Pathologic contractile function of the heart
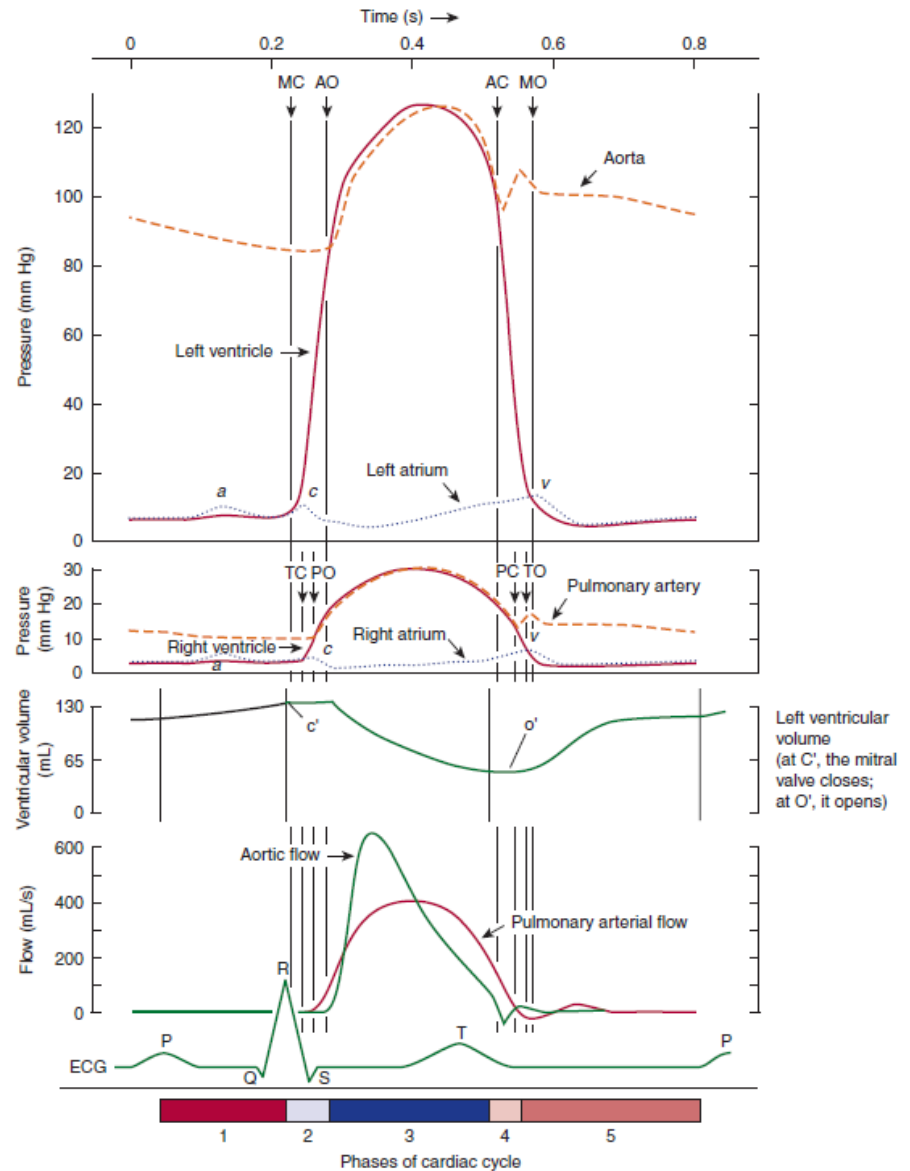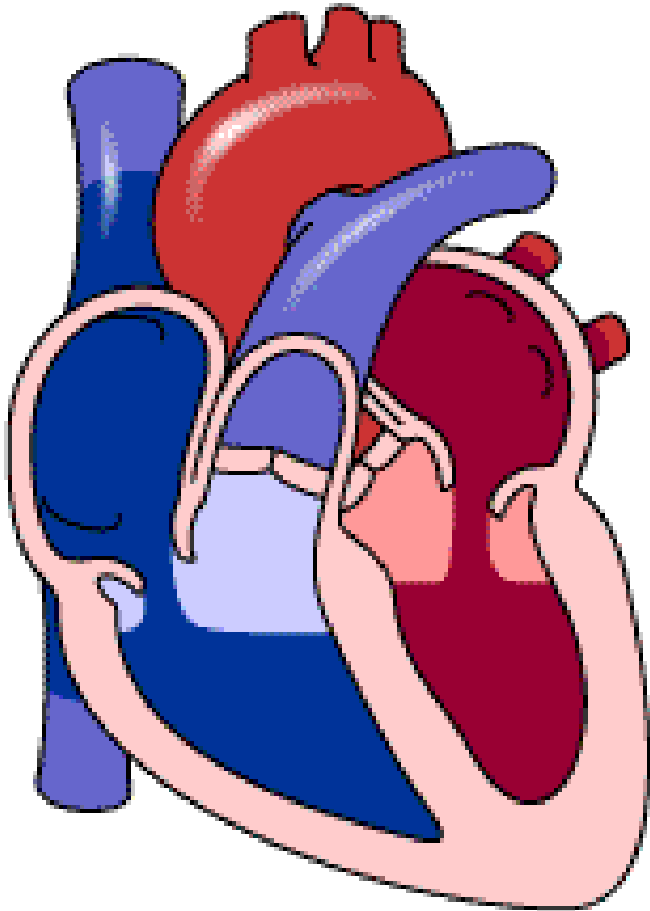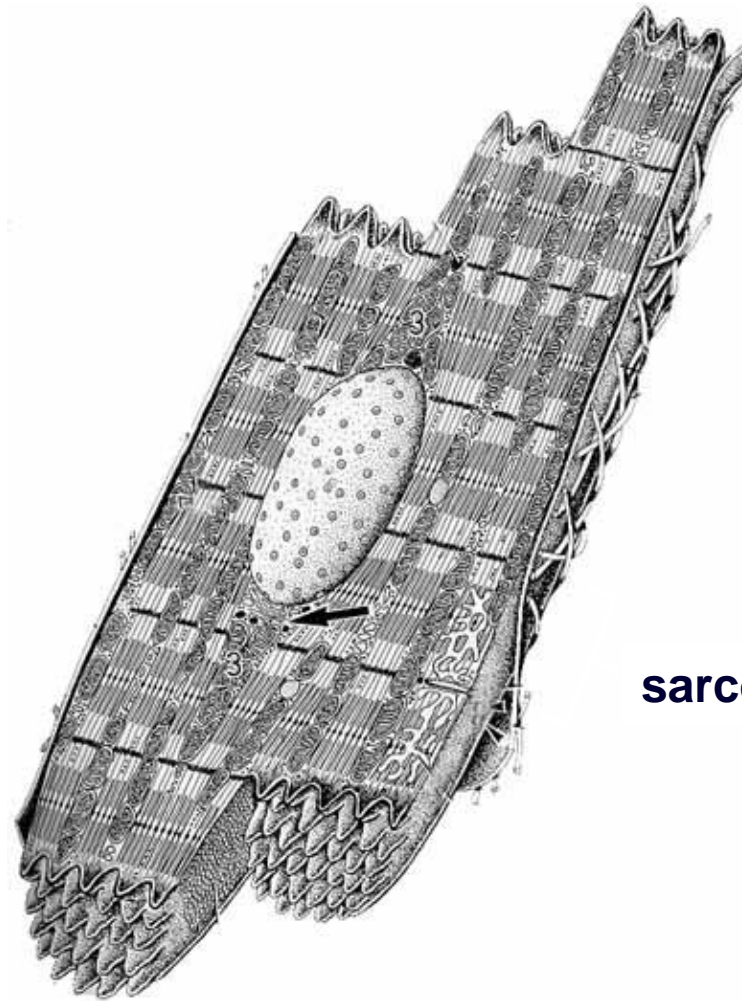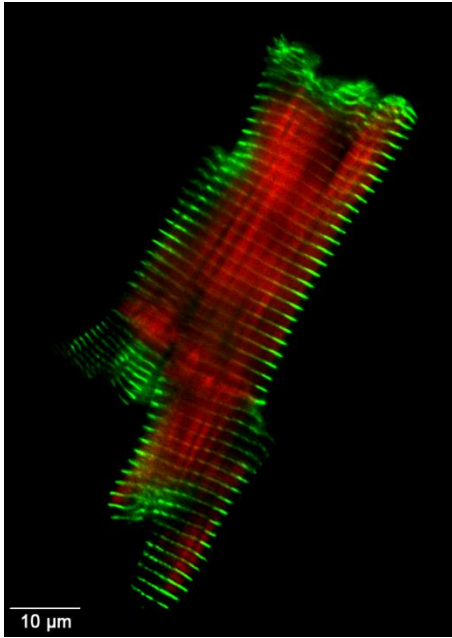
Dr. Zoltán Papp
UD Department of Cardiology
Division of Cinical Physiology
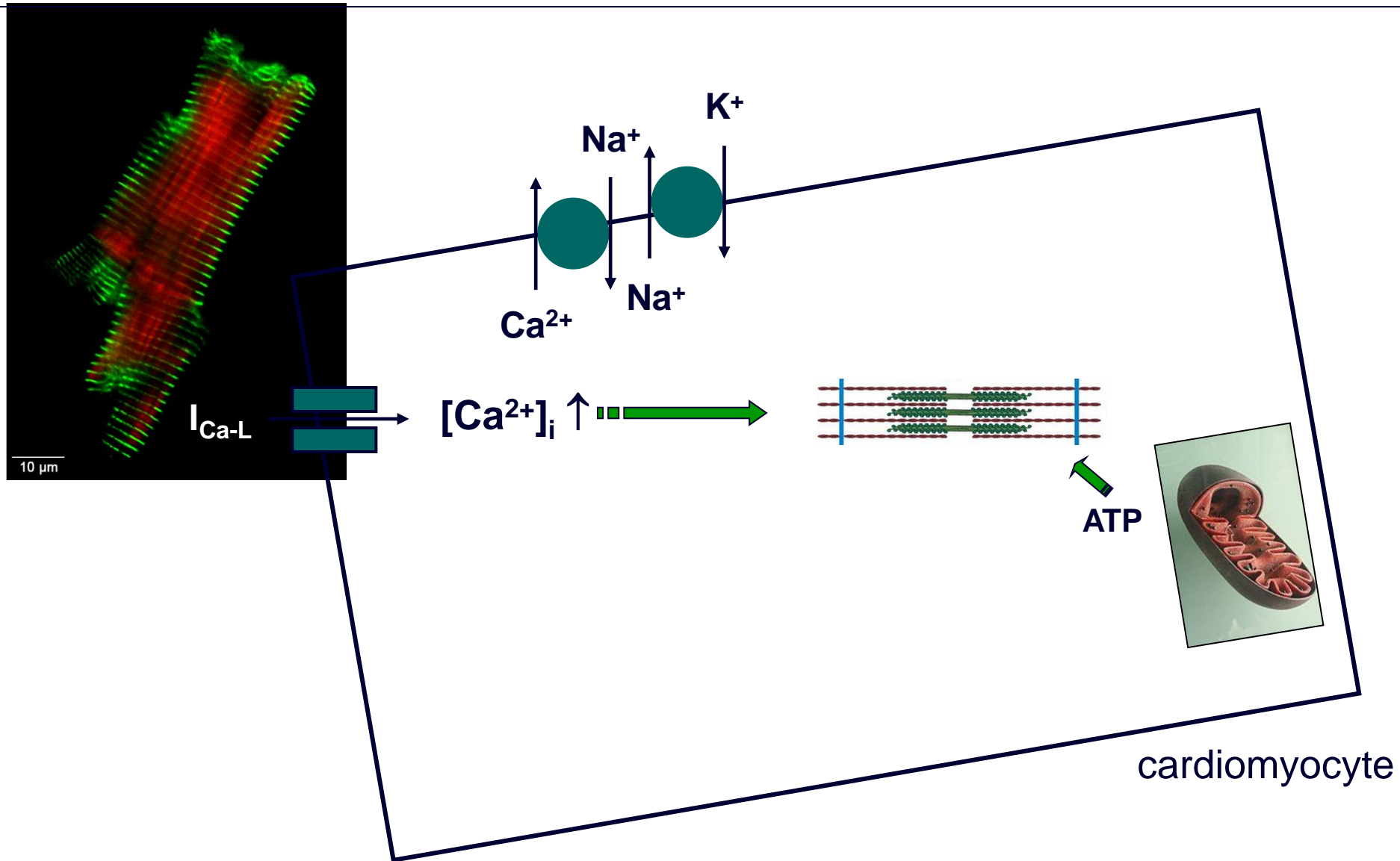
Events of the cardiac cycle

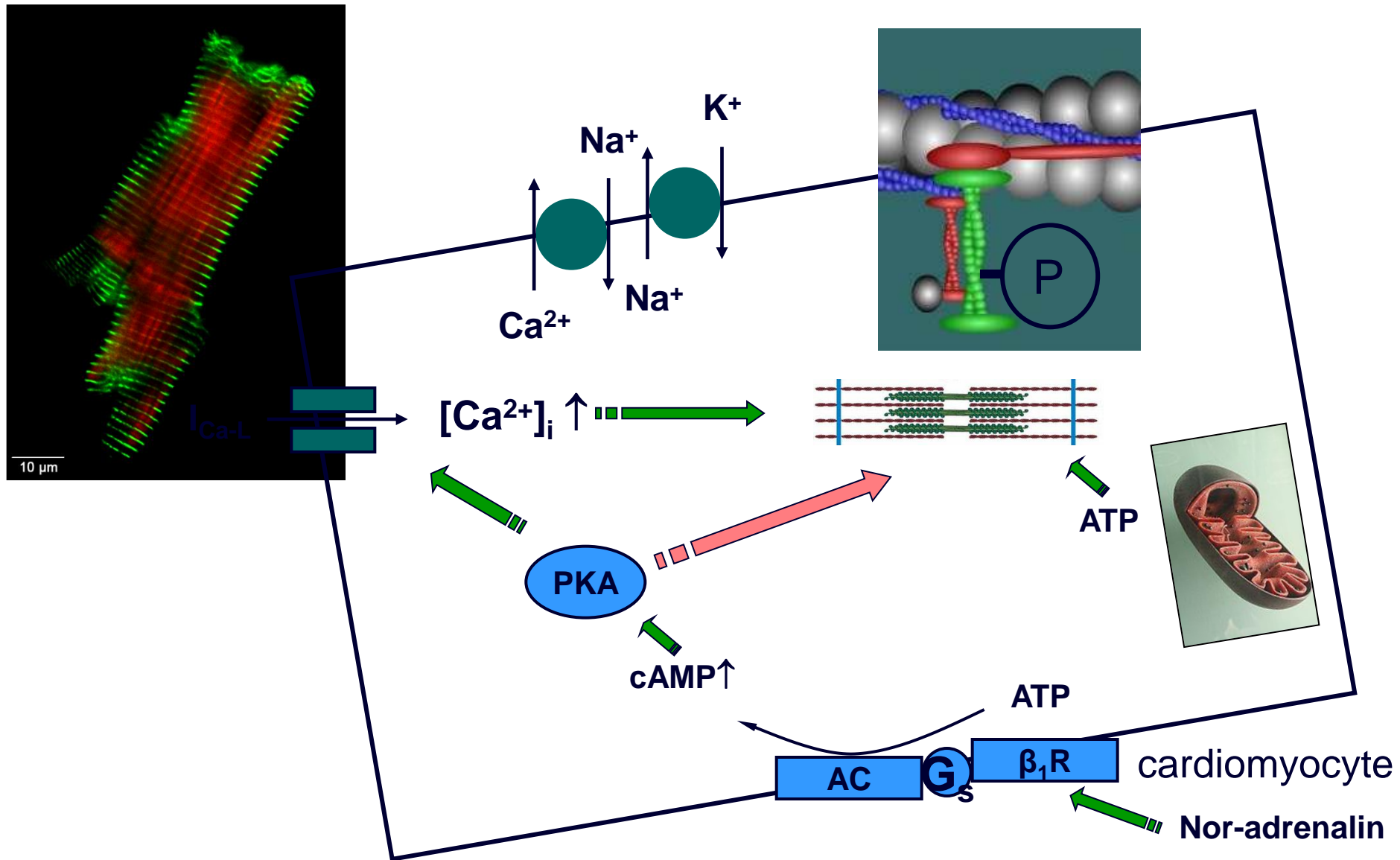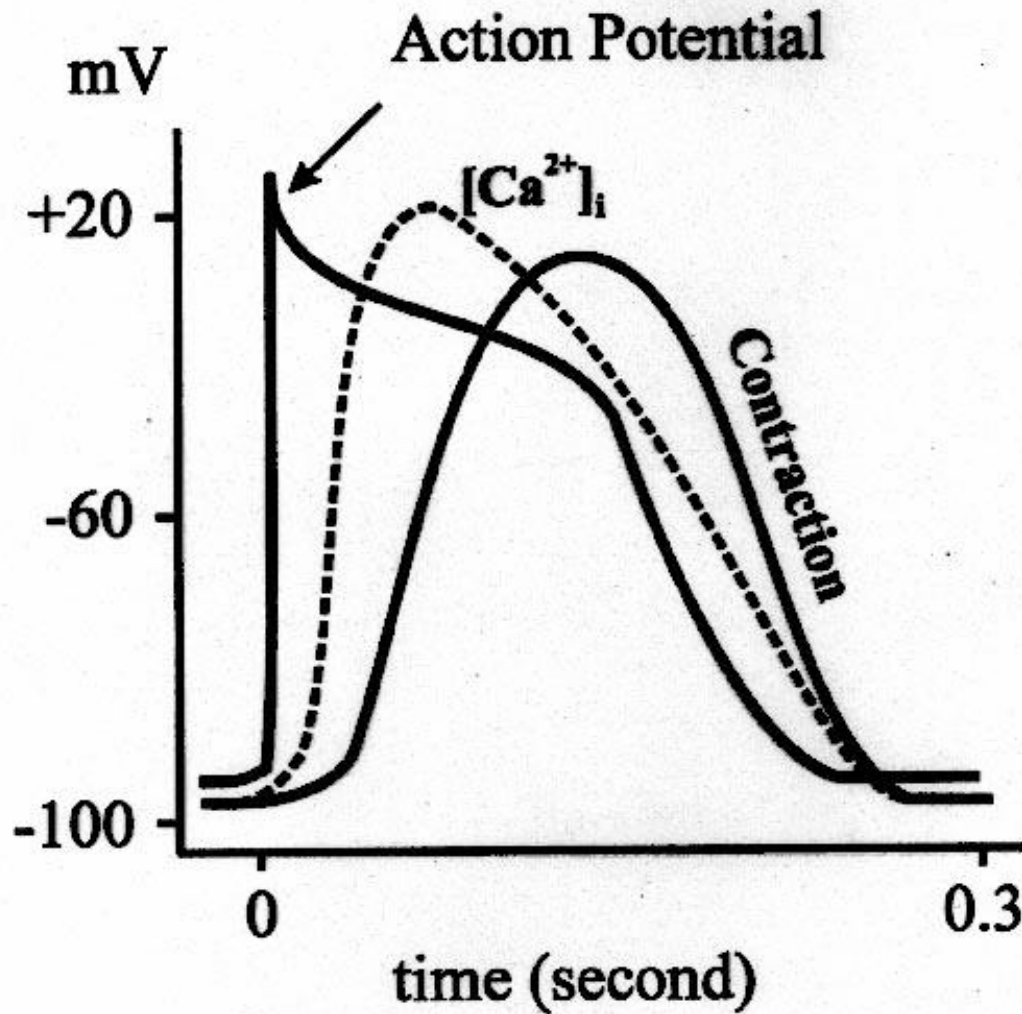# Contractile force is the result of sarcomere shortening

sarcomere

Myocardial contractility =
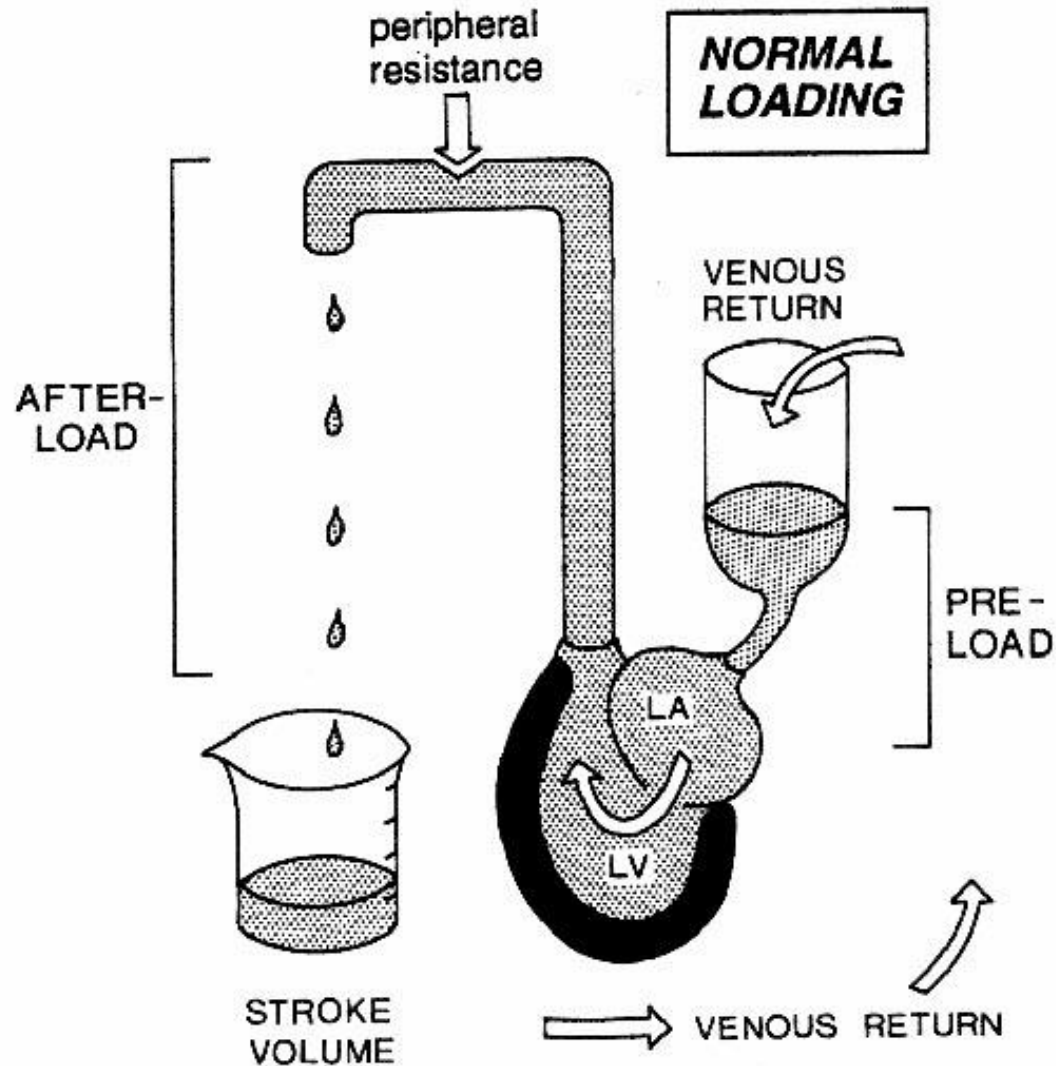# Ca^{2+}-concentration + Ca^{2+}-sensitivity

K^+

Na^+

Na^+

Ca^{2+}

I_{Ca-L}

$[Ca^{2+}]_i \uparrow$

ATP

cardiomyocyte

10 µm

Myocardial contractility =
Ca²⁺-concentration + Ca²⁺-sensitivity

K^+

Na^+

Na^+

Ca^{2+}

P

I_{Ca-L}

10 µm

$[Ca^{2+}]_i \uparrow$

ATP

PKA

cAMP$\uparrow$
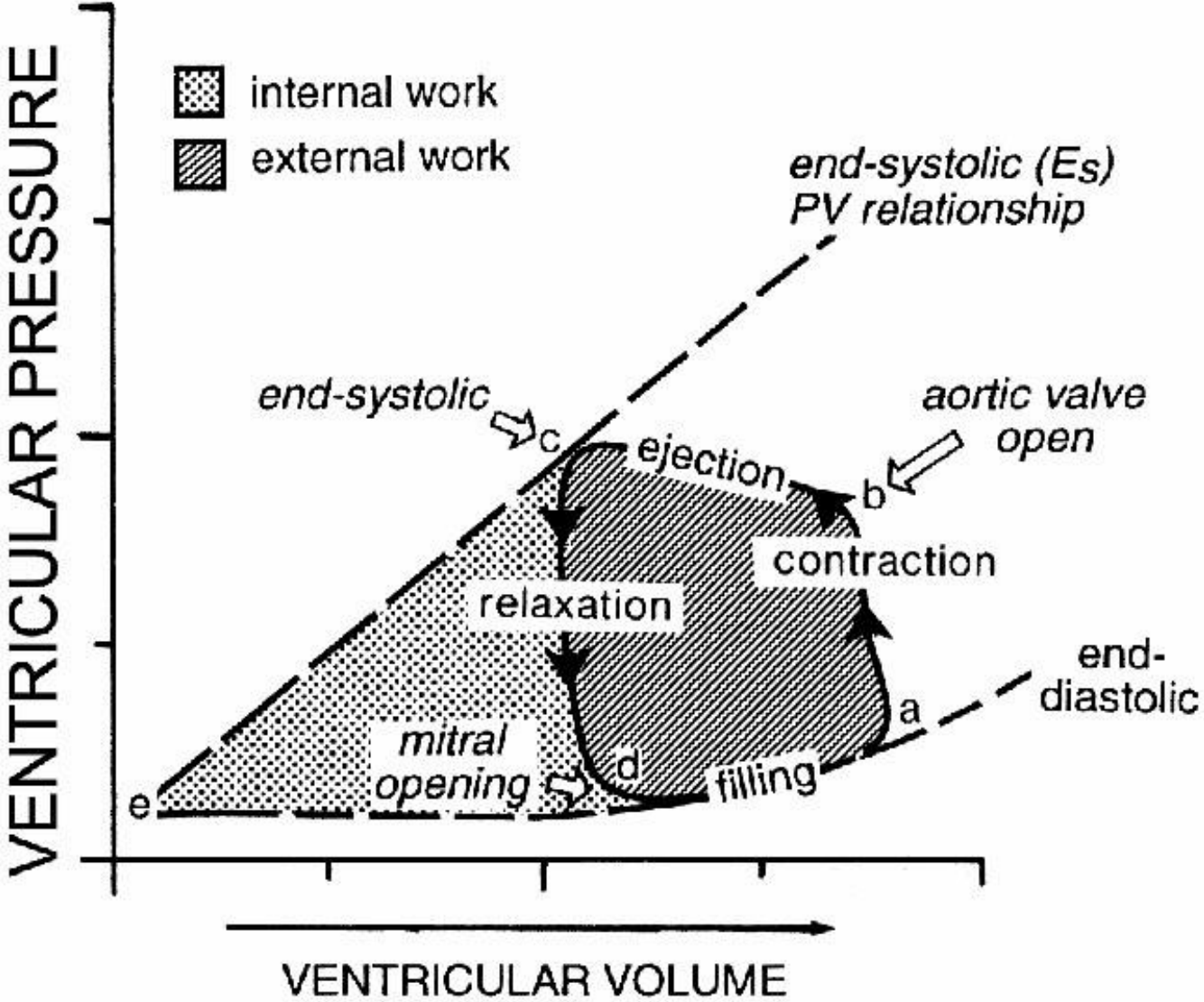
ATP

AC G$_s$ β₁R   cardiomyocyte
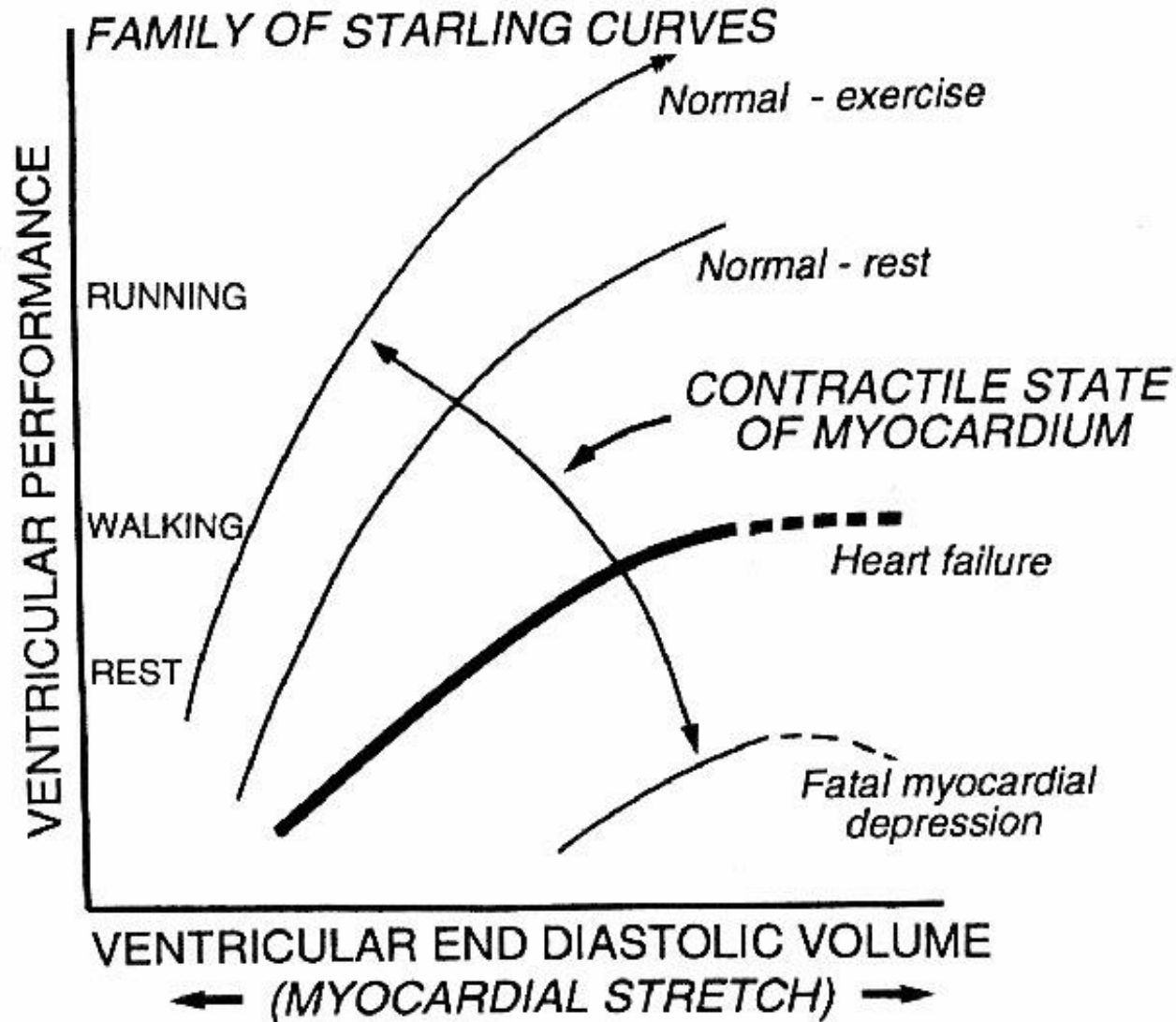
Nor-adrenalin

Action potential, Ca²⁺ transient, contraction
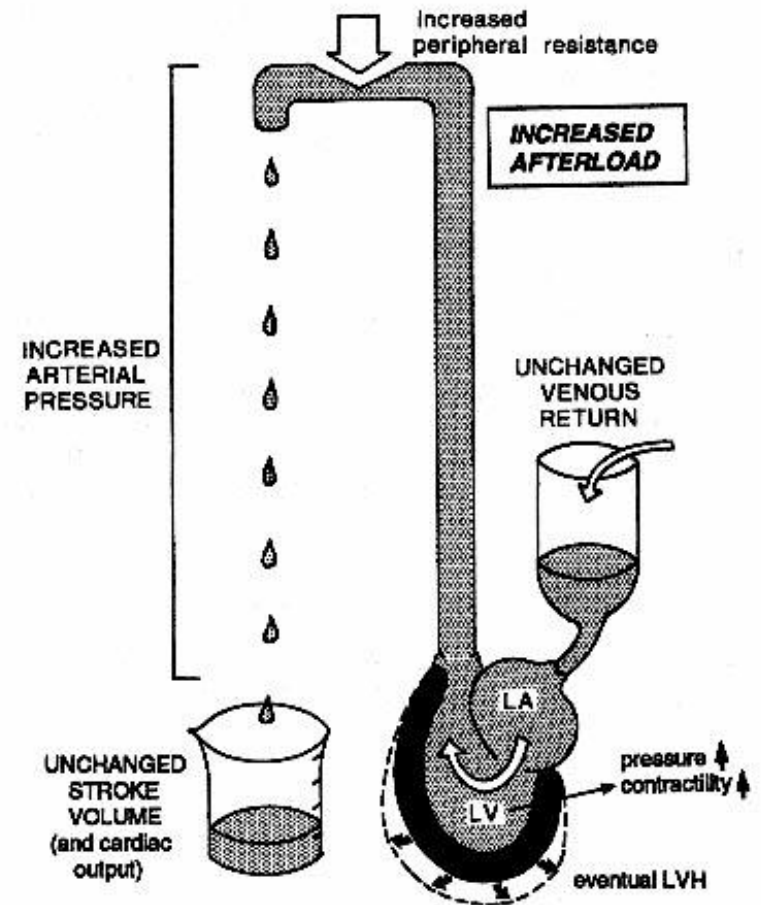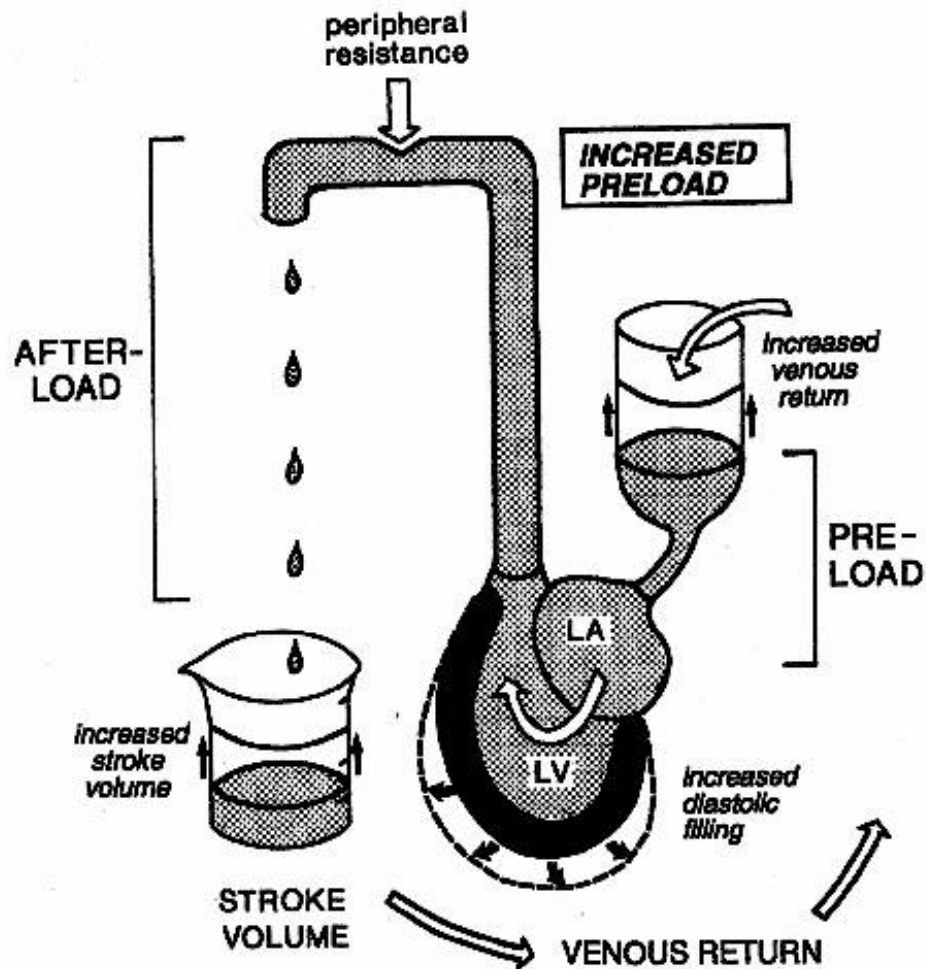
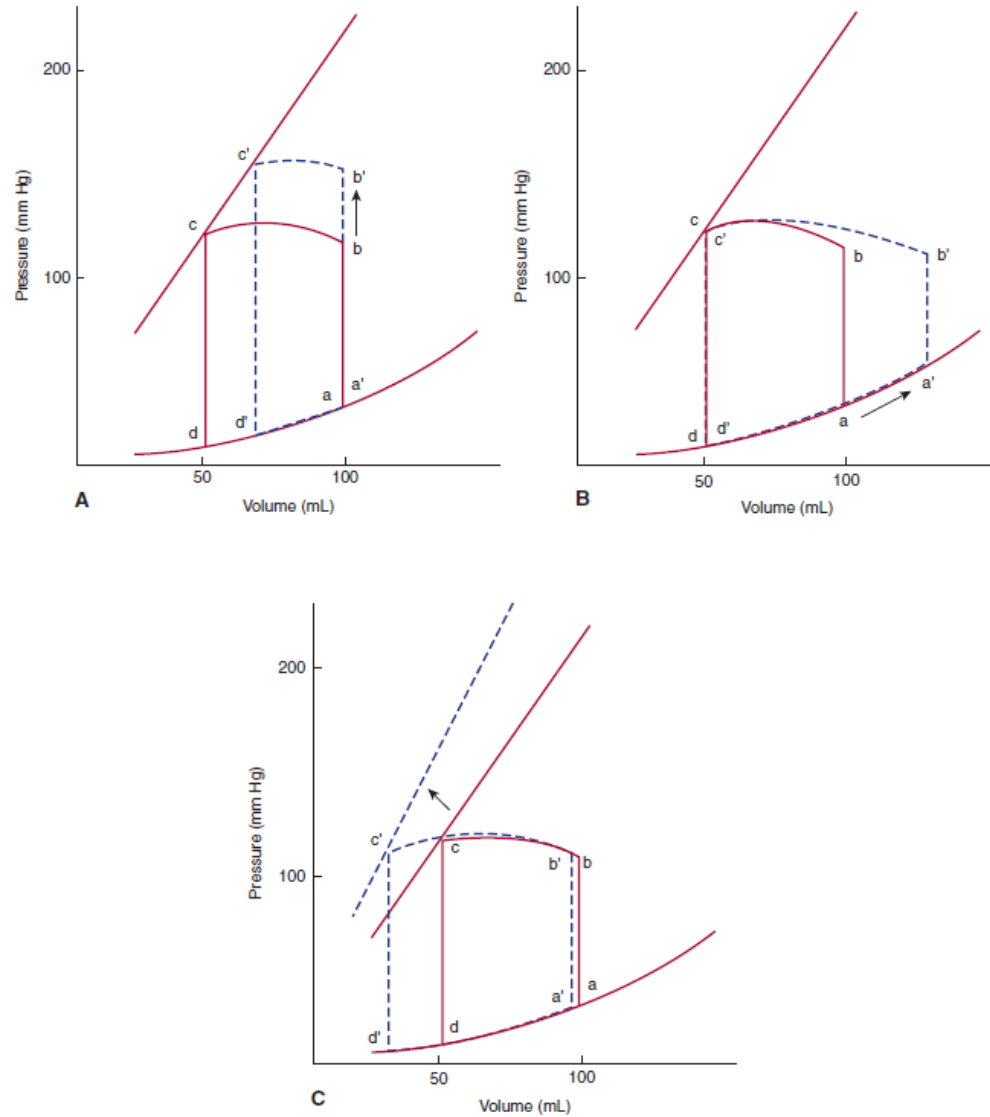# Cardiac preload and afterload

Cardiac cycle and cardiac work
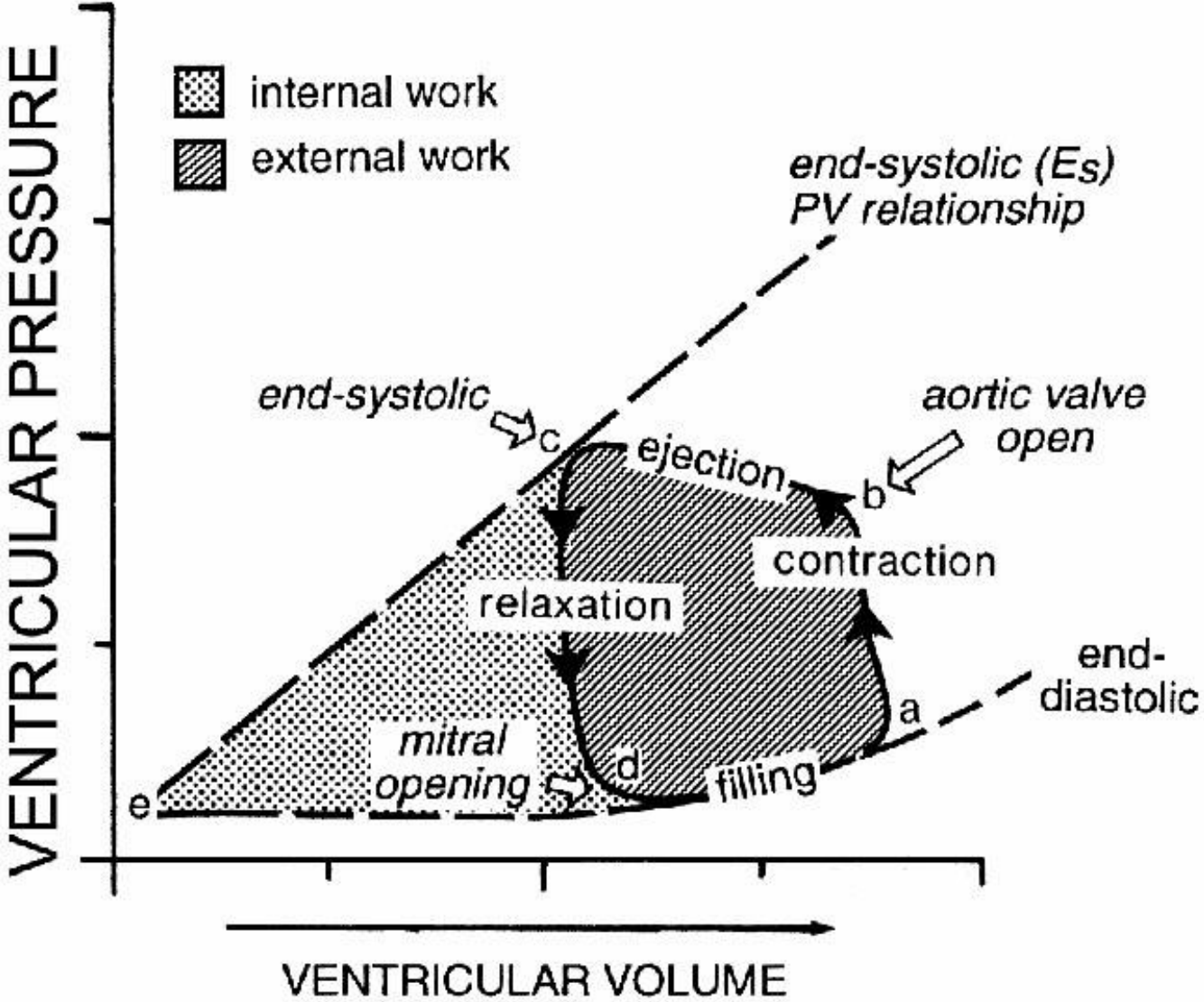
Ventricular function curves
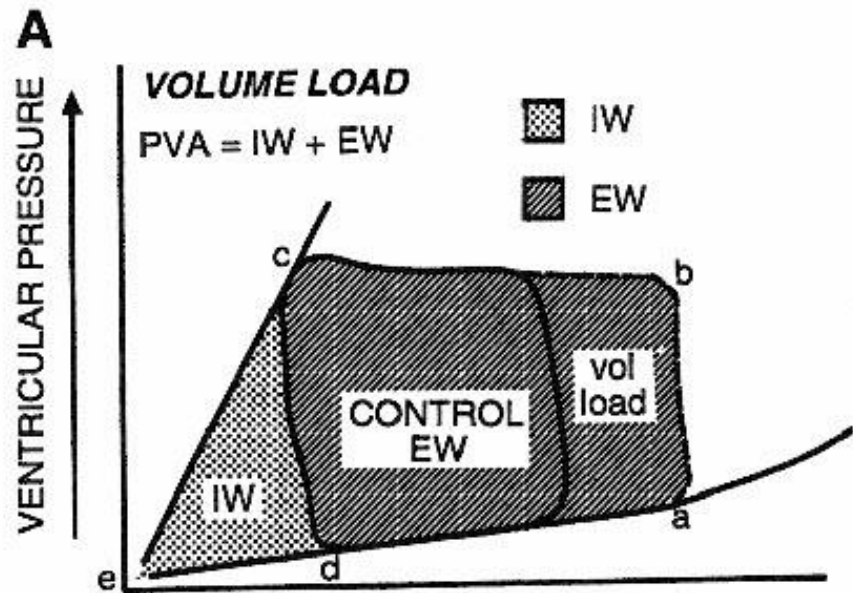
Increased preload and afterload

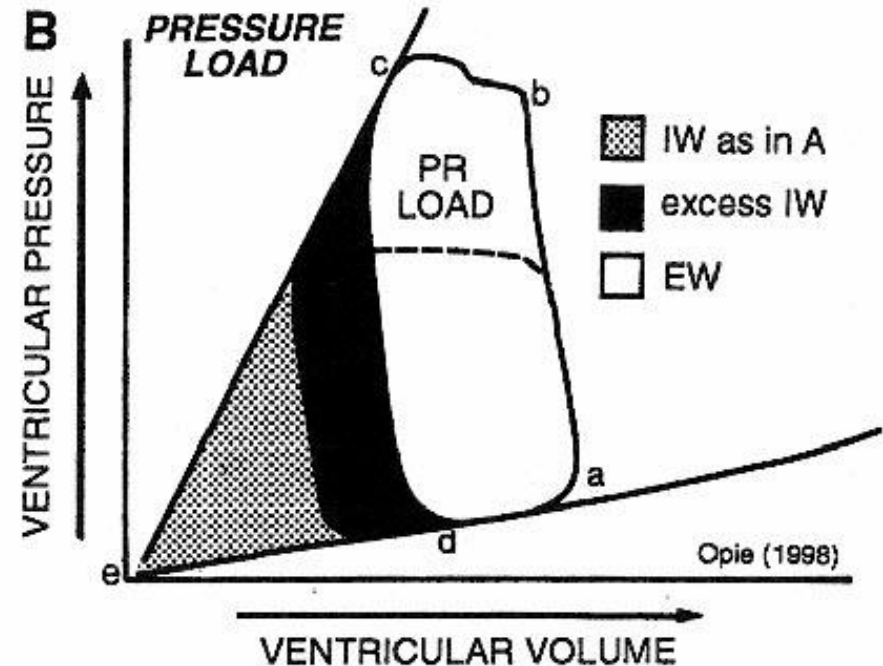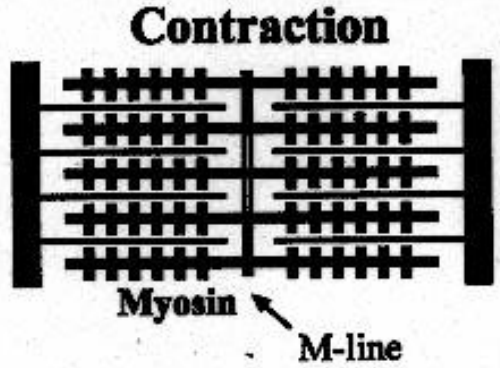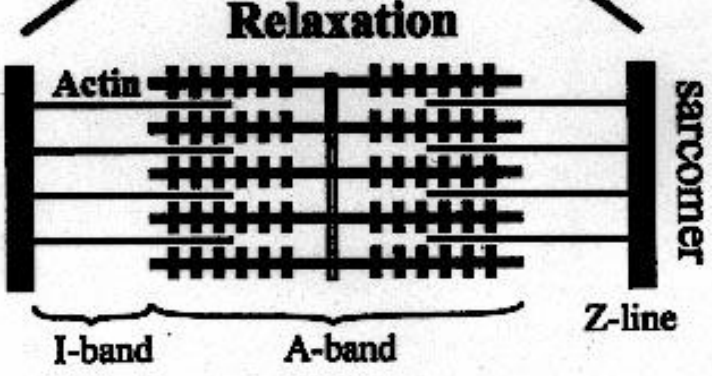# Responses on changes in loading conditions and contractility
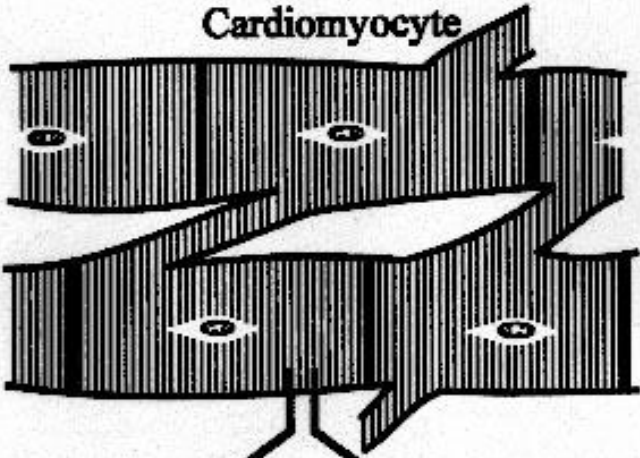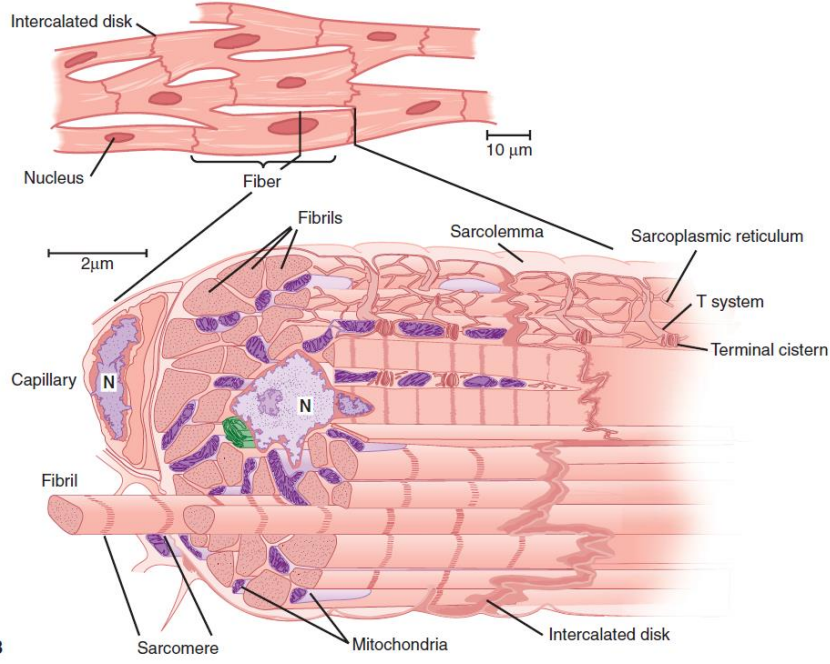
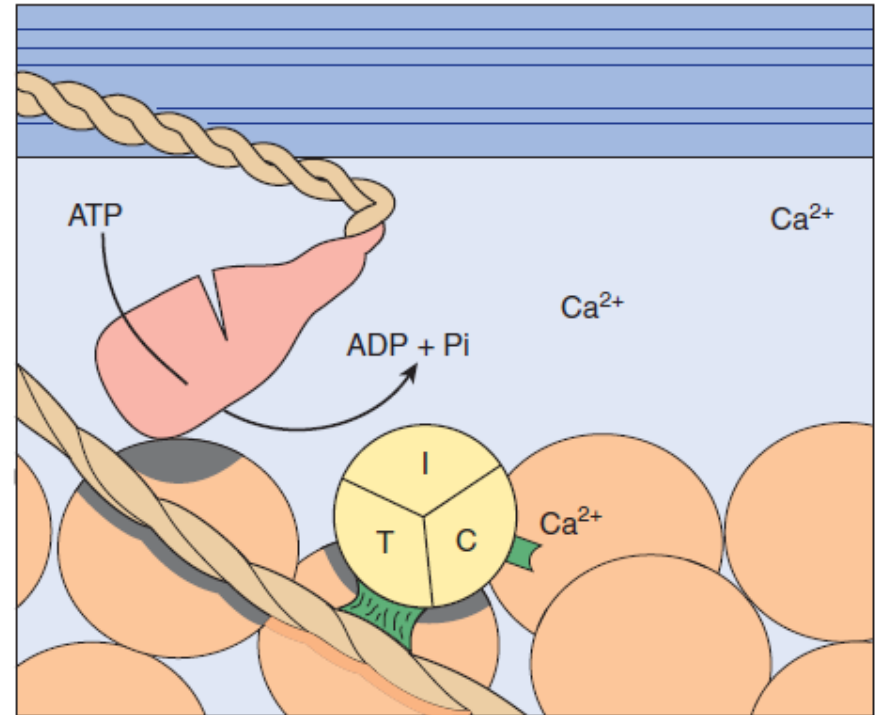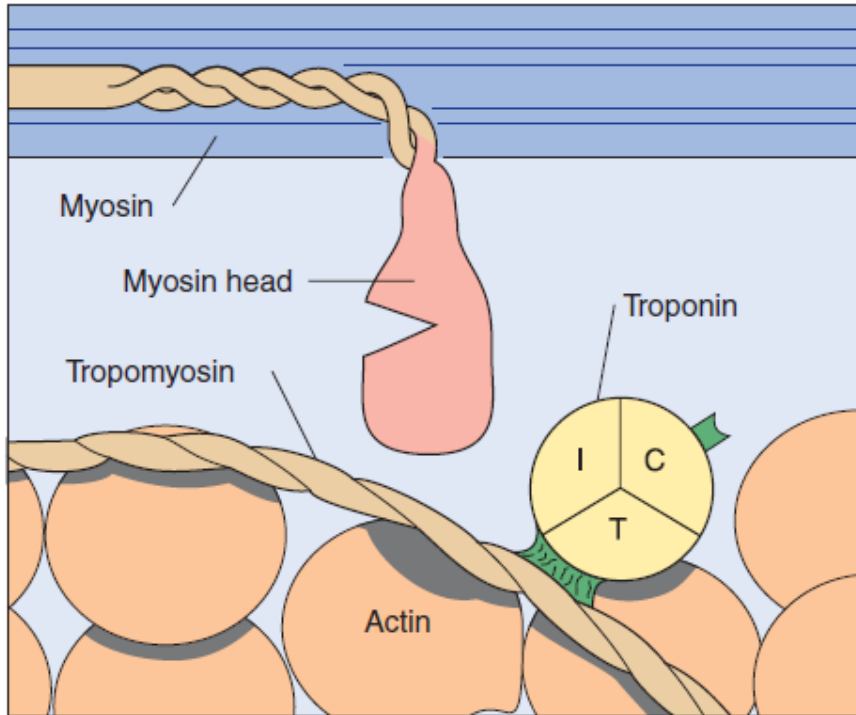# Cardiac cycle and cardiac work

Increased preload

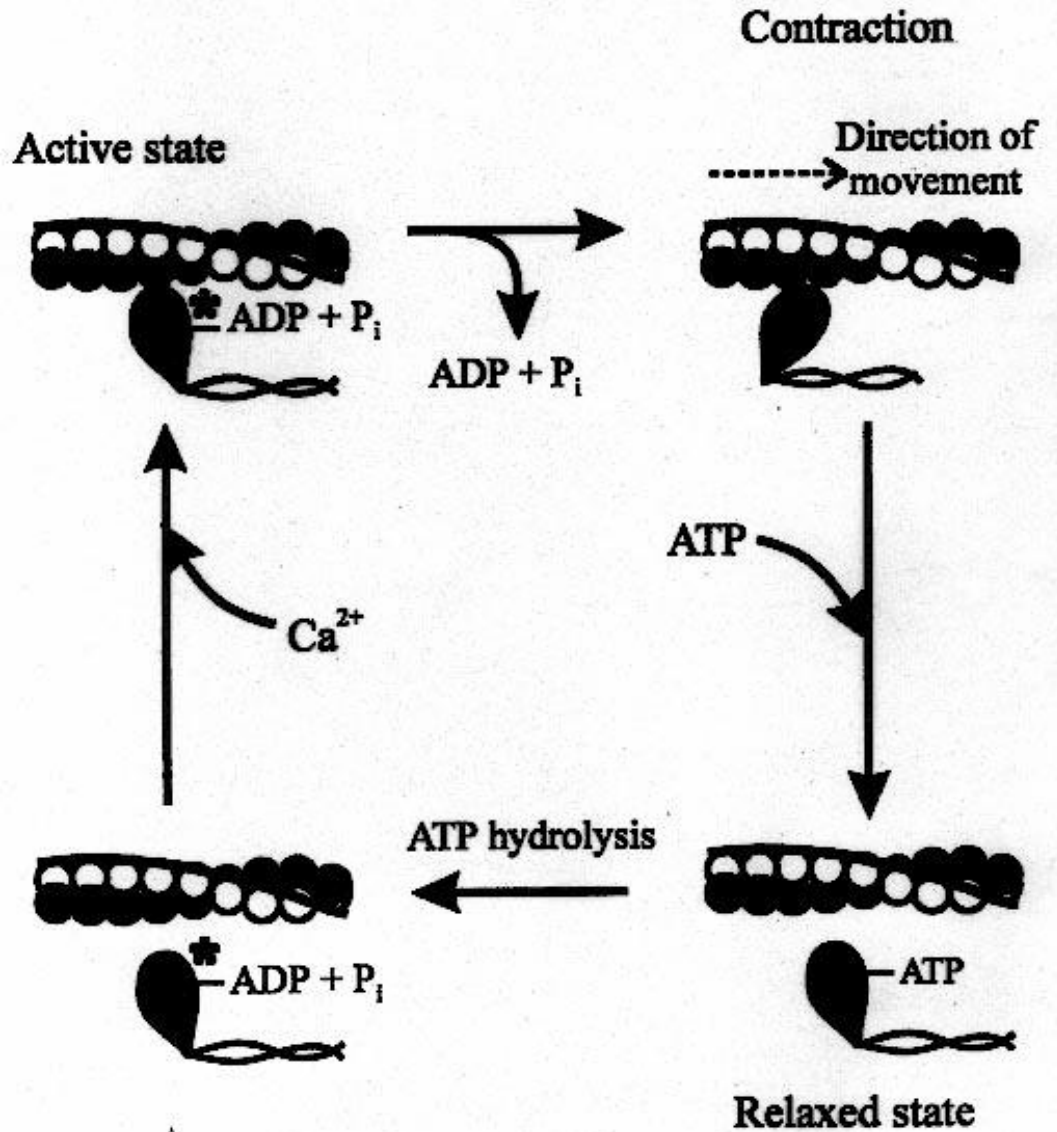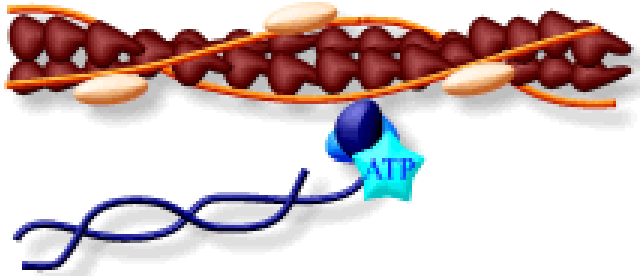**Increased afterload**
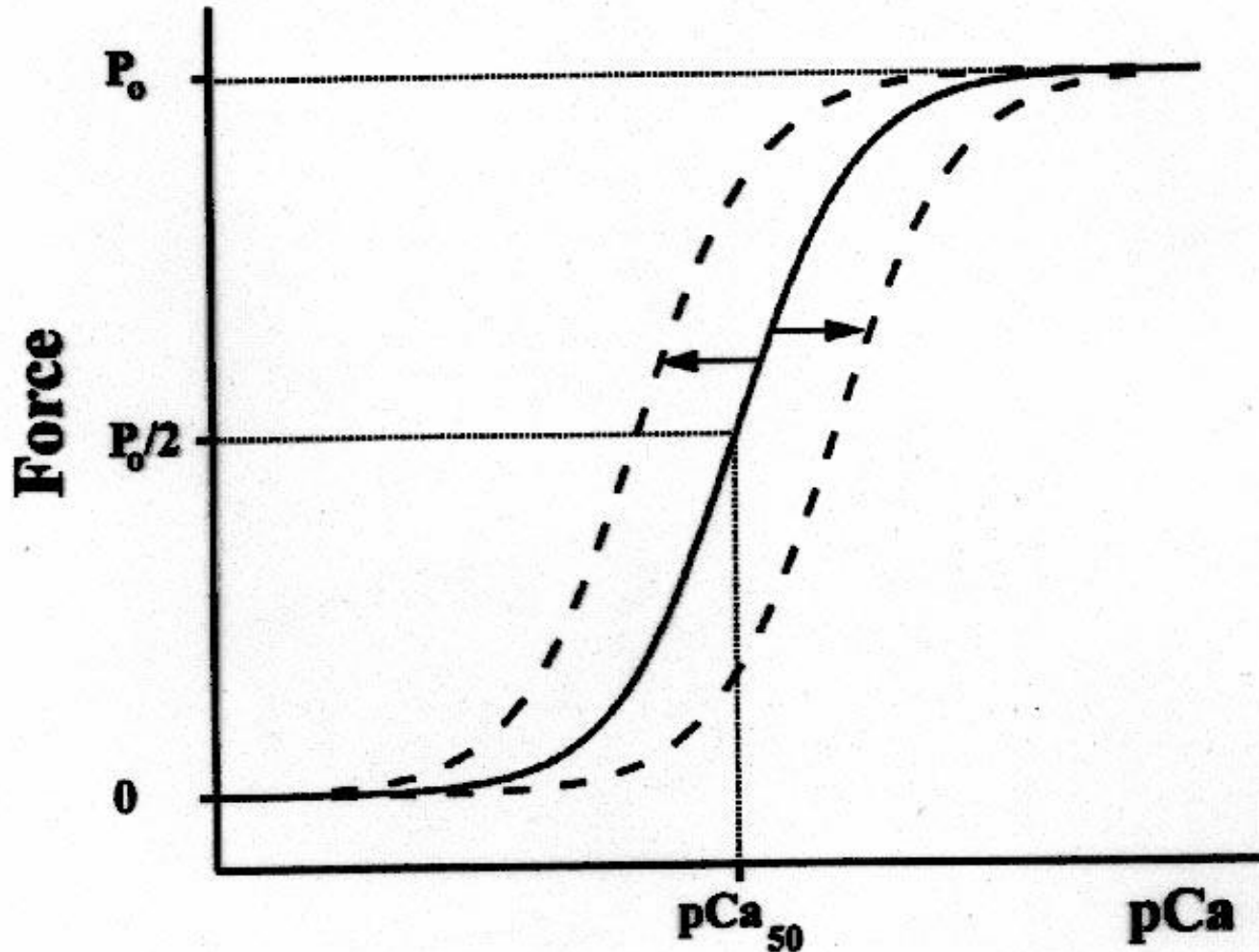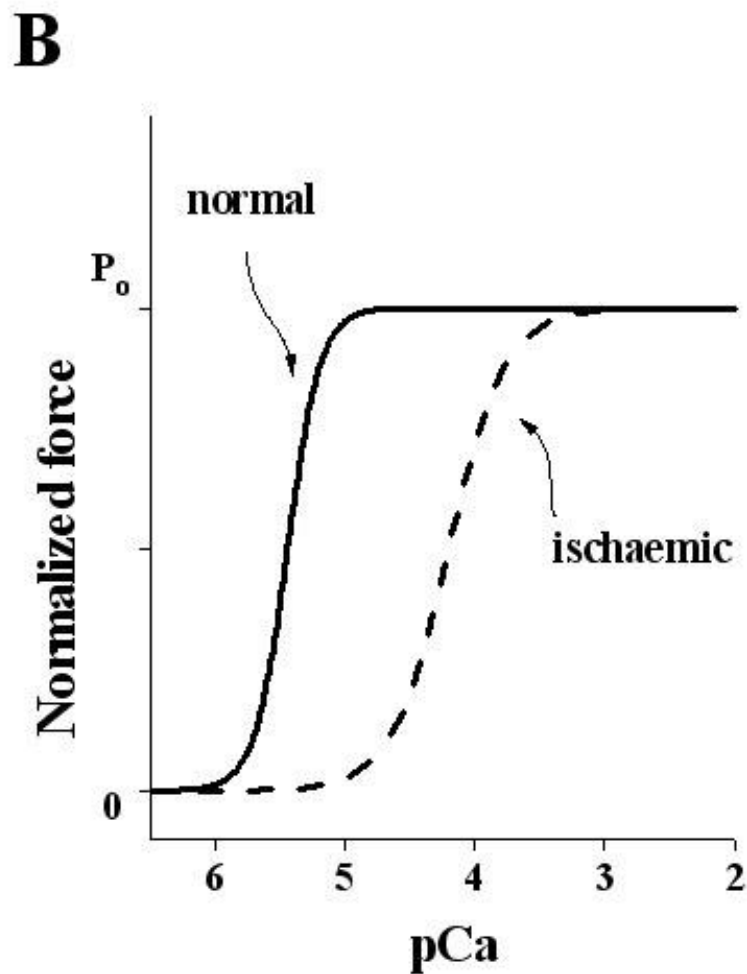
Contractile function and myofilaments
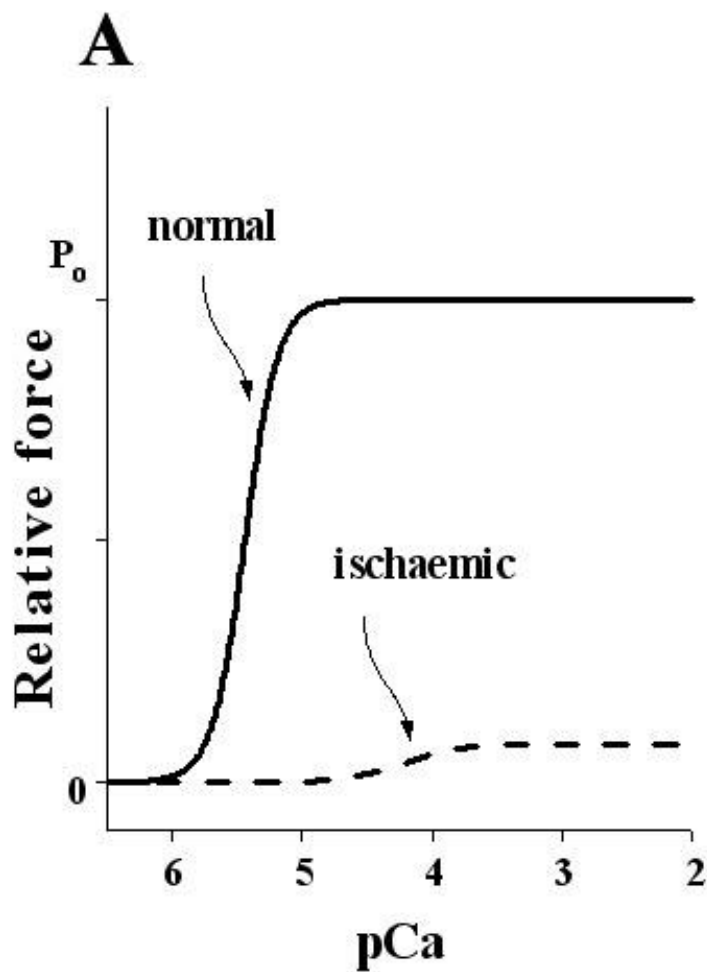
Contractile proteins
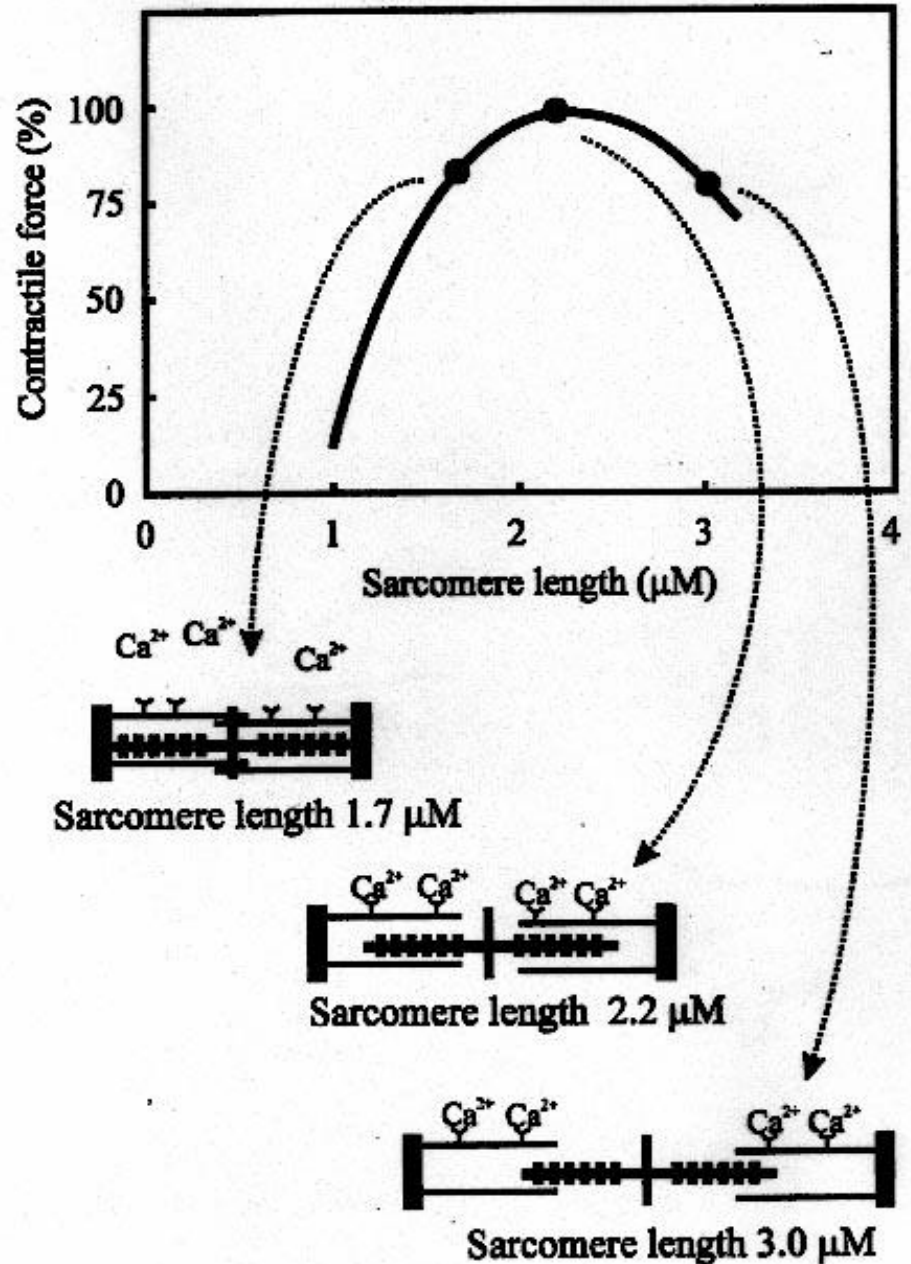
Actin-myosin cycle

Ca²⁺ - force relationship

The effects of ischaemic metabolites (P_i and low pH) on the Ca^{2+} - force relationship

Length – tension relationship and its explanation

Contractile force (%)

Sarcomere length (μM)

Ca^{2+} Ca^{2+} Ca^{2+}

Sarcomere length 1.7 μM

Ca^{2+} Ca^{2+} Ca^{2+} Ca^{2+}

Sarcomere length 2.2 μM

Ca^{2+} Ca^{2+} Ca^{2+} Ca^{2+}

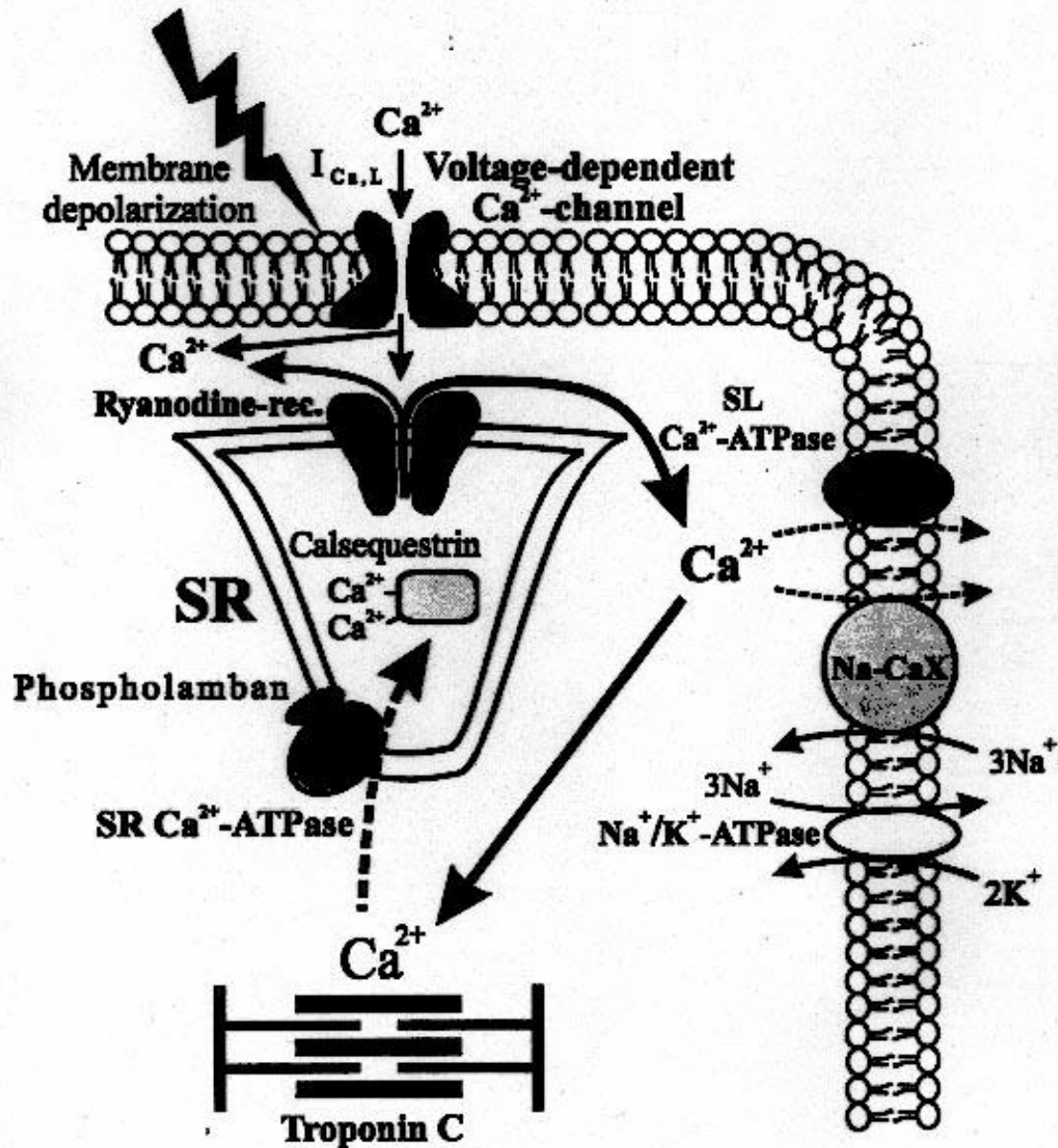Sarcomere length 3.0 μM

Frank-Starling-mechanism and sarcomere length

Frank-Starling-mechanism and sarcomere length

ventricular volume   **contractile force**   **sarcomere length**   **Ca²⁺ sensitivity**

time

1,9 µm

[Ca²⁺]

time

2,3 µm

[Ca²⁻]

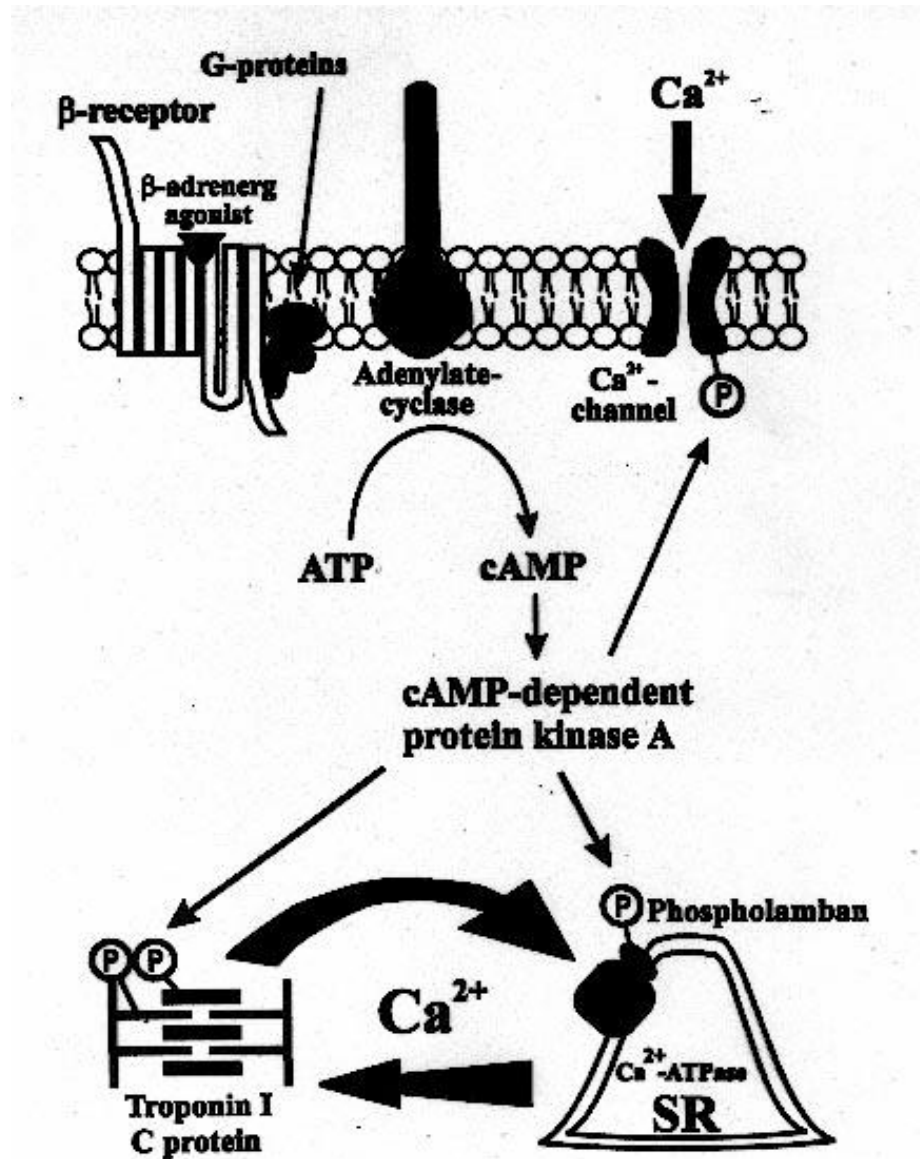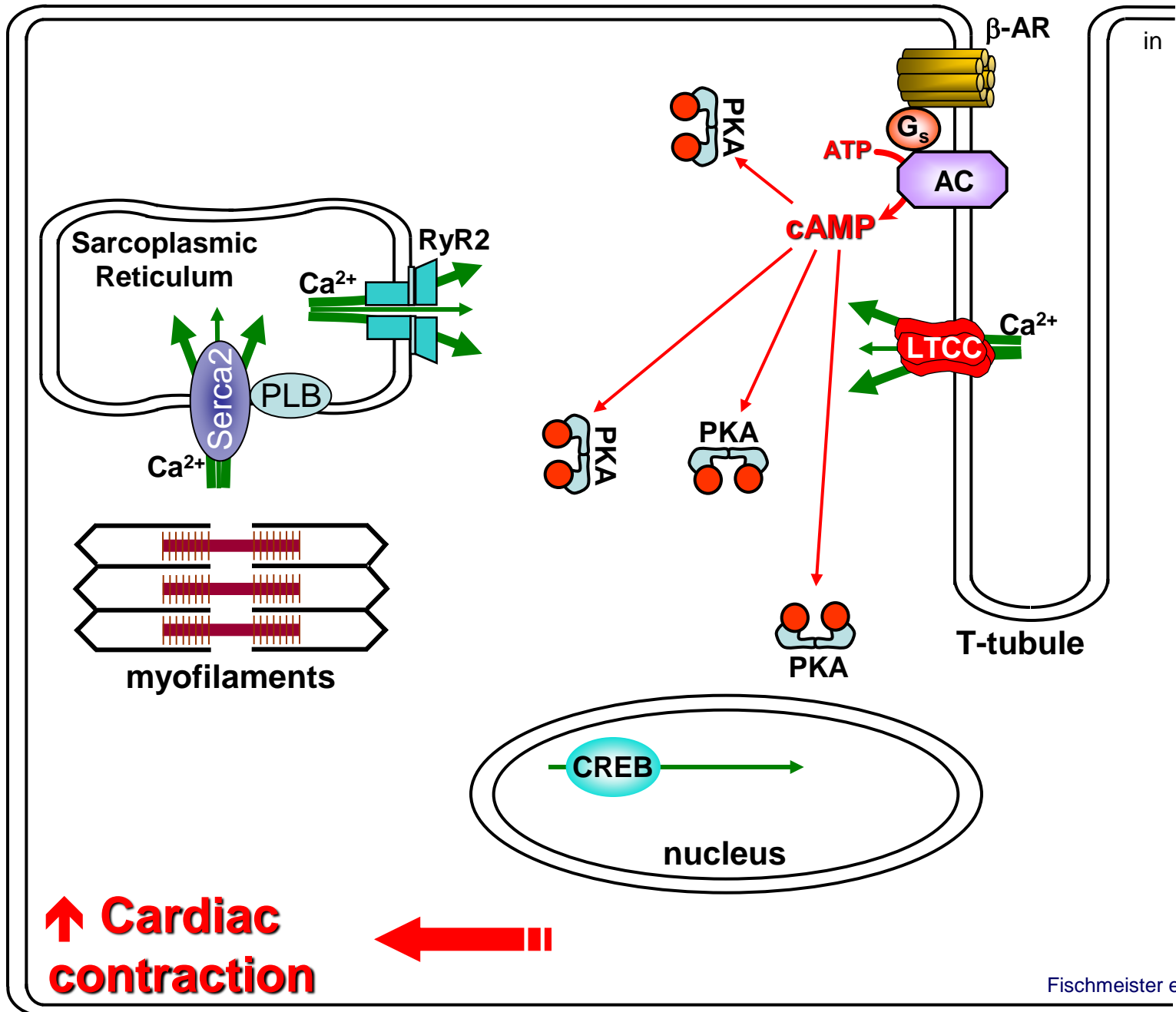# Intracellular Ca²⁺ balance

Force – frequency relationship

β - adrenergic regulation of contractility

β - adrenergic signaling in cardiomyocytes

Fischmeister et al.,
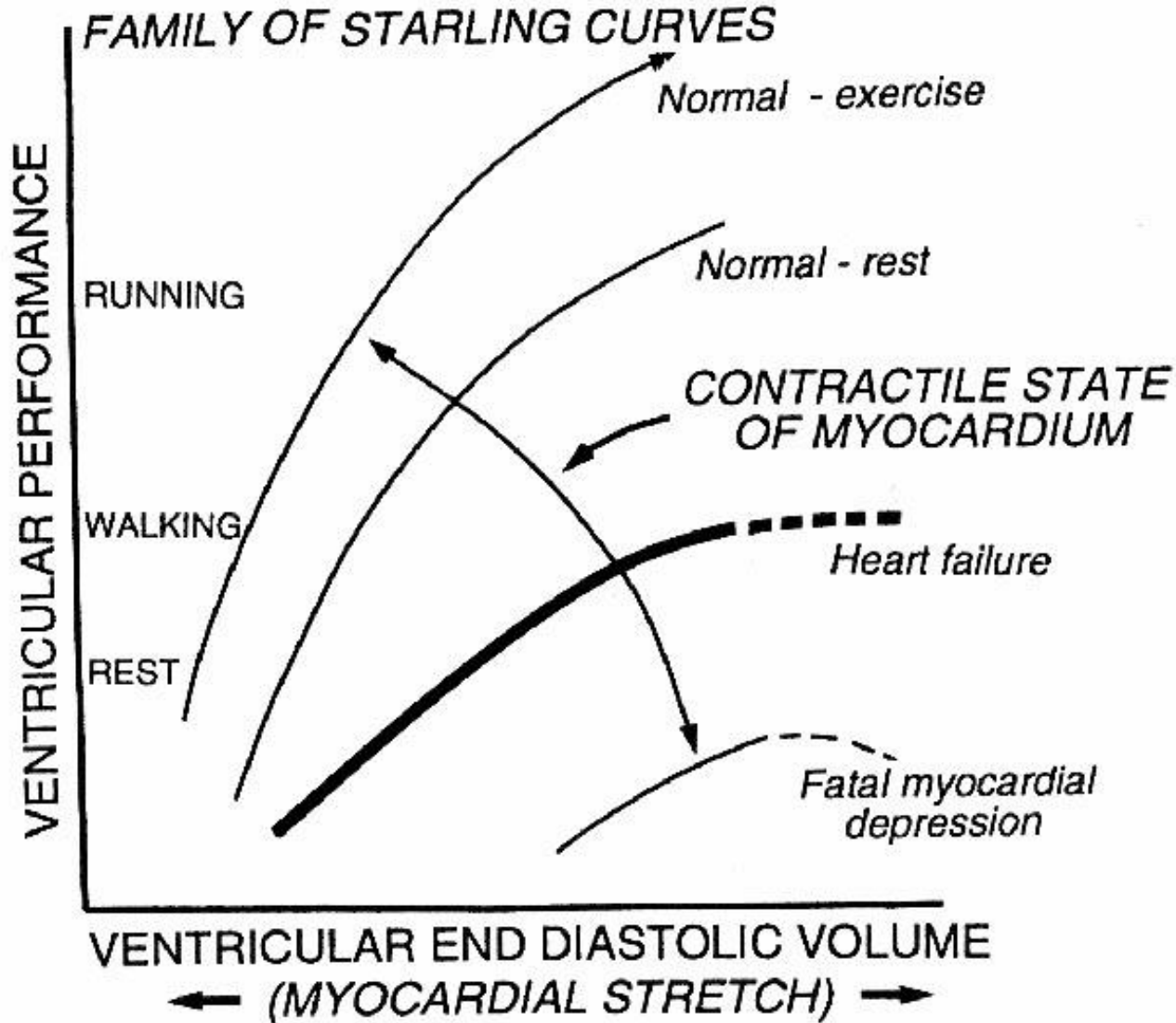
Cyclic nucleotide (cGMP) compartmentation in cardiomyocytes

Cyclic nucleotide microdomains in cardiomyocytes

Fischmeister et al.,

Ventricular function curves

Measures of myocardial contractile state