# The Heart physiology I.

## (excitation, conduction, contraction…)

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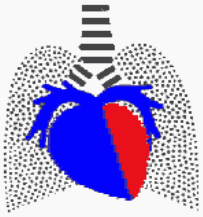
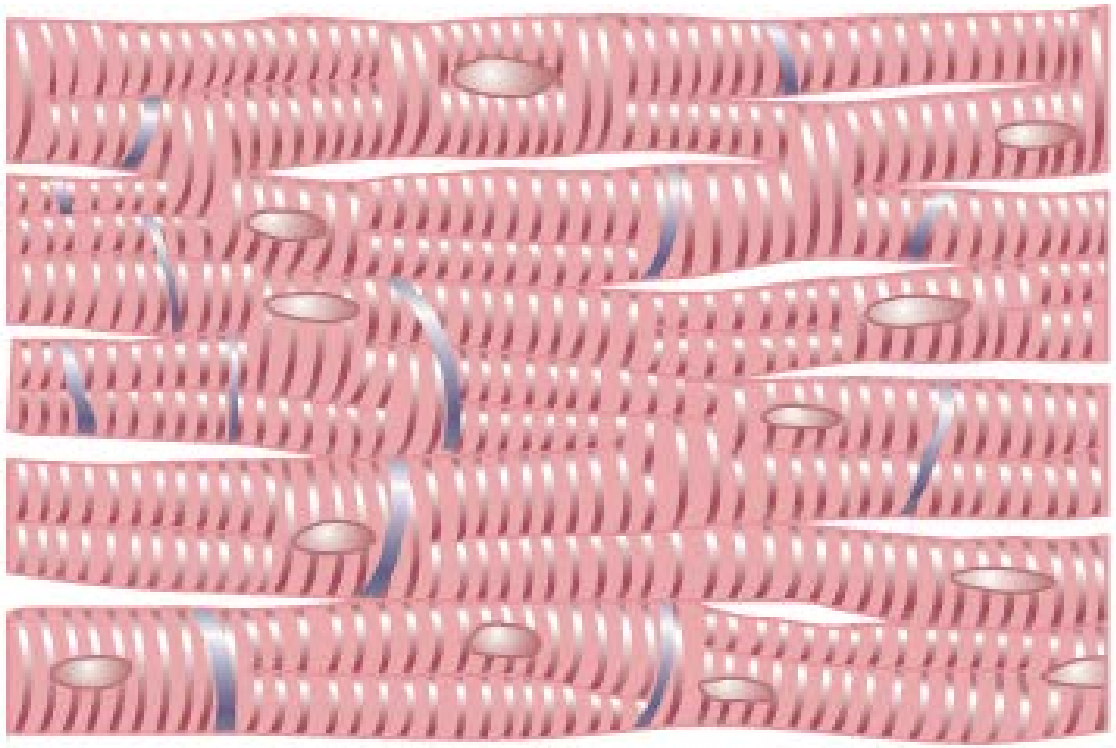


# The Heart Physiology

- The heart action potential (working myocardium)
- The heart automaticity and electrical conduction system
- Excitation – Contraction coupling in the heart muscle cells

# Myocardium = syncytium

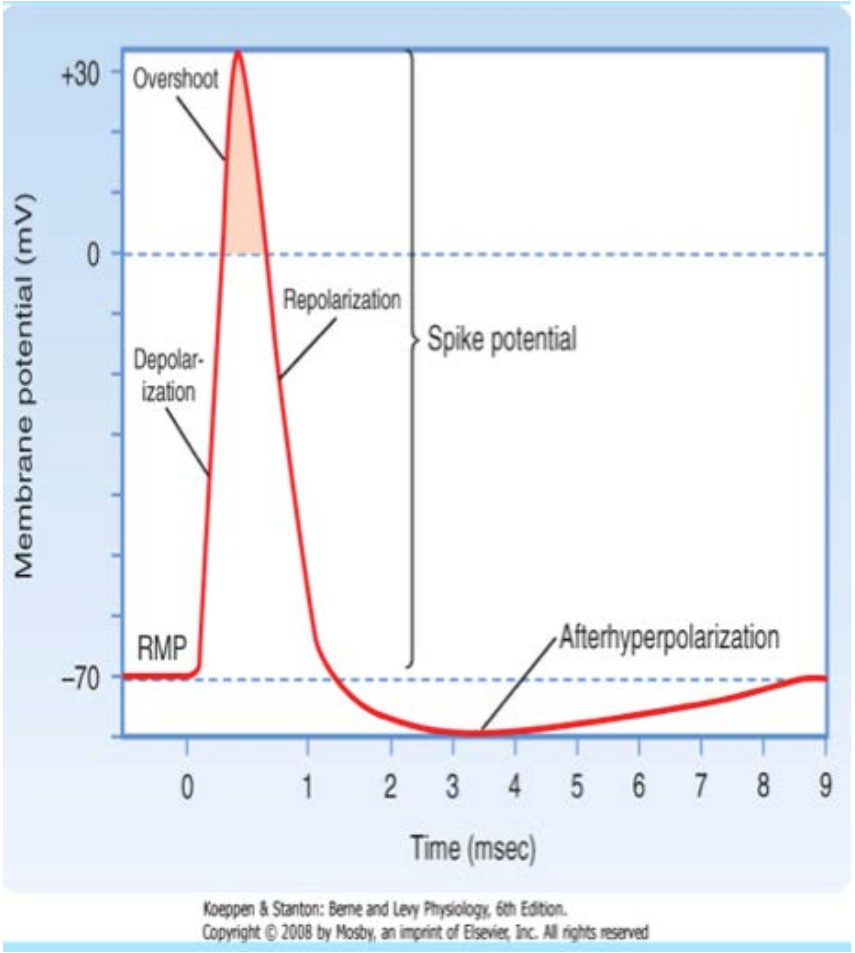



Gap junction = nexus

Elsevier. Guyton & Hall: Textbook of Medical Physiology 11e - www.studentconsult.c

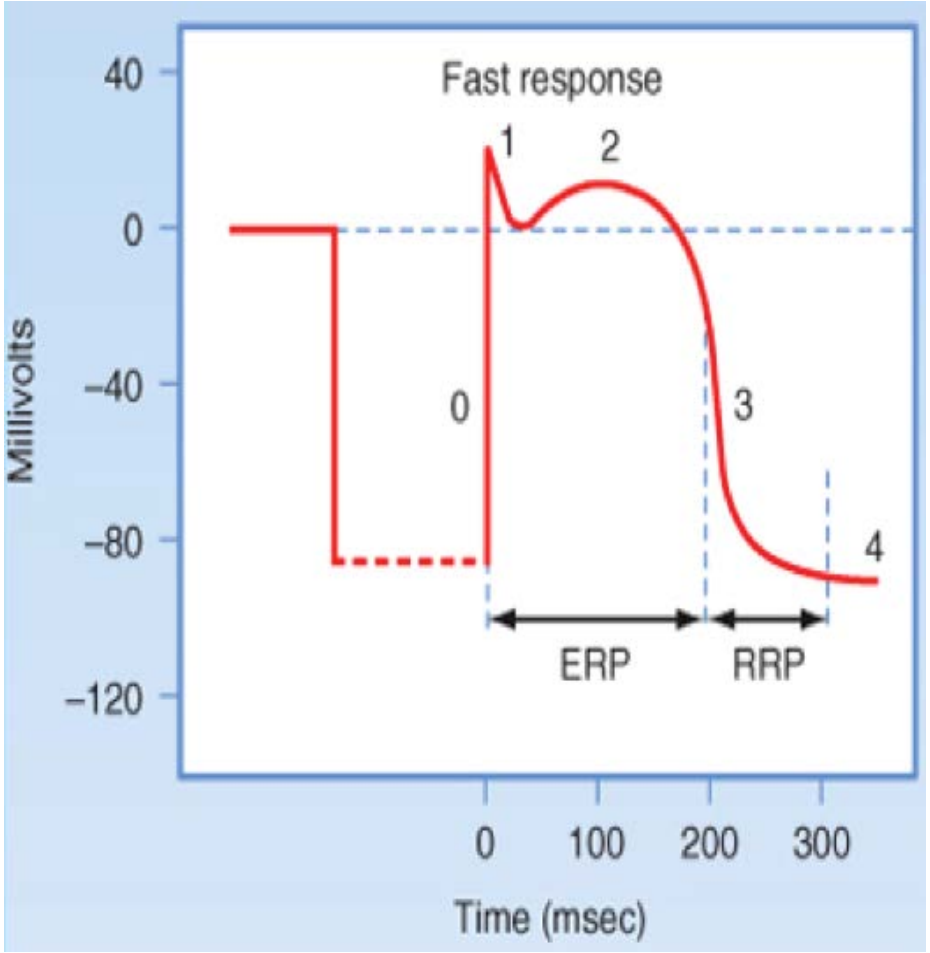
# Different types of the action potential in the heart

**Skeletal muscle, nerve**

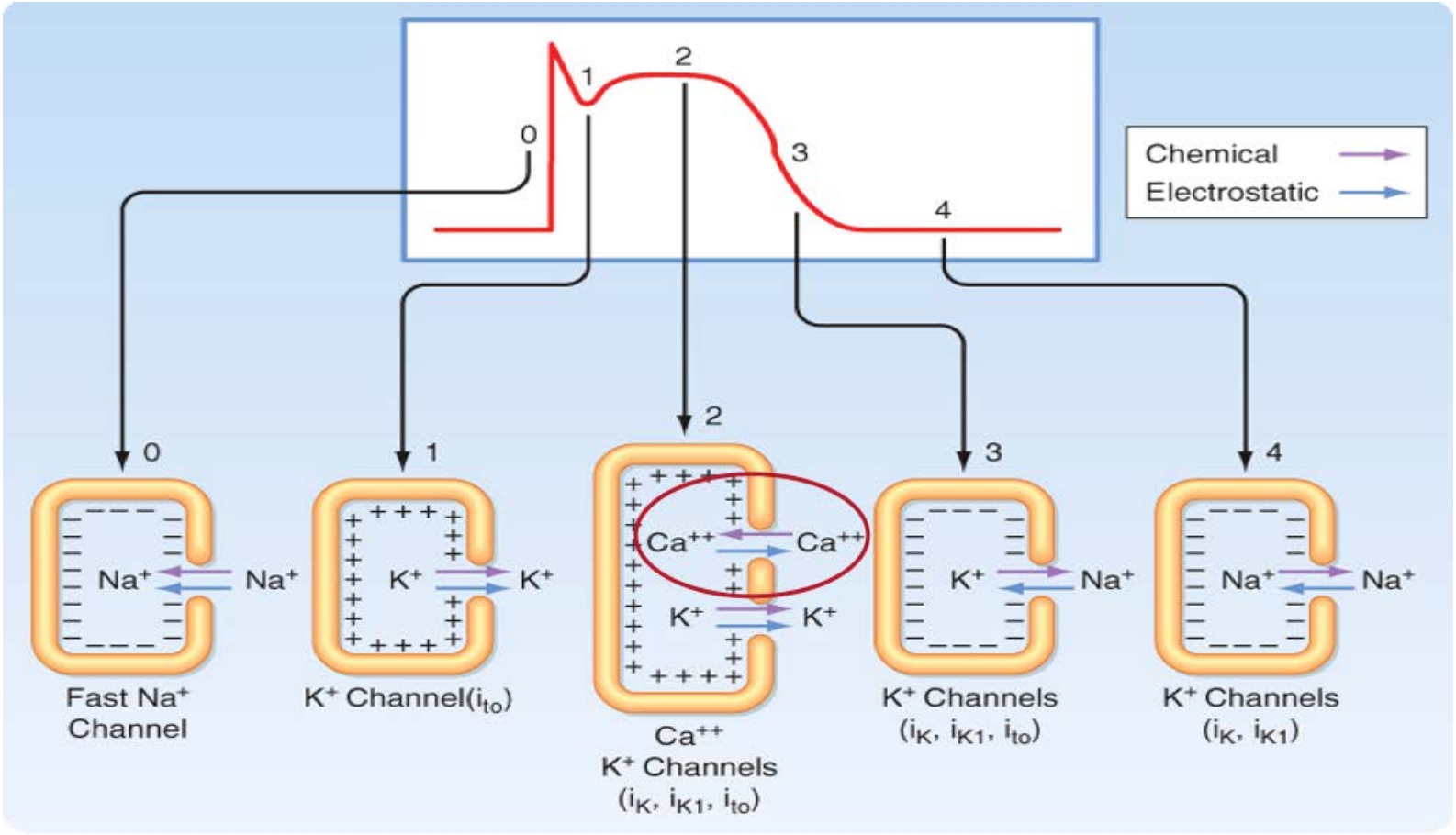





**Myocardium**

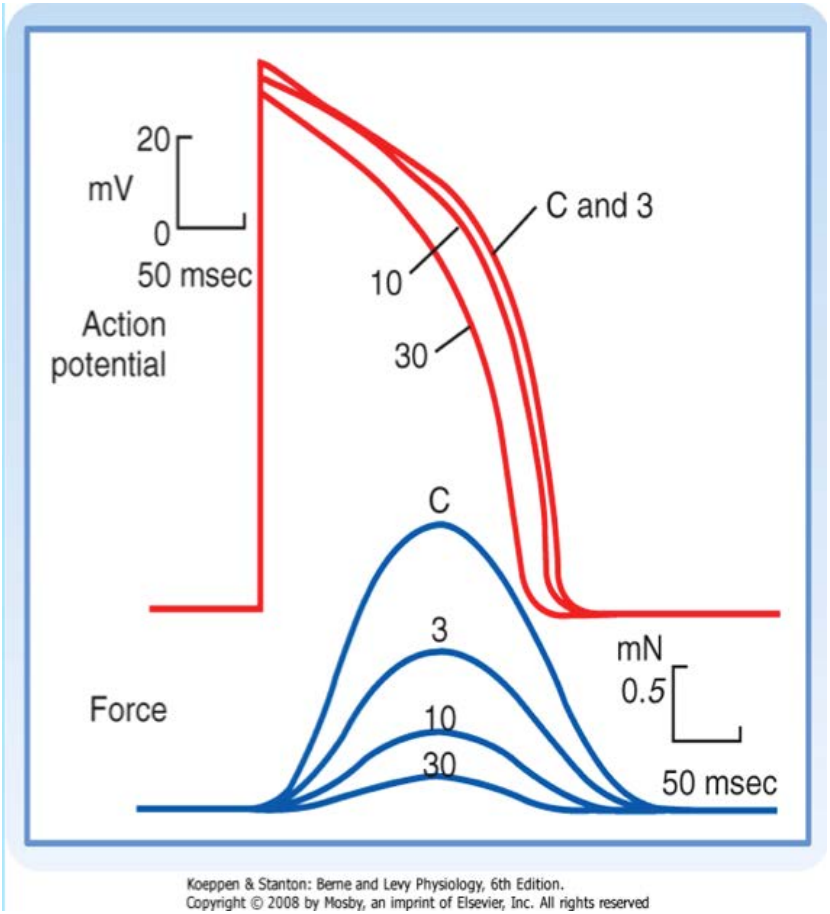


# Voltage gated $Ca^{2+}$ channels (L-type) are resposible for AP in the myocardium

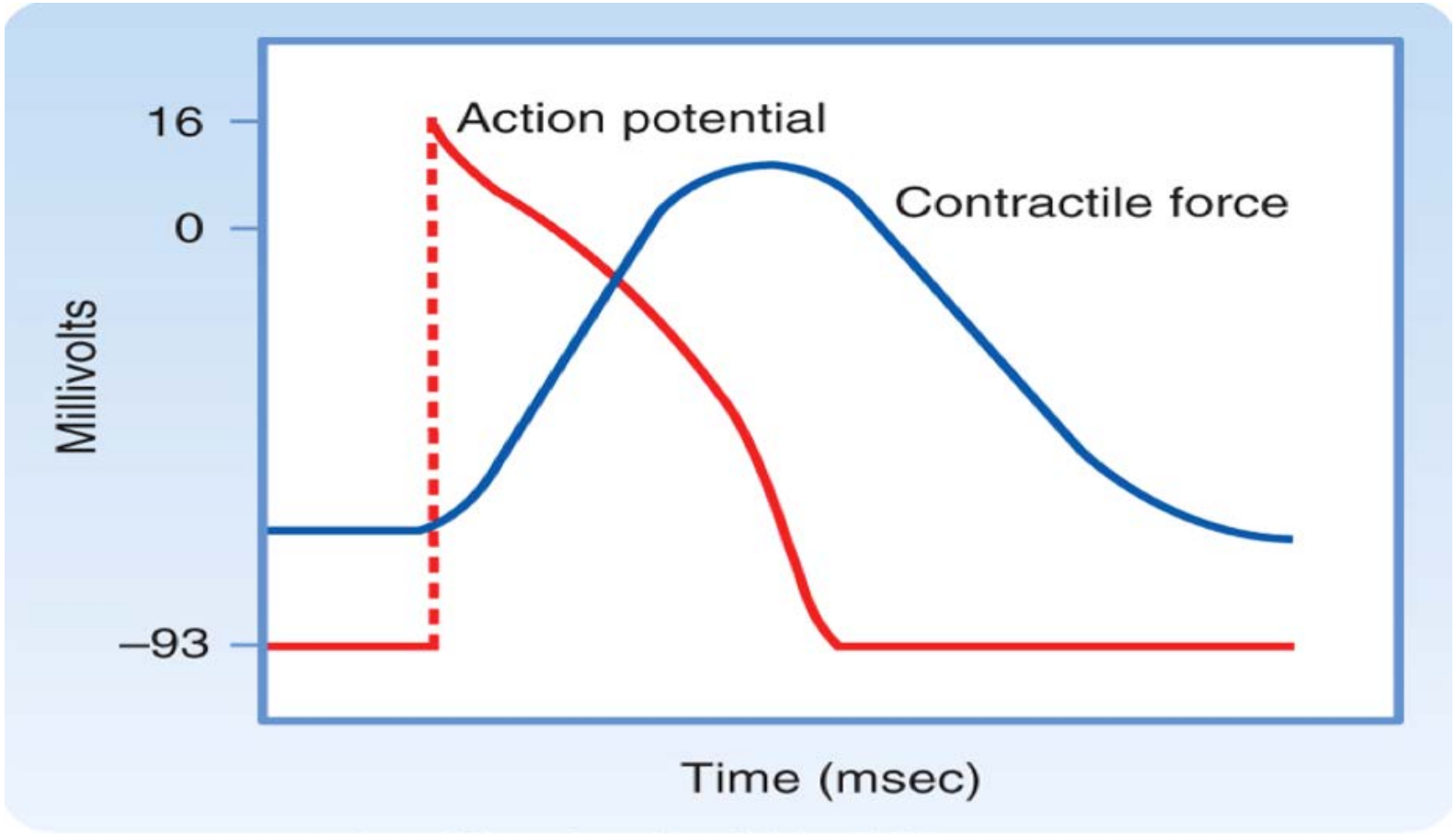


# Calcium influx plays role in strength and duration of the myocardial AP

Relationship between the strength + duration of the AP and calcium channels blocker (Verapamil)

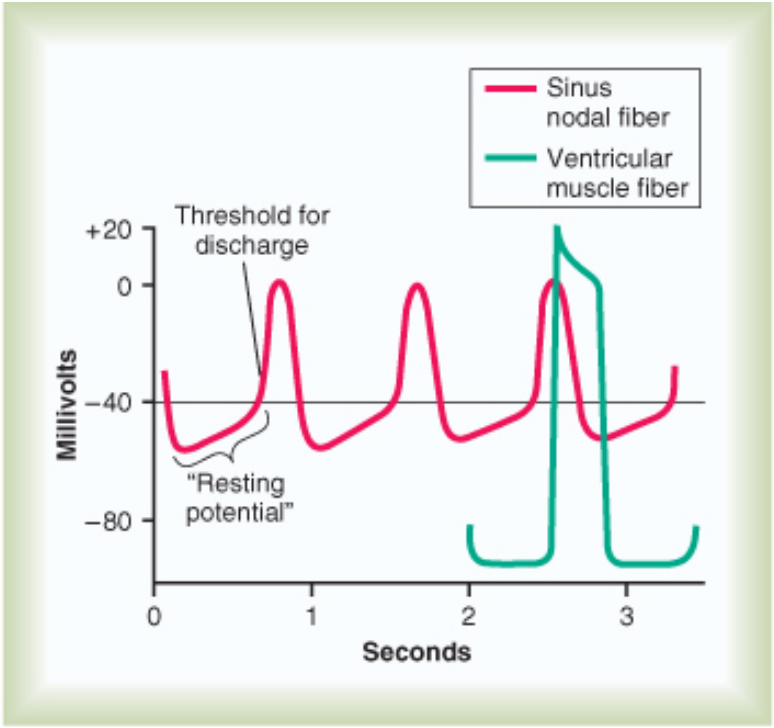


# Prolonged AP prevents tetanic myocardial contraction

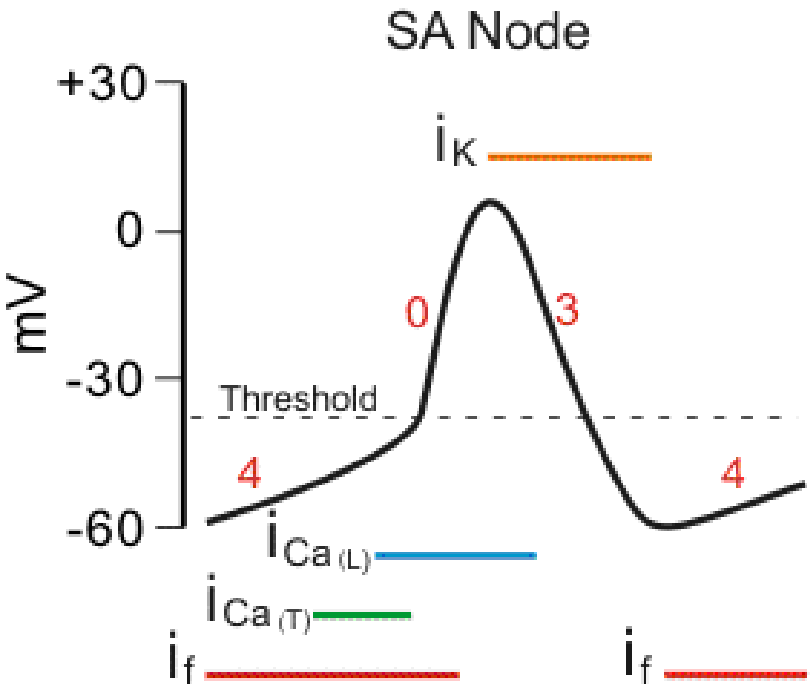


# Cardiac cells types

- working myocardium cells, about 99%
- electrical conduction system cells, about 1%



# Electrical conduction system AP



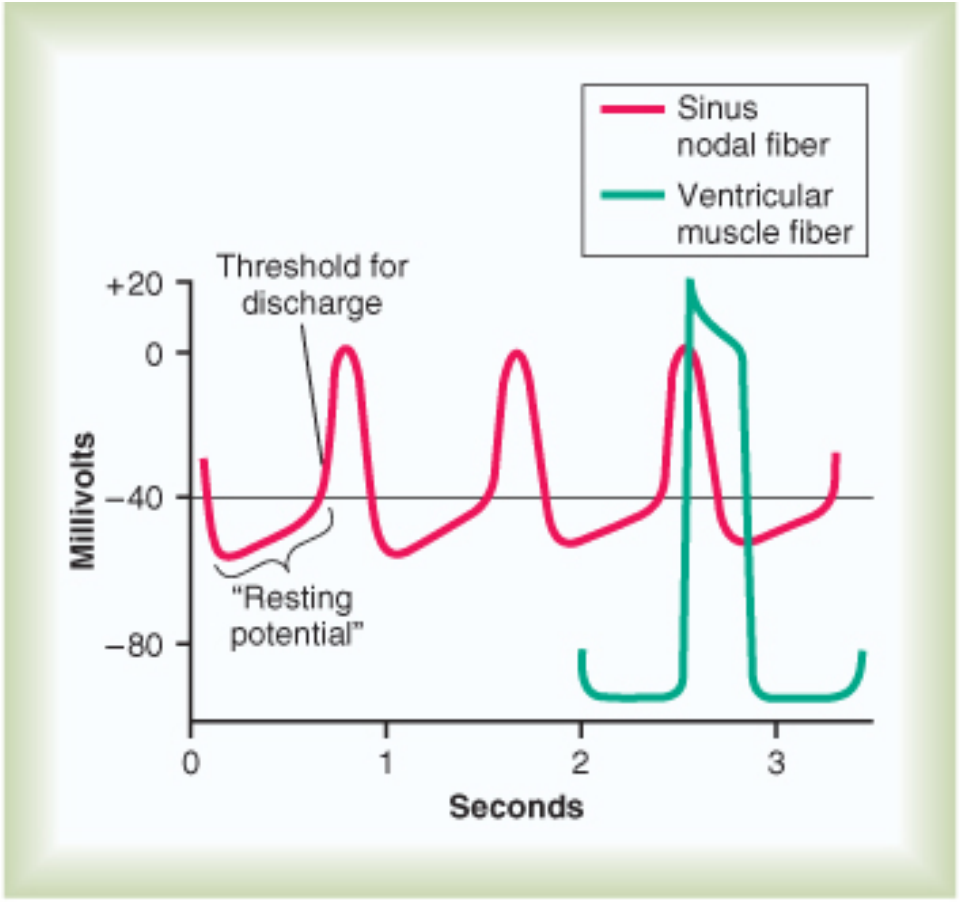

$i_f$ – „funny current“, $Na^+$ - channels

$i_{Ca(T)}$ – „transient“ $Ca^{2+}$ channels

$i_{Ca(L)}$ – „long lasting“ $Ca^{2+}$ channels

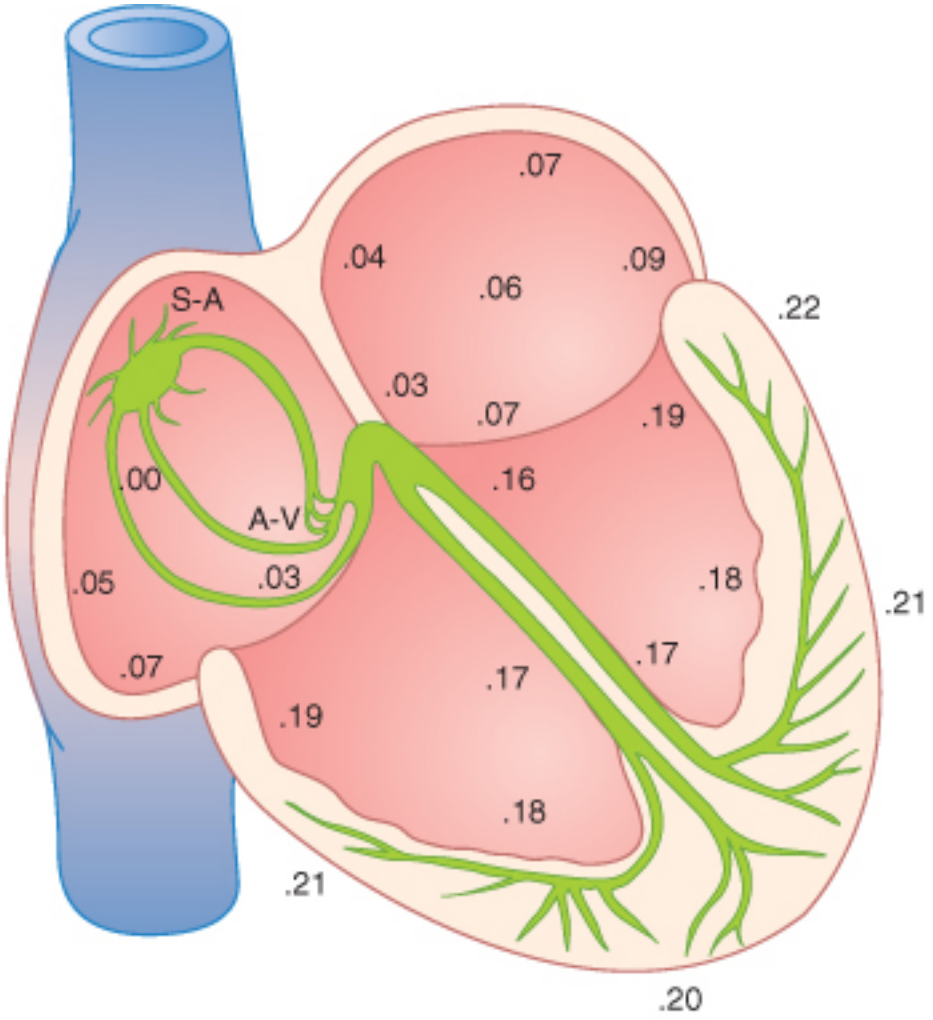
sinoatrial (SA) pacemaker action potencial

# Difference between AP of the working myocardium and the conduction system

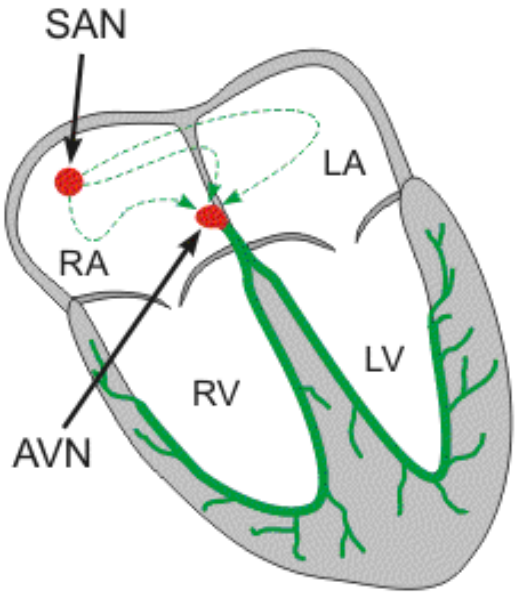



RMP

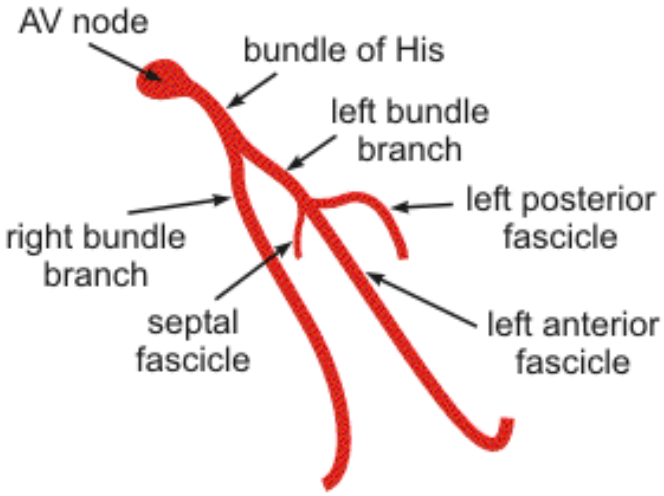
# Conduction system of the heart



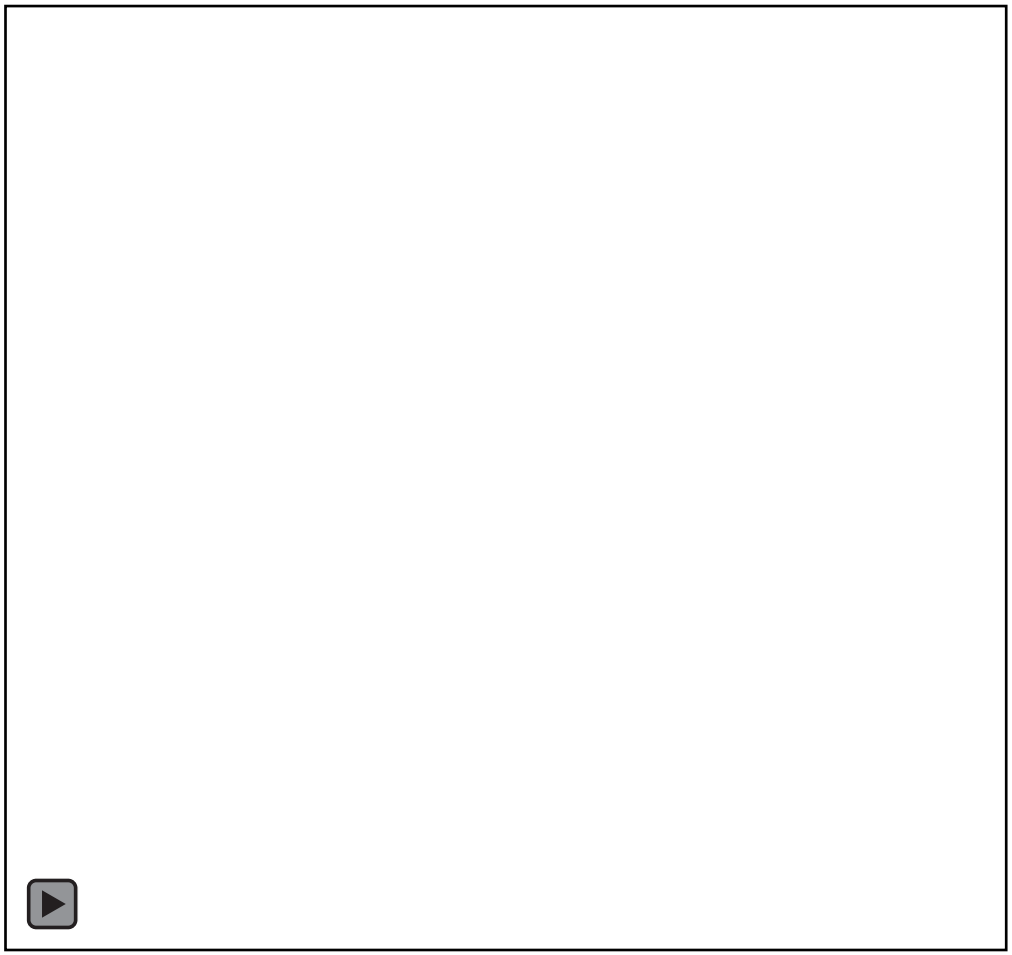
# Conduction of the heart




SAN, sinoatrial node; AVN, atrio-ventricular node; RA, right atrium; LA, left atrium, RV, right ventricle; LV, left ventricle.



# The heart AP propagation



# Electrical characterization of the myocardium

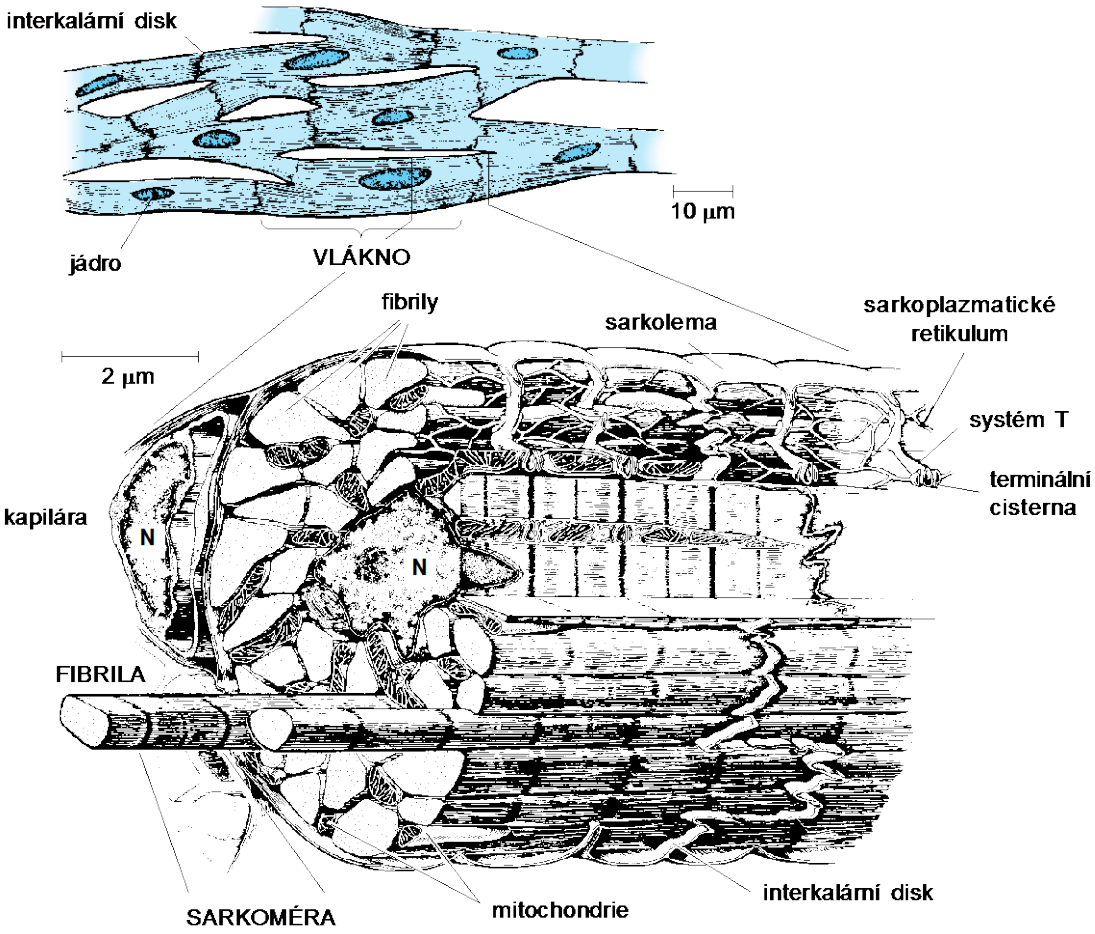
Constant parameters:

- velocity of the activation
- refractory period of the myocardium
- anatomical dimensions

# Excitation – Contraction coupling in the cardiac muscle

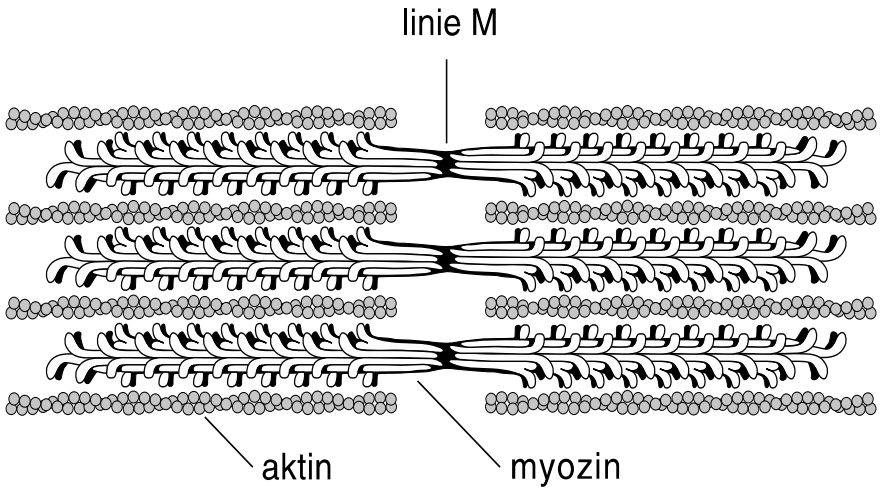
- Spontaneous the heart AP (automacity)
- Gap junctions
- T-tubules
- Contractile elements
- SR
- Mitochondria (ATP)
- $Ca^{2+}$ ionts

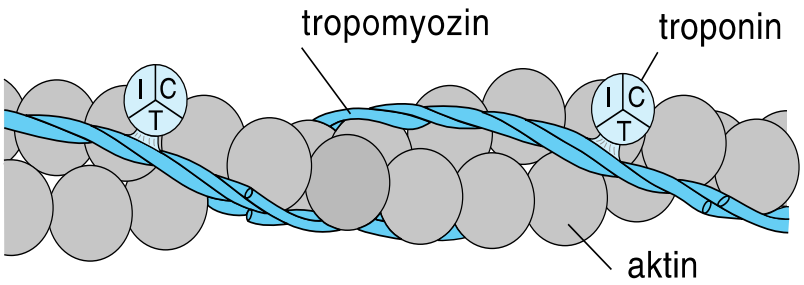
# Structure of the myocardium



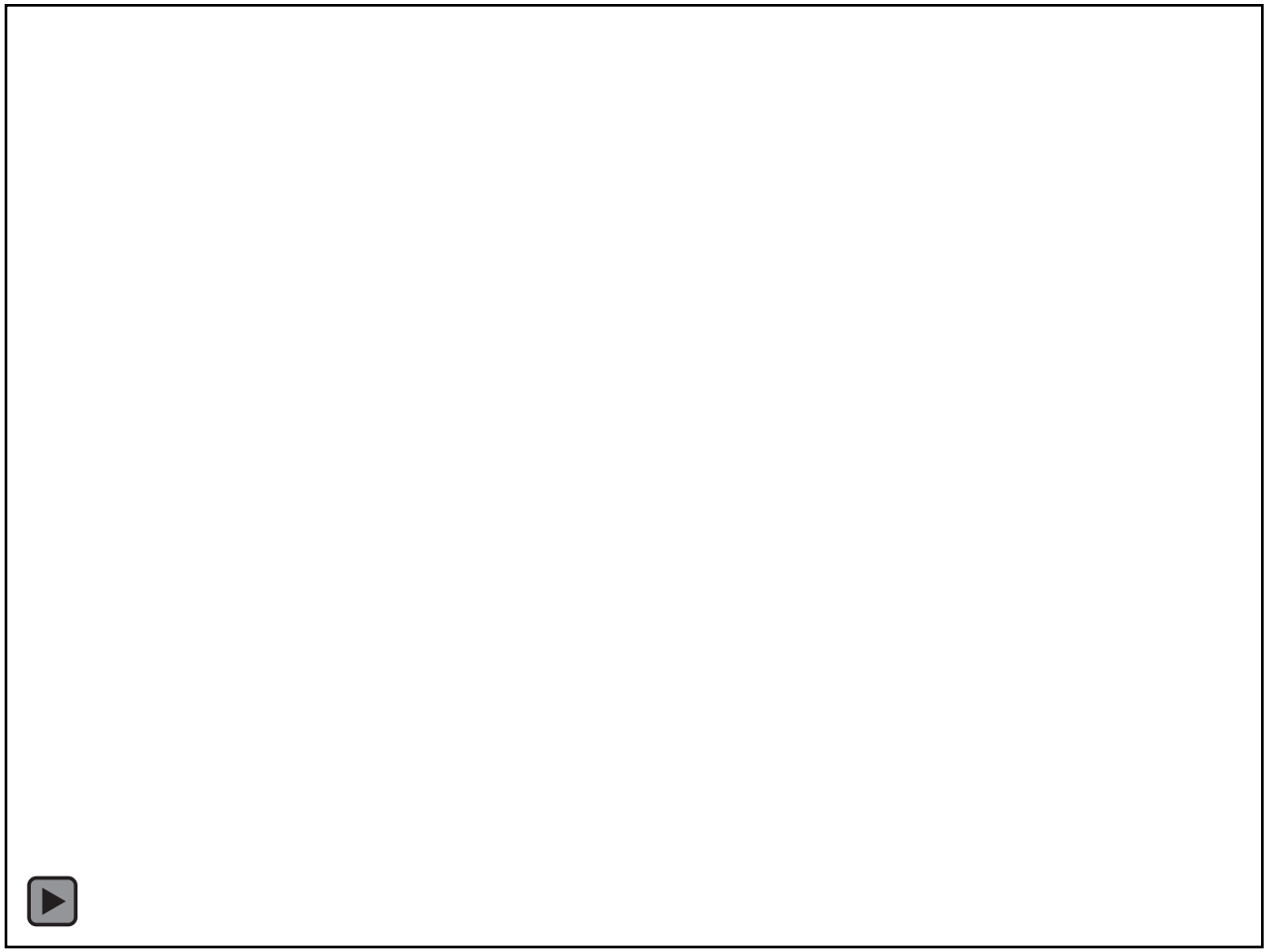
# Contractile elements

- Myosin – the heads=ATPase activity
- Actin
- Tropomyosin
- Troponin complex – TnT, TnC, TnI

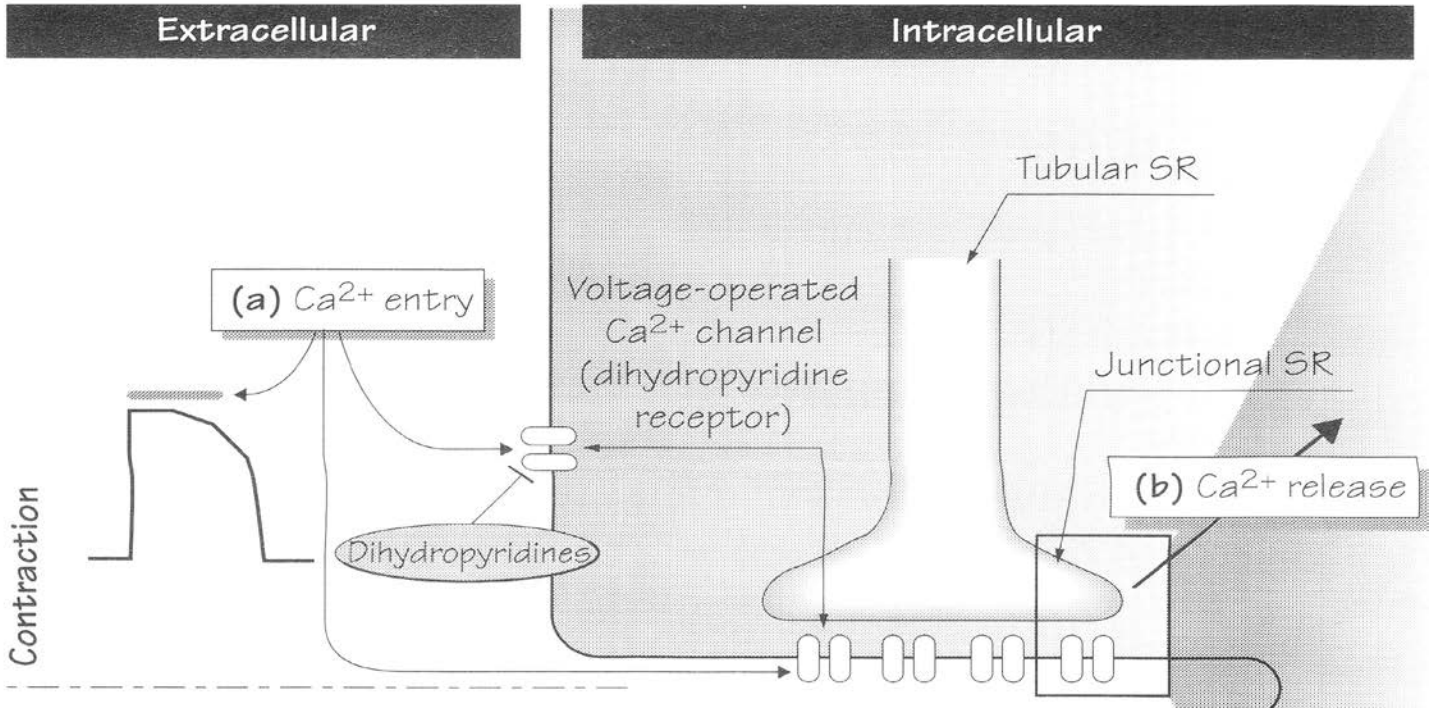


# Actin and myosin interaction



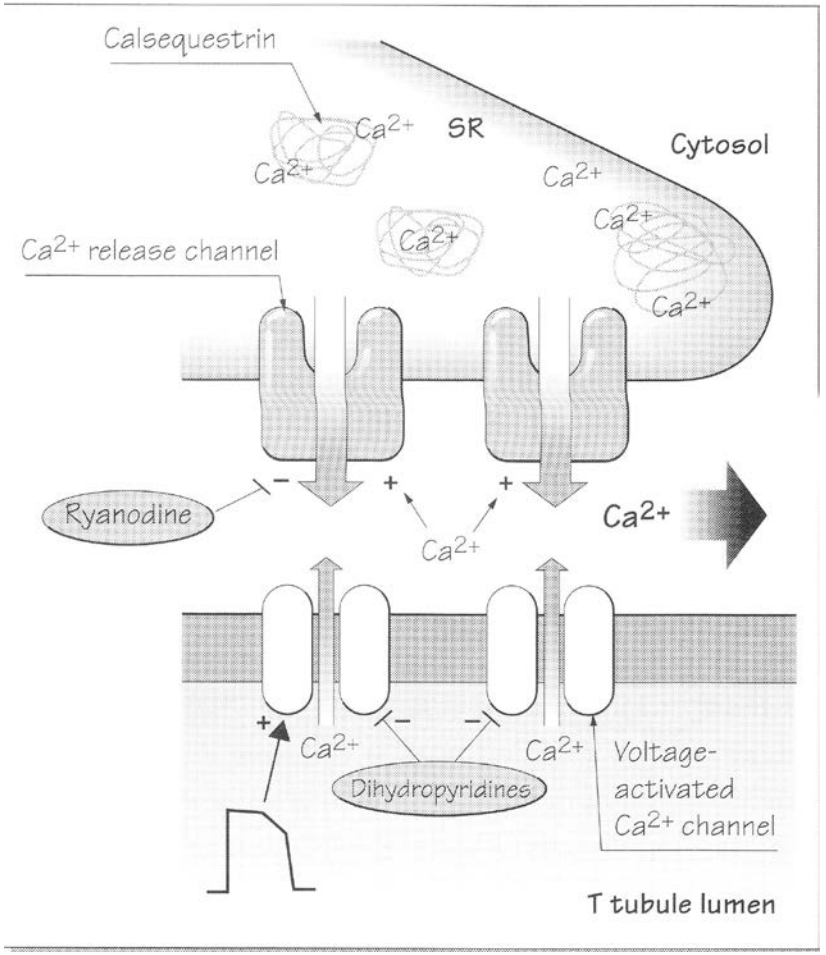
# Excitation – Contraction coupling: initiation of the contraction mechanism



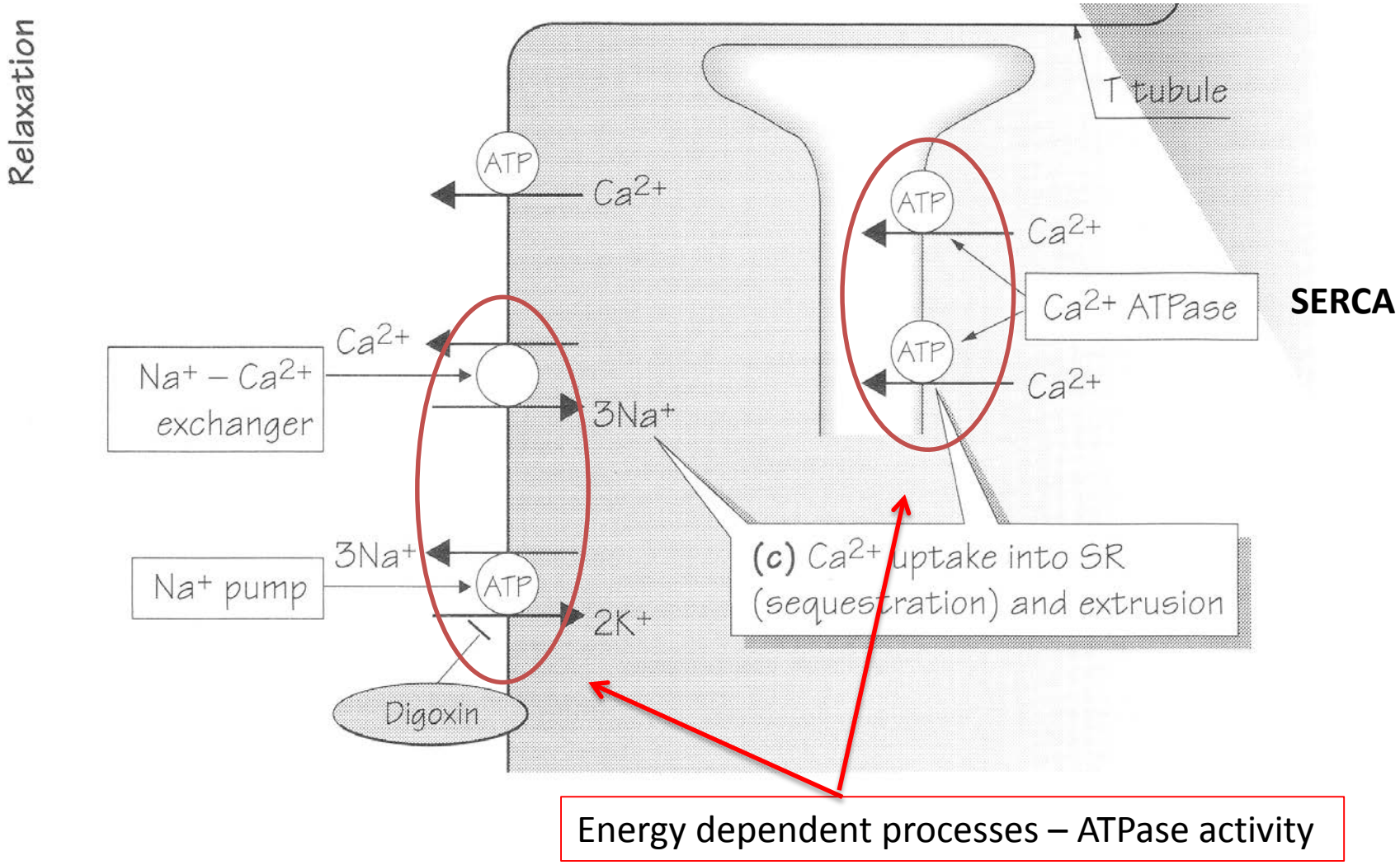

Calcium influx is essential to initiation of the myocardium contraction (about 20% of $Ca^{2+}$), but this amount of calcium is not sufficient to induced whole contraction

# Excitation – Contraction coupling: calcium release from SR

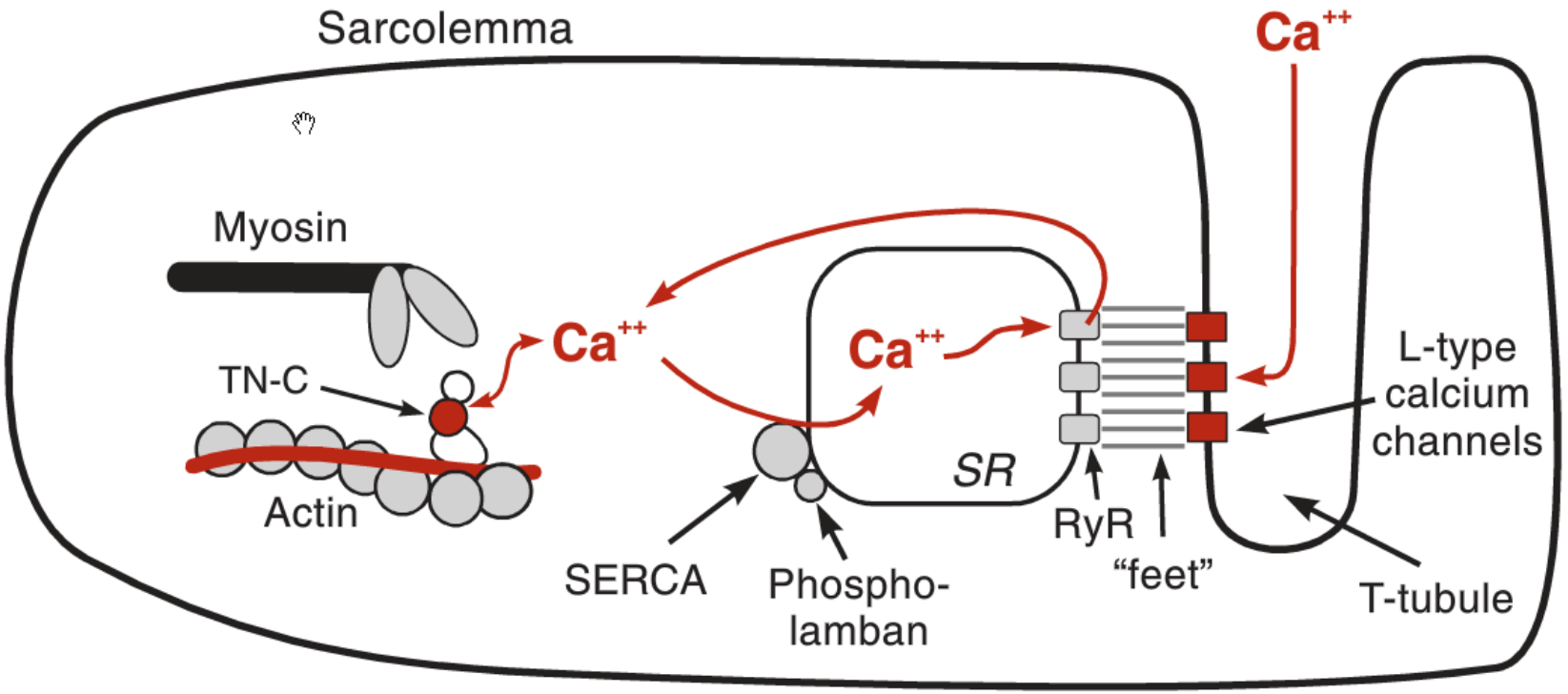
- CIRC – calcium-induced calcium release
- Calcium supply from SR is about 80% amount essential for contraction



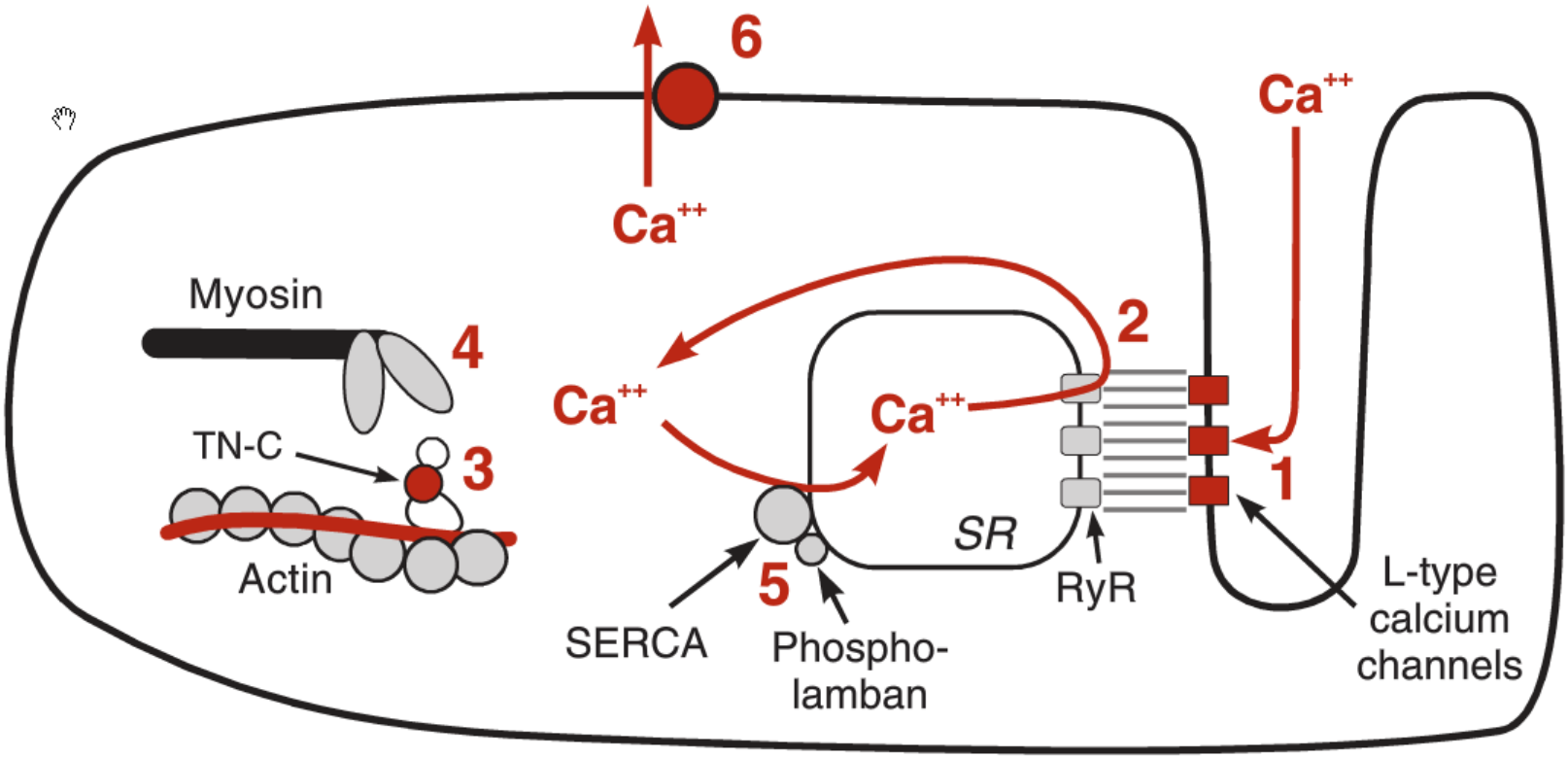
# Excitation – Contraction coupling: relaxation mechanism



# Excitation – Contraction coupling

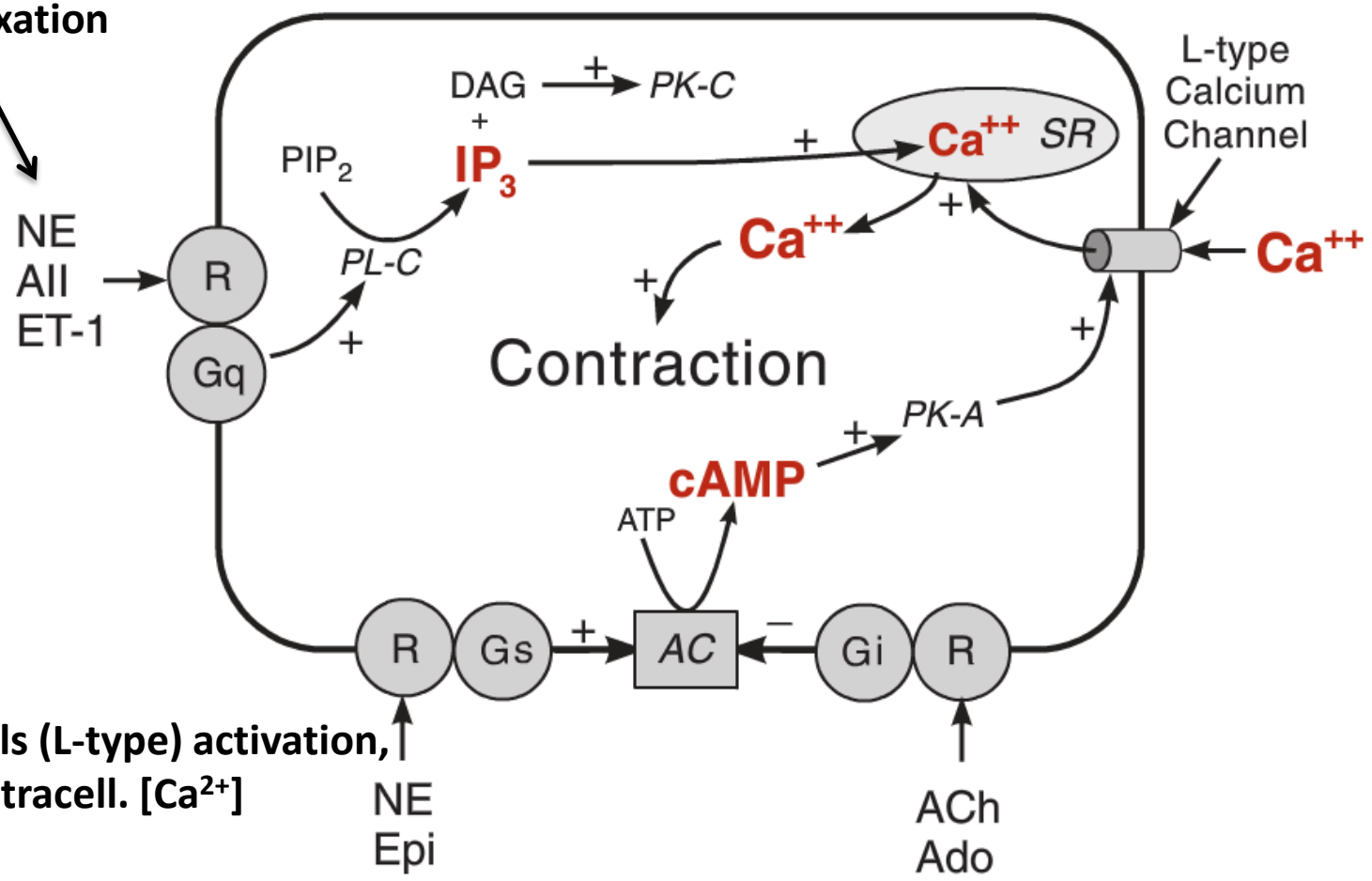


# Calcium ionts during excitation – contraction coupling



# Homeometric regulation of contraction by catecholamins

**Fosforylation of fosfolambam**
**faster relaxation**




**$Ca^{2+}$ chanels (L-type) activation,**
**Increase intracell. [$Ca^{2+}$]**

NE
Epi

ACh
Ado

Thank you

# Spřažení kontrakce - relaxace