://www.youtube.com/watch?v=6t05SXykeYQ

The Nobel Prize in Chemistry 2008

Osamu Shimomura, Martin Chalfie, Roger Y. Tsien

Share this: 11

Martin Chalfie - Facts

Martin Chalfie

Born: 15 January 1947, Chicago, IL, USA

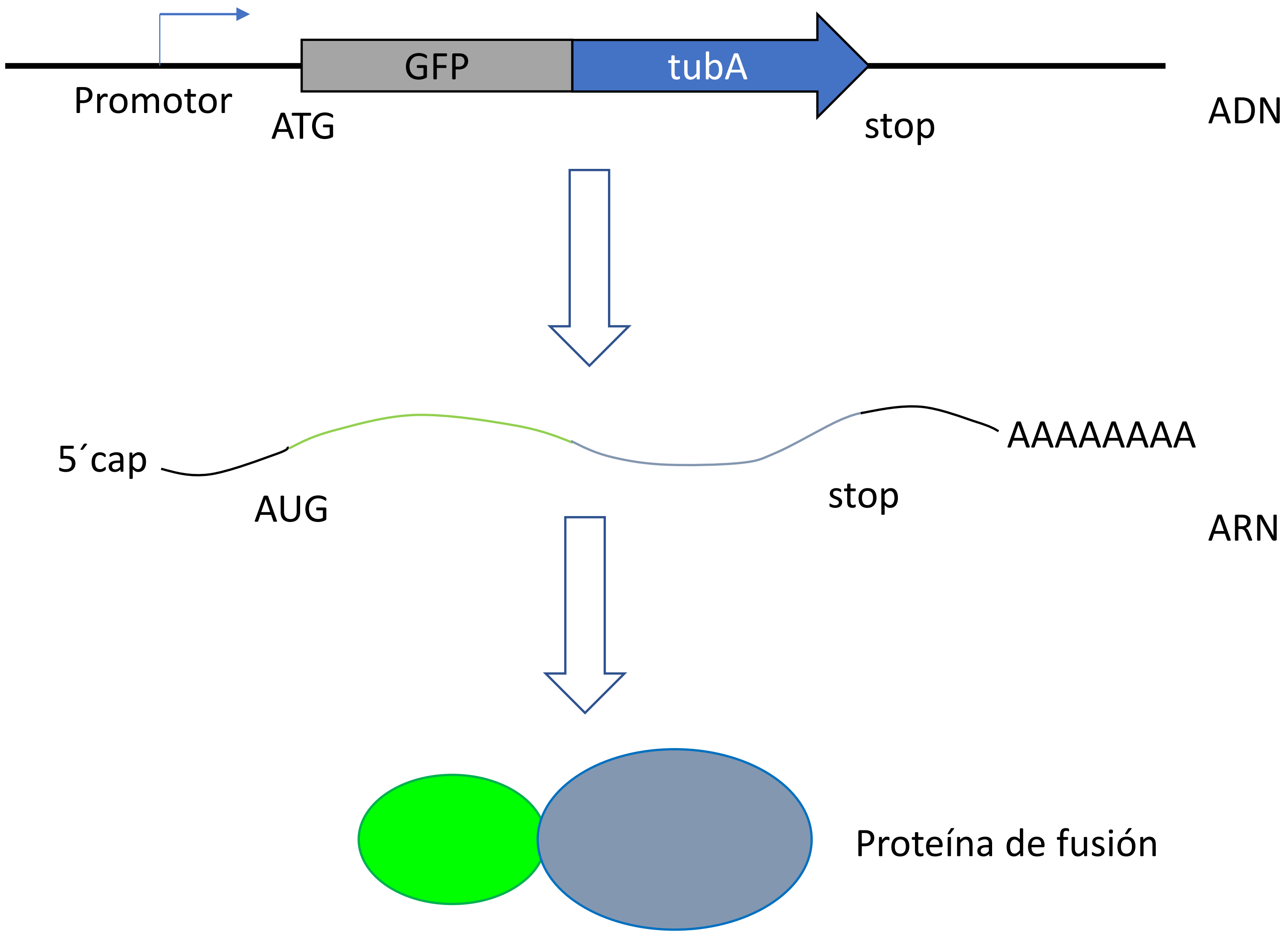
Affiliation at the time of the award: Columbia University, New York, NY, USA

Prize motivation: "for the discovery and development of the green fluorescent protein, GFP"

Field: biochemistry

Prize share: 1/3

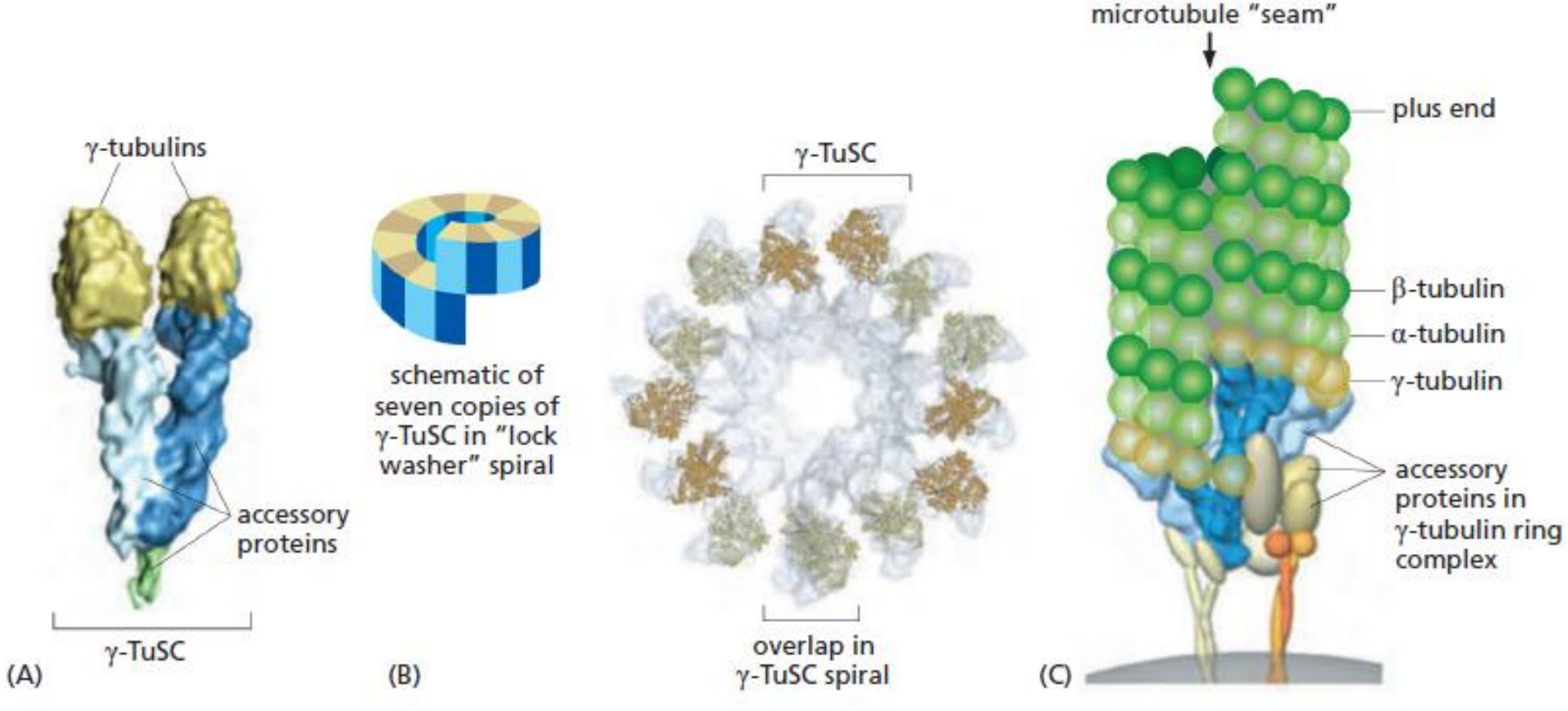
Osamu Shimomura, Martin Chalfie and Roger Tsien


GFP
tubA
Promotor
ATG
stop
ADN
5´cap
AAAAAAAA
AUG
stop
ARN
Proteína de fusión

cleación de microtúbulos

γ-tubulina y otras proteínas accesorias enriquecidas en "Centros Organizadores de Microtúbulos"

(Microtubule Organizing Centers)



El Centrosoma es un MTOC en animales

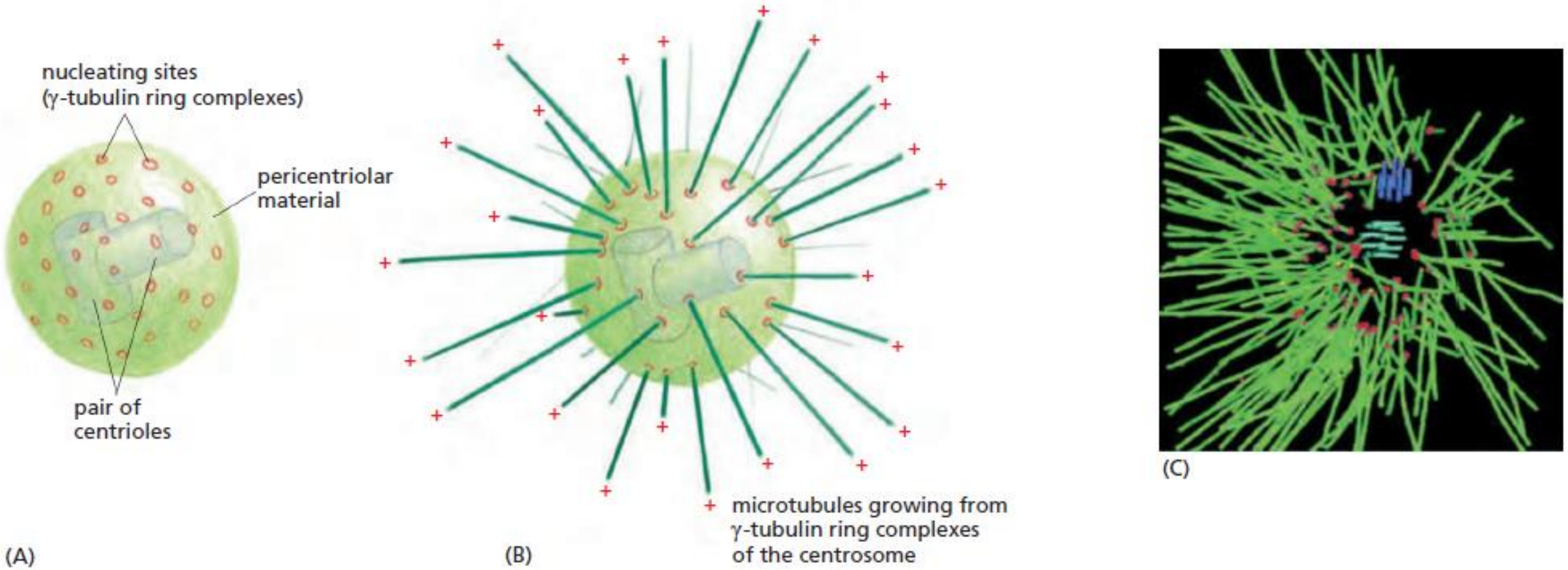
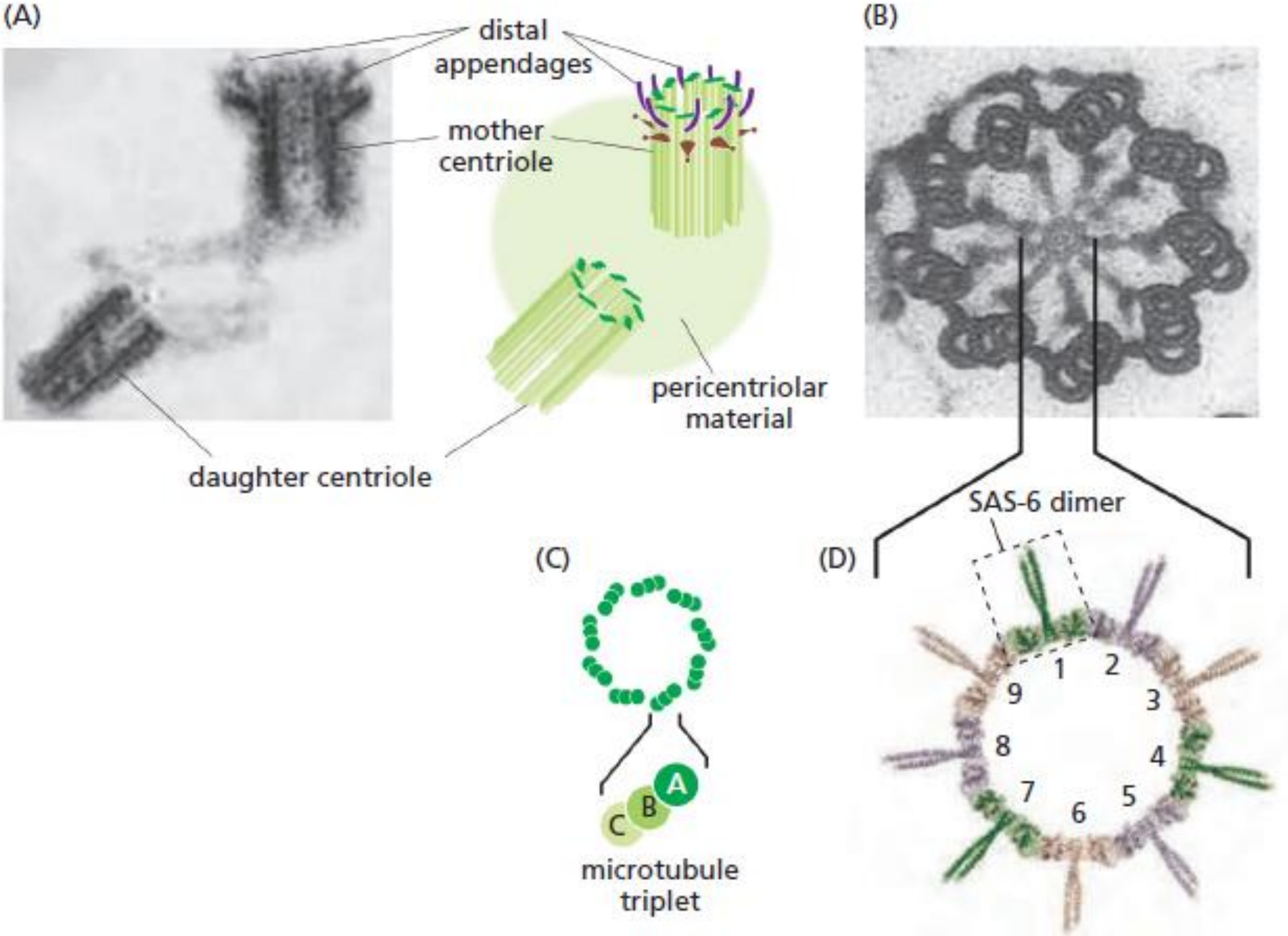


Figure 16–47 The centrosome. (A) The centrosome is the major MTOC of animal cells. Located in the cytoplasm next to the nucleus, it consists of an amorphous matrix of fibrous proteins to which the γ-tubulin ring complexes that nucleate microtubule growth are attached. This matrix is organized by a pair of centrioles, as described in the text. (B) A centrosome with attached microtubules. The minus end of each microtubule is embedded in the centrosome, having grown from a γ-tubulin ring complex, whereas the plus end of each microtubule is free in the cytoplasm. (C) In a reconstructed image of the MTOC from a *C. elegans* cell, a dense thicket of microtubules can be seen emanating from the centrosome. (C, from E.T. O'Toole et al., *J. Cell Biol.* 163:451–456, 2003. With permission from the authors.)


(A)
distal
appendages
mother
centriole
pericentriolar
material
daughter centriole
(B)
(C)
microtubule
triplet
A
B
C
(D)
SAS-6 dimer
1
2
3
4
5
6
7
8
9

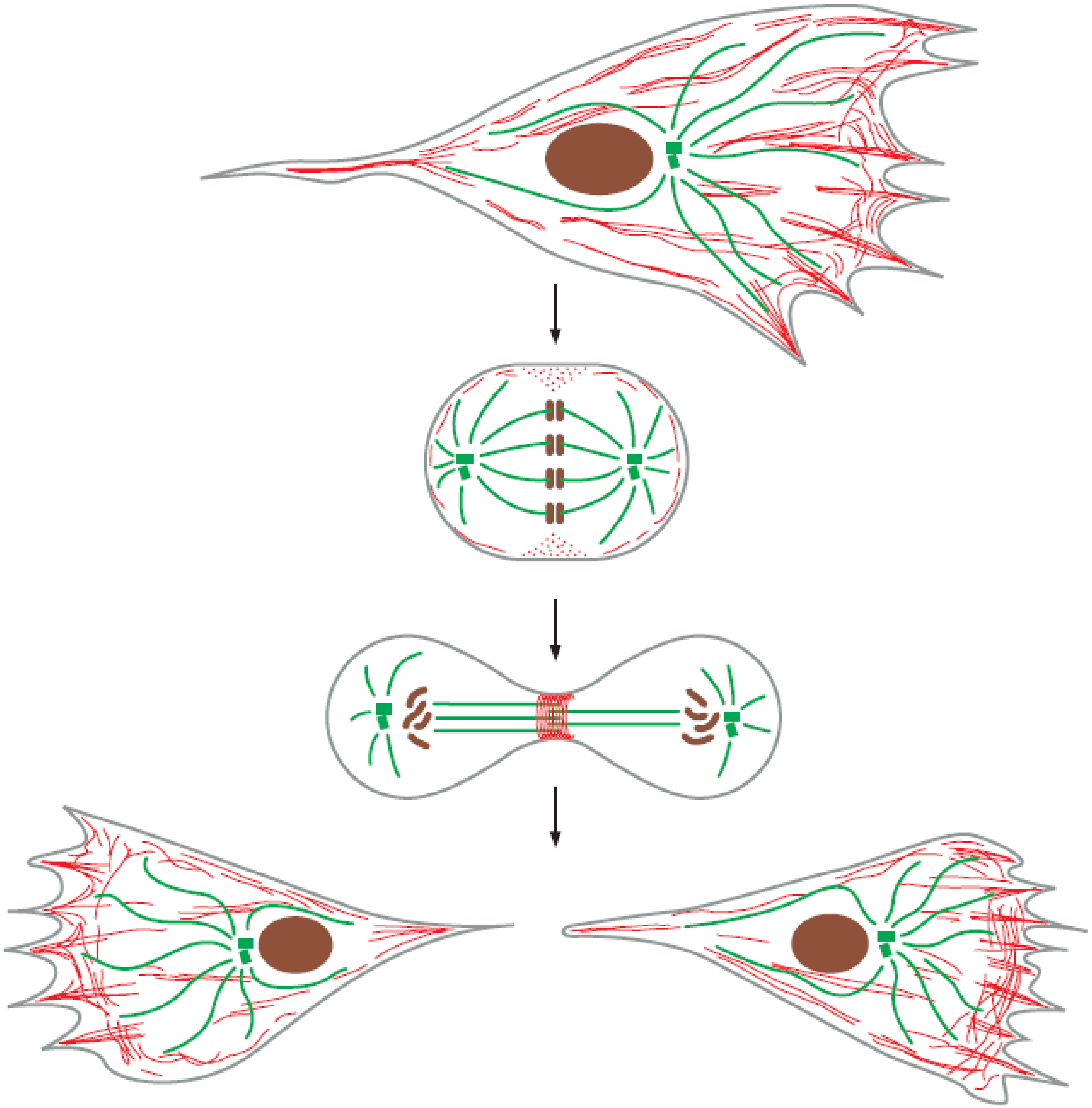
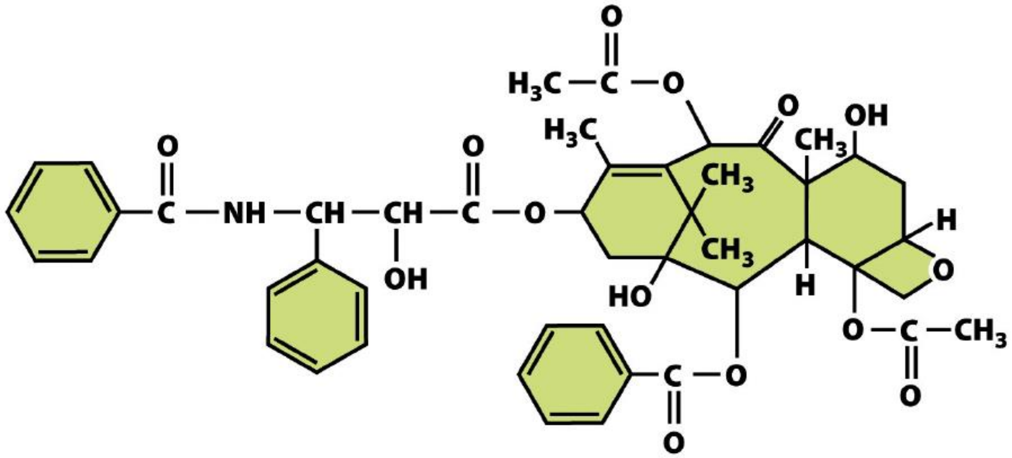
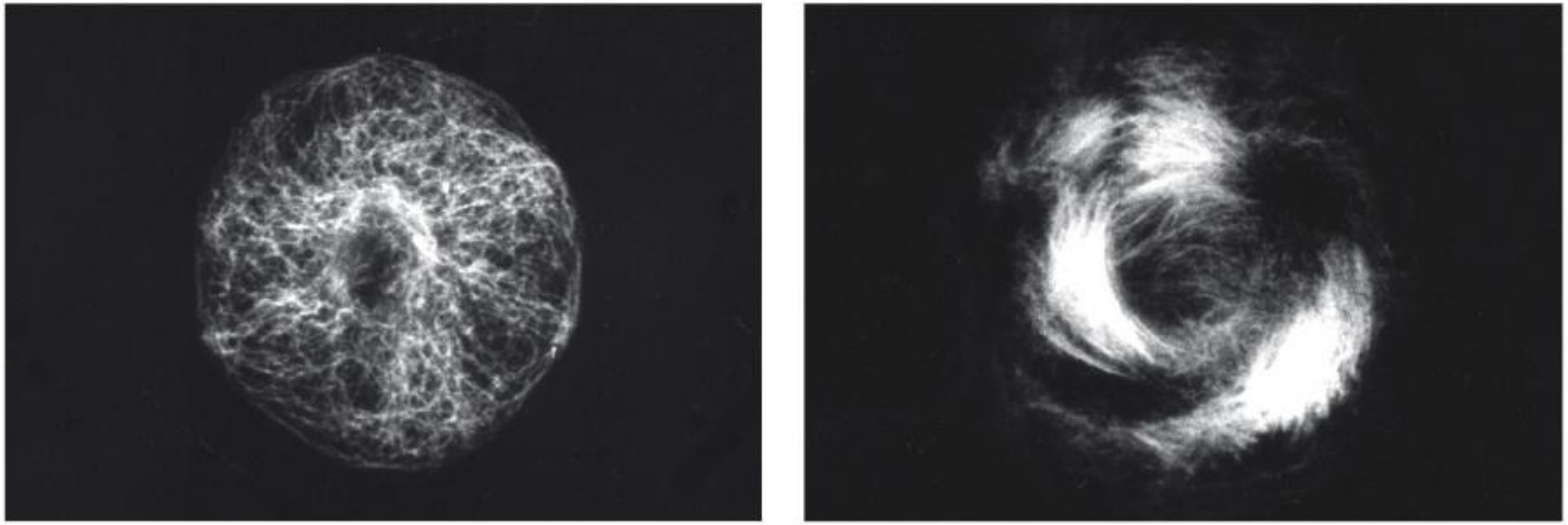


TABLE 16–1 Chemical Inhibitors of Actin and Microtubules

Chemical	Effect on filaments	Mechanism	Original source
Actin			
Latrunculin	Depolymerizes	Binds actin subunits	Sponges
Cytochalasin B	Depolymerizes	Caps filament plus ends	Fungi
Phalloidin	Stabilizes	Binds along filaments	*Amanita* mushroom
Microtubules			
Taxol® (paclitaxel)	Stabilizes	Binds along filaments	Yew tree
Nocodazole	Depolymerizes	Binds tubulin subunits	Synthetic
Colchicine	Depolymerizes	Caps filament ends	Autumn crocus

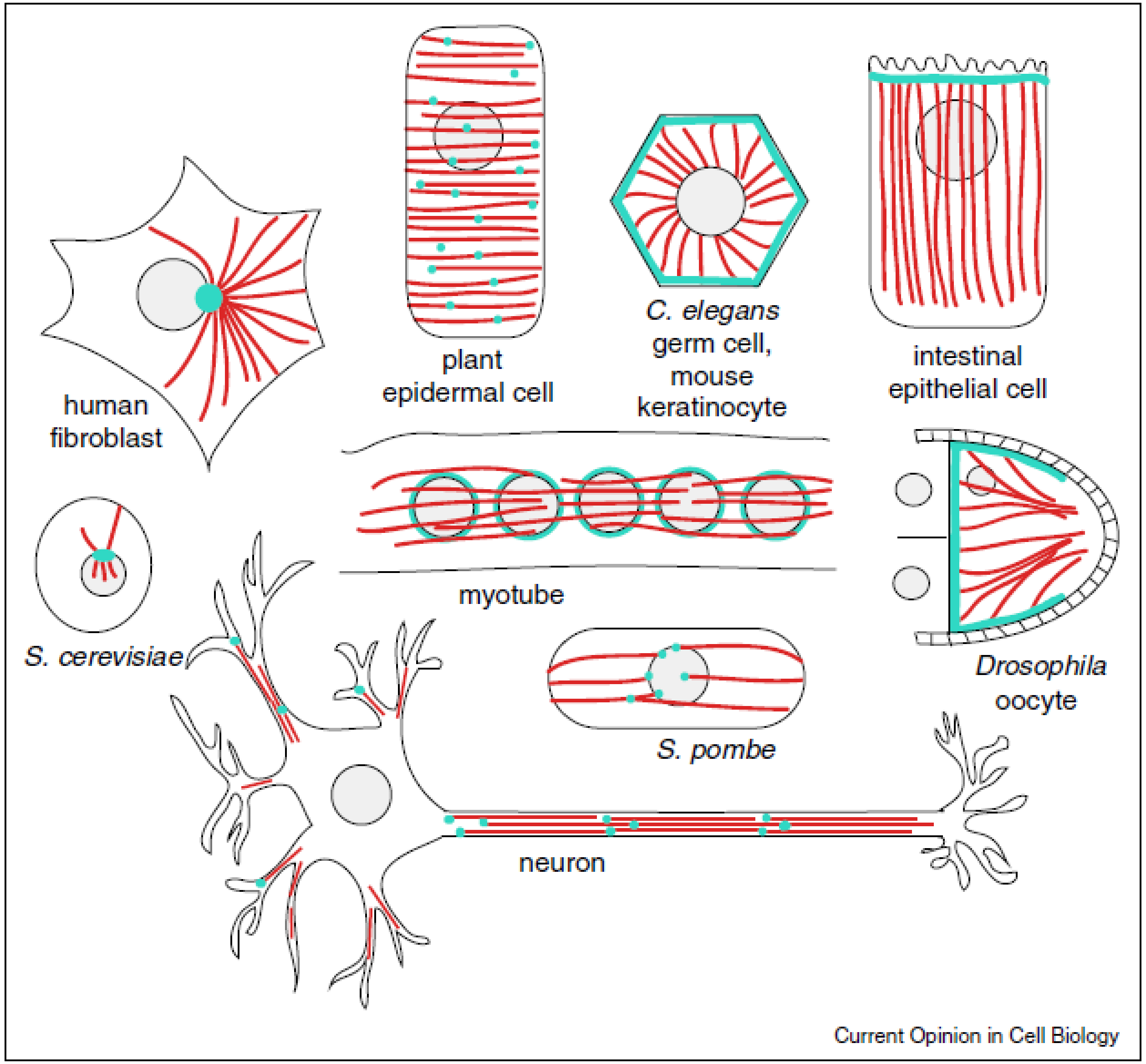


taxol

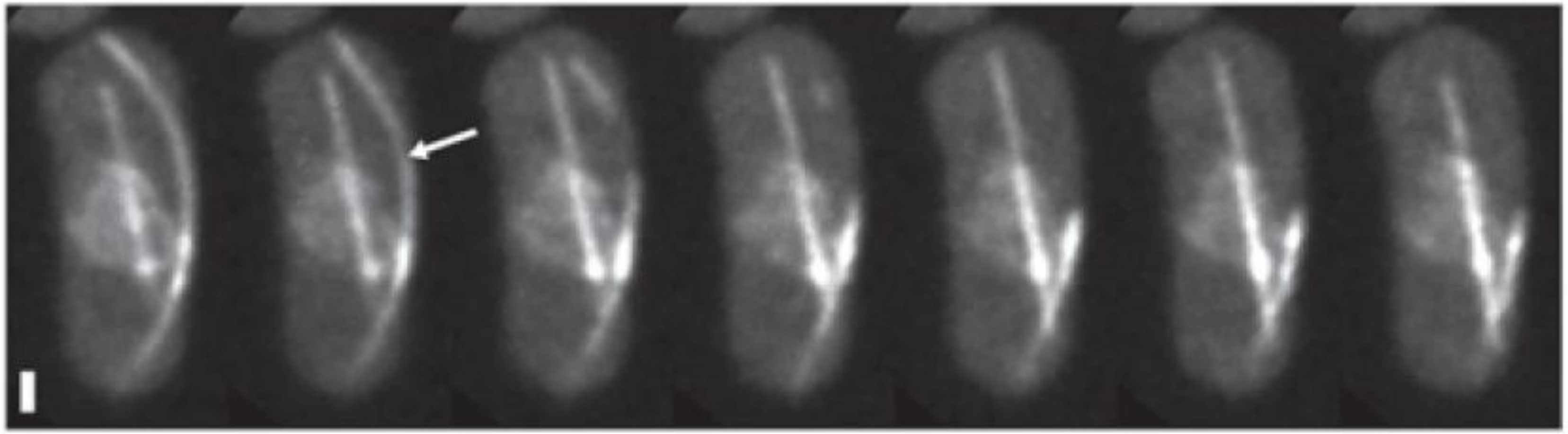


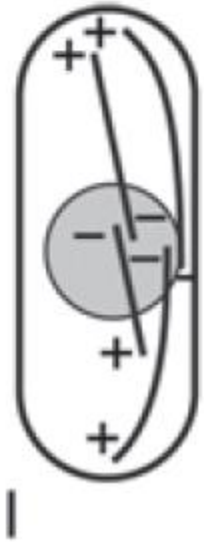
(B) 15 μm (C)

Otros MTOC en células especializadas



Ejercicio





Ablación laser de microtúbulos en levadura (*S. pombe*)

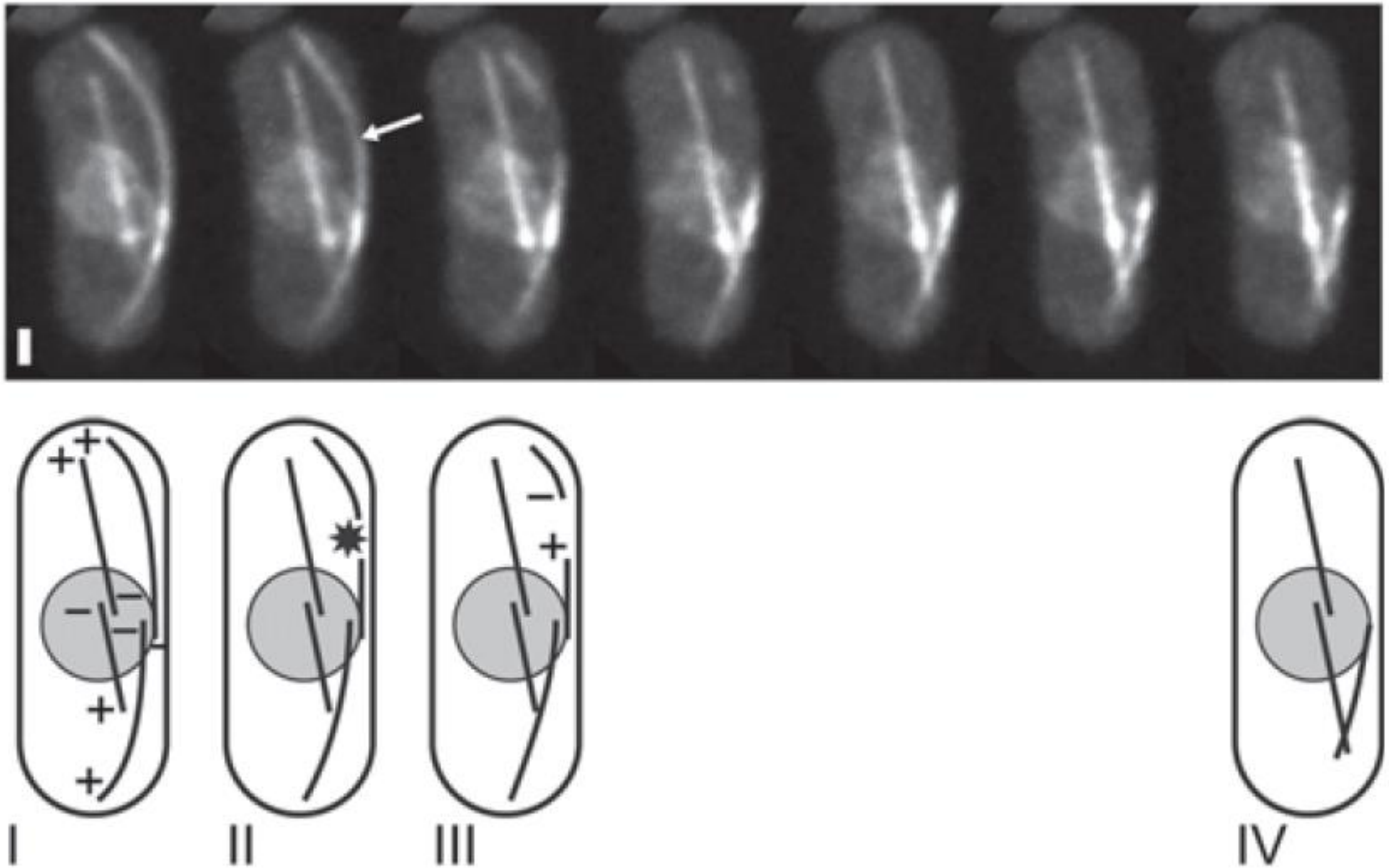
Microtúbulos marcados con tubulina-GFP

Tiempo entre imágenes: 5 segundos

¿Qué ocurre tras la ablación?

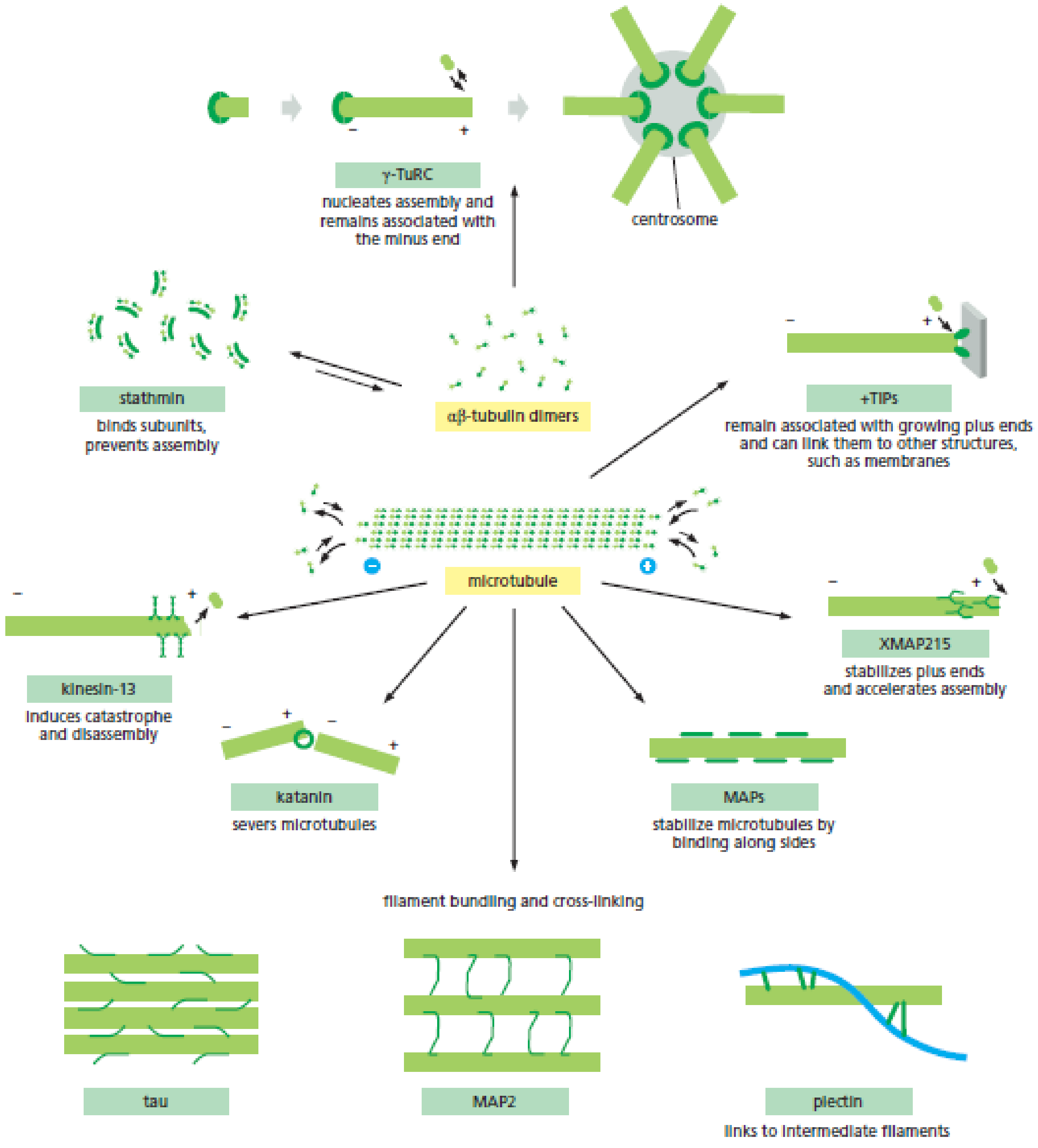
Maghelli & Tolic-Norrelykke (2010)

Ejercicio

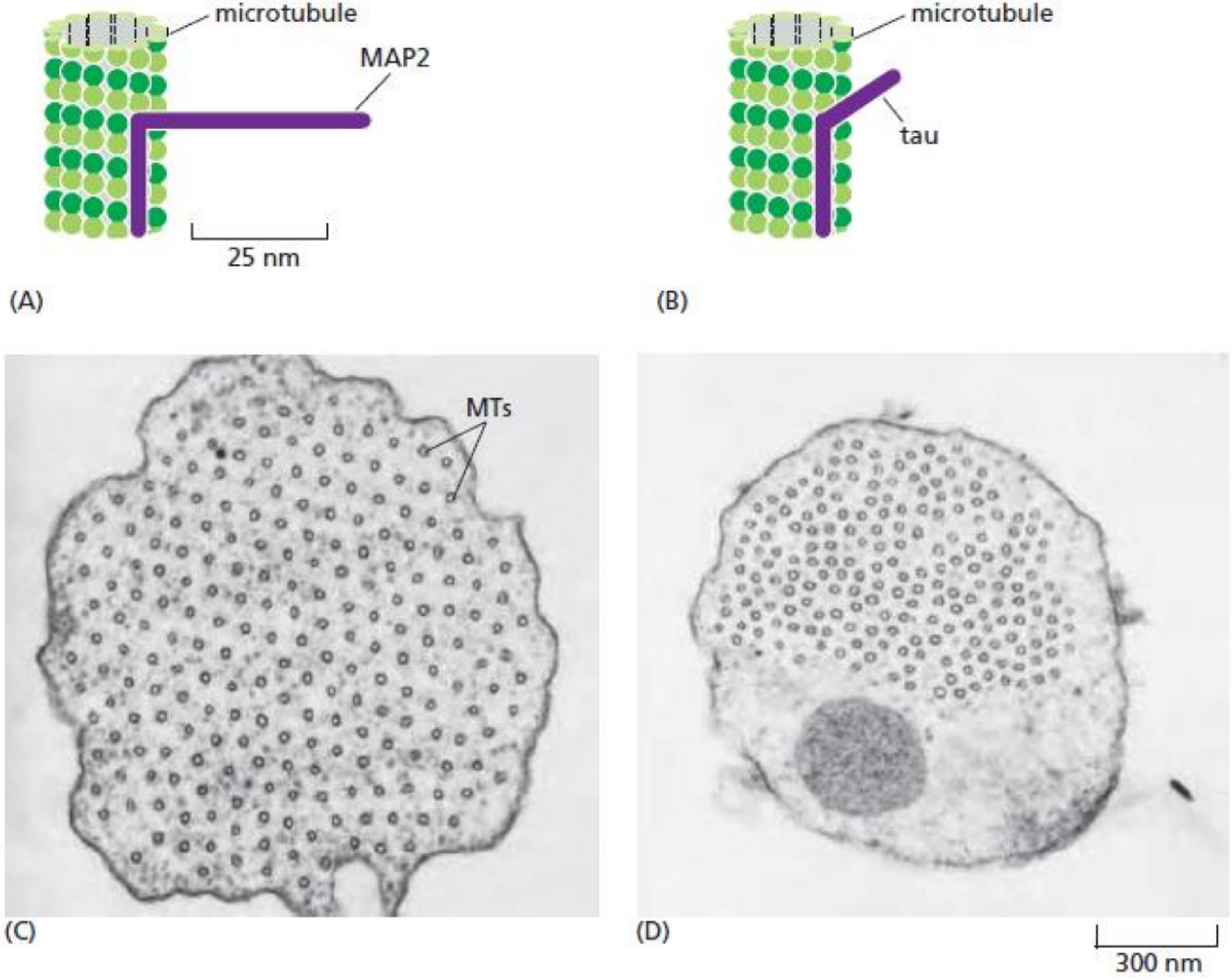


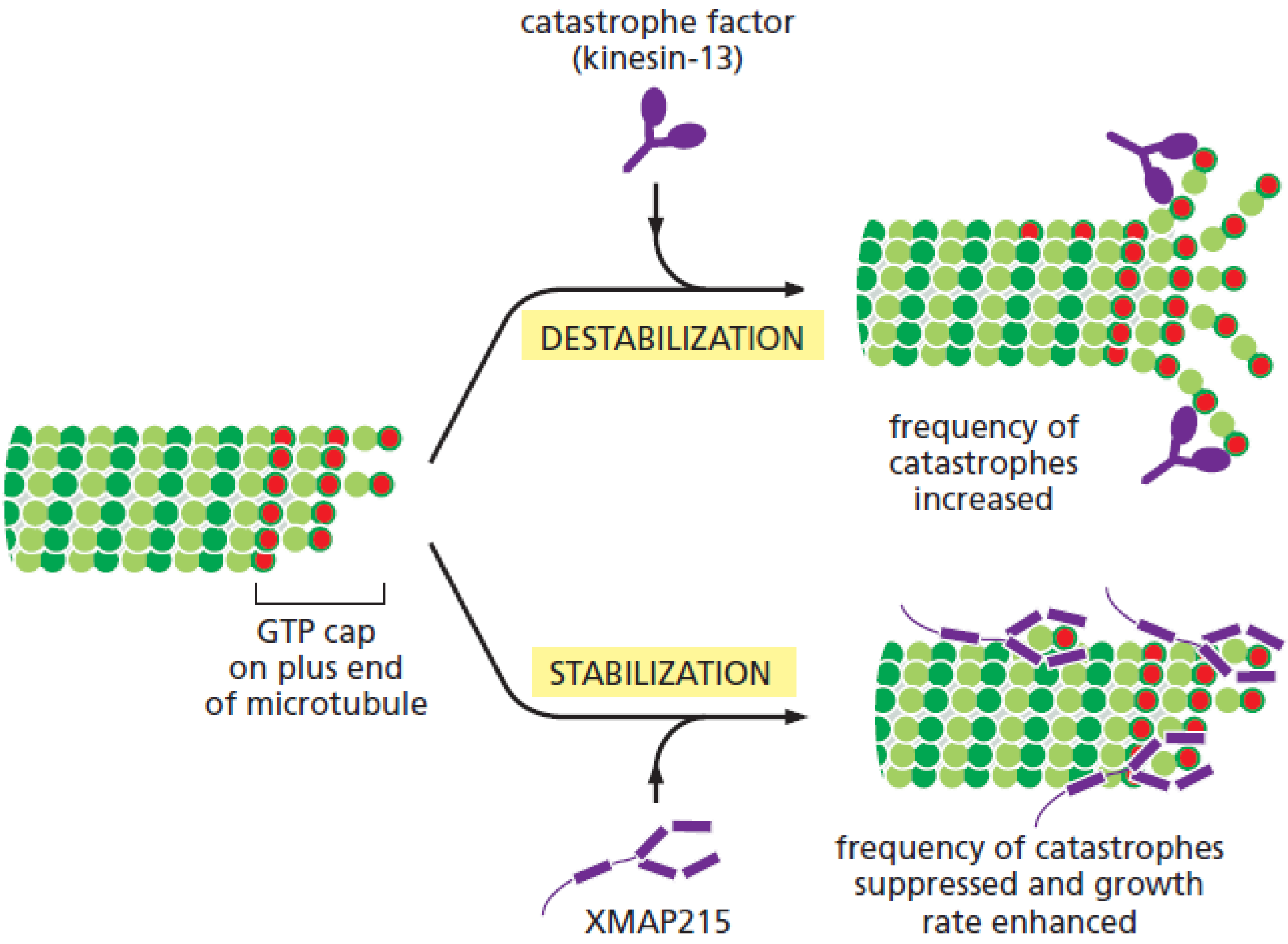
“Microtubule Associated Proteins“

MAPs

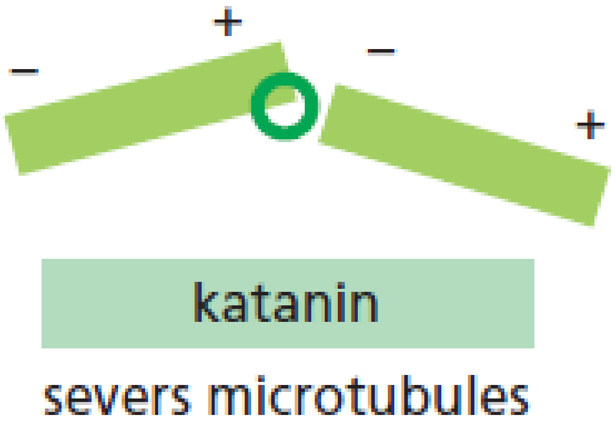



Tau
MAP2
10 µm

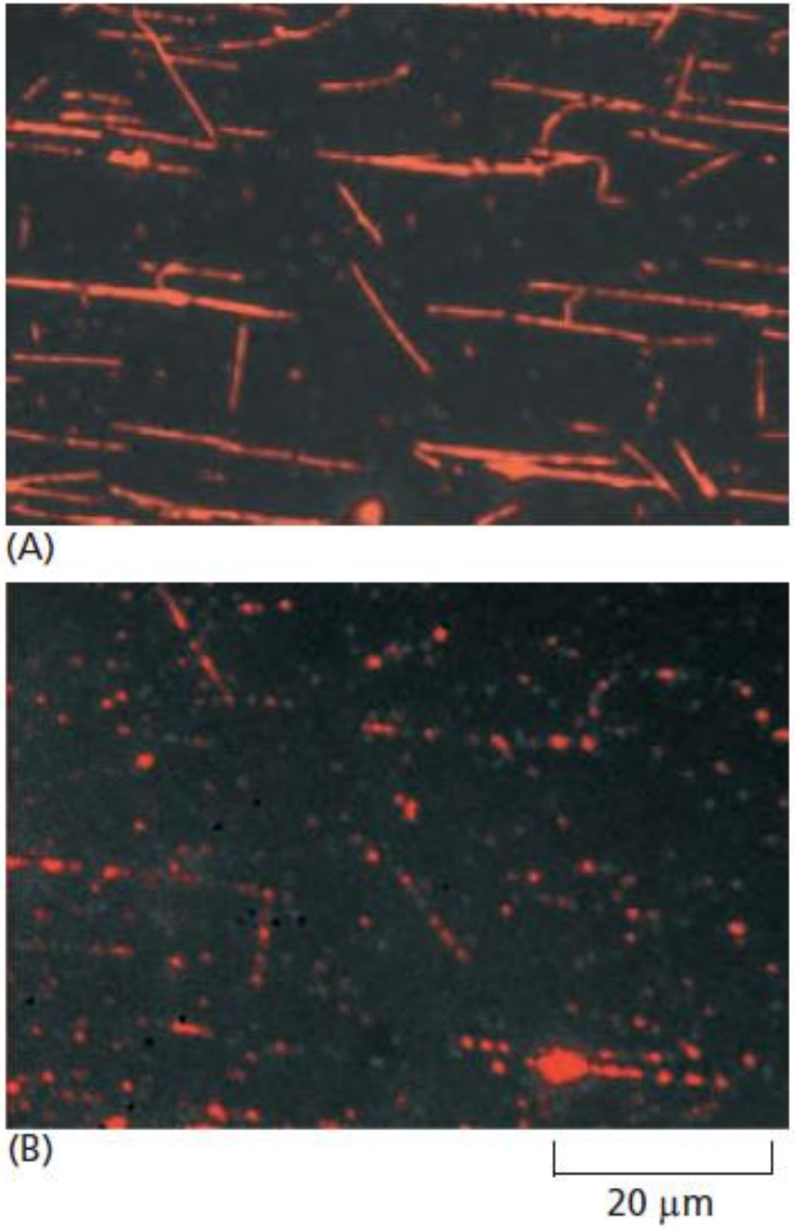

microtubule
MAP2
25 nm
(A)
microtubule
tau
(B)
MTs
(C)
(D)
300 nm



catastrophe factor
(kinesin-13)
DESTABILIZATION
frequency of
catastrophes
increased
GTP cap
on plus end
of microtubule
STABILIZATION
XMAP215
frequency of catastrophes
suppressed and growth
rate enhanced

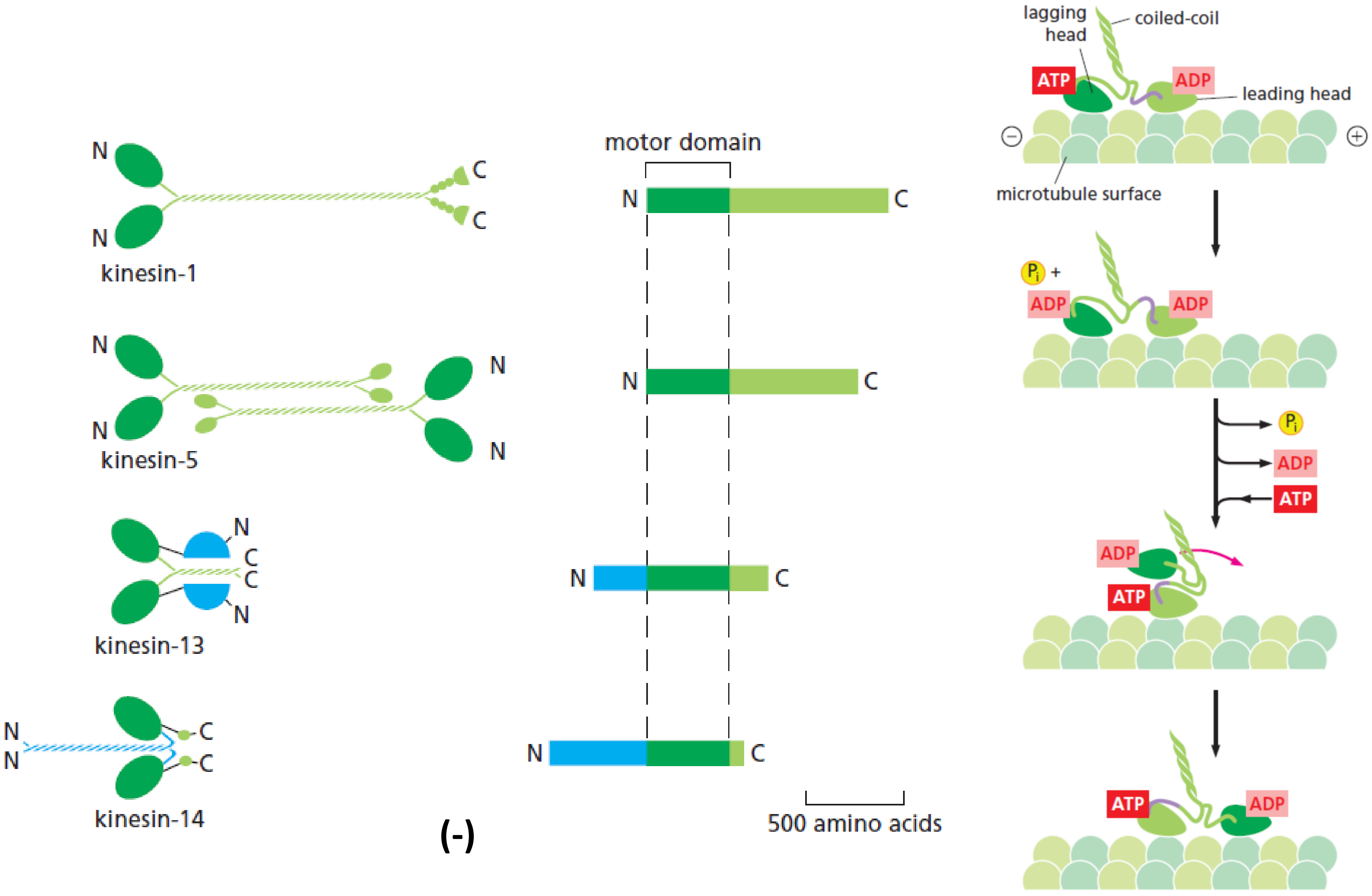


katanin
severs microtubules

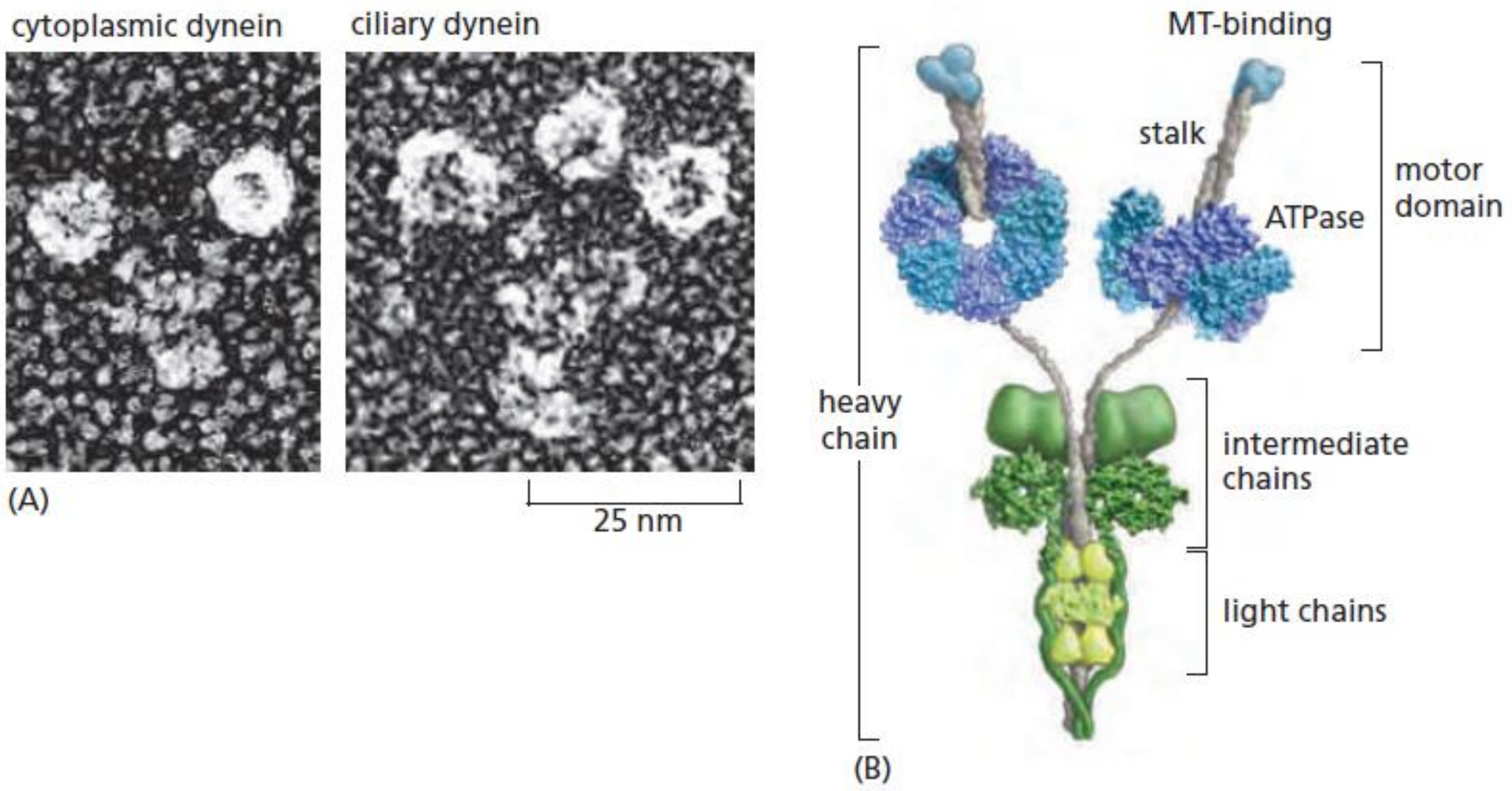


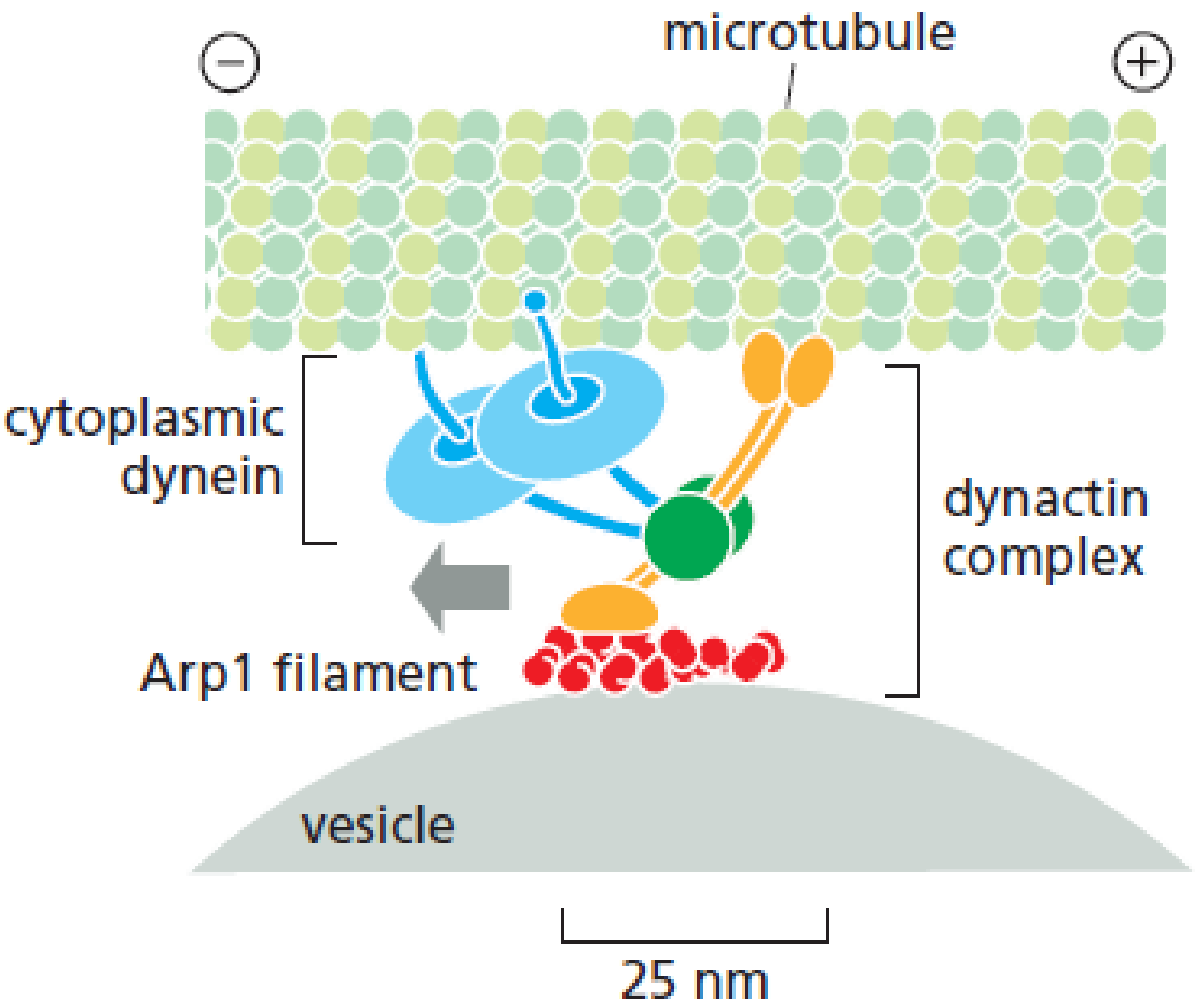
(A)
(B)
20 µm

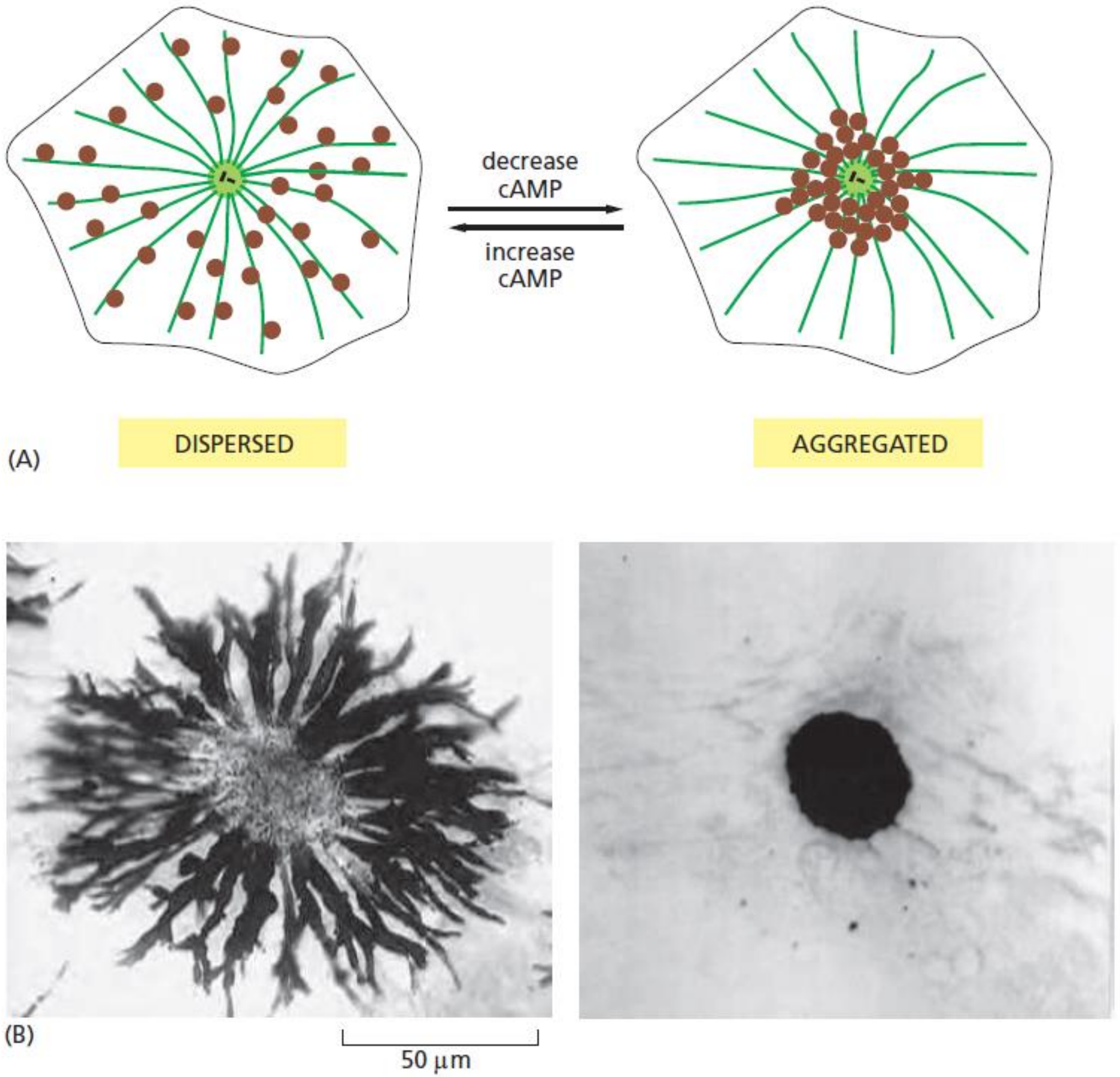
Proteínas motoras - kinesinas



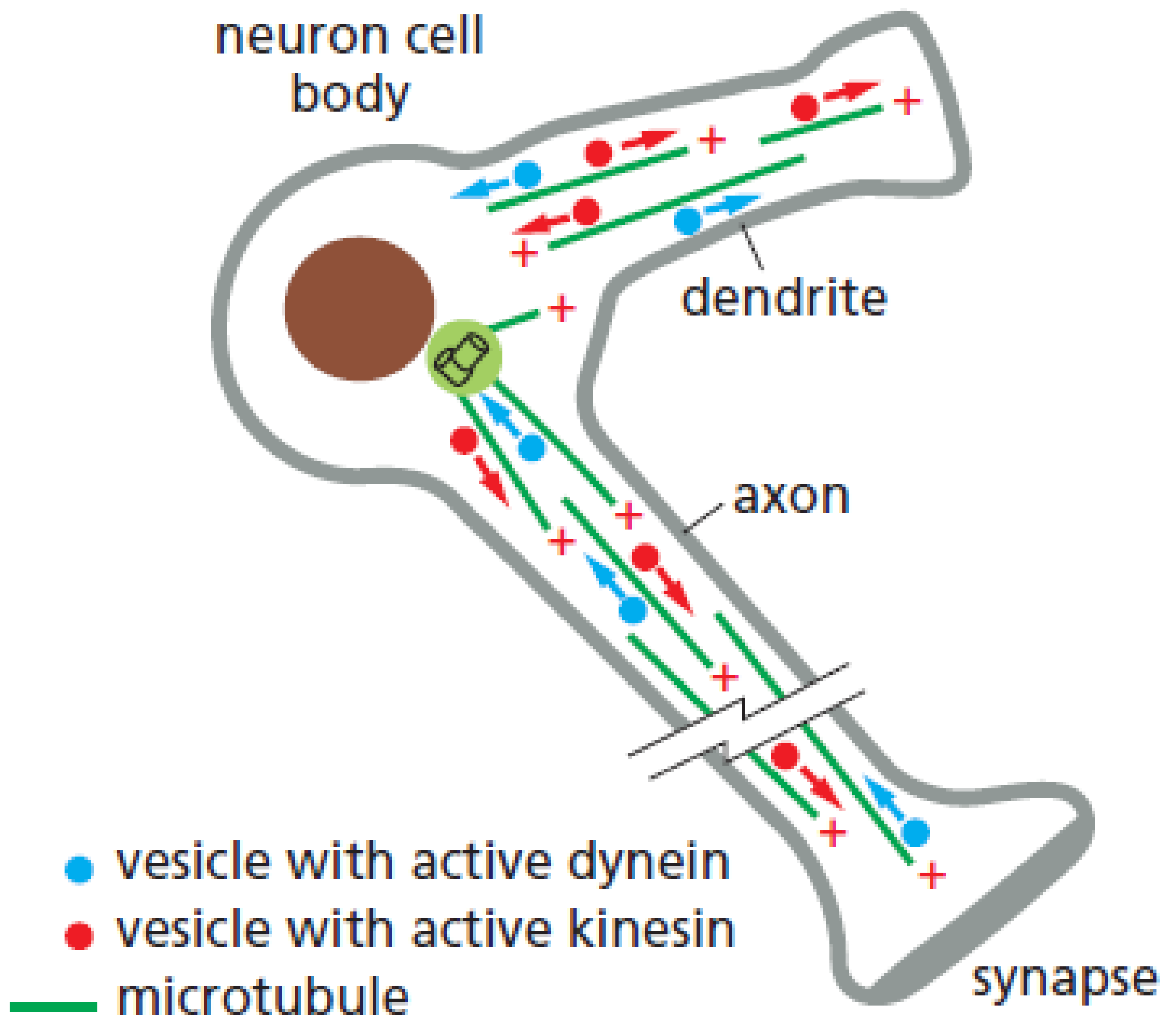
Proteínas motoras - dineínas



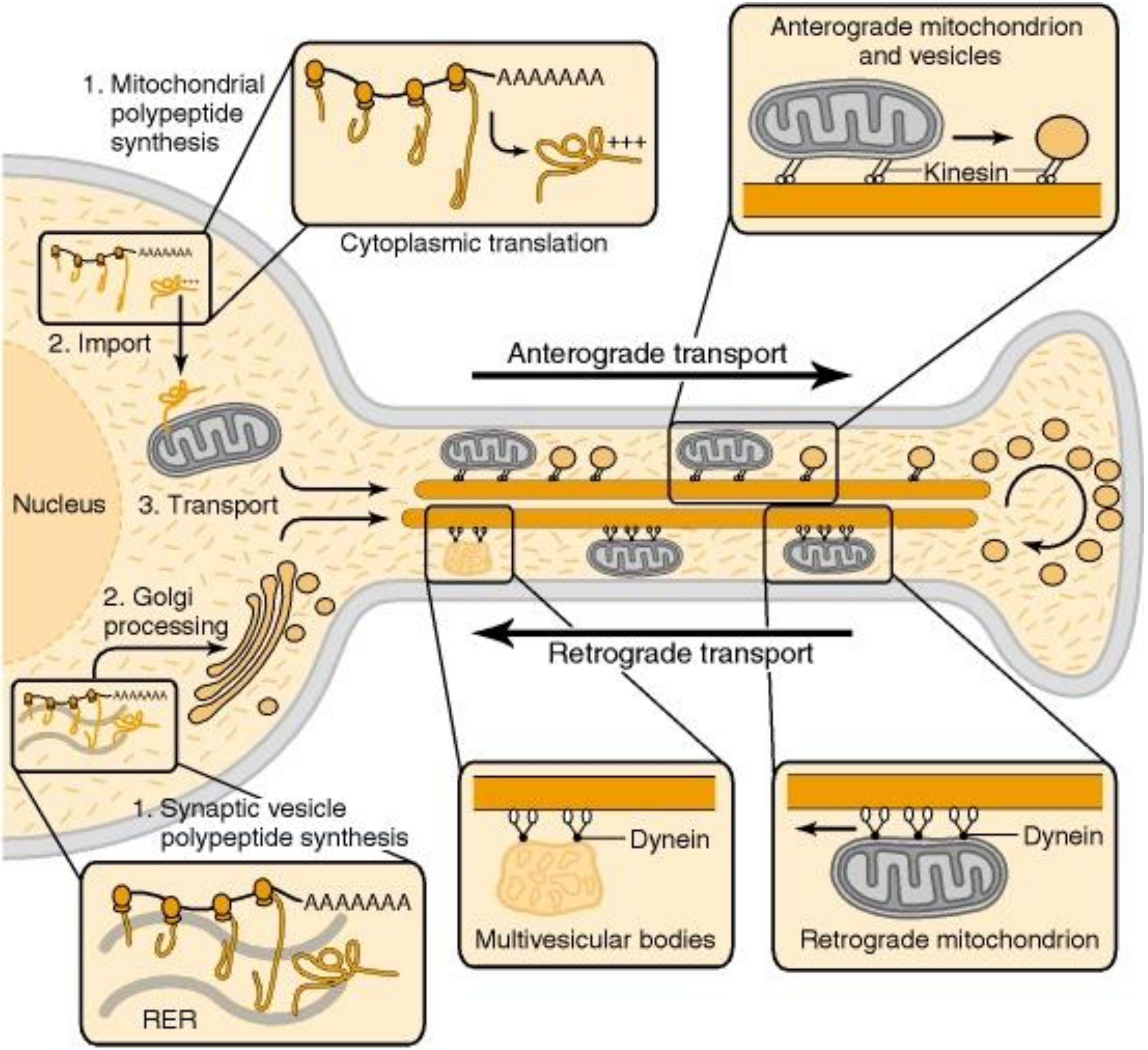

microtubule
−
+
cytoplasmic dynein
dynactin complex
Arp1 filament
vesicle
25 nm


decrease
cAMP
increase
cAMP
DISPERSED
AGGREGATED
(A)
(B)
50 μm

https://www.youtube.com/watch?v=hL0USeWjTHQ

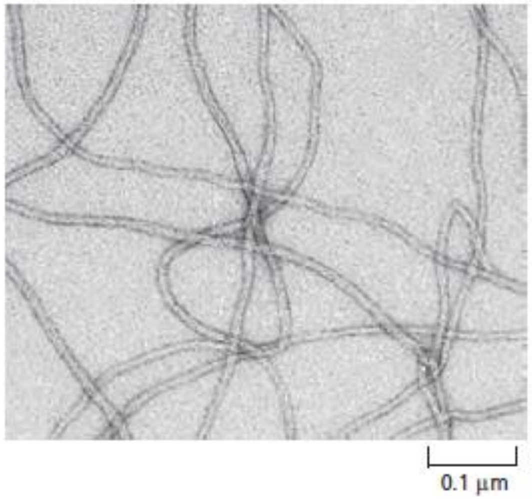

neuron cell body
dendrite
axon
synapse
vesicle with active dynein
vesicle with active kinesin
microtubule

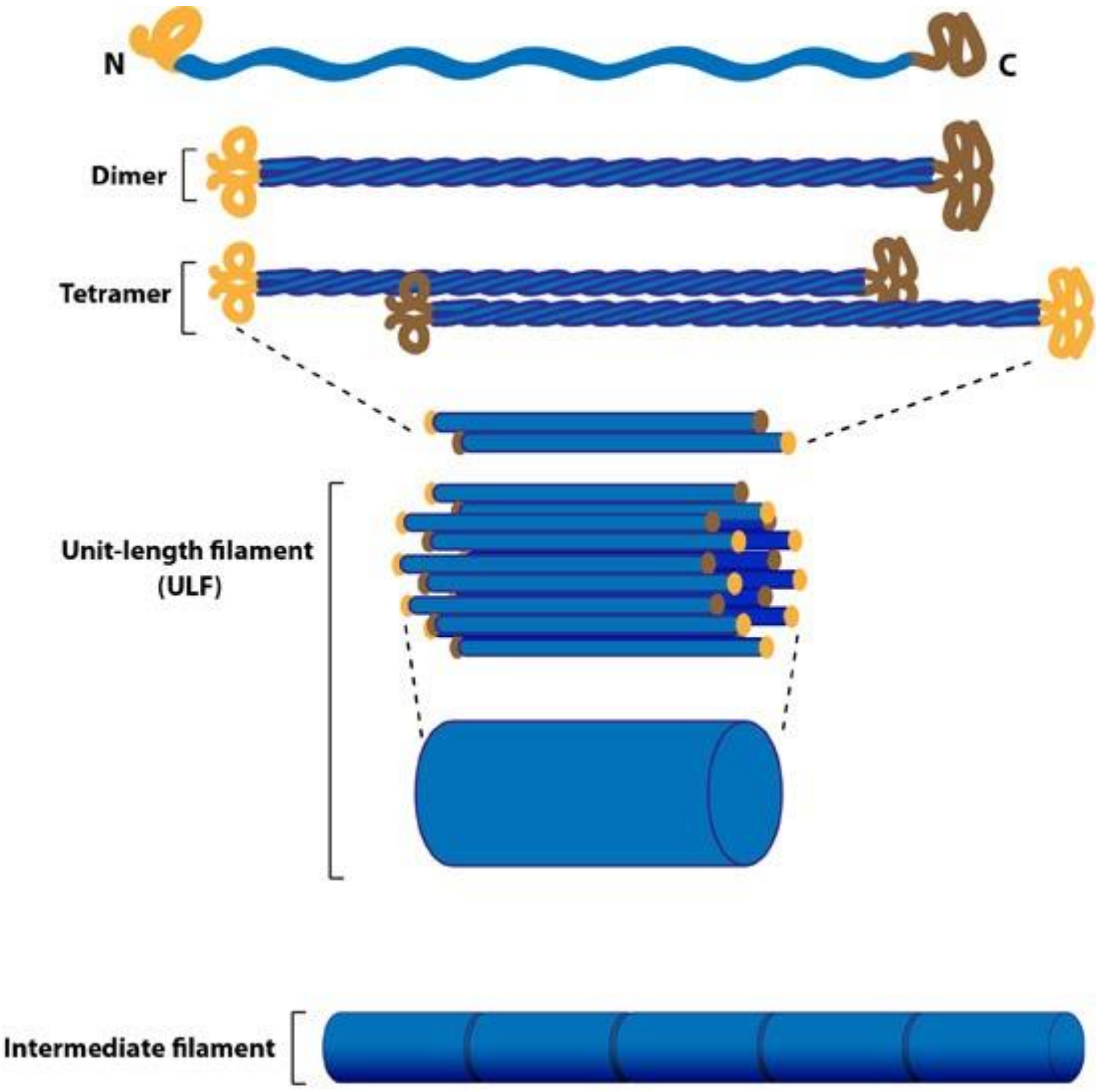
NEURON

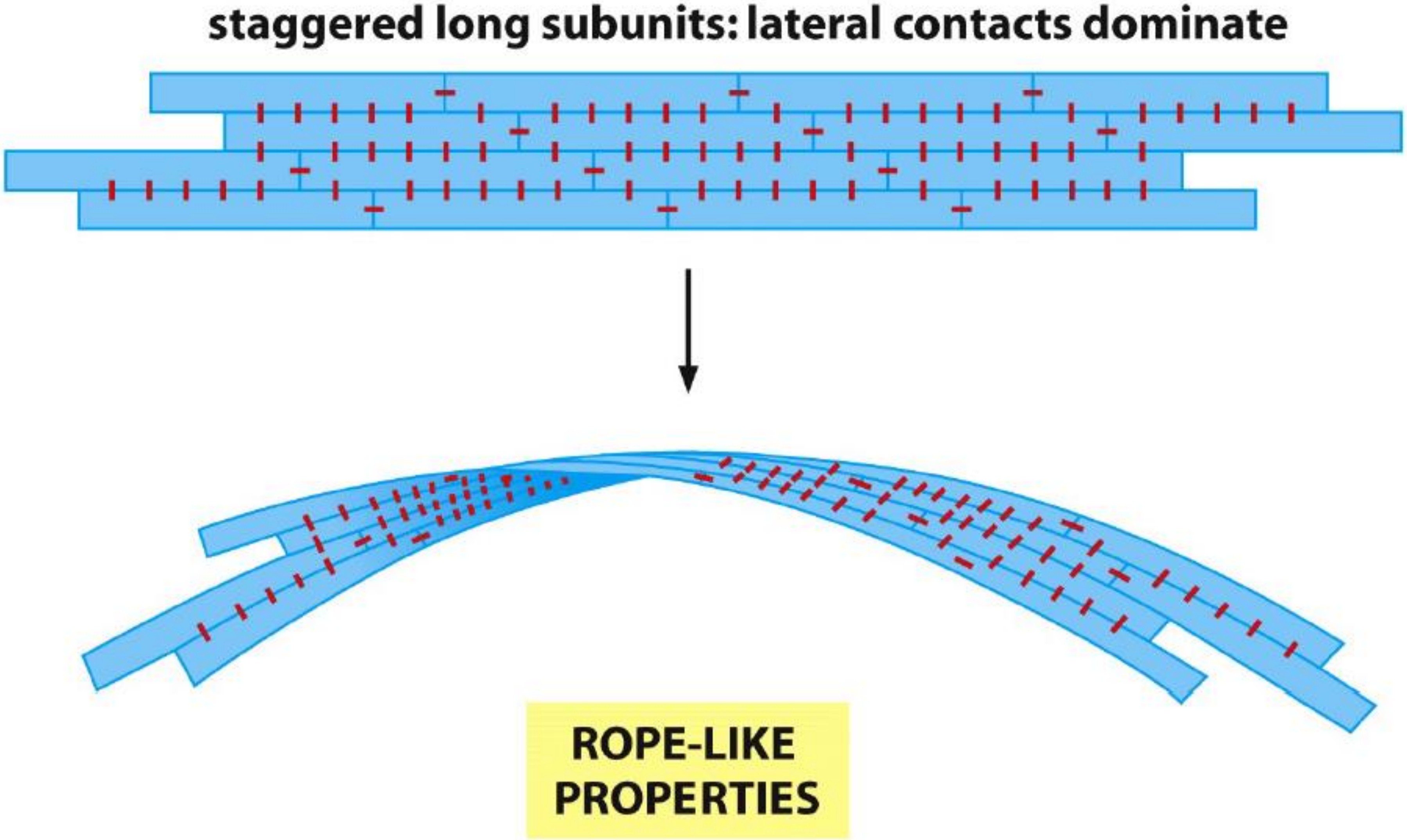


Axones de hasta 1 m!
Más de 2 días de viaje

Filamentos intermedios



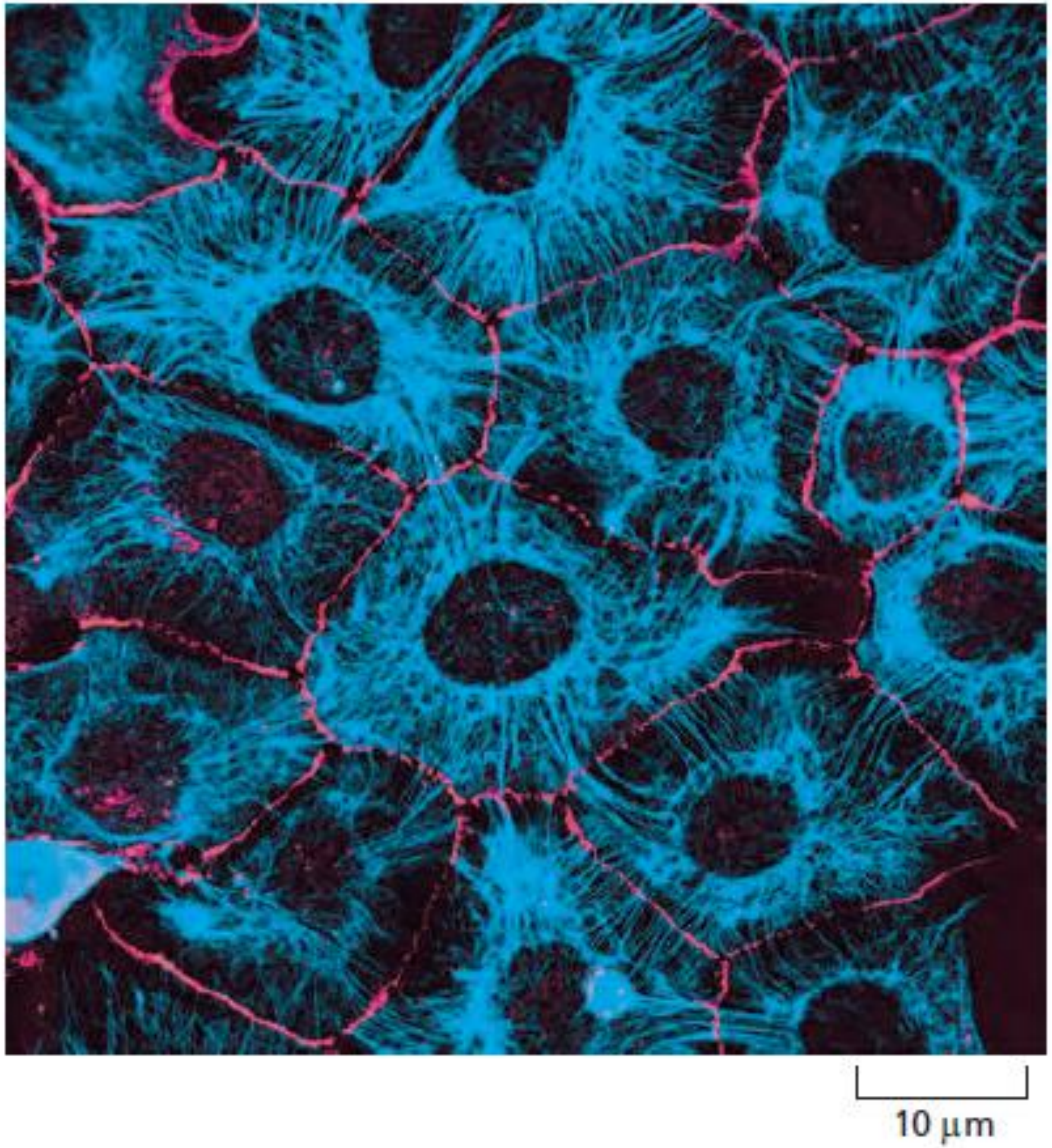




staggered long subunits: lateral contacts dominate
ROPE-LIKE PROPERTIES

TABLE 16–2 Major Types of Intermediate Filament Proteins in Vertebrate Cells

Types of intermediate filament	Component polypeptides	Location
Nuclear	Lamins A, B, and C	Nuclear lamina (inner lining of nuclear envelope)
Vimentin-like	Vimentin	Many cells of mesenchymal origin
	Desmin	Muscle
	Glial fibrillary acidic protein	Glial cells (astrocytes and some Schwann cells)
	Peripherin	Some neurons
Epithelial	Type I keratins (acidic)	Epithelial cells and their derivatives (e.g., hair and nails)
	Type II keratins (neutral/basic)	
Axonal	Neurofilament proteins (NF-L, NF-M, and NF-H)	Neurons


10 µm

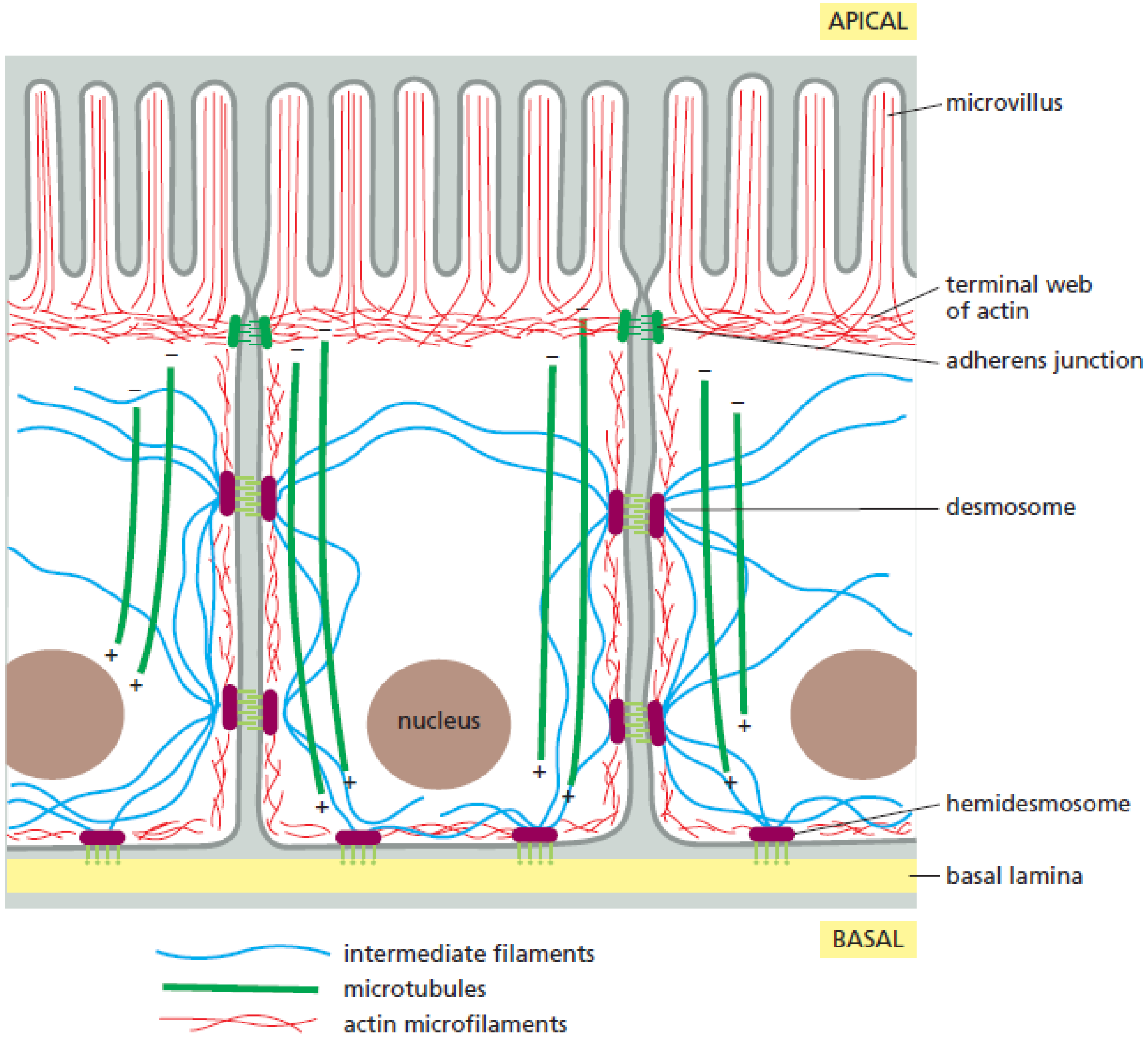


Figure 16–4 Organization of the cytoskeleton in polarized epithelial cells. All the components of the cytoskeleton cooperate to produce the characteristic shapes of specialized cells, including the epithelial cells that line the small intestine, diagrammed here. At the apical (upper) surface, facing the intestinal lumen, bundled actin filaments *(red)* form microvilli that increase the cell surface area available for absorbing nutrients from food. Below the microvilli, a circumferential band of actin filaments is connected to cell–cell adherens junctions that anchor the cells to each other. Intermediate filaments *(blue)* are anchored to other kinds of adhesive structures, including desmosomes and hemidesmosomes, that connect the epithelial cells into a sturdy sheet and attach them to the underlying extracellular matrix; these structures are discussed in Chapter 19. Microtubules *(green)* run vertically from the top of the cell to the bottom and provide a global coordinate system that enables the cell to direct newly synthesized components to their proper locations.

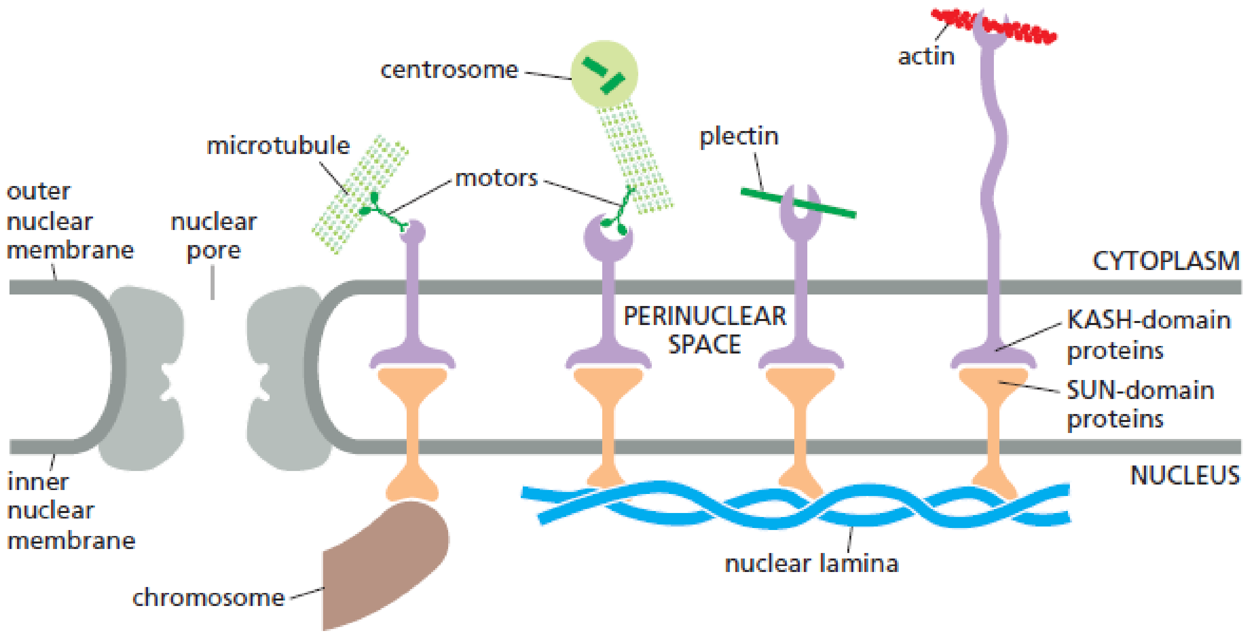


Figure 16–72 SUN–KASH protein complexes connect the nucleus and cytoplasm through the nuclear envelope. The cytoplasmic cytoskeleton is linked across the nuclear envelope to the nuclear lamina or chromosomes through SUN and KASH proteins (*orange* and *purple*, respectively). The SUN and KASH domains of these proteins bind within the lumen of the nuclear envelope. From the inner nuclear envelope, SUN proteins connect to the nuclear lamina or chromosomes. KASH proteins in the outer nuclear envelope connect to the cytoplasmic cytoskeleton by binding microtubule motor proteins, actin filaments, or plectin.

mplo de pregunta de examen

¿Qué es una proteína motora? De un ejemplo específico de una proteína motora, y describa su rol en un proceso celular.