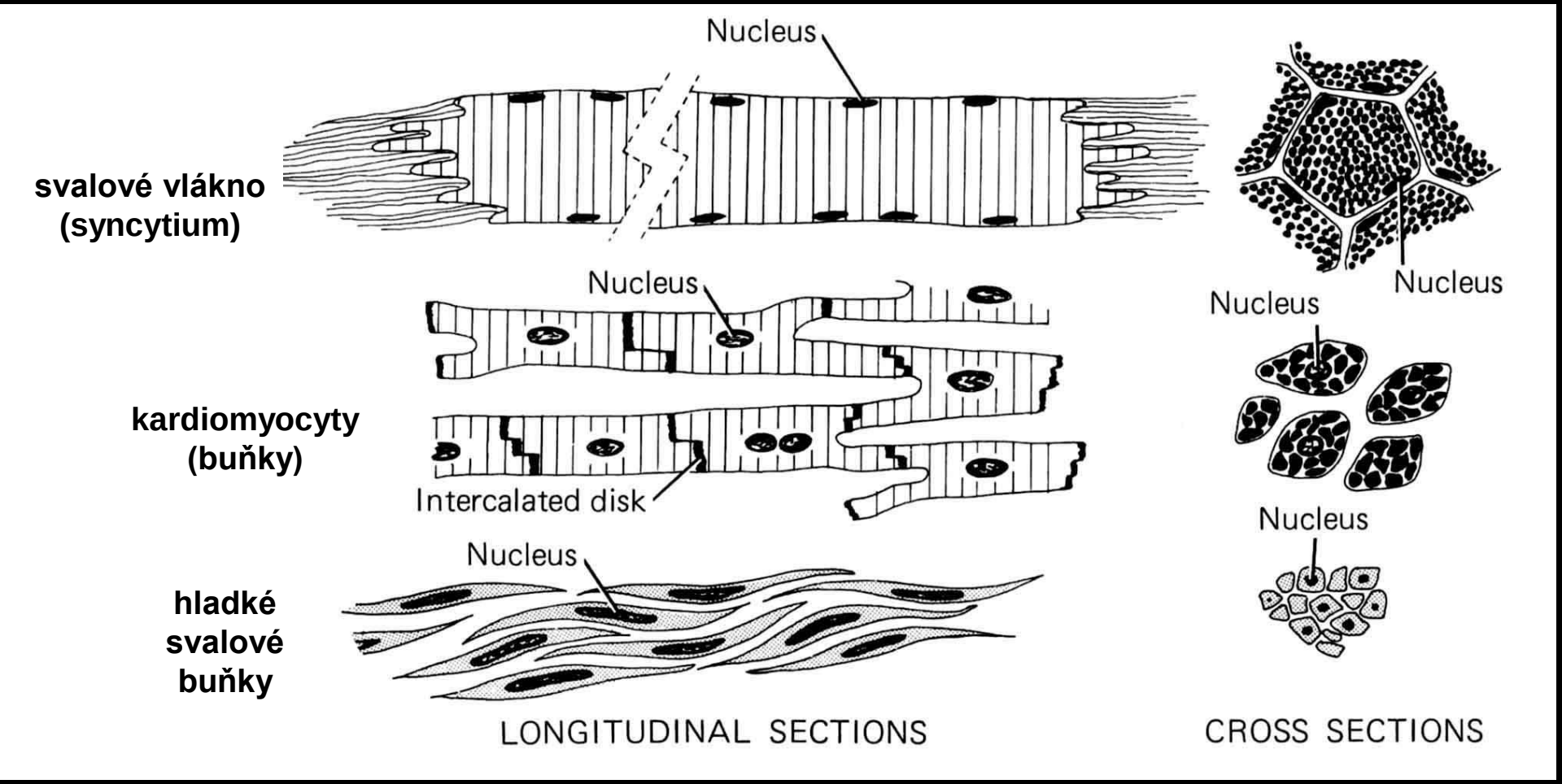
Tkáň svalová

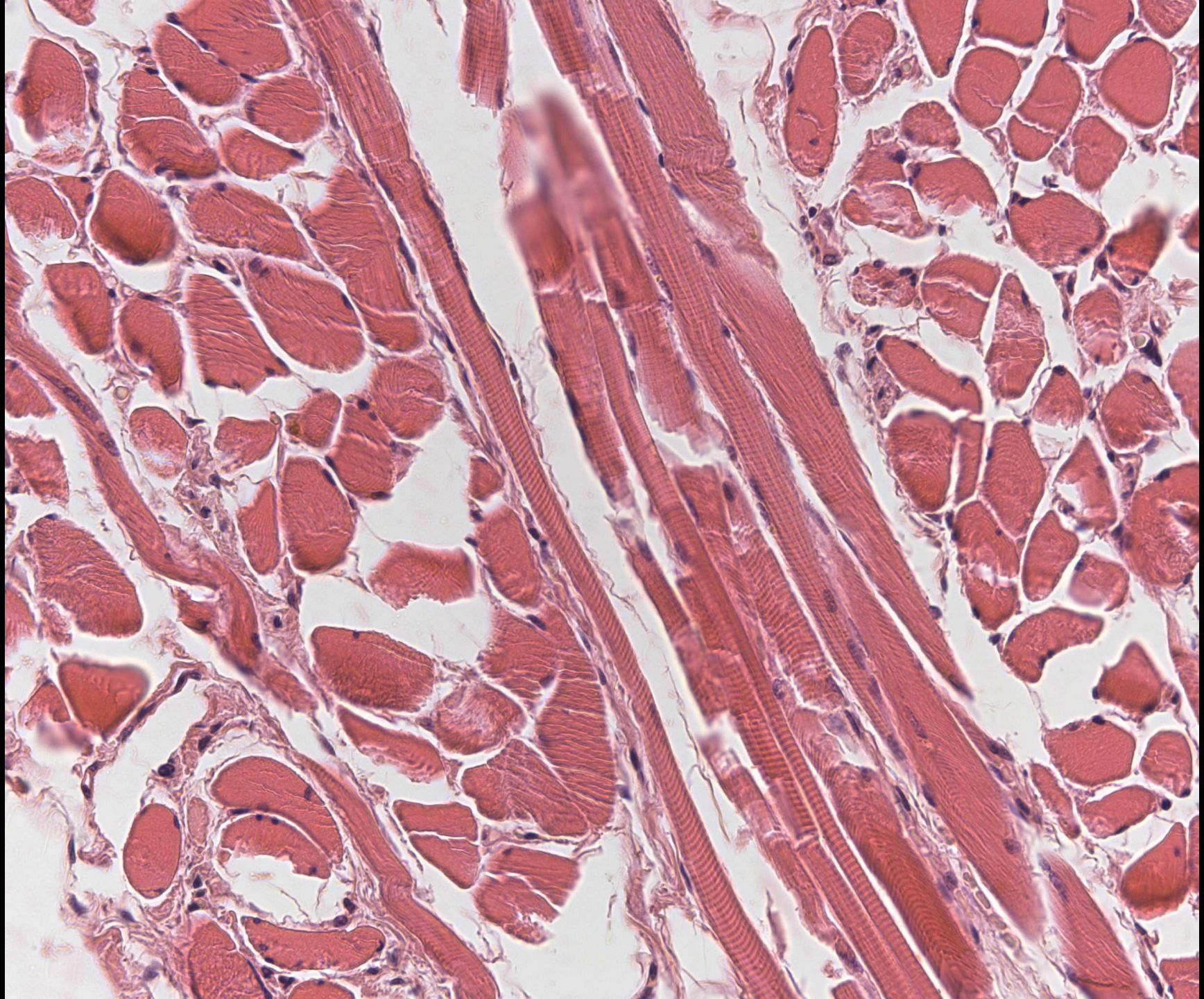
- tvořena protáhlými elementy, jejichž základní vlastností je schopnost kontrakce
- svalové elementy vytvářejí intercelulární kontakty
- množství extracelulární matrix je relativně malé, mnohem menší než v pojivové tkáni, ale větší než v epitelové a nervové tkáni

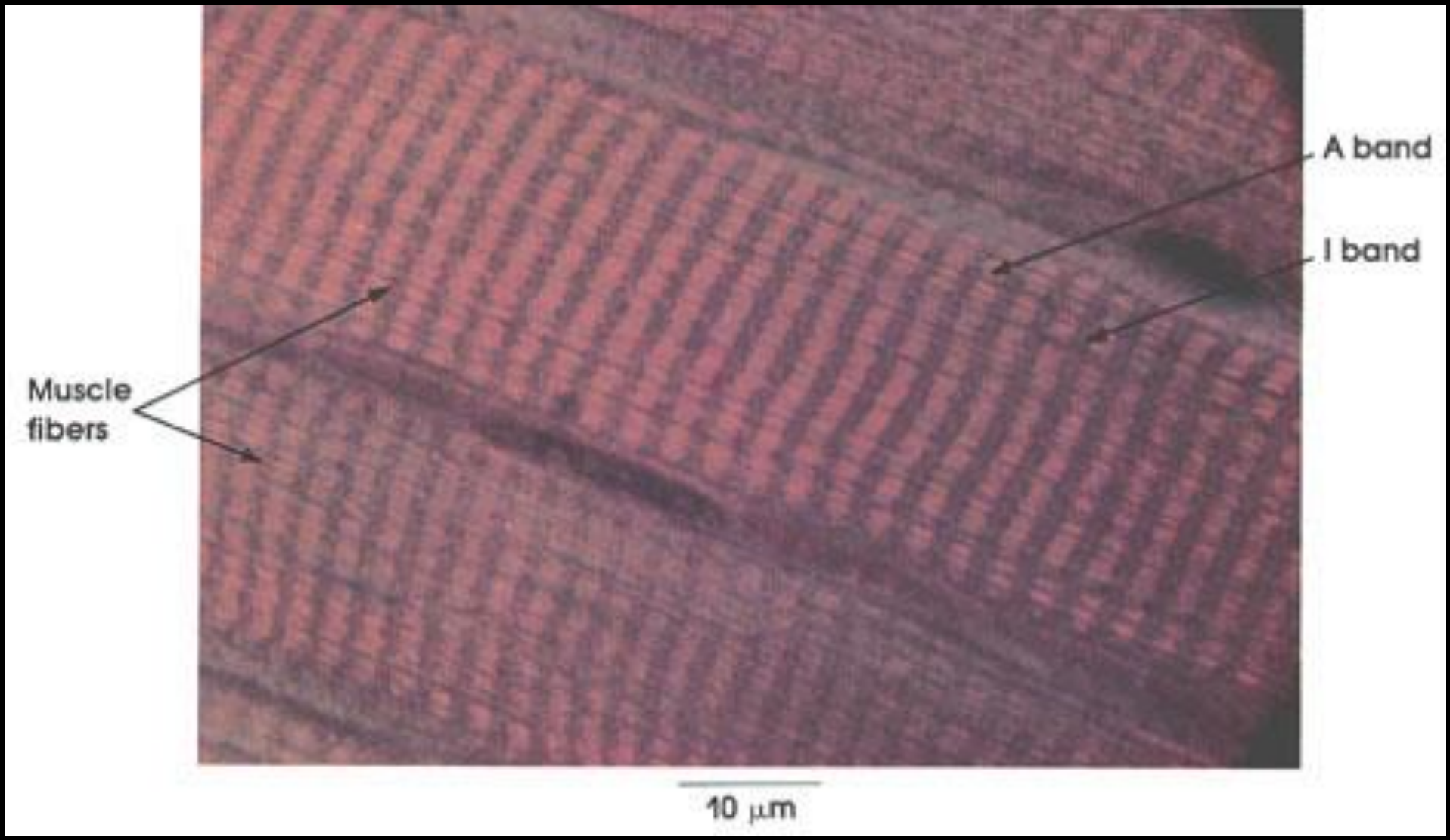
Svalové elementy



Příčně pruhovaná svalová tkáň kosterní

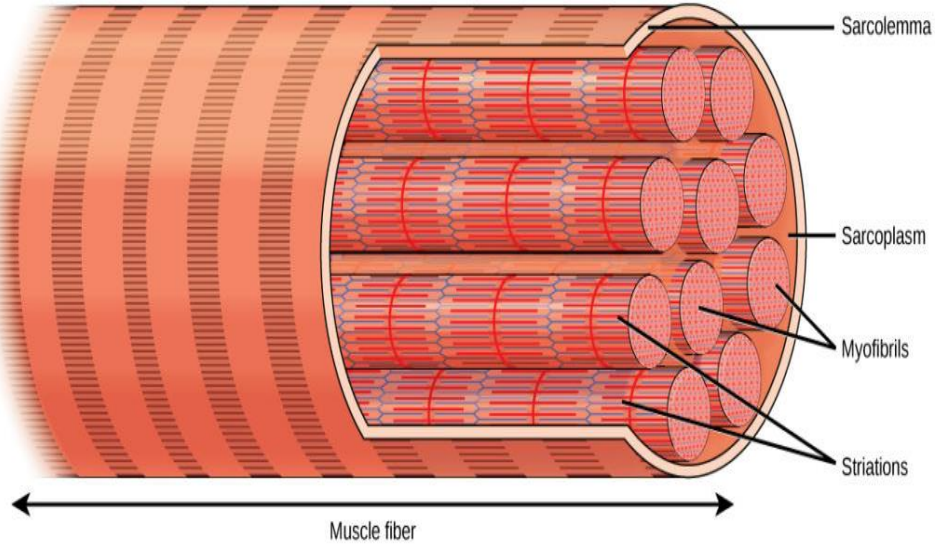
základní jednotka: SVALOVÉ VLÁKNO
mnohojaderný element - SYNCYTIUM
rychlá kontrakce ovládaná vůlí
délka: milimetry až desítky centimetrů
průměr: 10 – 100 mikrometrů
jádra umístěná na periferii
myofilamenta uspořádaná do myofibril



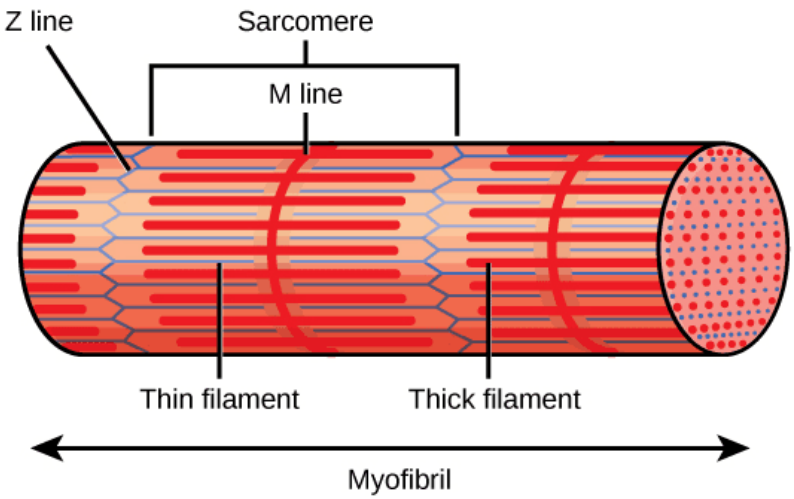


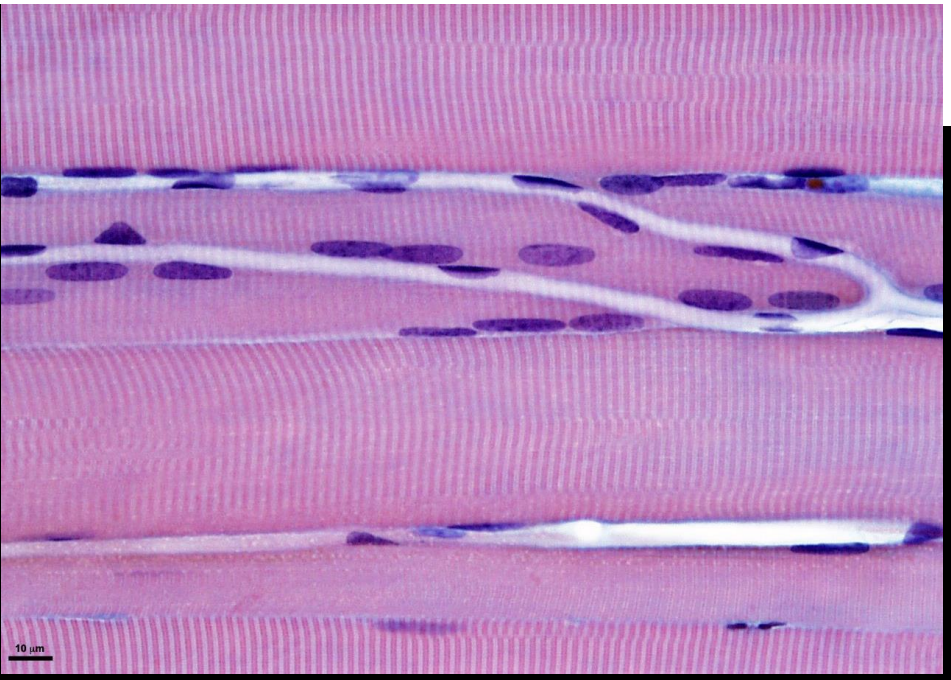
polarizační mikroskop

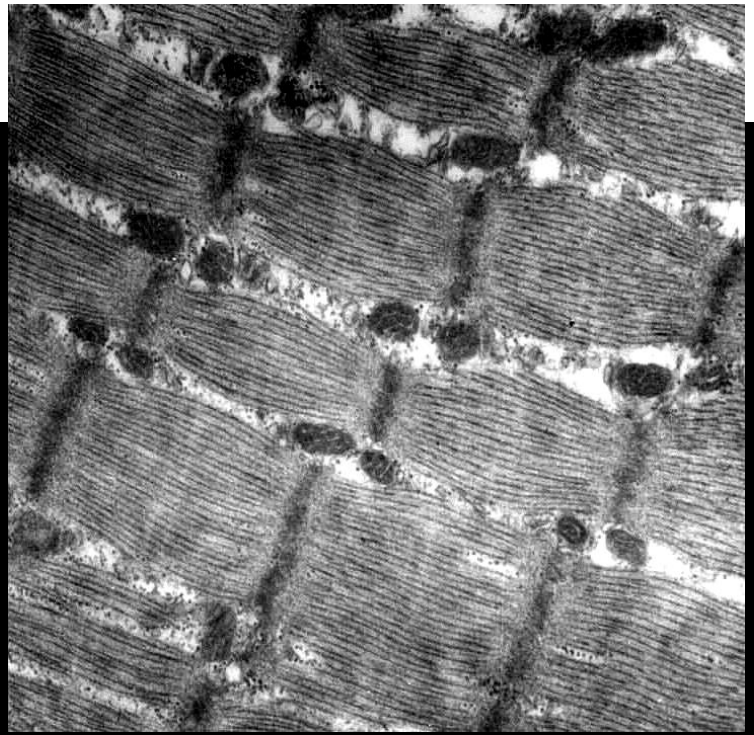
(Ø 10-100 µm)

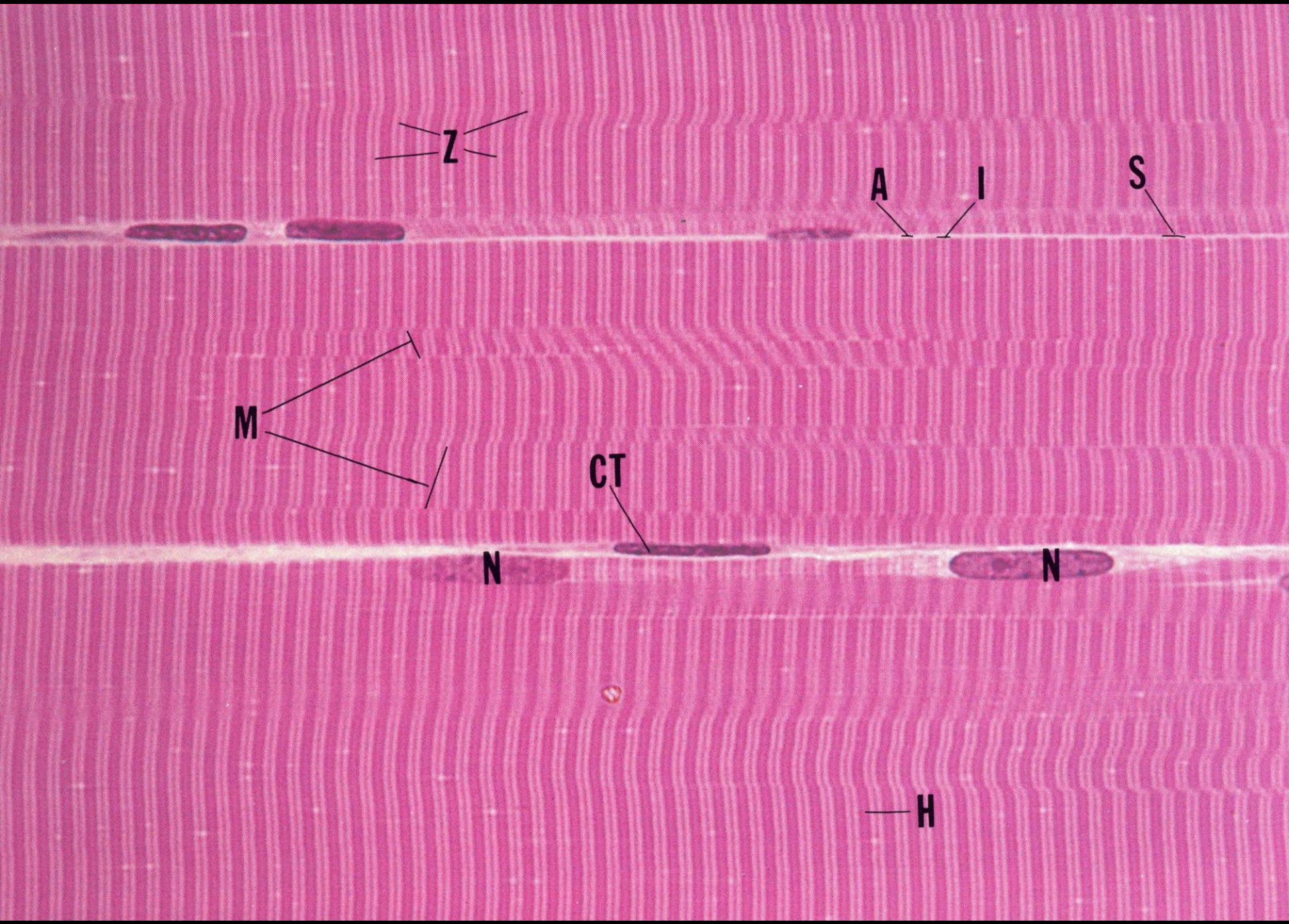


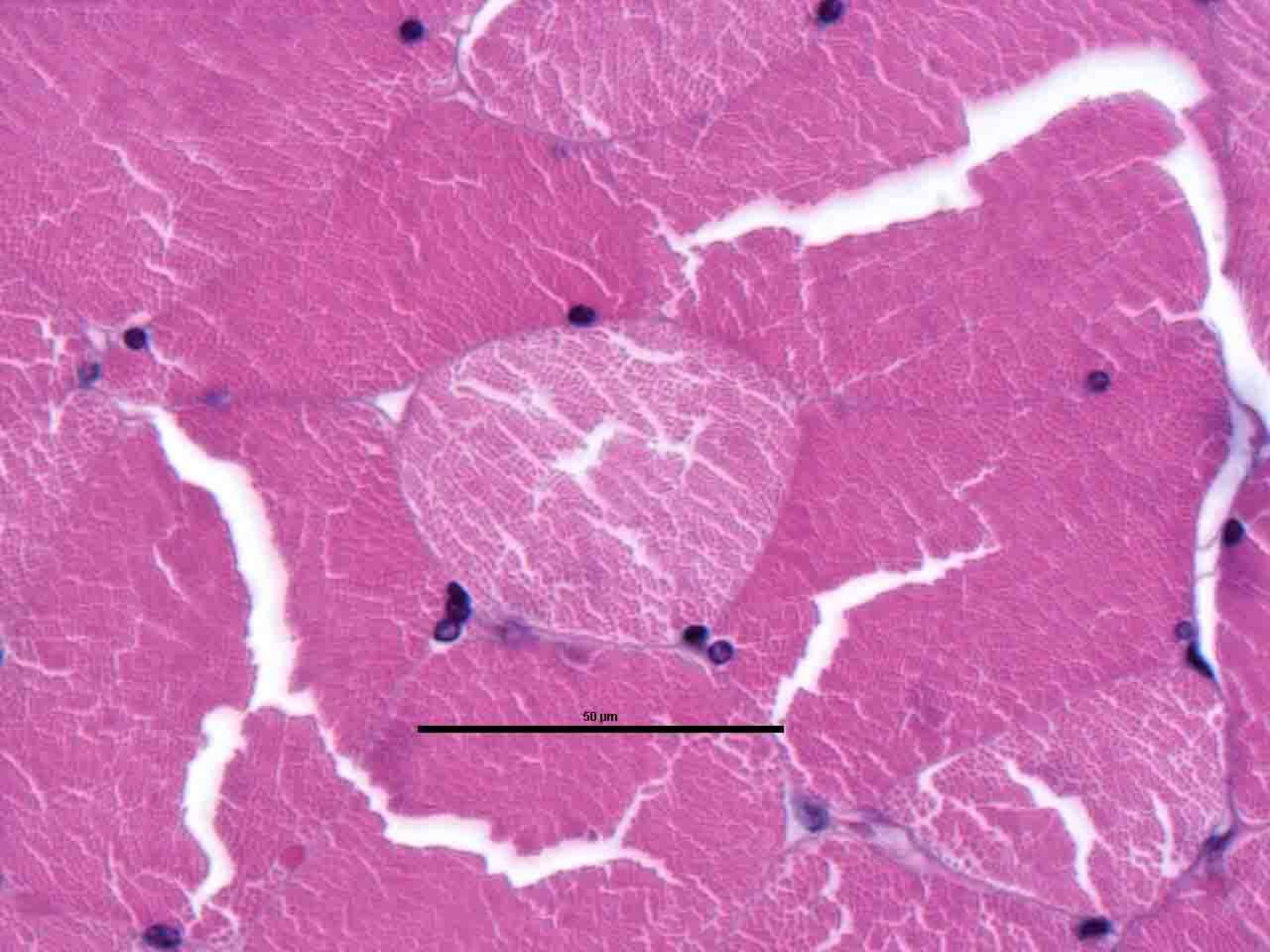
(Ø 1-2 µm)



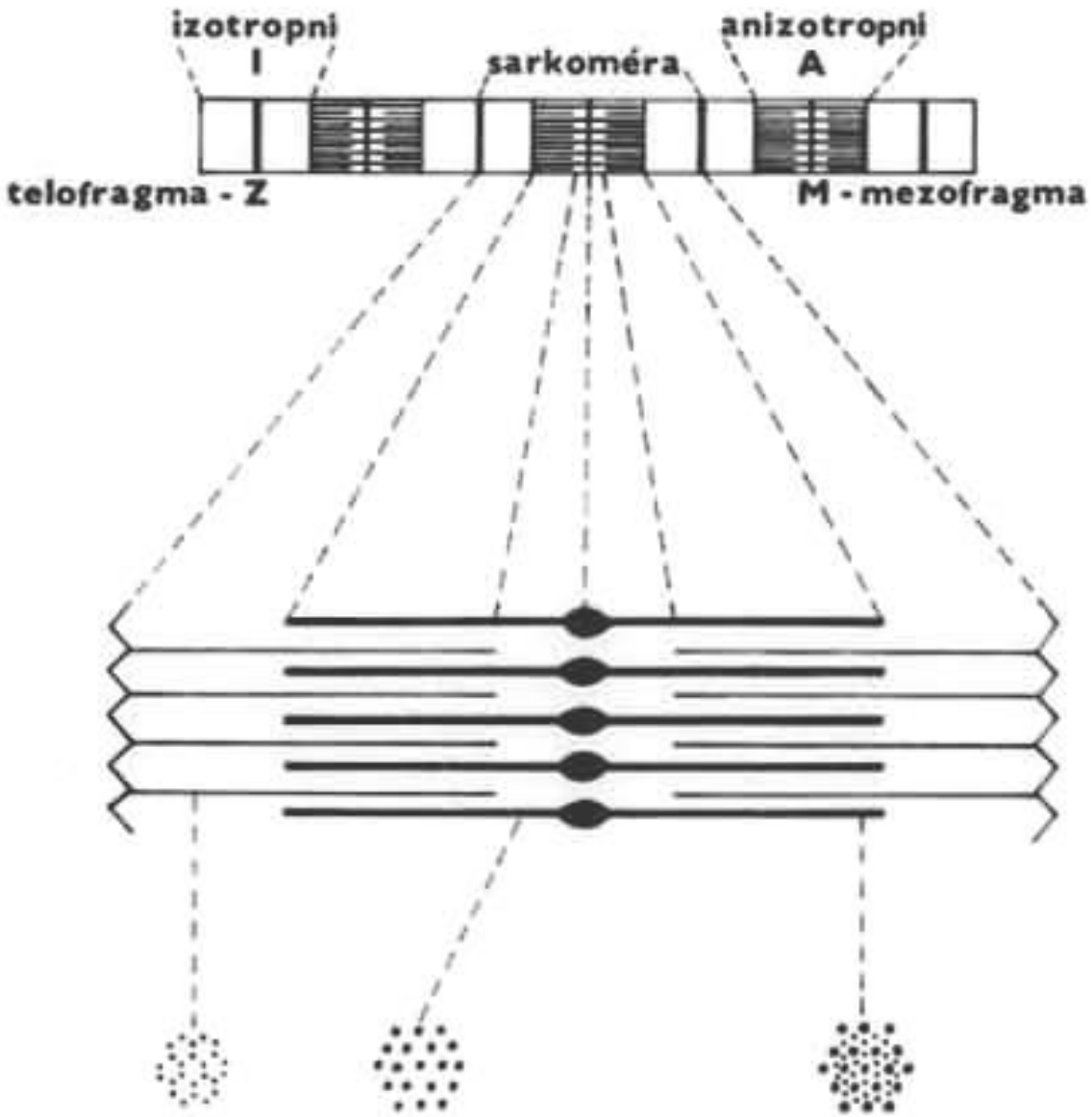


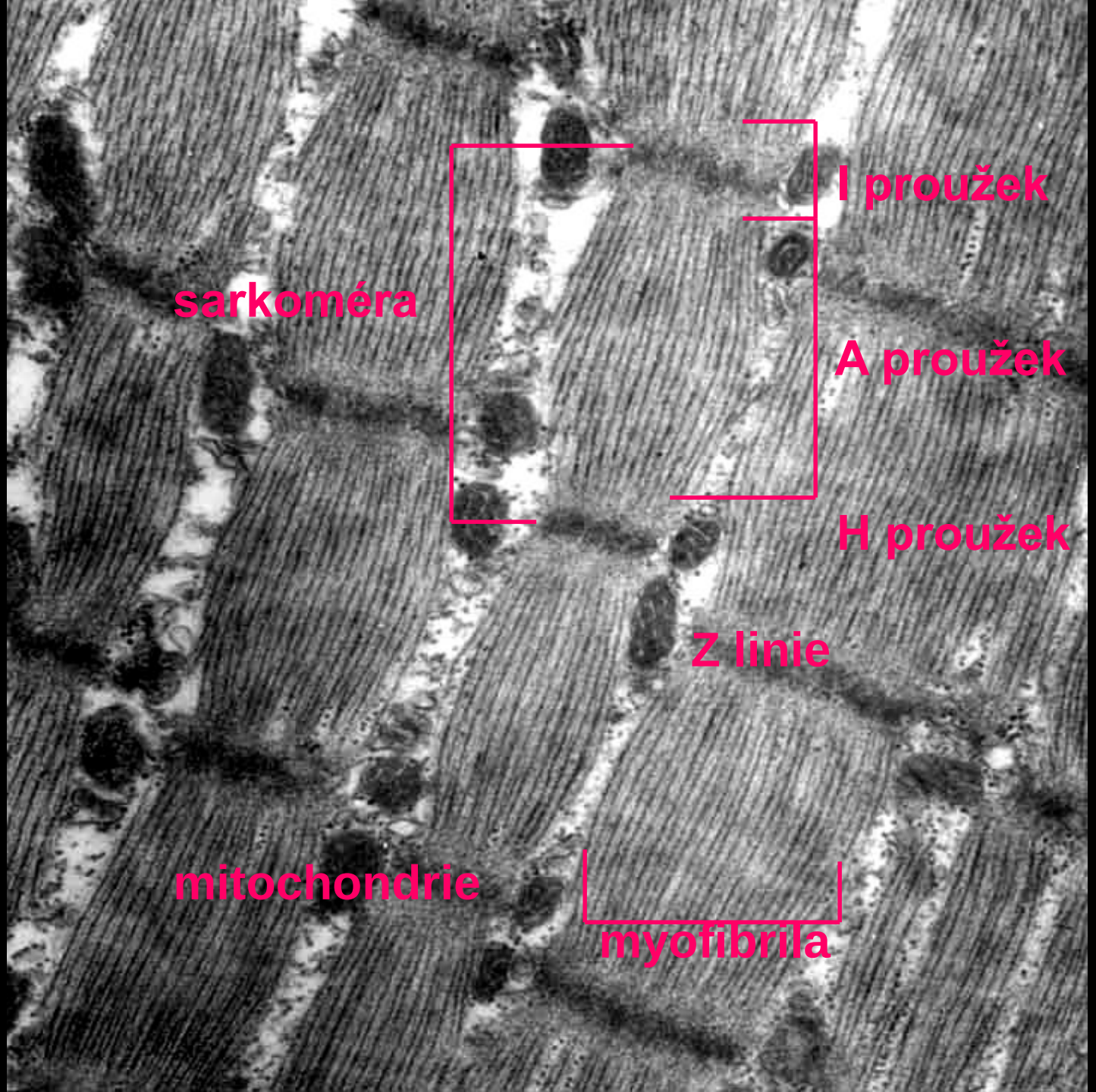


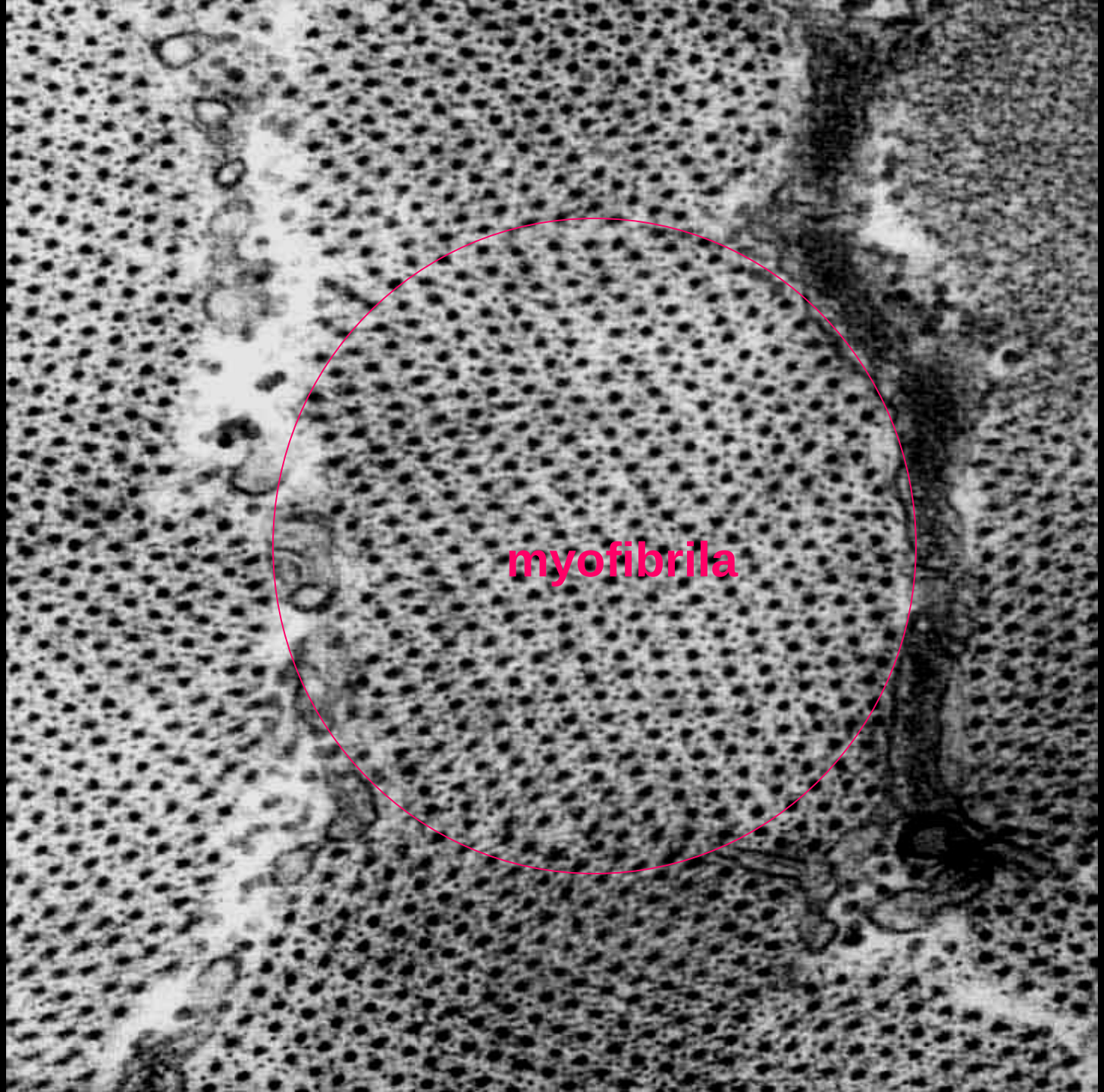

Z
A
I
S
M
CT
N
N
H

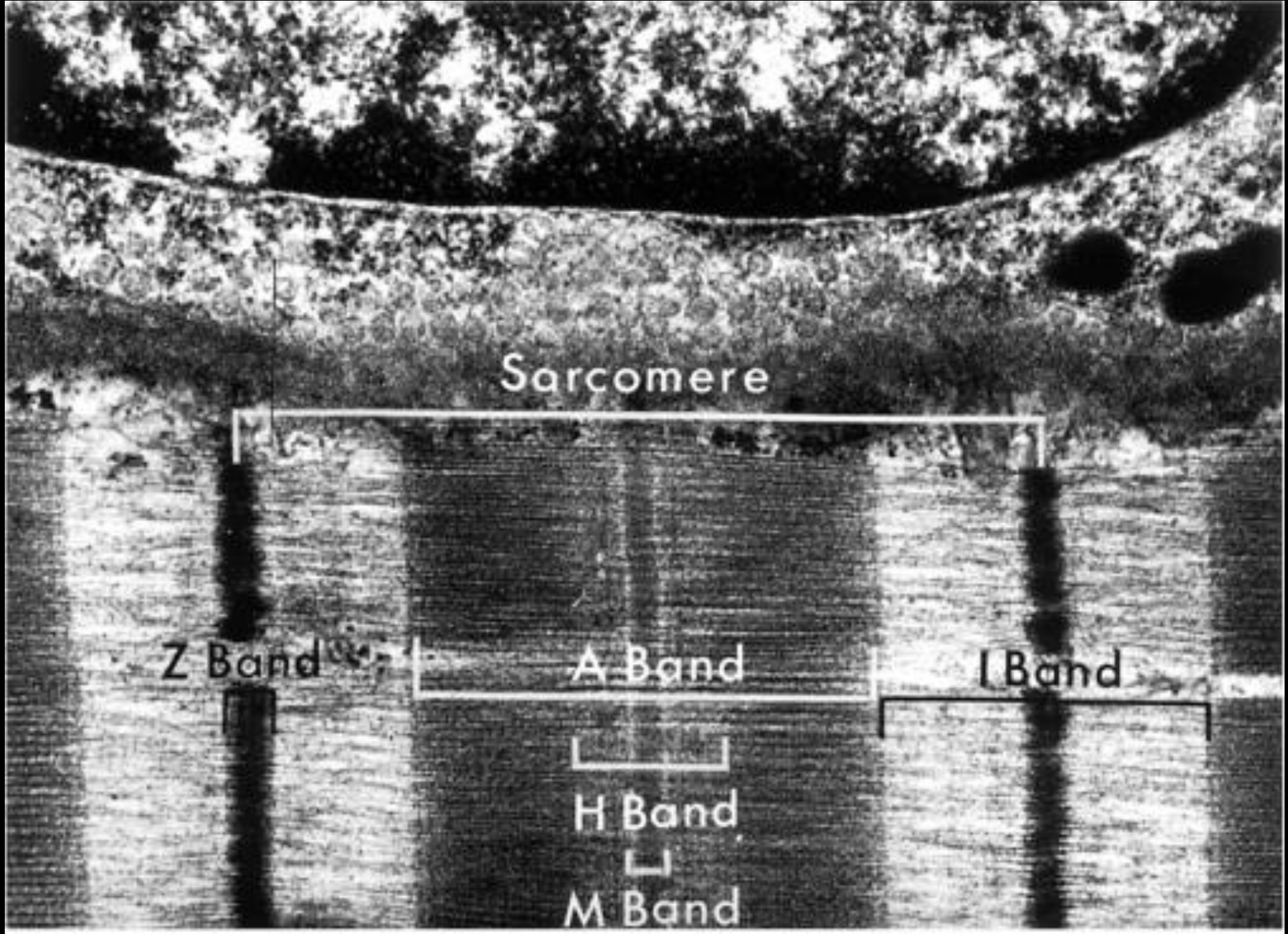

50 µm

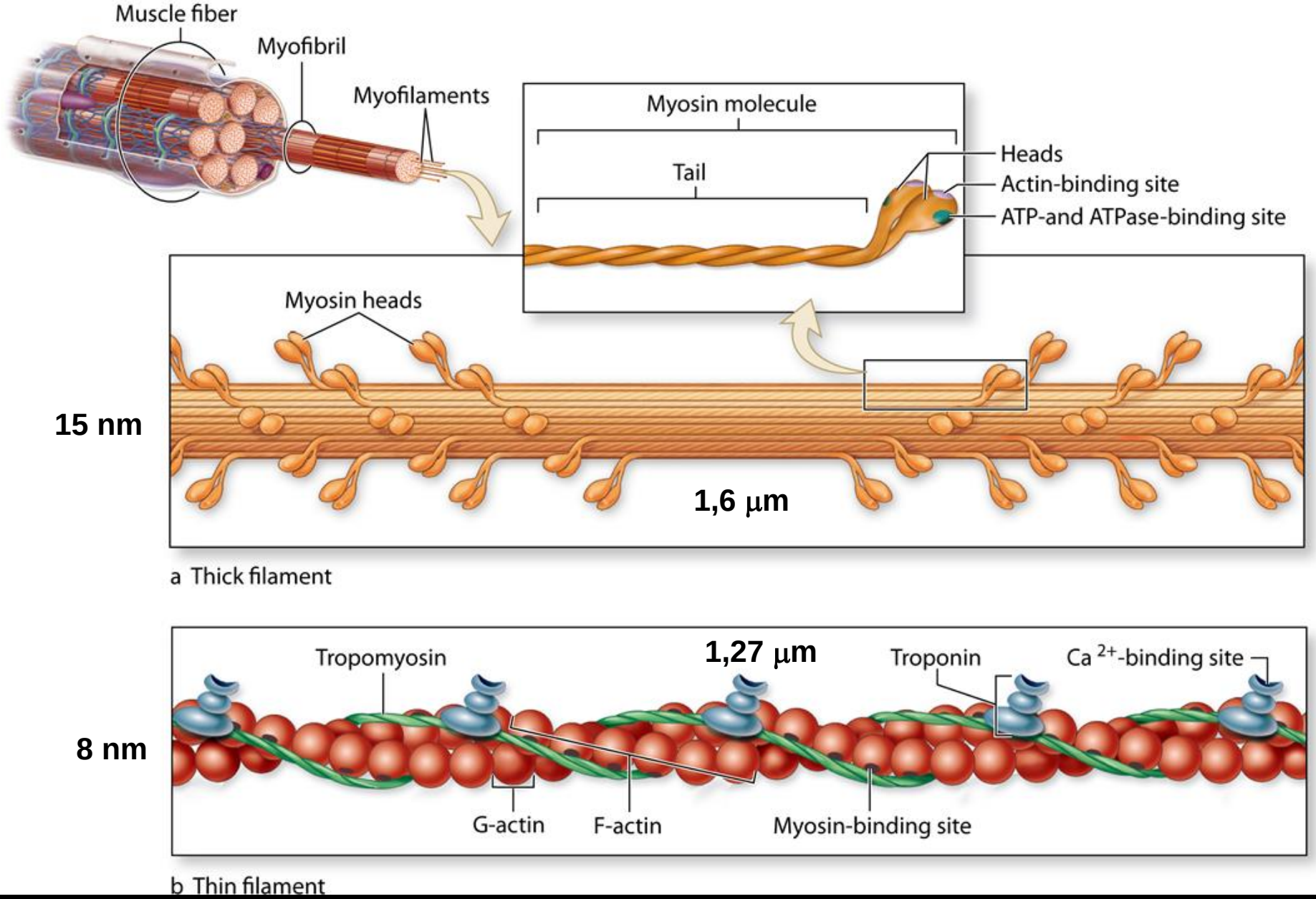
Myofibrila

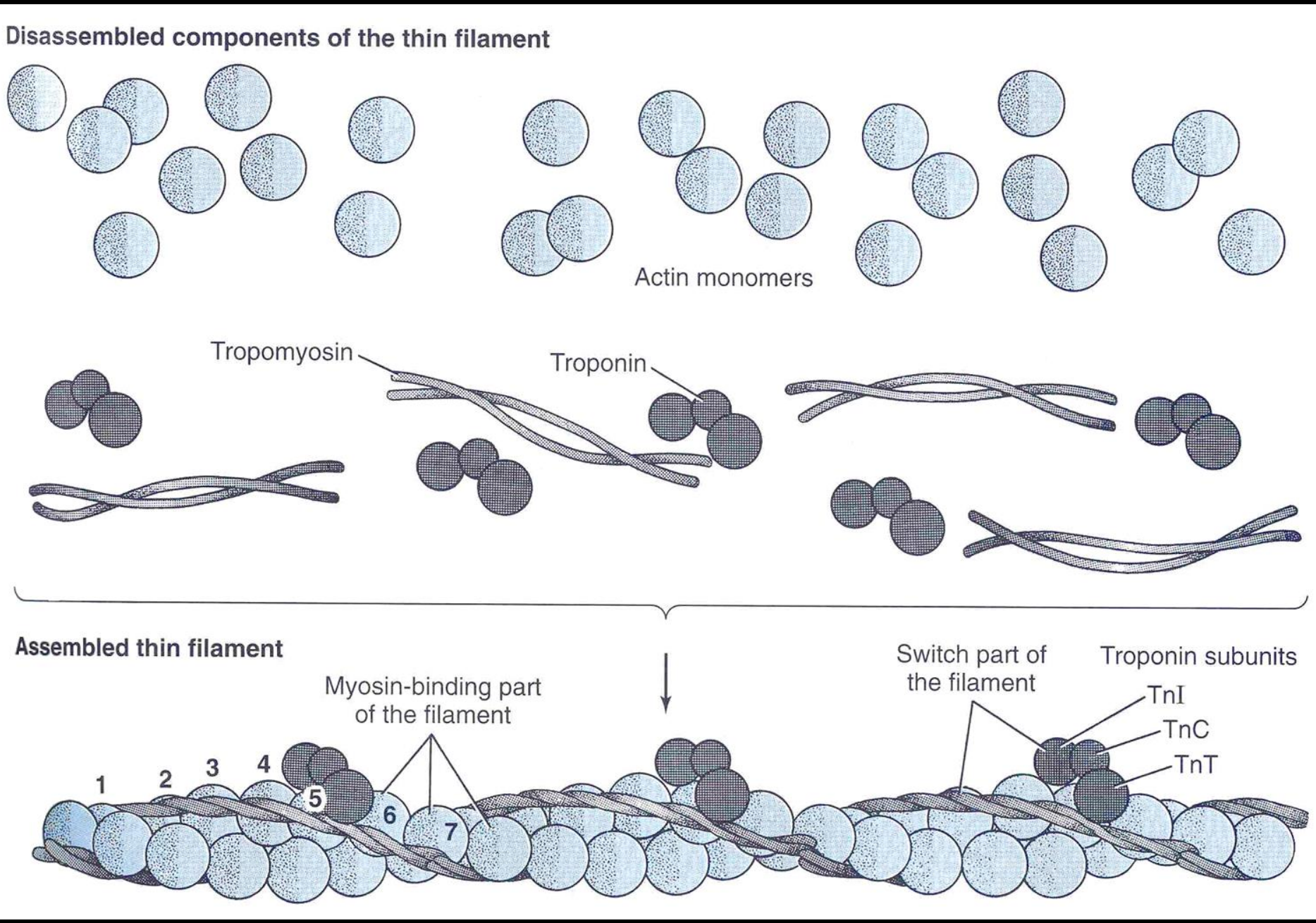

izotropni
I
anizotropni
A
sarkoméra
telofragma - Z
M - mezofragma


I proužek
sarkoméra
A proužek
H proužek
Z linie
mitochondrie
myofibrila

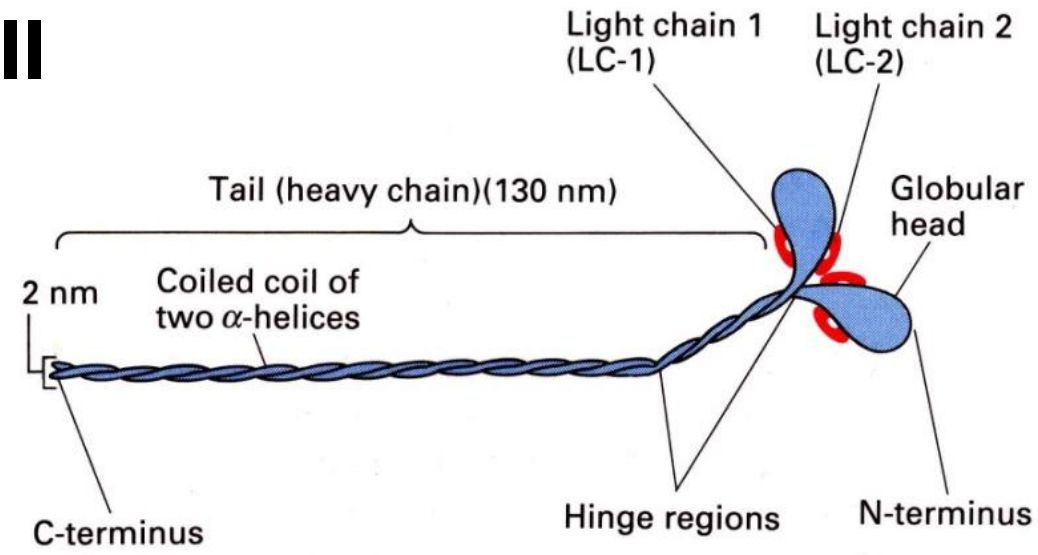

myofibrila



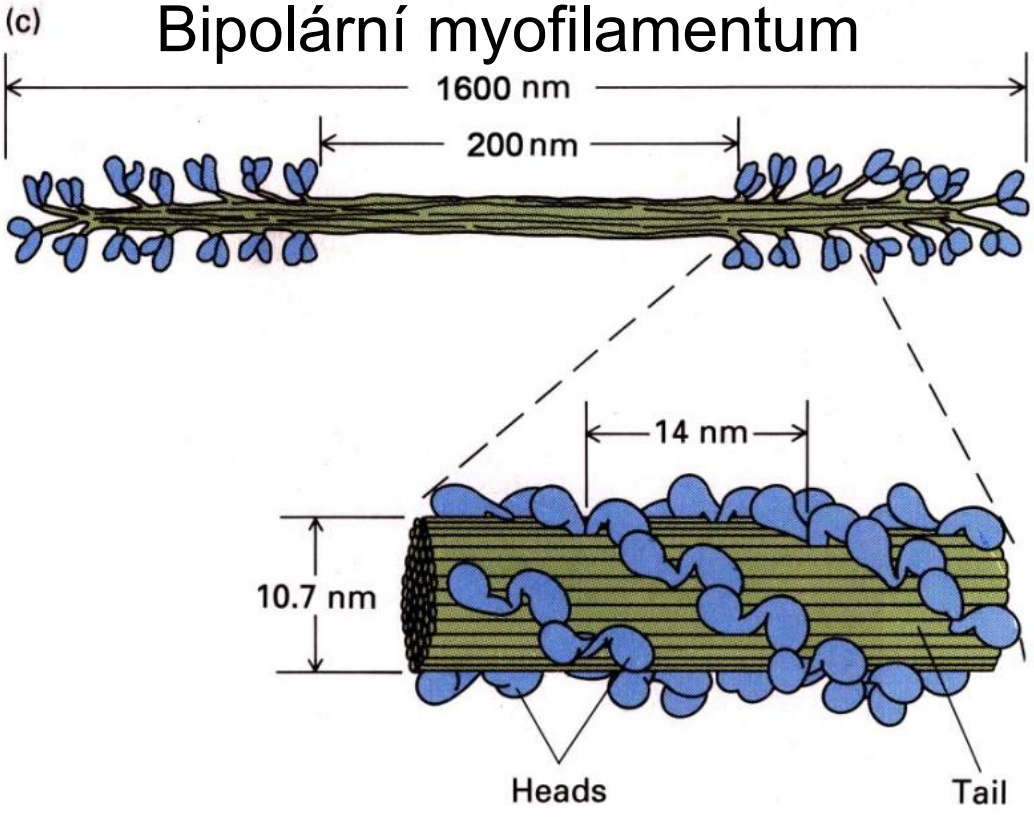

Muscle fiber
Myofibril
Myofilaments
Myosin molecule
Tail
Heads
Actin-binding site
ATP-and ATPase-binding site
Myosin heads
15 nm
1,6 μm
a Thick filament
1,27 μm
Tropomyosin
Troponin
Ca 2+-binding site
8 nm
G-actin
F-actin
Myosin-binding site
b Thin filament

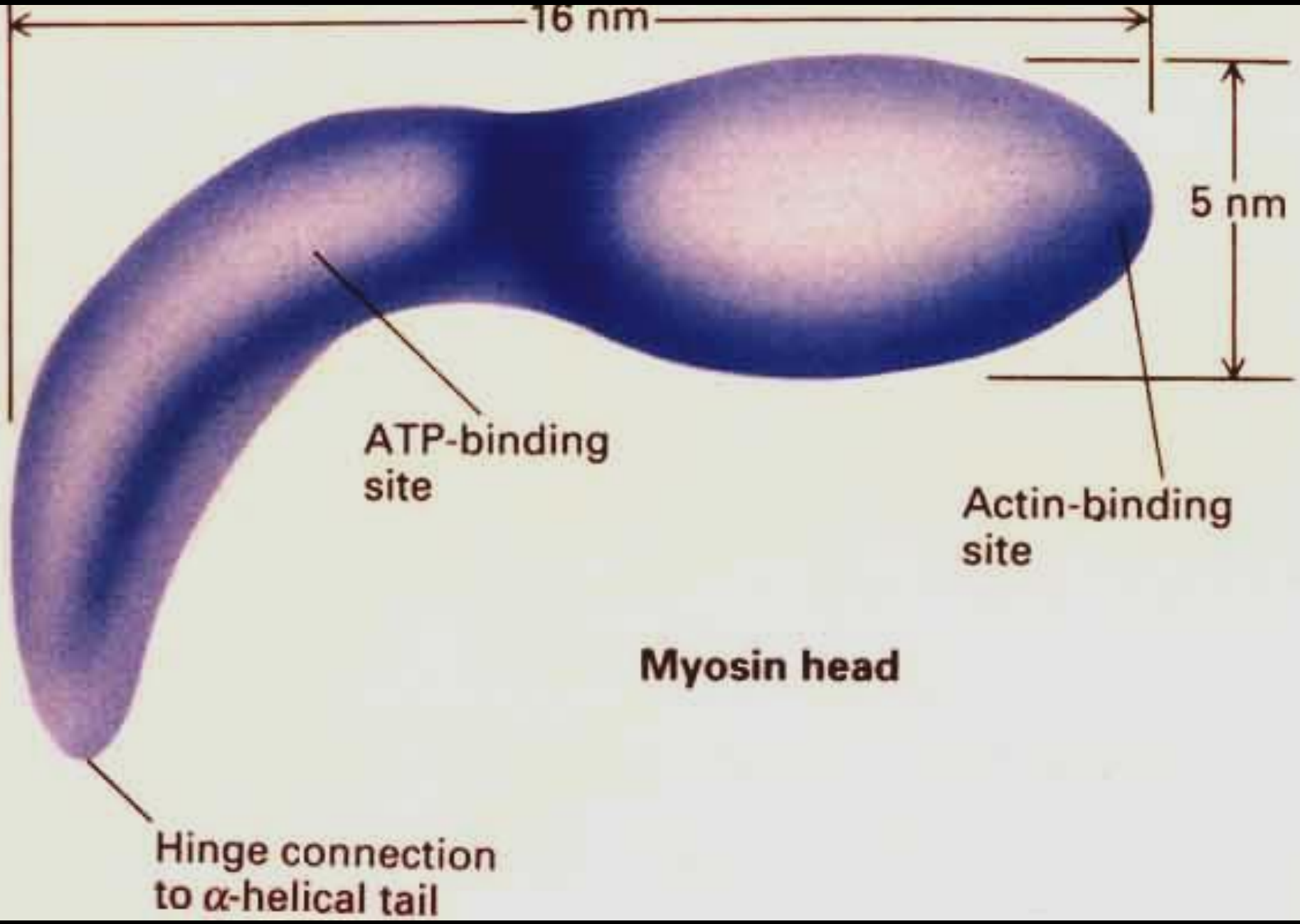

Disassembled components of the thin filament
Actin monomers
Tropomyosin
Troponin
Assembled thin filament
Myosin-binding part of the filament
Switch part of the filament
Troponin subunits
TnI
TnC
TnT
1
2
3
4
5
6
7

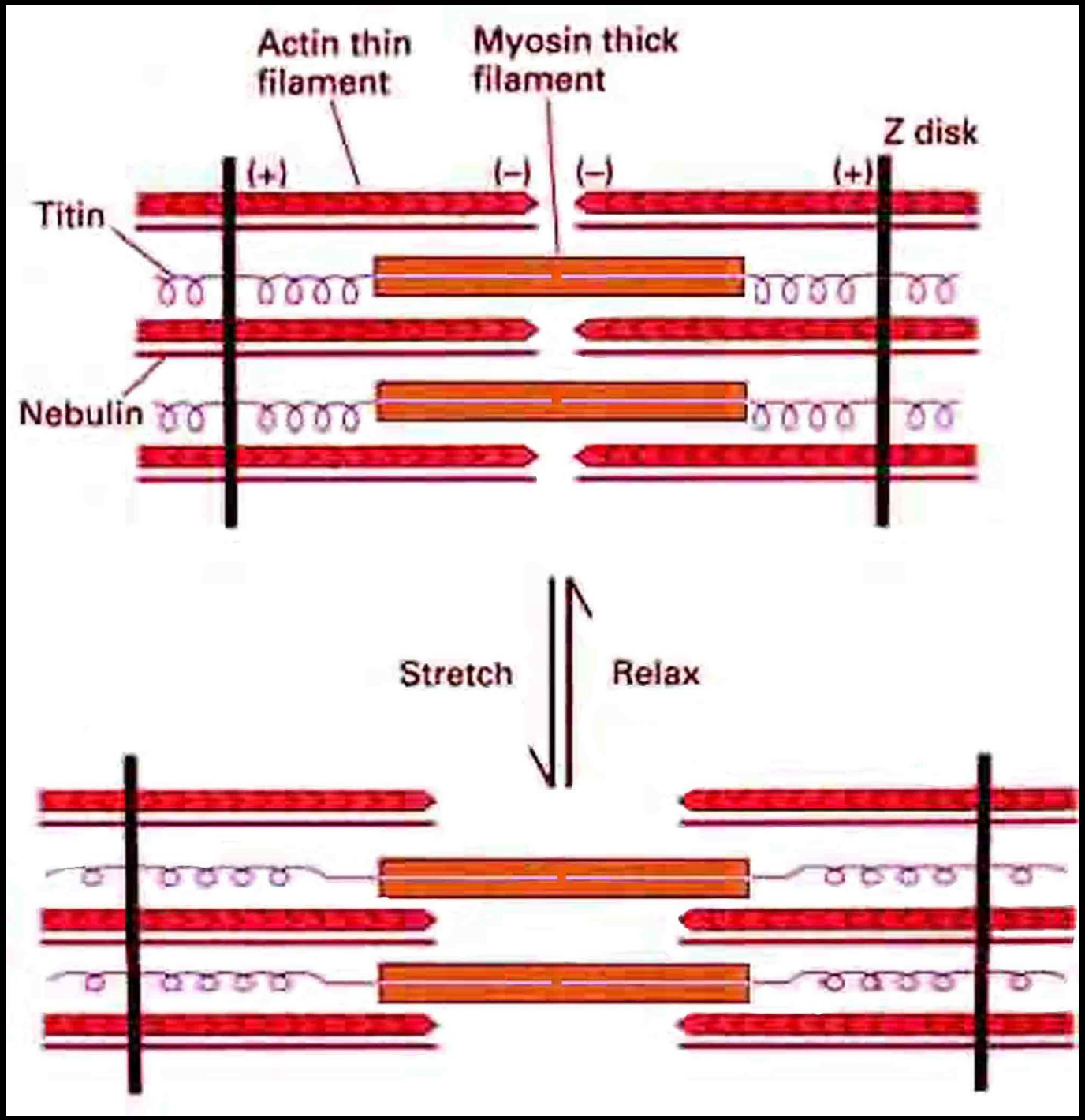
Myosin II

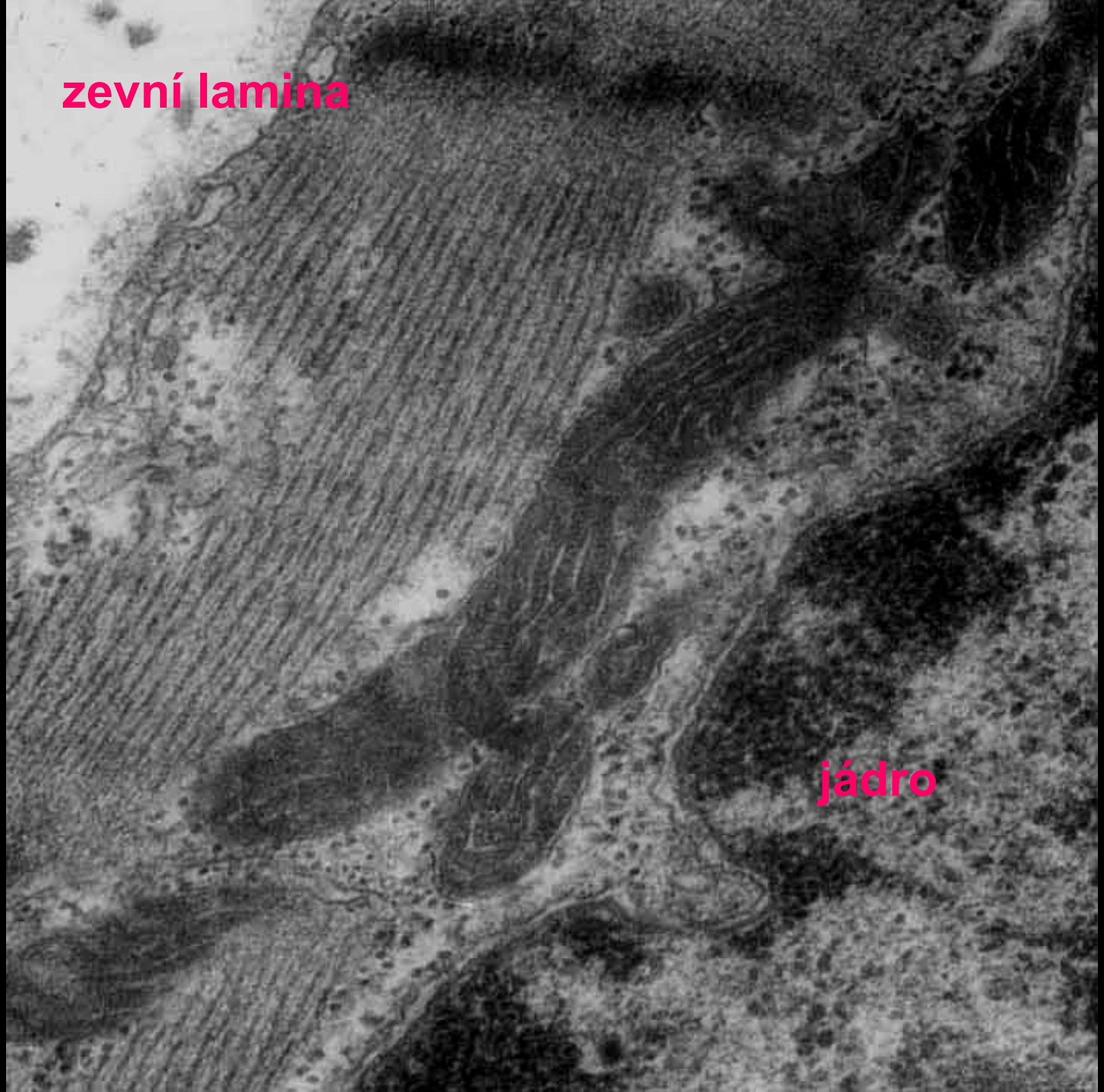


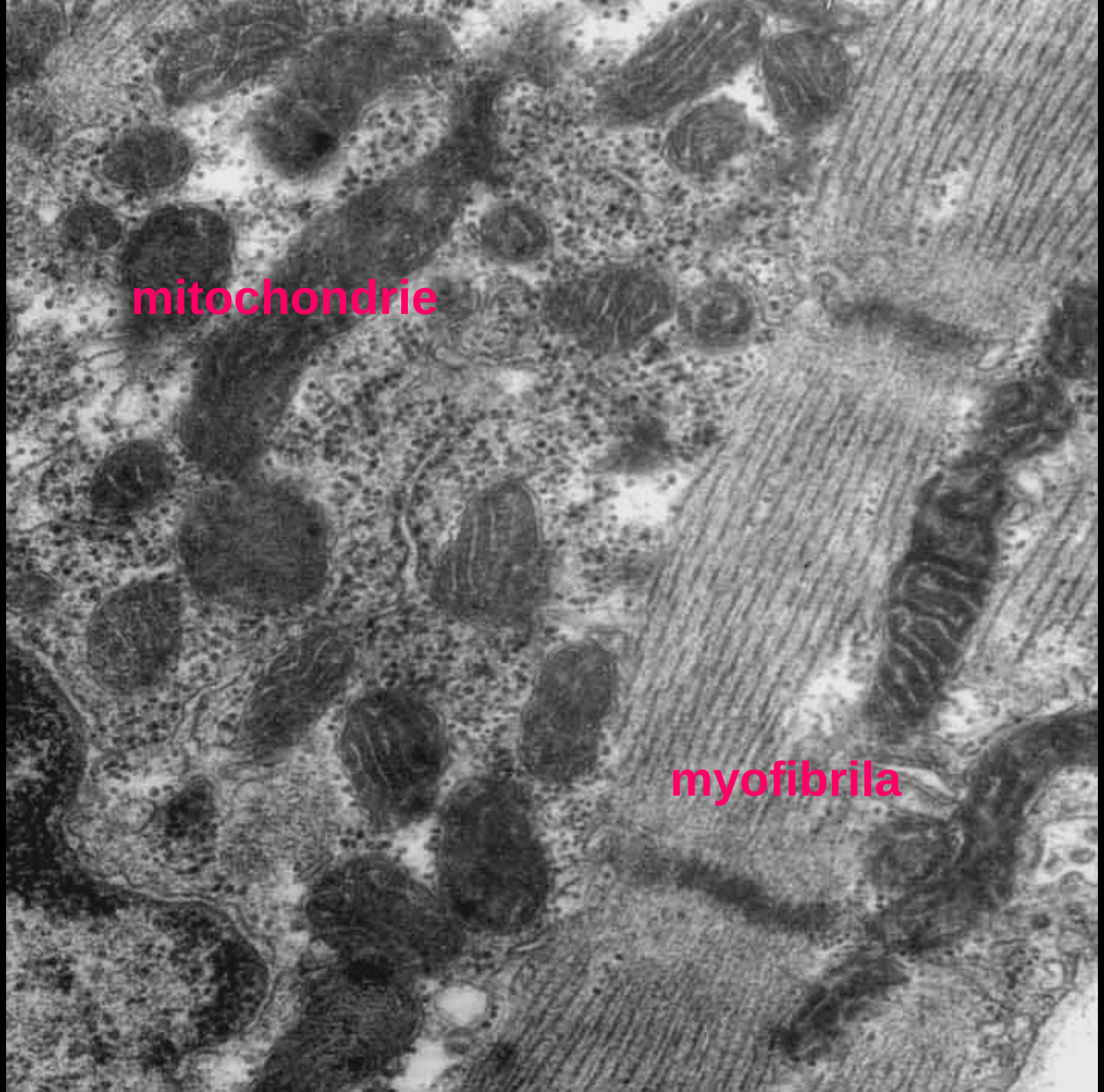
Bipolární myofilamentum



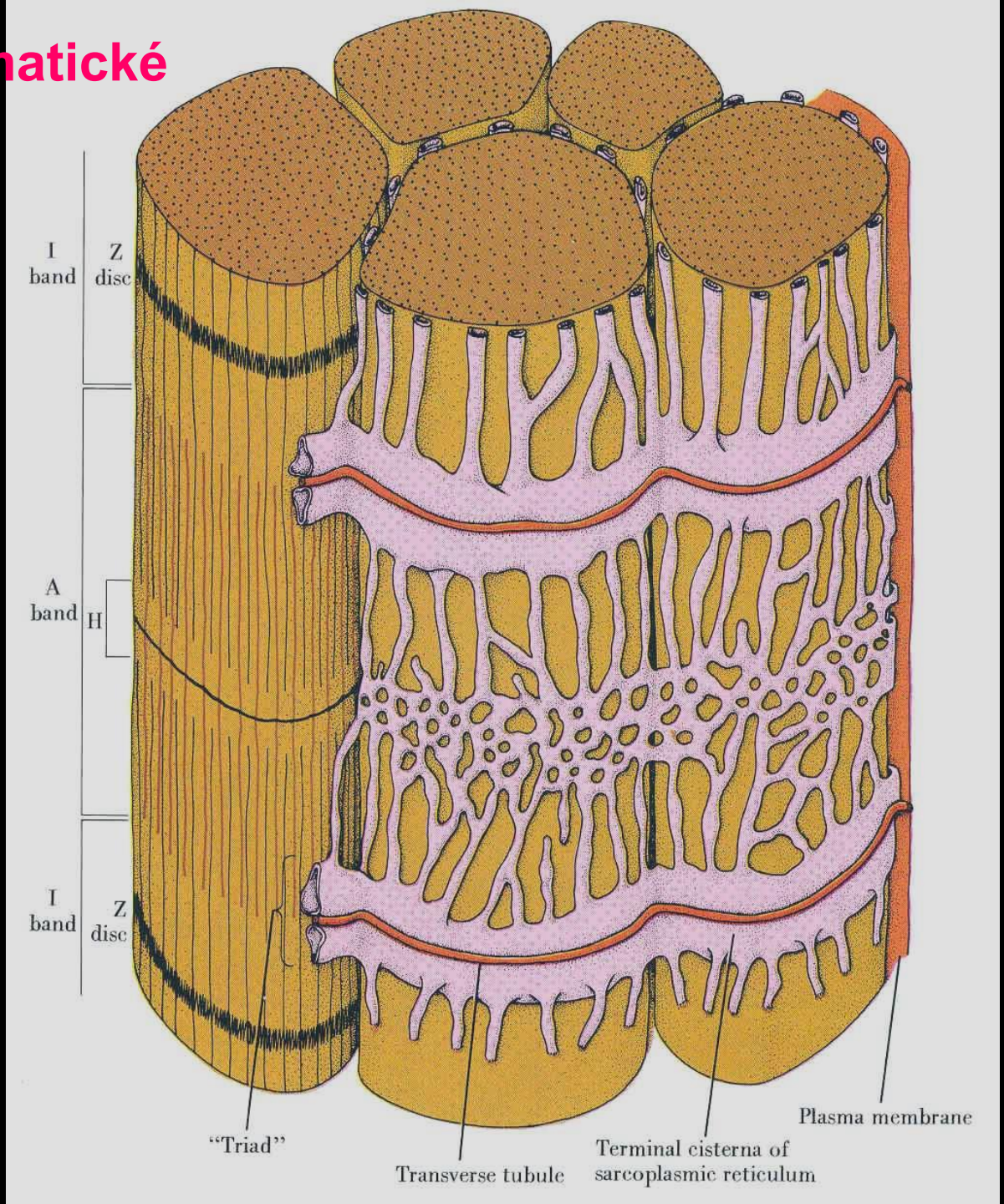

16 nm
5 nm
ATP-binding site
Actin-binding site
Myosin head
Hinge connection to α-helical tail

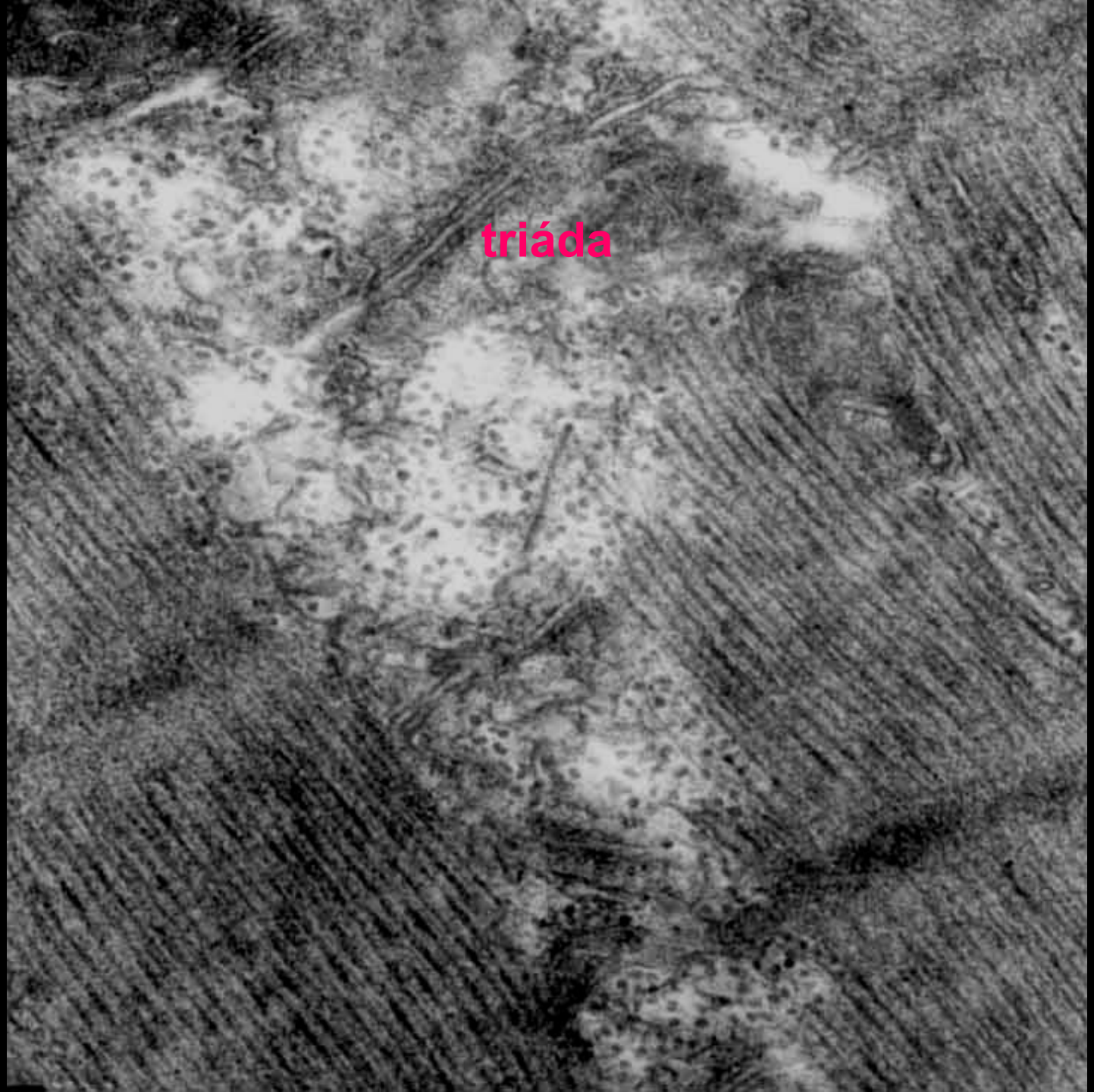

Actin thin filament
Myosin thick filament
Z disk
(+)
(–)
(–)
(+)
Titin
Nebulin
Stretch
Relax

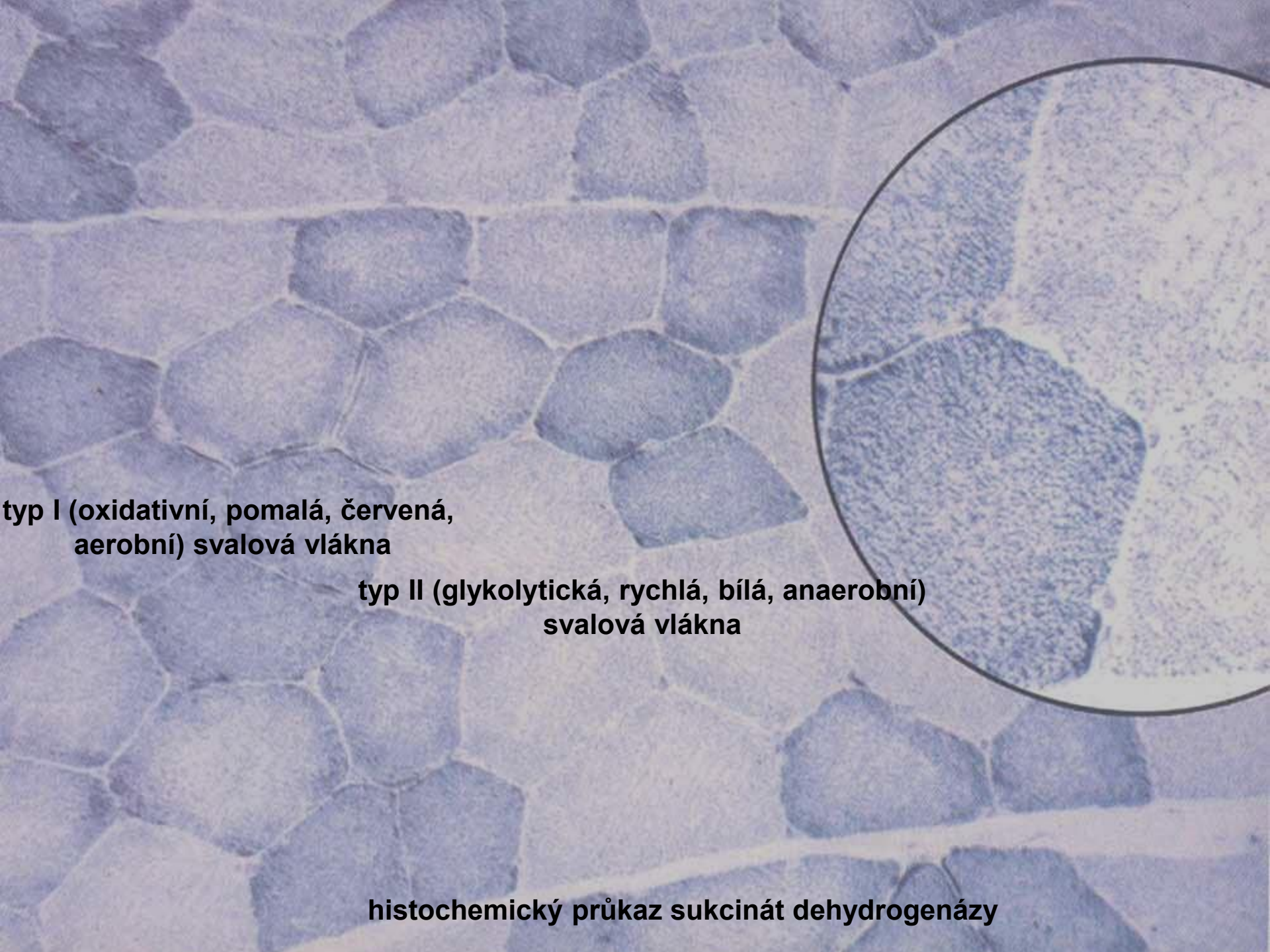

zevní lamina
jádro


mitochondrie
myofibrila

sarkoplasmatické retikulum

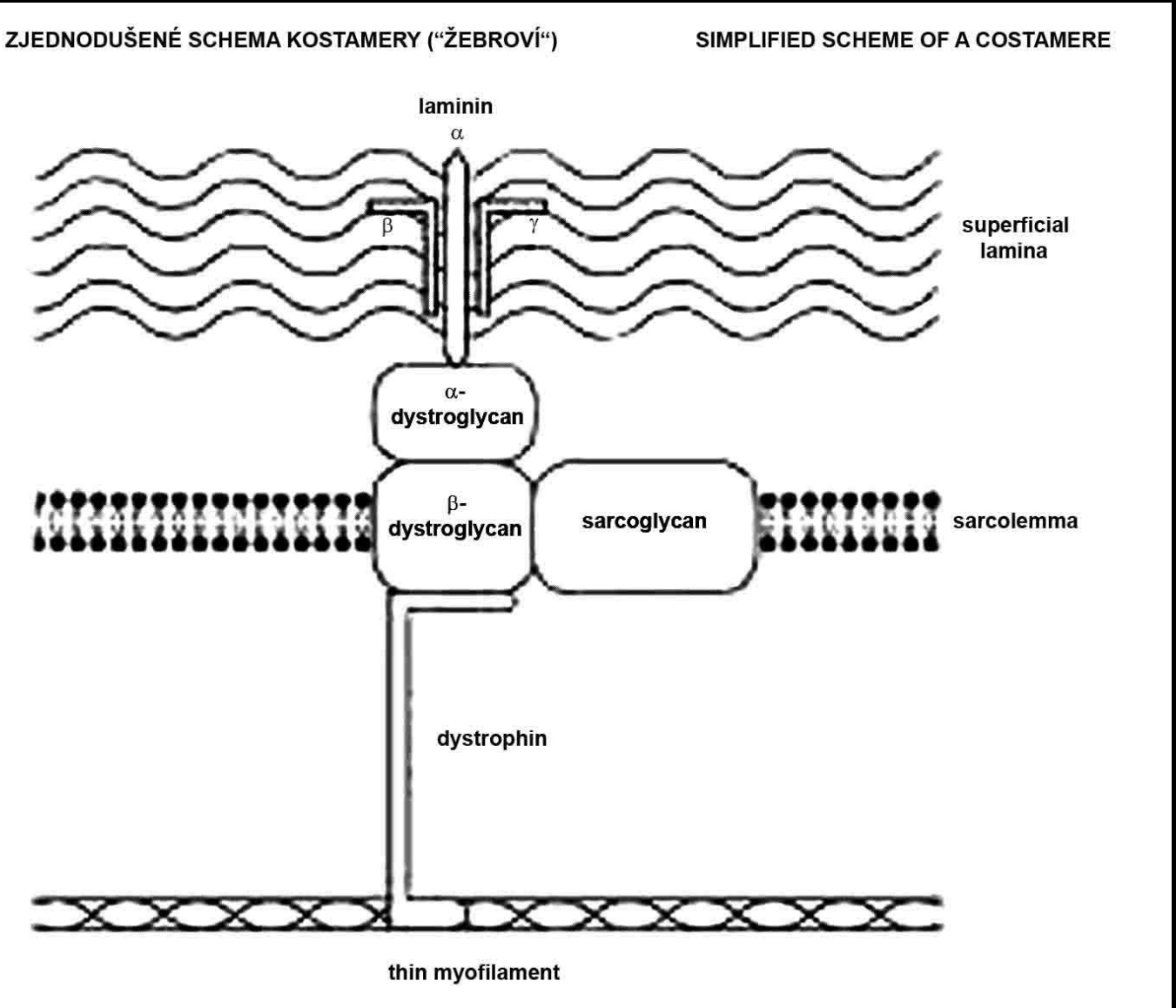



triáda



histochemický průkaz sukcinát dehydrogenázy

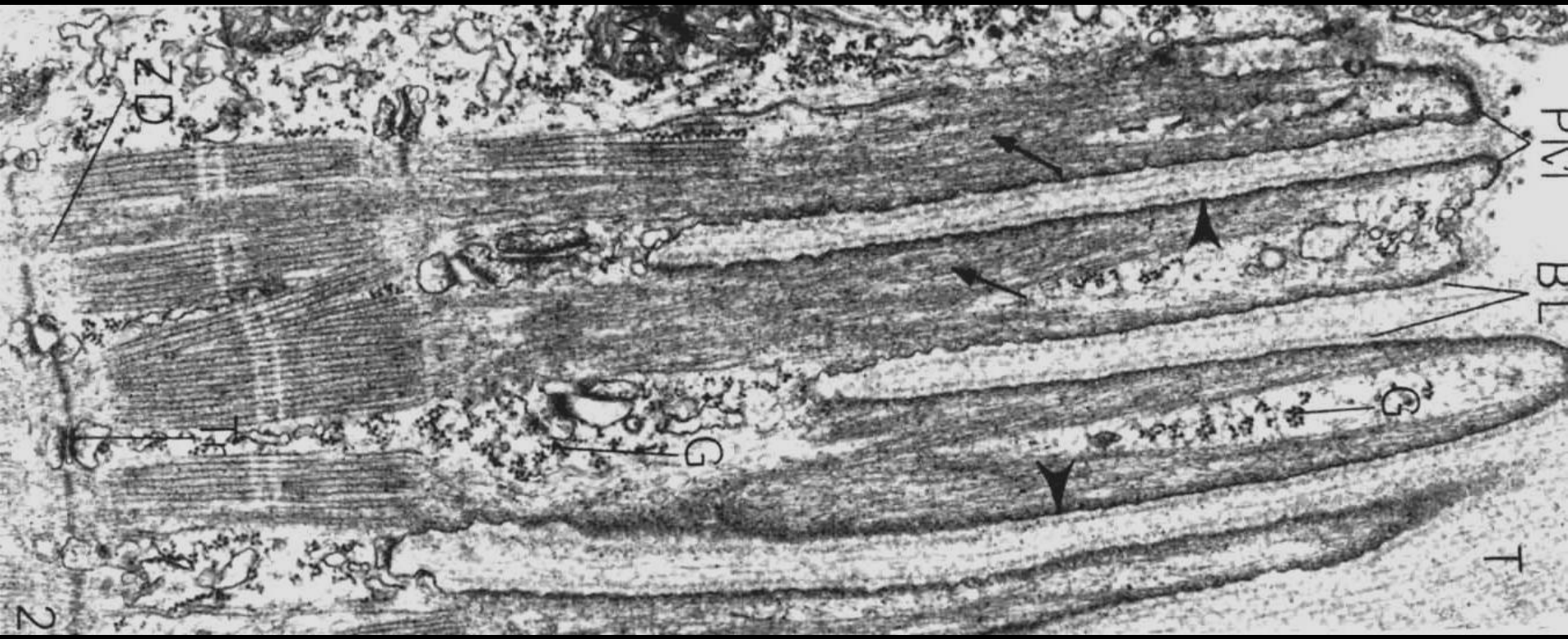
kontrakce myofibril musí být přenesena na sarkolemu a do endomysia
periferní myofibrily propojeny se sarkolemou u Z-linie



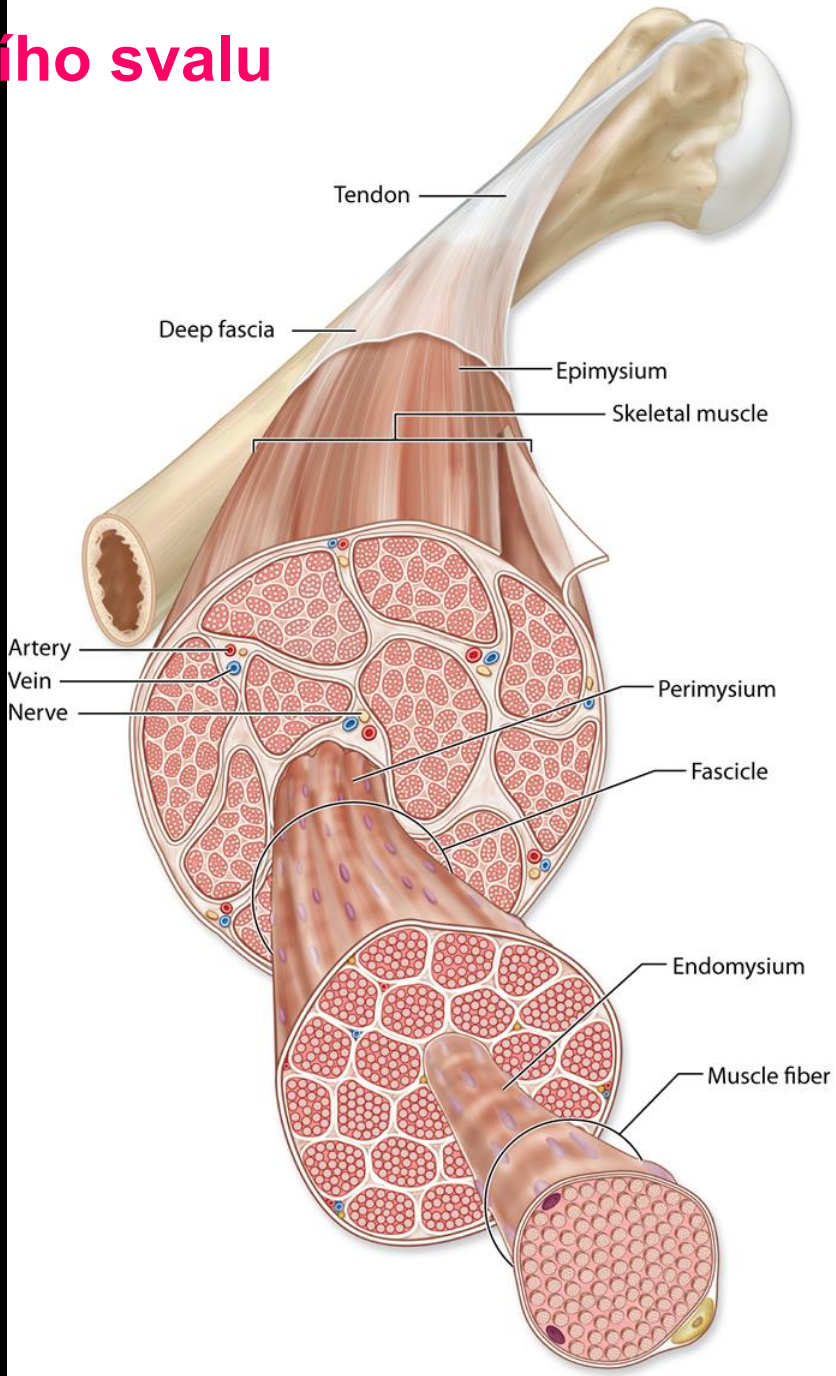
kostamera („žebroví“)

dystrofin
dystroglykan
sarkoglykan
synemin
synkoilin
dystrobrevin
sarkospan

Spojení svalového vlákna a šlachy

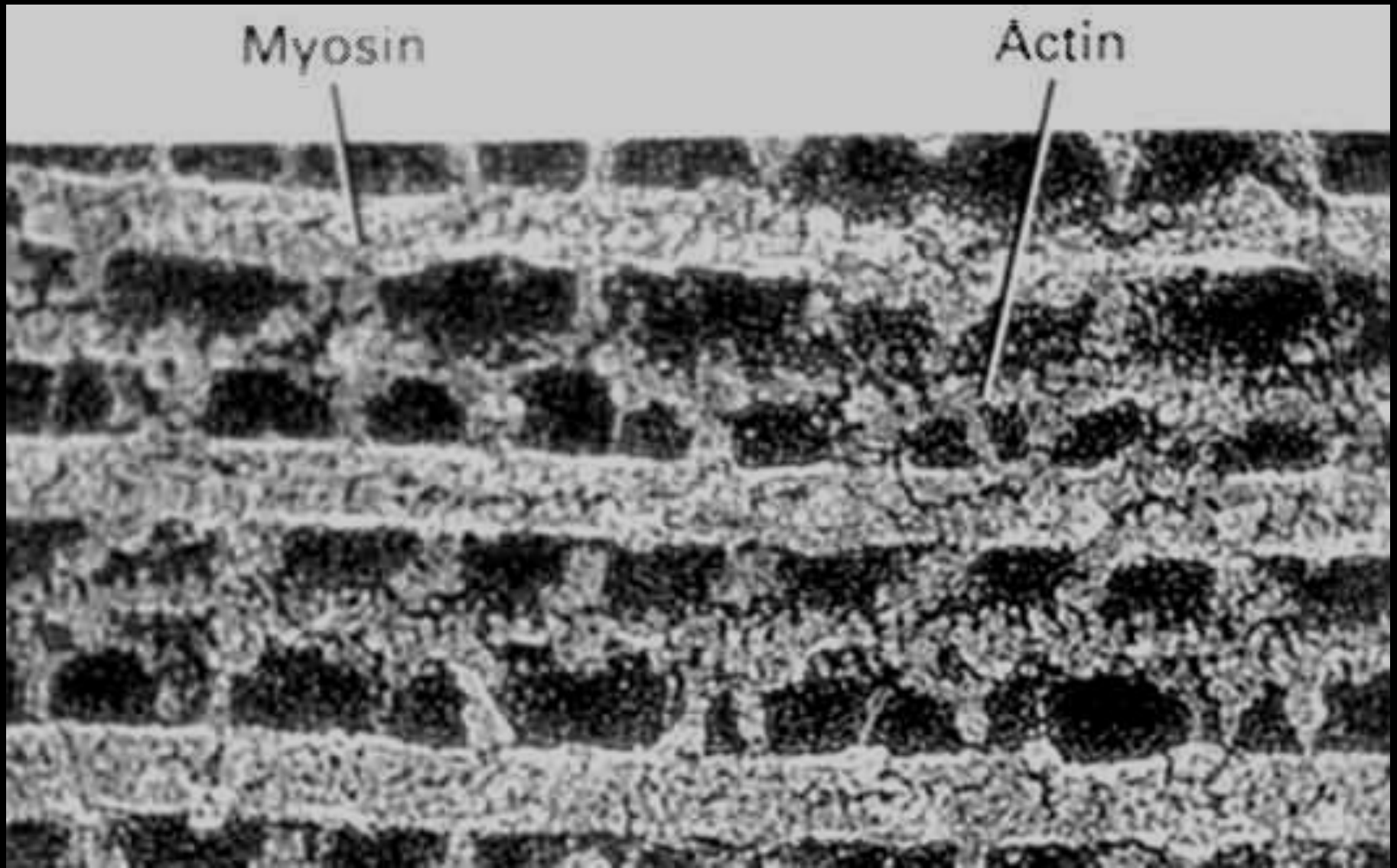


Stavba kosterního svalu

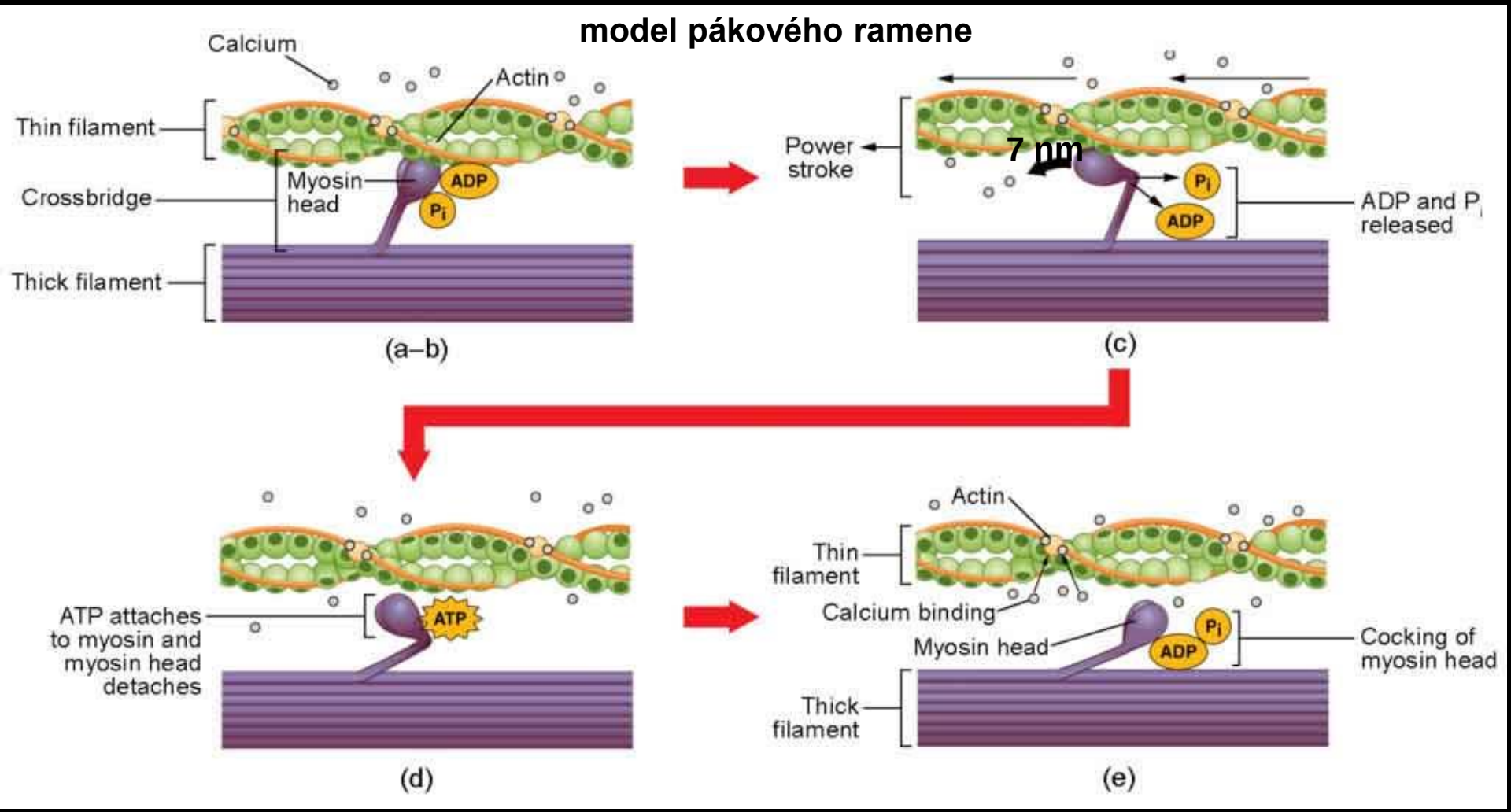


Kontraktilita

- interakce aktinu a myosinu
- oba proteiny tvoří filamenta = tenká a tlustá **myofilamenta**



Příčně pruhovaná svalovina (srdeční a svalová)



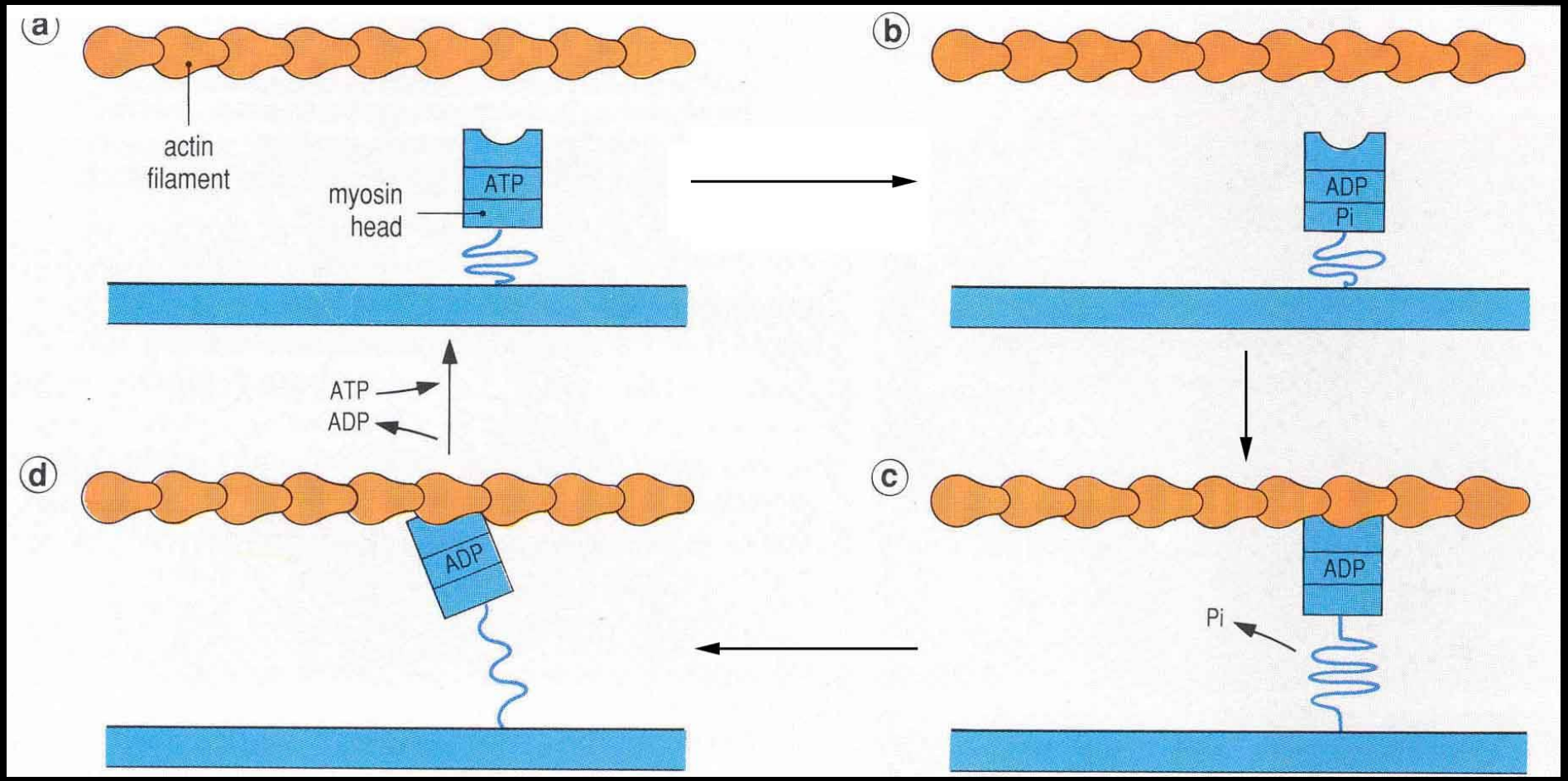
1) ATP je dostupný a navázaný na myosin,
Ca^{2+} není dostupný – klidový stav

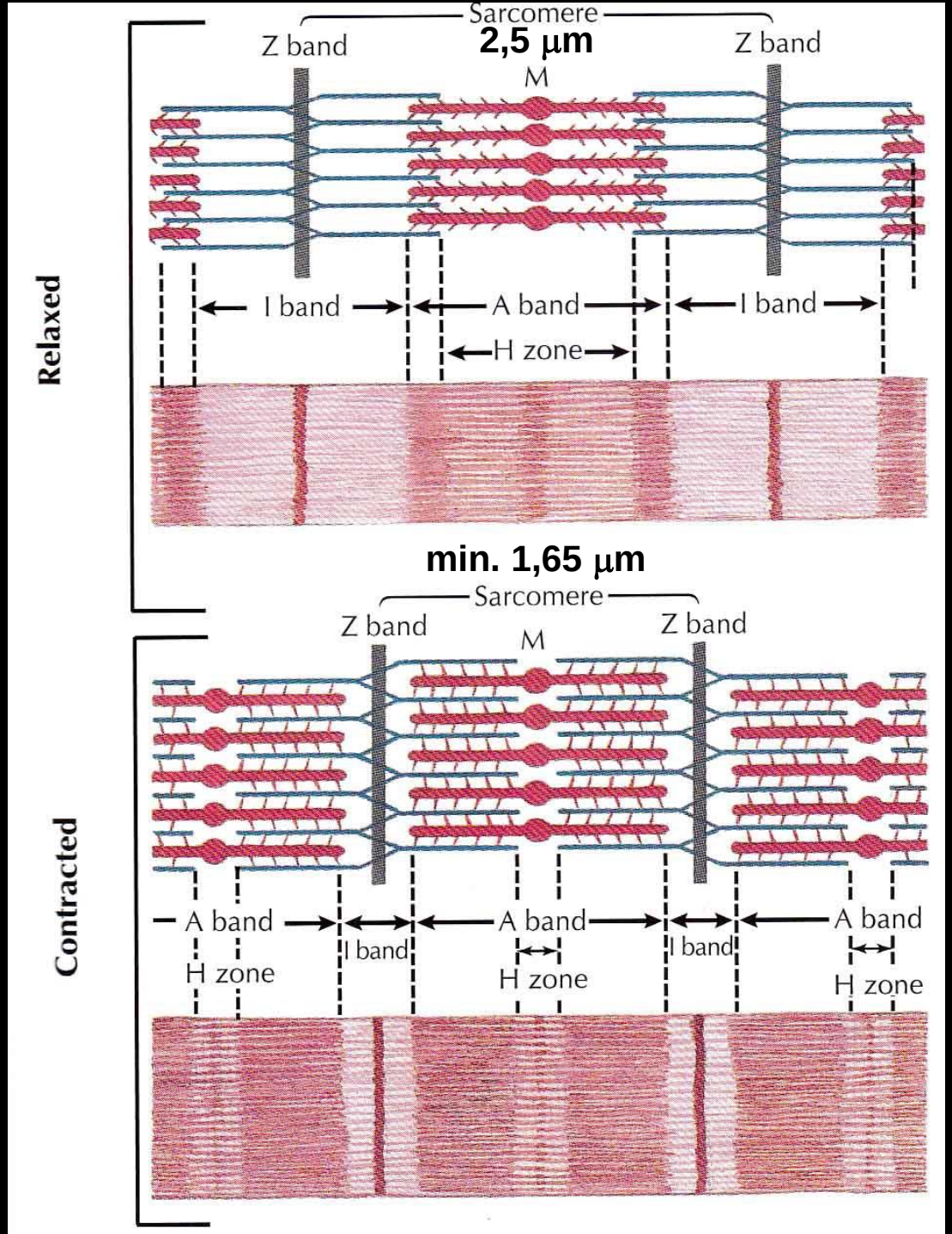
2) štěpení ATP na ADP a Pi bez uvolnění štěpných produktů, Ca^{2+} dostupný, TnI uvolní vazebné místo a myosin se naváže na aktin (aktin je třeba jako kofaktor pro uvolnění štěpných produktů)

3) uvolněná energie posunuje pákové raménko
o necelých 7 nm

4) navázání další molekuly ATP na myosin oslabí aktinomyosinový můstek,
cyklus se opakuje, dokud je k dispozici Ca^{2+}

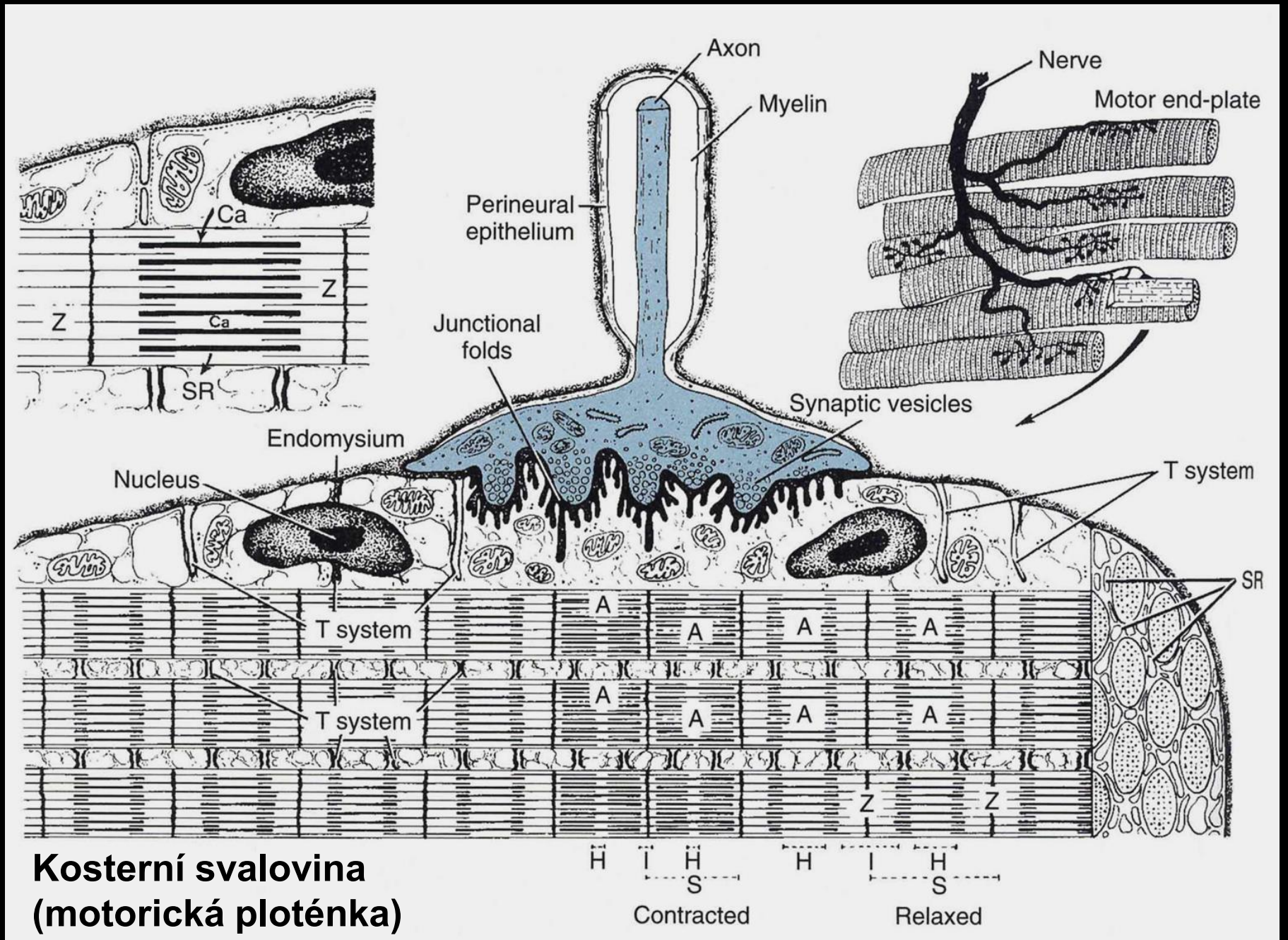
RIGOR MORTIS: ATP není dostupný, Ca^{2+} je dostupný - myosinové hlavy ve vazbě na aktin zůstávají


a
actin
filament
myosin
head
ATP
b
ADP
Pi
c
ADP
Pi
d
ATP
ADP
ADP

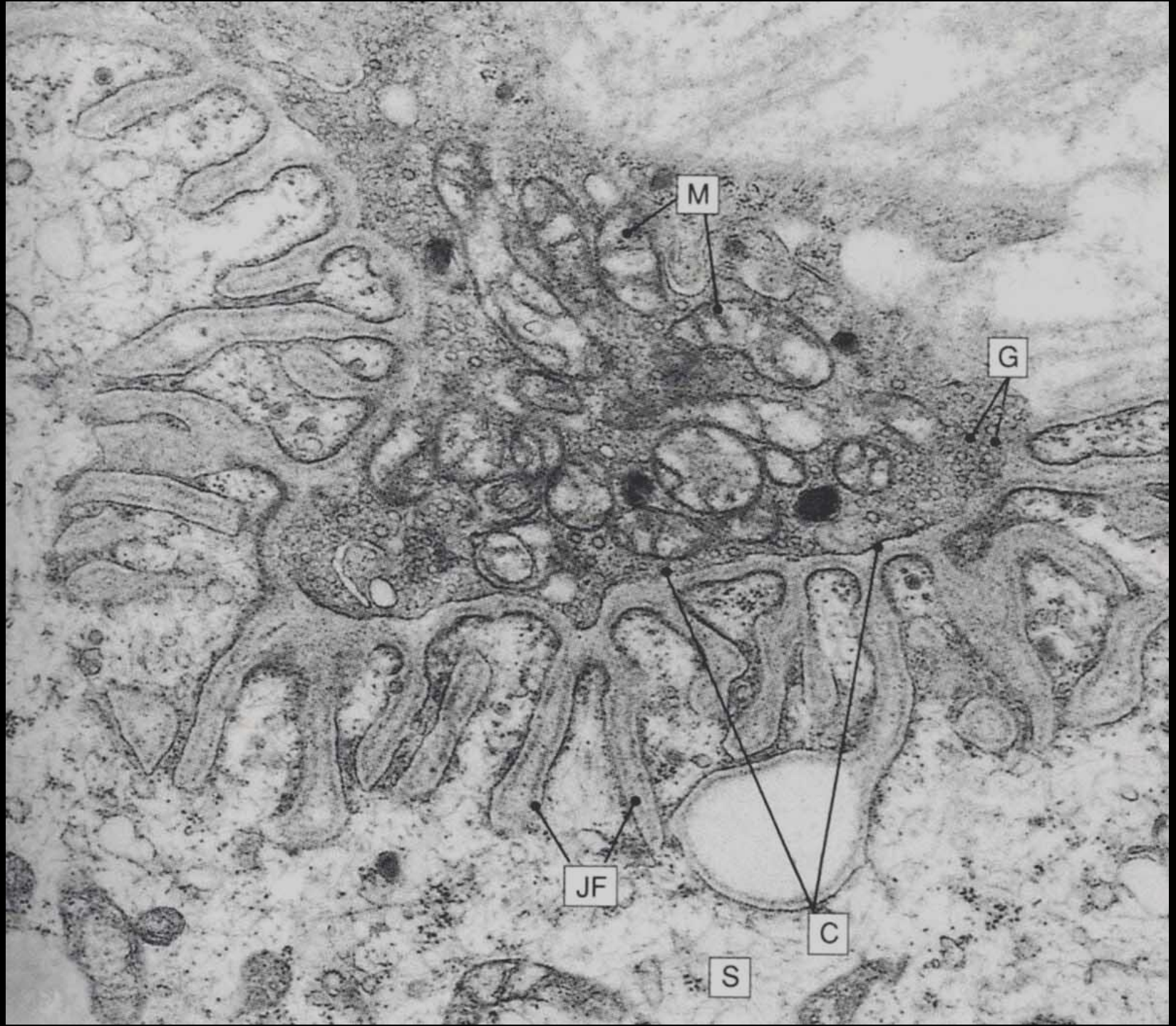


Ovalle W.K., Nahirney P.C.: Netter's Essential Histology. 2nd Ed., Elsevier 2013

Řízení svalové kontrakce

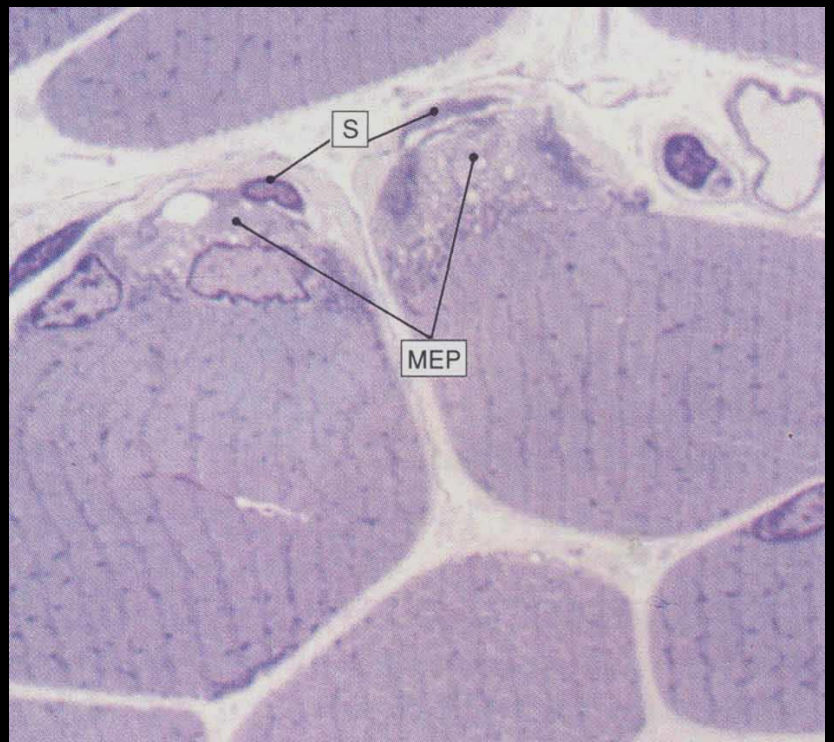


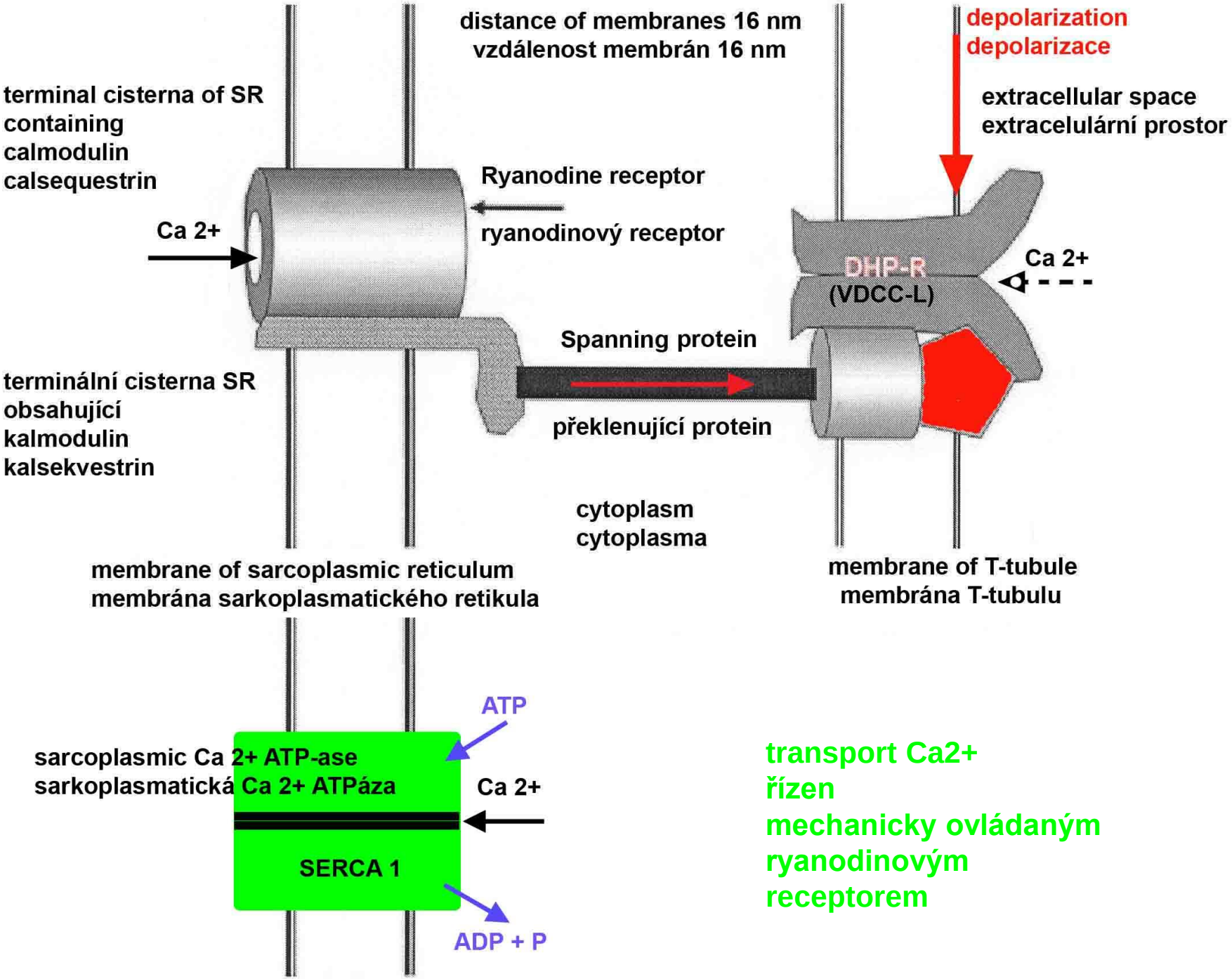
Kosterní svalovina (motorická ploténka)


M
G
JF
C
S

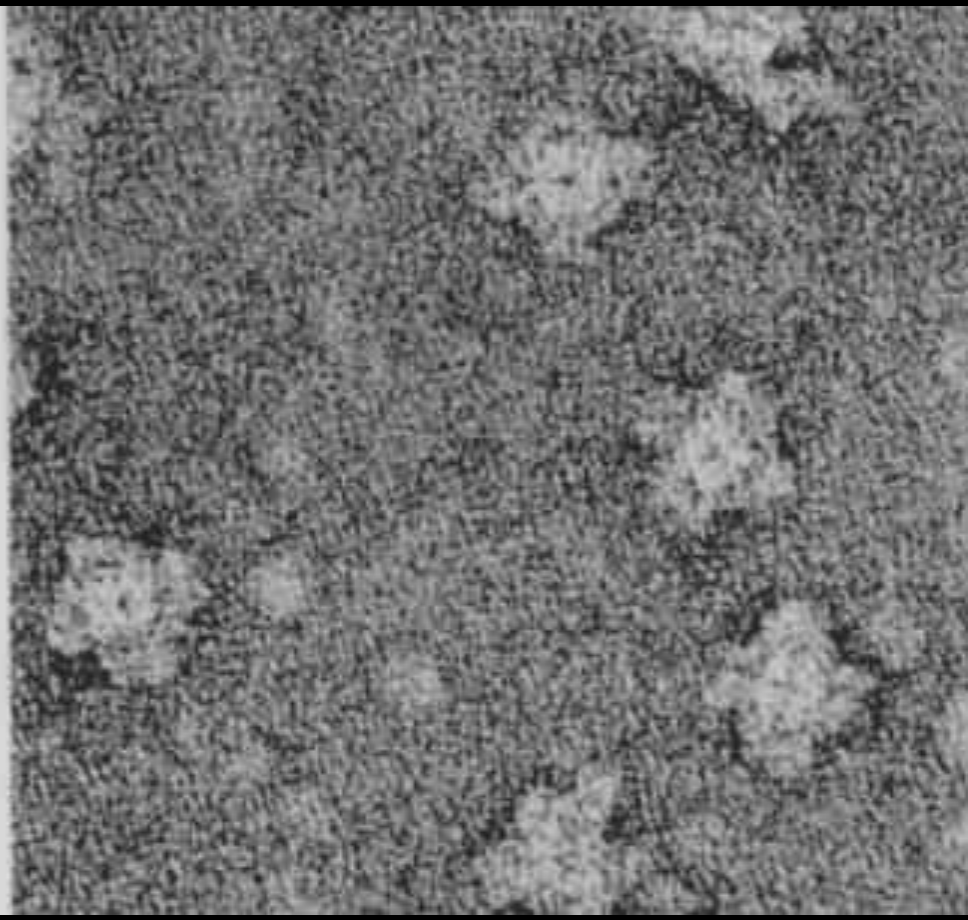
impregnace Ag

histochemický průkaz acetylcholinesterázy





transport Ca2+
řízen
mechanicky ovládaným
ryanodinovým
receptorem

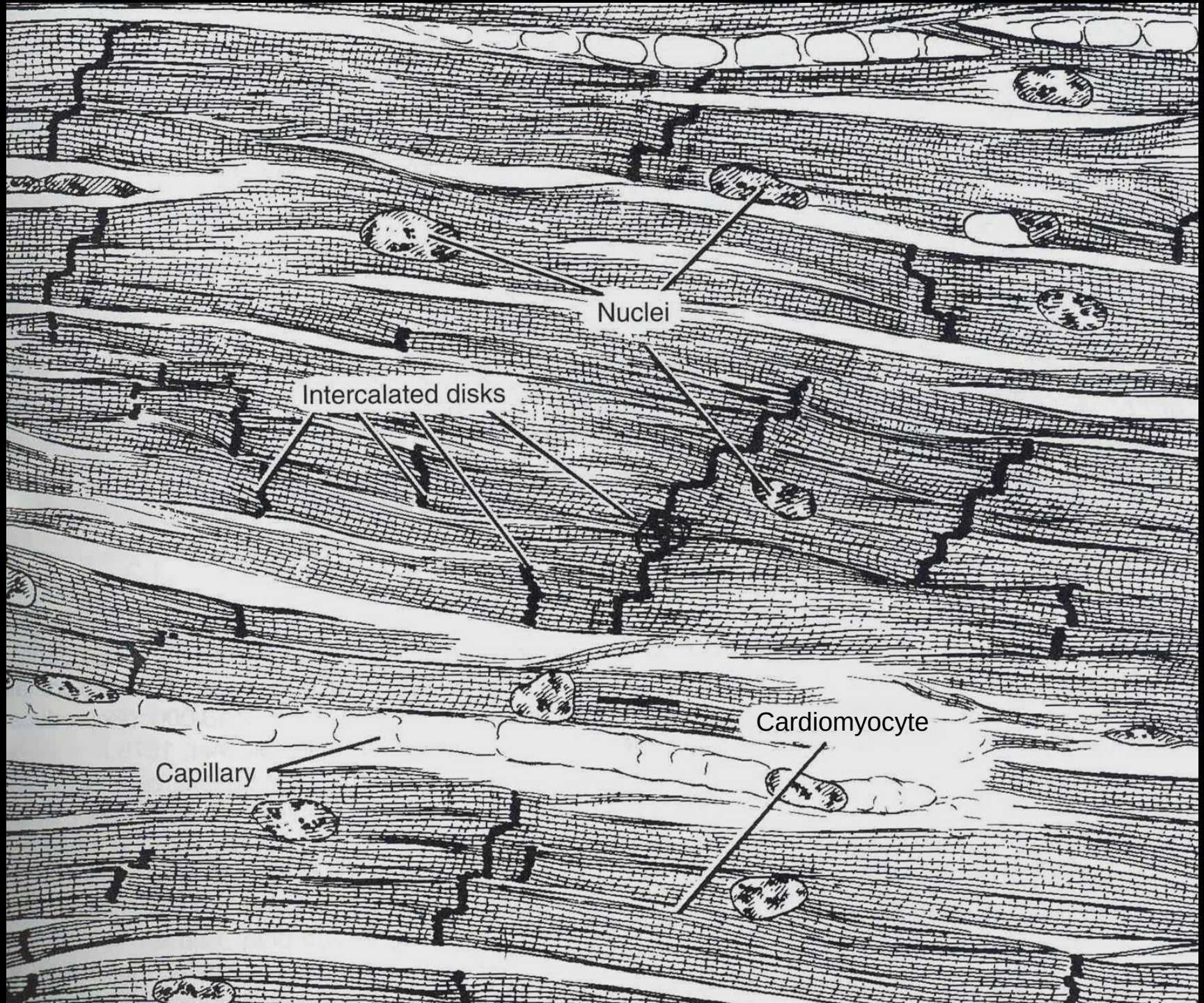


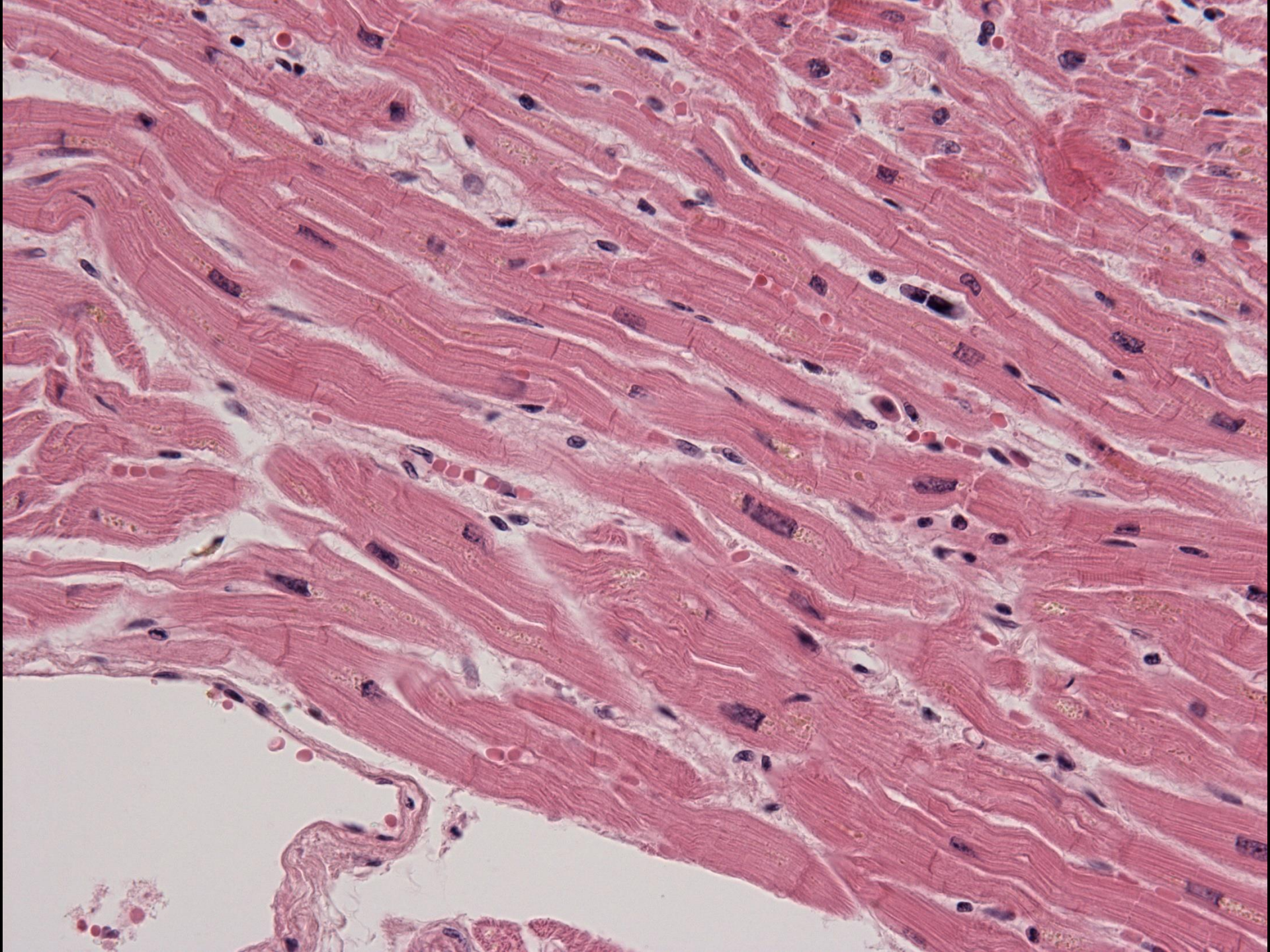
Regenerace kosterní svalové tkáně

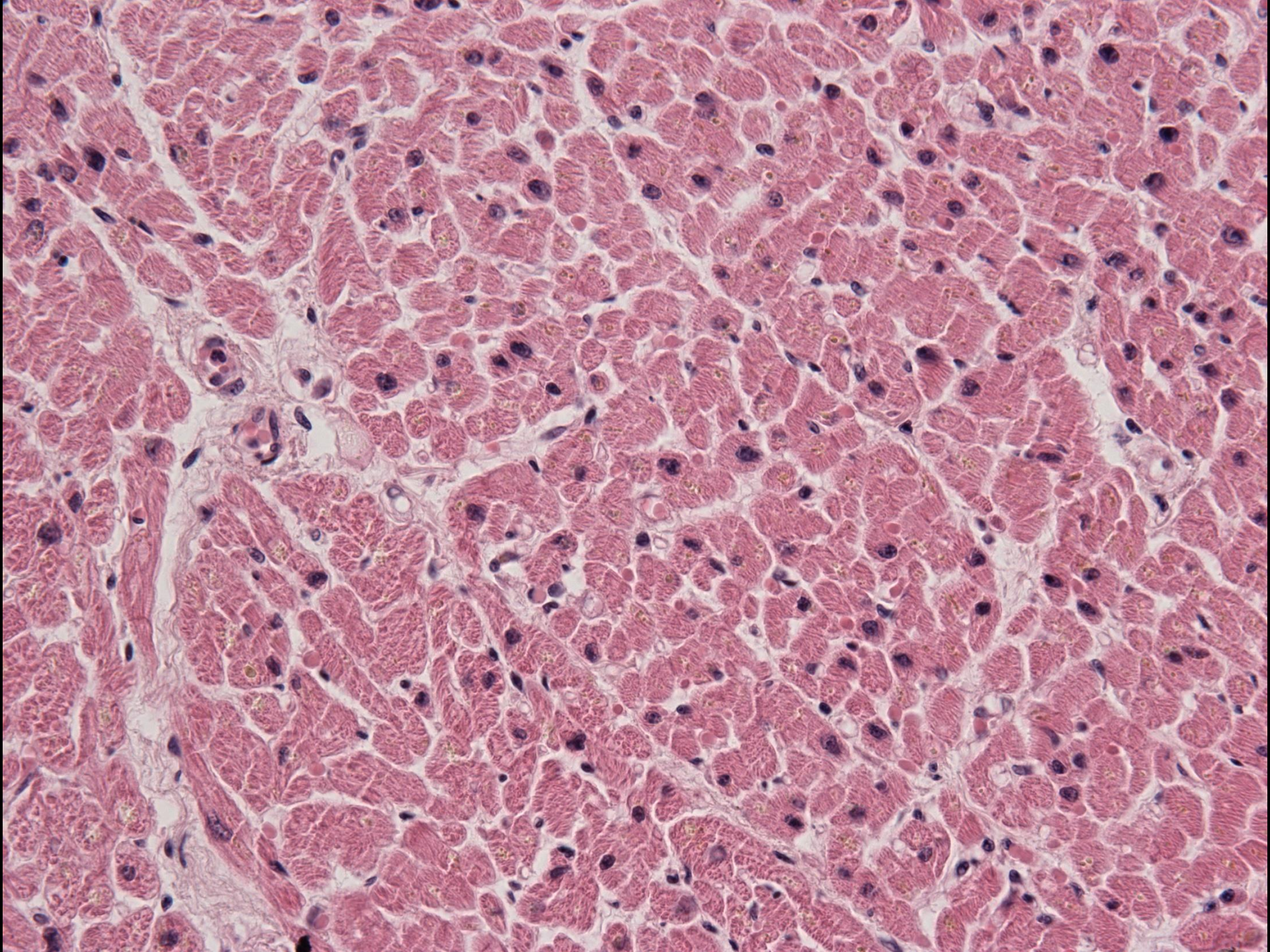
satelitová buňka (myoblast)

Příčně pruhovaná svalová tkáň srdeční

základní jednotka: KARDIOMYOCYT
většinou cylindrický, často rozvětvený element s jedním, řídce se dvěma jádry – BUŇKA
rytmická kontrakce bez volní kontroly
délka: kolem stovky mikrometrů
průměr: 15 - 20 mikrometrů
jádro umístěné ve středu buňky
myofilamenta uspořádána do myofibril

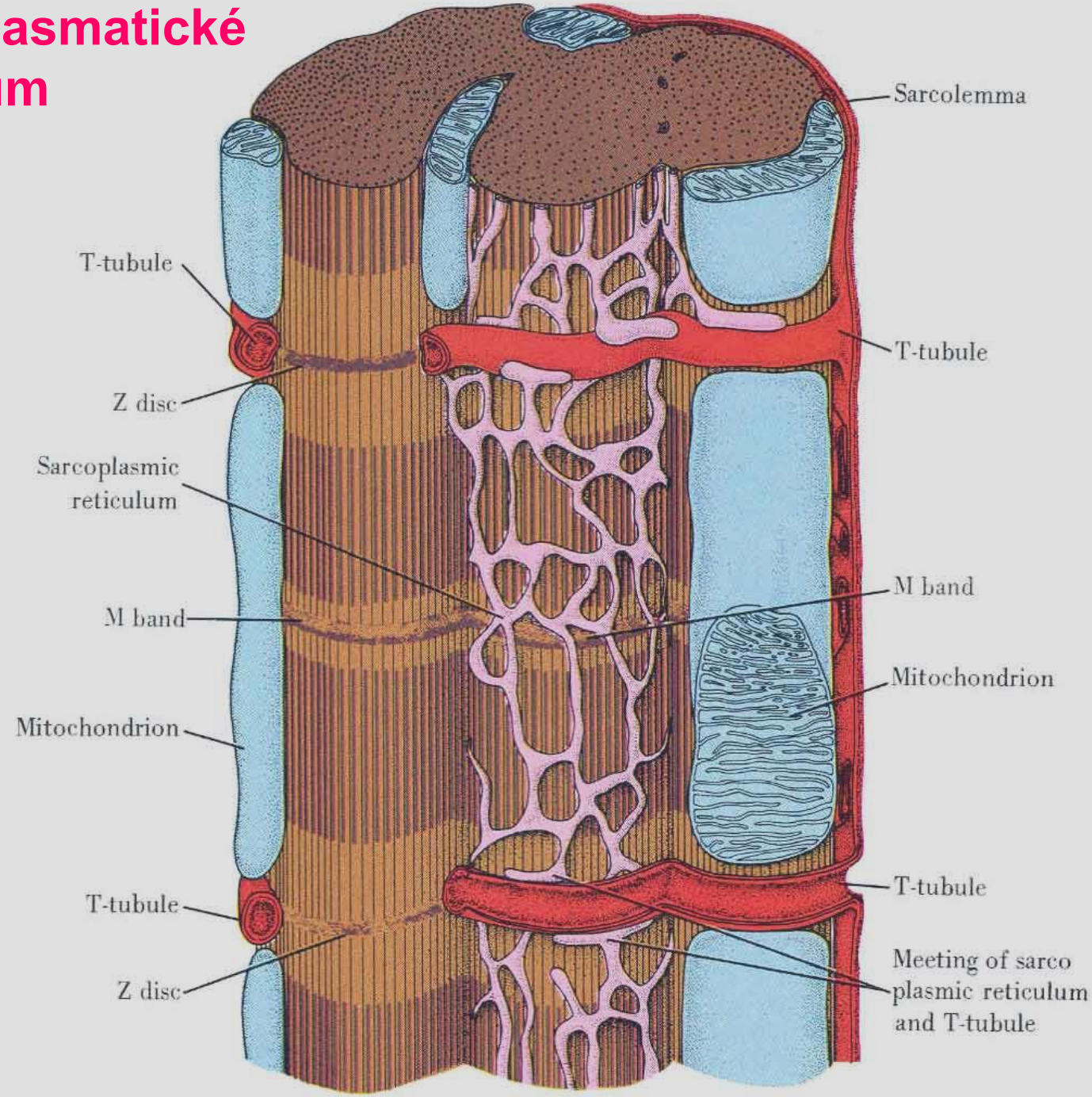

Nuclei
Intercalated disks
Cardiomyocyte
Capillary





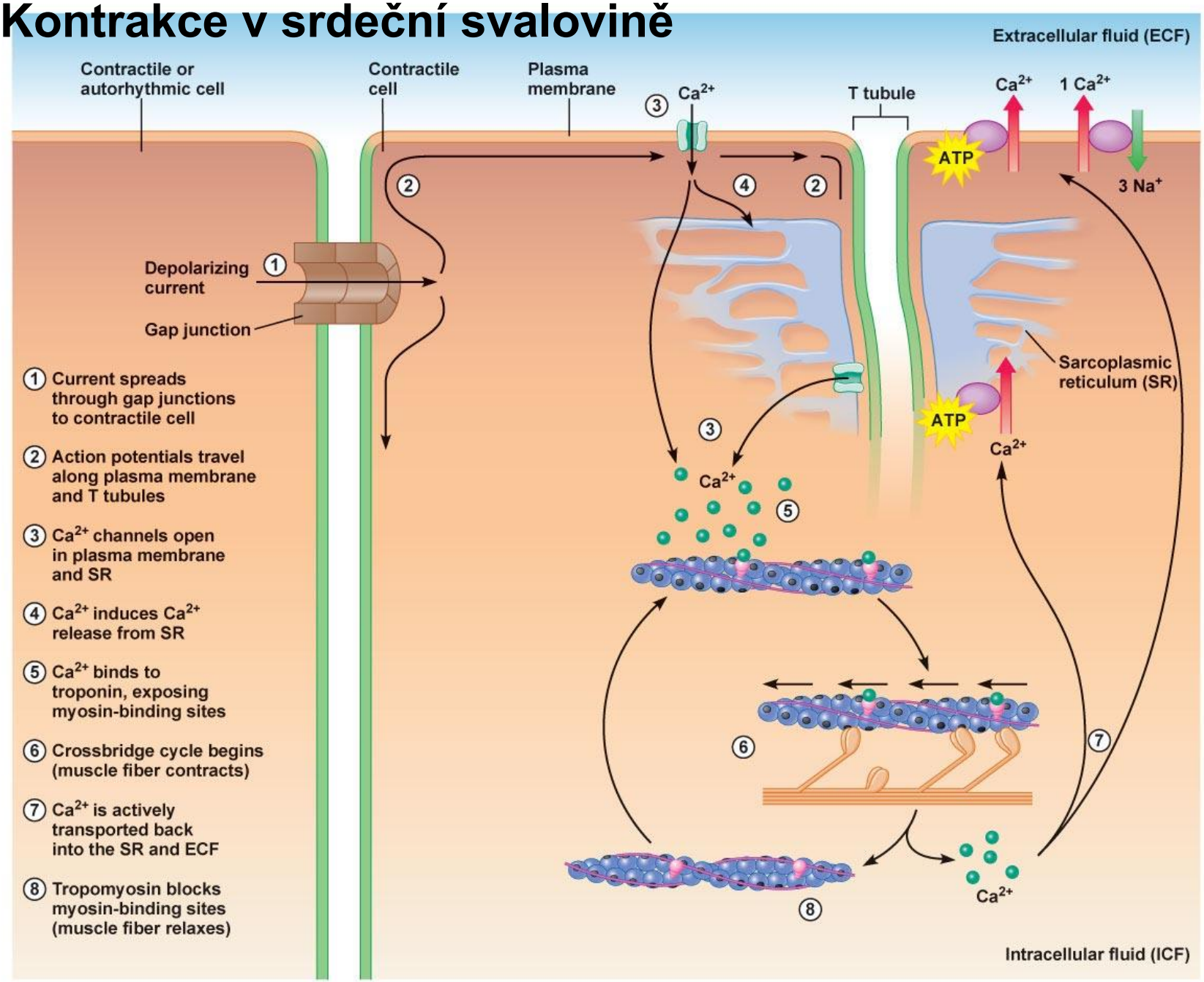
v kardiomyocytech jsou tenká myofilamenta v sarkomeře doprovázena nebuletou (menší izoforma nebulinu)

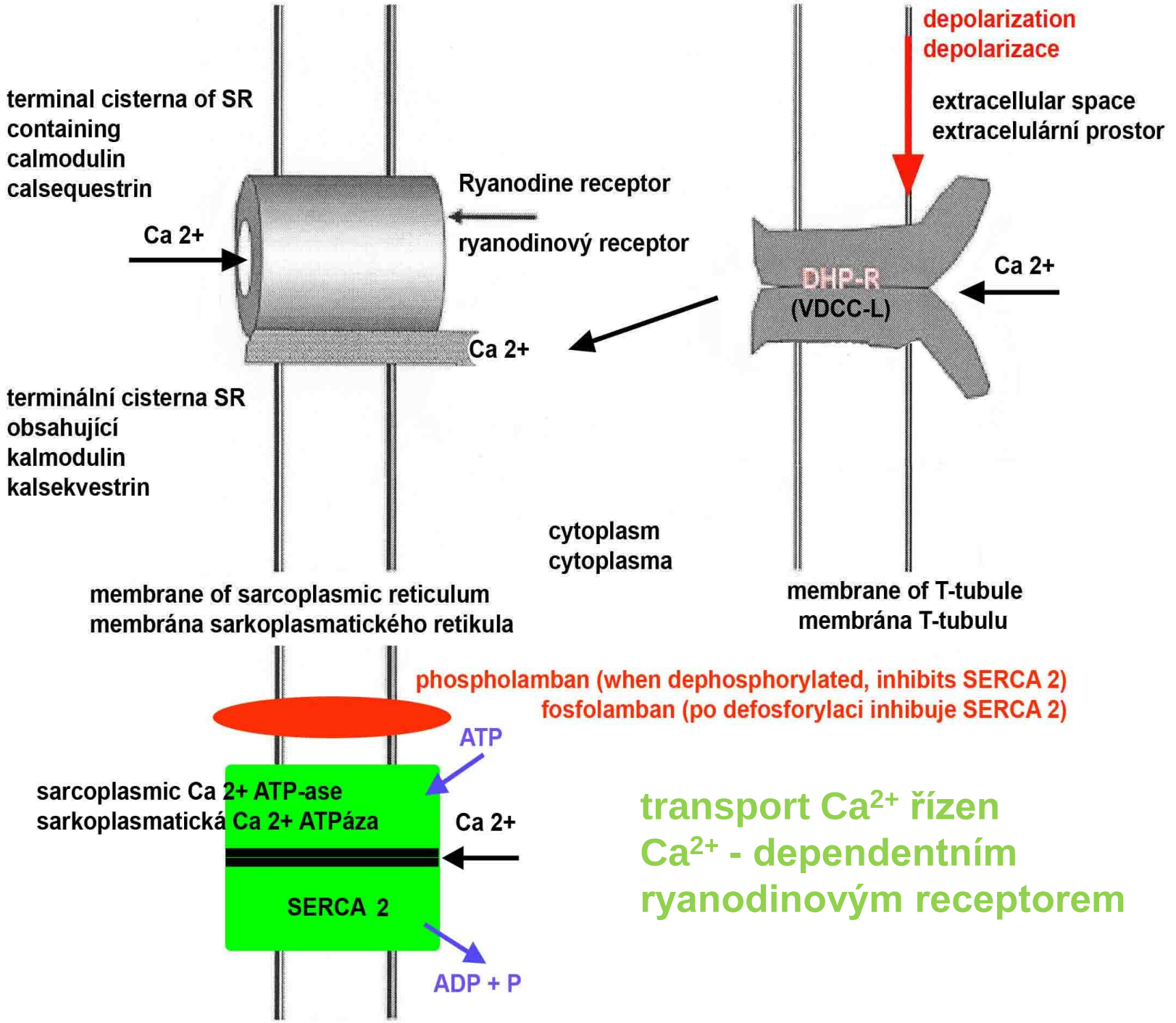
sarkoplasmatické retikulum




diáda

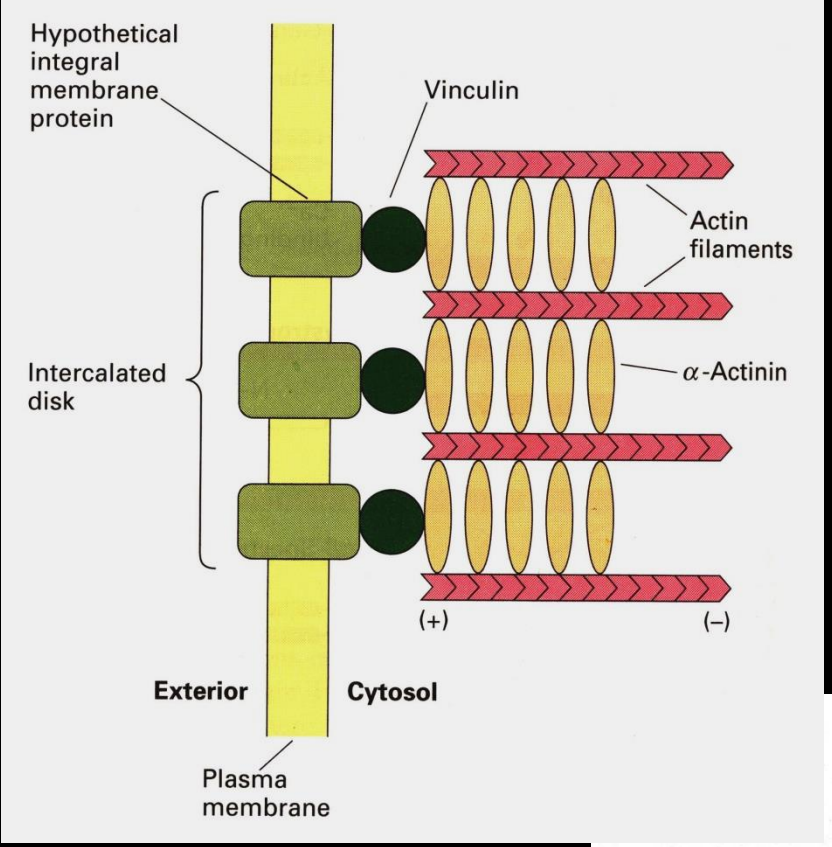
Kontrakce v srdeční svalovině

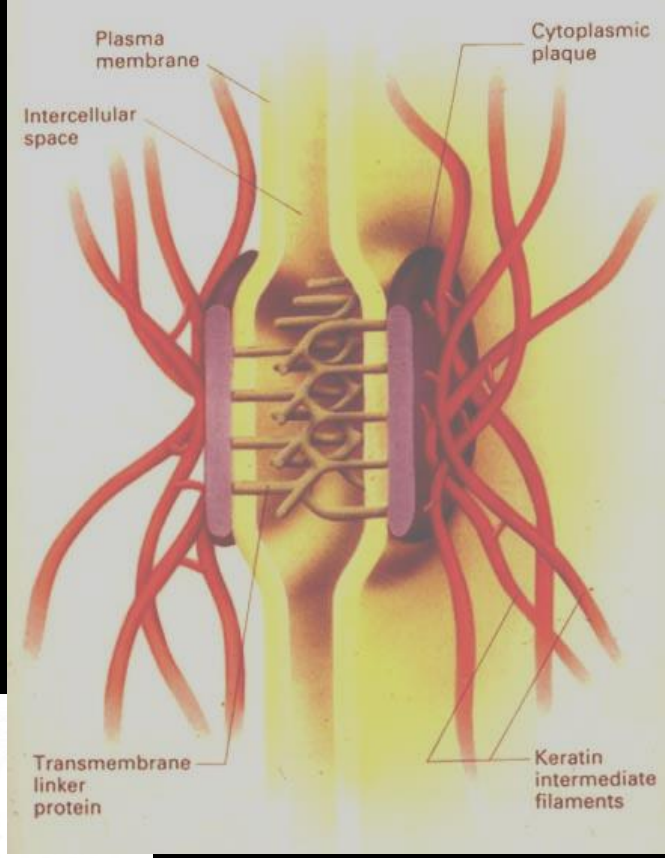




transport Ca^{2+} řízen Ca^{2+} - dependentním ryanodinovým receptorem

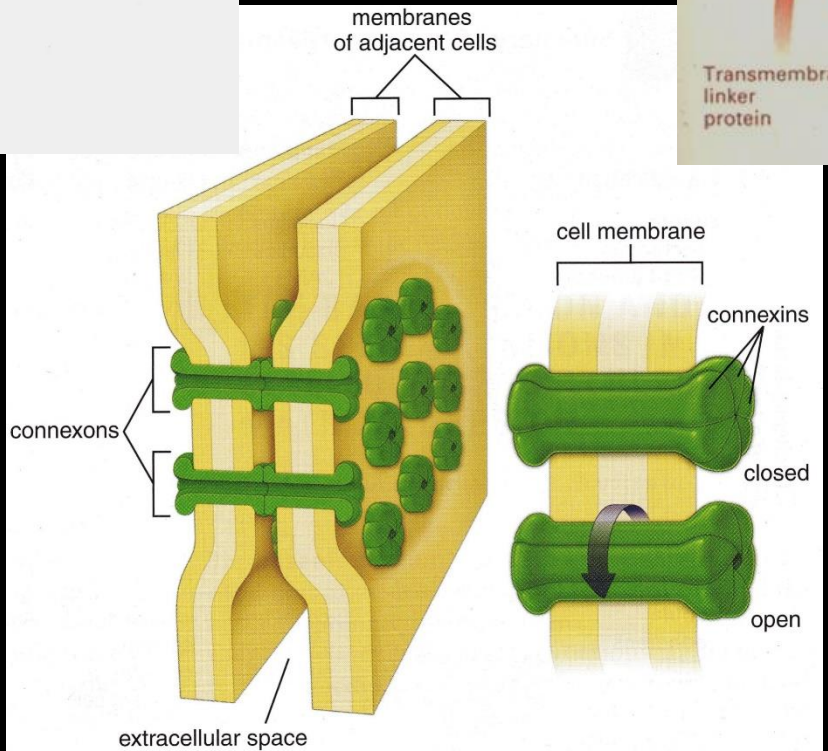
Spojení kardiomyocytů





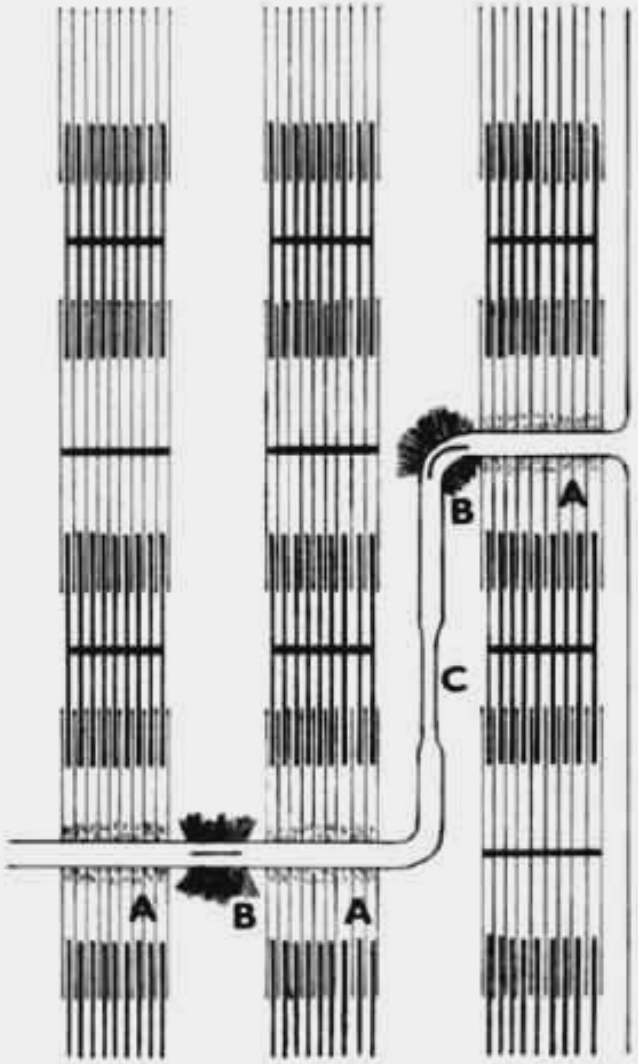
Fascia adhaerens

Nexus



Macula adhaerens (nexus)

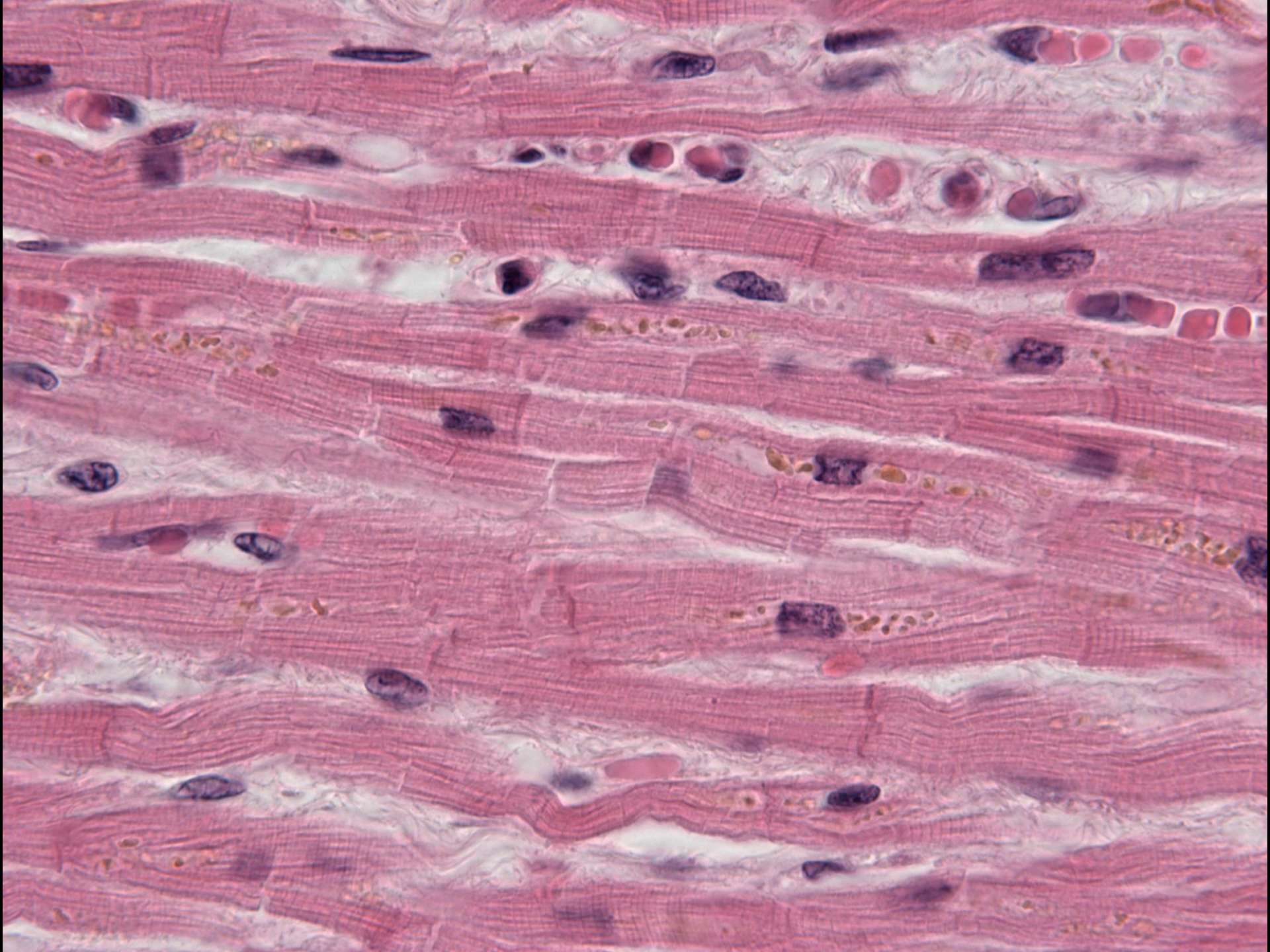
INTERKALÁRNÍ DISK

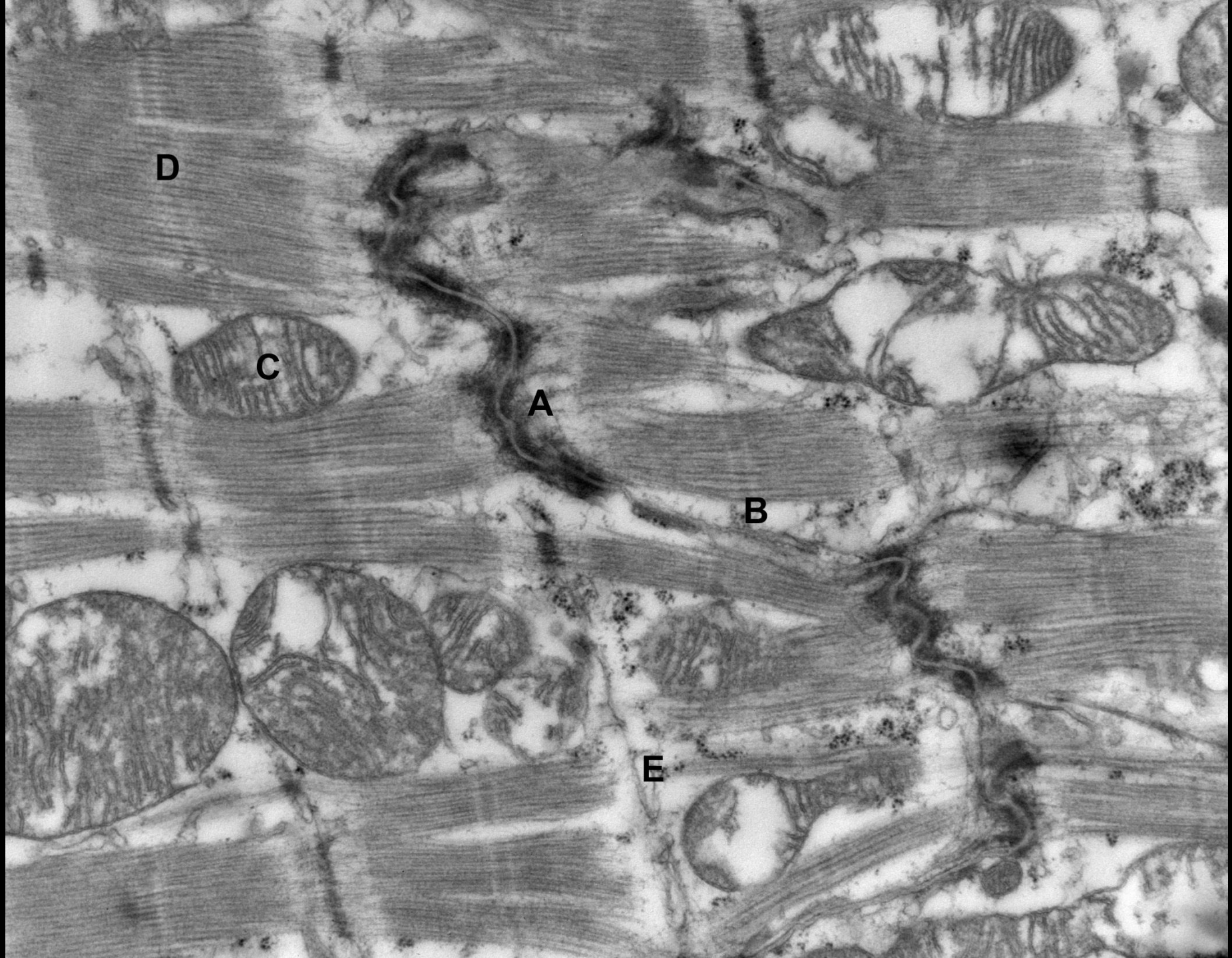


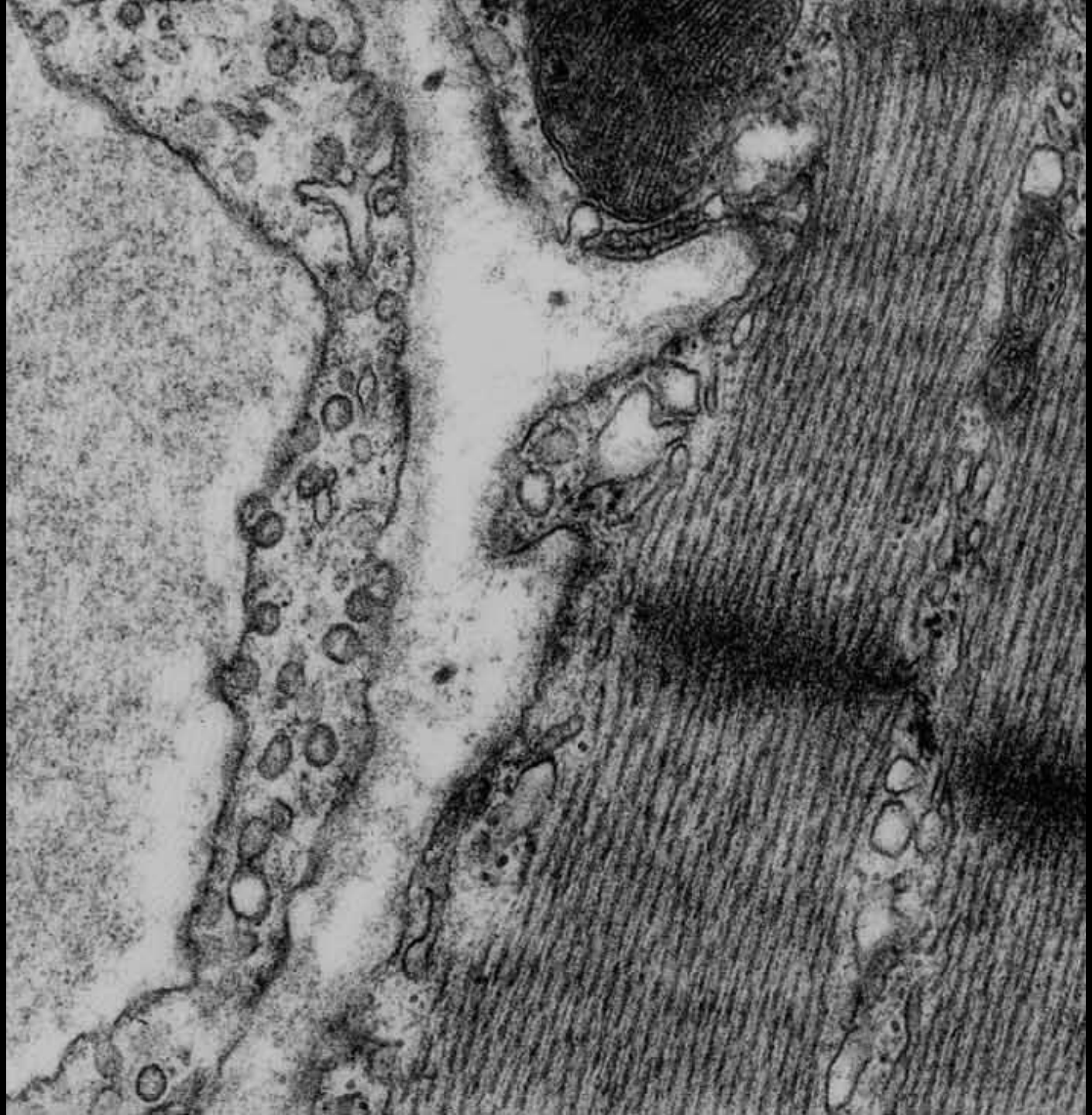
A - fascia adherens

B - macula adherens

C - nexus

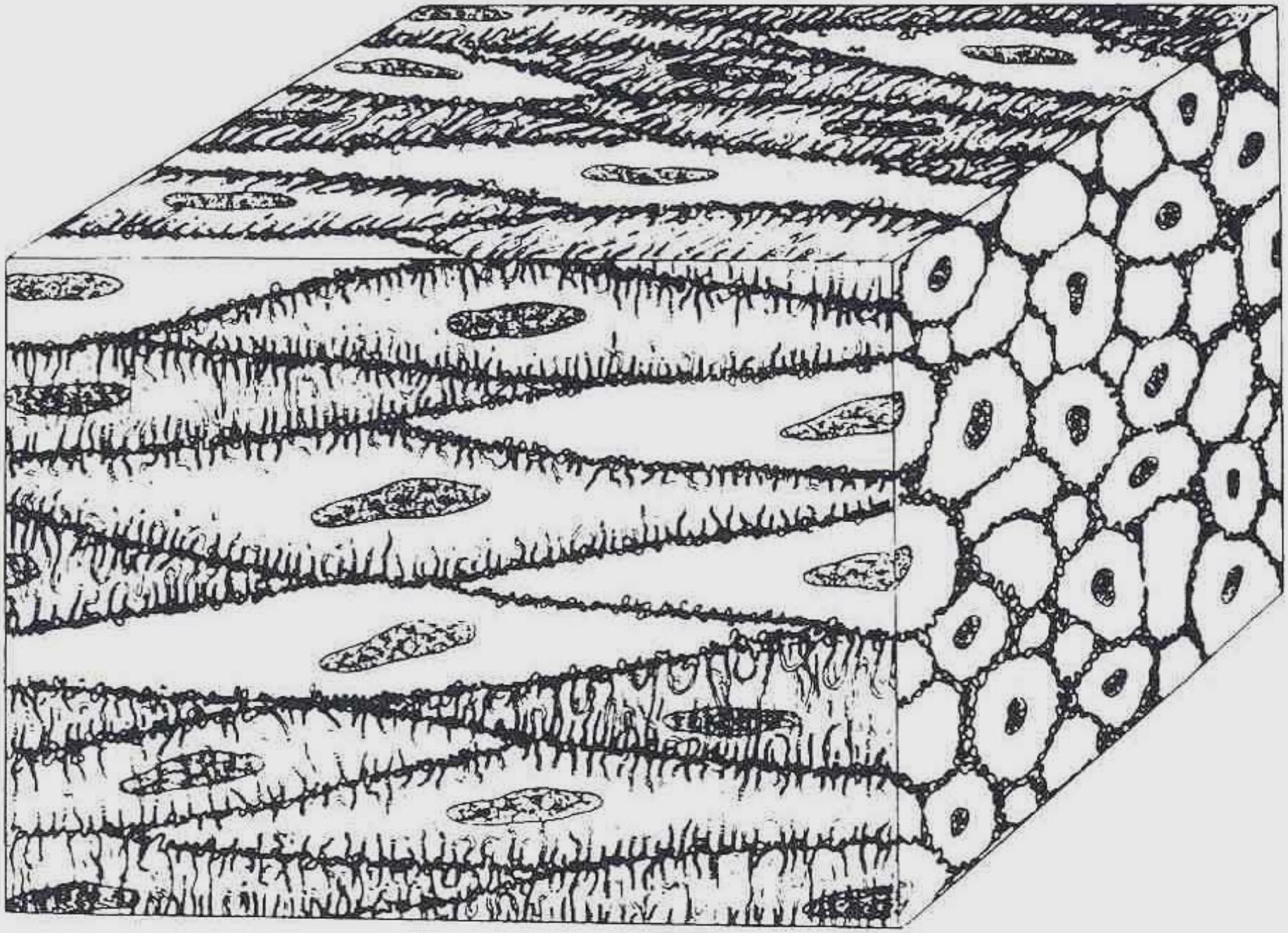


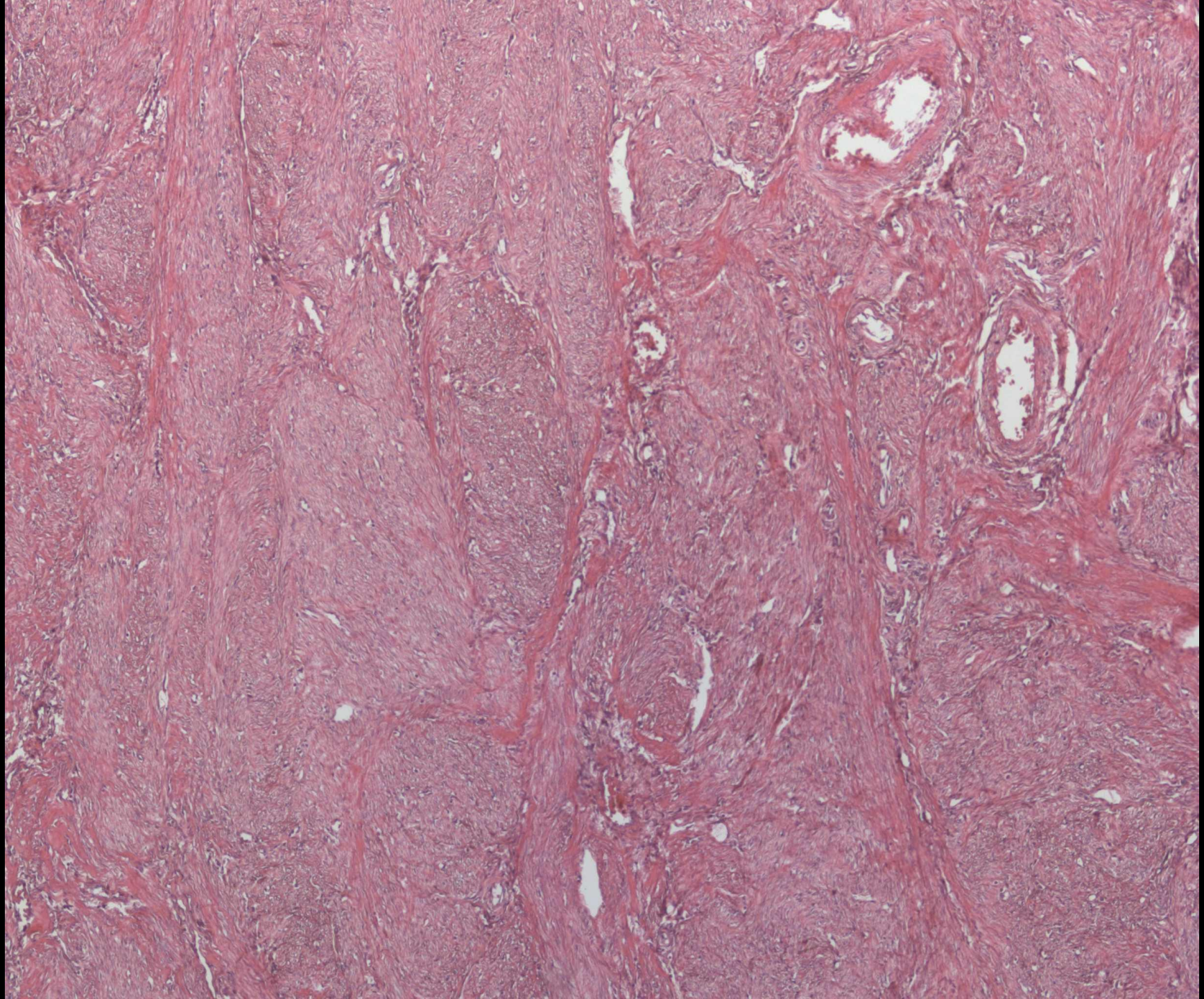

D
C
A
B
E

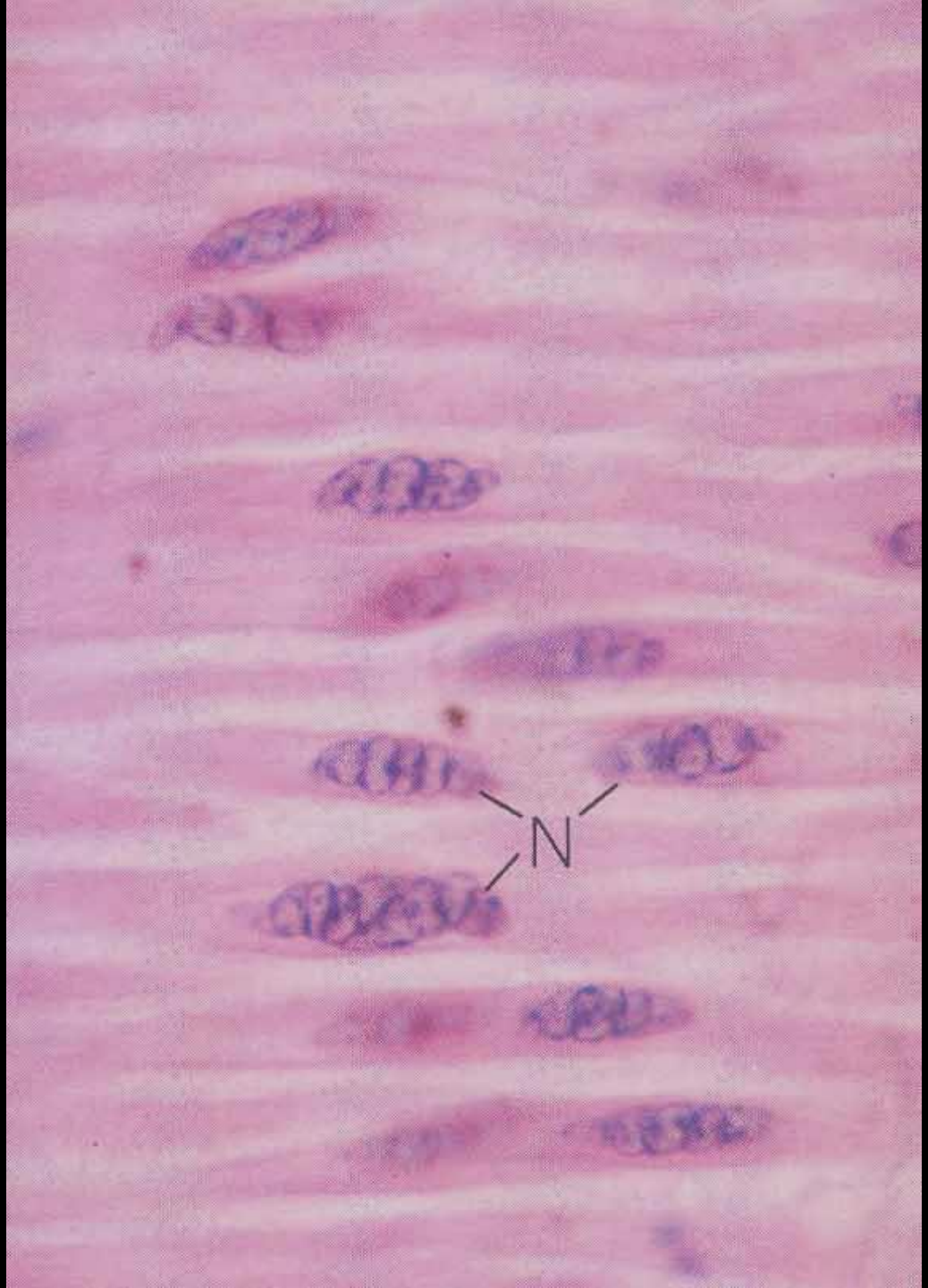


Hladká svalová tkáň

základní jednotka: HLADKÁ SVALOVÁ BUŇKA
vřetenovitý element s jedním jádrem - buňka
pomalá kontrakce bez volní kontroly
délka: od 15 do 500 mikrometrů
průměr: kolem 6 mikrometrů
jádro umístěné ve středu buňky
myofilamenta nepravidelně uspořádaná
(ŽÁDNÉ MYOFIBRILY)



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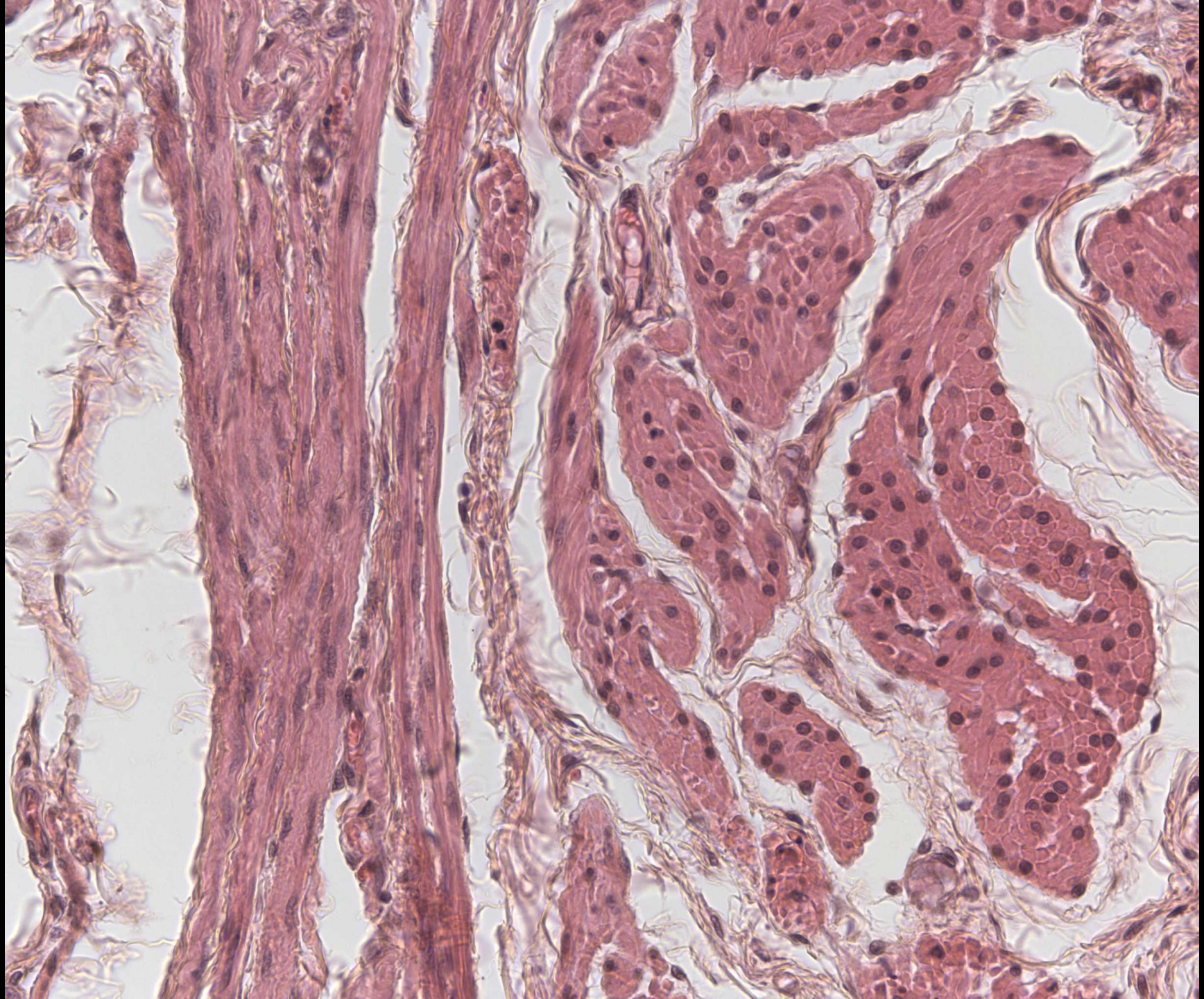
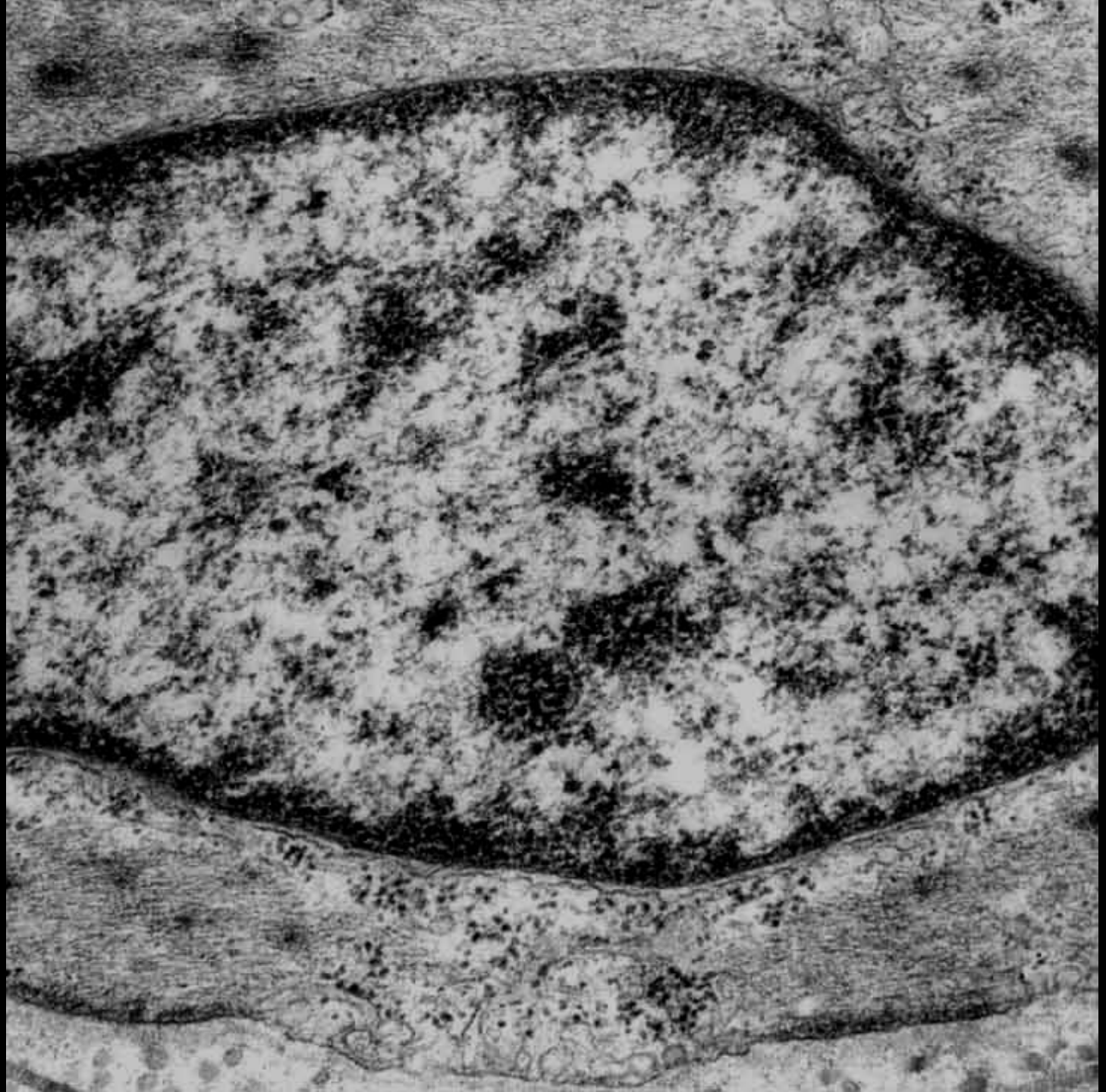
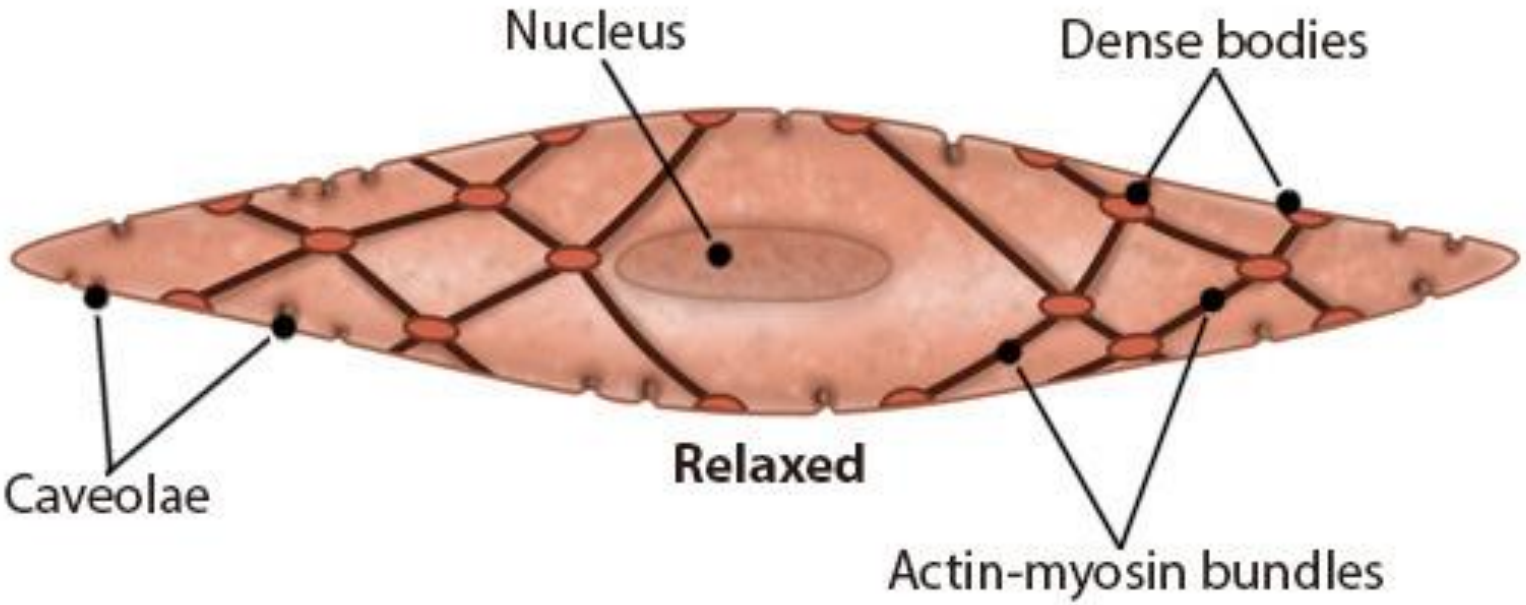
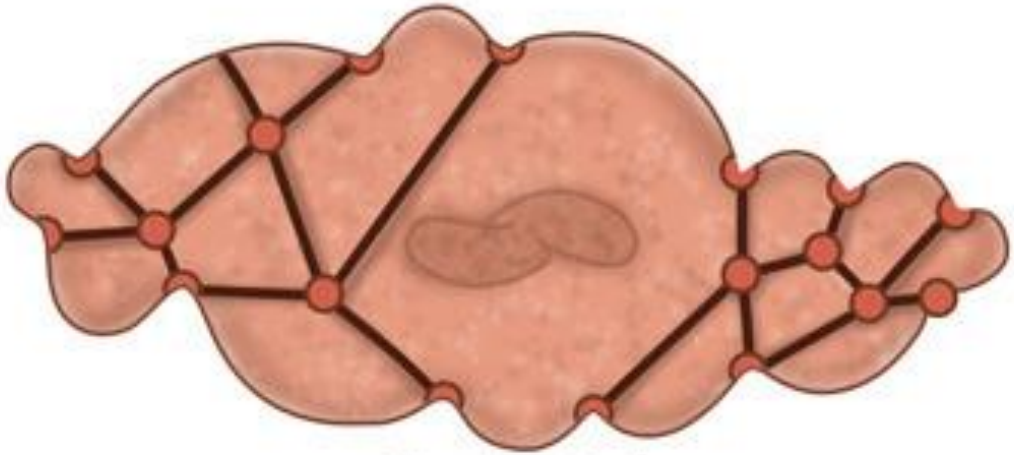
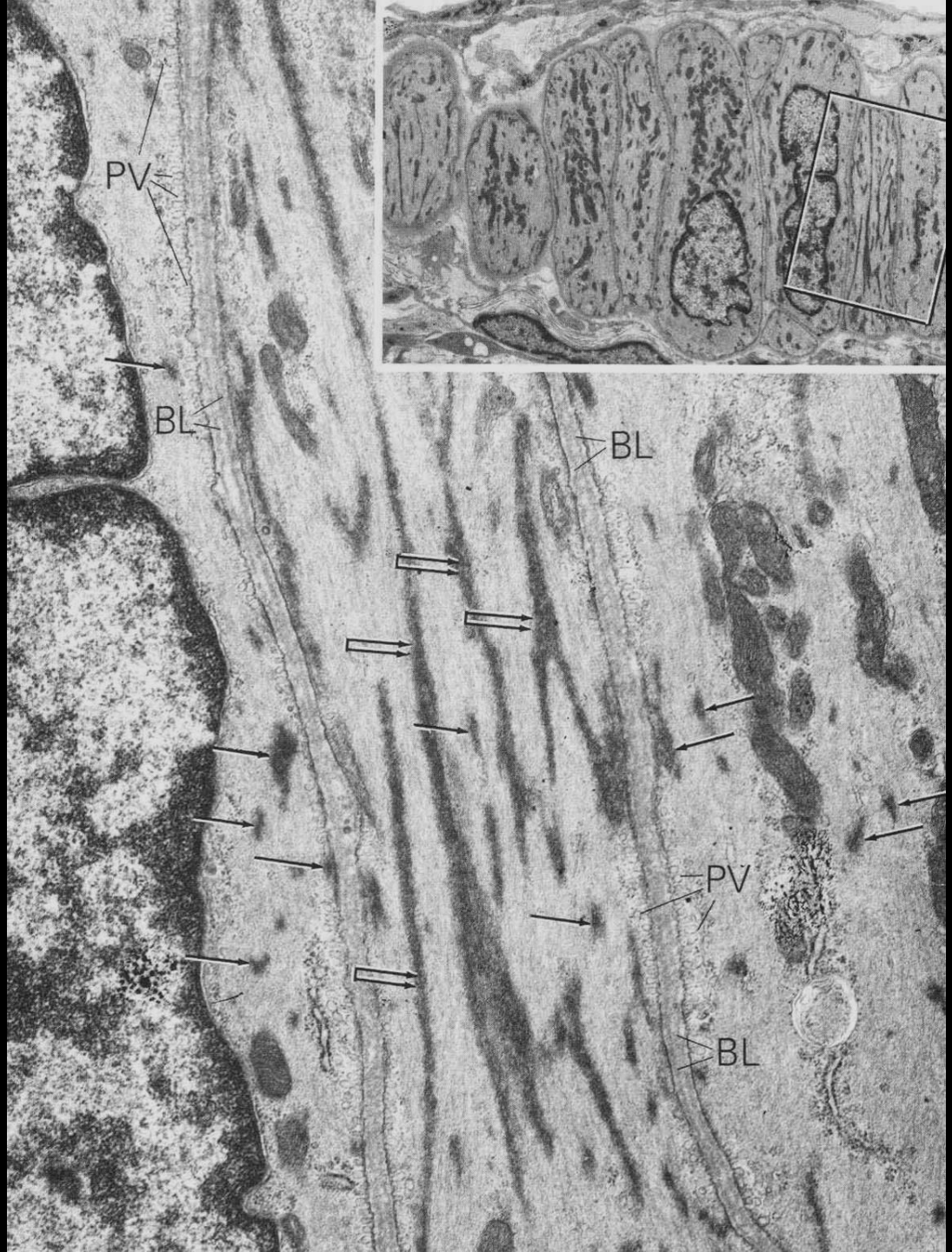





Nucleus
Dense bodies
Caveolae
Relaxed
Actin-myosin bundles



Contracted


PV
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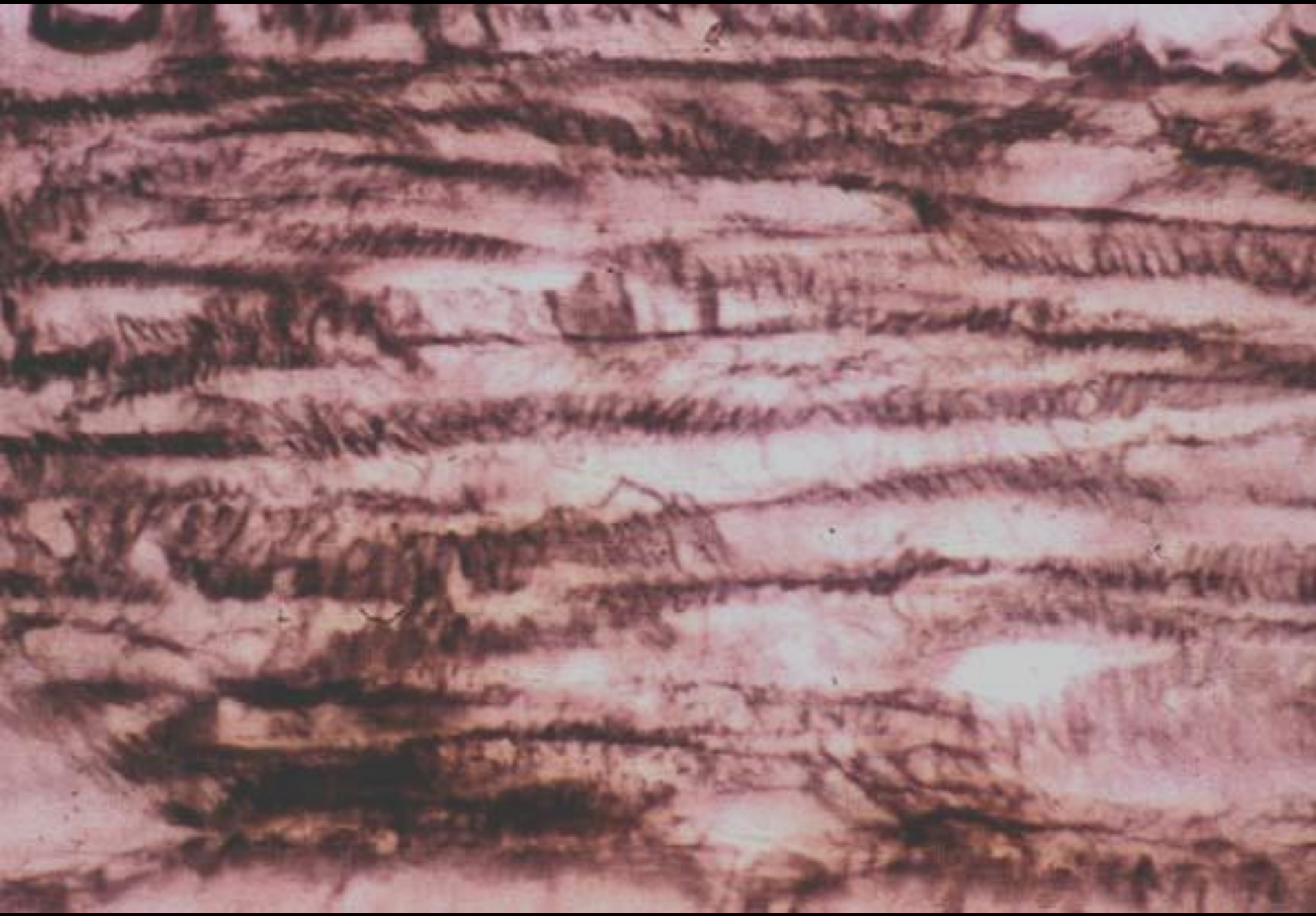
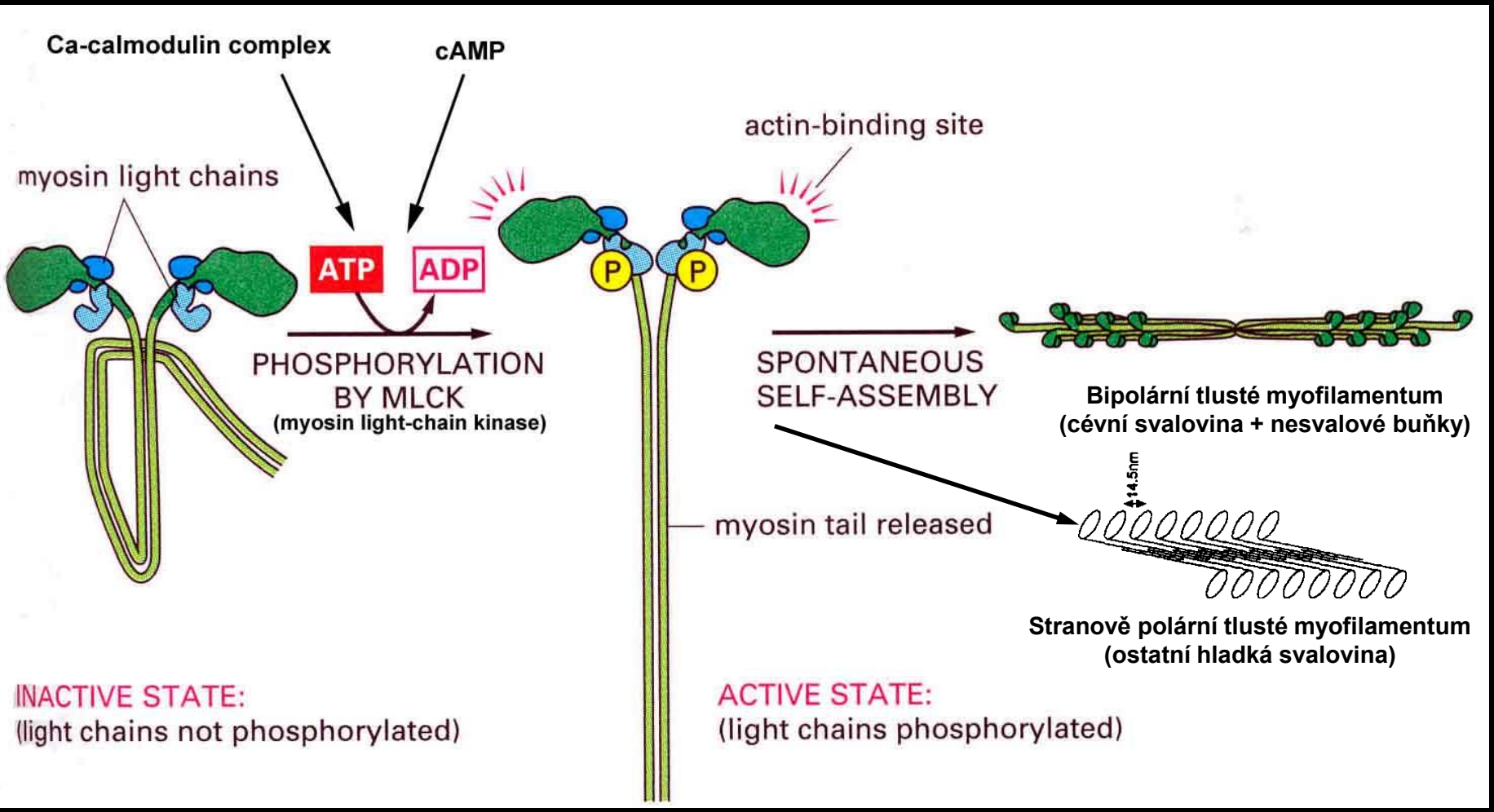
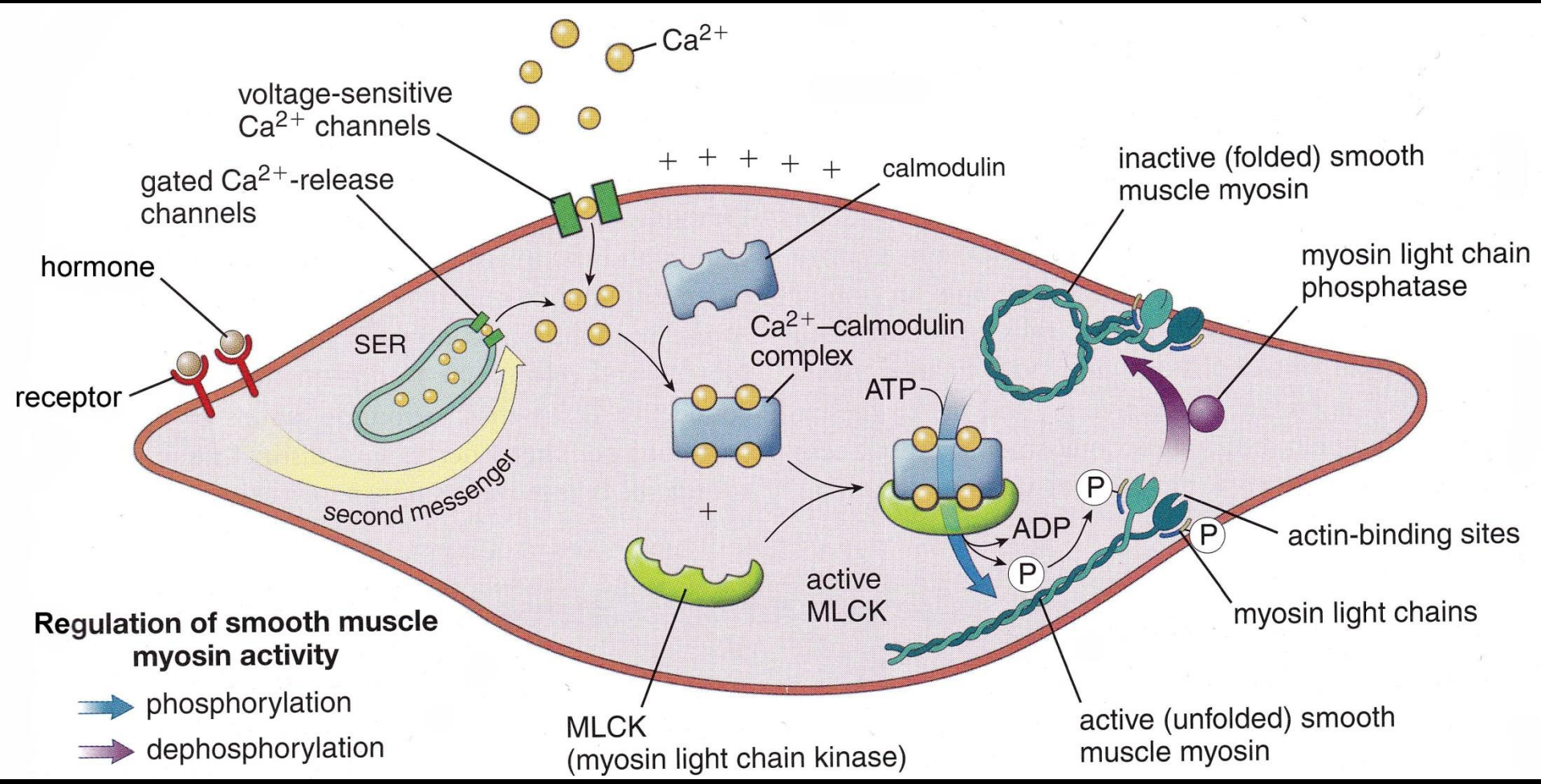


Kontrakce hladké svaloviny



interakce aktinu a myosinu pak probíhá stejně jako u příčně pruhované svaloviny

Hladká svalovina



Pawlina W.: Histology. A Text and Atlas, 7th Ed., Wolters Kluwer 2016