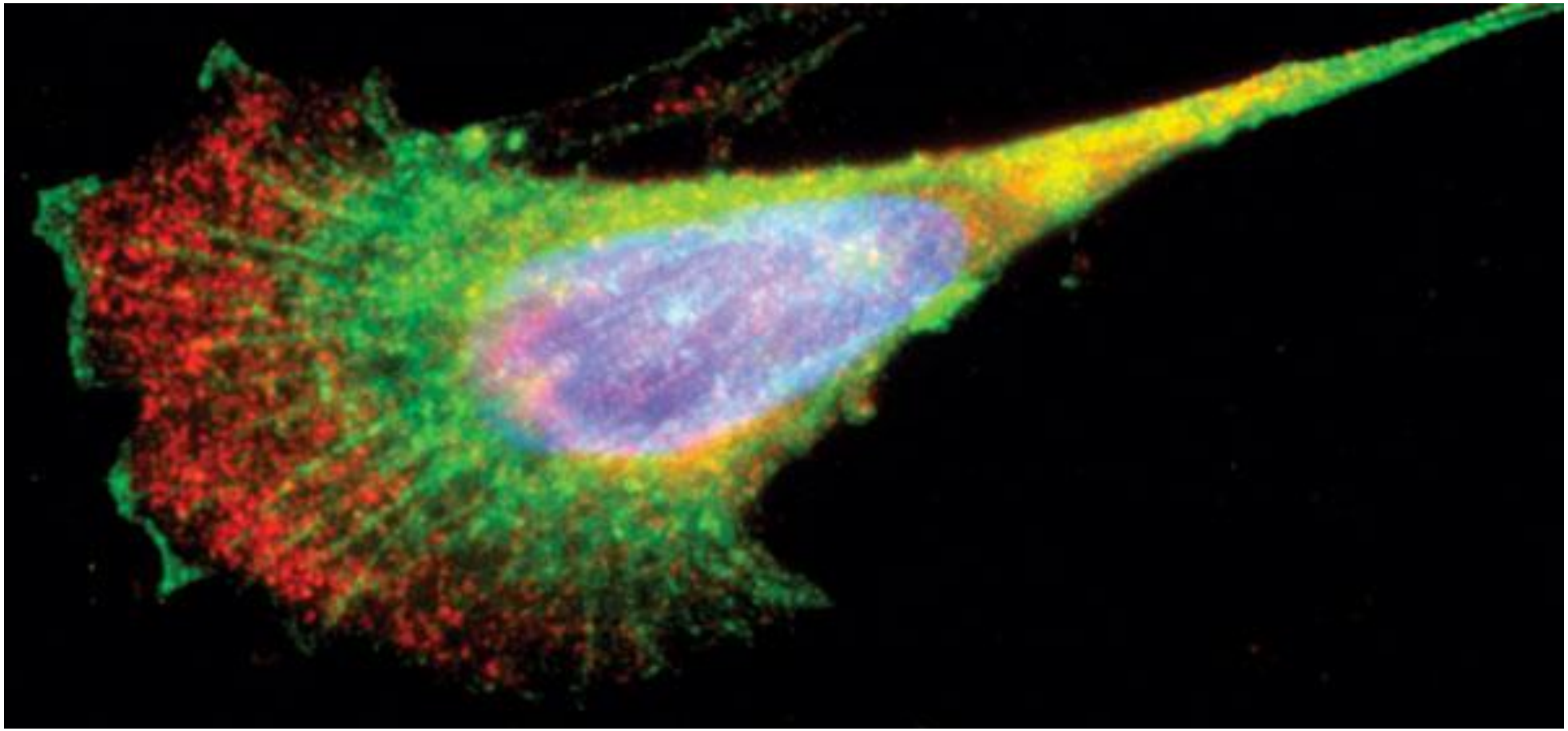
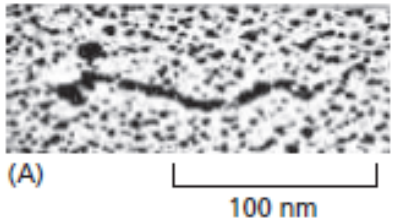
Motilidad celular II

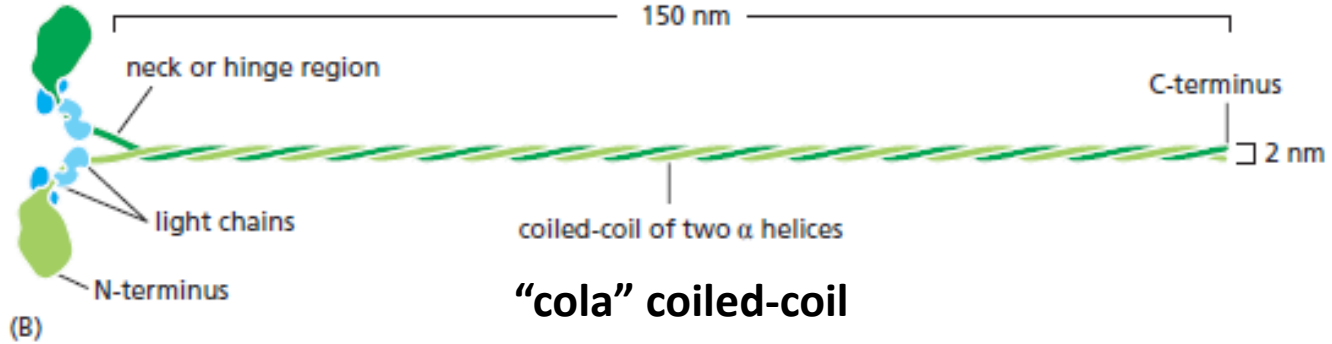


Uriel Koziol
ukoziol@fcien.edu.uy

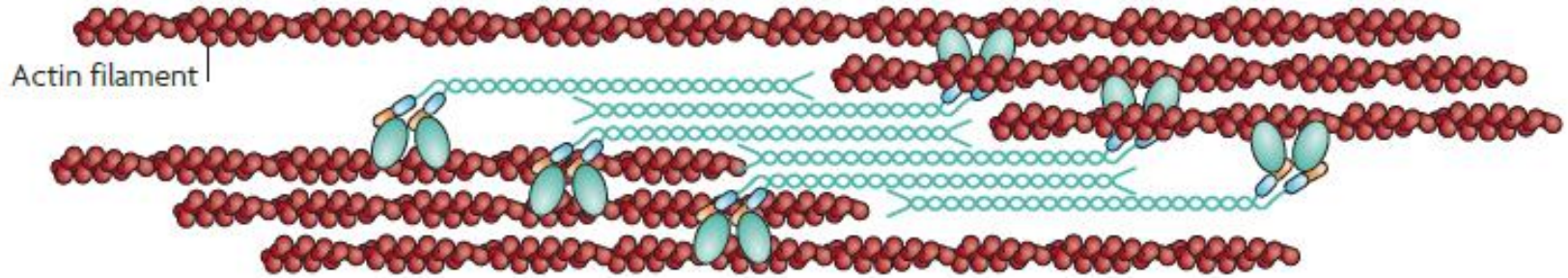
Miosina II forma haces que se intercalan con los filamentos de actina en fibras de tensión (y en el músculo)

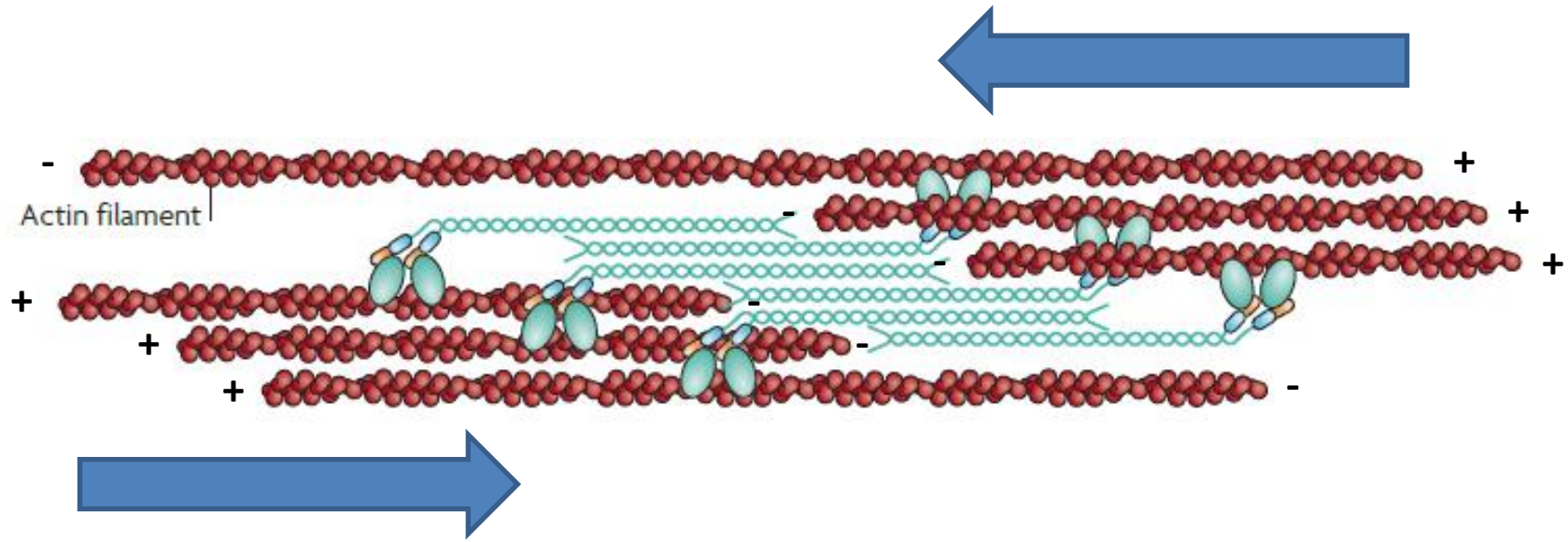
“cabezas” globulares





“cola” coiled-coil



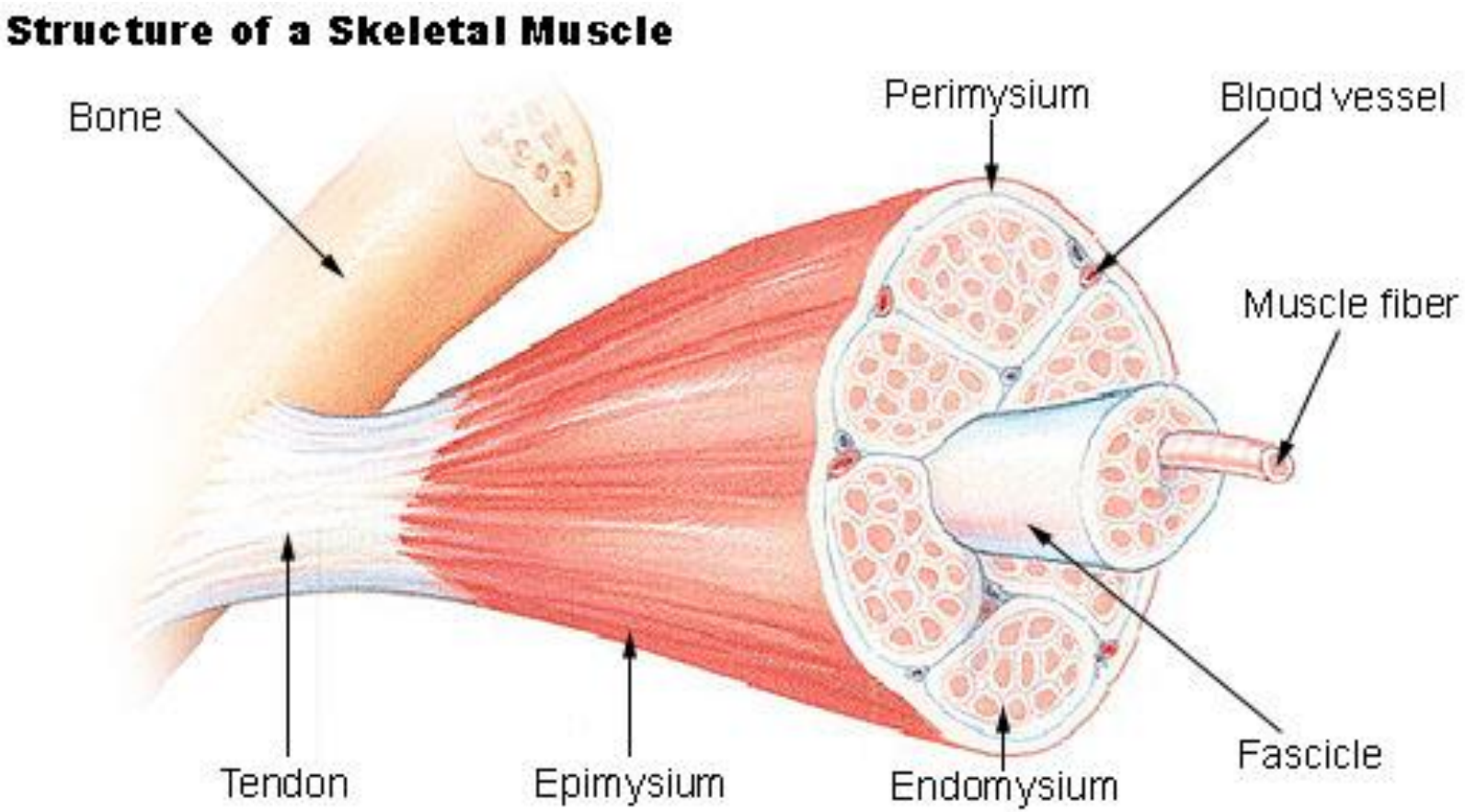

Actin filament
-
+
-
+
+
-
+
-
+
-
+
-

CÉLULAS MUSCULARES

Células especializadas para la contracción

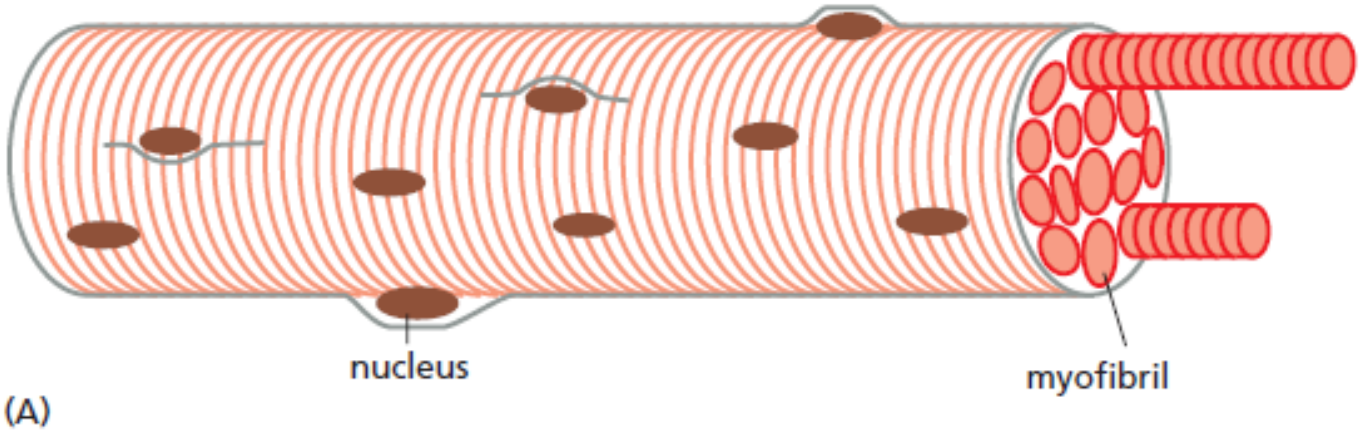
Estructuras altamente organizadas de filamentos de actina + motores tipo miosina

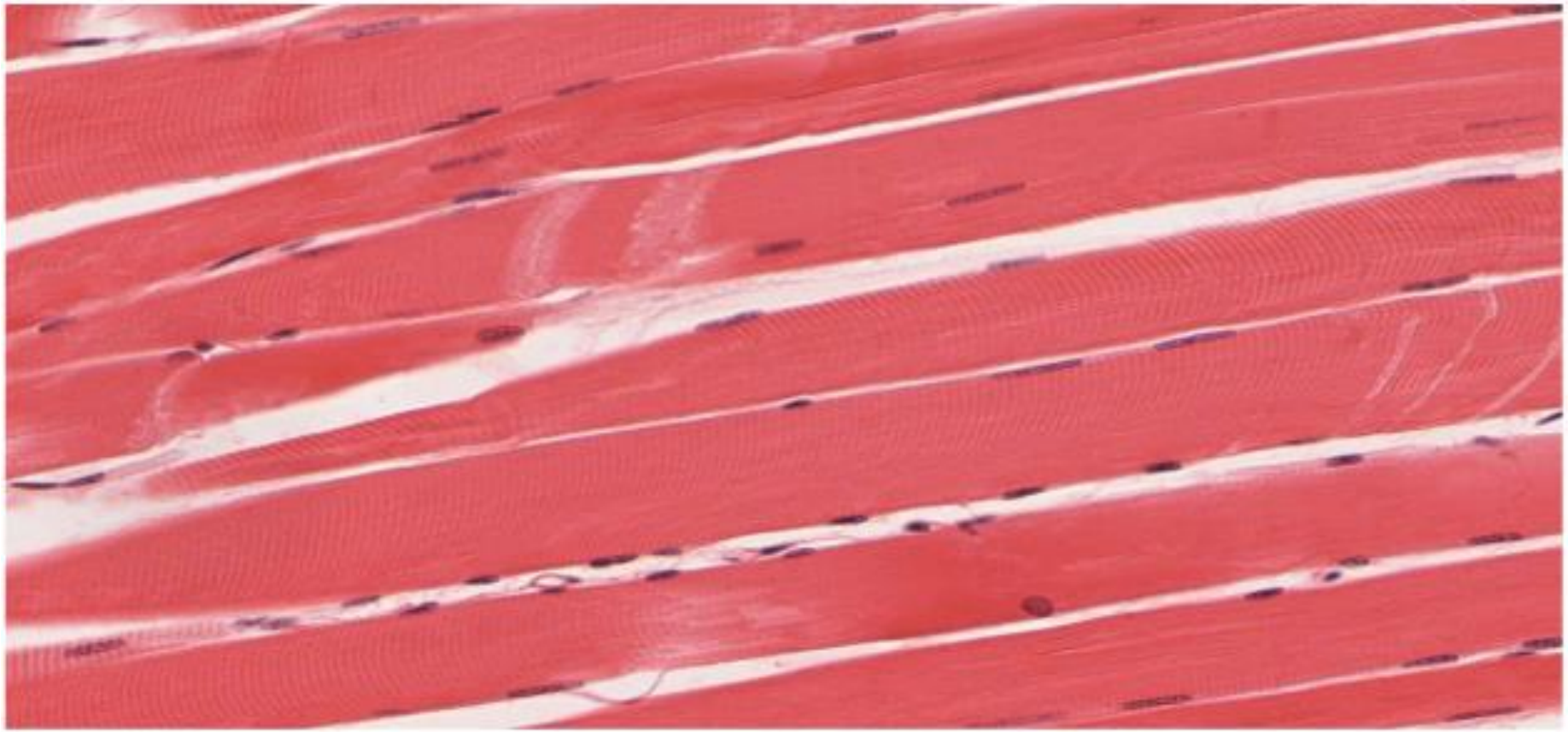
Músculo esquelético – fibras sincitiales

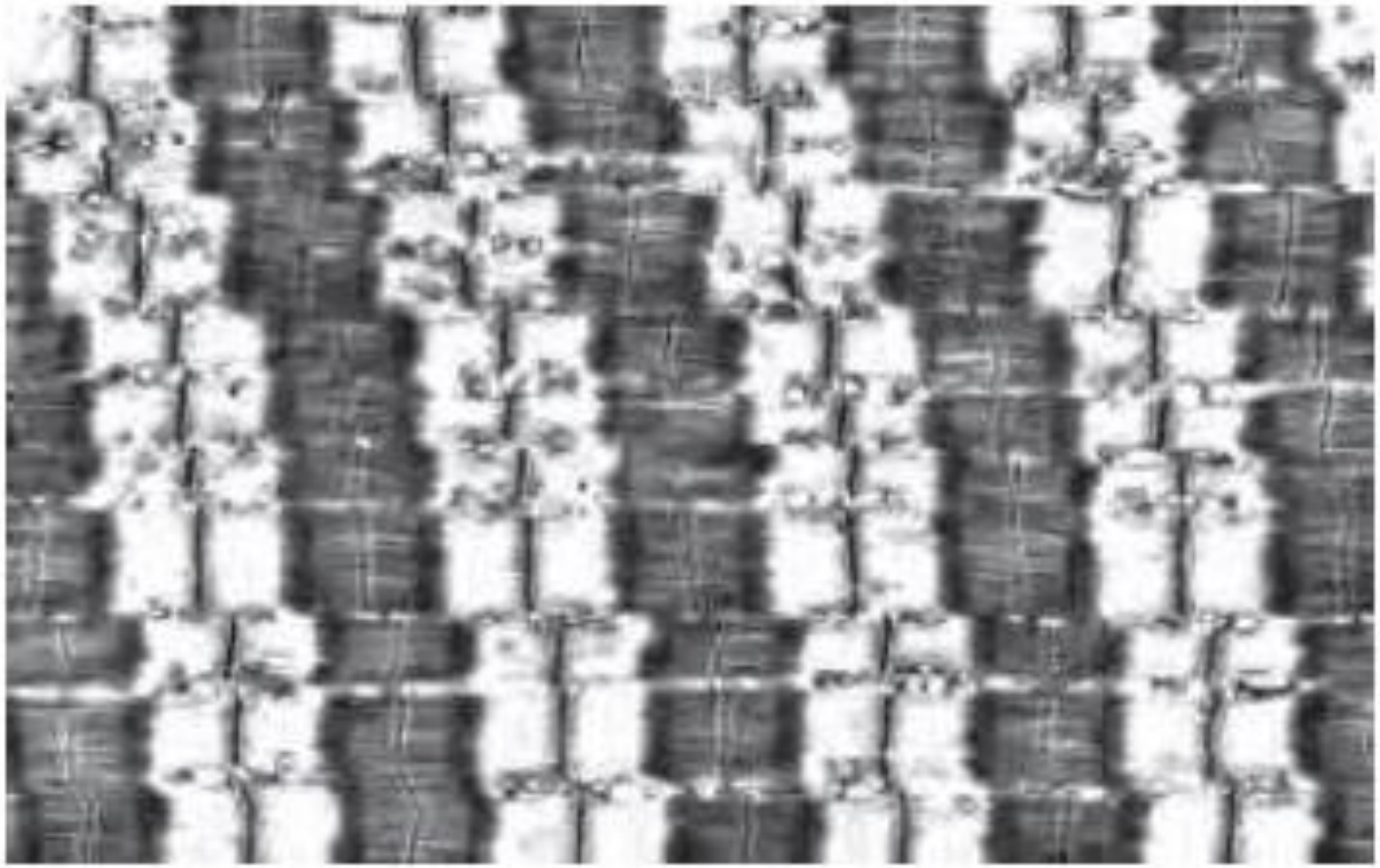


Músculo esquelético – fibras sincitiales

Figure 16–31 Skeletal muscle cells (also called muscle fibers). (A) These huge multinucleated cells form by the fusion of many muscle cell precursors, called myoblasts. Here, a single muscle cell is depicted. In an adult human, a muscle cell is typically 50 μm in diameter and can be up to several centimeters long. (B) Fluorescence micrograph of rat muscle, showing the peripherally located nuclei *(blue)* in these giant cells. Myofibrils are stained *red*. (B, courtesy of Nancy L. Kedersha.)





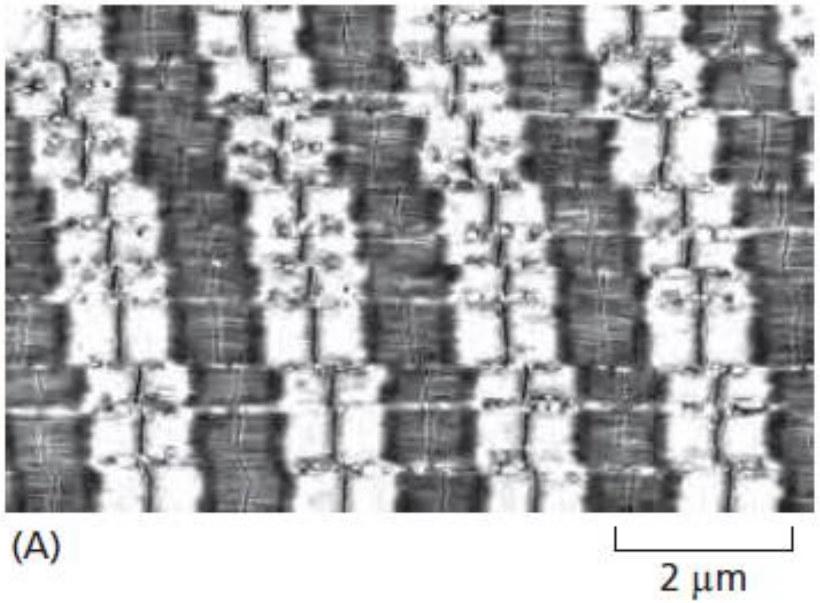


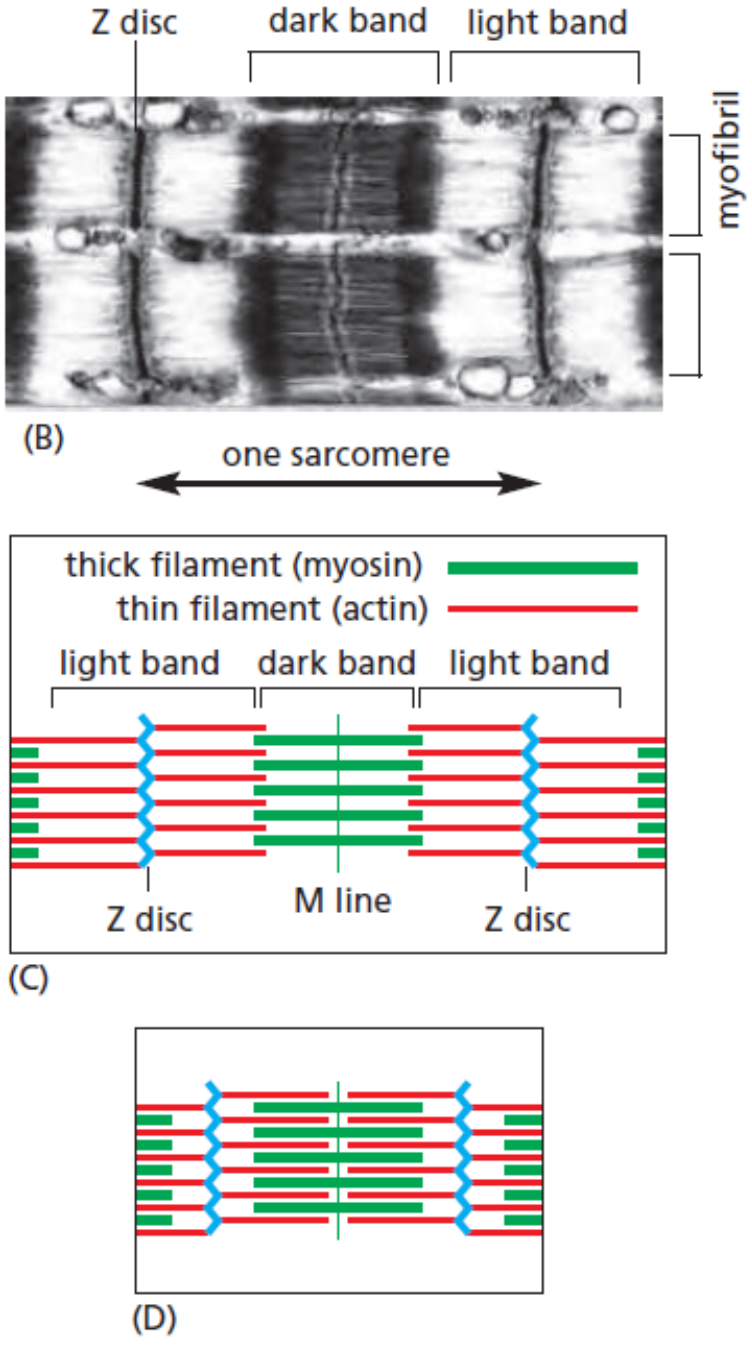
(A)

Banda I (lúcida) **Banda A (densa)**

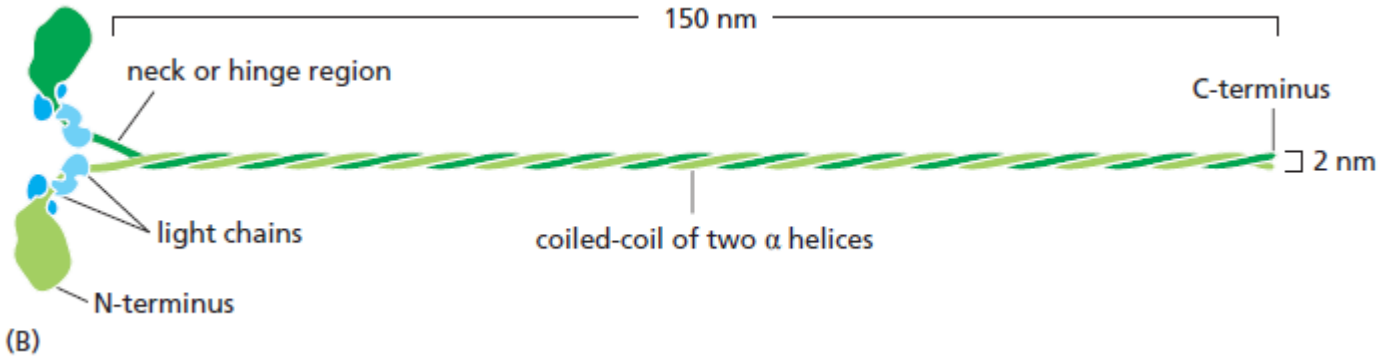
2 µm

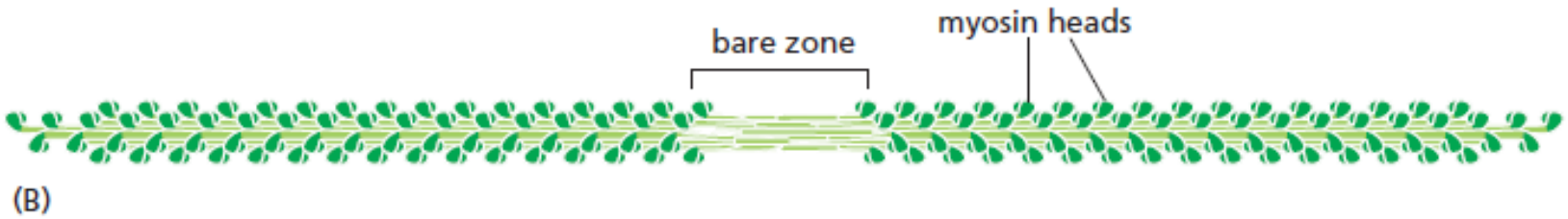
Organización en <u>miofibrillas</u> = repeticiones de <u>sarcómeros</u> (unidades contráctiles)



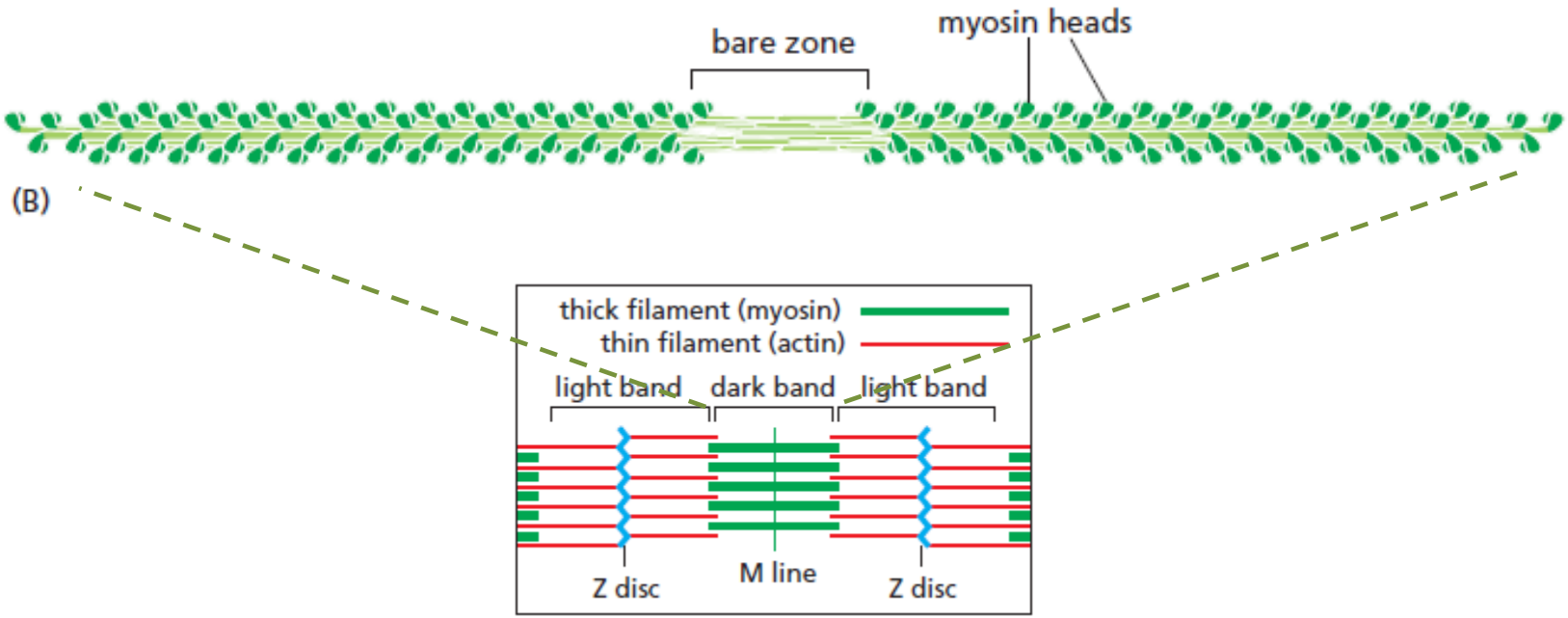


Miosina II en músculo esquelético

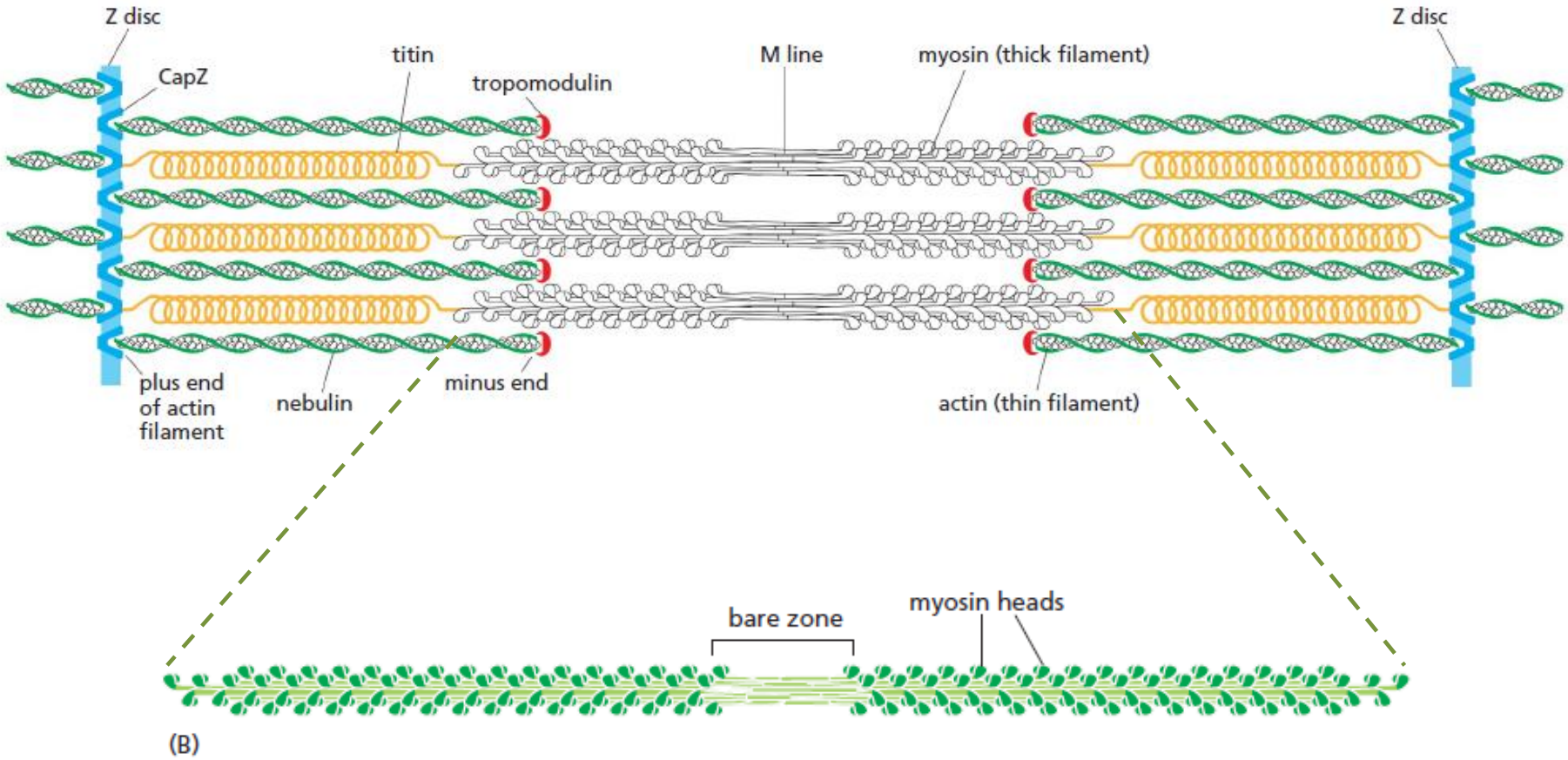


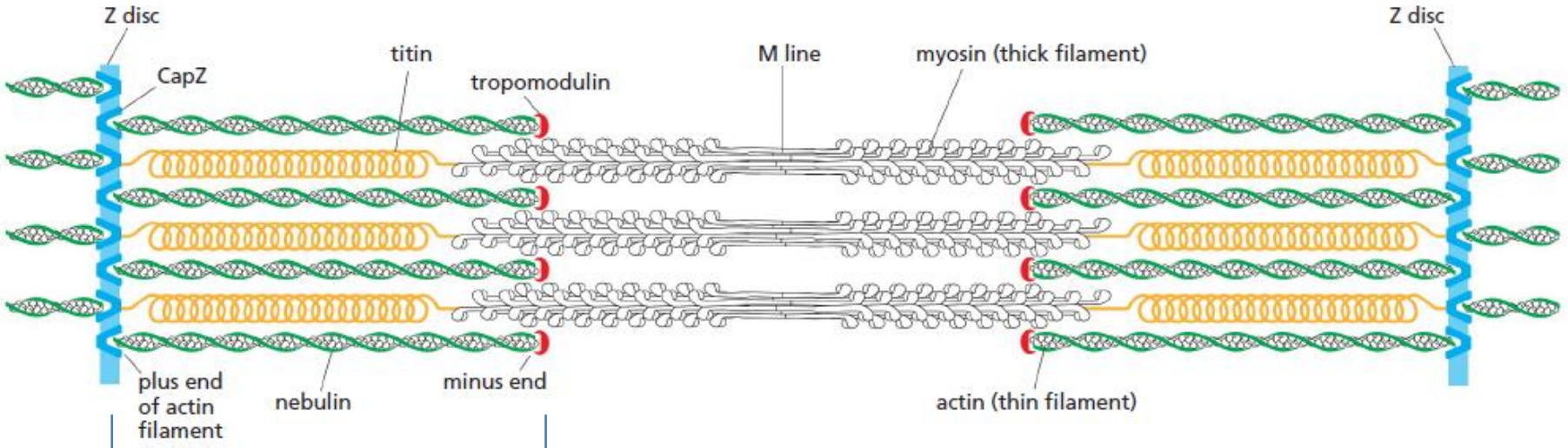


Miosina II en músculo esquelético



Organización del sarcomero – filamentos de actina, miosina, y proteínas accesorias

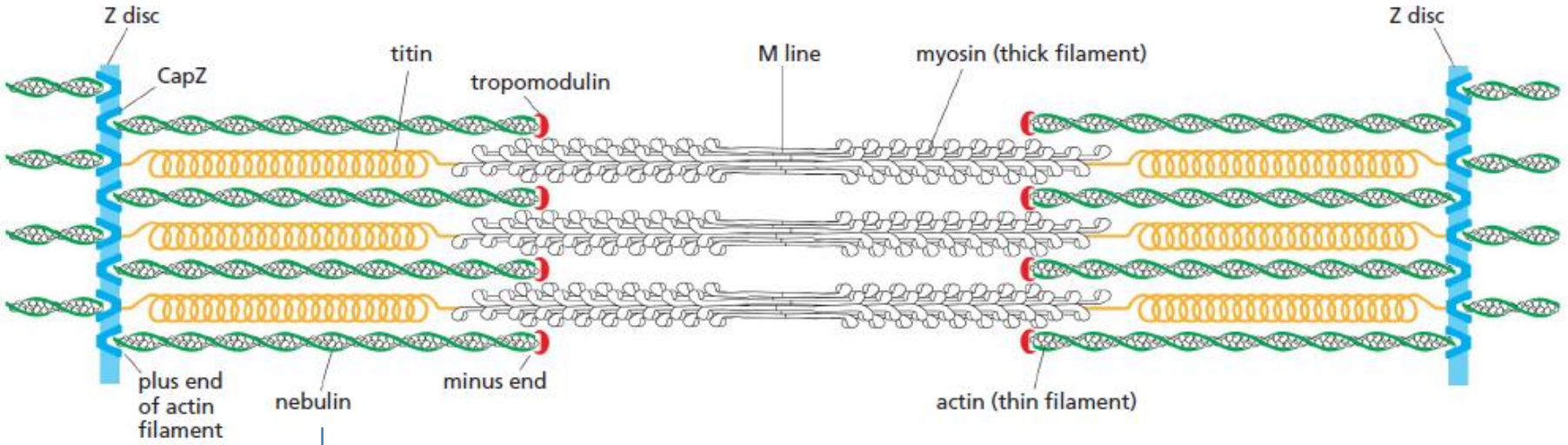




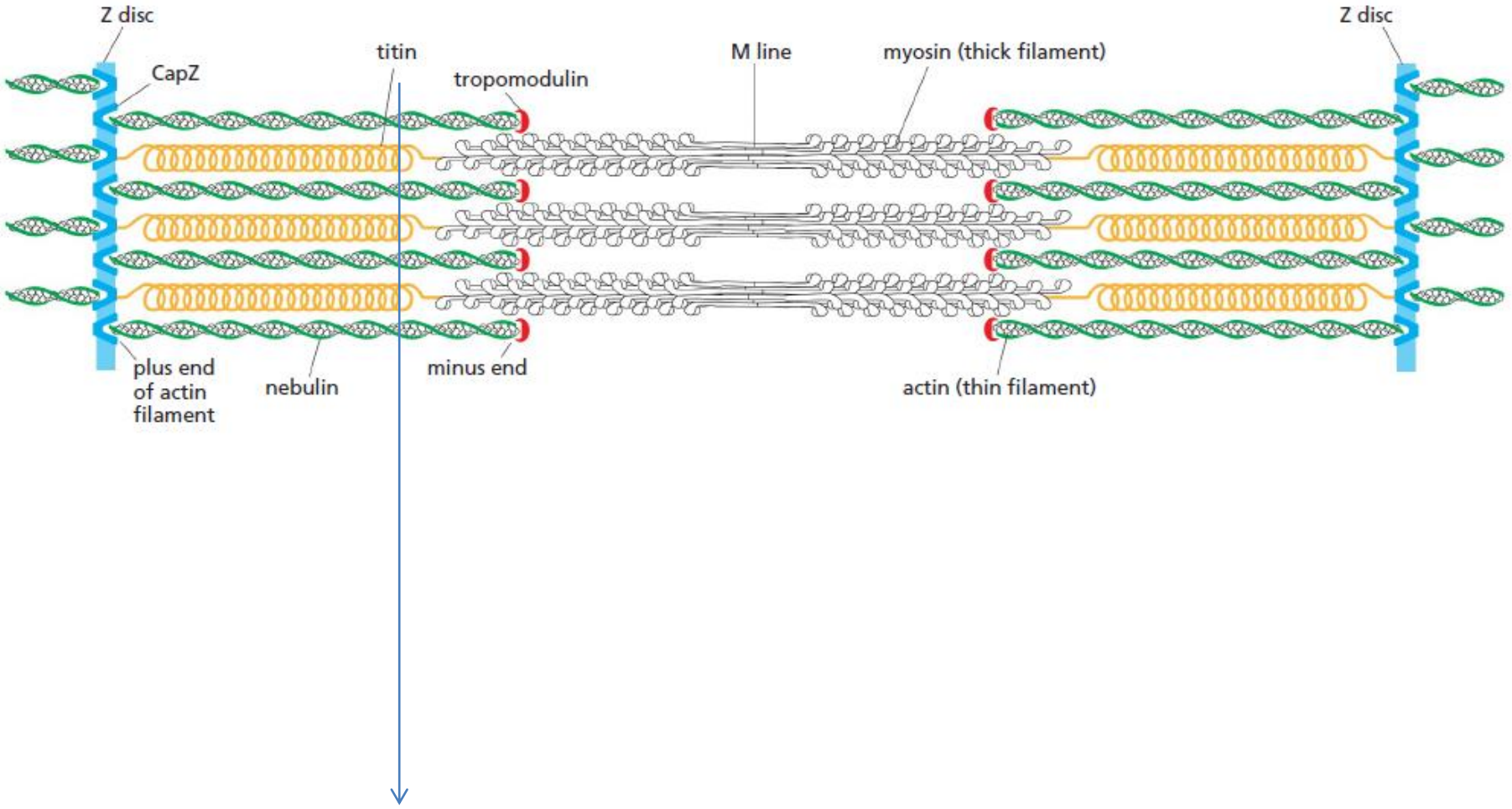
Discos Z: CapZ unido a extremo (+) de filamento de actina, impide despolimerización
α-actinina da separación regular

Tropomodulina unida a extremo (-) impide despolimerización

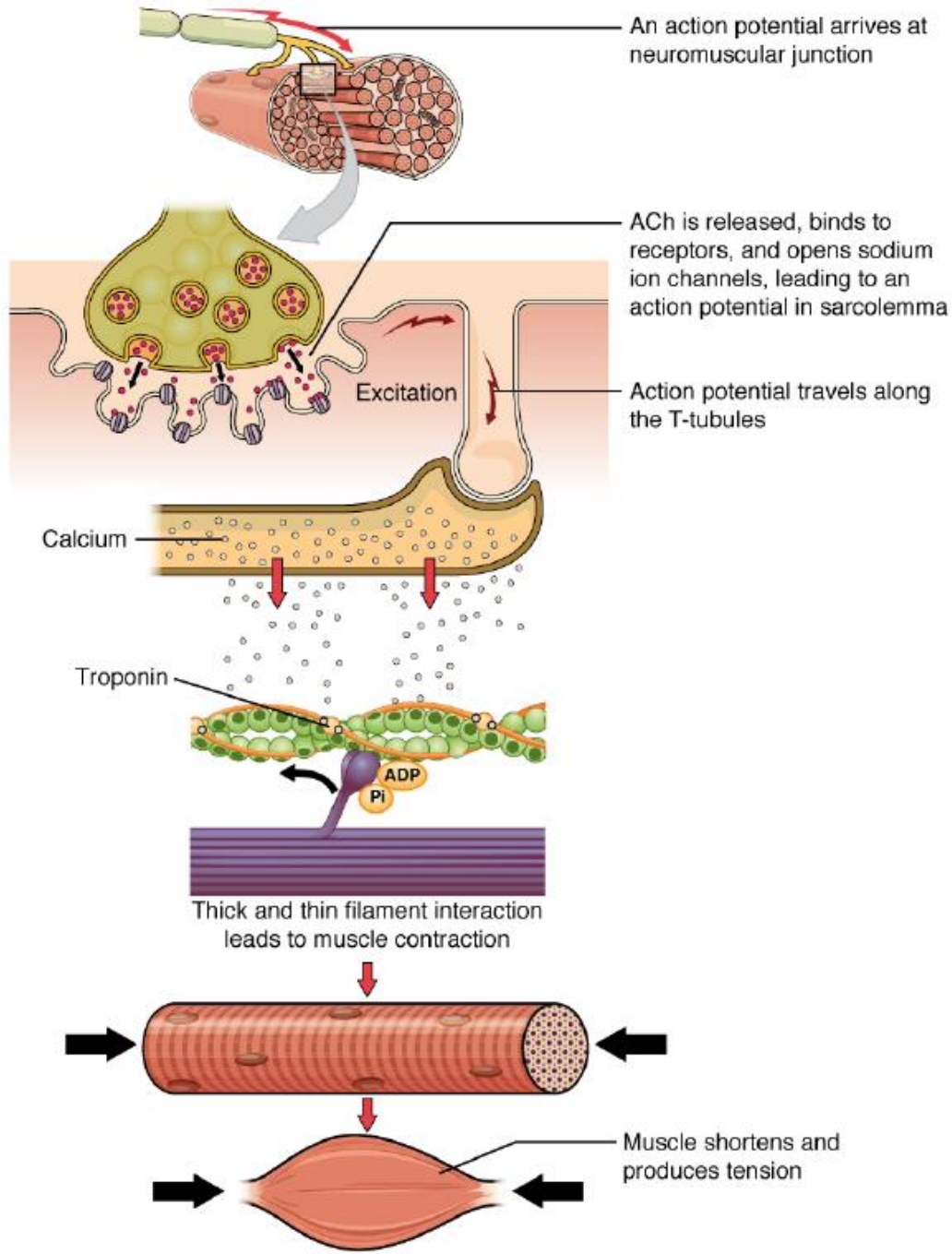
Si bien hay recambio de subunidades de actina, tiempos de recambio son **muy** largos (días!) comparados con microfilamentos en otras células



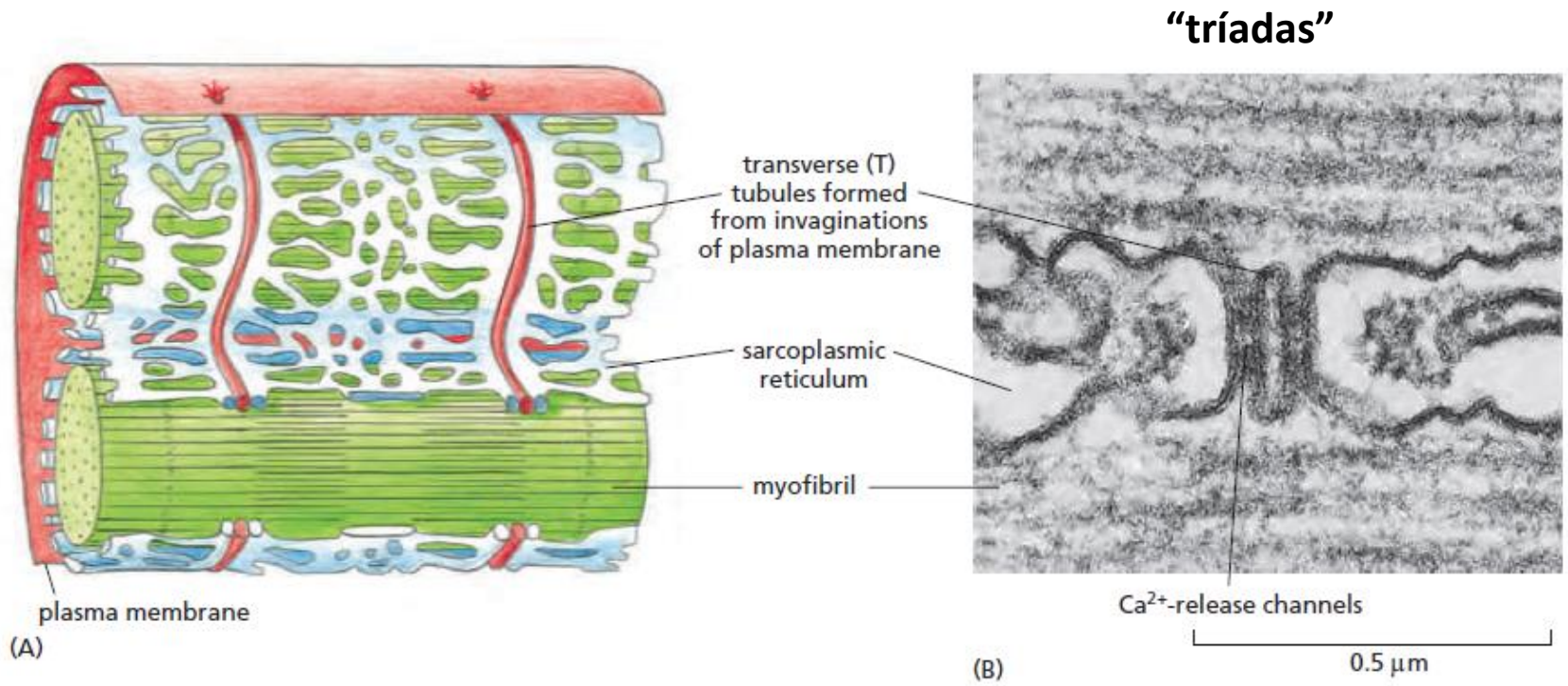
Nebulina: proteína gigante (900 KDa)
Repetición de dominio de unos 35 aminoácidos, genera “regla” que da largo de microfilamentos en sarcómero



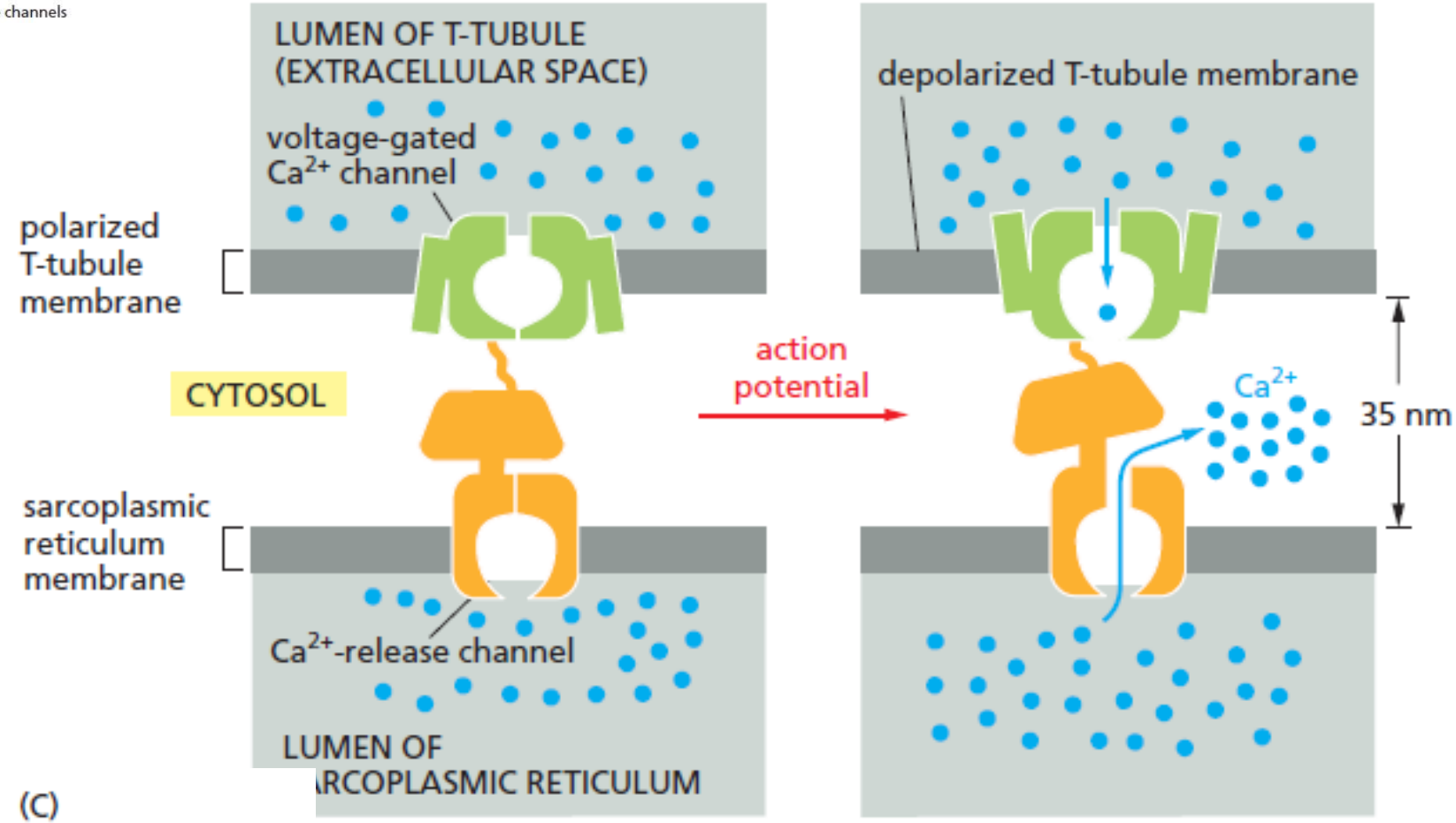
Titina: proteína gigante, “resorte molecular” con repetidos que se plegan y despliegan según tensión. Une filamentos gruesos de miosina y linea Z, manteniéndolos centrados, también posiblemente “regla” que da largo total del sarcomero


An action potential arrives at neuromuscular junction
ACh is released, binds to receptors, and opens sodium ion channels, leading to an action potential in sarcolemma
Excitation
Action potential travels along the T-tubules
Calcium
Troponin
ADP
Pi
Thick and thin filament interaction leads to muscle contraction
Muscle shortens and produces tension

Regulación de la contracción – rol del Ca^{2+}

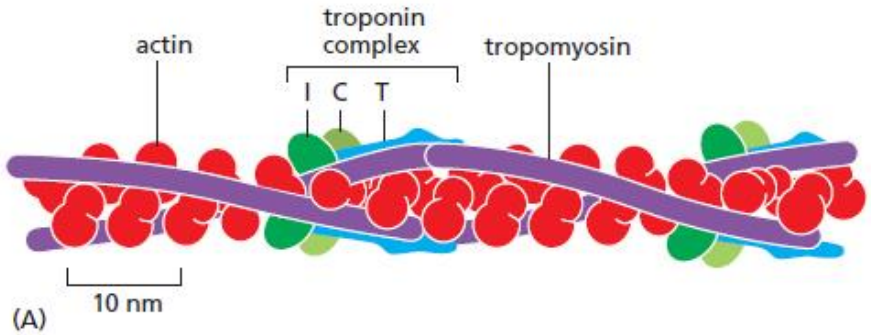


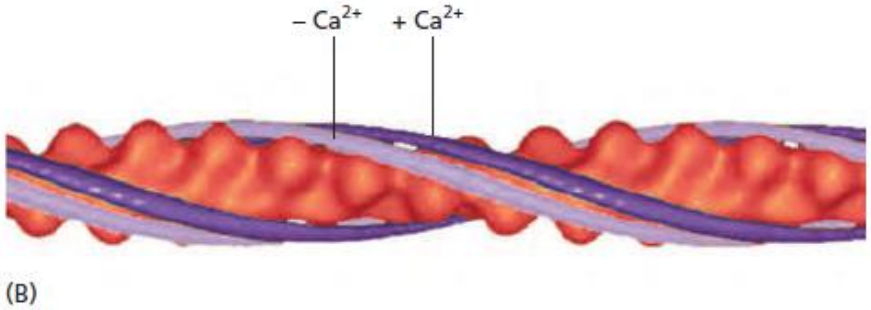

Ca^{2+}-release channels

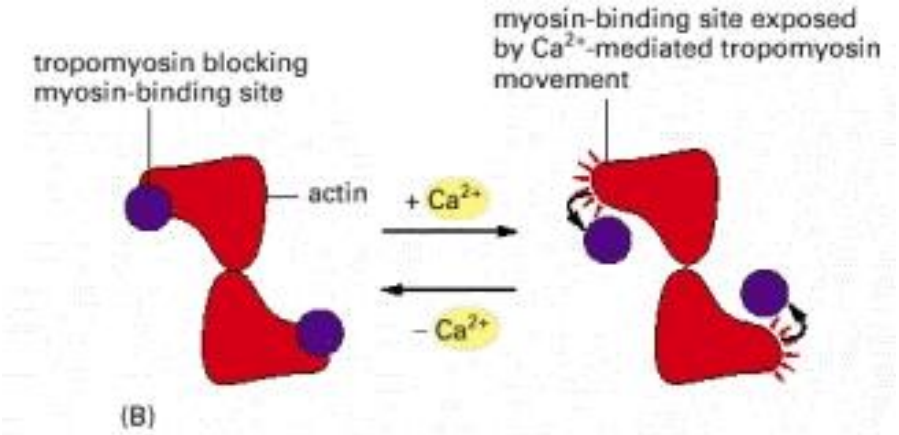

LUMEN OF T-TUBULE
(EXTRACELLULAR SPACE)
voltage-gated
Ca^{2+} channel
polarized
T-tubule
membrane
CYTOSOL
sarcoplasmic
reticulum
membrane
Ca^{2+}-release channel
LUMEN OF
RCOPLASMIC RETICULUM
action
potential
depolarized T-tubule membrane
Ca^{2+}
35 nm

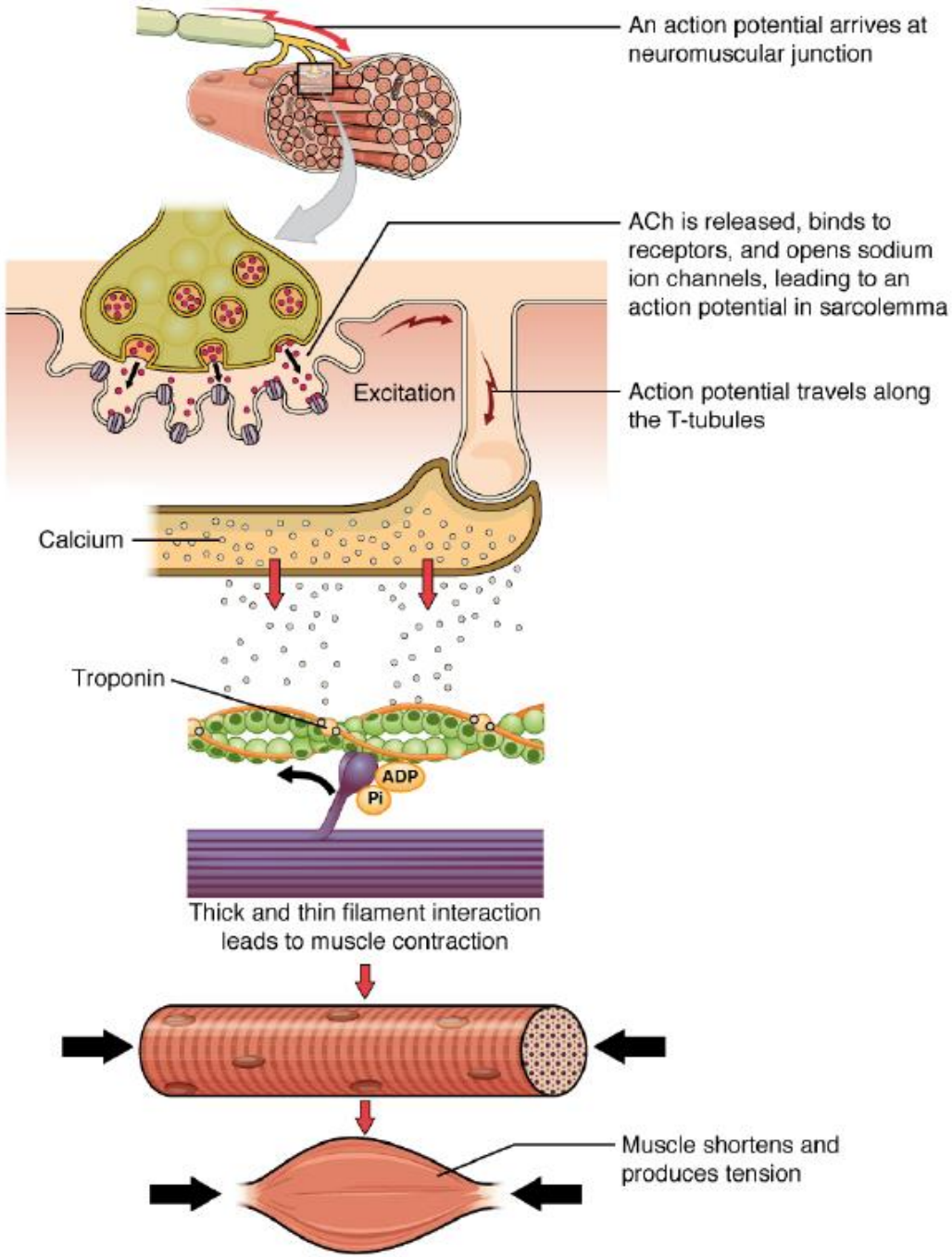
(C)

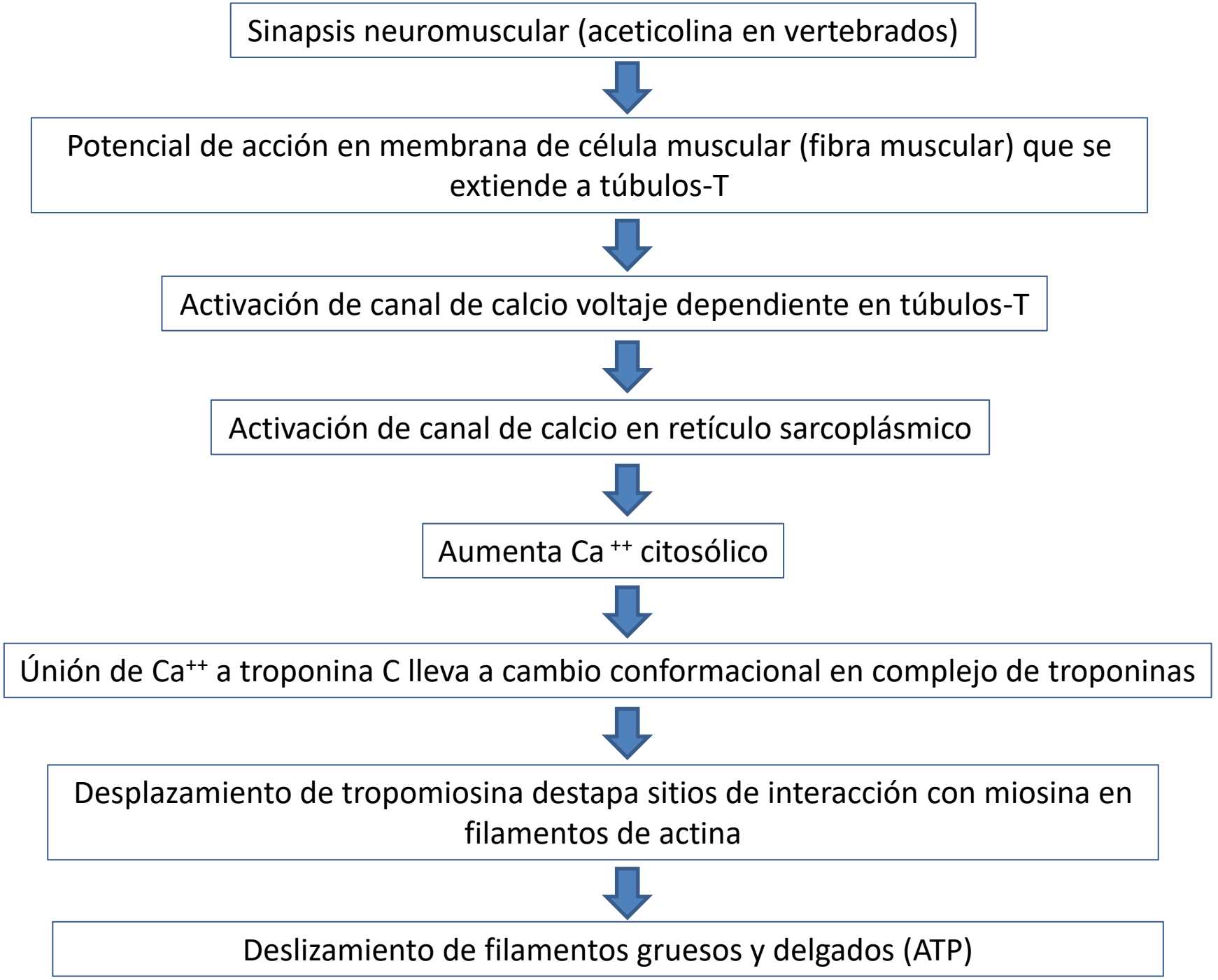
La entrada de calcio lleva a que se descubran los sitios de las subunidades de actina que interaccionan con miosina







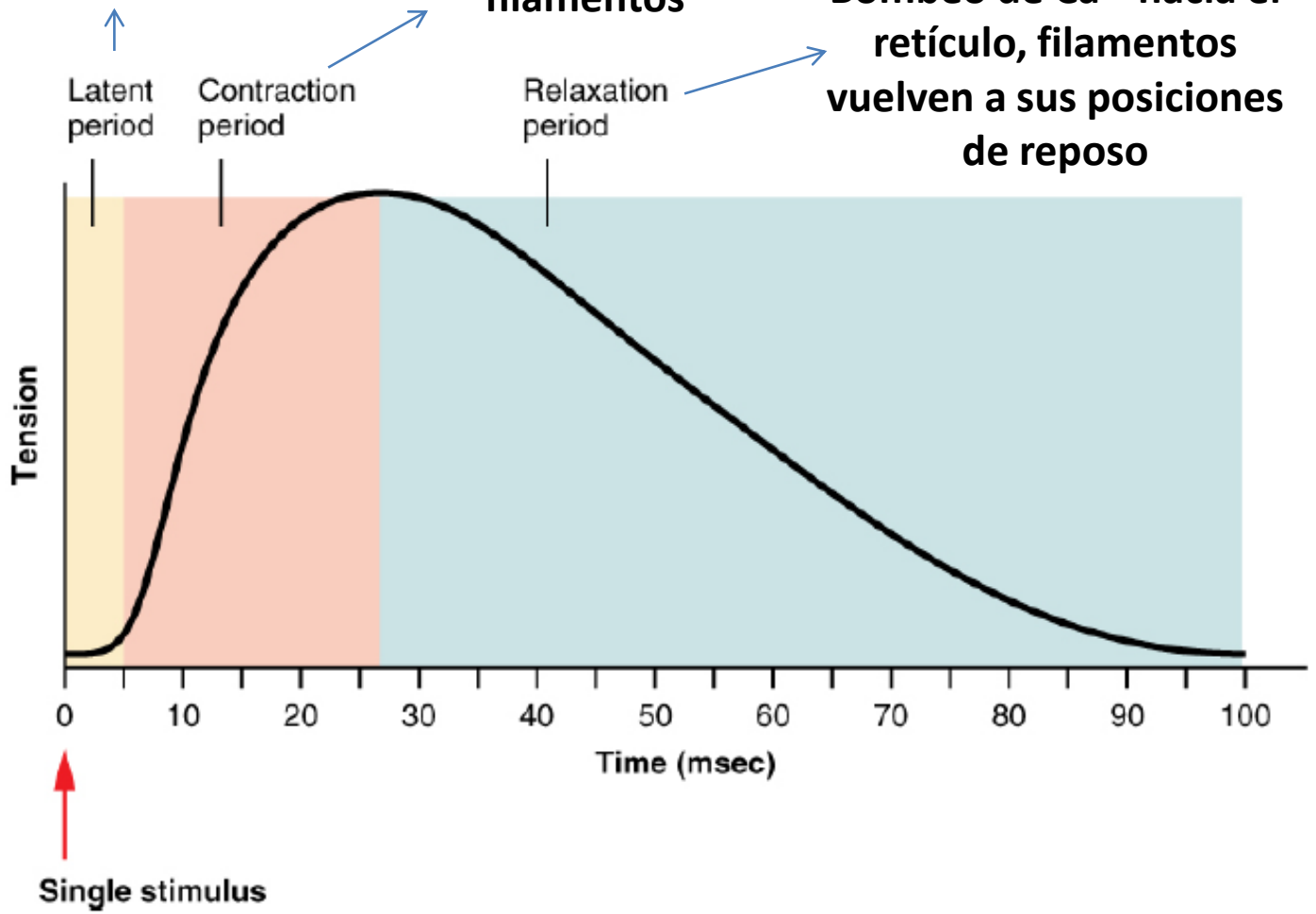

An action potential arrives at neuromuscular junction
ACh is released, binds to receptors, and opens sodium ion channels, leading to an action potential in sarcolemma
Excitation
Action potential travels along the T-tubules
Calcium
Troponin
ADP
Pi
Thick and thin filament interaction leads to muscle contraction
Muscle shortens and produces tension


Sinapsis neuromuscular (aceticolina en vertebrados)
Potencial de acción en membrana de célula muscular (fibra muscular) que se extiende a túbulos-T
Activación de canal de calcio voltaje dependiente en túbulos-T
Activación de canal de calcio en retículo sarcoplásmico
Aumenta Ca ++ citosólico
Únión de Ca++ a troponina C lleva a cambio conformacional en complejo de troponinas
Desplazamiento de tropomiosina destapa sitios de interacción con miosina en filamentos de actina
Deslizamiento de filamentos gruesos y delgados (ATP)

Propagación del potencial de acción

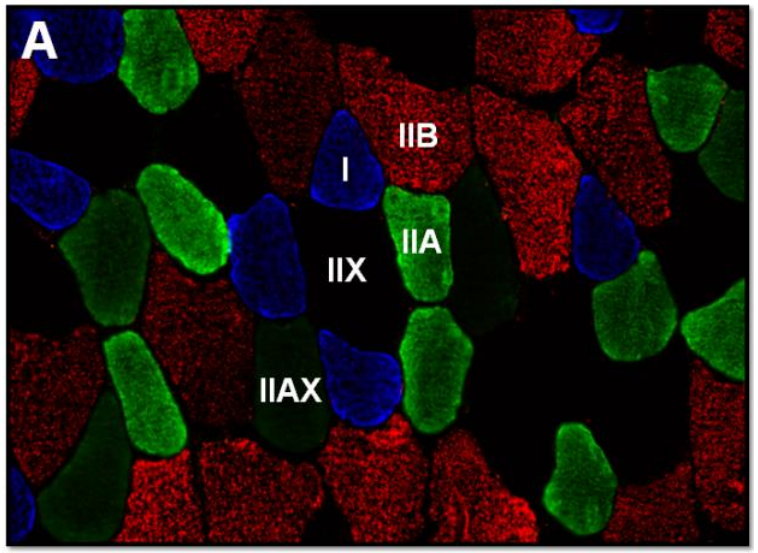
Liberación de Ca^{++} deslizamiento de filamentos

Bombeo de Ca^{++} hacia el retículo, filamentos vuelven a sus posiciones de reposo

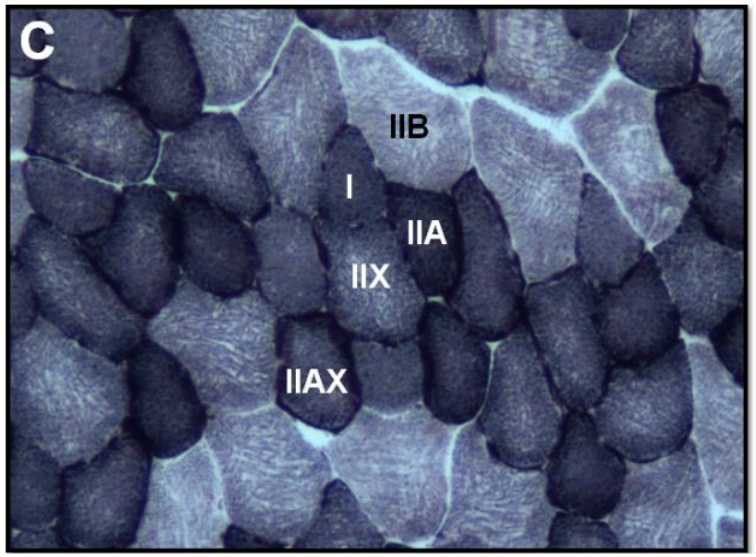


Tipos de fibras musculares esqueléticas

Cadenas pesadas de miosina (inmunofluorescencia)



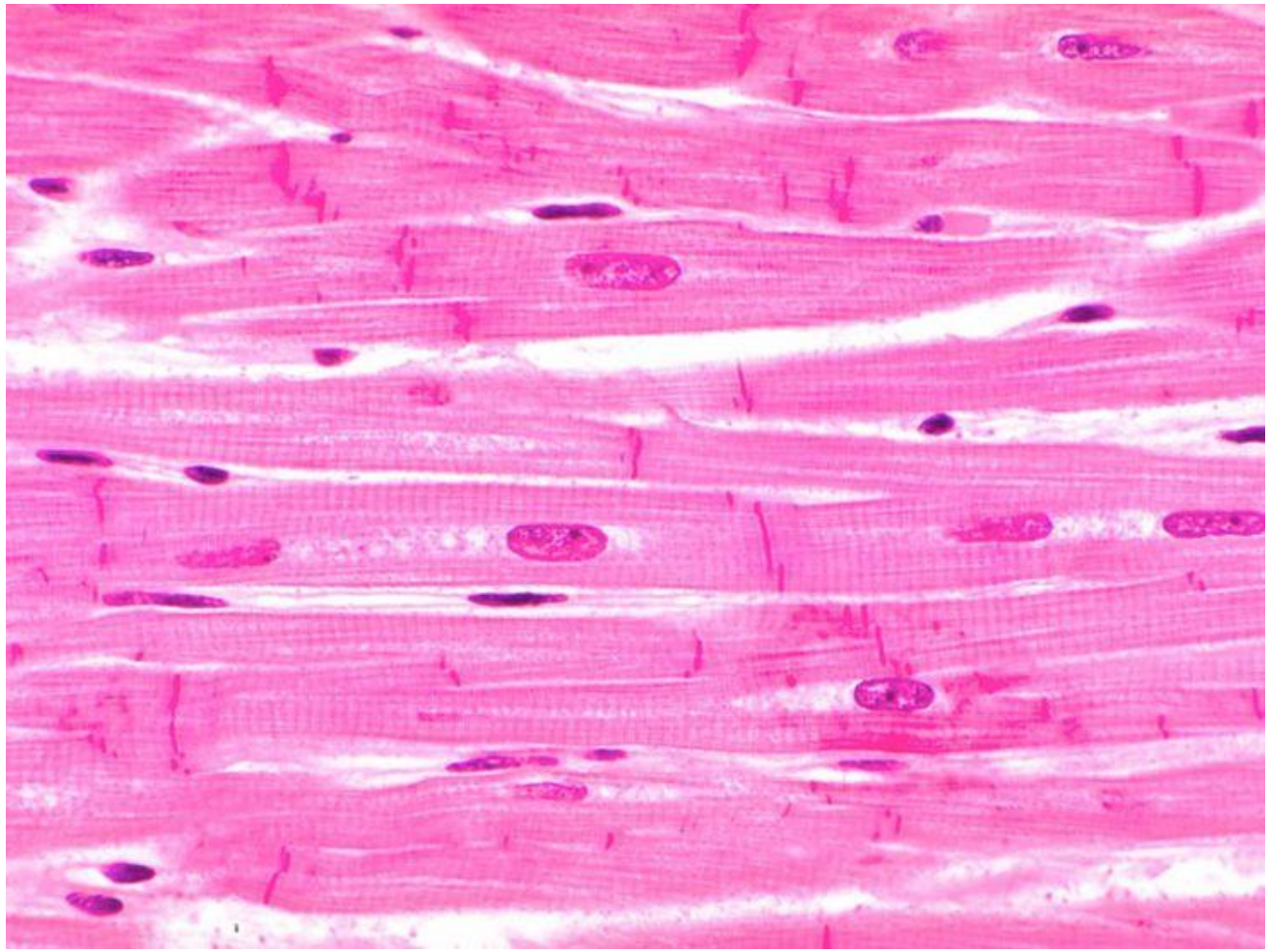
Succinato deshidrogenasa (histoquímica)

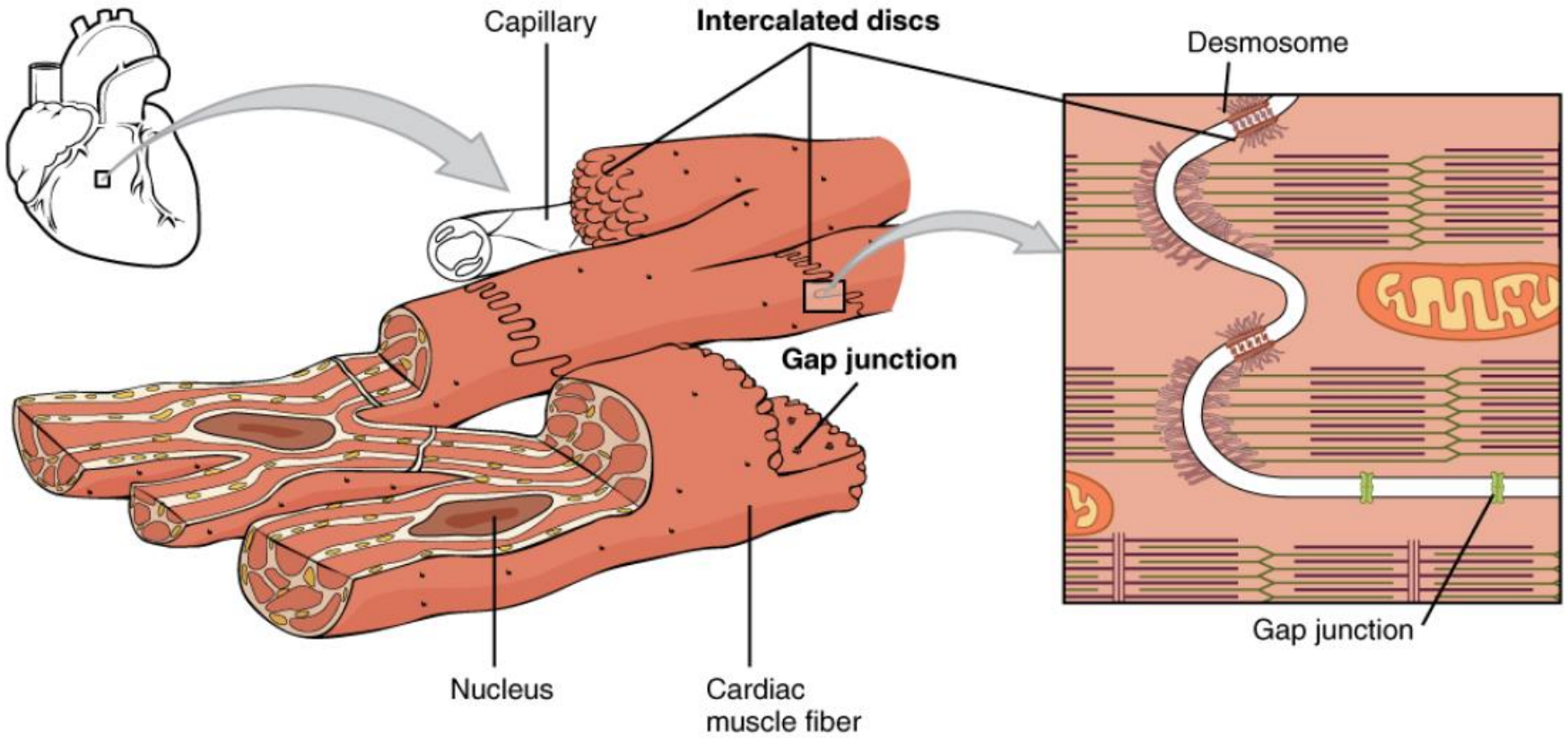


Clasificación antigua pero didáctica

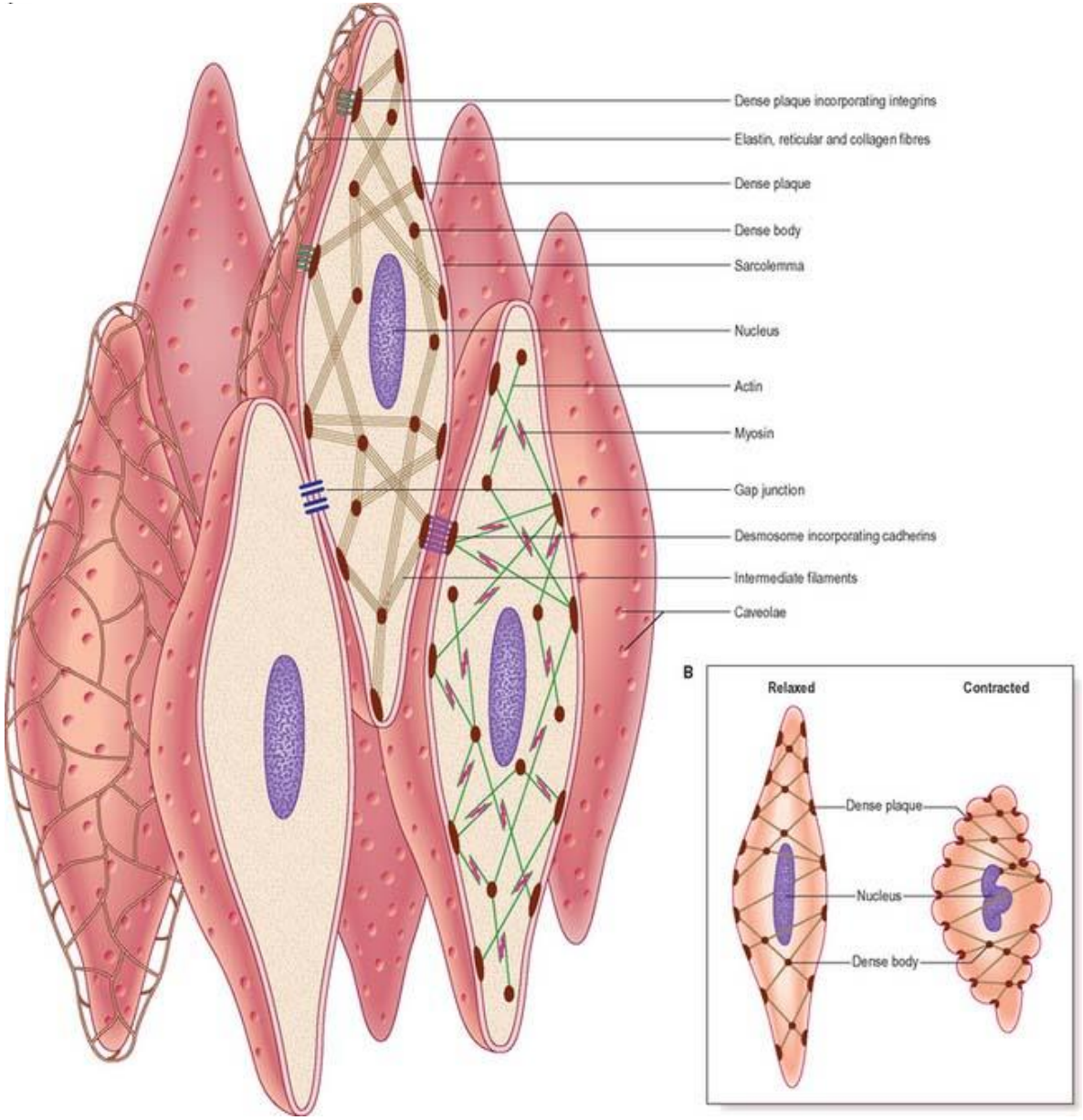
	Blanca / Rápida / FG (Esfuerzo "explosivo"- ej. correr)	Roja / Lenta / SO (Fuerza mantenida – ej. postura)	Rosada/ Intermedia /FOG (ej. caminar)
Metabolismo	Anaeróbico (glicólisis, fermentación láctica)	Aérobico	"Mixto"
Mitocondrias	Pocas	Abundantes	Abundantes
Mioglobina	Poca	Abundante	Abundante
Glúcogeno	Abundante	Poco	Intermedio
Triglicéridos	Pocos	Abundantes	Intermedio
Velocidad de contracción	Rápida	Lenta	Rápida
Fatiga	Rápido	Lento	Intermedio

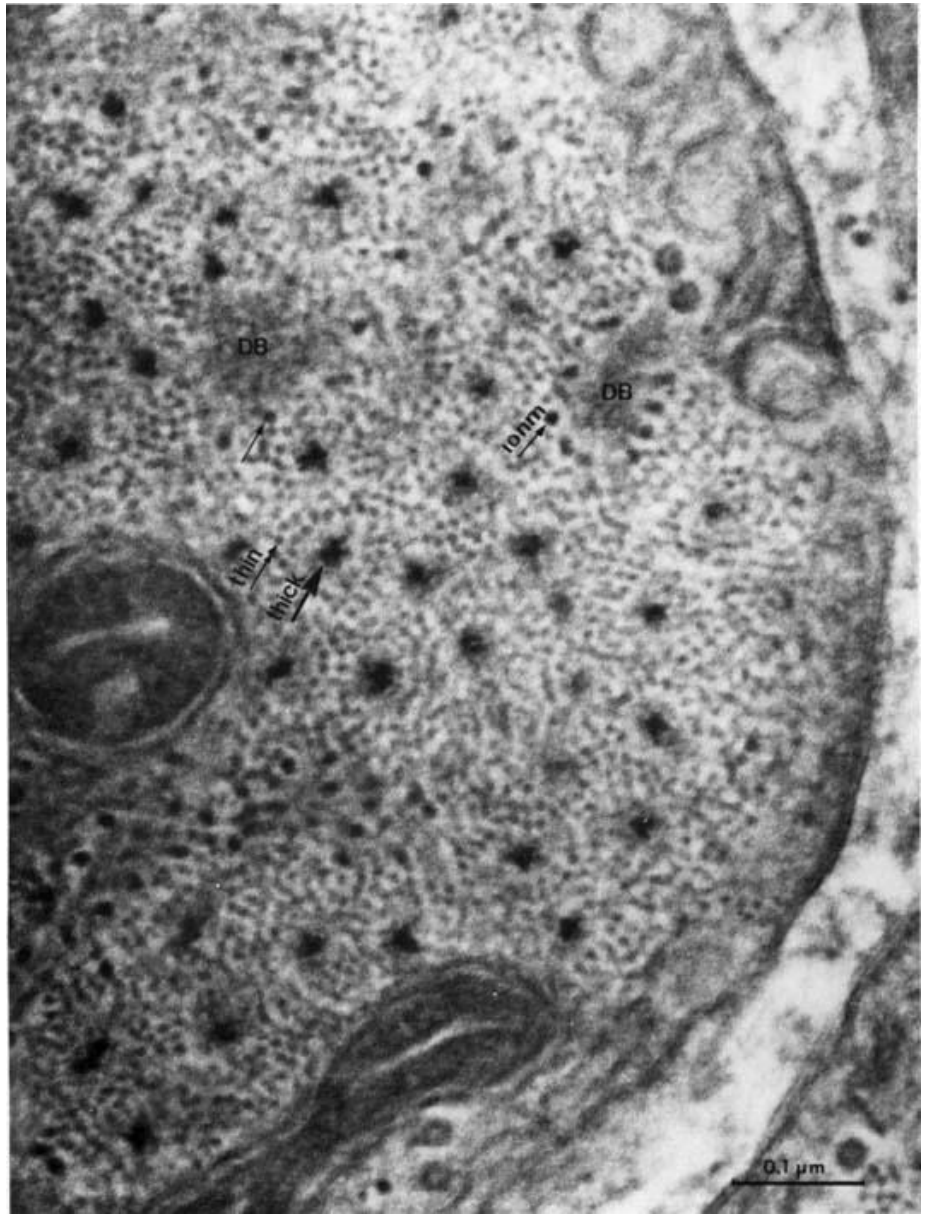
Músculo cardíaco



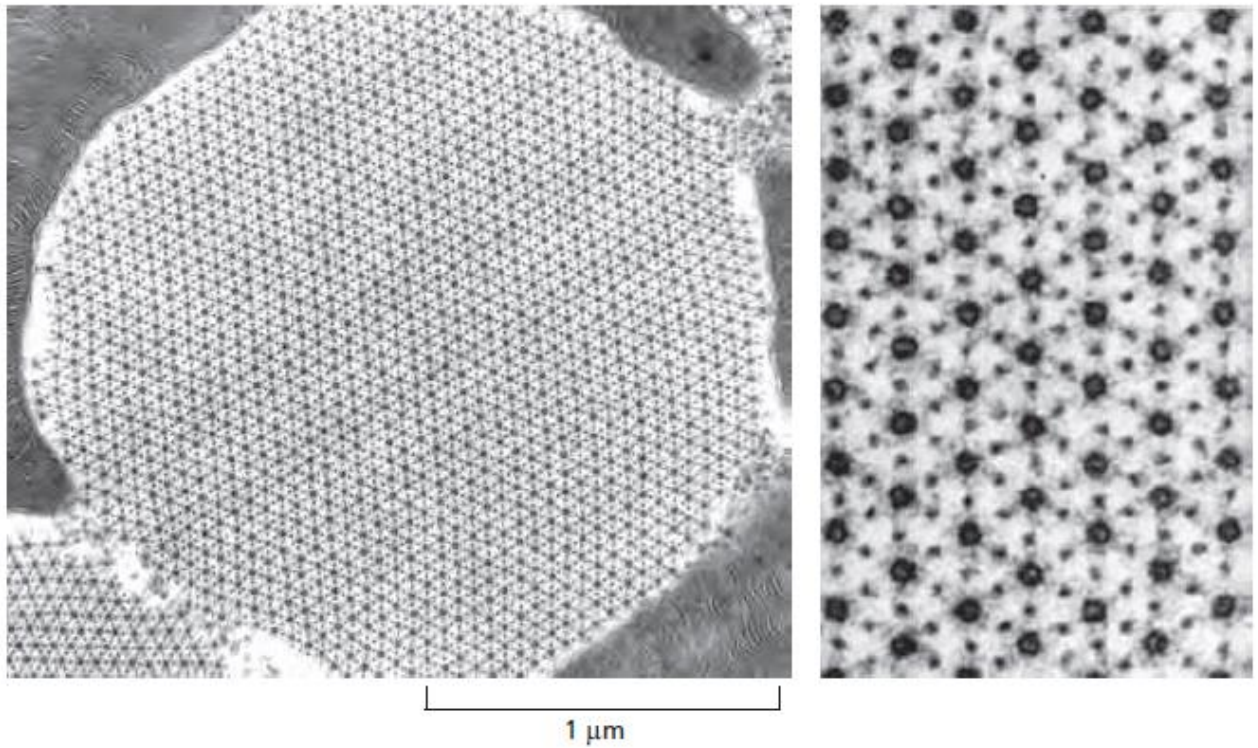

Capillary
Intercalated discs
Desmosome
Gap junction
Nucleus
Cardiac muscle fiber
Gap junction

Músculo liso



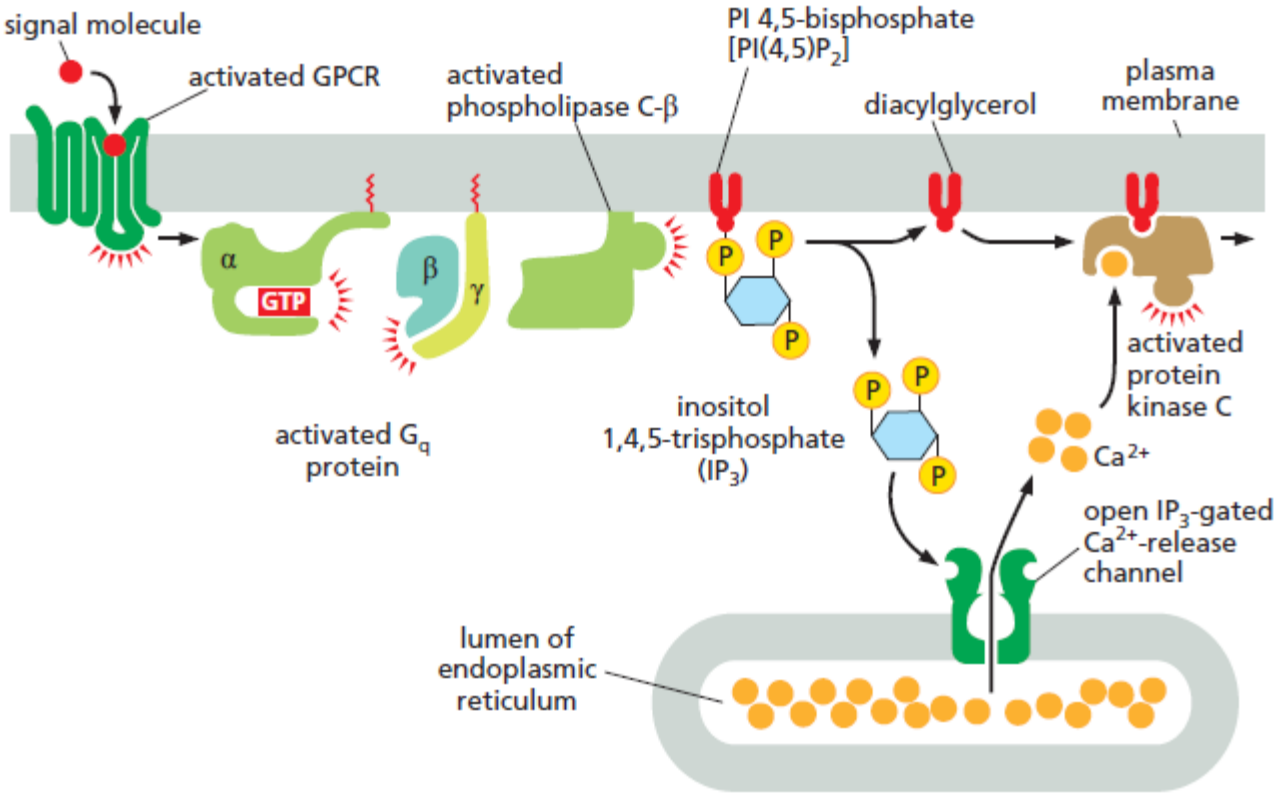


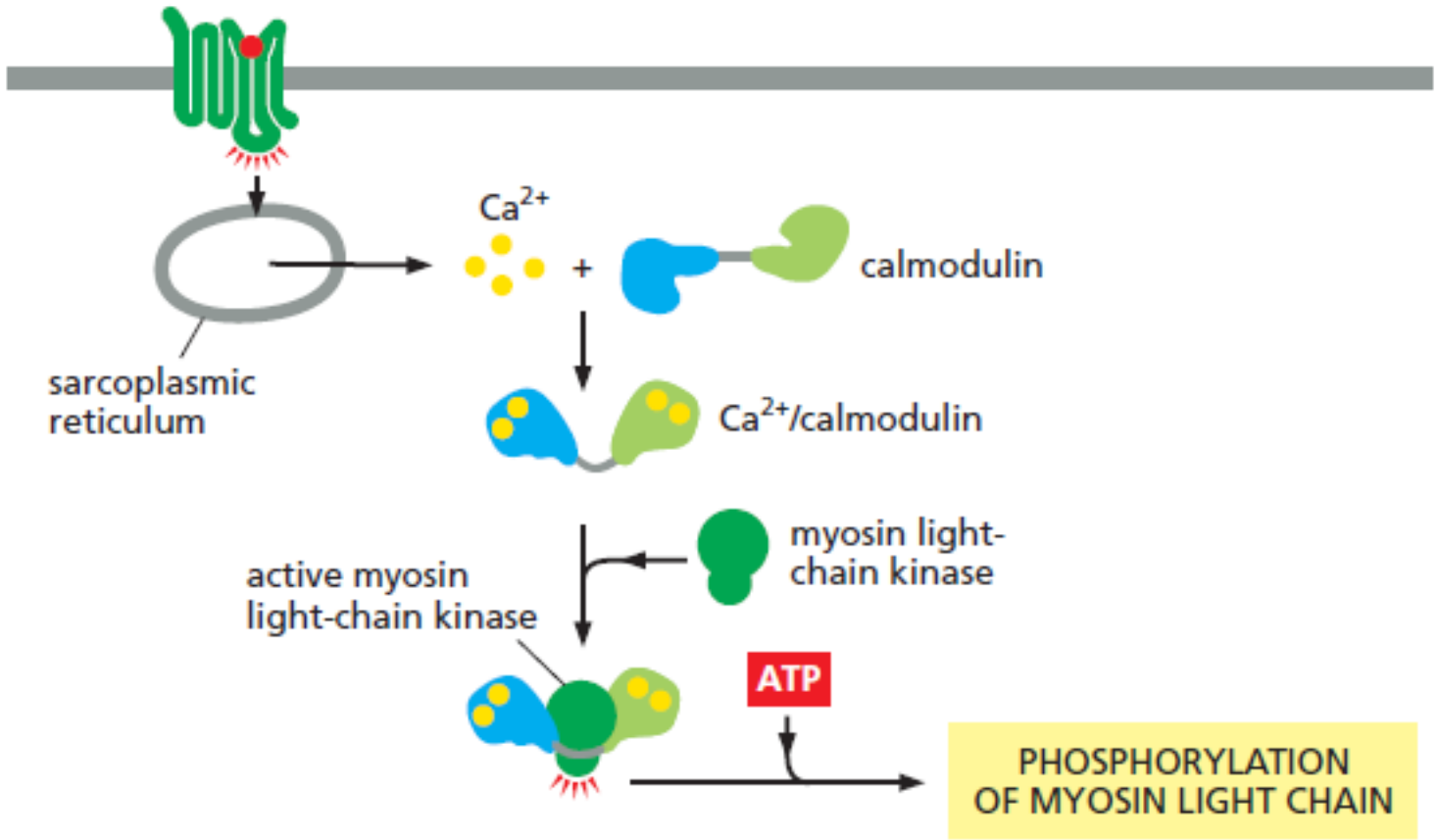
Músculo liso



Músculo estriado

Contracción del músculo liso




Ca2+
+
calmodulin
sarcoplasmic
reticulum
Ca2+/calmodulin
myosin light-
chain kinase
active myosin
light-chain kinase
ATP
PHOSPHORYLATION
OF MYOSIN LIGHT CHAIN

Ejercicio

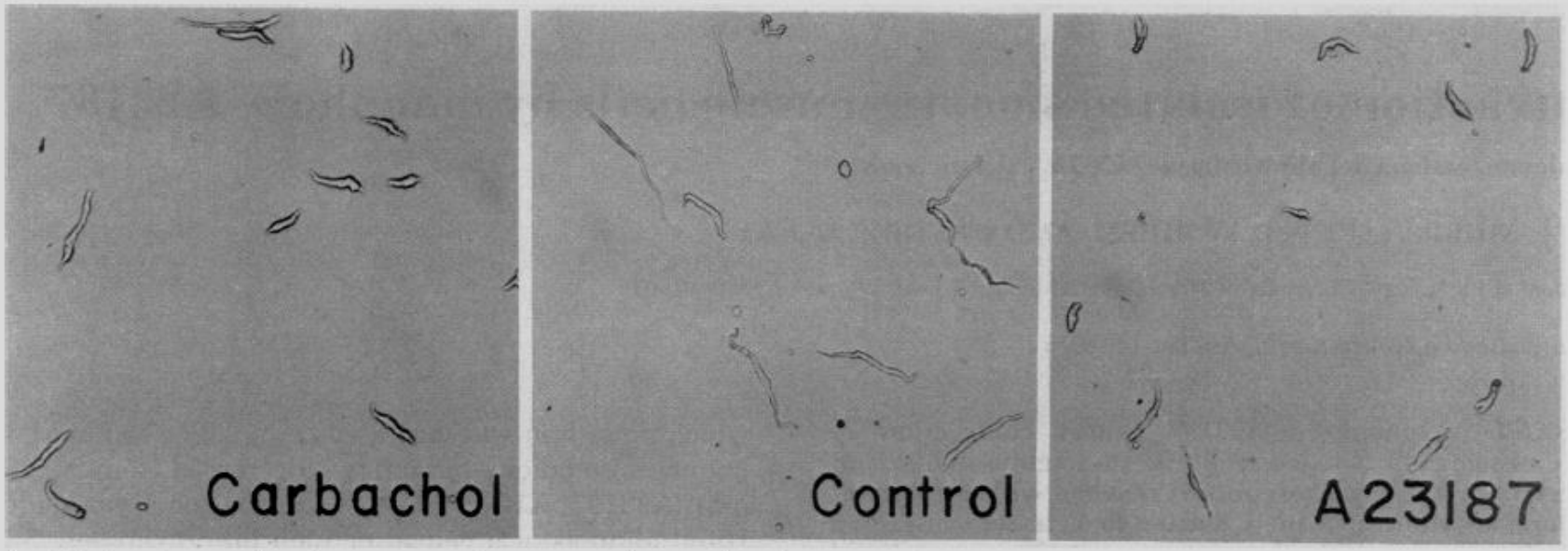
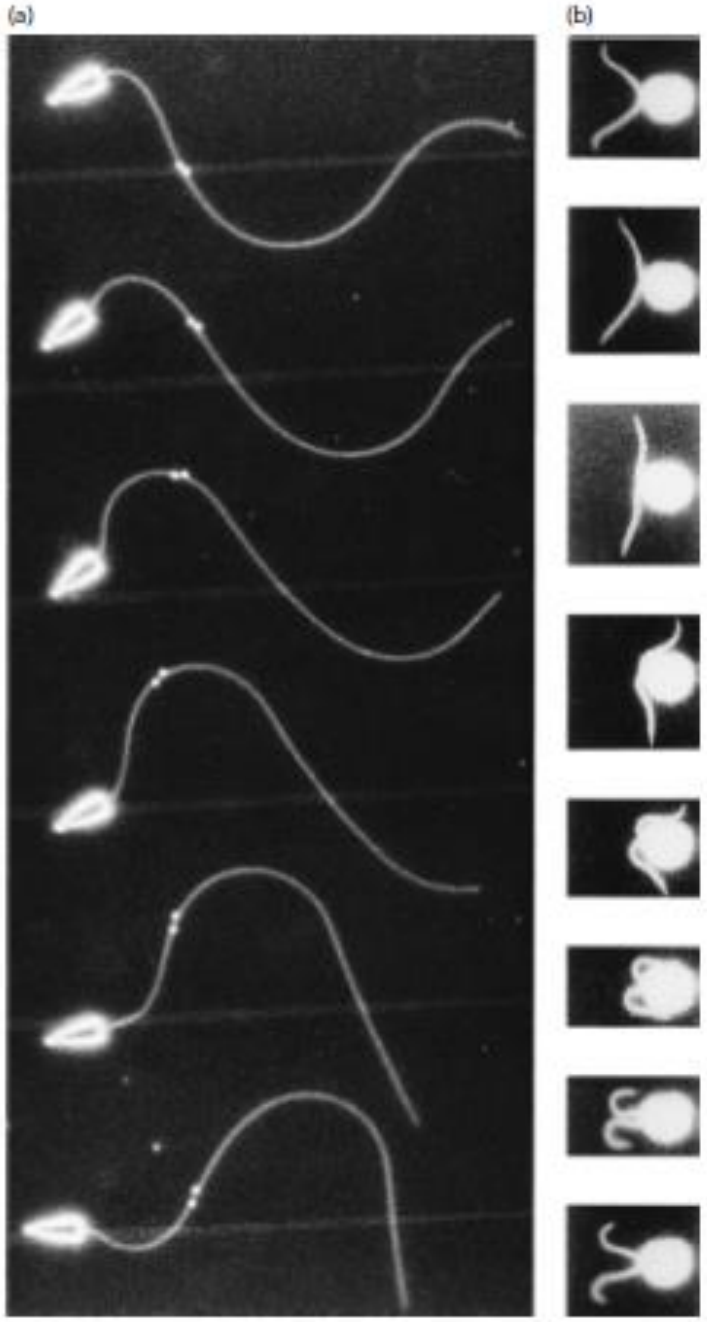


FIG. 1. Photomicrographs of representative groups of treated and untreated cells from a suspension of isolated smooth muscle cells. Prior to fixation, the cells on the left were treated with carbachol (1×10^{-5} M) for 15 sec, and those on the right were treated with A23187 (5×10^{-6} M) for 10 sec. The cells in the center were untreated before fixation. Phase contrast, ×72.

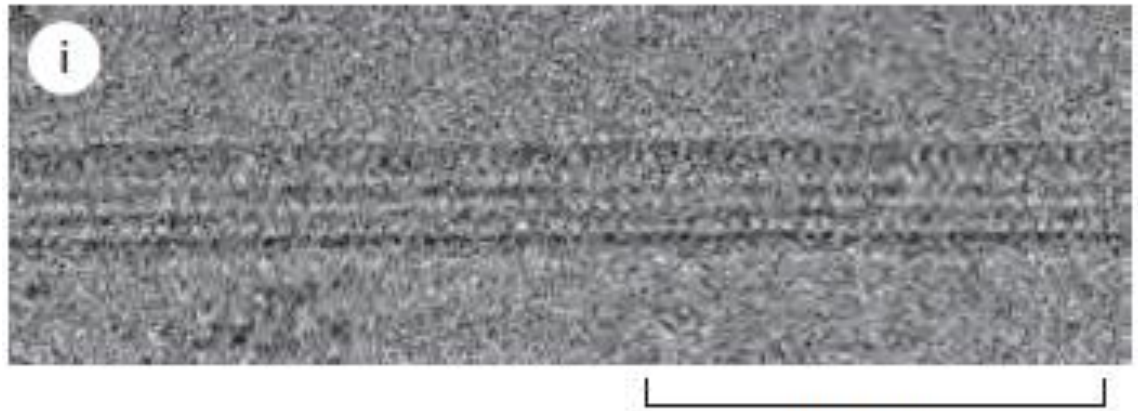
¿Qué es el Carbachol? - ¿Qué es A23187?

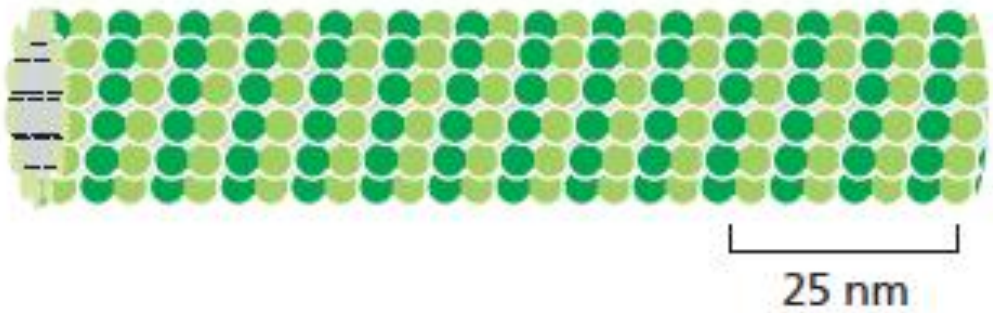
¿Qué ocurre al añadirlos a células de músculo liso *in vitro*?
¿Por qué?

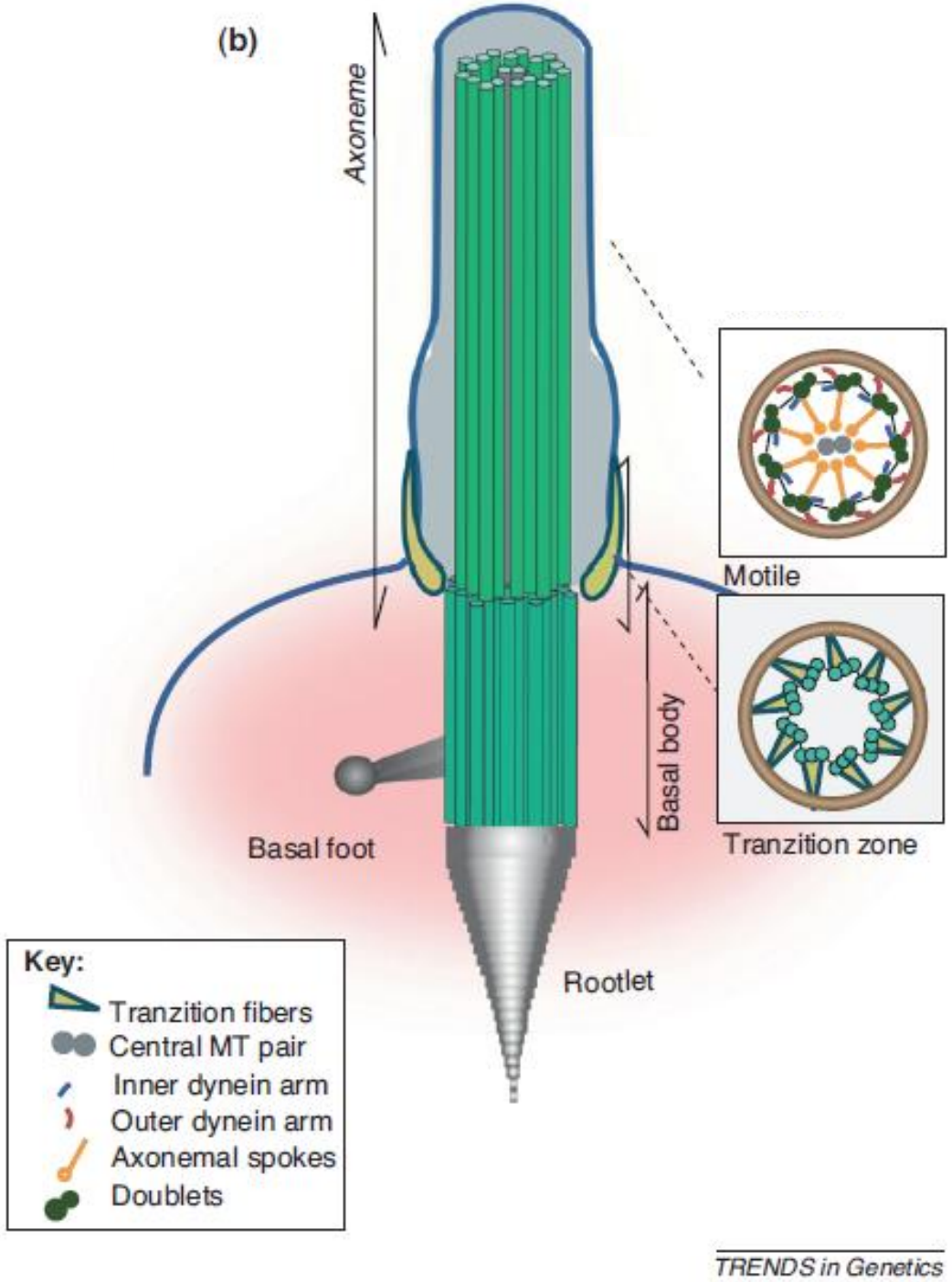
CILIAS y FLAGELOS



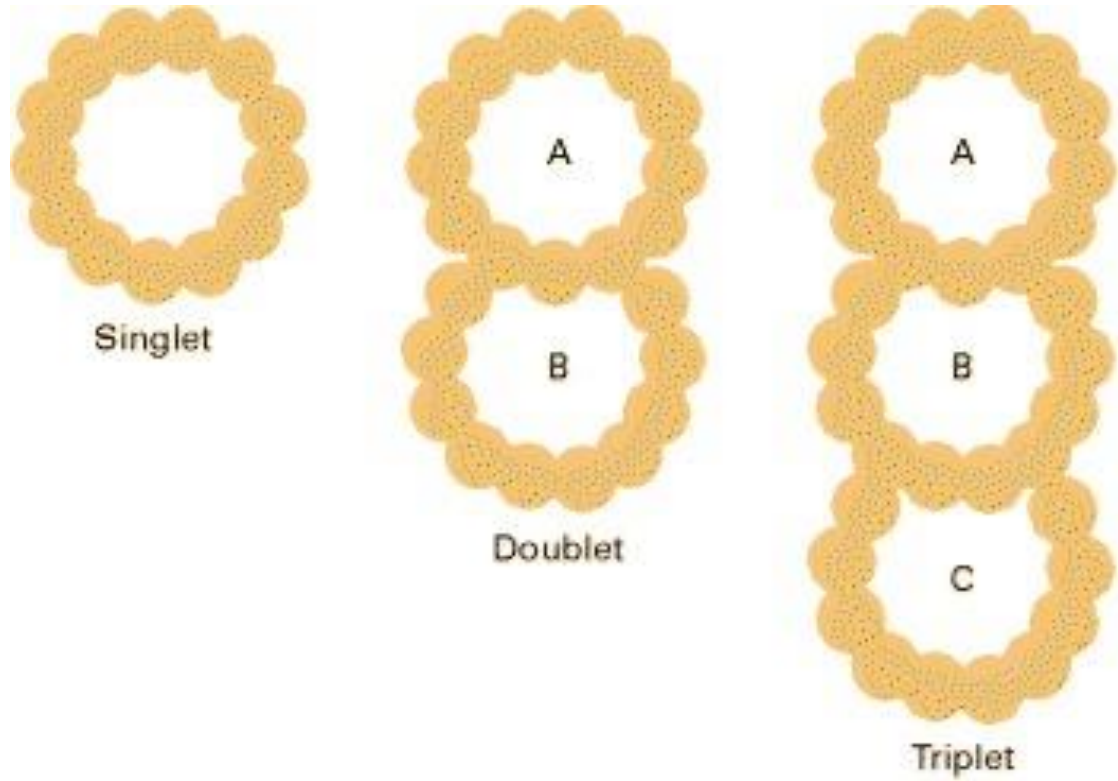
MICROTUBULES



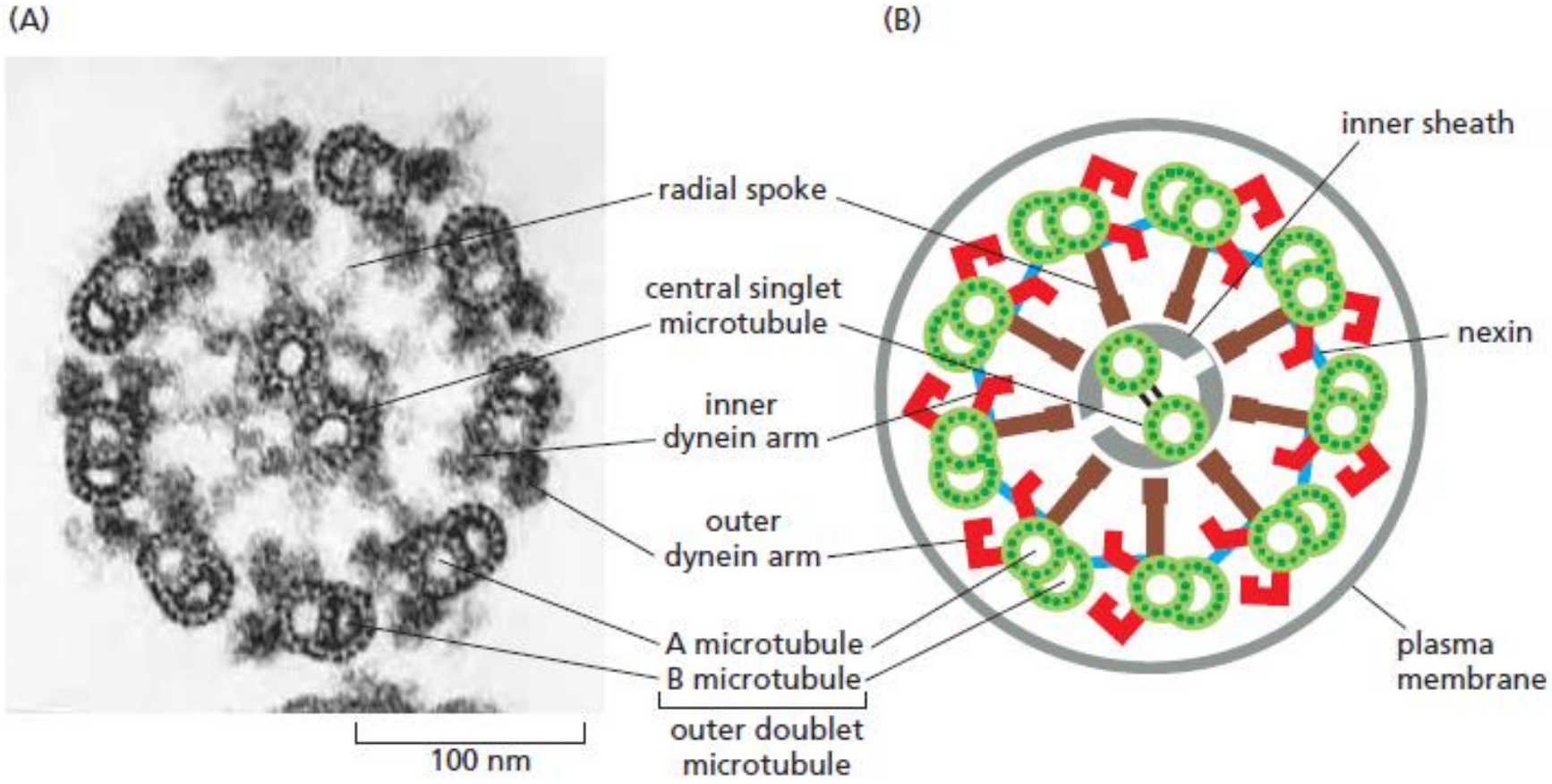




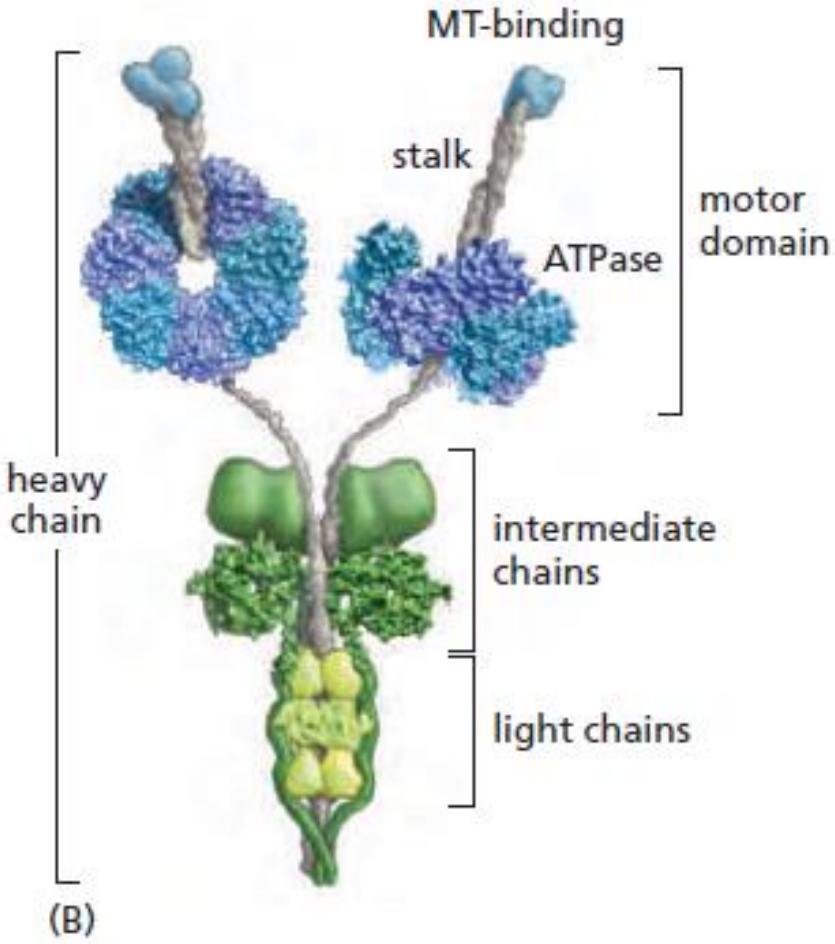
EN CILIAS **EN CENTRÍOLOS**

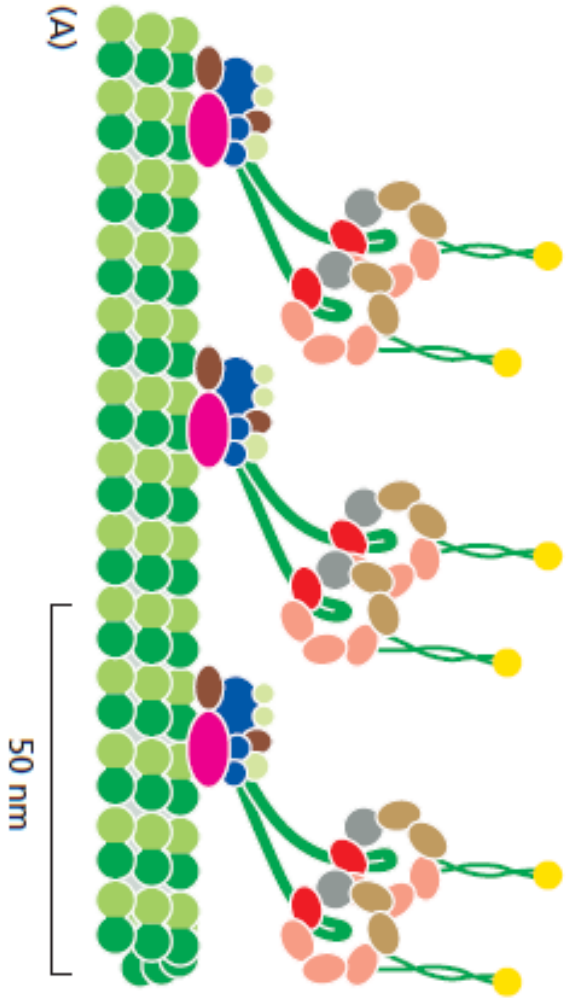


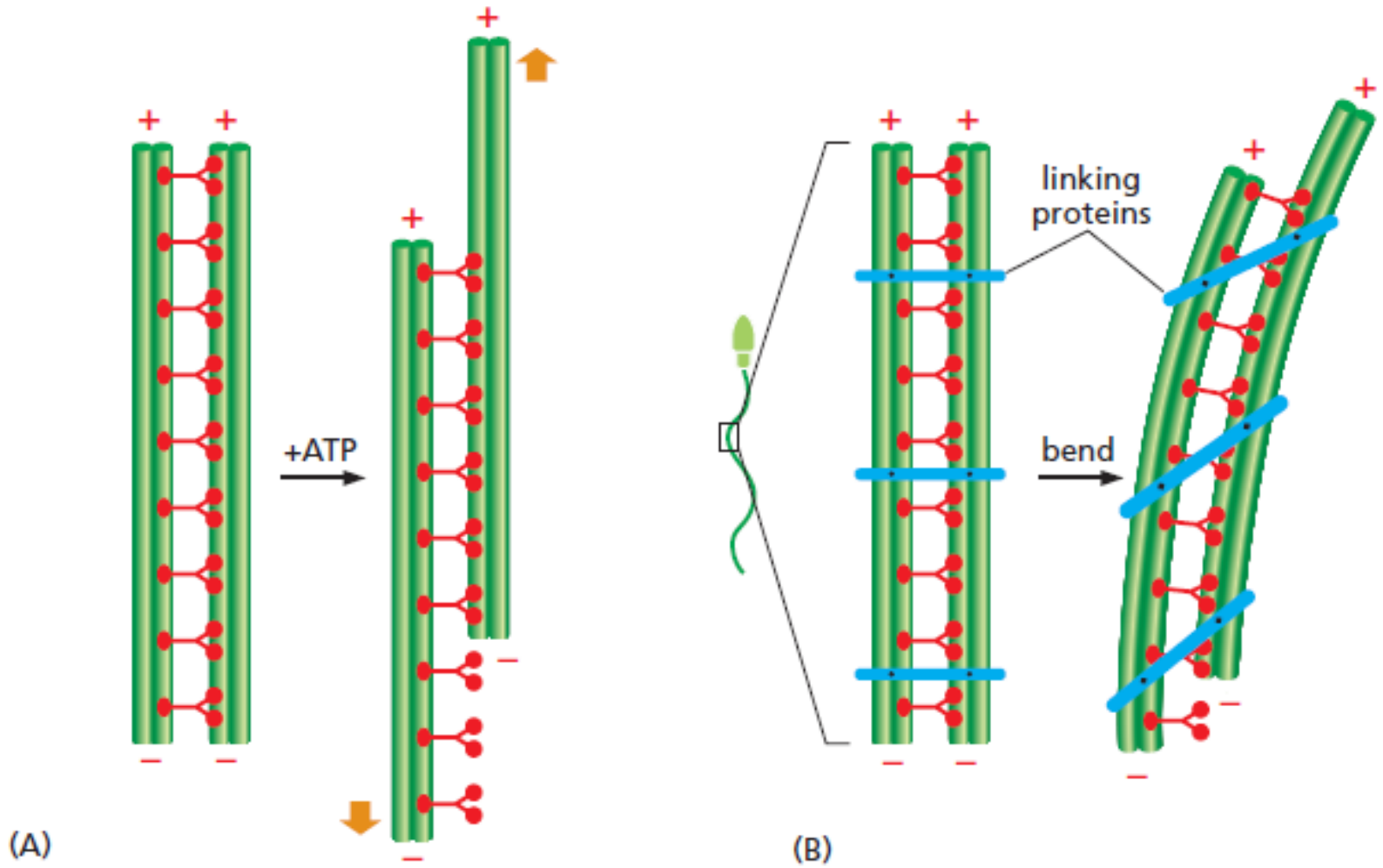
Axonema


(A)
(B)
radial spoke
central singlet microtubule
inner dynein arm
outer dynein arm
A microtubule
B microtubule
outer doublet microtubule
100 nm
inner sheath
nexin
plasma membrane

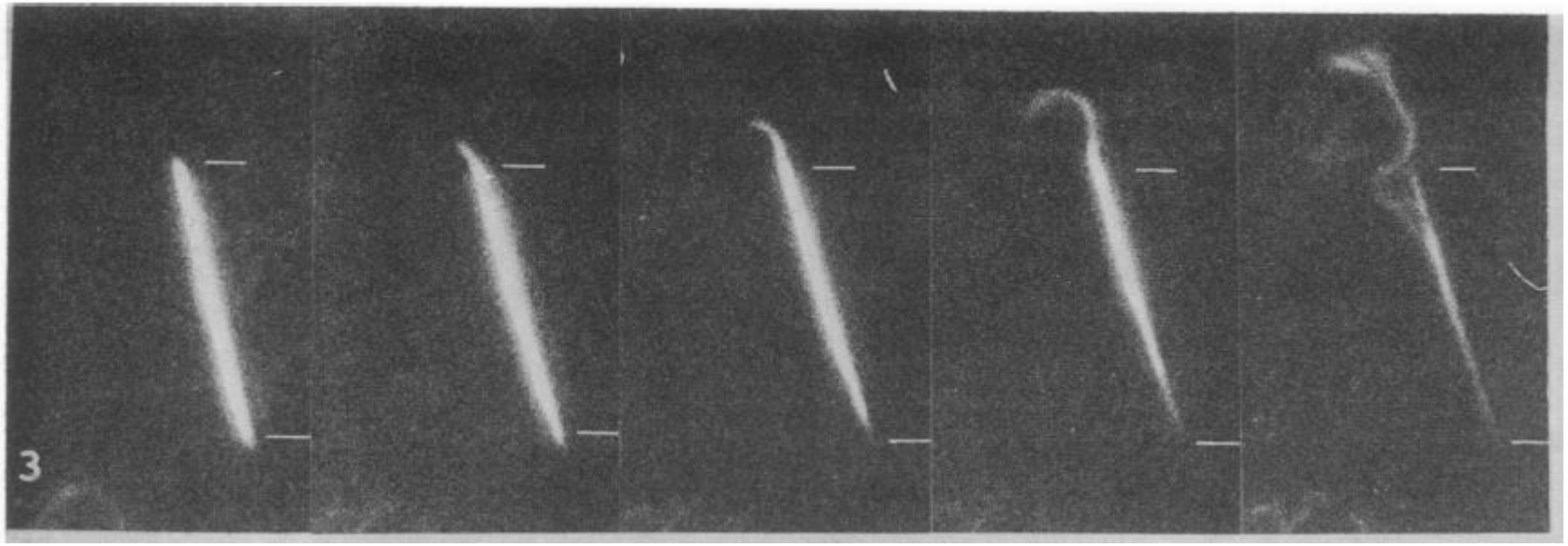
Dineínas


MT-binding
stalk
ATPase
motor domain
heavy chain
intermediate chains
light chains
(B)


(A)
50 nm


+
+
+
+
+ATP
−
−
−
(A)
linking
proteins
bend
(B)

Ejercicio - II



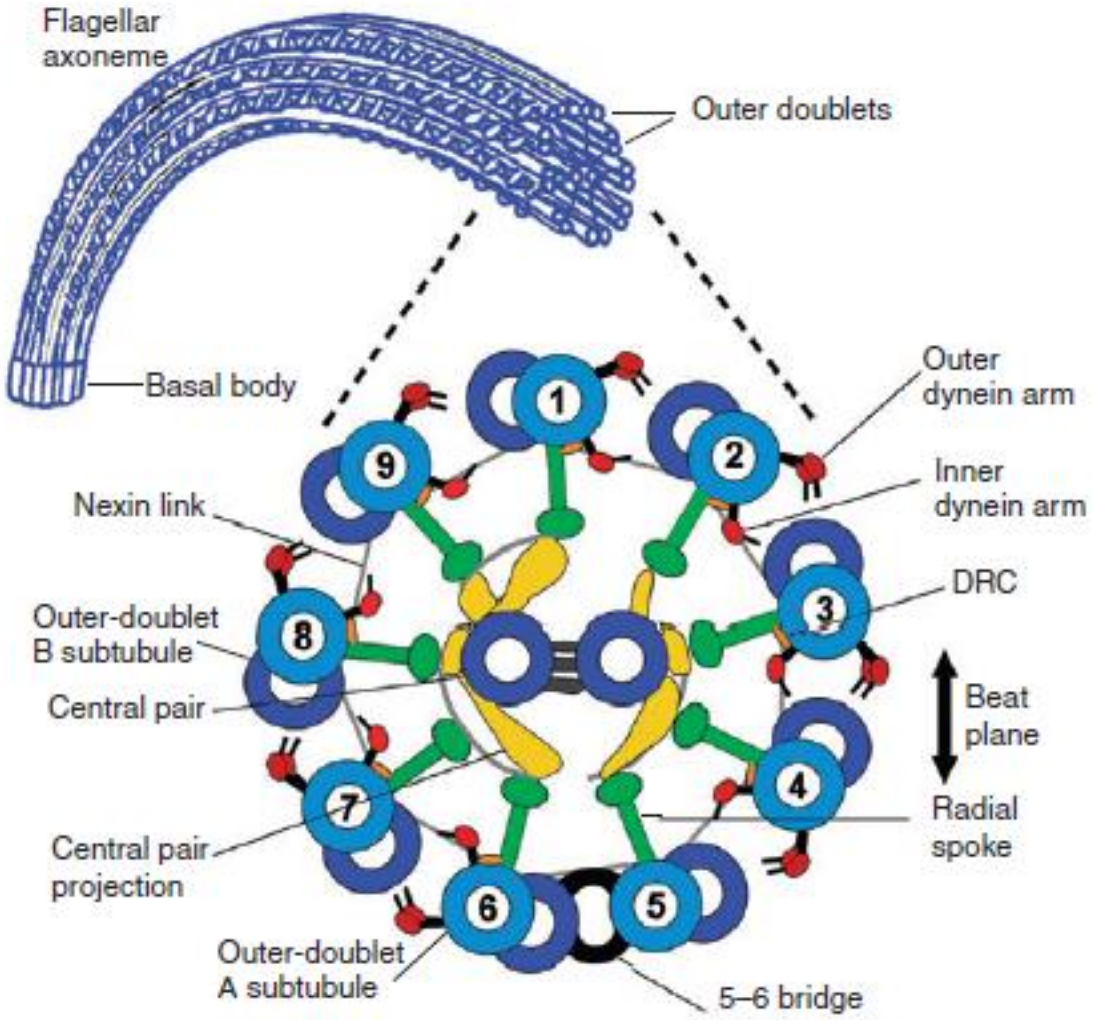
Axonemas de espermatozoides de erizo de mar aislados

Tratamiento suave con proteasa

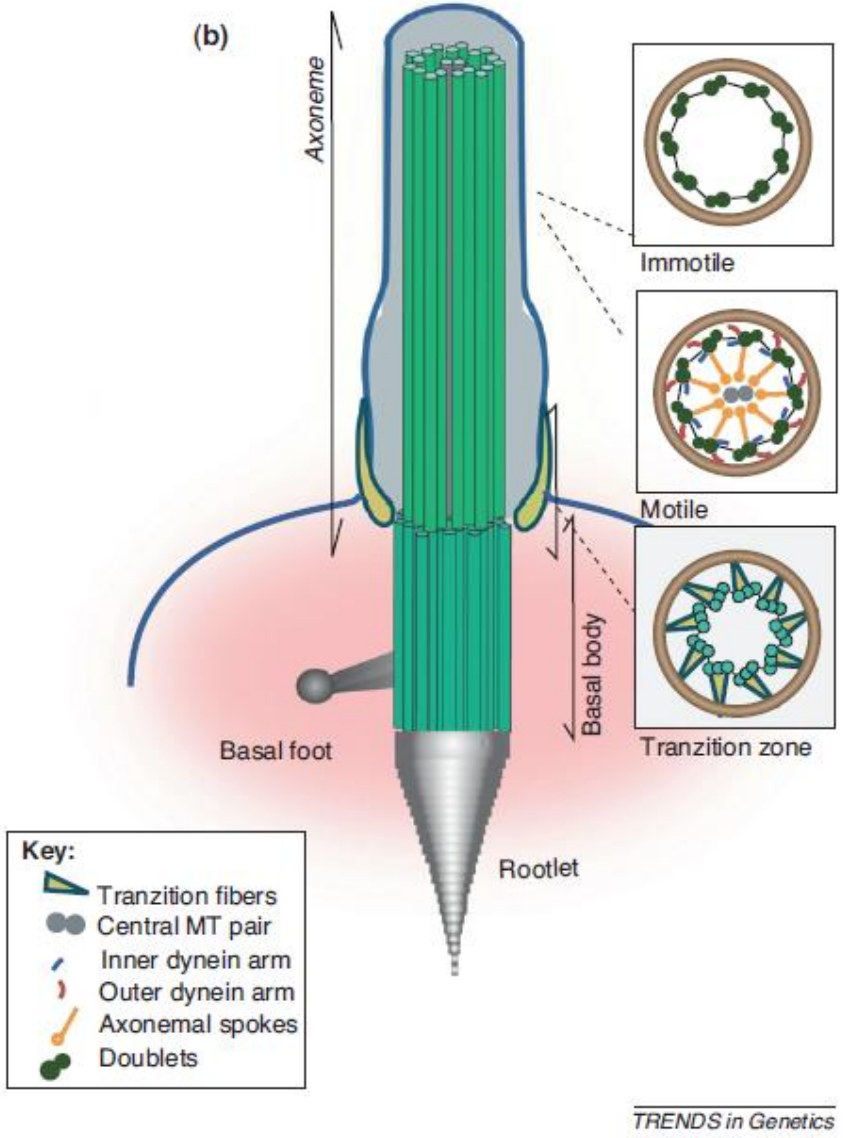
Añadido de ATP

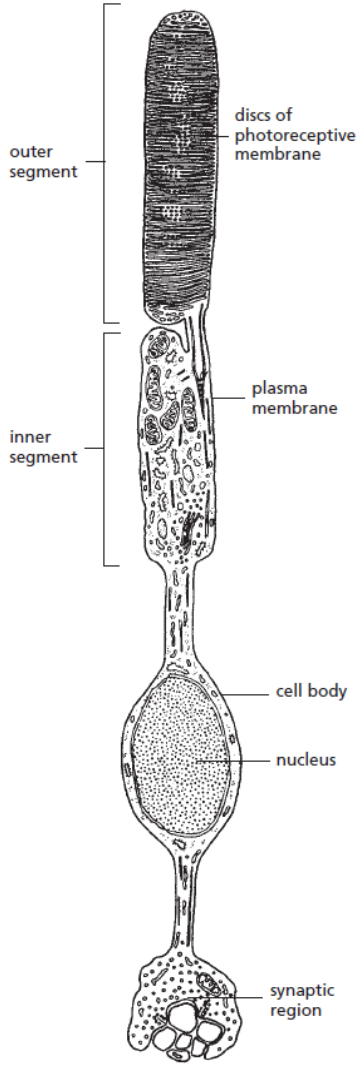
¿Qué estamos viendo?
¿Qué proteína esperan que haya sido clivada por la proteasa?

Alternancia en el deslizamiento de los dobletes de microtúbulos



Cilias primarias (no mótiles)





Pregunta de examen

Describa el mecanismo que genera el movimiento a partir de la energía química del ATP en las cilias.