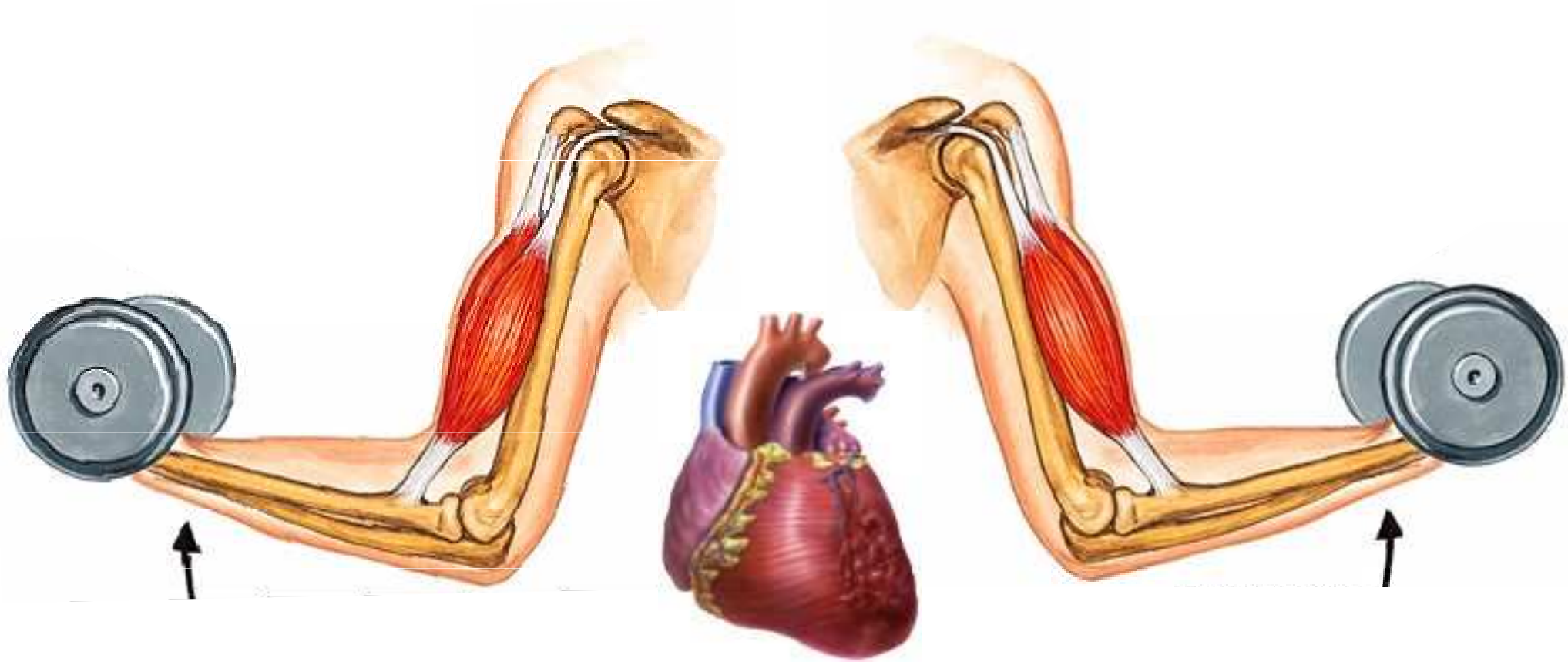
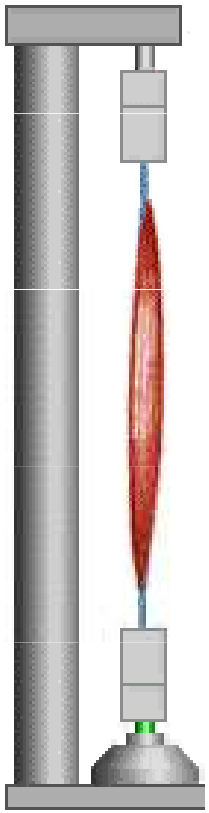
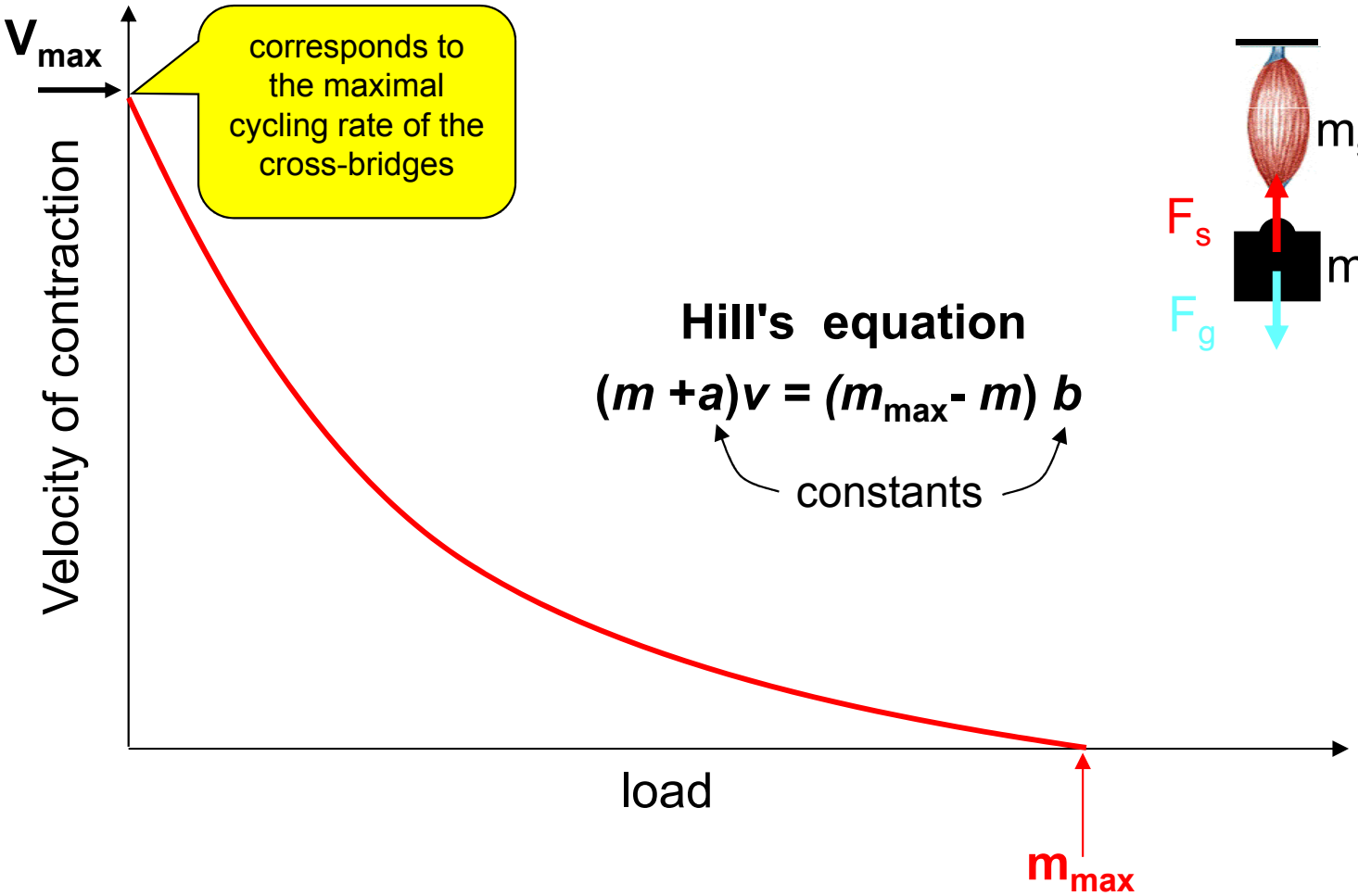
# EVALUATION OF MUSCLE CONTRACTION



# EVALUATION OF CONTRACTION IN SKELETAL MUSCLE

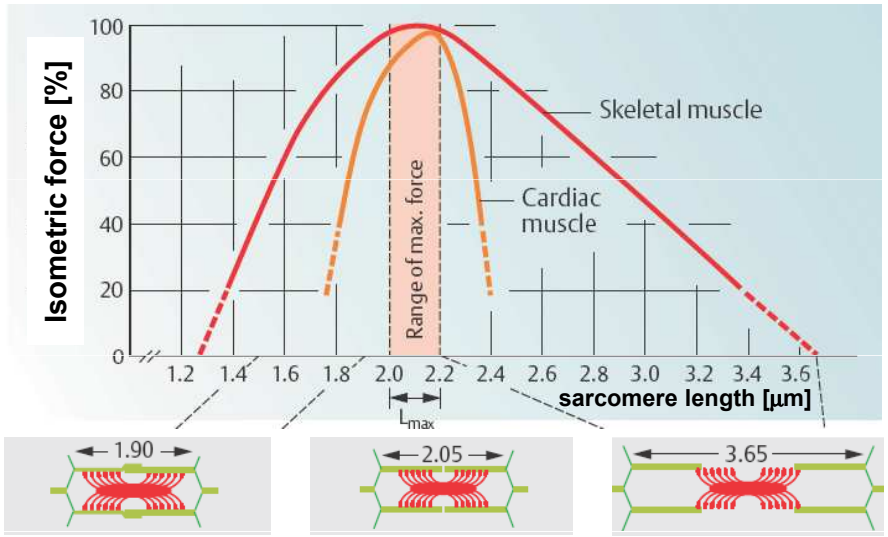
## Relationship between load and contraction velocity of skeletal muscle

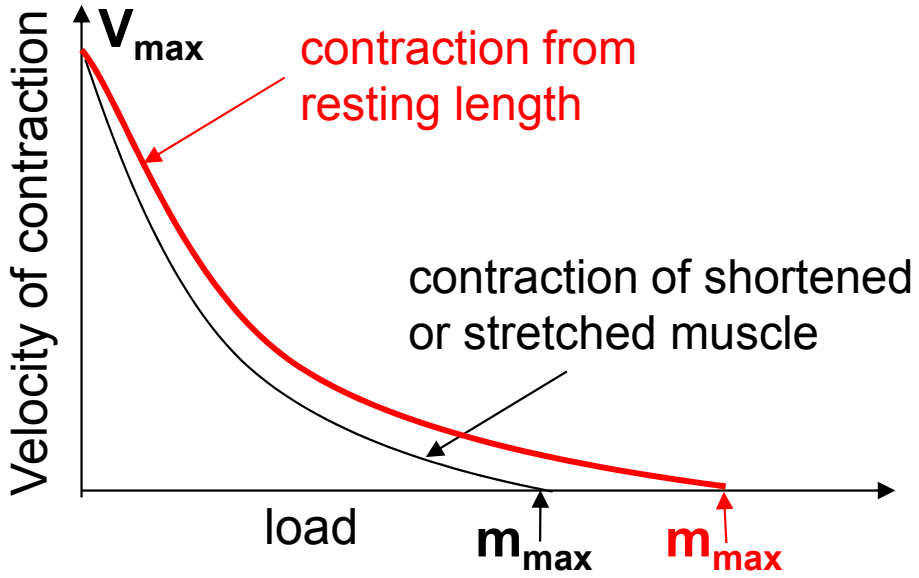




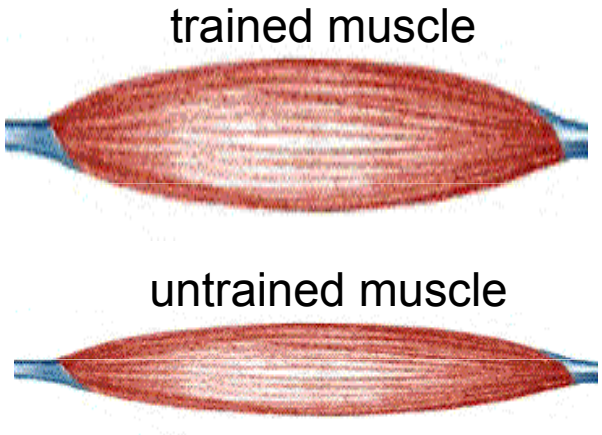
# Physiological factors affecting relationship between load and contraction velocity of skeletal muscle

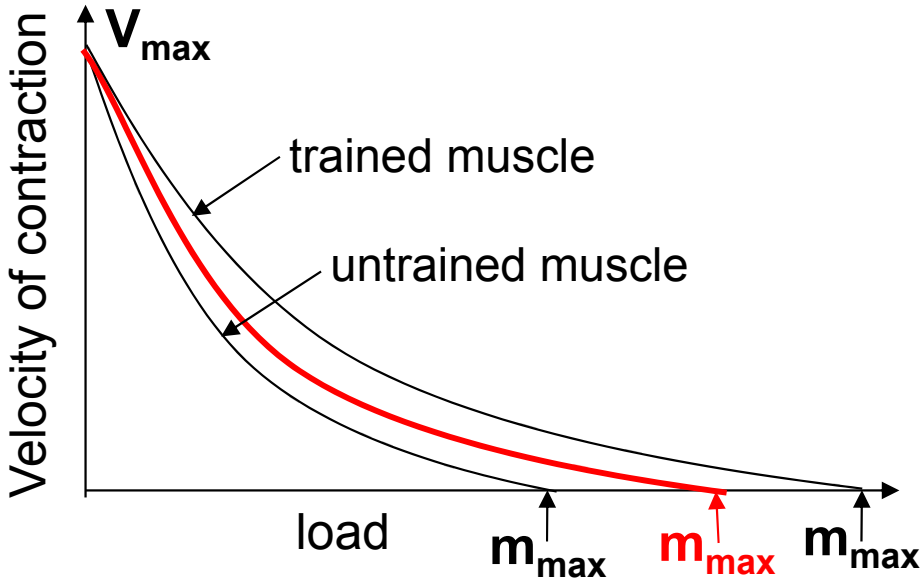
## 1) Initial length of muscle (sarcomeres)




## 2) Number of active sarcomeres



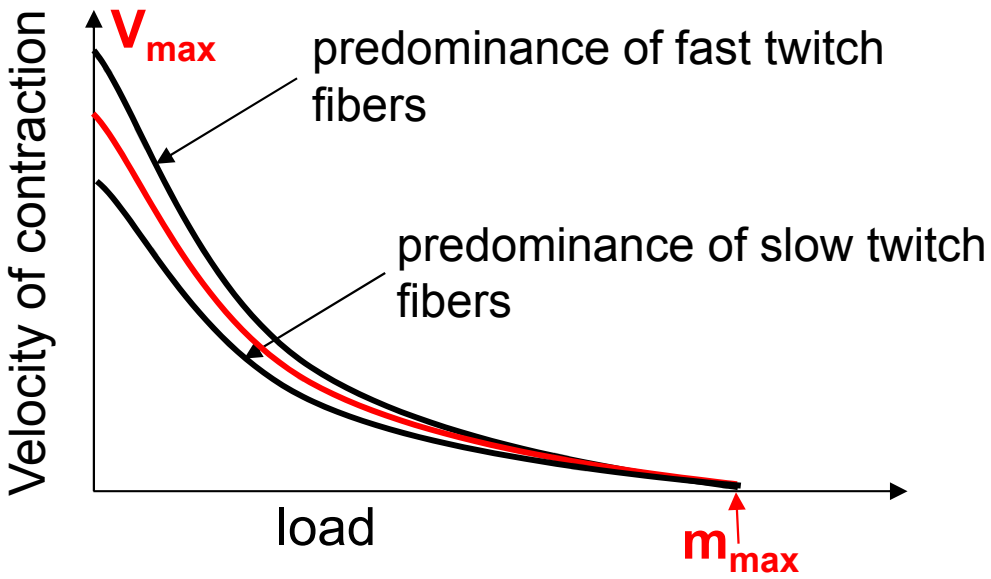
## 3) Type of muscle fibers

### slow twitch muscle fibers

aerobic metabolisms, slow rate of contraction, can be active long time before they fatigue

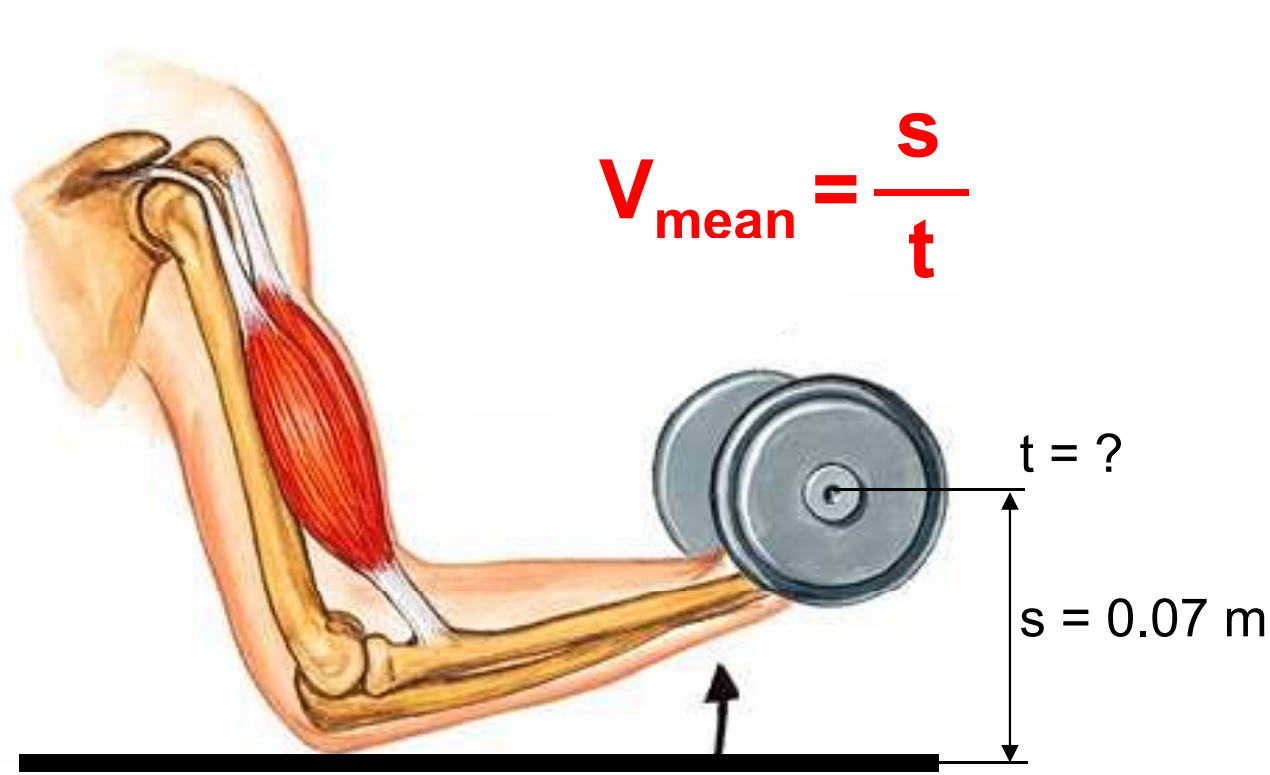
### fast twitch muscle fibers

anaerobic metabolisms, high rate of contraction, fatigue quickly



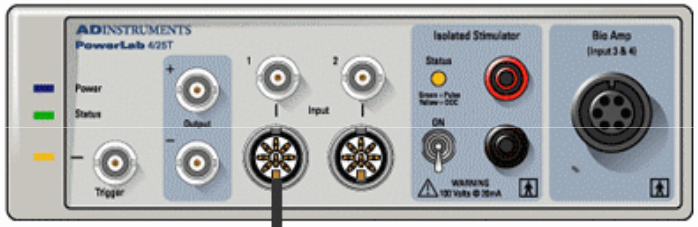

Note: Depending on the intensity of muscle contraction certain types of muscle fibbers are preferentially activated.

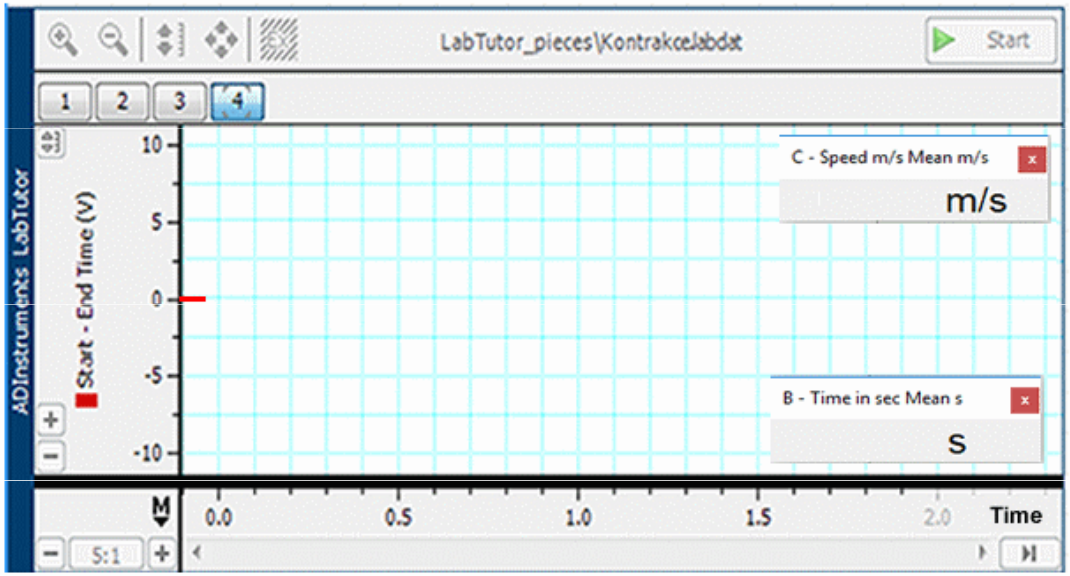
# Exploration of dependence of contraction velocity on skeletal muscle load

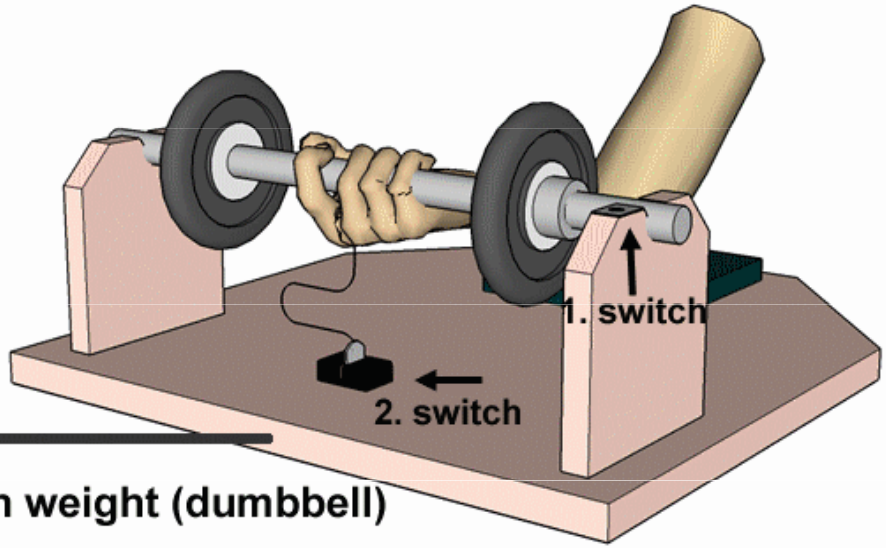


# Setup for measurement of contraction velocity of skeletal muscle

PowerLab

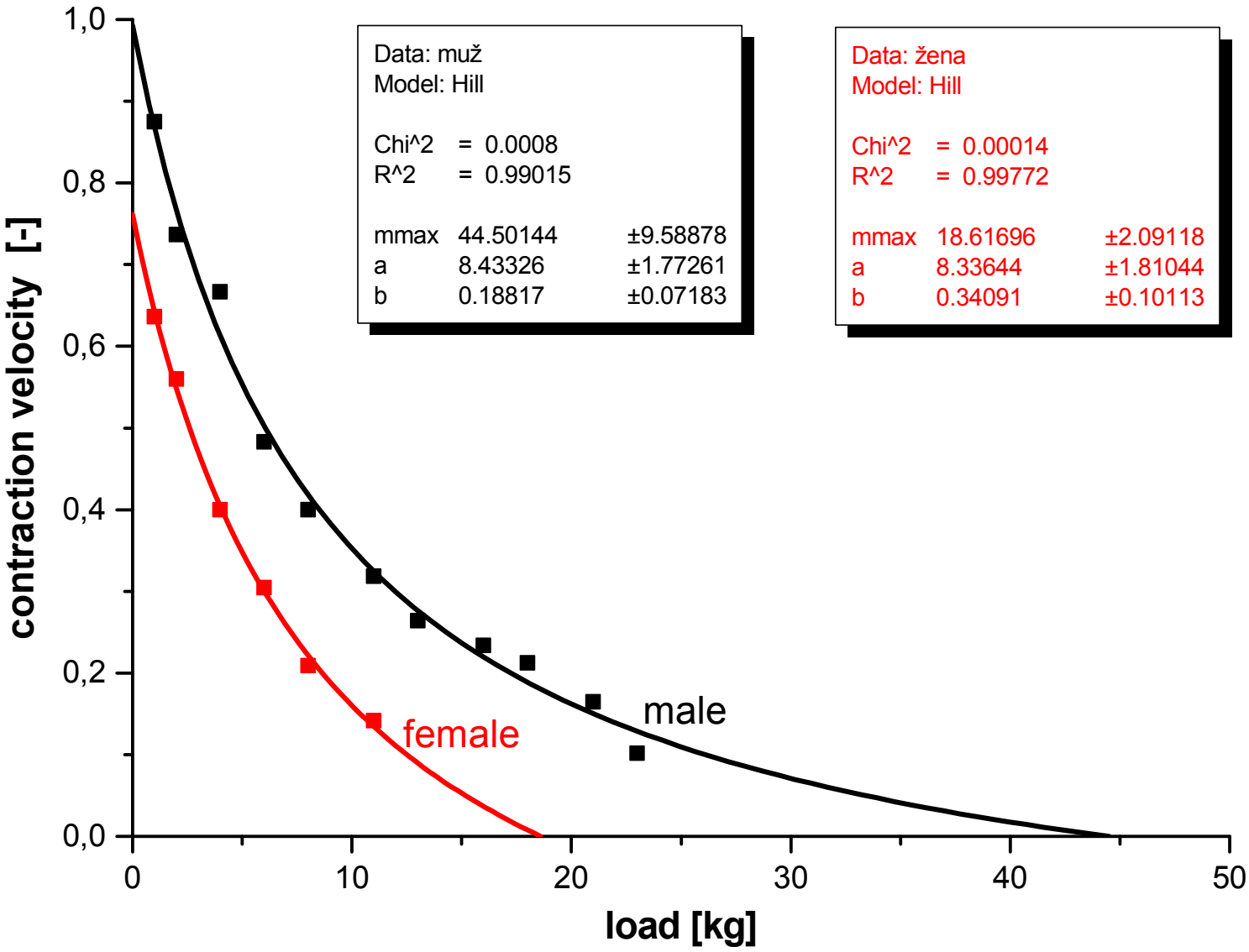



Equipment with weight (dumbbell)

# Representative results of measurement

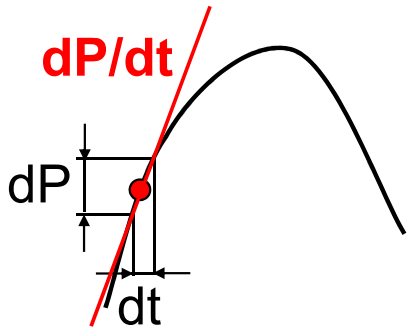


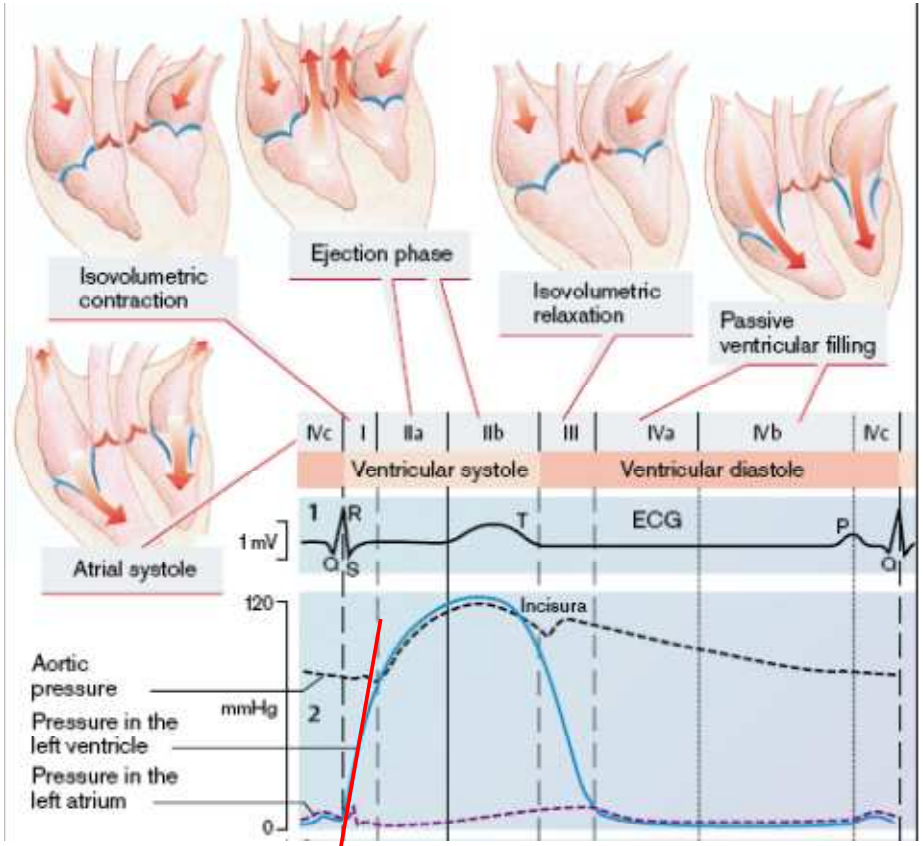
# EVALUATION OF CARDIAC MUSCLE CONTRACTILITY

1

# Index $(dP/dt)_{max}$

**Index $(dP/dt)_{max}$ represents maximum velocity of left ventricle pressure rise**




**Normal values:**
**<u>1300-1900 mmHg/s</u>**

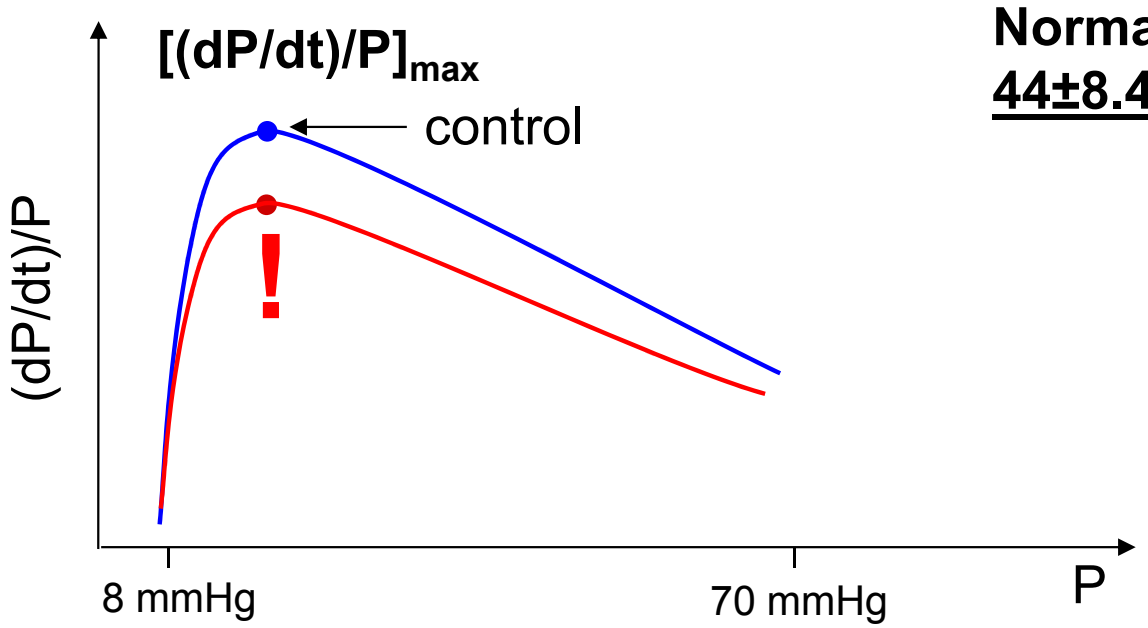
**Assessment:** by means of cardiac catheterization.

**Use:** mainly for research purposes (difficult and expensive invasive method).

**Note.:** this index may be affected by the Frank-Starling mechanism (e.g. at hypertension when end-diastolic volume is increased)!

# 2 Index $[(dP/dt)/P]_{max}$

**Index $[(dP/dt)/P]_{max}$ represents maximum velocity of cardiac muscle contraction**




**Normal values:**
**$44 \pm 8.4\ s^{-1}$**

**Assessment:** by means of cardiac catheterization.

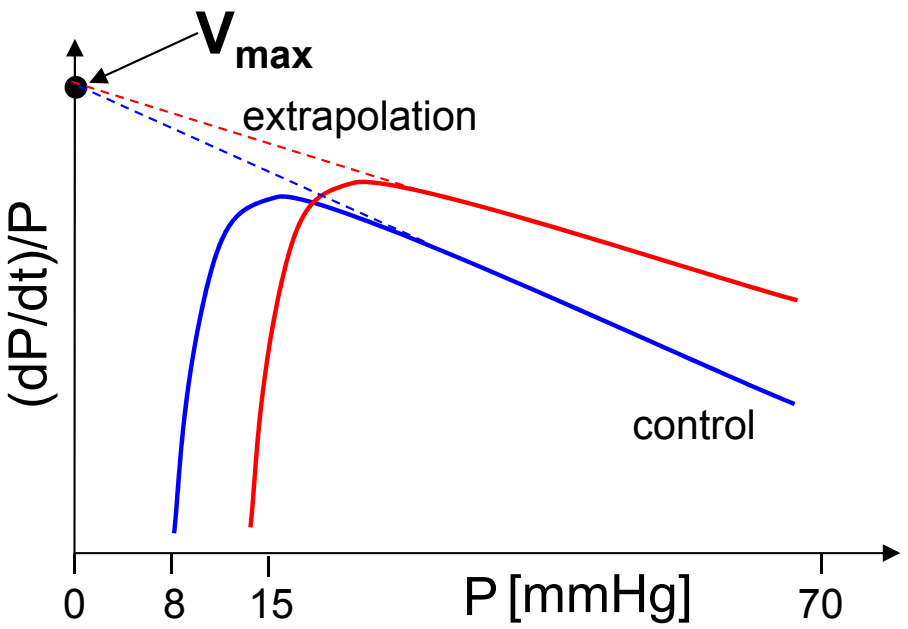
**Use:** mainly for research purposes (difficult and expensive invasive method).

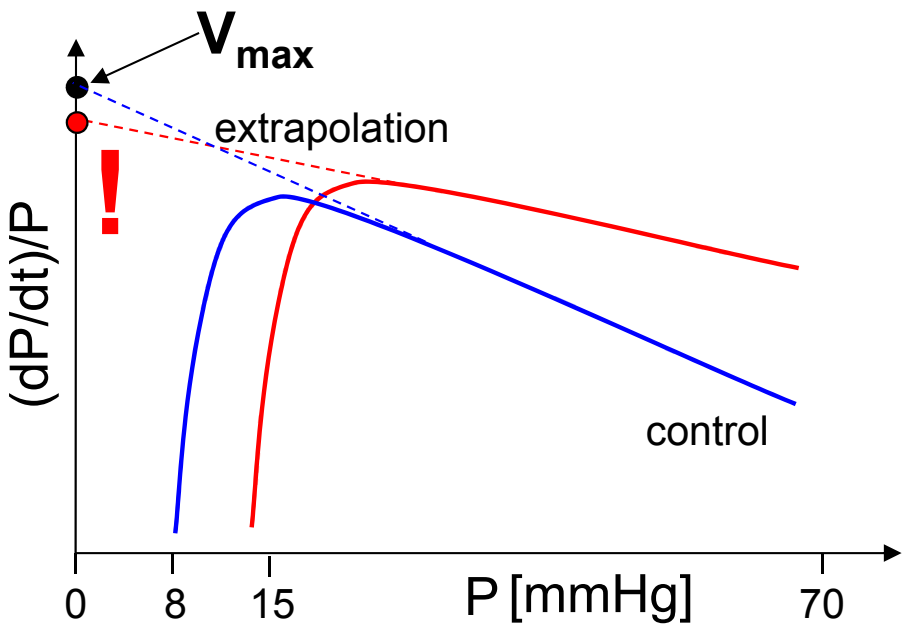
**Note.:** this index may be affected by high end-diastolic pressure in left ventricle!

3

# Index $V_{max}$

**Index $V_{max}$ represents velocity of cardiac muscle contraction at zero pressure**




**Assessment:** by means of cardiac catheterization.

**Use:** mainly for research purposes (difficult and expensive invasive method).

**Note.:** this index may be affected by inaccurate extrapolation!

4

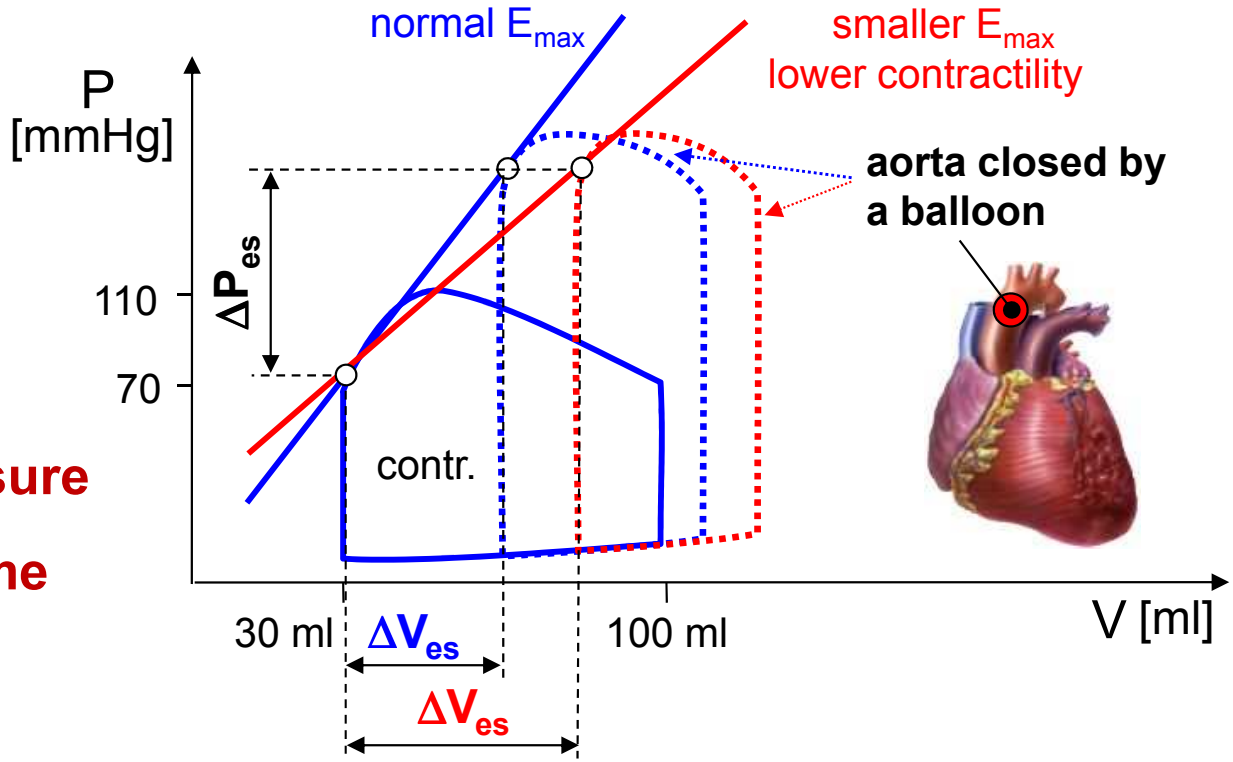
# Index $E_{max}$

**Index $E_{max}$ represents slope of the line determined from end-systolic values of P-V diagrams**

$$E_{max} = \frac{\Delta P_{es}}{\Delta V_{es}}$$

**$P_{es}$ - end-systolic pressure**

**$V_{es}$ - end-systolic volume**




**Assessment:** by means of cardiac catheterization.

**Use:** mainly for research purposes (difficult and expensive invasive method).

**Note.:** index $E_{max}$ is the most exact method for evaluation of cardiac muscle contractility independent on preload and afterload of left ventricle!

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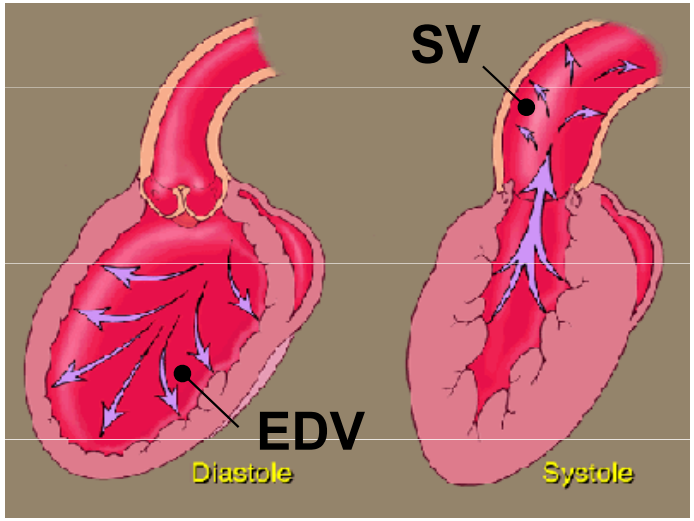
5

# Ejection fraction (EF)

$$EF = \frac{SV}{EDV}$$




**SV – stroke volume**

**EDV – end-diastolic volume**

**Normal values: SV ≈ 70 ml, EDV ≈ 100 ml, EF = 50 - 70%**

EF increases under sympathetic stimulation and with increasing inotropic state
EF lower than 40 % indicates decreased contractility of cardiac muscle (systolic dysfunction)

**Assessment:** by means of magnetic resonance or echocardiography.

**Use.: assessment of EF is a non-invasive method commonly used in clinical practice to estimate left ventricular contractility and systolic performance!**

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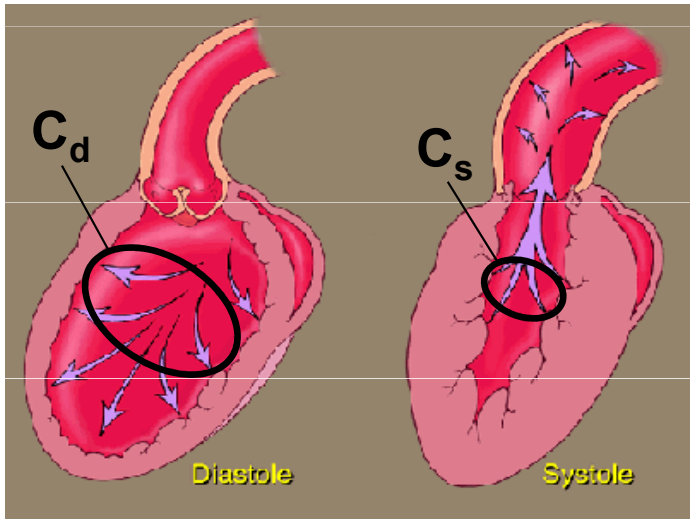
# 6 Velocity of circumferential fiber shortening ($V_{cf}$)

$$V_{cf} = \frac{(C_d - C_s)}{C_d \cdot t_{ef}}$$




$C_d$ – length of inner circumferential left ventricle fiber in diastole

$C_s$ – length of inner circumferential left ventricle fiber in systole

$t_{ef}$ – duration of ejection fraction

**Normal value:** $1.09 \pm 0.12$ circ $\cdot s^{-1}$

**Assessment:** by means of echocardiography

**Use.:** **assessment of $V_{cf}$ is a non-invasive method commonly used in clinical practice to estimate left ventricular contractility!**