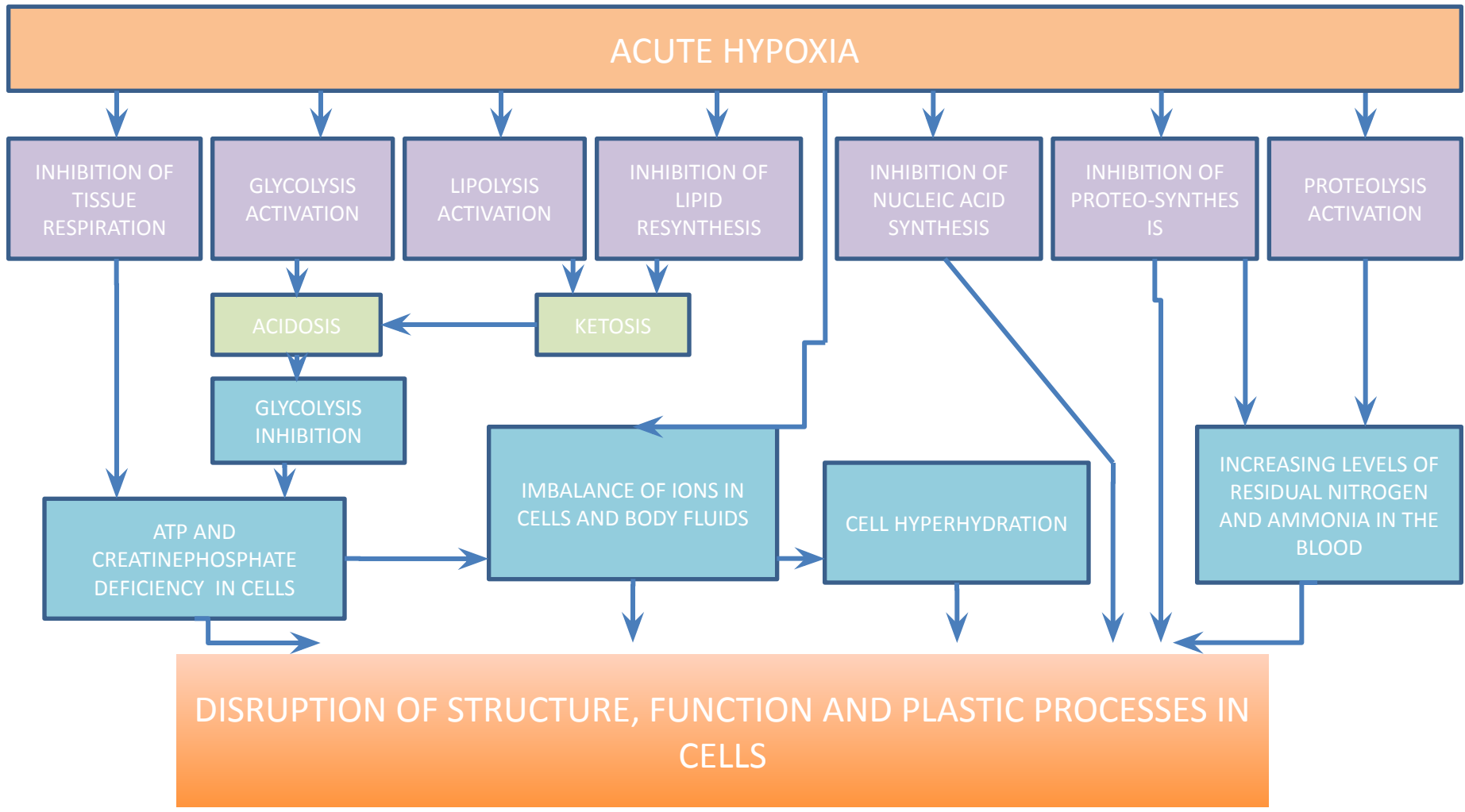
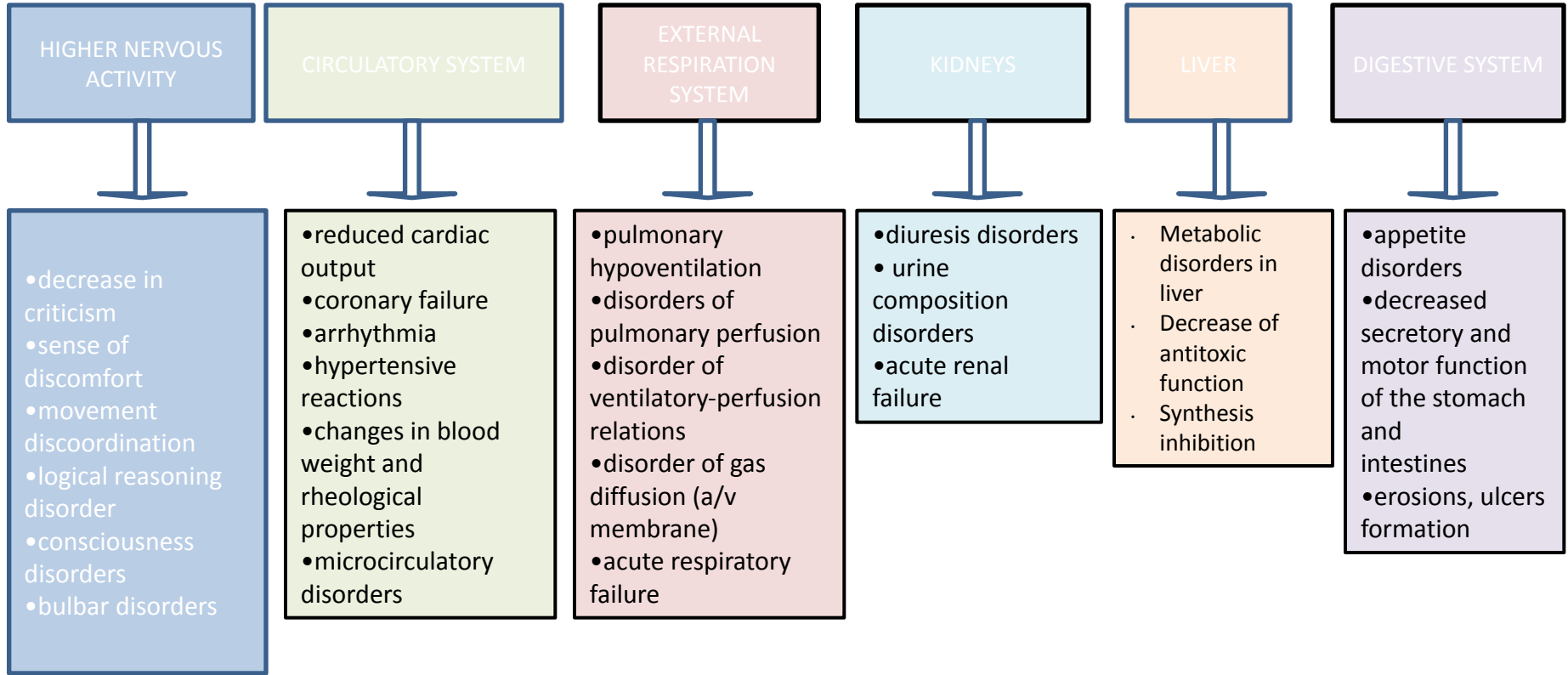


# Metabolic disorders in acute hypoxia

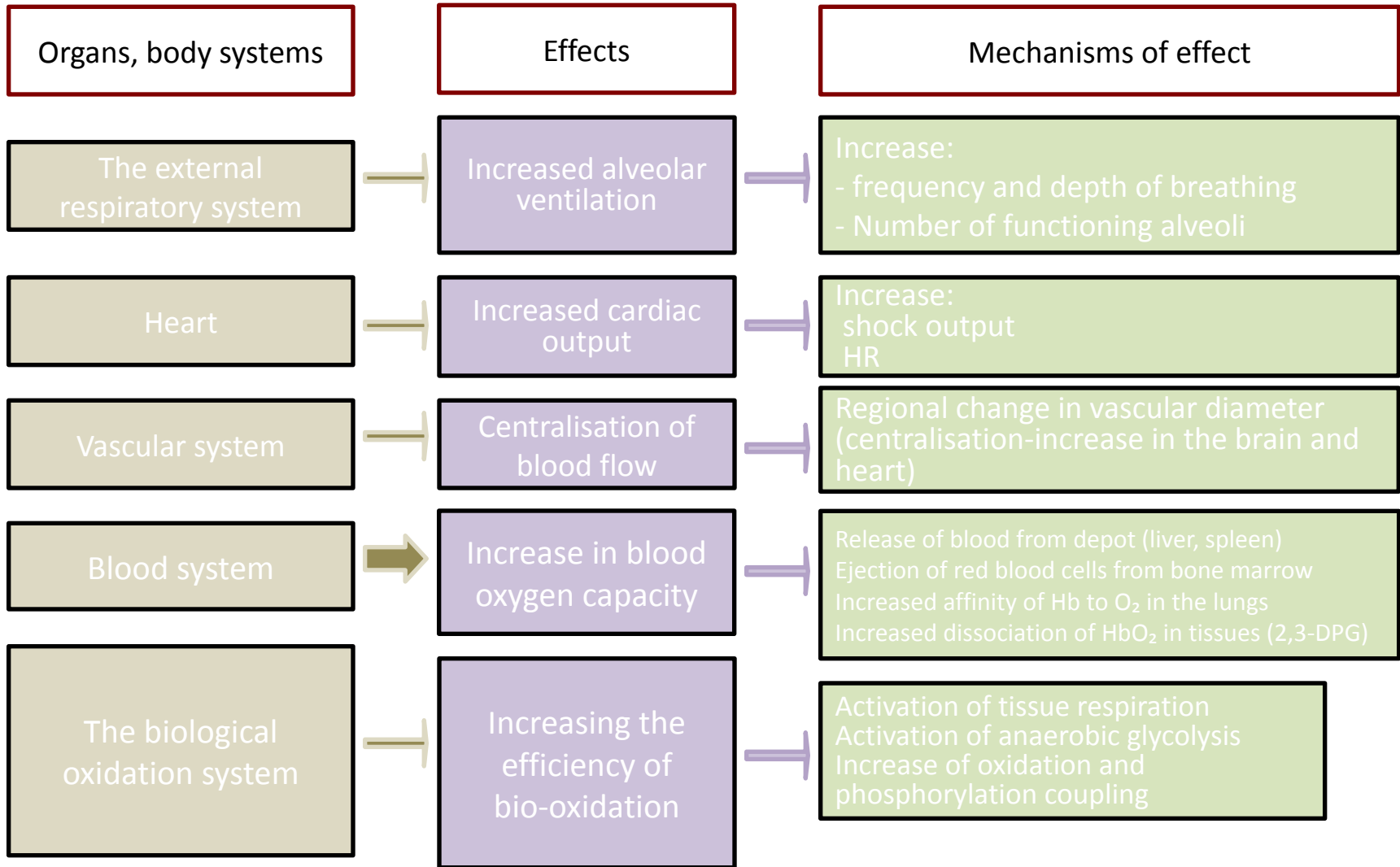


# Disorders of body functions in acute hypoxia

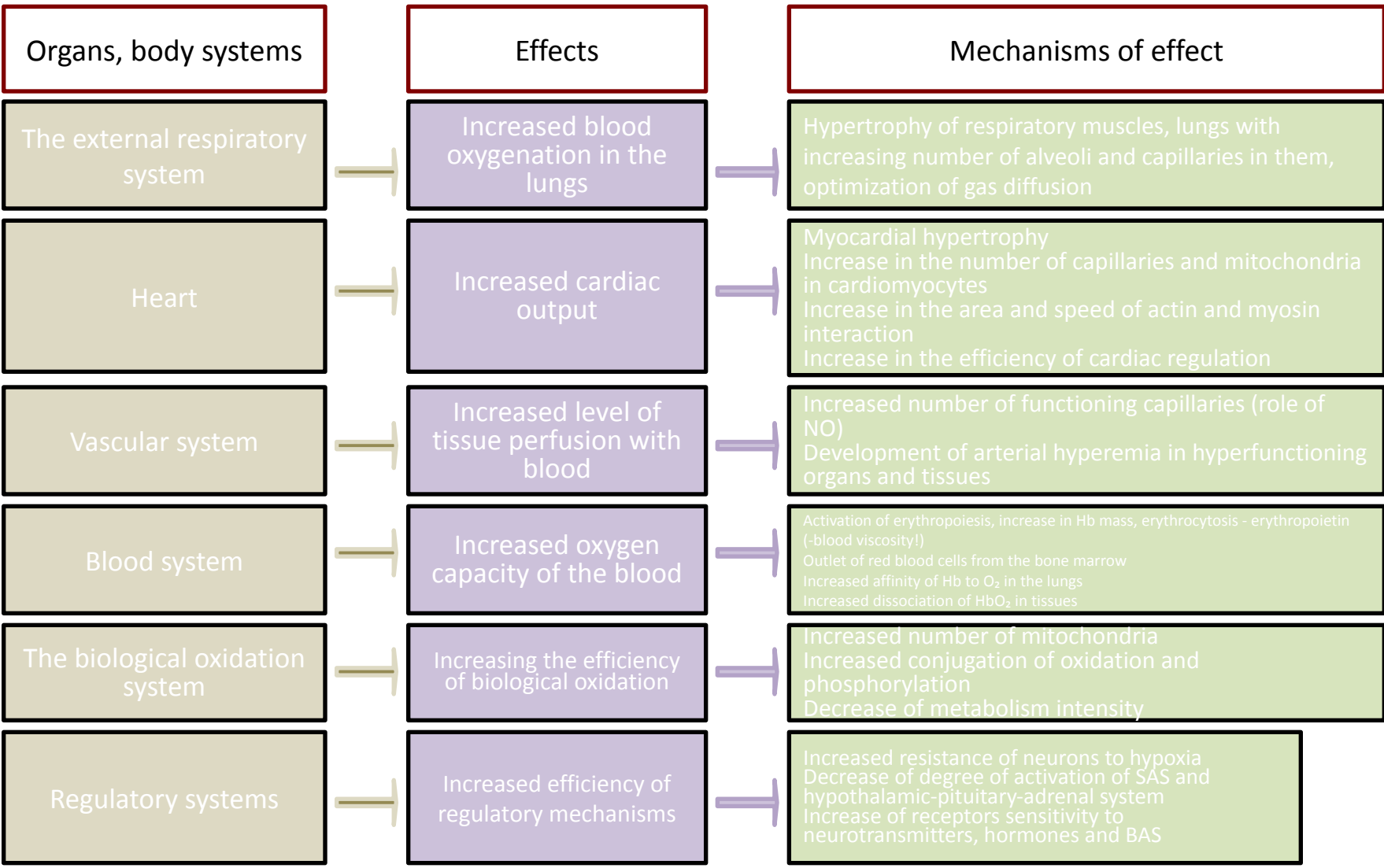


**The development of mountain sickness**  
High altitude pulmonary oedema  
High altitude cerebral oedema  
Haemorrhagic syndrome  
Disseminated intravascular coagulation syndrome (hypercoagulemia)

# Mechanisms of operational adaptation to hypoxia

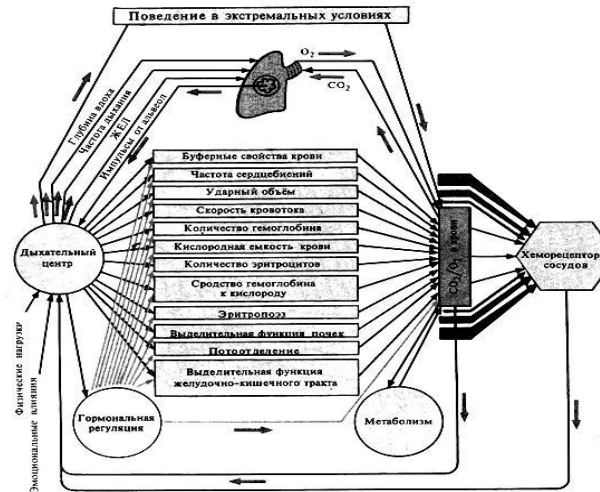


# Mechanisms of long-term adaptation to hypoxia



# Conclusion:

- hypoxia (exogenous) is a typical pathophysiological systemic process;
- at moderate intensity of the stimulus and prolonged exposure, a complex of adaptive shifts develops in the organism that increases its resistance to oxygen deficiency;



- in the applied aspect - the grounds for using hypoxic stimulus as a training options for adaptive mechanisms



# **1.2 History of development of methods of adaptation to hypoxia. Adaptive effects of hypoxic effects: systemic morphofunctional footprint**

Doctor of Sciences., professor O.S. Glazachev

Department of Normal Physiology

Institute of Clinical Medicine named after N.V. Sklifosovsky Institute of Clinical Medicine

Sechenov University

**Moscow, Russia**

# Toward a History of Methods of Adaptation to Hypoxia

**Hypoxia is a pathophysiological, potentially damaging process!**

**J. Barcroft (Cardiff, 1920):**

"Hypoxia not only intercepts the machine, but also damages the mechanism"

**R. Roach (Hypoxia into the next millenium, 2000):**

"Hypoxia is a constant threat throughout life"

**But:**



# Toward a History of Methods of Adaptation to Hypoxia

Hippocrates (V century B.C.) recommended that people with lung diseases and after a serious illness go to the mountains for a while.

Marco Polo (13th and 16th centuries), traveling through Asia, noted that valley dwellers suffering from various diseases, when moving to the mountains, recovered within a few days.

Dr. Meyer-Arens (1867) recommended the mountain climate for patients suffering from "bronchial catarrh with profuse sputum".

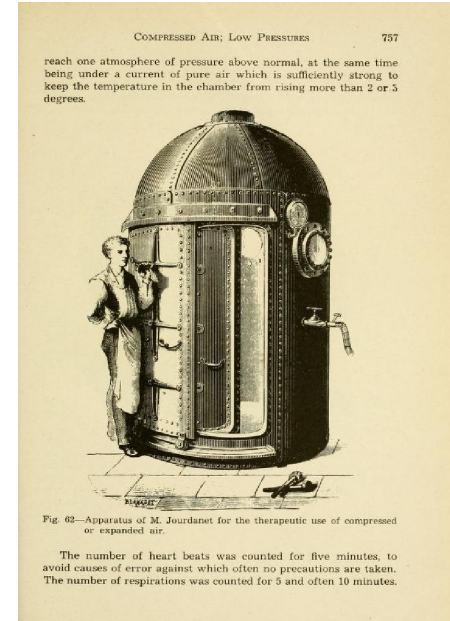
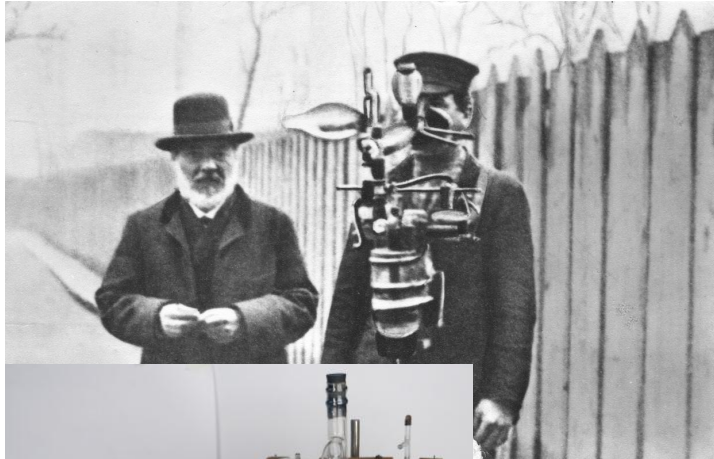
Dr. Lombard (1885) considered the mountain climate the best remedy for "raw asthma"

N. N. Sirotinin and his school (Kiev, 1939-2012): "Hypoxia, even harsh but brief and/or intermittent, can have a positive effect on the body."

# Toward a History of Methods of Adaptation to Hypoxia

Paul Bair, professor at the Sorbonne, in 1878 in his book "Barometric Pressure. Studies in Experimental Physiology," an apparatus for therapy with "compressed" or "expanded" air.

*Illustration from Paul Baer's classic book, in the American translation of 1943.*



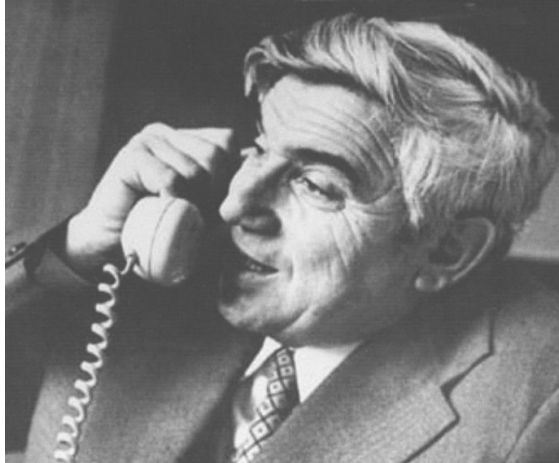
И.М.Сеченов: закон постоянства  
газового состава альвеолярного воздуха,  
портативный газоанализатор,  
закономерности адаптации к высокому и  
низкому атмосферному давлению,  
газы крови и солевой состав плазмы.

# Toward a History of Methods of Adaptation to Hypoxia



<http://biph.kiev.ua/>

Kolchinskaya Asya  
Zelikovskaya



Russian Journal of Cardiology.2001; 4 (30).

Meerson Felix  
Zalmanovich



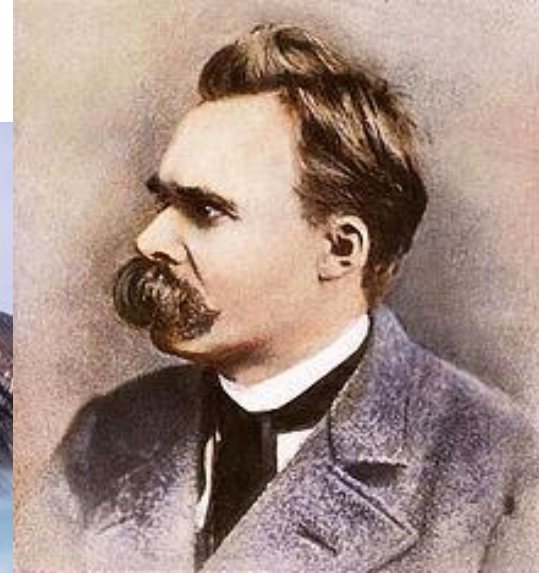
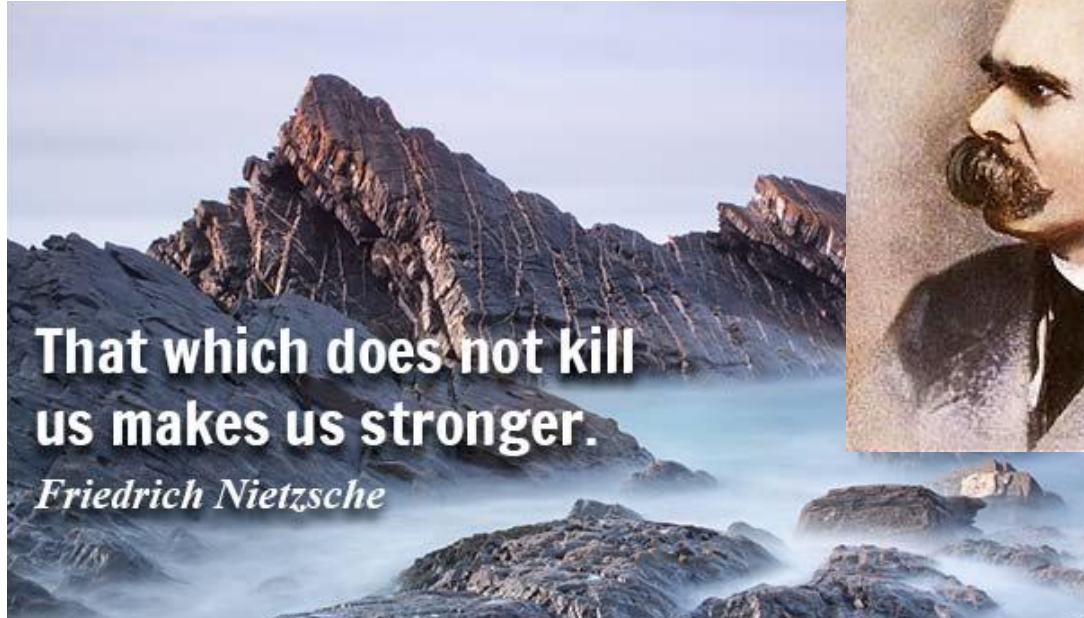
Aghajanyan  
Nikolai  
Alexandrovich



Mirrakhimov  
Mirsaid  
Mirhamidovich

<http://www.warheroes.ru>

# Adaptive effects of hypoxic effects



# Adaptive effects of hypoxic effects

Adaptation medicine is the study of the adaptive capabilities of humans to environmental conditions, as well as the development of methods and means to improve these capabilities, health reserves and quality of life.

Adaptation medicine is based on the concept of adaptation syndrome (G.Selye) and the phenomenon of pre/post-conditioning.

**Preconditioning** - is a procedure in which a stressor/harmful stimulus of an intensity somewhat below the damage threshold is exposed to the tissue (organism). Shortly after the presentation or in the retarded period the organ (and the organism as a whole) develops resistance to the same, similar or even a different damaging stimulus at an intensity even above the damage threshold, thus preventing or significantly reducing the damage it could have caused.

Dirnagl U., Becker K., Meisel A. Preconditioning and tolerance against cerebral ischaemia: from experimental strategies to clinical use //The Lancet Neurology, 2009: 8(4).

Verges S., Chacaroun S., Godin-Ribuot D., Dailieul S. Hypoxic conditioning as a new therapeutic modality // Frontiers in Pediatrics, 2015; 3.

# Adaptive effects of hypoxic effects

## 4 main signs of pre-post-conditioning (adaptation to the applied factor):

Increased/accelerated delivery of biosubstrates,

Reduction of energy consumption,

Activation of defense mechanisms to the damaging factor,

stimulation of recovery processes

## Conditioning Factors:

- Physical Stress
- Simulation of emotional stress
- Hypoxia
- Temperature effects
- Electrical stimulation ...

# Adaptive effects of hypoxic effects

Breathing adaptation

Circulatory adaptation

## **General signs of adaptation:**

Adaptation of the blood system

Muscle adaptation

## **Local Signs:**

Tissue adaptation

Cellular adaptation

# Adaptive effects of hypoxic effects

**Specific mechanisms**

**direct-**

**and**

**Non-specific mechanisms  
(adaptive stress syndrome)**

**cross effects:**

