

GENERAL ADAPTATION SYNDROME AND ITS APPLICATIONS IN SPORT TRAINING

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1.1. FORMULATION OF THE GAS CONCEPT

In the 1936, Hans Selye, discovered *the syndrome produced by diverse nocuous agents*.



Hans Selye (Department of Biochemistry, McGill University, Montreal, Canada)

A SYNDROME PRODUCED BY DIVERCE NOCUOUS AGENTS

Nature, vol. 138, 1936

“...Experiments on rats show that if the organism is severely damaged by acute nonspecific nocuous agents such as exposure to cold, surgical injury, production of spinal shock (transcision of the cord), excessive muscular exercise, or intoxications with sub lethal doses of diverse drugs (adrenaline, atropine, morphine, formaldehyde, etc.), a typical syndrome appears, the symptoms of which are independent of the nature of the damaging agent or the pharmacological type of the drug employed, and represent rather a response to damage as such...

This syndrome develops in three stages with different manifestations: the first stage occurs 6–48 hours after the initial injury, the second stage occurs beginning 48 hours after the injury. If the treatment be continued with relatively small doses of the drug or relatively slight injuries, the animals will build up such resistance that in the later part of the second stage the appearance and function of their organs returns practically to normal; but with further continued treatment, after a period of one to three months (depending on the severity of the damaging agent), the animals lose their resistance and succumb with symptoms similar to those seen in the first stage, this phase of exhaustion being regarded as the third stage of the syndrome.

1936

...It seems to us that more or less pronounced forms of this three-stage reaction represent the usual response of the organism to stimuli such as temperature changes, drugs, muscular exercise, etc., to which habituation or inurement can occur”.

1.1. FORMULATION OF THE GAS CONCEPT

In 1938, H.Selye described the “*syndrome produced by diverse noxious agents*” as the organism’s response to “*a stimulus to the quality or intensity of which it is not adapted*”, which has been termed the General Adaptation Syndrome (GAS).



Hans Selye (Department of Biochemistry, McGill University, Montreal, Canada)

EXPERIMENTAL EVIDENCE SUPPORTING THE CONCEPTION OF “ADAPTATION ENERGY”

American Journal of Physiology, vol. 123, 1938

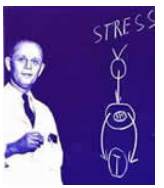
“It has been shown that when an organism is exposed to a stimulus to the quality or intensity of which it is not adapted, it responds with a reaction which has been termed the “general adaptation syndrome”. The symptoms of this syndrome...are largely independent of the specific nature of the agent to which adaptation occurs, so that the reaction has been regarded as them somatic expression of damage as such.

1938

The general adaptation syndrome develops in three distinct stages which have been termed: 1, the stage of the alarm reaction; 2, the stage of resistance, and 3, the stage of exhaustion..

1.1. FORMULATION OF THE GAS CONCEPT

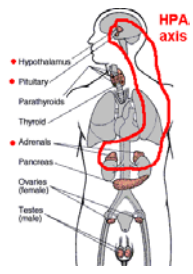
To name the effect of *acute non specific nocuous agents*, Hans Selye coined the term “**Stress**”, which has been accepted into the lexicon of various other languages.



Selye noticed that the changes, which take place within the body during both physical and emotional stress have the same pattern. They disrupt normal physiologic mechanisms and trigger an array of diseases, which lead to illness and eventually death.

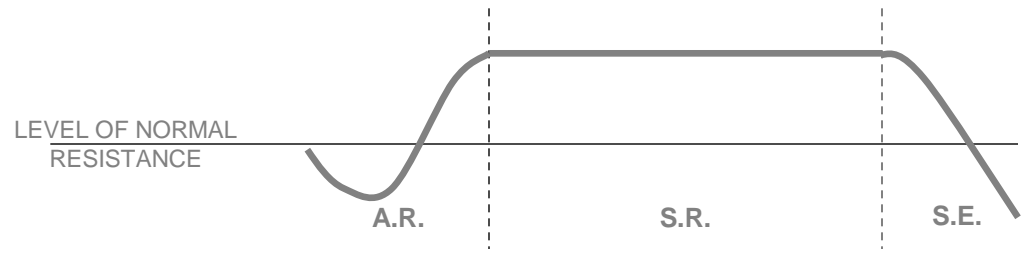
Later, Selye conceptualized the physiology of stress as having two components:
1) the development of a pathological state from ongoing, unrelieved stress, and
2) a set of responses which he called the “General Adaptation Syndrome”, “*to which habituation or inurnment can occur*”.

“The general adaptation syndrome is defined as the sum of all non-specific, systemic reactions of the body which ensue upon long continued exposure to stress”.
Selye H. The general adaptation syndrome and the diseases of adaptation. Journal of Clinical Endocrinology 6:117-231, 1946



Selye showed that the organism’s adaptation to stress is mediated by the common mechanism, related with the activity of hypothalamic-pituitary-adrenal axis (HPA axis): interactions among glands, hormones, and parts of the midbrain.

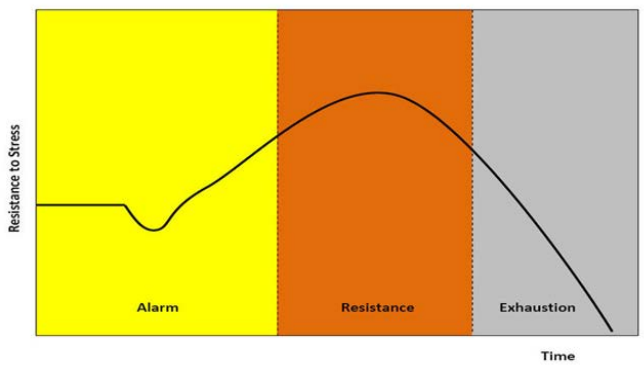
1.1. FORMULATION OF THE GAS CONCEPT



The triphasic course of the stress responds.

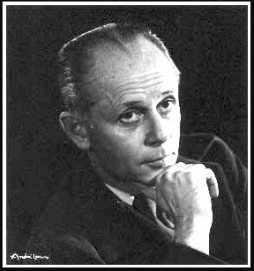
“ Stress is the common denominator of all adaptive reactions of the body..

All the changes just enumerated varied during the three phases of the G.A.S. in a characteristic and predictable manner. This variation of response during exposure to unvarying stressor made it possible to use the measurable indicators of stress (structural or chemical changes) for the appraisal of the evolution of the GAS in time.... (H.Selye, “Stress of life”, 1956)



A diagram of the General Adaptation Syndrome model (Wikipedia)

1.1. FORMULATION OF THE GAS CONCEPT

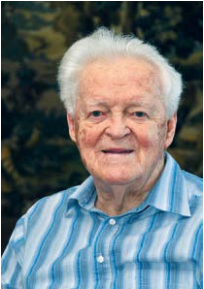


The General Adaptation Syndrome (GAS) is the concept, proposed in 1938 by Austro-Hungarian physiologist Hans Selye, as the universal mechanism of the organism's adaptation to external environment.

The GAS concept was formulated on the basis of H.Selye's discovery of stress syndrome - the non-specific organism's reaction to the influence of diverse damaging factors, such as: intoxications with sub lethal doses of drugs, surgical injury, exposure to cold and excessive muscular exercise.

Selye conceptualized the stress syndrome as General Adaptation Syndrome, because he postulated that "*stress is the common denominator of all adaptive reactions of the body*".

1.2. THE FIRST ATTEMPTS TO APPLY THE GAS CONCEPT IN SPORT TRAINING



Prof. Ludwig Prokop was the first who used the Selye's concept of General Adaptation Syndrome to explain the necessity to vary (periodically decrease) the volume of training loads during the sport training (*Prokop, L., Rossner F. Erfolg im Sport: Theorie und Praxis der Leistungssteigerung. Vien/Munich: Herbert St. Förlinger, 1959*)



Prof. Lev Matveev, author of the book "The problem of Periodization in the Training Process" (1964), was not in agreement with L. Prokop. According to Matveev, the GAS theory of Selye cannot be used as the theoretical framework of the concept of Periodization, because "*Selye's stress theory was based on the pathological material*".

1.2. THE FIRST ATTEMPTS TO APPLY THE GAS CONCEPT IN SPORT TRAINING



In the **September of 1960**, Fred Wilt, editor of *Track Technique*, published the article "Stress and Training". In this article, Wilt recognized the importance of Selye's work.

To further expand on Selye's significant contribution, Wilt referenced the work of Forbes Carlile, Australian Olympic swim coach, former marathon runner and physiology lecturer of the Sydney University.

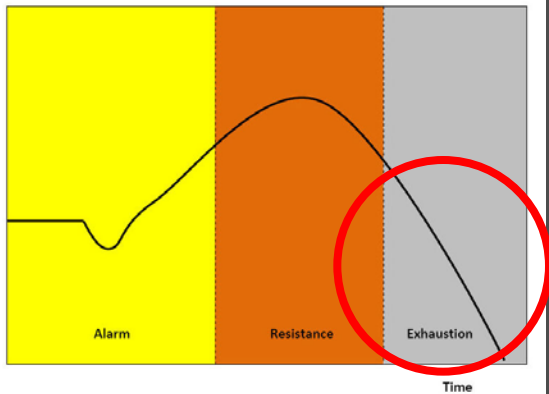


In the **September 1961** issue of *Track Technique*, Carlile published the article "*The Athlete and Adaptation to Stress*" in which he proposed the acceptance of Selye's General Adaptation Syndrome to provide a theoretical framework for coaching and future scientific research. Carlile supposed that what was termed "*staleness*" had its genesis in the G.A.S. and was indicative that the athlete had reached the final stage of exhaustion.

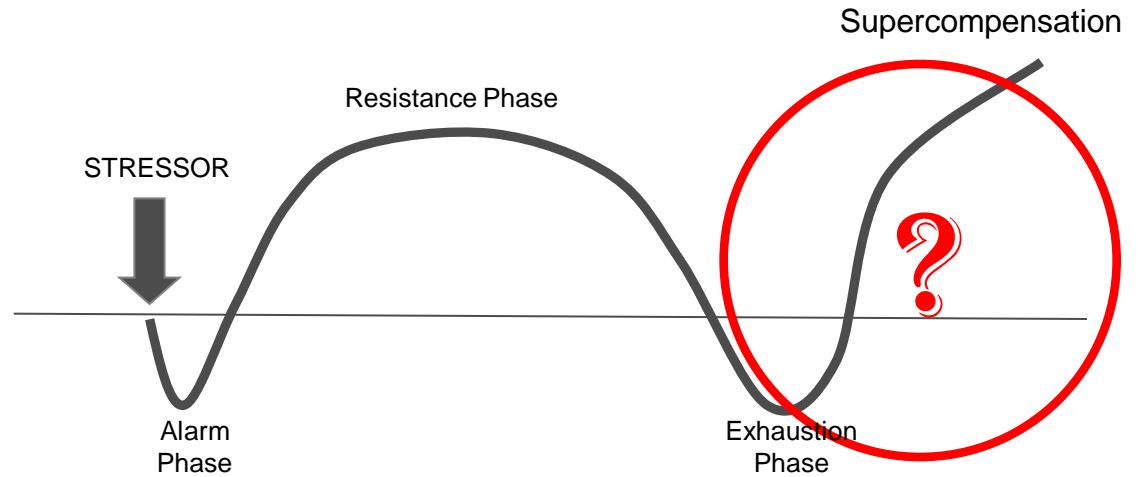
1.3. TYPICAL OPINIONS ABOUT THE ROLE OF GAS IN SPORT TRAINING

Stress is recognised as a typical reaction of the athlete’s body on the loads used during training and competitive activity, so increasing the athlete’s performance is based on the adaptation to stress

A diagram of the General Adaptation Syndrome model



Selye’s General Adaptation Syndrome model

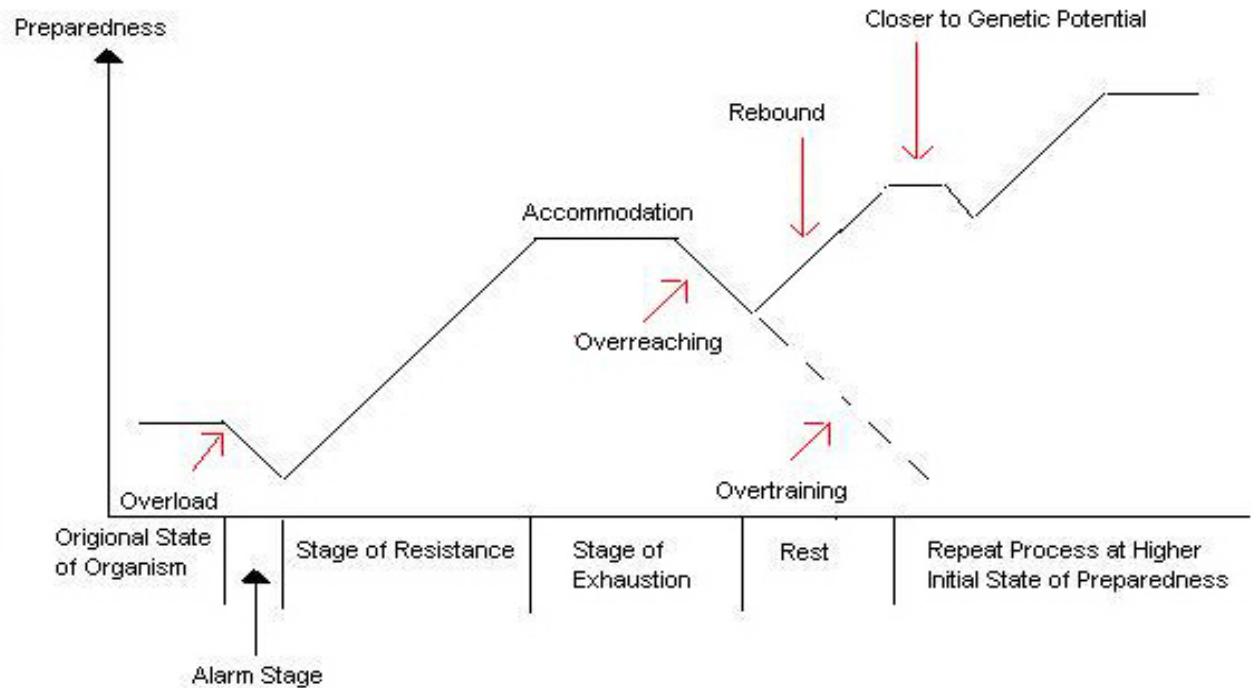
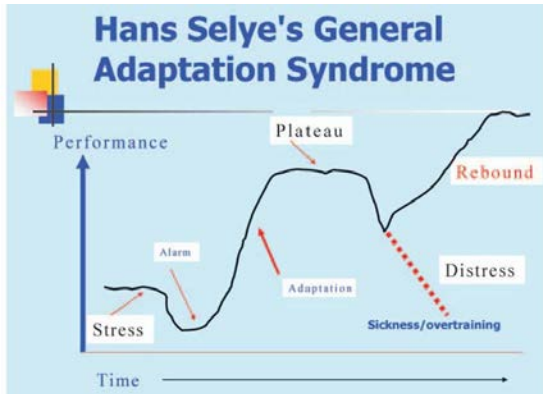


The Single-Factor Model of Training (The Suprecompensation Model).

*“The single-factor model ...provide a theoretical foundation from the principle of supercompensation.
...Training may than be described as the process whereby the body is systemically exposed to a given set of stressors to enable it to efficiently manage future exposure to those stressors” (M. Siff).*

1.3. TYPICAL OPINIONS ABOUT THE ROLE OF GAS IN SPORT TRAINING

In was accepted, that in traditional periodization models, there are multiple bouts of training, resulting in multiple flights of alarm and resistance stages



1.4. THE PROBLEMS IN APPLYING THE GAS CONCEPT IN SPORT TRAINING

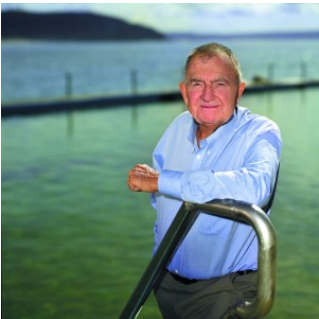


*“Training of an athlete is a great responsibility because two of his very important personal attributes are being used—the athlete’s time and his powers of adaptation to life stresses. Training him may be likened to bending a green twig. The body may eventually mould itself to the force of continuously imposed physical exercise, but a little too much and the body, like the twig, may show signs of strain. **More stress and the breaking point may be reached.**”*

In the September 1961, Forbes Carlile asked two questions considered essential to train athletes:

- 1) What are the main stresses which affect the ability of an athlete to adapt? and**
- 2) What signs and symptoms are indicative of a failure of an athlete to adapt to stress?**

Forbes Carlile. “THE HISTORY OF AUSTRALIAN SWIMMING TRAINING” A presentation at the World Swimming Coaches Clinic in Indianapolis, Indiana, under the auspices of the American Swimming Coaches Association. October 9, 2004



*“...One reason we undertook testing lay in the hypothesis that marked physiological changes would serve as a good guide for detecting the over trained state...We quite often found marked physiological changes coinciding with poor performances. Nevertheless, **it should be said that the testing approach turned out in one respect to be a false trail because these tests only touched on unravelling the complexity of the situation of overtraining. No one test or even a group of tests can be all revealing or common to all over trained athletes.**”*

1.4. THE PROBLEMS IN APPLYING THE GAS CONCEPT IN SPORT TRAINING



“Important condition of ensuring the training effect is the stress influence of training loads, which brings to increasing the level of homeostatic regulation and to mobilization of the body’s energetic and plastic resources”

Atko Viru. Hormonal mechanisms of adaptation and training. 1981

What the stress influence is?

“Stress is the organism’s state (status, condition) characterized by the development of general non-specific adaptation mechanism, which assures the positive background for the accomplishment of homeostatic reactions and mobilization of the organism’s defence abilities.”

“Often, stress is related to the influence of a certain unusual or extraordinary strong irritant. However, as it was shown, even very common irritants could be stressors. Obviously, decisive arguments is not the inequality or extreme of this irritant, but its ability to activate the non-specific mechanisms of adaptation “

1.4. THE PROBLEMS IN APPLYING THE GAS CONCEPT IN SPORT TRAINING



D.Dasheva

National Sports Academy, Department of Sports Training, Sofia, Bulgaria

THE SPORTS TRAINING AS A STRESS FACTOR

“The adaptation toward the physical and psychological stress is the main factor for obtaining the high sports performance.

...The specific program including the stress training is the keystone for creating the psychological stability and work-capacity during the anxiety situations as the sport competition.

...The stress training is related to the " threshold of adaptive changes". This is the moment, that the stimulus able to provoke a "shaking" effect on the different bodily function must be changed in intention to produce the new reactions and posteriorly new structural changes”.

What level of stressor’s influence corresponds to the " *threshold of adaptive changes*“?

1.2. THE FIRST ATTEMPTS TO APPLY THE GAS CONCEPT IN SPORT TRAINING

In the field of sport science, the General Adaptation Syndrome became the basic theoretical framework in the conception of training process periodization.

Usually, the term “stress” is used to name the physiological impact of training load on the athlete’s body.

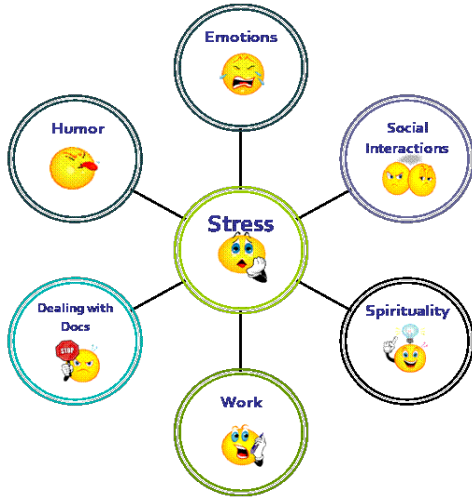
According to common opinion, to obtain the best training effect, the training loads must “stress” the athlete’s body. In the same time, training experts and coaches try to solve the problem of how to stress the athlete’s body and, in the same time, non provoke its overload.

Searching the way to solve this problem, they often refer to the theories of Selye.

However, notwithstanding the great popularity of Selye’s theories, many in experimental physiology considered his GAS concept too vague and incomplete.

1.4. THE PROBLEMS IN APPLYING THE GAS CONCEPT IN SPORT TRAINING

The most important problem is related to the term “Stress”



Stress is a term that is commonly used today but has become increasingly difficult to define. It shares, to some extent, common meanings in both the biological and psychological sciences. Stress typically describes a negative concept that can have an impact on one’s mental and physical well-being, but it is unclear what exactly defines stress and whether or not stress is a cause, an effect, or the process connecting the two.



Russell Viner is an academic paediatrician and adolescent physician at the UCL Institute of Child Health in London.

“...Selye's notion of a universal non-specific reaction has become accepted in almost all forms of human discourse about life and health, and physiologists in the 1990s use Stress as a unifying concept to understand the interaction of organic life with the environment. However, this modern use of Stress contains none of the physiological postulates of Selye's original findings...”

Russell Viner
Putting Stress in Life
Hans Selye and the Making of Stress Theory
Social Studies of Science June 1999 vol. 29 no. 3 391-410

1.4. THE PROBLEMS IN APPLYING THE GAS CONCEPT IN SPORT TRAINING

Ever since the first his publications, the crucial argument of their criticism was that stress, the pathological reaction on the influence of strong, damaging stimuli, cannot be a common pattern (*common denominator*) for the adaptive reactions on the mild stimuli



At the end of 1970°, the GAS concept was updated and reformulated by the group of Russian scientists, led by **prof. L.Garkavi**.

It was showed that the tem “Stress” should be used only to name the pathological organism’s reaction on the influence of very strong, damaging stimuli; the stress reaction cannot be a common pattern (*common denominator*) for all adaptive reactions of the body.

“...It was experimentally verified, that the organism responds on the influence of external and internal environmental factors with qualitatively different general non-specific adaptation reactions, which regularity of development was unknown before: the factors having mild (threshold) or middle (moderate) biological activity provoke the development of different sets of neuro-endocrine and metabolic changes, which assure, as consequence, a gradual or fast increasing of non-specific organism’s resistance”.

State register of the USSR for inventions and discoveries. Discovery No. 158, 1976



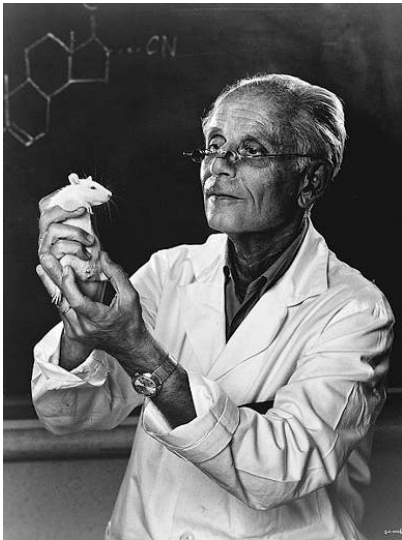
So, the most important questions of training practice may be formulated in the following way:

1. What is a typical reaction of the athlete's body on the loads used during training and competitive activity?
2. What factors affect the ability of an athlete to adapt?
3. What level should the training loads be to provide a training effect ?
4. What signs and symptoms indicate a failure of the athlete's adaptability ?

To answer these questions, it's necessary to clarify:

1. What are the physiological postulates of Selye's original findings?
2. How does new research data change these postulates?

1°. The organism's response to the sever damages of acute nocuous agents is independent of the nature of the damaging agent and represents a response to damage as such.



*“...Experiments on rats show that if the organism is severely damaged by **acute non-specific nocuous agents** such as:*

- ✓ exposure to cold,
 - ✓ surgical injury, production of spinal shock (transition of the cord),
 - ✓ excessive muscular exercise,
 - ✓ *intoxications with sub lethal doses of diverse drugs,*
- ...a typical syndrome appears...the symptoms of which are independent of the nature of the damaging agent or the pharmacological type of the drug employed, and represent rather a response to damage as such.”*

H.Selye, 1936

The acute nocuous agents, having different nature provoked the same pathologic reaction which was manifested by adrenal enlargement, gastrointestinal ulceration, thymus involution and deviation from the normal level of the white blood cells counts (WBC):

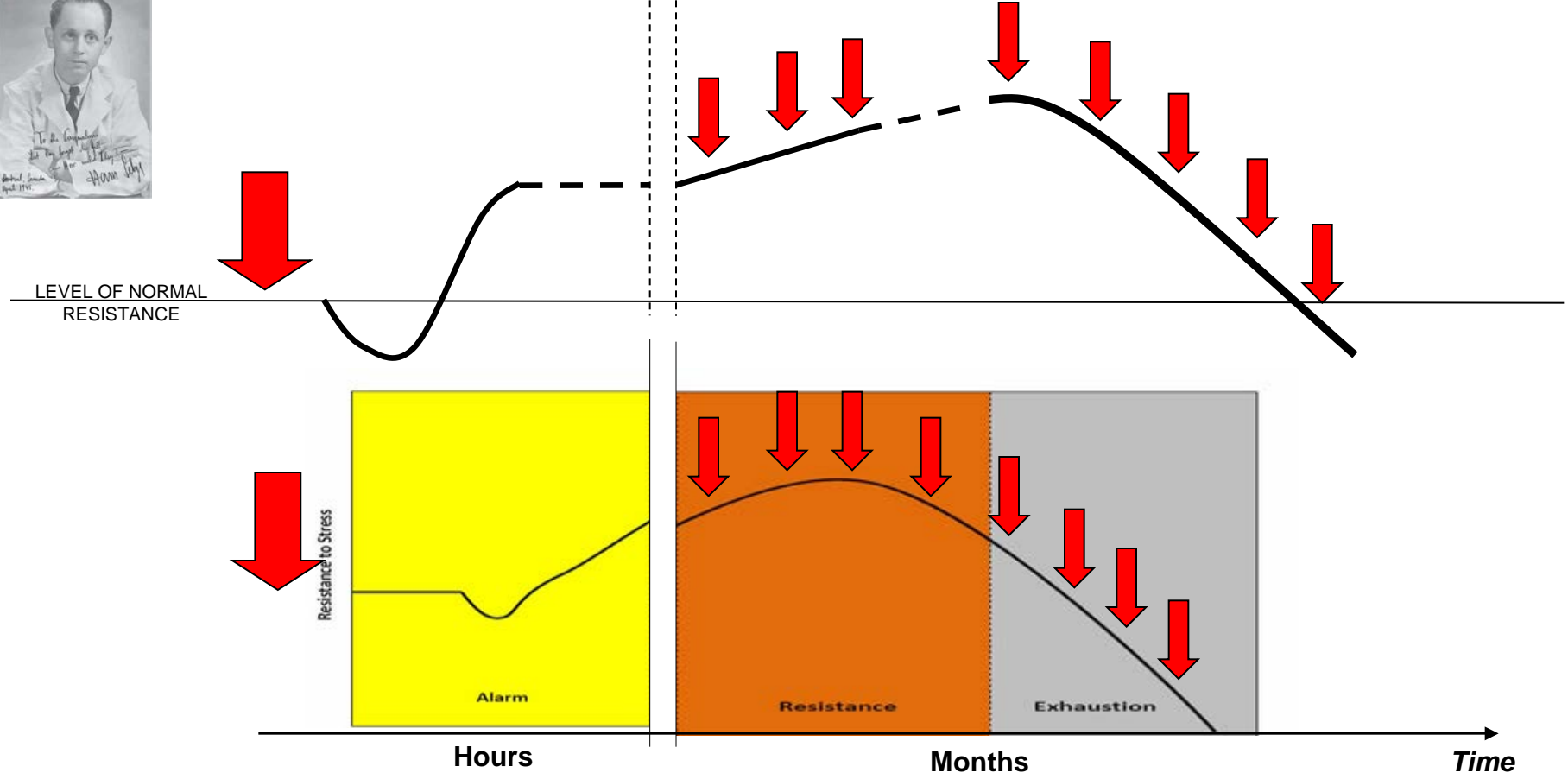
- raising the leycocytes count (leukocytosis);
- decreasing the lymphocytes count (limphopenia);
- decreasing the eosinophiles count (eosinopenia).

2°. During the response to the influence of acute nocuous agent the organism develops resistance, which overcomes its normal level



Case 1° - initial injury with sub-lethal dose of drug

Case 2° - repetitive treatment with relatively small doses of drug



2. THE GAS CONCEPT: KEY POINTS, CRITIQUE AND UPDATES

2.1. KEY POINTS OF SELYE'S EXPERIMENTAL FINDINGS

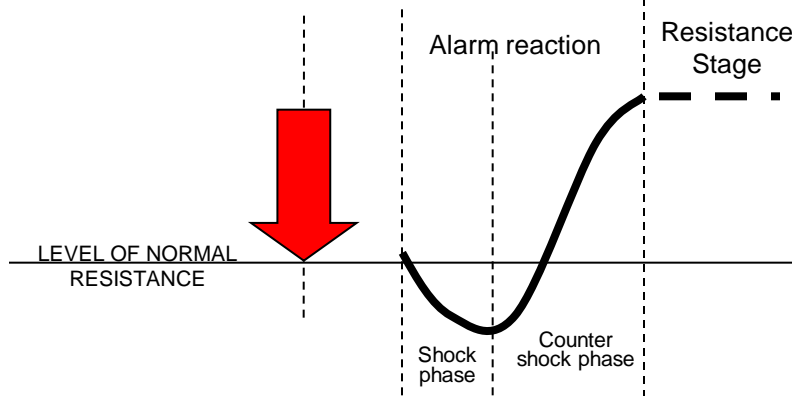
2°. During the response to the influence of acute nocuous agent the organism develops resistance, which overcomes its normal level

Case 1° - single injury with sub-lethal dose of noxious agent



"...6–48 hours after the initial injury, one observes rapid decrease in size of the thymus, spleen, lymph glands, and liver... We consider the first stage to be the expression of a general alarm of the organism when suddenly confronted with a critical situation, and therefore term it the "general alarm reaction."

In the second stage, beginning 48 hours after the injury, the adrenals are greatly enlarged but regain their lipoid granules... It would seem that the anterior pituitary ceases production of growth and gonadotropic hormones and prolactin in favor of increased elaboration of thyrotropic and adrenotropic principles, which may be regarded as more urgently needed in such emergencies.



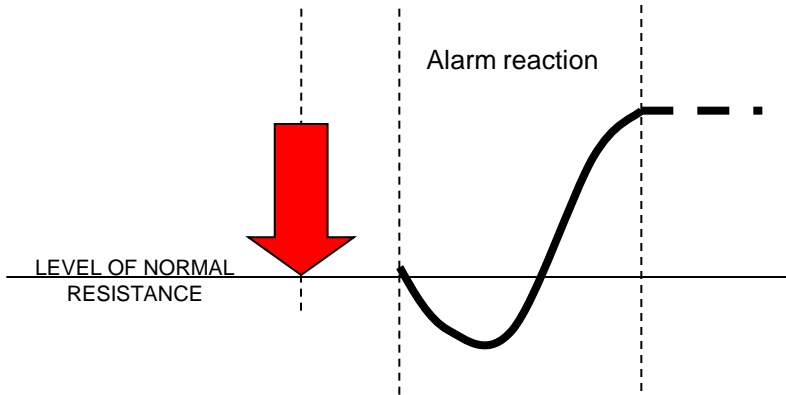
According to A. Viru (1981), Alarm reaction includes two phases: Shock and Counter-shock. It seems that Selye, describing the second stage, referred to the Counter Shock phase of Alarm reaction.

"Counter-shock represents the transitional phase to the following resistance stage, which could be observed under the chronically acting agents having the lower magnitude (their magnitude level not overcome the capability of the organism's defence systems)".

So, Resistance Stage occurs only in the Case 2°.

2°. During the response to the influence of acute nocuous agent the organism develops resistance, which overcomes its normal level

Case 1° - single injury with sub-lethal dose of noxious agent



Alarm reaction is recognised as psychosomatic flight-fight reaction of organism on a serious threat; it is not related to the phenomenon of Super-compensation, i.e. the phenomenon of restitution of exhausted substance (or energy) with over-reaching its initial level



At the beginning of Alarm reaction, *“the changes in endocrine system represent, per se, not a “call to arms”, but “call to disarmament”, because these changes lead to decreasing the activity of organism's defence systems. ... But how to explain why, after Alarm reaction, without any additional influence, the organism's resistance increases? (Garkavi, 1977)*

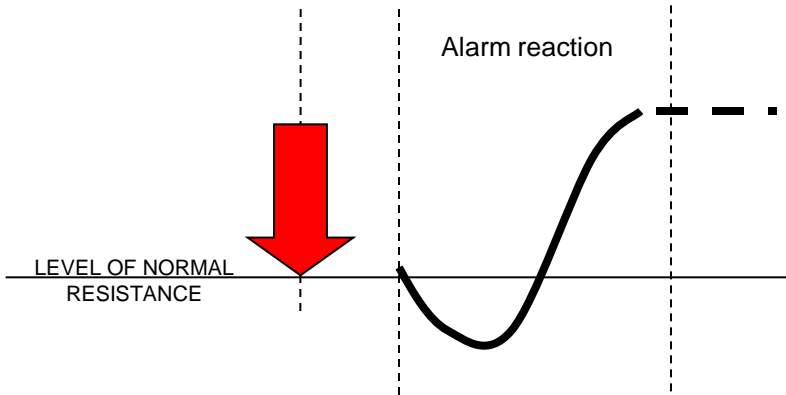


“That which does not kill us makes us stronger” ?

Friedrich Nietzsche

2°. During the response to the influence of acute nocuous agent the organism develops resistance, which overcomes its normal level

Case 1° - single injury with sub-lethal dose of noxious agent



According to L.Garkavi (1977), the cause of increasing the organism's resistance, after the strong injury with sub-lethal dose of nocuous agent, is the development of *protective inhibition* in CNS, which provokes decreasing the organism sensibility to the occurring damage.



*...Sweet are the uses of adversity;
Which like the toad, ugly and venomous,
Wears yet a precious jewel in his head...*

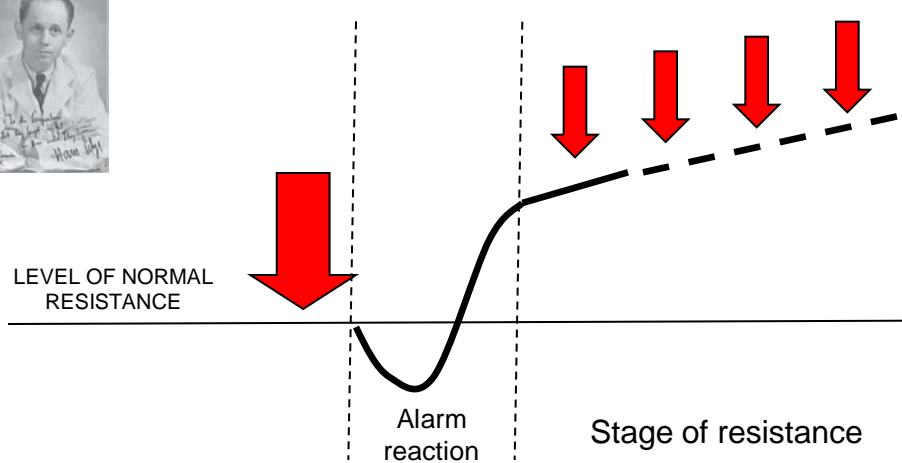
William Shakespeare

The first impact with “adversity”
resizes (downsizes) our perception
of “adversity”

That which does not kill us make us not stronger, but less sensitive

3°. The short term application of relatively small doses of a nocuous agent allows the organism to recover after the damages produced by sub-lethal dose of this agent

Case 2° - continuous application of relatively small doses of a noxious agent after initial injury with sub-lethal dose of this agent

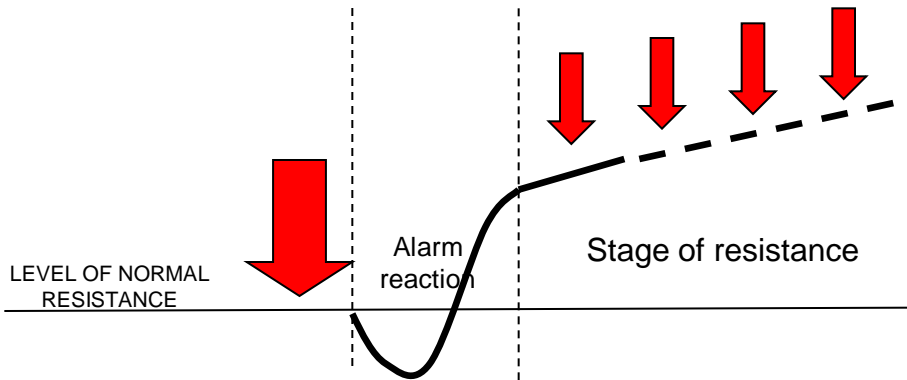


“...If the treatment be continued with relatively small doses of the drug or relatively slight injuries, the animals will build up such resistance that in the later part of the second stage the appearance and function of their organs returns practically to normal” . (H.Selye. 1936).

That which make us stronger is not that which does kill us

3°. The short term application of relatively small doses of a nocuous agent allows the organism to recover after the damages produced by sub-lethal dose of this agent

Case 2° - continuous application of relatively small doses of a noxious agent after initial injury with sub-lethal dose of this agent



"...As a result of developing protection inhibition, the CNS sensibility decreases...."

For this reason, the following stimuli are perceived by organism as the mild external influences, which stimulate increasing the organism resistance" (Garkavi, 1977)

"For every substance, small doses stimulate, moderate doses inhibit, large doses kill"

Arndt-Schulz rule, 1888



Rudolf Arndt (1835 – 1900) was a German psychiatrist, an ardent advocate of *homeopathy*. He found similar results in his researches on the effects of low doses of drugs on animals. He claimed that the low doses of toxins in general produced stimulation of biological endpoints such as growth or fertility.



Hugo Paul Friedrich Schulz (1853 – 1932) was a German pharmacologist. His research of a phenomenon known as *hormesis*, showed that toxins can have the opposite effect in small doses than in large doses. He proved this in his experiments with chemical compounds on yeast cells.

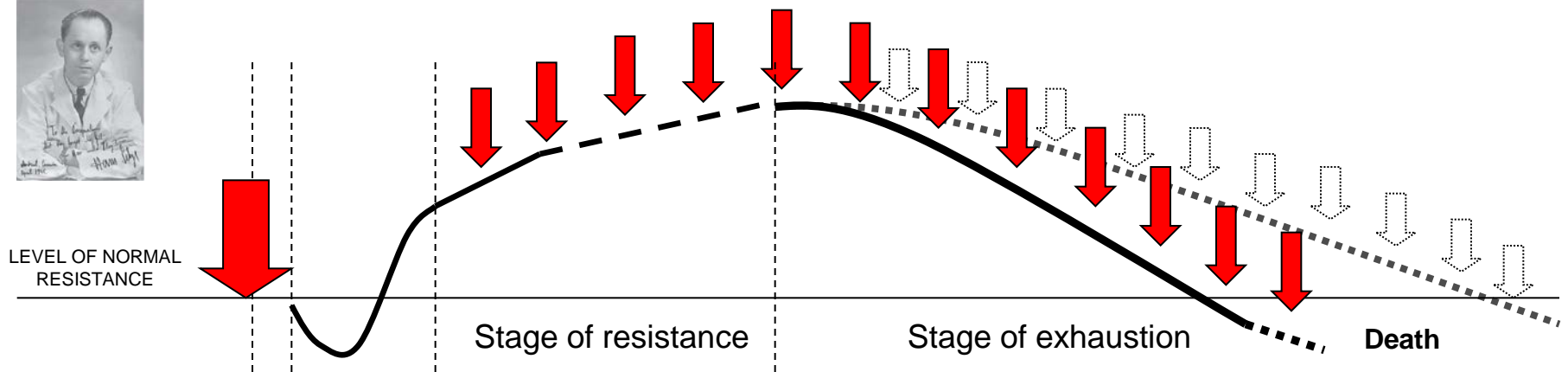
2. THE GAS CONCEPT: KEY POINTS, CRITIQUE AND UPDATES

2.1. KEY POINTS OF SELYE'S EXPERIMENTAL FINDINGS

4°. The long term treatment of organism with relatively small doses of nocuous agent leads to development of exhausting stage, which duration depends on the magnitude of said doses

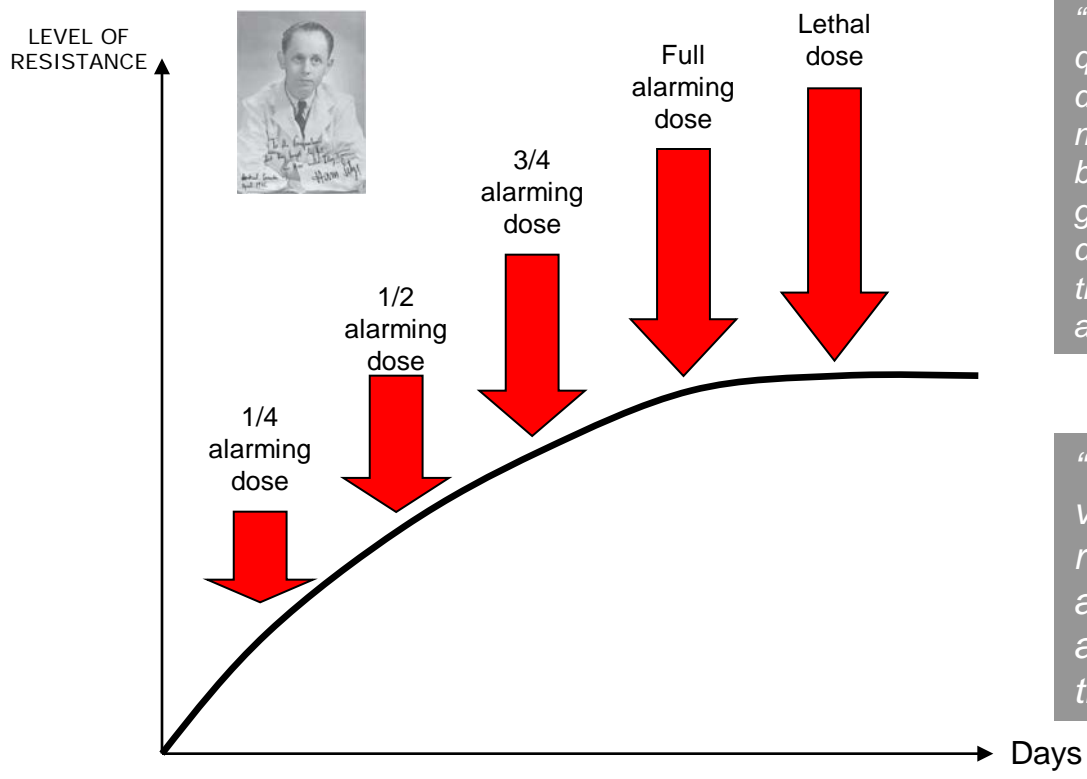
Case 2° - continuous treatment with relatively small doses of noxious agent after initial injury with sub-lethal dose of this agent

"... with further continued treatment, after a period of one to three months (depending on the severity of the damaging agent), the animals lose their resistance and succumb with symptoms similar to those seen in the first stage" (H.Selye, 1936)



"Prolonged treatment by the same "dose" of damaging agent, bring to the "exhaustion phase", which has the same symptoms as in the "alarm phase". ... The loss of acquired adaptation during the stage of exhaustion is difficult to explain but as a working hypothesis, it was assumed that every organism possesses a certain limited amount of "adaptation energy" and once this is consumed, the performance of adaptive processes is no longer possible" (H.Selye, 1938).

5°. The organism became more resistant to the influence of a large “dose” of nocuous agents after its pre-treatment with relatively small, but progressively increasing, “doses” of this agent



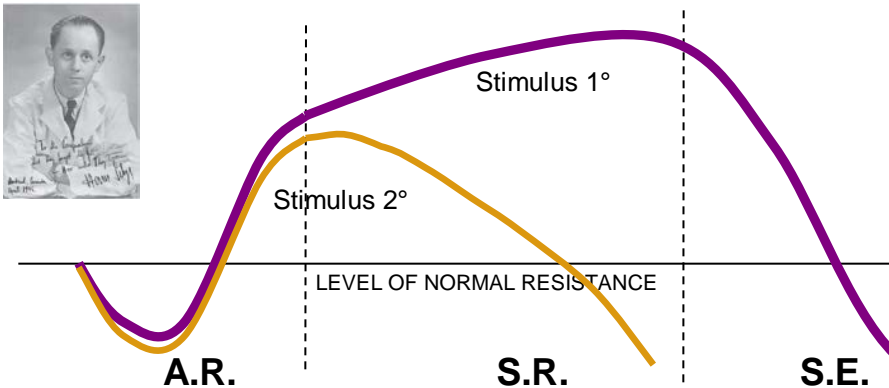
“The animals pre-treatment, starting with one quarter of the “full alarming dose” (which has been defined as the dose just sufficient to produce a marked alarm reaction within 48 hours after the beginning of the experiment)” and then by giving gradually increasing doses until the full alarming dose within 5 to 12 days, assures the increase of the animal resistance to the influence of damaging agent”.

“By giving gradually increasing doses of various alarming stimuli, one may raise the resistance of animals... rats pre-treated with a certain agent will resist such doses of this agent which would be fatal for not pre-treated controls”. (H.Selye, 1938)

That which make us stronger may be named “training”

6°. When the organism's resistance to a particular stimulus increases, its resistance to some other stimuli of a different nature simultaneously decreases

Case 1° - single initial injury with sub-lethal dose of drugs

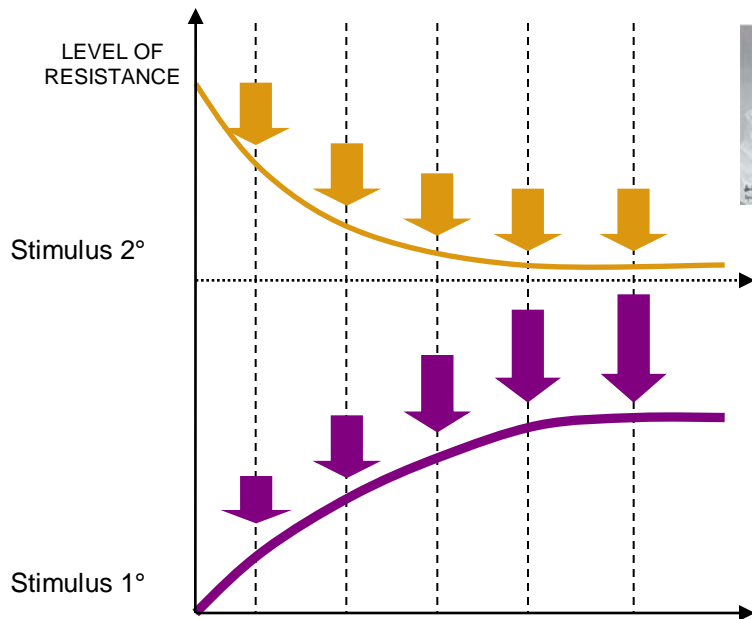


"... During the Alarm reaction, the resistance of the organism is increased, not only to the stimulus with which the Alarm reaction had been elicited but also to agents of a different nature. However, during the second stage of the adaptation syndrome, this non-specific resistance vanishes rapidly at a time when the specific resistance to the agent with which the animal had been pretreated, is still very high."

These findings are in accord with the conception of adaptation energy. Yet we must realize that this conception is quite contrary to common belief, since it is generally agreed that all vital processes are performed merely at the expense of the caloric energy of the ingested food. ... The two most important facts capable of proving that such a principle is utilized during adaptation and that the organism possesses only a limited amount of this "adaptation energy" are that acquired adaptation vanishes after a certain time and that while an organism builds up resistance against a certain agent it loses much of its ability to resist agents of a different nature." (H.Selye, 1938).

6°. When the organism's resistance to a particular stimulus increases, simultaneously, its resistance to the other stimuli, of a different nature, decreases

Case 2° - continuous treatment with the same noxious agent with increasing its dose (from relatively small to sub-lethal)



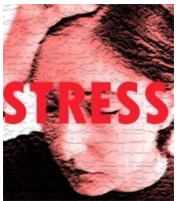
*"...during adaptation to a certain stimulus the resistance to other stimuli decreases. ...rats pre-treated with a certain agent will resist such doses of this agent which would be fatal for not pre-treated controls. At the same time, their resistance to toxic doses of agents other than the been adapted decreases below the initial value. ...These findings are tentatively interpreted by the assumption that the resistance of the organism to various damaging stimuli is dependent on its adaptability. This adaptability is conceived to depend upon adaptation one to which they have energy of which the organism possesses only a limited amount, so that if it is used for adaptation to a certain stimuli will necessarily decrease. We conclude that **adaptation to any stimulus is always acquired at a cost, namely, at the cost of adaptation energy**". " (H.Selye, 1938)*

To become stronger, we must be focused on the limited number of objectives.

2. THE GAS CONCEPT: KEY POINTS, CRITIQUE AND UPDATES

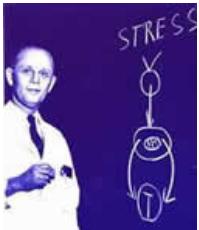
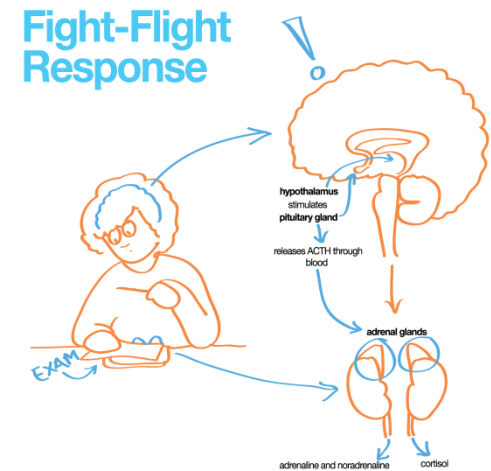
2.2. THEORETICAL CONCEPT OF GAS AND ITS CRITIQUE

“Stress has become such an ingrained part of our vocabulary and daily existence, that it is difficult to believe that our current use of the term originated only a little more than 50 years ago, when it was essentially “coined” by Hans Selye”. (Paul J. Rosch)



In the 1920s and 1930s, the term “stress” was occasionally being used in biological and psychological circles to refer to a mental strain, unwelcome happening, or, more medically, a harmful environmental agent that could cause illness.

Most often, the term Stress was used to name a person's physiological response to an internal or external stimulus that triggers the fight-or-flight response: our body's primitive, automatic, inborn response that prepares the body to “fight” or “flee” from perceived attack, harm or threat to our survival.



Hans Selye coined the term “**Stress**” to name the effect of “*acute non-specific noxious agents*”: “strong damaging factors”.
After, he defined Stress as “a *common denominator of all adaptive reactions of the body*”.
As a result, the term Stress started to be used to name the effect of any kind of body reaction on the change of external environment.

2. THE GAS CONCEPT: KEY POINTS, CRITIQUE AND UPDATES

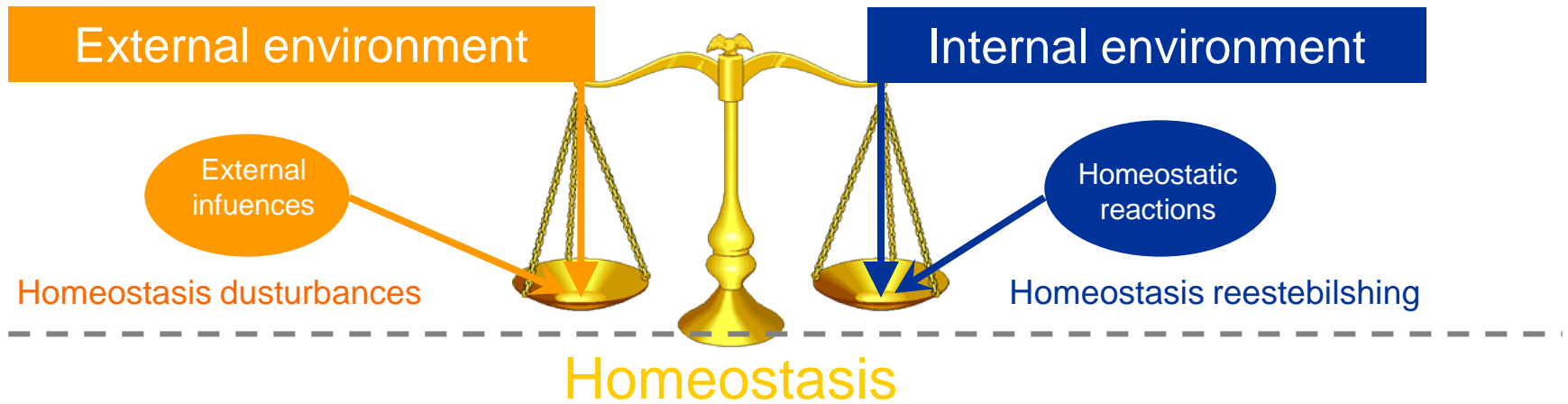
2.2. THEORETICAL CONCEPT OF GAS AND ITS CRITIQUE



Selye has acknowledged the influence of Walter Cannon, who used the term Stress to refer to external factor that disrupted what he called *homeostasis*.

Homeostasis is dynamic equilibrium state of the organism's internal environment; is also understood as the ability of the body to seek and maintain a condition of equilibrium or stability within its internal environment when dealing with external changes.

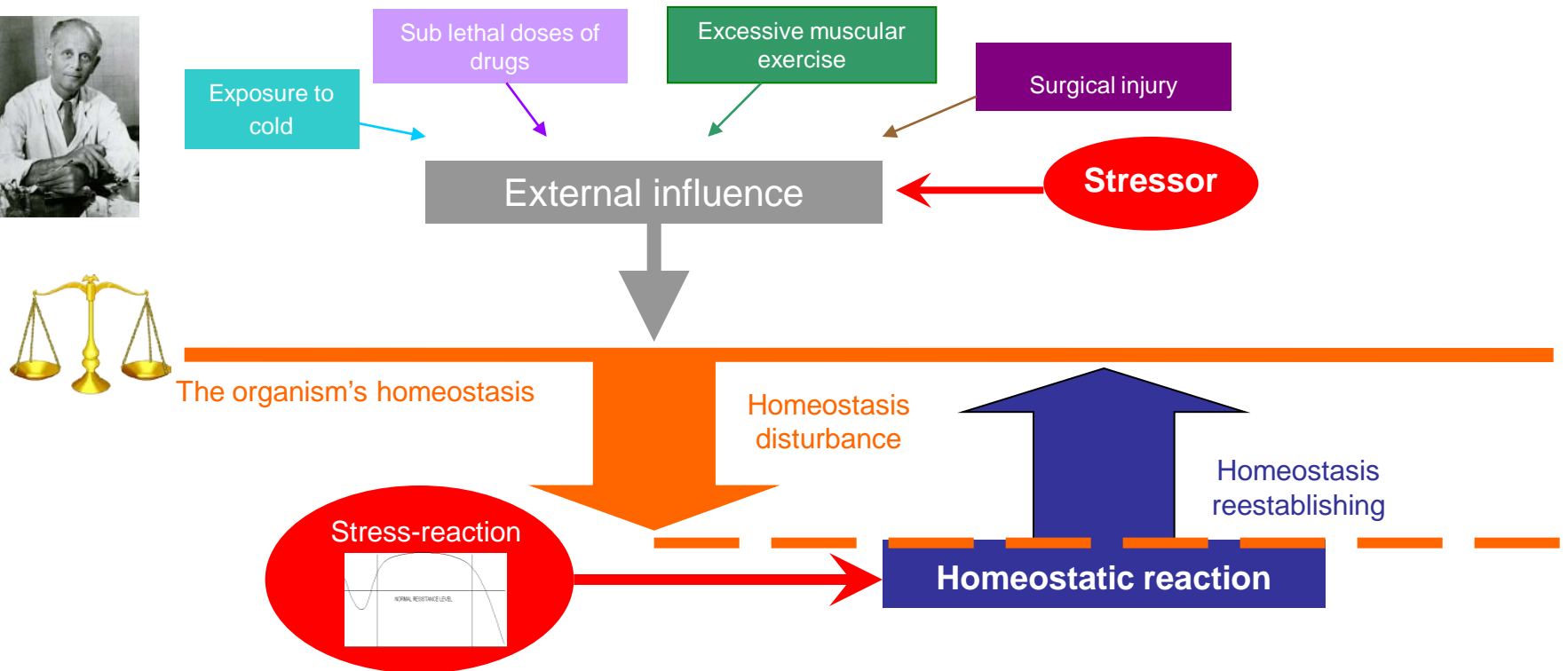
According to W.Cannon, the stress is stressful because it sharply disrupts dynamic equilibrium state of organism.



The concept of Homeostasis, or the Staying Power of the Body, helps us understand why “*various types of treatment and many, if not all, diseases have certain things in common, have certain non-specific, stereotyped features*” (Selye, 1956): because they are commonly perceived as the homeostasis disturbances.

2. THE GAS CONCEPT: KEY POINTS, CRITIQUE AND UPDATES

2.2. THEORETICAL CONCEPT OF GAS AND ITS CRITIQUE



Intoxication with sub lethal doses of diverse drugs, surgical injury, exposure to cold and excessive muscular exercise were “stressors” which provoked the Stress Syndrome in Selye’s experiments, because they sharply disrupted dynamic equilibrium state of the organism.

2. THE GAS CONCEPT: KEY POINTS, CRITIQUE AND UPDATES

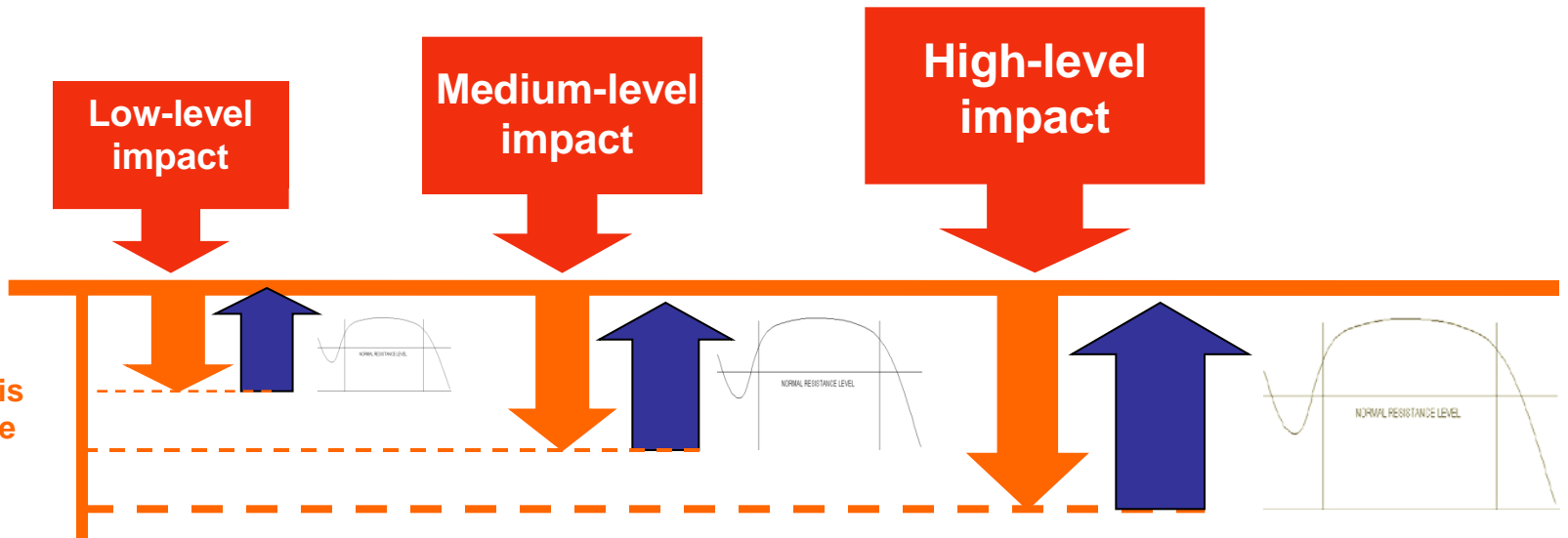
2.2. THEORETICAL CONCEPT OF GAS AND ITS CRITIQUE



According to Selye, the three-stage organism's reaction on the influence of acute noxious agents, termed as "stress syndrome", is universal: it occurs, in its more or less pronounced forms, in response to every "magnitude" of such influences.



Homeostasis
disturbance
level



Main part of Selye's followers accepted that the organism adaptation to each quality and each quantity of change in external environment is based on the adaptation to the Stress. However, it also became the main argument of the critique of GAS concept.

2. THE GAS CONCEPT: KEY POINTS, CRITIQUE AND UPDATES

2.2. THEORETICAL CONCEPT OF GAS AND ITS CRITIQUE

BERNARD GOLDSTONE
THE GENERAL PRACTITIONER AND THE GENERAL ADAPTATION SYNDROME
S.A. MEDICAL JOURNAL, 1952

“...Selye's work is concerned with adaptation to gross stimuli. He calls such stimuli stressors. (Stress is the state produced by a stressor). The great merit of his work is that he showed that there is the same reaction to every sort of unfamiliar stressor ...Selye's General Adaptation Syndrome ... is a ready-made mechanism to enable the individual to cope with all strange new severe stimuli; when the body learns how to cope with a specific stimulus, the G.A.S. is no longer essential to survival. ...A continuous minor stimulus is easily countered with continuous adaptation.

*...The G.A.S. bridges the gap until specific adaptation has been acquired. **The G.A.S. is an abstraction; it is never seen in its pure form** because it may be altered (conditioned) at any level in the long chain of its causal mechanism either by external conditioning (the particular nature of the stimulus) or by internal conditioning (biochemical values peculiar to the individual).”*



“...Of course, the concept of stress is an abstraction; but so is that life, which could hardly be rejected as irrelevant to the study of biology. No one has study life in a pure, uncontaminated form.

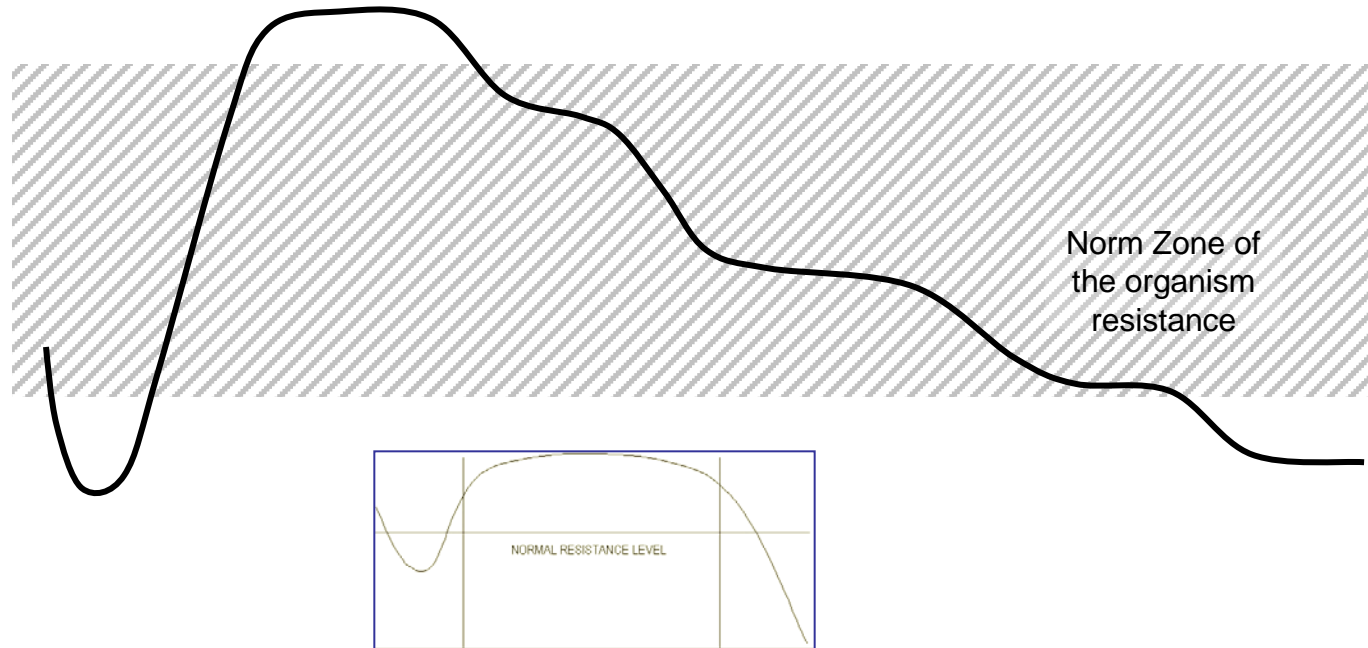
*...In other dimension, in time, the triphasic evolution of the stress response can be used as a measurable fact. **All the changes just enumerated varied during the three phases of the G.A.S. in a characteristic and predictable manner.** This variation of response during exposure to unvarying stressor made it possible to use the measurable indicators of stress (structural or chemical changes) for the appraisal of the evolution of the GAS in time.*

...Stress is the common denominator of all adaptive reactions of the body..”

Hans Selye “The Stress of Life”, 1956

2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING

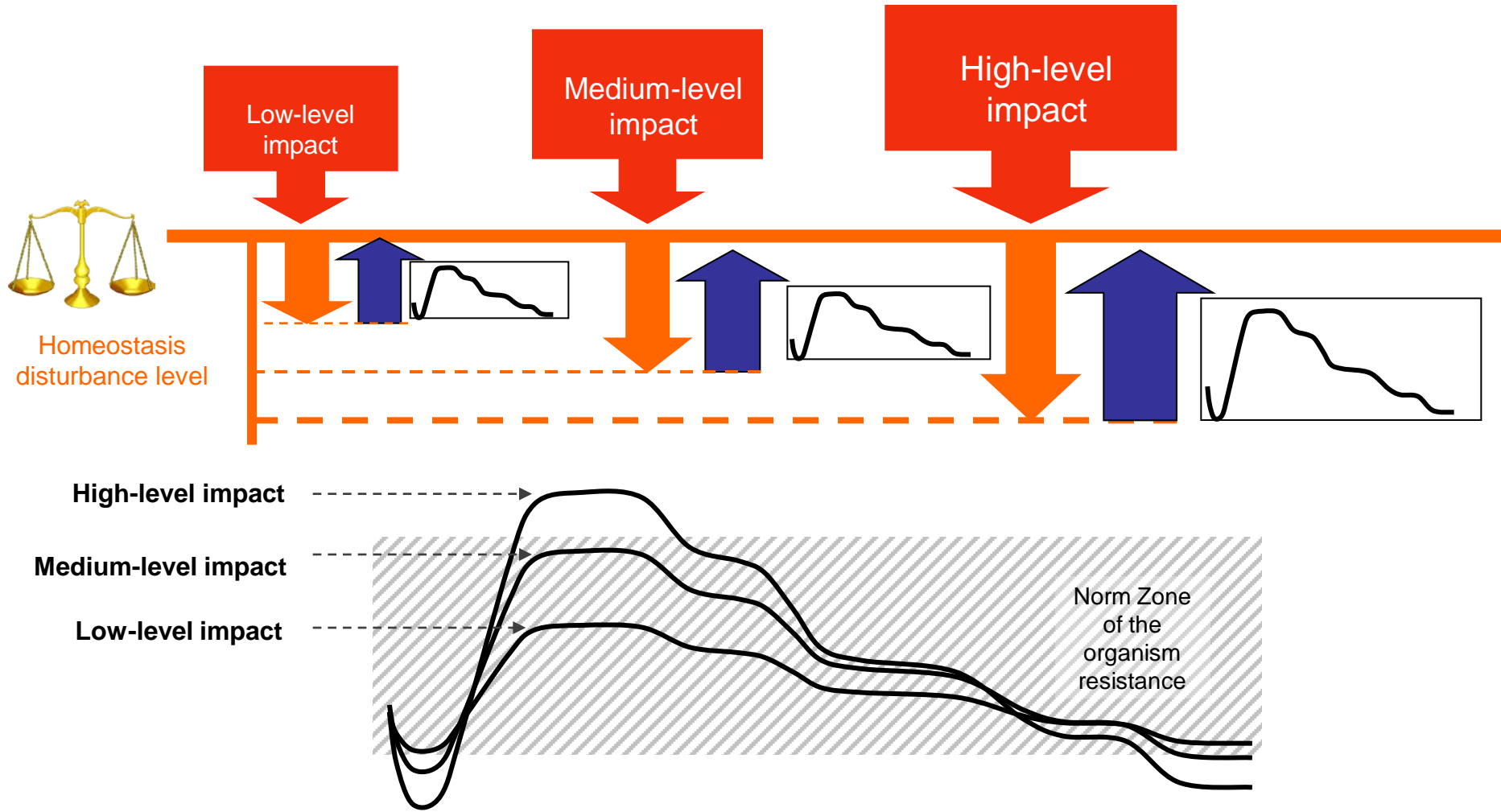
At the end of 60th, Russian scientists L. Garkavi, M. Ukolova and E.Kvakina had decided to complete the Selye's researches and to verify the organism responds to the stimuli of different magnitudes.



The respond on the high level stimuli (the same, as those used in the experiments of Selye) was characterized by the classic stress reaction.

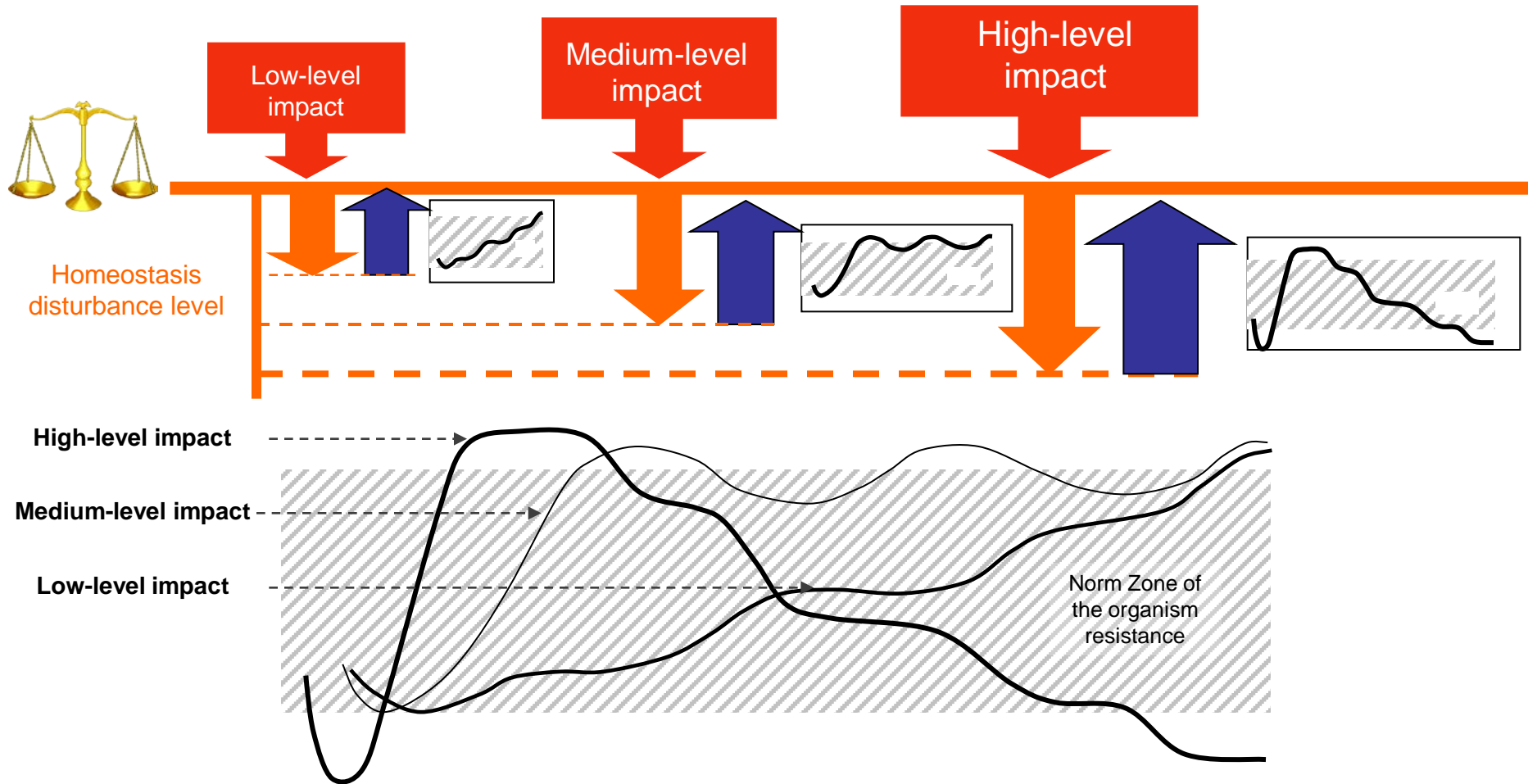
2. THE GAS CONCEPT: KEY POINTS, CRITIQUE AND UPDATES

2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING



This is what Garkavi supposed would happen as the organism's responds to the influences of stimuli having different magnitudes, according to Selye's theory.

2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING

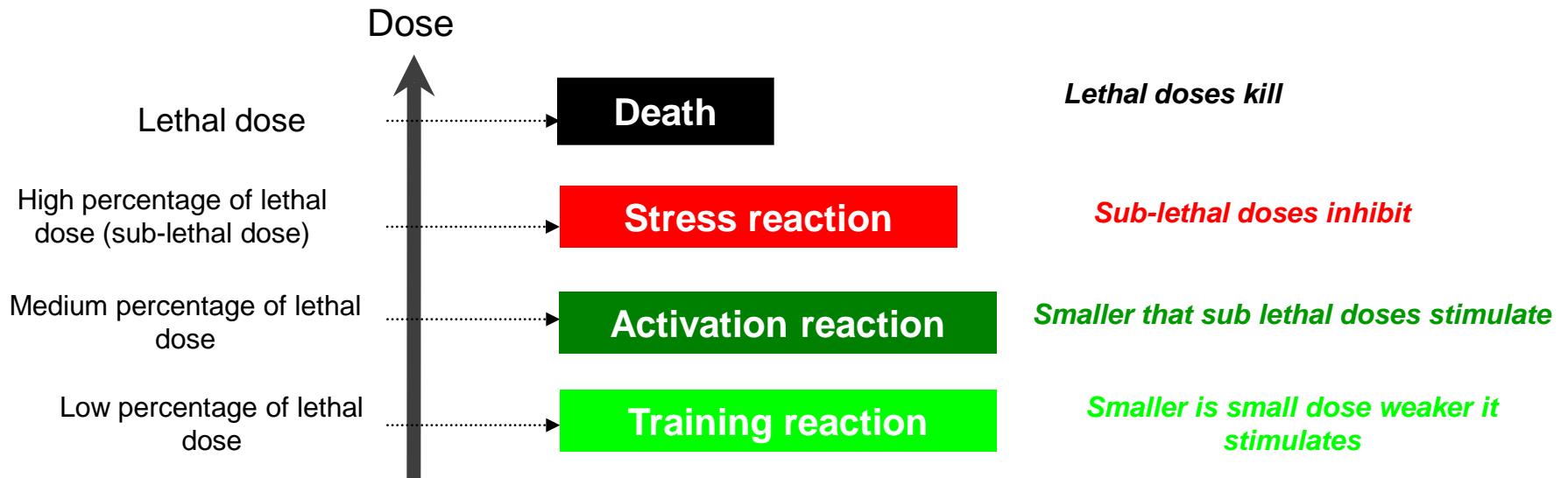


This is what Garkavi came up with as the organism's responds to the influences of the stimuli having different magnitudes.

2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING



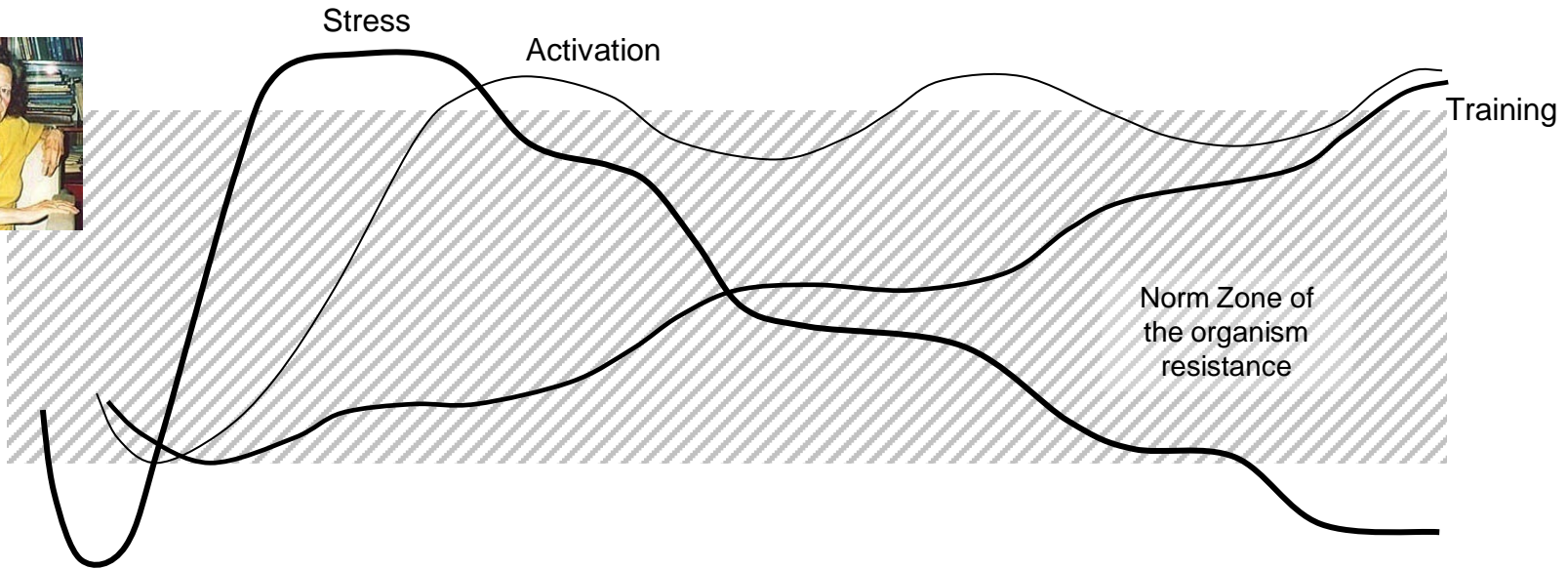
In the 1975, L. Garkavi, M. Ukolova and E. Kvakina established that medium and low influences bring an anti-stress adaptation reactions. These reactions enhance non-specific resistance of the human body to any damaging factors of the internal or external environment without energy losses in functional systems of the body. The reaction to the low level influences was named the “**Training reaction**”. The reaction to the medium level influences was named the “**Activation reaction**”.



“For every substance, small doses stimulate, moderate doses inhibit, large doses kill”

2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING

At the beginning of each of the three different reactions, the organism resistance initially decreases and then subsequently increases. The repetitive influences of high level impacts (stressors) bring about a decrease in the organism resistance; however, low and especially medium level impacts ("training" and "activation" reactions) bring about an increase in the organism's resistance.



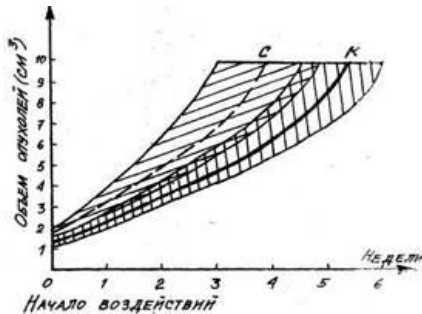
Schema of L. Garkavi, E. Kvakina and M.Ukolova (1975). Changing the organism resistance under the repetitive influences of the same damaging factors having three different "magnitude" of impacts:

- the high level impacts – "stress" reaction;
- medium level impacts – "activation" reaction
- low level impacts – "training" reaction.

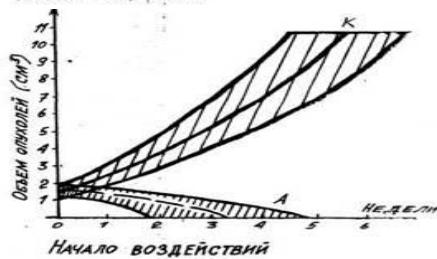
2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING



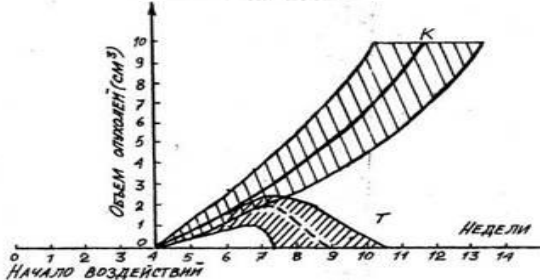
The results of researches conducted by L Garkavi



In two equal groups of rates, affected by cancer, the first group was treated with the “full alarming dose”. The first group was dead after 3 weeks. The other, control group was dead after around 5 weeks.



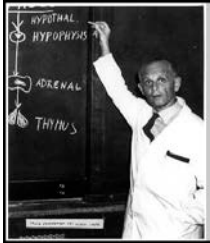
In two equal groups of rates, affected by cancer, the first group was treated with the percentage of “full alarming dose”, which induced the Activation reaction. The first group was healed after around 3 weeks. The other, control group, was dead after approximately 5 weeks.



In two equal groups of rates, affected by cancer, the first group was treated with the lower percentage of “full alarming dose”, which induced the Training reaction. The first group was healed after about 5 weeks. The other, control group was dead after approximately 7 weeks.

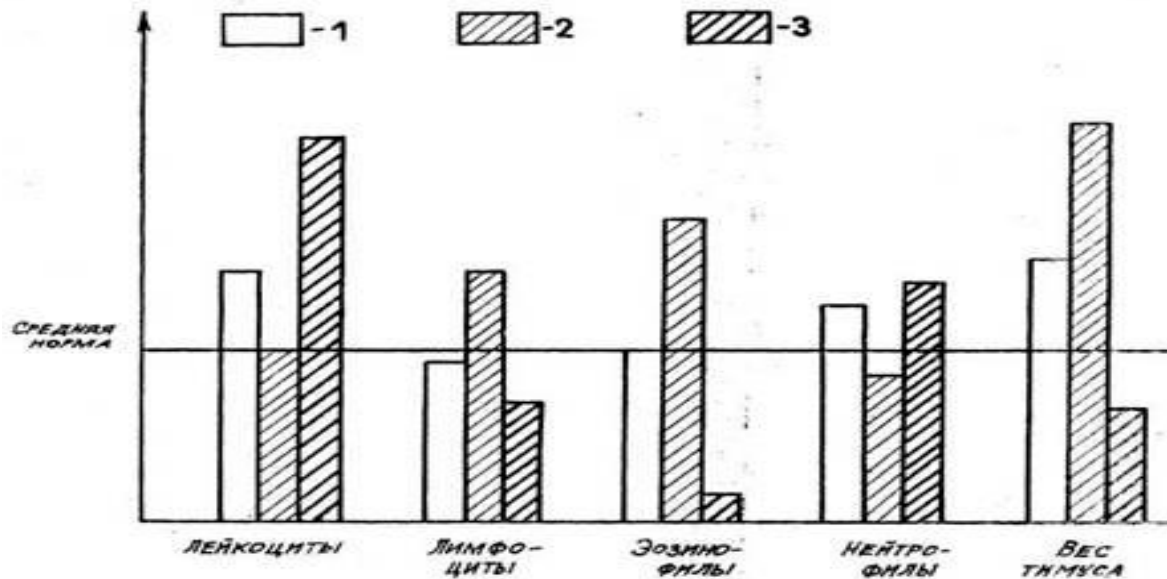
2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING

The first phase of the Stress reaction and anti-stress reactions is manifested by different characteristics of WBT counts and thymus mass changing



According to H. Selye, the first phase of stress reaction (Alarm phase) is manifested by:

- 1) increase in the leucocytes count above the normal range in the blood,
- 2) decrease in the lymphocytes count in the blood,
- 3) decrease in the eosinophils count in the blood,
- 4) decrease in the thymus mass.

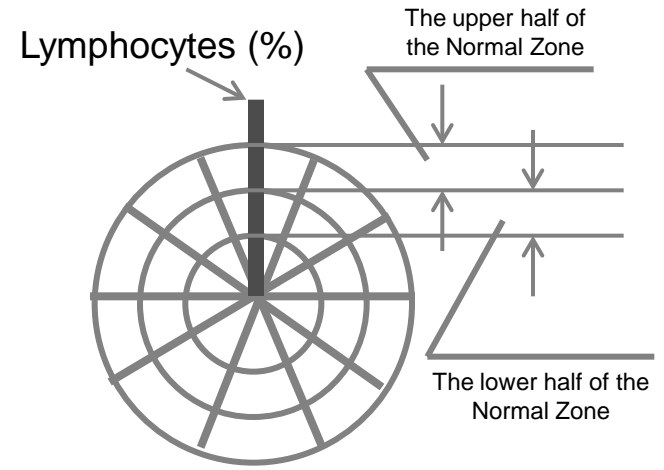
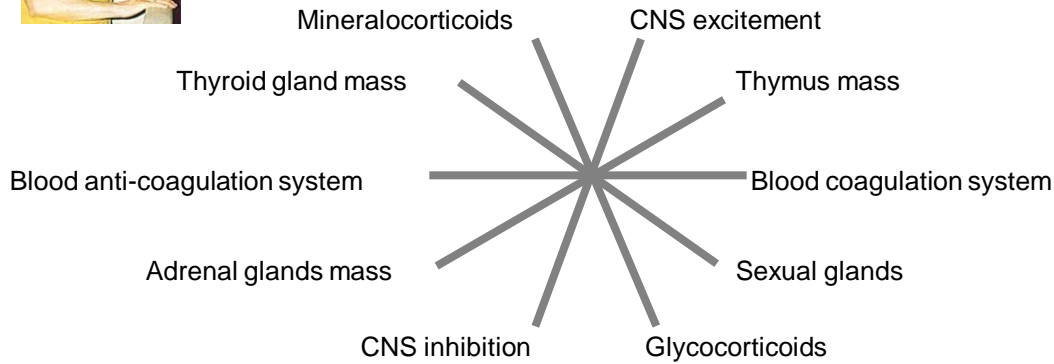


The leukocytes, lymphocytes, eosinophiles and neutrophiles number and the thymus weight during the first stages of the "training" reaction (1), the "activation" reaction (2) and the "stress" reaction (3). (L. Garkavi, E. Kvakina and M.Ukolova (1975))

2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING



The results of researches conducted by L Garkavi



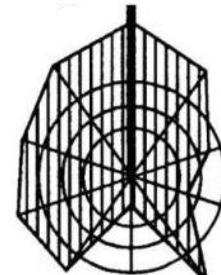
Training reaction



Calm Activation



High Activation



Over-activation



Stress reaction

Activation reaction

2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING



Garkavi's group made important updates to Selye's research that were in contrast to his theoretical postulates. It was shown that the General Adaptation Syndrome is not the common denominator of all adaptive reactions of the body:

- The Stress syndrome is only the organism reaction, an unwelcome responds to a sharp environmental change.
- The organism adaptation to the lower level environmental changes, which is the main mechanism of its adaptation during life, is induced by other non-specific reactions, having different physiological characteristics.

2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING



L.Garkavi had formulated the new, more complete version of the GAS concept and had elaborated the new method of medical treatment, called **Activation Therapy**. This method was based on applying the low doses of different non-specific stimuli (drugs, electric discharges, physical exercises, etc.) to provoke the anti-stress reactions and to activate, in this way, the body defense mechanisms. The magnitudes of stimuli were verified in relation to the typology of anti-stress reactions, which they provoke in a given patient: each of these reactions can be defined using the Garkavi's markers, based on the corresponding to each of them hemogramms of white blood cells counts.

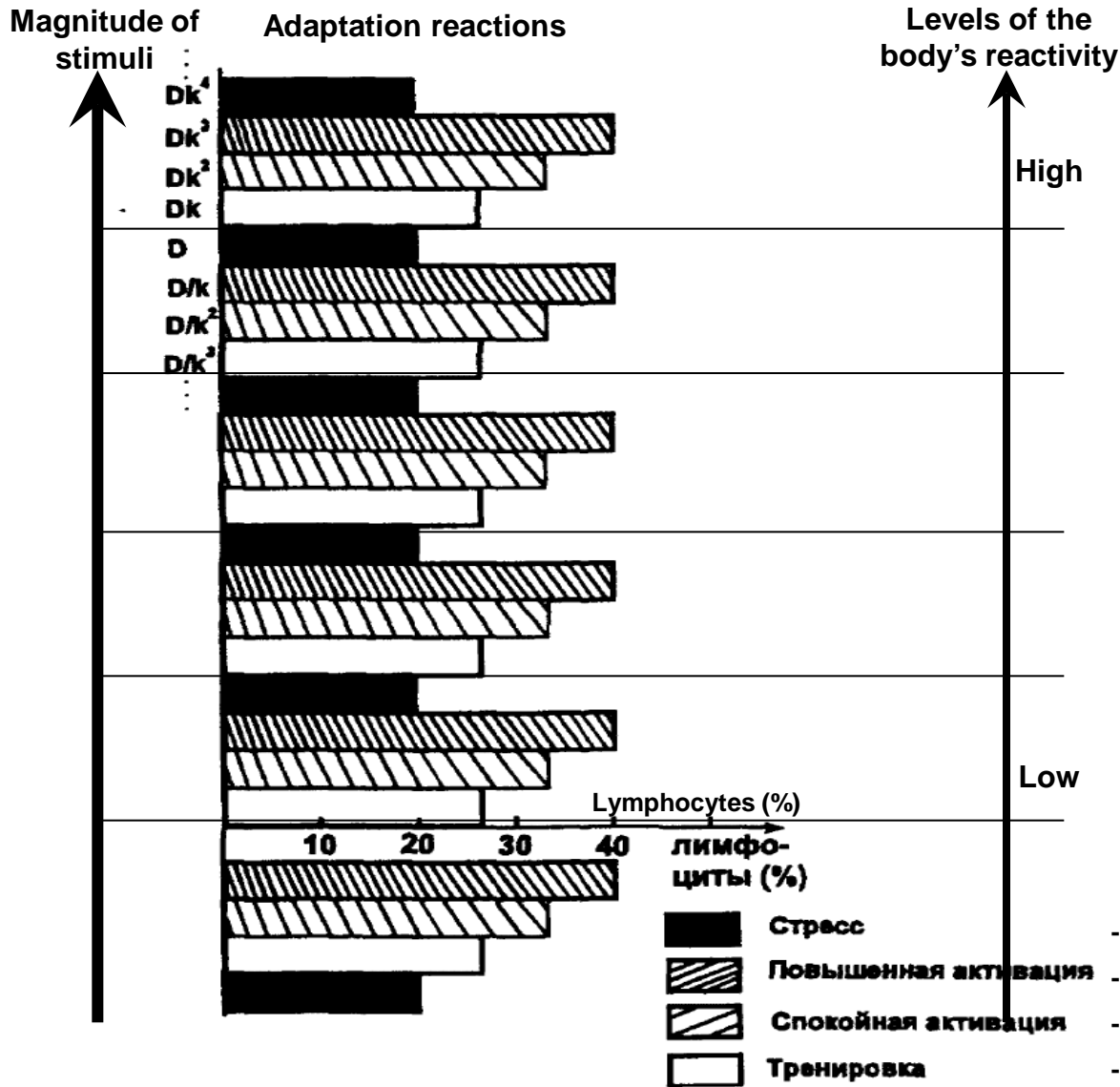
2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING



Garkavi's markers of non-specific reactions

		LEUKOCYTES (n x10 ⁹)	LYMPHOCYTES/ LEUKOCYTES (%)	PMN NEUTROPHILES/ LEUKOCYTES (%)
TRAINING REACTION		4 - 6.5	20 - 27.5%	55 - 65%
ACTIVATION REACTION	CALM ACTIVATION	4 - 6.5	28 - 33.5%	47 - 55%
	HIGH ACTIVATION	4 - 6	More than 33.5 until 40 - 45%	less than 50%
	OVER- ACTIVATION	In the limits of norm	More than 40 - 45%	less than 50%
STRESS REACTION	ACUTE STRESS	More than 7	Less than 20%	More than 70%
	CHRONIC STRESS	Various	Less than 20%	More than 70%

2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING



Periodical repetition of the "triads" of adaptation reactions (Training, Activation, Stress) when the magnitude of external influence (the dose of agent) increases for 10-20% (L.Garkavi et al, 1977).

If the magnitude of stimuli increases too rapidly, the body could respond on their influence with not normal form of adaptation reactions, having the "signs of tension".

2.3. GARKAVI'S UPDATES TO SELYE'S RESEARCHES DATA AND THEIR THEORETICAL MEANING

The sighs of tension indicate that the body is still not ready to the next step of increasing the magnitude of stimuli

Garkavi's markers of non-specific reactions with the levels of their tension



The WBC markers of non-specific reactions

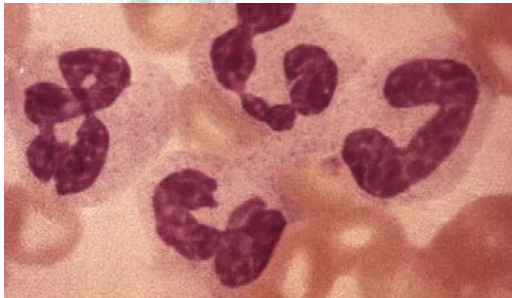
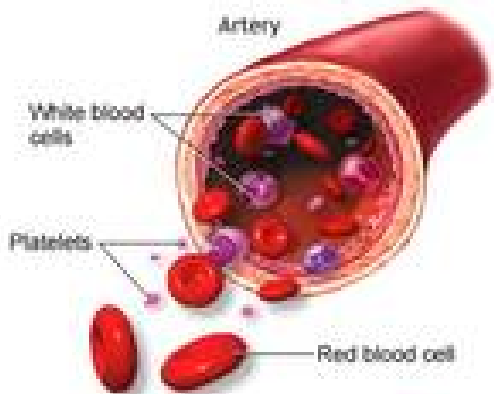
The markers of their tension

	WBC DIFFERENTIAL COUNTS (%)						PMN NEUTROPHILS / LYMPHOCYTES (%)	
	BASOPHILS	EOSINOPHILS	BAND NEUTROPHILS	PMN NEUTROPHILS	LYMPHOCYTES	MONOCYTES	NORMAL FORM OF REACTION	REACTION WITH SIGNS OF TENSION
TRAINING REACTION	0-1	1-4	1-5	54-73	20-27	4-7	0.27-0.52	0.26-0.27 0.52-1.17
ACTIVATION REACTION	0-1	1-4	1-4	40-65	28-45	4-6.5	0.45-1.12	0.44-0.45 1.12-3.0
CALM ACTIVATION	0-1	1-4	1-4	49-65	28-33.5	4-6.5	0.45-0.64	0.44-0.45 0.64-1.43
HIGH ACTIVATION	0-1	1-4	1-4	40-49	34-40 (45)	4.6	0.7-1.12	0.57-0.7 1.12-3.0
STRESS REACTION	0-1	0-4	1-7	62-82	6-19.5	4-8	0.07-0.31	0.31-0.58

1. What is a typical reaction of the athlete's body on the loads used during training and competitive activity?
2. What factors affect the ability of an athlete to adapt?
3. What level should the training loads be to provide a training effect?
4. What signs and symptoms indicate a failure of the athlete's adaptability?

3.1. WHAT IS A TYPICAL REACTION OF THE ATHLETE'S BODY ON THE LOADS USED DURING TRAINING AND COMPETITIVE ACTIVITY?

The changes in white blood cells counts (WBC) after the muscular work depend on the amount of this work

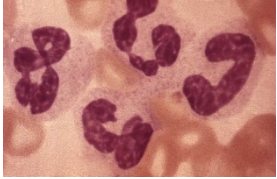


W. Winternitz (1893) and E. Willebrand (1903) discovered the leukocytosis after the intense muscular activity

E. Grawitz (1910) named this kind of leucocytosis *miogenic*. He theorized that it is a result of the organism's inundation by the products of metabolism (the protein depletion); increasing of the leukocytes number assures an increase in the organism defence from its inundation. This idea was confirmed by the experimentally obtained fact that the level of increase of leucocytes depends on the intensity (the power output) of muscular work.

3.1. WHAT IS A TYPICAL REACTION OF THE ATHLETE'S BODY ON THE LOADS USED DURING TRAINING AND COMPETITIVE ACTIVITY?

The WBC changes, equal to the Alarm phase of Stress, occur only after the heavy sport workouts.

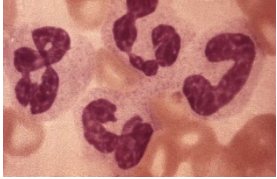


A.Egorov (1926) described three different types of white blood cells reaction to different “amounts” of muscular work (three different levels of its heaviness): only the reaction to heavy work was similar to the Alarm reaction of Stress syndrome

EXTERNAL INFLUENCE	TYPOLOGY OF REACTION		CHANGES IN THE WHITE BLOOD CELLS COUNTS			
			LEUKOCYTES	LIMPHOCITES	EOSINOFILOCITES	NETROFILOCYTES
NON-SPECIFIC STRESSOR	ALARM REACTION		High increase	Decrease	Very low decrease	Increase
RELATIVELY SMALL AMOUNT OF WORK	LEUKOCYTARIAN REACTION		Increase	Increase	Decrease	Decrease
RELATIVELY LARGE AMOUNT OF WORK	NEUTROFILIAN REACTION		Little increase	Decrease	Decrease	Increase
HEAVY WORK	INTOXICATION REACTION	REGENERATIVE VARIANT	High increase	Decrease	Elimination	Increase
		DEGENERATIVE VARIANT	Very little increase	Increase	Increase	Rapid increase

3.1. WHAT IS A TYPICAL REACTION OF THE ATHLETE'S BODY ON THE LOADS USED DURING TRAINING AND COMPETITIVE ACTIVITY?

The WBC changes, equal to the Alarm phase of Stress, occur only after the heavy sport workouts.



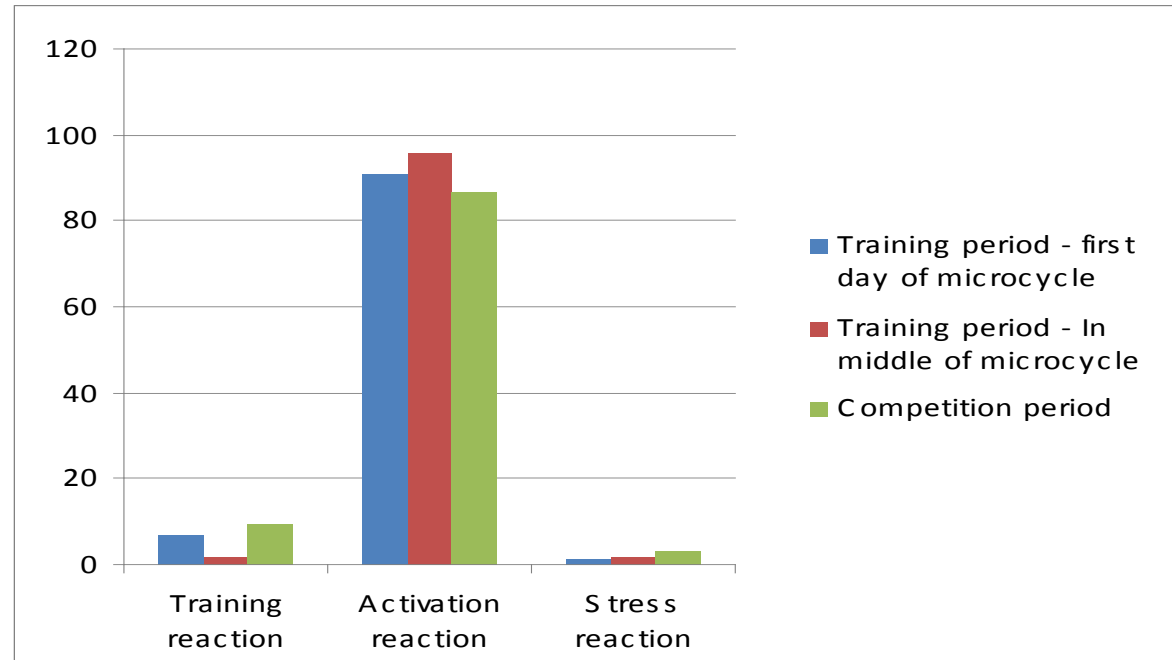
A.Egorov (1926) described three different types of white blood cells reaction to different “amounts” of muscular work (three different levels of its heaviness): only the reaction to heavy work was similar to the Alarm reaction of Stress syndrome

Author	EXTERNAL INFLUENCE	TYPOLOGY OF REACTION	CHANGES IN THE WHITE BLOOD CELLS COUNTS			
			LEUKOCYTES	LIMPHOCYTES	EOSINOPHILS	NEUTROPHILS
H.Selye	NON-SPECIFIC STRESSOR	ALARM REACTION	High increase	Decrease	Very low decrease	Increase
A. Egorov	RELATIVELY SMALL AMOUNT OF WORK	LEUKOCYTARIAN REACTION	Increase	Increase	Decrease	Decrease
	RELATIVELY LARGE AMOUNT OF WORK	NEUTROFILIAN REACTION	Little increase	Decrease	Decrease	Increase
	HEAVY WORK	INTOXICATION REACTION	DEGENERATIVE VARIANT	High increase	Decrease	Elimination
DEGENERATIVE VARIANT			Very little increase	Increase	Increase	Rapid increase

3.1. WHAT IS A TYPICAL REACTION OF THE ATHLETE'S BODY ON THE LOADS USED DURING TRAINING AND COMPETITIVE ACTIVITY?

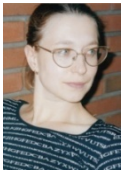
Activation reaction most frequently occurs during sport training; the Stress reaction is very rare.

Kuznetzova T., *Control of the body tolerance to the training loads in sport swimming on a base of white blood system markers*. PhD dissertation, 1989

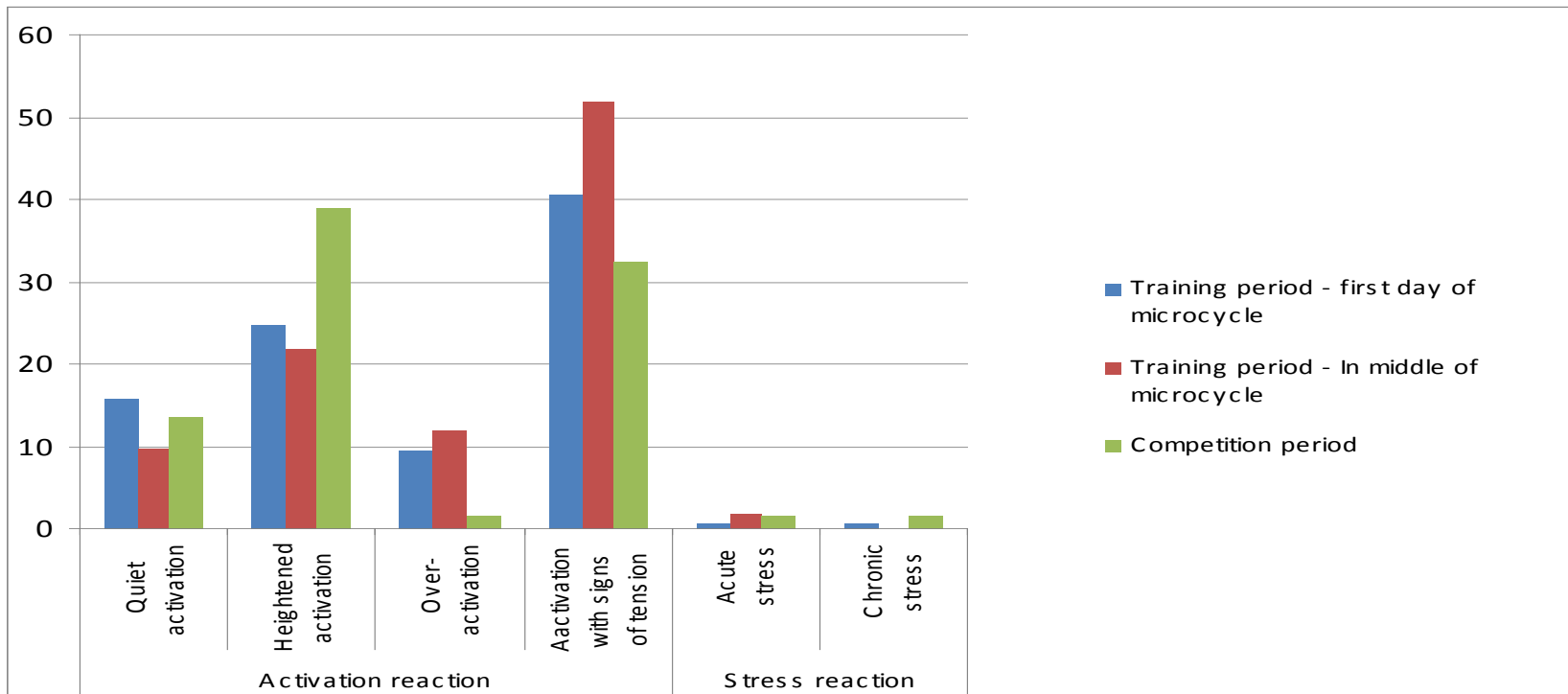


3.1. WHAT IS A TYPICAL REACTION OF THE ATHLETE'S BODY ON THE LOADS USED DURING TRAINING AND COMPETITIVE ACTIVITY?

The High Activation reaction is most frequent during sport training, however, almost in half of the cases it occurs with signs of tension

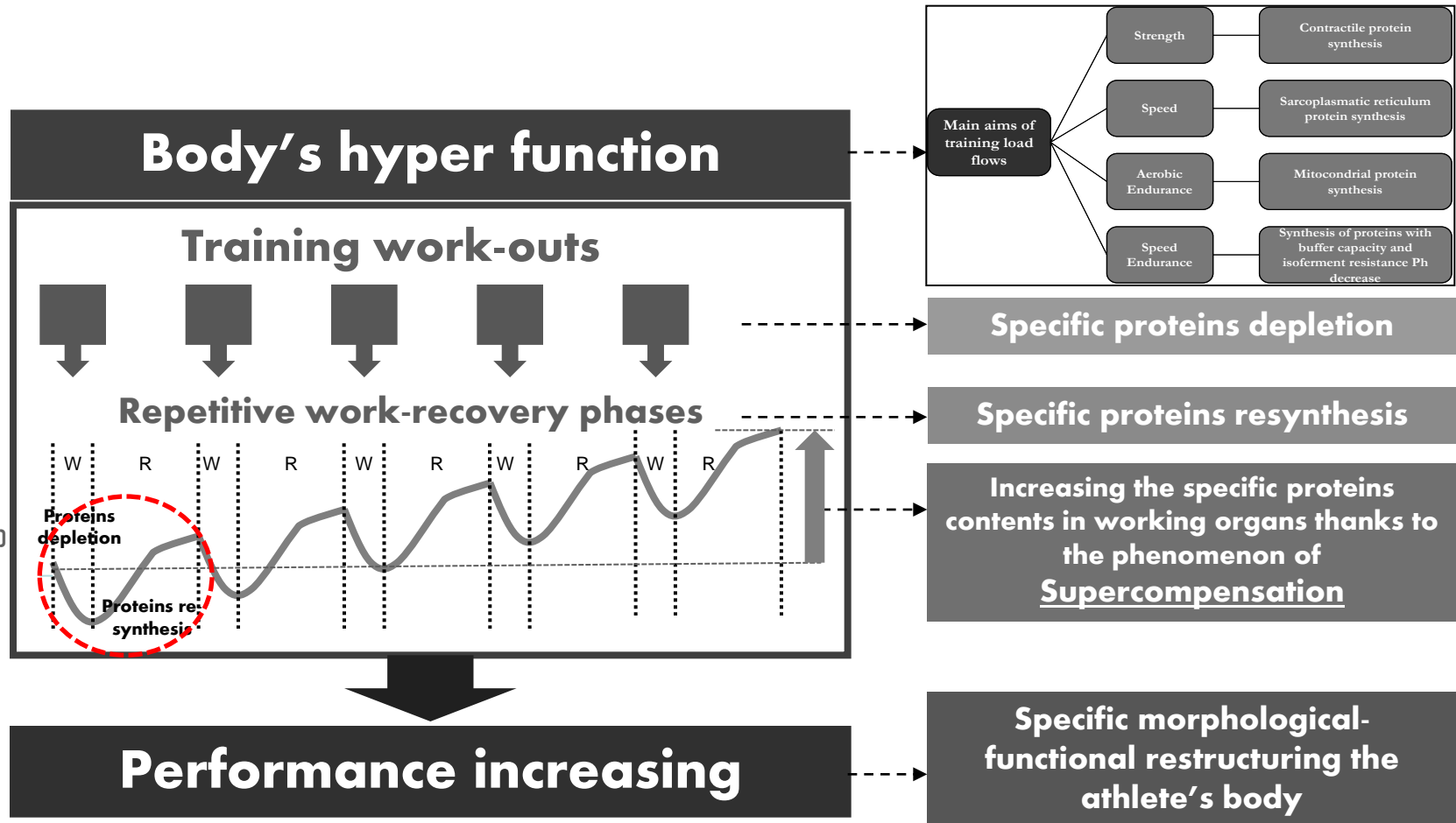


Kuznetzova T. *Control of the body tolerance to the training loads in sport swimming on a base of white blood system markers.* PhD dissertation, 1989



3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

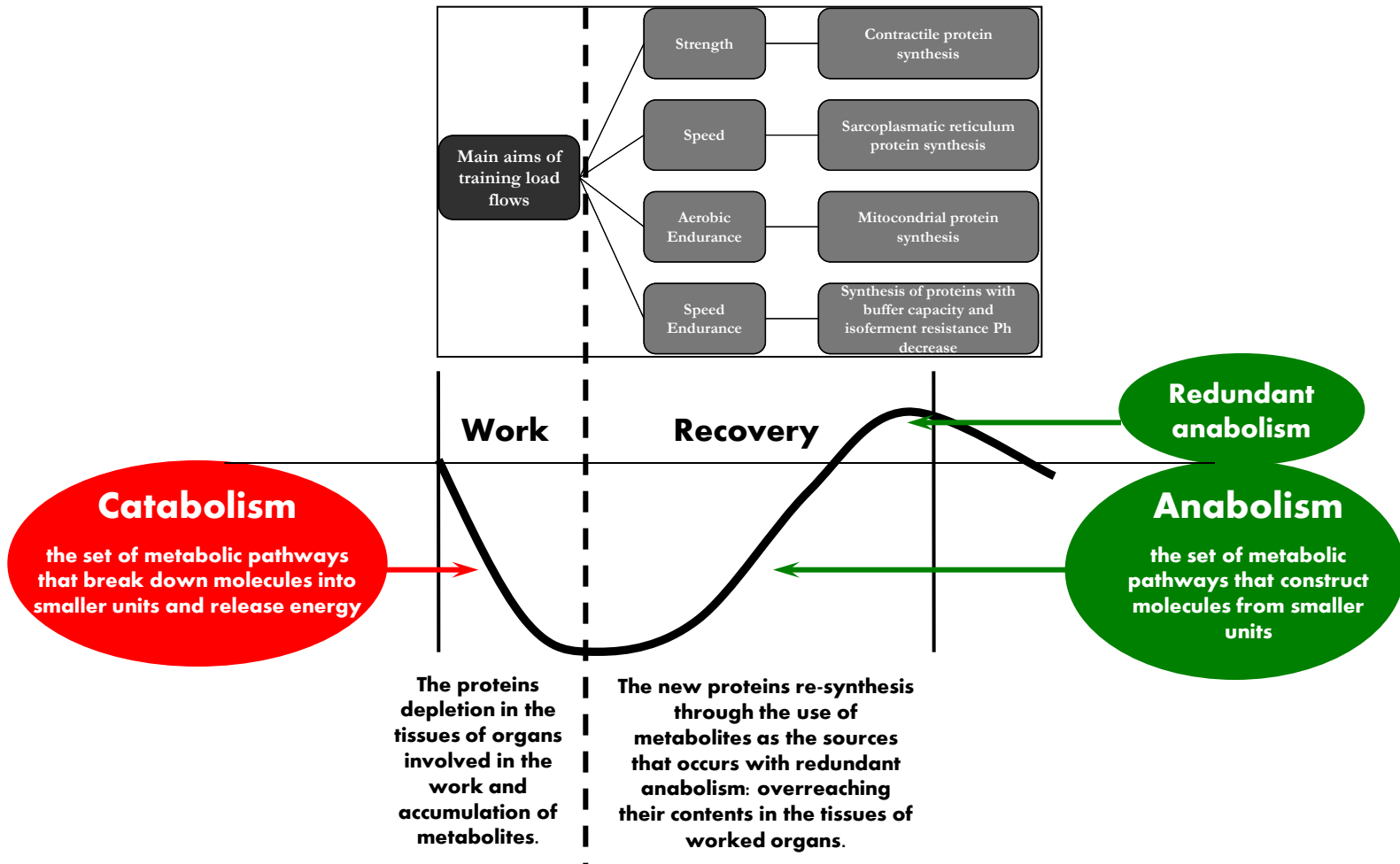
The scheme of specific adaptation during the training process



The athlete's progress in physical performance, during the training process, is assured by repetitive training workouts, which activate the specific mechanisms of the body's adaptation to the physical hyper function. These mechanisms assure the grow of specific proteins contents in working organs, which leads to the increasing their functional capacity

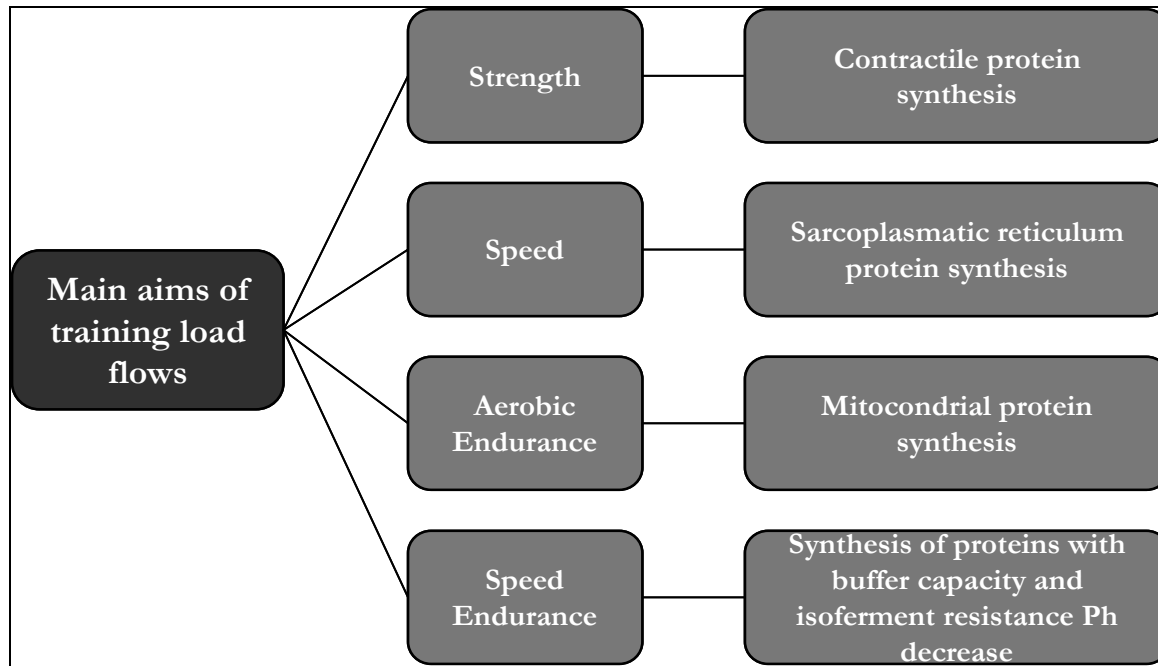
3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

Specific mechanism of adaptation to intensive muscular work



3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

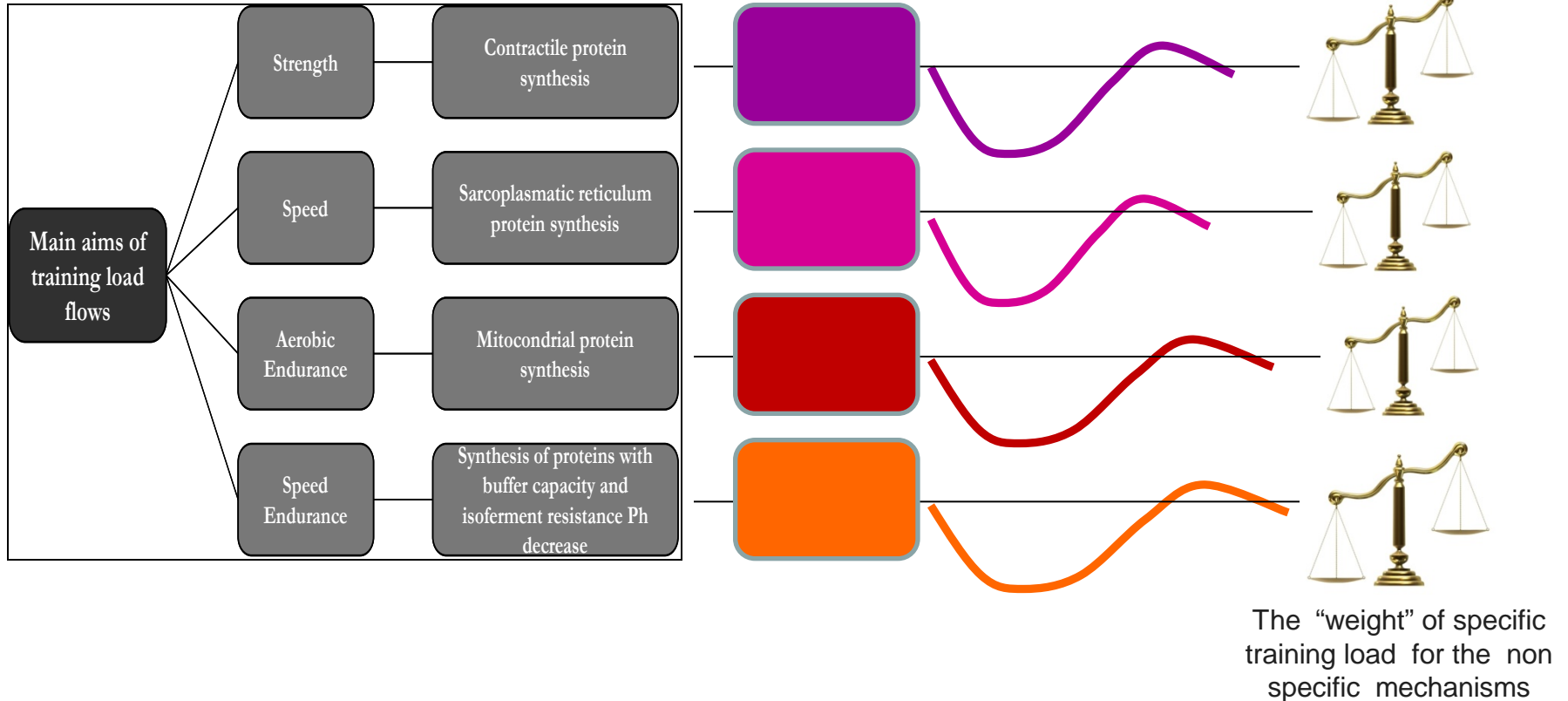
Specific mechanism of adaptation to intensive muscular work



Specific metabolites determine the recruitment of proteins, the synthesis of which is conditioned by the increased activity. Also ensured with this is the relationship between functional activity and the adaptational protein synthesis. Not only are the proteins synthesized from which the functional cell structure is actively formed, but also enzymes and catalytic biochemical reactions, lying in the base of the corresponding cellular functions

3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

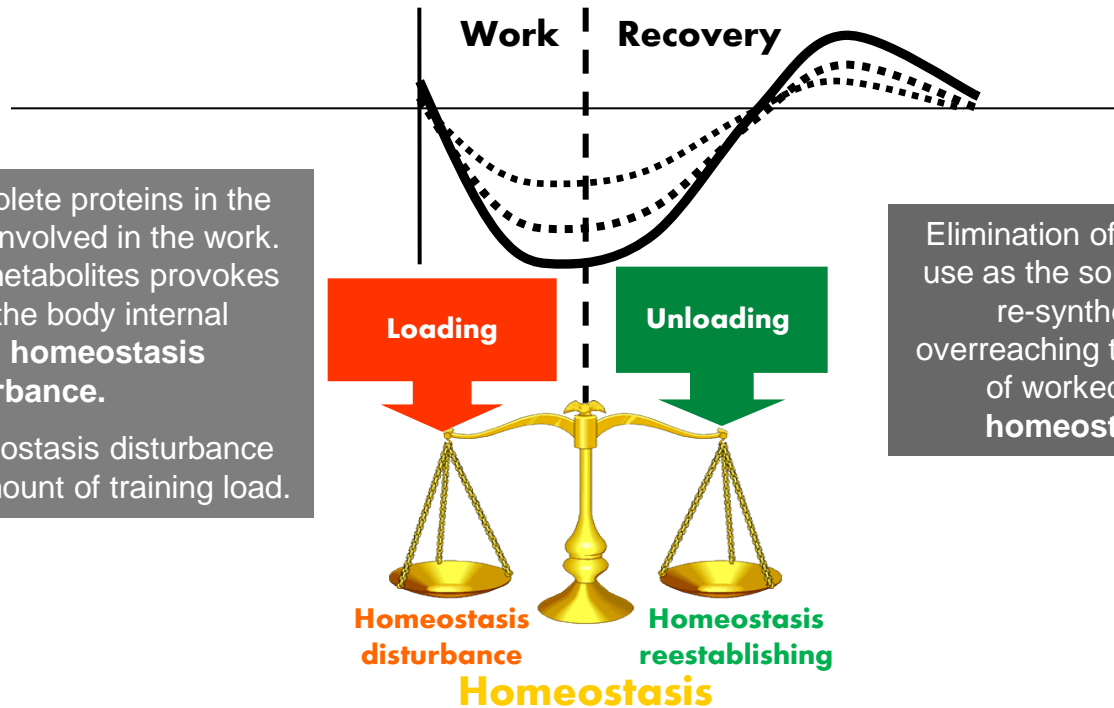
Relationship between specific and non-specific mechanisms of adaptation



Every kind of training loads deplete specific proteins in the tissues of organs involved in the work, provoking accumulation of specific metabolites and also the change in the body internal environment (homeostasis disturbance), which level depends on the amount of specific load

3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

Non-specific mechanism of adaptation to intensive muscular work



Training loads deplete proteins in the tissues of organs involved in the work. Accumulation of metabolites provokes the change in the body internal environment: **homeostasis disturbance**.

The level of homeostasis disturbance depends on the amount of training load.

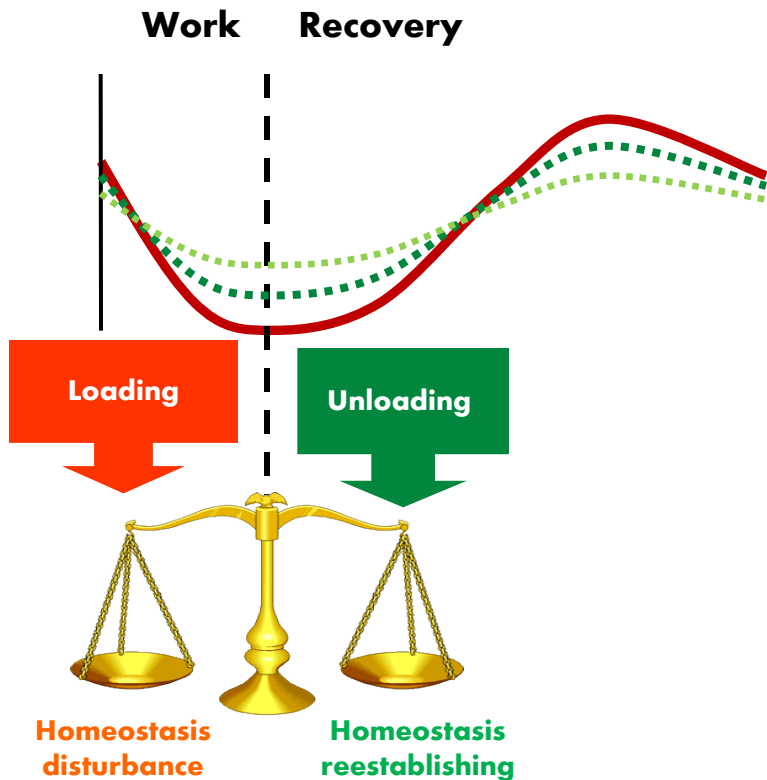
Elimination of metabolites, through their use as the sources for the new proteins re-synthesis (which occurs by overreaching their contents in the tissues of worked organs), assures the **homeostasis re-establishing**.

The GAS concept concerns the functions of non-specific adaptation mechanisms, which govern the quantitative aspects of specific adaptation process.

The non specific mechanisms regulate the body ability to give the adaptive respond to the training work in relation to its amount: the magnitude of training load's impact on the athlete's body, perceived as the level of homeostasis disturbance.

3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

Non-specific mechanism of adaptation to intensive muscular work

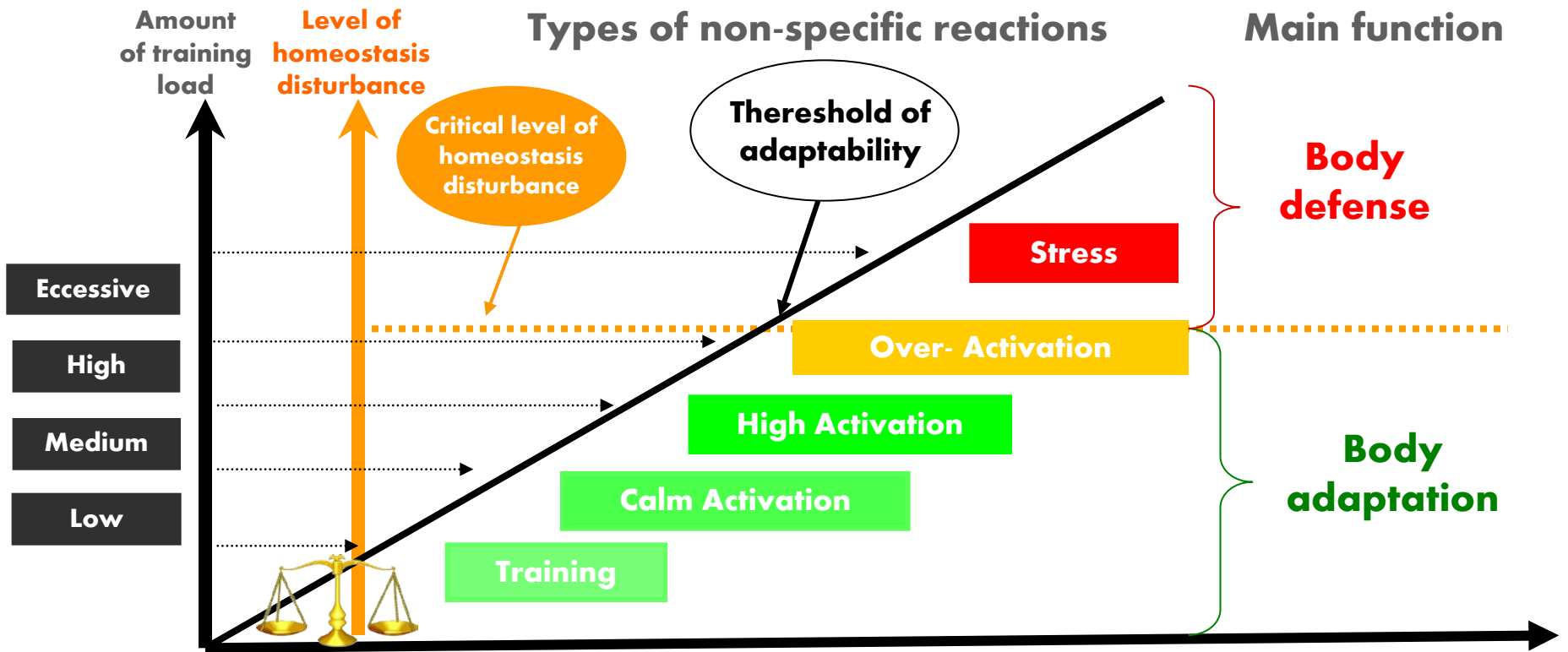


The level of homeostasis disturbance determines the type of non-specific reactions and the body ability to give an adaptive response to the training load (the body's adaptation ability):

- Training reaction assures the “training” of the body's adaptation ability;
- Activation reaction assures the “activation” of the body's adaptation ability (quite, high or over-activation);
- Stress reaction provokes the inhibition of the body's adaptation ability, related to the necessity to mobilize all physiological system to the body defence.

3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

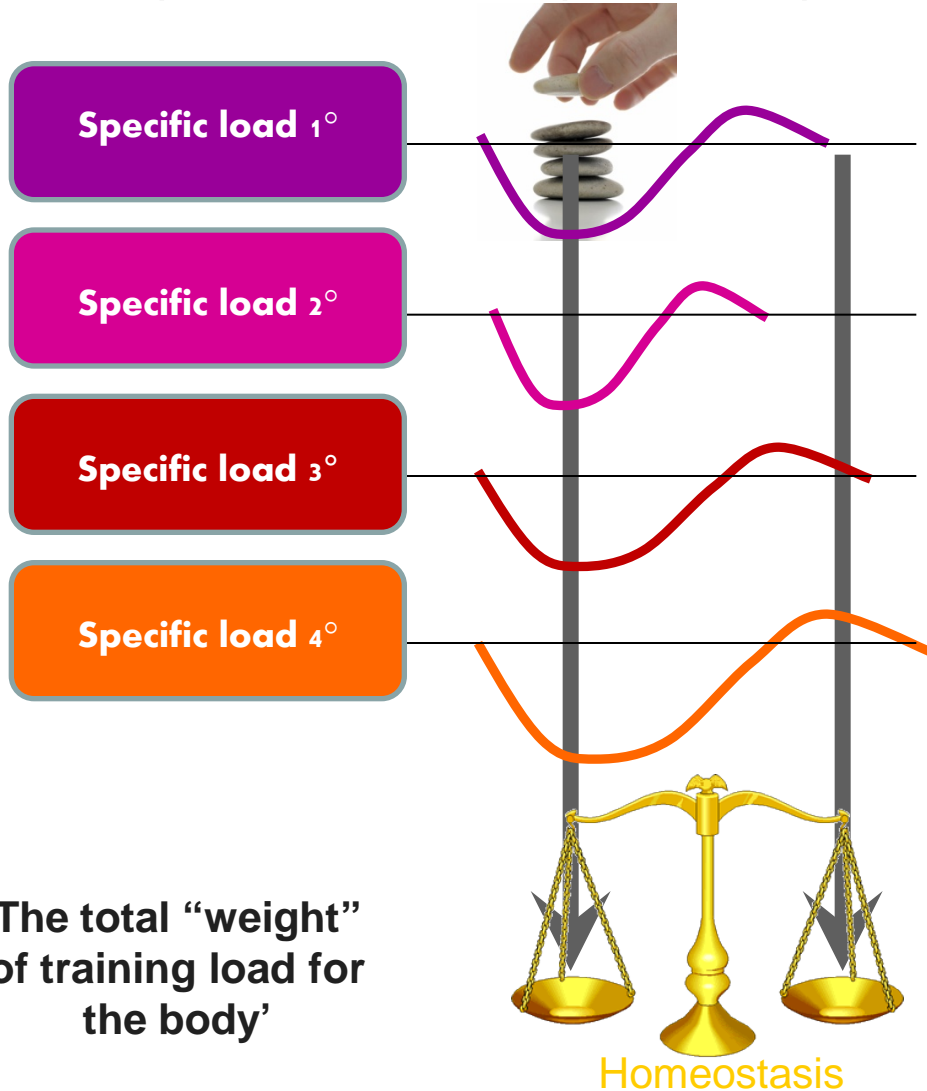
Non-specific mechanism of adaptation to intensive muscular work



When the training load impact provokes the Over-Activation reaction, the prevalence of anabolic process switches to catabolic. This change indicates the Threshold of adaptability has been surpassed, which is also related to critical level of Homeostasis disturbance.

3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

Specific and non-specific responds on the complex training load



A. Viru
Mechanism of general adaptation.

Med. Hypotheses, 1992

"The mobilization of the reserve for protein synthesis is connected with induction of the adaptive synthesis of the enzyme and structural proteins in order to restore and develop the functional capacity of cellular structures that were highly active during acute influence of various stressors".

"The integrated sum of specific adaptive responses constitute homeostatic regulation in order to maintain a constant level of rigid constants of the body's internal milieu. The constancy of rigid constants (temperature, pH, osmotic pressure, and contents of ions, water and pO₂) is necessary to ensure the optimal activity of enzymes."

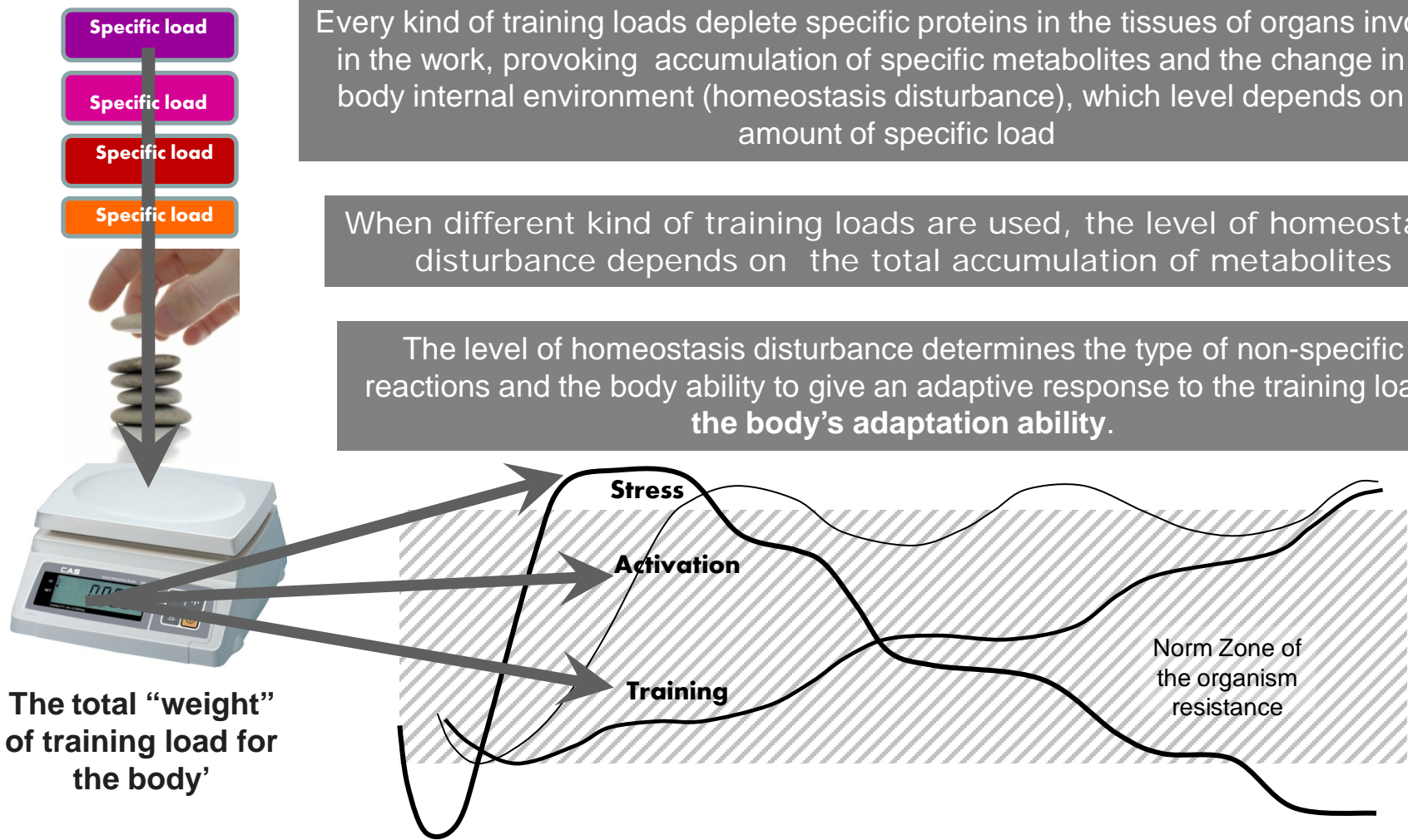
3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

Specific and non-specific responds on the complex training load

Every kind of training loads deplete specific proteins in the tissues of organs involved in the work, provoking accumulation of specific metabolites and the change in the body internal environment (homeostasis disturbance), which level depends on the amount of specific load

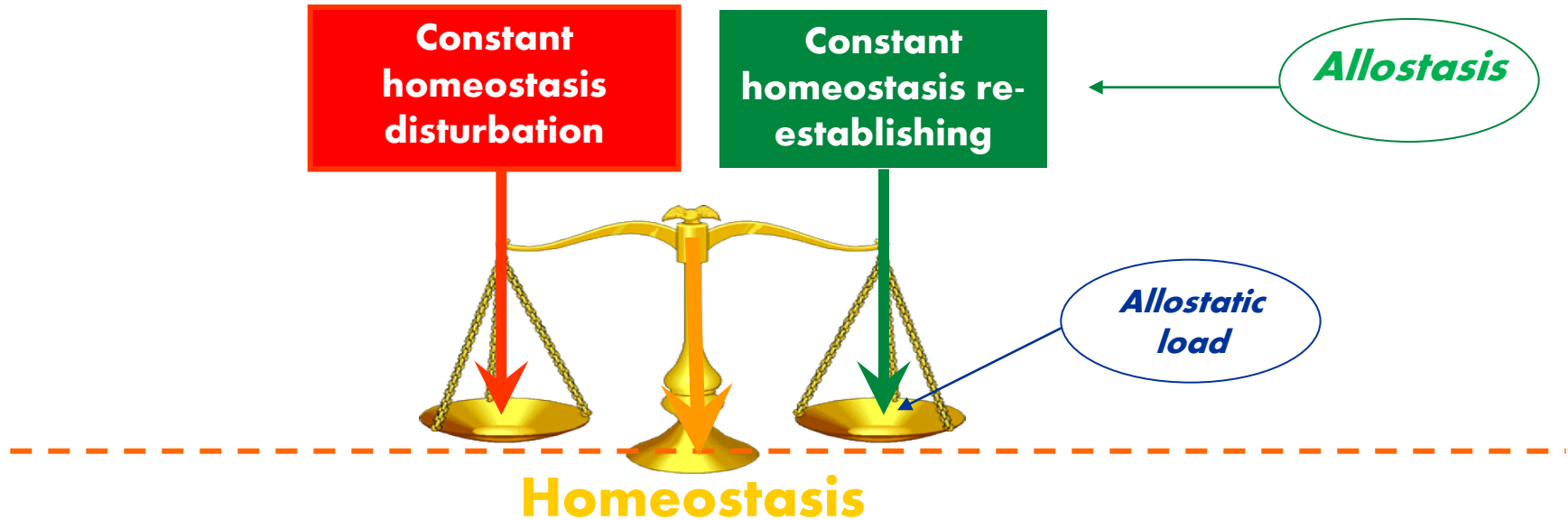
When different kind of training loads are used, the level of homeostasis disturbance depends on the total accumulation of metabolites

The level of homeostasis disturbance determines the type of non-specific reactions and the body ability to give an adaptive response to the training load: **the body's adaptation ability.**



3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

Non-specific responds on the long term training loading

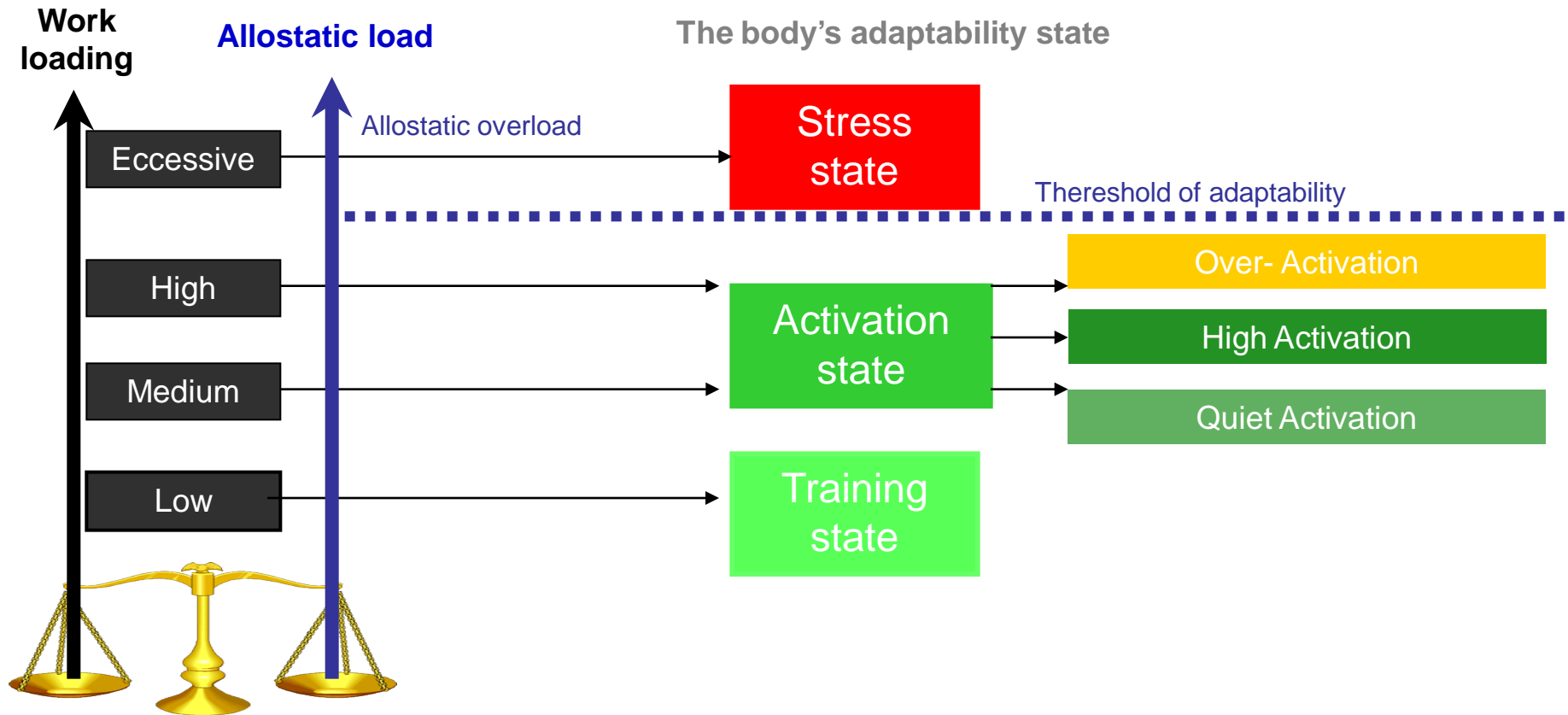


During the training process, the athlete's body is constantly submitted to the homeostasis disturbances and, as consequence, it is constantly involved in the process of homeostasis establishing (*allostasis*).

A cumulative strain of the body, under the frequent activation of the body's response on homeostatic disturbance, is named *allostatic load*; it is the cost to the body of homeostasis reestablishing.

3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

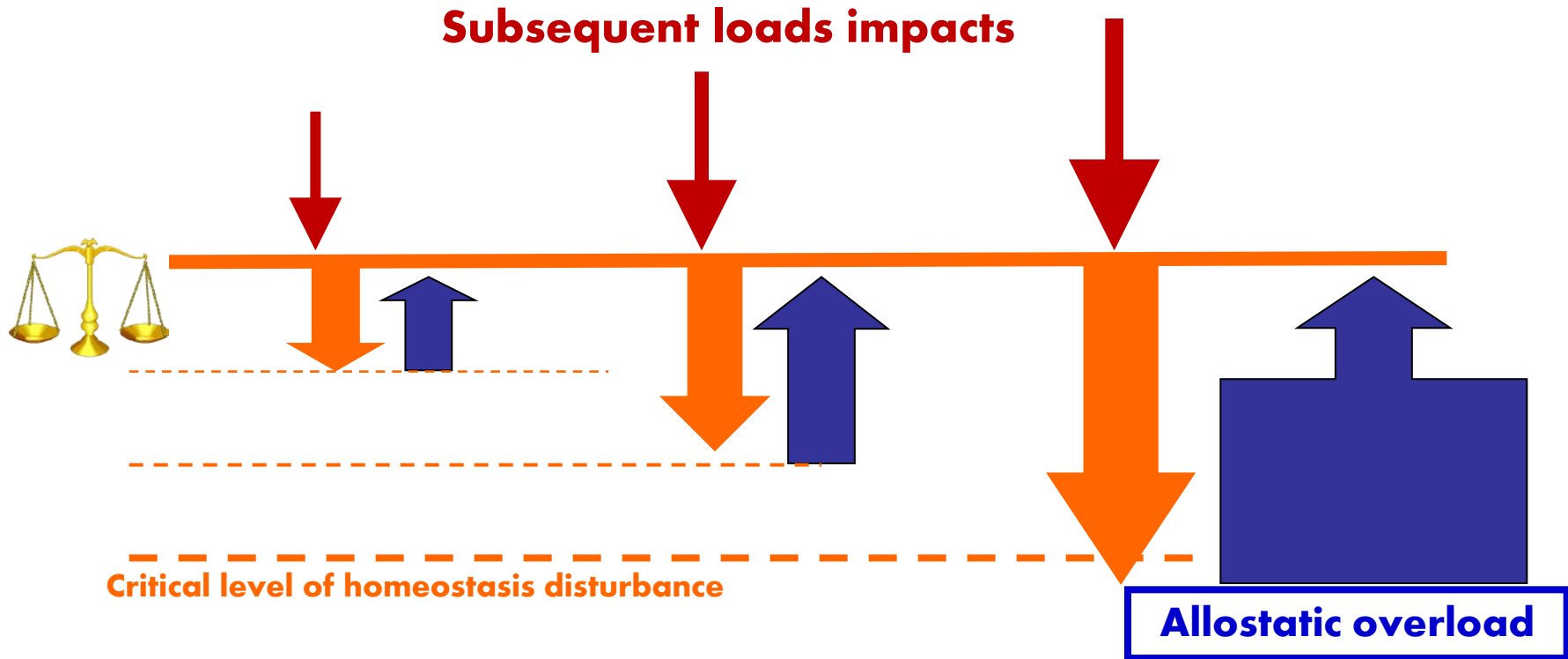
Non-specific responds on the long term training loading



Similarly as, during execution of training exercise, the overcoming the anaerobic threshold brings to development of glycolysis and the consequent decreasing the body workability, also, during the training process, the overcoming of certain level of training loading brings to development of stress syndrome and the consequent decreasing the body adaptability.

3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

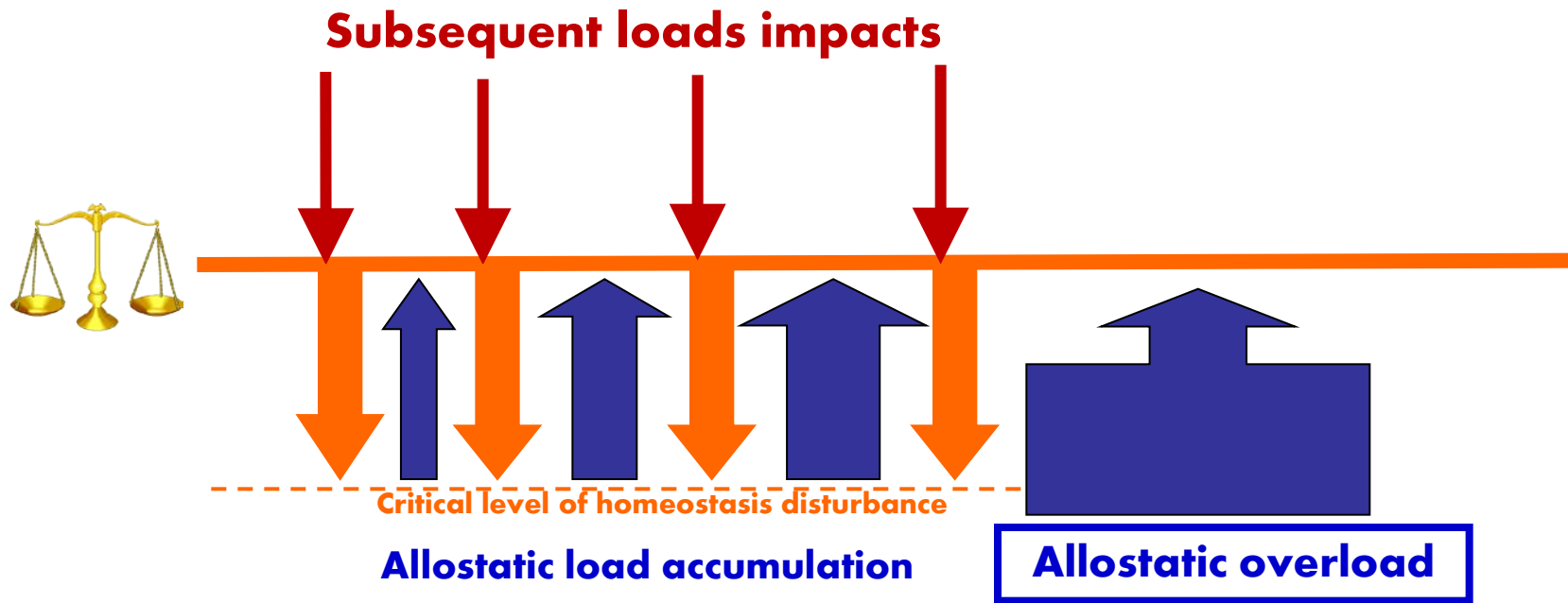
Non-specific responds on the long term training loading



Accumulation of allostatic load, which supersedes the critical level of homeostatic disturbance, results in activation of the emergency systems: it is defined as **allostatic overload**.

3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

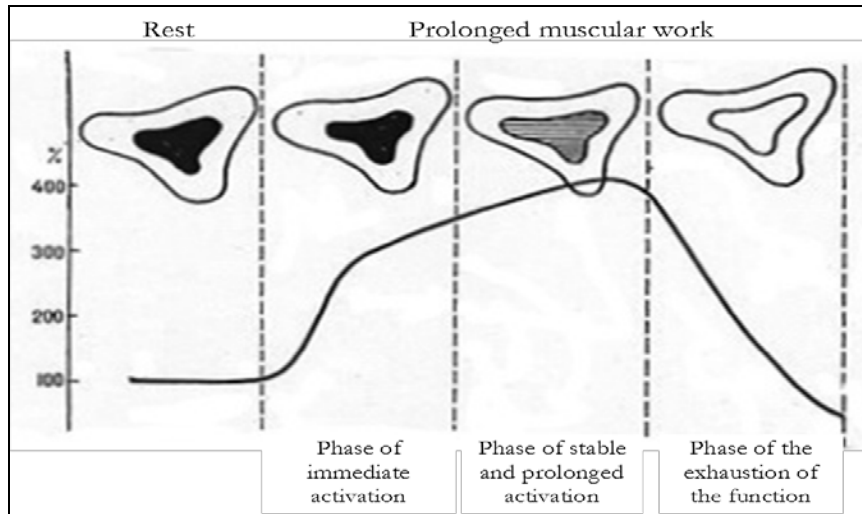
Non-specific responds on the long term training loading



The human body cannot maintain such allostatic load for very long without consequences. In the long run, allostatic changes may fail to be adaptive as the maintenance of allostasis changes over a long period.

3.2. WHAT FACTORS AFFECT THE ABILITY OF AN ATHLETE TO ADAPT?

Non-specific responds on the long term training loading



The phases of the noradrenaline system responding to the influence of prolonged muscular activity, evaluated on the basis of the change in the content of adrenaline in the adrenal ganglions. The curve points out the change in the concentration of adrenaline in the blood (Kassil and others, 1973).

The phases of the changes of the noradrenaline system's state under the influence of prolonged muscular work (Kassil, 1978):

- **the immediate activation phase** - a 'strengthened flow' of adrenaline in the blood immediately after beginning the workout; a lowering of the contents in the adrenal ganglions is absent.
- **the stable and prolonged activation phase** - an increasing upsurge of adrenaline secretion in the blood with the gradual lowering of the content in the adrenal ganglions.
- **the function exhaustion phase** - the lowering of noradrenalin activity, externally evident in that

In the long run, allostatic changes may fail to be adaptive because they exhaust the hypothalamic-pituitary-adrenal axis (HPA axis) function.

3.3. WHAT LEVEL SHOULD THE TRAINING LOADS BE TO PROVIDE A TRAINING EFFECT?

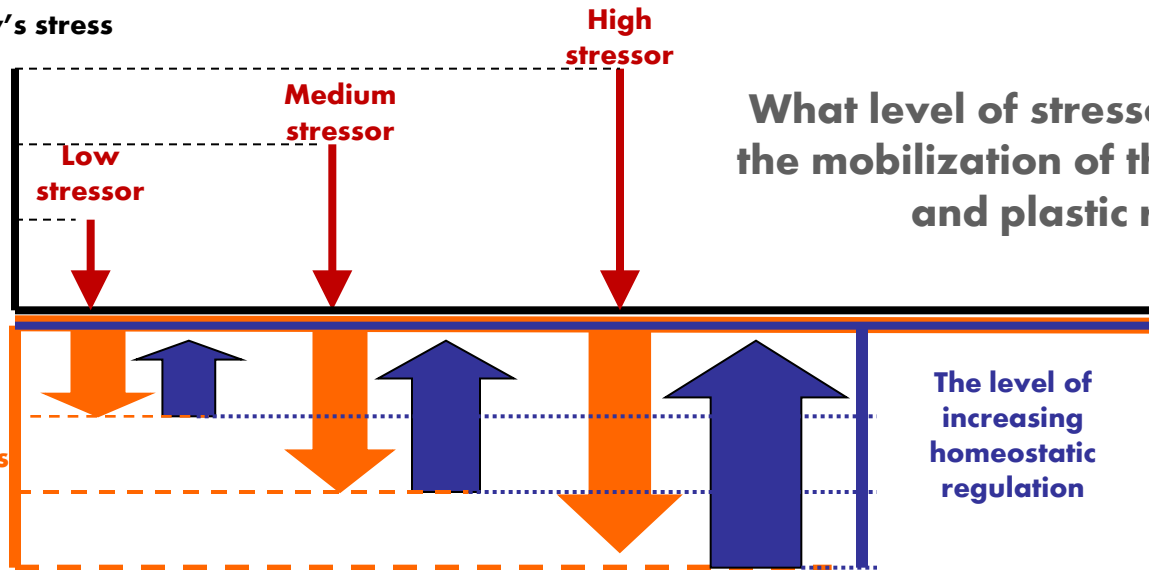
Quantifying the level of training loads according to A.Viru



The level of body's stress



The level of body's homeostasis disturbance



What level of stressor is able to assure the mobilization of the body's energetic and plastic resources ?

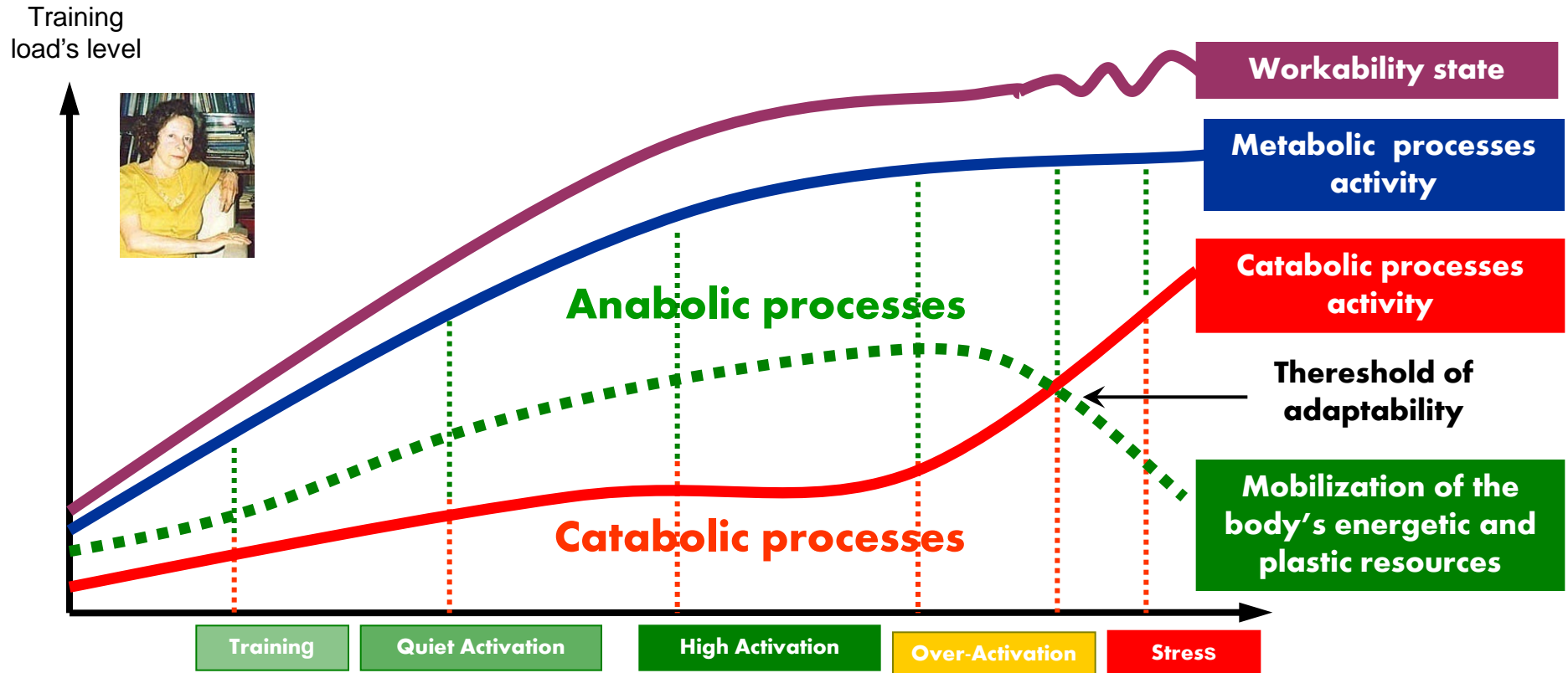
According to A.Viru, "important condition of ensuring the training effect is increasing the level of homeostatic regulation which brings to mobilization of the body's energetic and plastic resources"; this condition may be assured if the training loads will have the stress influence. The stress influence is understood as such an influence that is able to activate the non-specific mechanism of adaptation.

At the same time, according to Selye, every kind of external influence is able to activate the non-specific mechanism of adaptation, provoking the stress reaction, which quantitative expression is related to the level of homeostasis disturbance.

What is not clear, however, is what level of stressor is able to assure the *mobilization of the body's energetic and plastic resources*.

3.3. WHAT LEVEL SHOULD THE TRAINING LOADS BE TO PROVIDE A TRAINING EFFECT?

Quantifying the level of training loads according to L.Garkavy



According to L.Garkavy, mobilization of the body's energetic and plastic resources occurs already during the Training reaction: the metabolic processes activity is not high, but consists mostly of anabolic processes. To provide the highest training effect, training load should guarantee the development of a High Activation reaction and not surpass the level of an Over-Activation reaction.

3.3. WHAT LEVEL SHOULD THE TRAINING LOADS BE TO PROVIDE A TRAINING EFFECT?

The influences of different non-specific reactions on the body's metabolic processes activity and workability state



	BIOLOGICAL MEANING OF REACTION	METABOLIC PROCESSES STATE		WORKABILITY STATE
		ACTIVITY OF ANABOLIC AND CATABOLIC PROCESSES	ENERGY EXCHANGE	
TRAINING	<i>Cutting off nonessential, weak repetitive stimuli by developing a protective inhibition in the brain</i>	Not high with prevalence of anabolic processes.	Energy substrate accumulation exceeds energy expenditure, thus energy is stored.	Workability level is low in terms of operation speed but it is good in terms of working time.
CALM ACTIVATION	<i>Increasing activity of control systems of the body</i>	High with prevalence of anabolic processes.	High-speed metabolism of energy-supplying substrates, well-balanced by their expenditure and replenishment.	Workability level is high both in terms of precise execution, operation speed and duration of working.
HIGH ACTIVATION	<i>Increasing the activity of control and protective systems of the body</i>	Very high, with a significant prevalence of anabolic processes	High-speed metabolism of energy-supplying substrates, well-balanced by their expenditure and replenishment.	Workability level is high, especially in terms of precise execution and operation speed and some lower in terms of duration of working.
OVER-ACTIVATION	<i>An attempt to retain the activation response without falling into stress.</i>	Very high and tense without prevalence	Expenditure of energy-supplying substrates grows and their replenishment gradually lags behind.	Workability level is high, however there may be breakdowns activity.
STRESS	<i>Prevention of too high a reaction of the body that could result in death.</i>	Very high with prevalence of catabolic processes.	Expenditure of energy-supplying substrates is sharply increased, their replenishment is reduced. Increasing the proportion of glycolytic processes.	Workability level, in terms of operation speed, can be high at the beginning, but then it falls. Workability in terms of accuracy and duration of working is decreased.

3.3. WHAT LEVEL SHOULD THE TRAINING LOADS BE TO PROVIDE A TRAINING EFFECT?

According to the new version of GAS concept, the non-specific response of the athlete's body to the influence of multiple impacts of training loads depends on the typology of non-specific reaction, which they provoke:

- 1) If the magnitude of training loads impact provokes the anti-stress reaction, the athlete's body will be able to respond to their influences with activation of the specific adaptation process (increasing the protein synthesis in the tissues of organs, involved in training work).
- 2) Greater will be the magnitude of training loads impact, greater will be their specific training effect.
- 3) However, if this magnitude will reach the level, which provokes the stress reaction, the body adaptability to the training stimuli will decrease because of the development of stress syndrome.

3.3. WHAT LEVEL SHOULD THE TRAINING LOADS BE TO PROVIDE A TRAINING EFFECT?

WHAT LEVEL SHOULD THE TRAINING LOADS BE TO PROVIDE A TRAINING EFFECT?

To provide a training effect training loads should assure the anti-stress reactions and not arrive at the level of Stress reaction, because, in this case, the training loads impact overcomes the “threshold” of body adaptability and brings to decreasing their training effect

3.4. WHAT SIGNS AND SYMPTOMS INDICATE A FAILURE OF THE ATHLETE'S ADAPTABILITY?

The “threshold” of body adaptability is related to the current status of the body defense system activity. This status could be valuated using Garkavi's markers of non-specific reactions, because each of the non-specific body reactions has definite effect of the body adaptability.

The simple procedure of routine medicine diagnostics could be used to control what kind of non-specific reaction is developing in the athlete's body, to definite the current athlete's adaptability status and to regulate, in relation to this status, the training loads level.



3.4. WHAT SIGNS AND SYMPTOMS INDICATE A FAILURE OF THE ATHLETE'S ADAPTABILITY?

The lymphocyte percentage in the white blood count is used to identify the state of non-specific adaptive response as shown in the table below. The signs of Over-Activation reaction indicate that the athlete comes in the critical state which could bring the stress state and to the failure of his adaptability

Lymphocyte percentage in White Blood Count

Age(years)	Type if non specific adaptive response				
	Stress	Training Response	Mild Activation	STRONG Activation	Over Activation
LYMPHOCYTES, %					
3-5	<29,5	29,5-37,5	38-45	45,5-57	>57
6-9	<25	25-32	32,5-40	40,5-51	>51
10-13	<23	23-30	30,5-38	38,5-48	>48
14-16	<20,5	20,5-28,5	29-36	36,5-46	>46
Adults	<20	20-27,5	28-34	34,5-44	>44

Khan M.A., Datchenko A.A. THERAPEUTIC MULTILAYER BLANKET APPLICATIONS FOR CLINICAL TREATMENT, REHABILITATION, PREVENTION AND HEALTH ENHANCEMENT. Guidelines for Medical Personnel. Victory-TM, L.L.C., 2004.

3.4. WHAT SIGNS AND SYMPTOMS INDICATE A FAILURE OF THE ATHLETE'S ADAPTABILITY?

The body reactivity level, at which a non-specific adaptive response develops, is reliably identified by the tension degree in the white blood count, as specified in the table below.

The high tension degree indicates that the training loads are too high or are not correctly organised in time .

Tension Degree in the White Blood Count

Blood cells	Tension Degree				
	0	1	2	3	4
Monocytes	5-7	7.5-8.5 4-4.5	9.0-11.0 3.0-3.5	11.5-15.0 2.0-2.5	>15.0 <2.0
Eosinocytes	1-4.5	5.0-6.0 0.5	6.5-8.5 0.5	9.0-15.0	>3
Basophils	0-0.5	1	1.5	2.0-3.0	>15.0
Stab neutrophils	3-5.5	6.0-7.0 2-2.5	7.5-9.0 1.0-1.5	9.5-15.0 0.5	>10x10 ⁹ <2.9x10 ⁹
Total leucocytes	4-6X 10 ⁹	6.1-6.5 x10 ⁹ 3.7-4.0 x 10 ⁹	6.6-7.9 x10 ⁹ 3.2-3.6 x 10 ⁹	8.0-10 x10 ⁹ 2.9-3.1 x 10 ⁹	
Other				1-2 plasma cells	More than 2 plasma cells or neocytes
Toxic neutrophils	No	No	In isolated cells	In half of cells	Almost in all cells

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3.4. WHAT SIGNS AND SYMPTOMS INDICATE A FAILURE OF THE ATHLETE'S ADAPTABILITY?

Every type of non-specific reaction is characterised by specific changes in the psycho-emotional state and the workability state. So, their could be verified also if the coach will observe the athlete's behaviour during the training workout or competition



3.4. WHAT SIGNS AND SYMPTOMS INDICATE A FAILURE OF THE ATHLETE'S ADAPTABILITY?

In stress conditions, the athlete is able to obtain the highest level of power output in competition exercise, but could have coordination difficulties during its execution



The features of non-specific adaptive reactions on the training workouts in the sport dancers during competition period. Nikolaeva E.P., 2000

		TRAINING REACTION	ACTIVATION REACTION			STRESS REACTION
			CALM (QUIET) ACTIVATION	HIGH ACTIVATION	OVER-ACTIVATION	
OCCURRENCE FREQUENCY OF ADAPTIVE REACTION		25%	22,5%	42,5%	5%	5%
FEATURES OF THE DANCE FIGURES EXECUTION	COORDINATION LEVEL	High	High		Middle	Low
	SPEED LEVEL	Relatively low	High		High	High
GENERAL EMOTIONAL BACKGROUND		Middle	Positive		Variable	Negative
THE RATE OF RECOVERY		Middle	High		Variable	Variable

3.4. WHAT SIGNS AND SYMPTOMS INDICATE A FAILURE OF THE ATHLETE'S ADAPTABILITY?

The symptoms of Over-Activation reaction indicate that the athlete comes in the critical state which could bring to the stress state and to the failure of his body adaptability

	PSYCHO-EMOTIONAL STATE	WORKABILITY STATE
TRAINING	Calmness, some inertia (moderate activity), low anxiety, low aggressiveness, satisfactory sleep and appetite.	Low operation speed but good working time.
CALM ACTIVATION	High activity, calmness, good mood and low aggressiveness.	High, both in terms of precise execution, operation speed and duration of working.
HIGH ACTIVATION	Very high activity (thirst for action), optimism, excellent mood, sometimes even with slight euphoria (although without losing the ability to correctly appraise a situation), excellent sleep and appetite.	High especially in terms of precise execution and operation speed and some lower in terms of duration of working.
OVER-ACTIVATION	High activity, shortness of temper, aggressiveness, disturbed sleep but without loss of appetite.	High, however, there may be breakdowns activity.
STRESS	Depression, low spirits, sometimes aggressiveness, high anxiety, abnormal sleep and appetite.	Operation speed can be high at the beginning, but then it falls. Accuracy and duration of working is decreased.

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Training loads level	Coach's decision
Low	It's better to increase the training loads volume and intensity
Medium	It's possible to increase the training loads intensity
Optimally high	OK
Critical	Immediately decrease the training loads intensity
Too high	"Go home to have a rest, at least, for 3-5 days"



The mind, once expanded to the dimensions of larger ideas, never returns to its original size.

O.W. Holmes