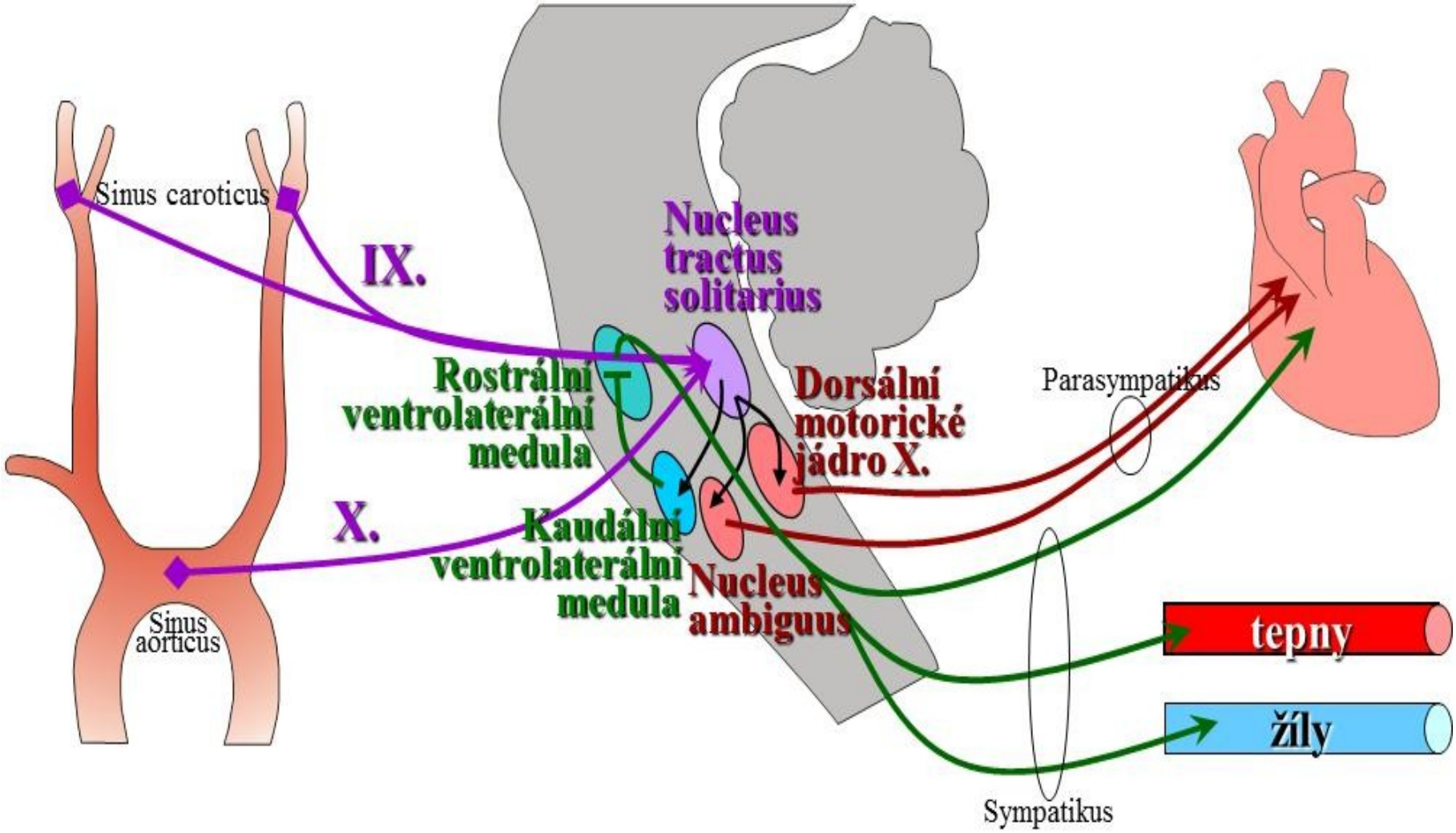
Physiology of every day life

INTEGRATIVE PHYSIOLOGY

EXAMS ARE COMING…

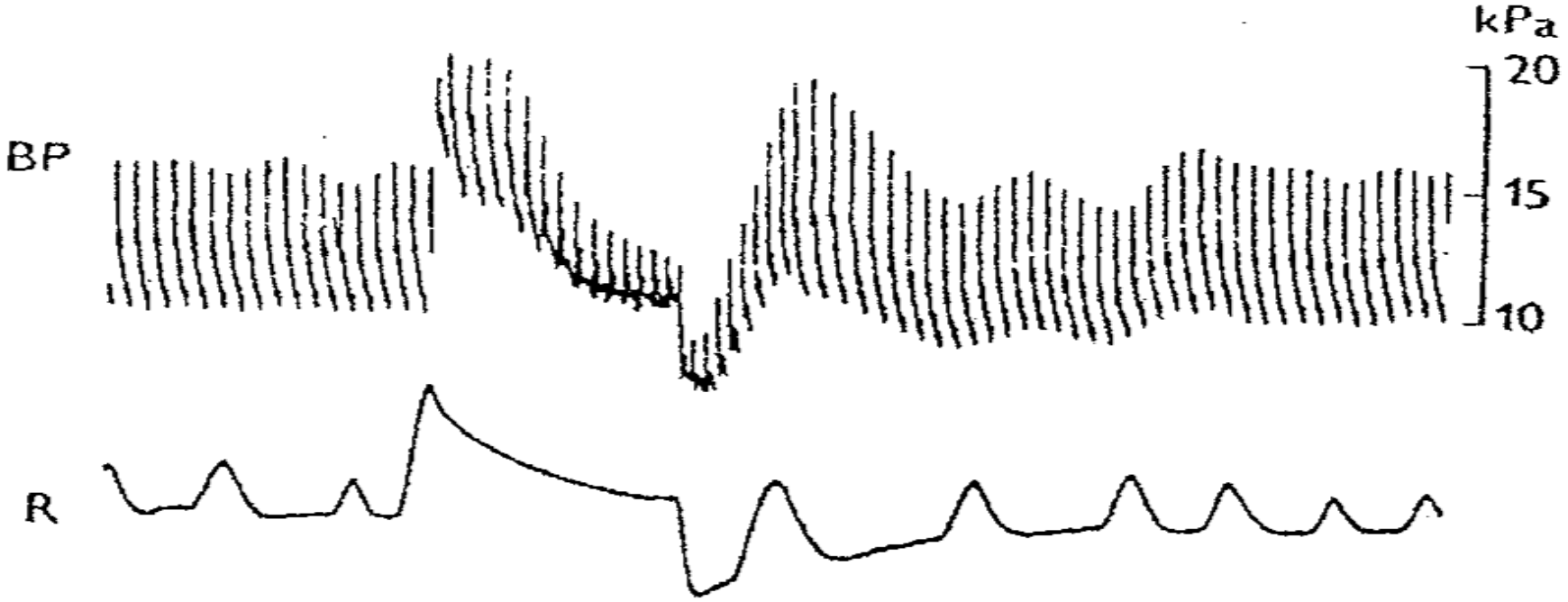
Short term regulation

BAROREFLEX



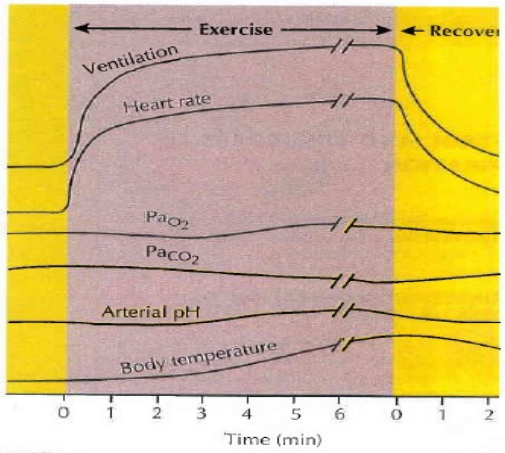
Stanovení citlivosti baroreflexu

Valsalvův manévr



Ganong WF, 2005

Respiratory Response to Exercise

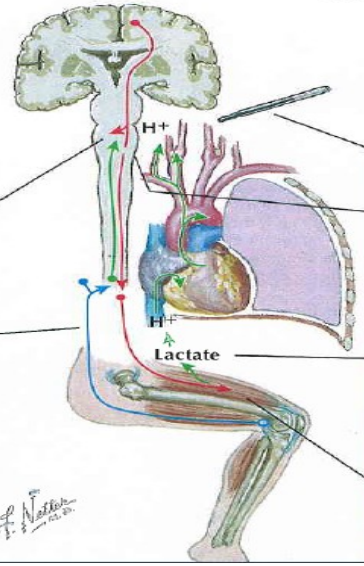


Factors that may account for initial abrupt rise and sharp terminal drop in ventilation

Collaterals to respiratory centers from motor pathways for muscle activation

Proprioceptive afferents from joint receptors to respiratory centers

Other unknown factors



Factors that may play a part in continued elevation of ventilation during continuing exerc

Rise in body temperatu accounts for a small pa of elevation

Respiratory neurons see to be more responsive t changes in chemorecep activity. Centers may b more sensitive to fluctuation than to absc values of Pa_{O_2}, Pa_{CO_2}, or pH

Lactic acid production due to anaerobic metabolism in muscle may increase H^+ con-centration of blood and CSF, thus affecting chemoreceptors

Possible metaborecepto in exercising muscle

Other unknown factors

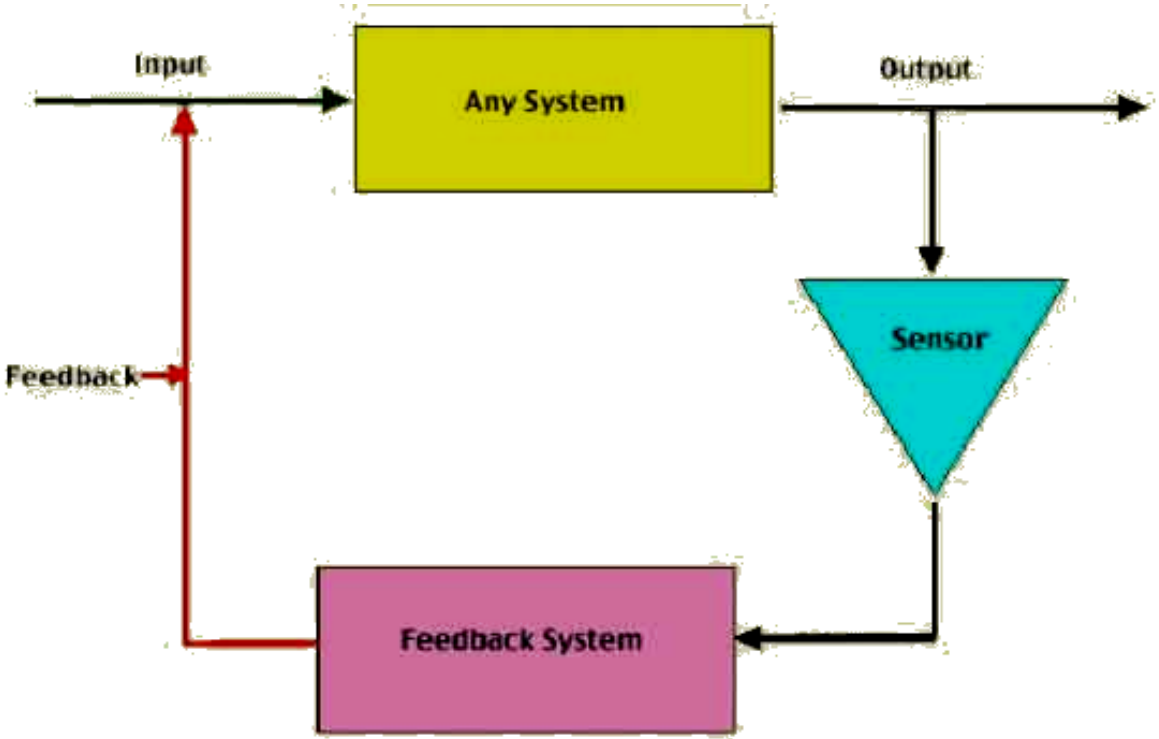
Types of regulation - general view

2 basic types:

- ✓ Nervous regulation
- ✓ Humoral regulation
  - ✓ Feedback control - negative
  - ✓ - positive

autoregulation – local regulation – system regulation

Feedback regulation



Simple Feedback Loop

http://www.slideshare.net/drpsdeb/presentations

REGULATION VS. ADAPTATION

REGULATION

- management of living systems
- at all system levels

ADAPTATION

- kind of response to long-acting stimulus
- evolutionary process

REGULATION vs. ADAPTATION

TIME

REGULATION

1. local/autoregulation

- physical or chemical
- are largely autonomous

Blood flow regulation
1. Bayliss effect (myogenic autoregulation) or NO
2. pO_2, pCO_2
3. Adrenaline, noradrenaline, RAAS
4. Sympathetic

2. metabolic

- regulated by metabolic products
- belongs to local regulation

3. hormonal

endocrine secretion

paracrine secretion

autocrine secretion

4. nervous regulation

- central nervous system
- periferal nervous system

Autoregulation

Autoregulation – the capacity of tissues to regulate their own blood flow

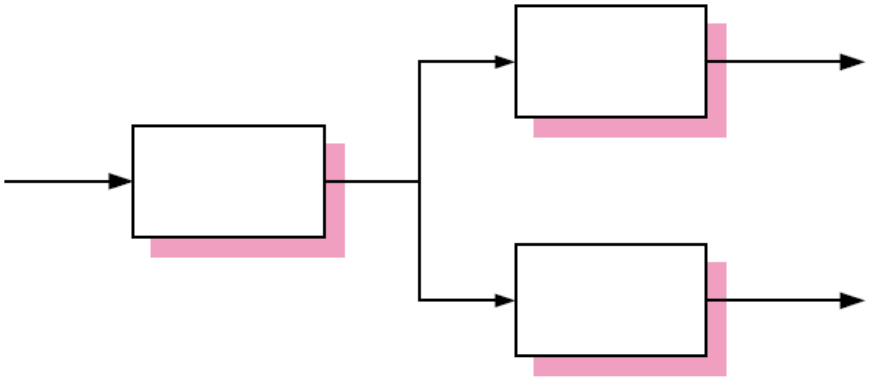
Myogenic theory – Bayliss phenomenon (as the pressure rises, the blood vessels are distended and the vascular smooth muscle fibres that surround the vessels contract; the wall tension is proportional to the distending pressure times the radius of the vessels – law of Laplace:

T=P x r)

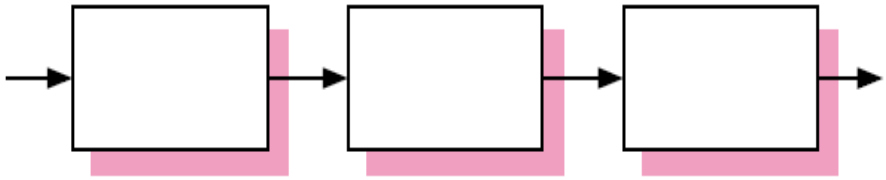
Autoregulation

- **Metabolic theory** – vasodilator substances tend to accumulate in active tissue, and these metabolites also contribute to autoregulation
  - ending products of energetic metabolism – CO_2, lactate acid, K^+
  - effect of hypoxia (circulation: vasodilatation x pulmonary circulation: vasoconstriction)
  - Adenosin – coronary circulation: vasodilatation

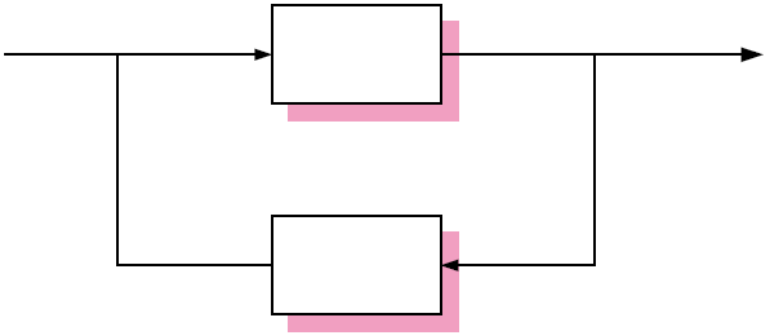
TYPES OF PHYSIOLOGICAL REGULATIONS



parallel feedback

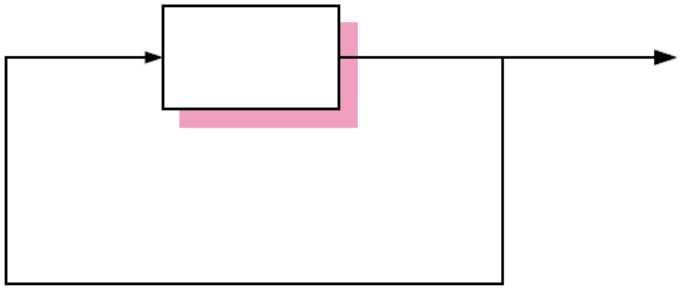


serial feedback

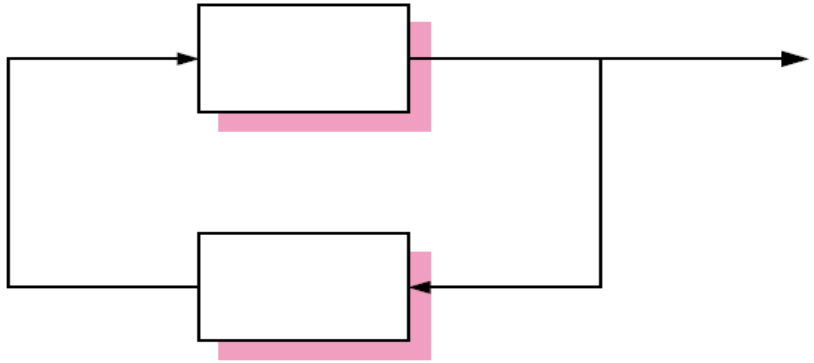


feedback

FEEDBACK



direct feedback

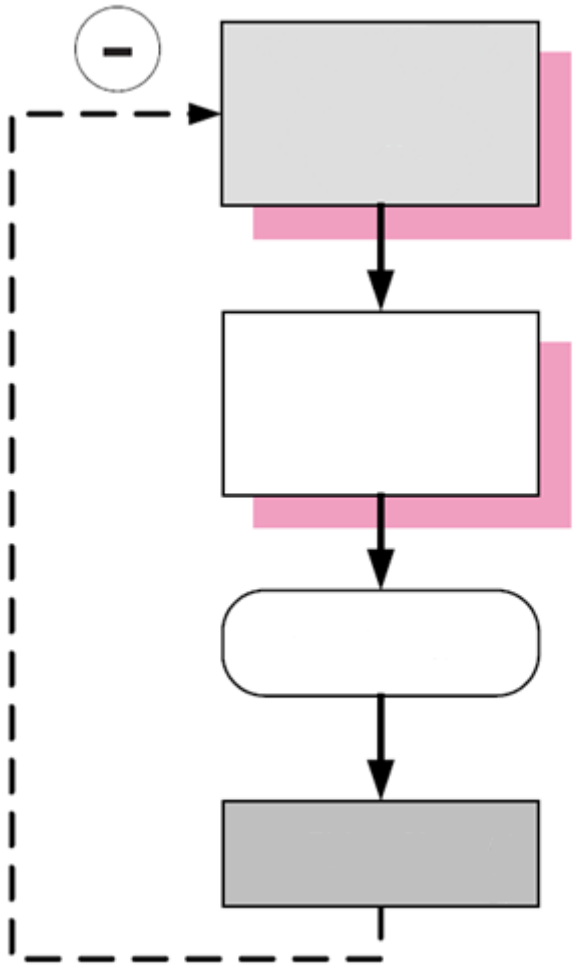


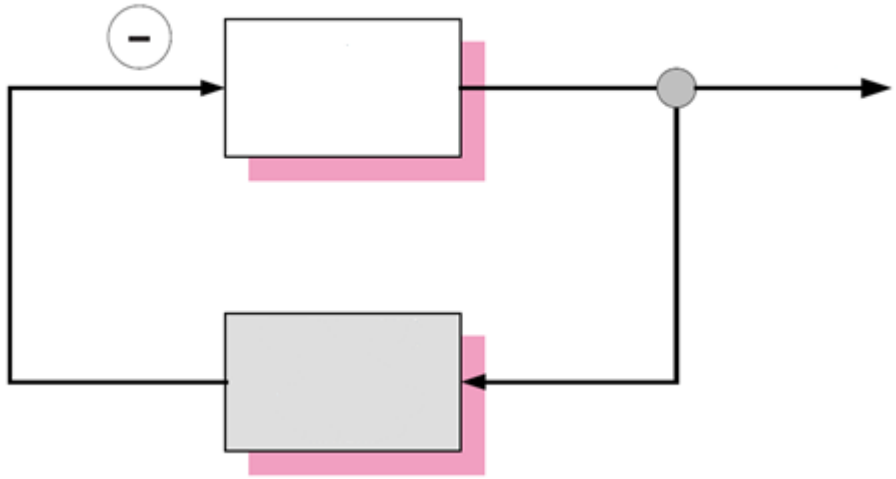
indirect feedback

+

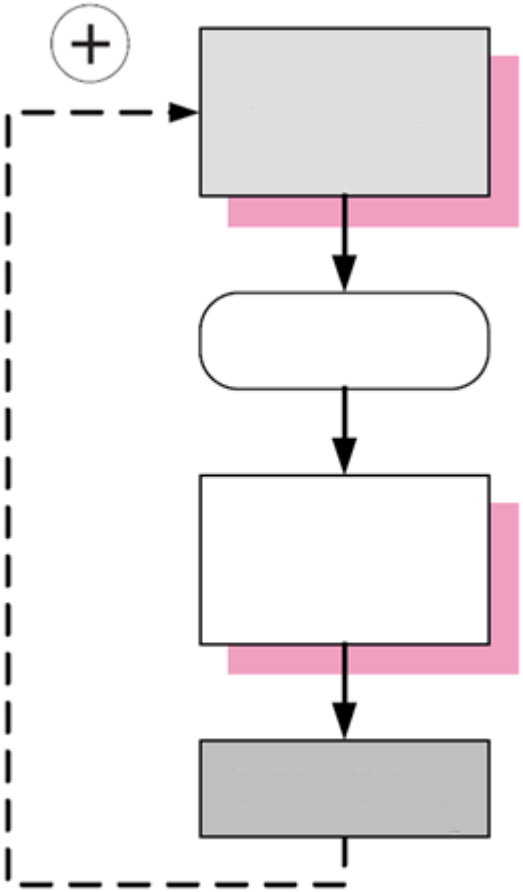
−

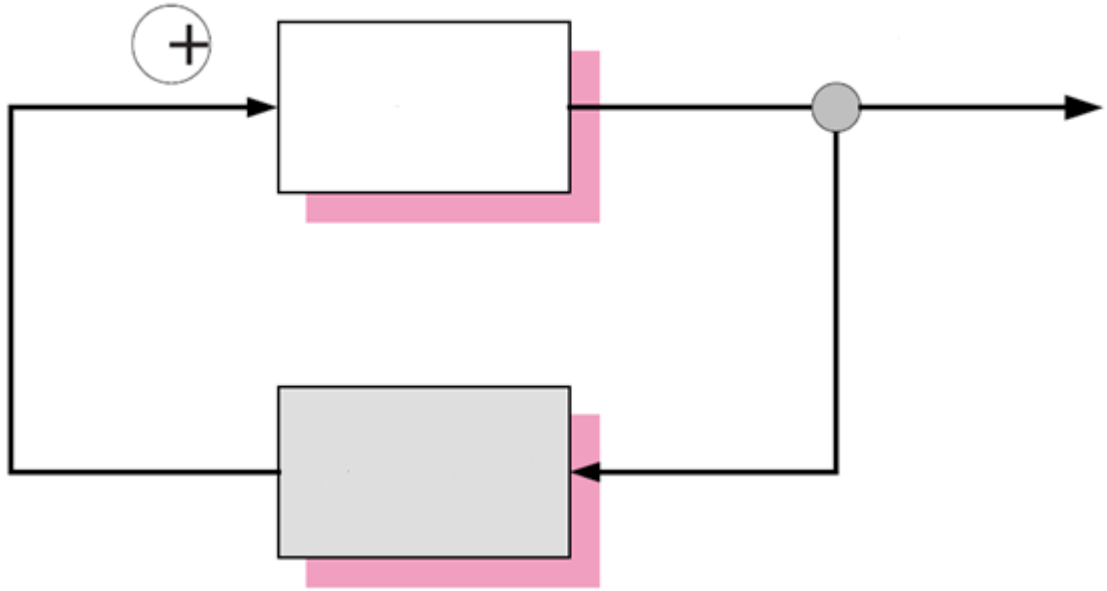
FEEDBACK

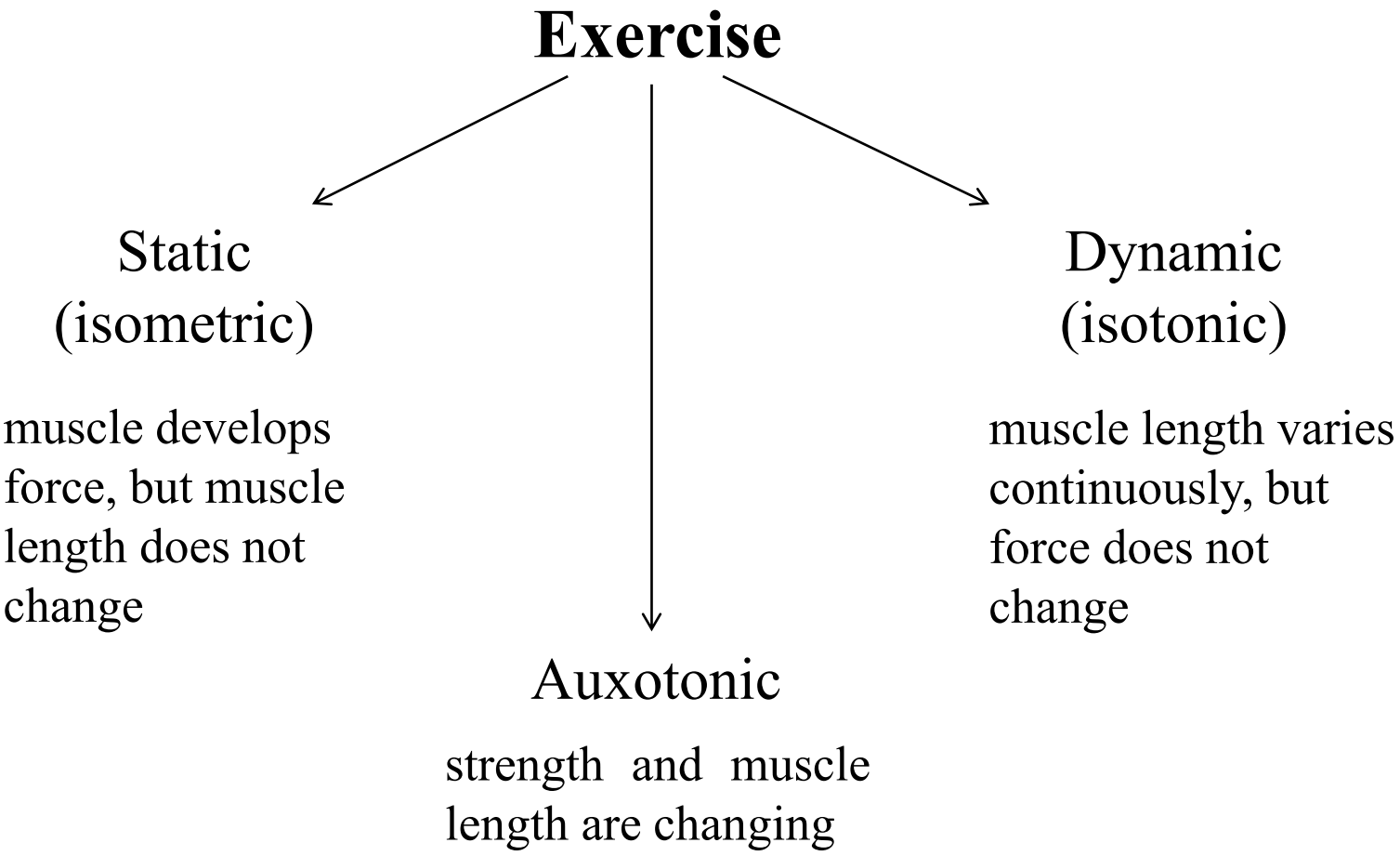


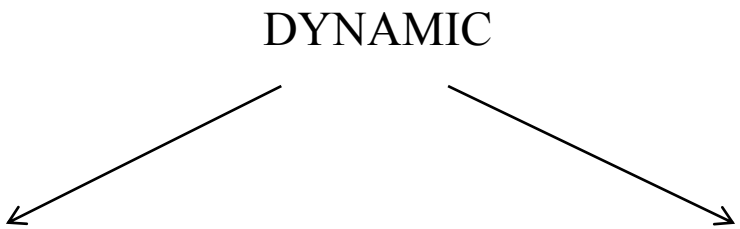


FEEDBACK






Exercise
Static
(isometric)
muscle develops force, but muscle length does not change
Auxotonic
strength and muscle length are changing
Dynamic
(isotonic)
muscle length varies continuously, but force does not change



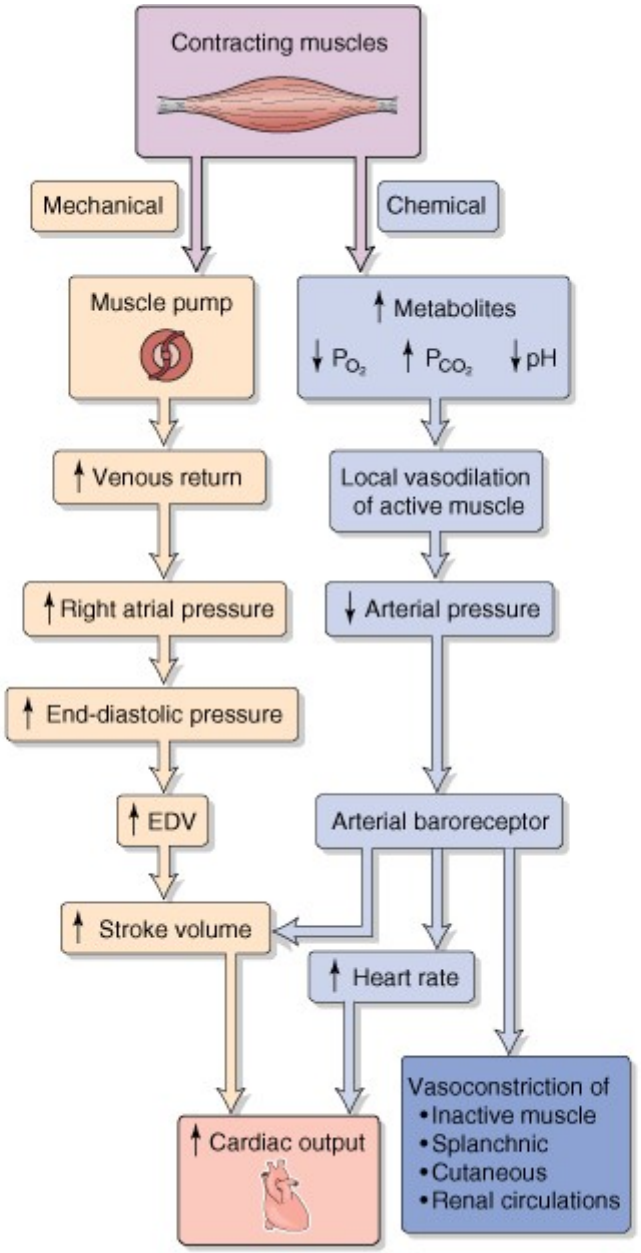
POZITIVE

muscle shortens against constant or rising resistance, some of the energy in the muscle is converted into kinetic or potential energy

NEGATIVE

muscle during contraction is driven by external force, the bulk of the energy is converted into heat

REACTION OF CARDIOVASCULAR SYSTEM TO WORKLOAD



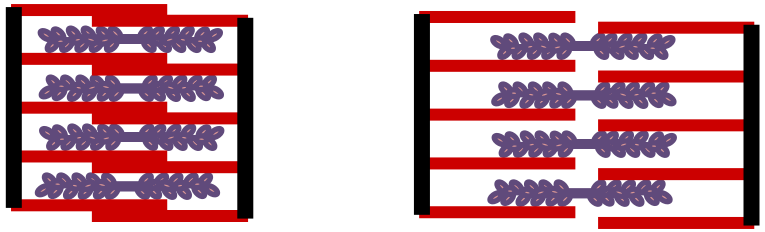
parameter	**rest**	**workload**
CO (l/min)	5-6	25(35)
HR (t/min)	70	210 (250-190) Age dependence
SV (ml)	70	115
SBP (mmHg)	120	115↑
DBP (mmHg)	70	↑ or = or ↓

... reserve = maximum .../resting...

AUTOREGULATION OF THE CARDIAC MUSCLE

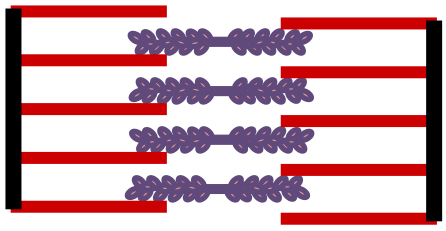
Heterometricautoregulation (Frank-Starling):

- serves to immediately compensate for natural variations in the filling of left and right chambers



Rest heart filling

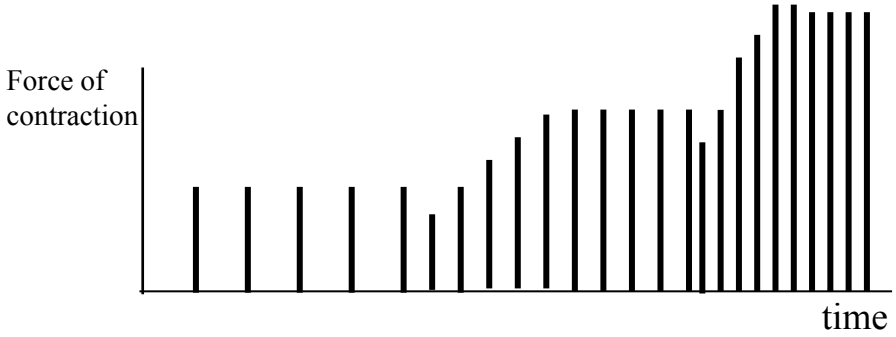
higher heart filling



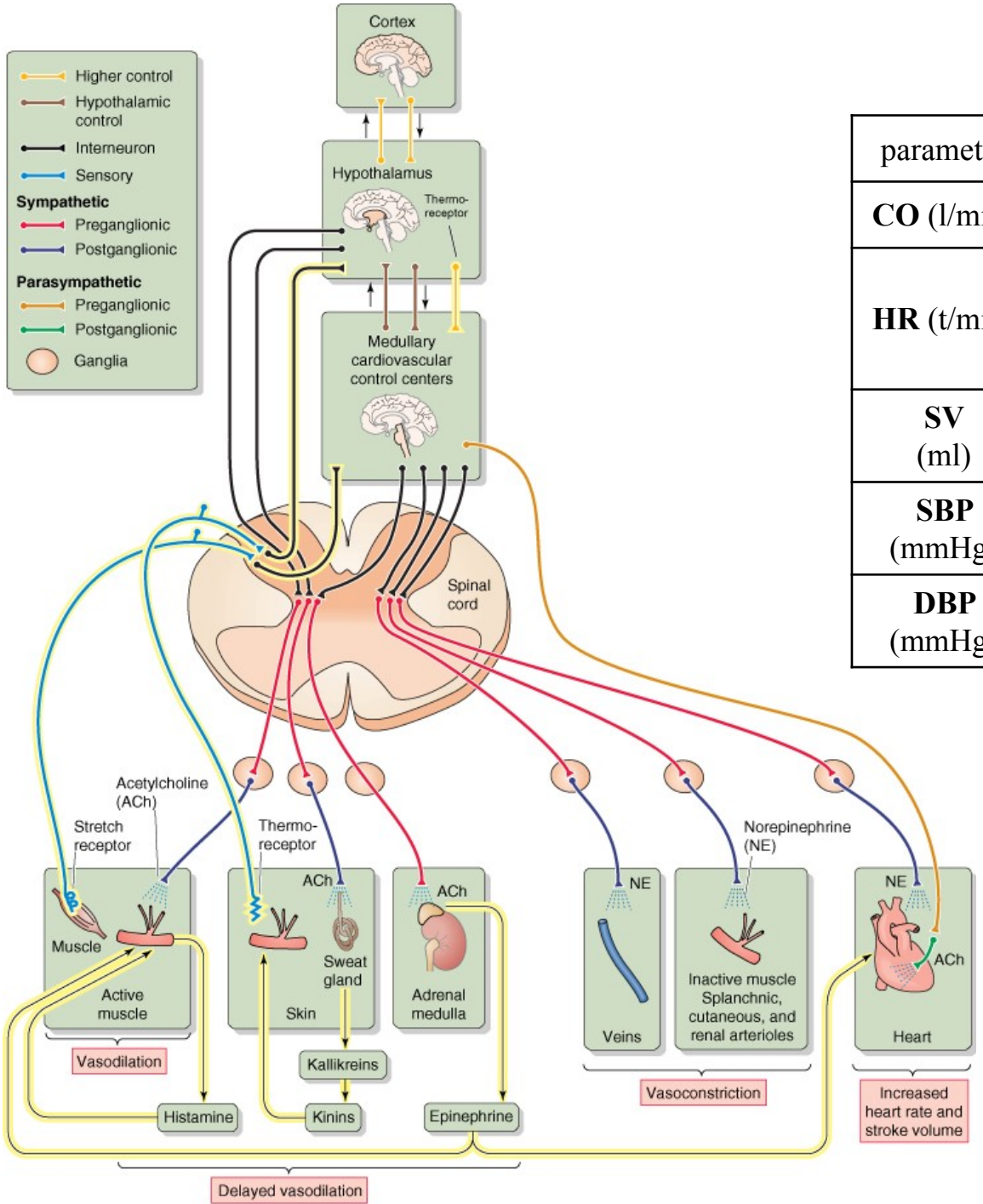
extremal heart filling

Homeometric autoregulation: (Bowditch phenomenon)

- due to homeometric autoregulation increase of heart rate leads to increase the force of contraction



Bowditch phenomenon



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DBP (mmHg)	70	↑ or = or ↓

REGULATION AND ADAPTATION TO EXERCISE

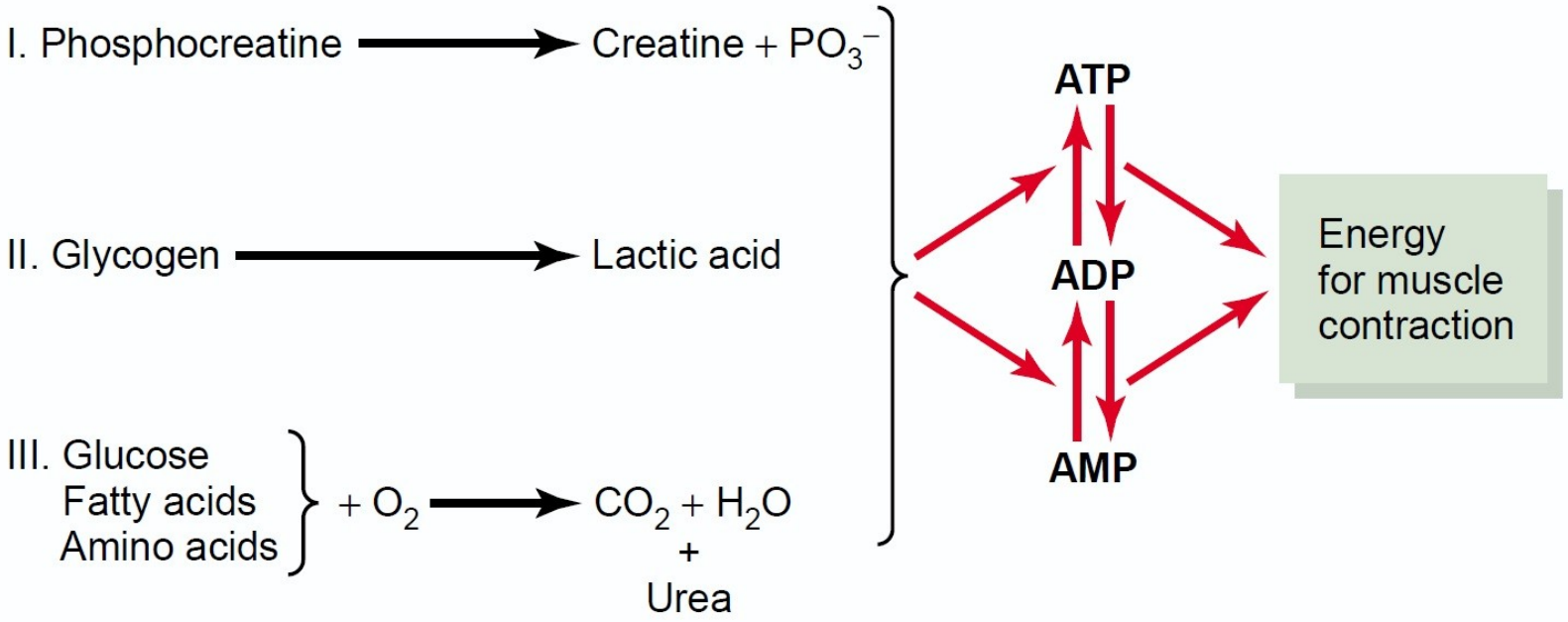
CARDIOVASCULAR

parameter	**rest**	**workload**
CO (l/min)	5-6	25(35)
HR (t/min)	70	210 (250-190)
SV (ml)	70	115
SBP (mmHg)	120	↑
DBP (mmHg)	70	↑ or = or ↓

RESPIRATORY

parameter	**rest**	**workload**
MV (l/min)	6-12	90-120
BF (d/min)	12-16	40-60
BO (ml)	0,5-0,75	2
blood flow (l/min)	5,5	20-35
intake O_2 (ml/min)	250-300	3000

METABOLISM RESPONSE TO WORKLOAD



Energy Systems Used in Various Sports

Phosphagen system, almost entirely
- 100-meter dash
- Jumping
- Weight lifting
- Diving
- Football dashes

Phosphagen and glycogen-lactic acid systems
- 200-meter dash
- Basketball
- Baseball home run
- Ice hockey dashes

Glycogen-lactic acid and aerobic systems
- 800-meter dash
- 200-meter swim
- 1500-meter skating
- Boxing
- 2000-meter rowing
- 1500-meter run
- 1-mile run
- 400-meter swim

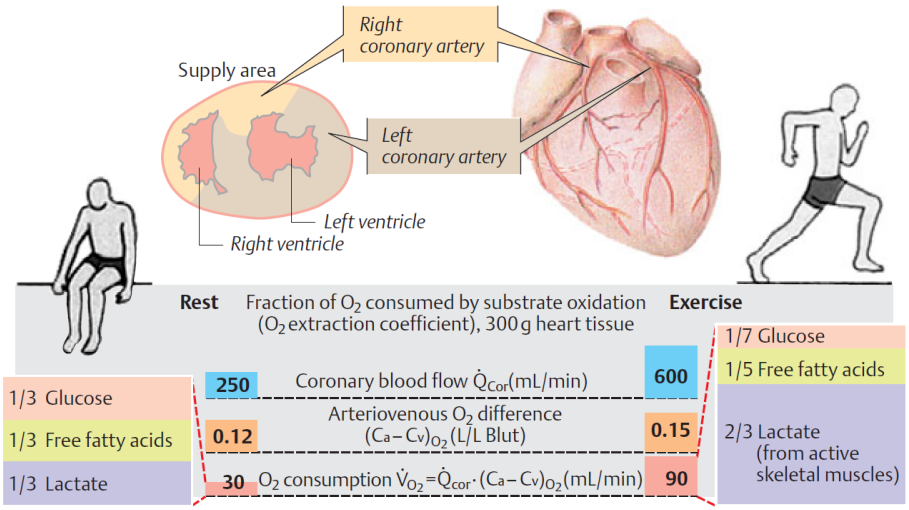
Glycogen-lactic acid system, mainly
- 400-meter dash
- 100-meter swim
- Tennis
- Soccer

Aerobic system
- 10,000-meter skating
- Cross-country skiing
- Marathon run (26.2 miles, 42.2 km)
- Jogging

CARDIOVASCULAR SYSTEM

Athletic heart :

- Hypertrophy + dilatation
- Increased volume reserve (1,5x)
- Increased chronotropic reserve



„Physiological“ hypertrophy

- Extending muscle fibers and increasing their thickness
- Remodeling accompanied by normal or increased contractility