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Original Article

The character of adaptation changes in bodybuilders in conditions of sequential use of isolation and basic exercises

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Abstract.
Purpose: to study the features of the influence of training loads in bodybuilding with the sequential use of basic and isolation exercises on the nature of adaptive body changes in athletes. **Methods.** 60 bodybuilders aged 18 ± 0.23 were divided into 3 groups, which used different combinations of basic and isolation exercises at the stage of specialized basic training during 4 months. To determine the effectiveness of the proposed training programs on the nature of adaptive changes in the body of athletes we used morphometric parameters, indicators of bioimpedansometry and biochemical analysis of cortisol concentration and lactate dehydrogenase activity in the blood. **Results.** The pronounced adaptive changes for the period of research were observed mainly in athletes of the third group due to increase in the circumferential sizes by 7.7% ($p < 0.05$) and increase in fat-free mass by 8.5% ($p < 0.05$) and decrease in body fat by 9.1% ($p < 0.05$). Representatives of groups 1 and 2 also had positive dynamics in circumferential sizes and body composition, but with a less pronounced progression over the same period. At the same time, the results of biochemical blood control indicated the manifestation of compensatory reactions in response to physical stimuli in bodybuilders of group 1, especially at the beginning of the study. Thus, group 1 athletes had a decrease in the cortisol concentration by 26.8% ($p < 0.05$) on the background of a significant increase in LDH activity by 37.4% ($p < 0.05$) in the blood almost to the upper limit of the norm. Athletes of groups 2 and 3 showed a safe increase in cortisol concentration and LDH activity in response to a stress stimulus. At the end of the study, we observed the effect of long-term adaptation mainly in group 3 athletes on the background of no significant changes in cortisol concentration and LDH activity in the blood serum in response to exercise, which indicated increasing the body resistance to the physical stimuli. **Conclusion.** Using the proposed mechanism of the training process correction at the stage of special basic training in bodybuilding allows to optimize the training load parameters as well as achieve pronounced adaptive changes in the body of athletes and their muscle growth.
Key words: bodybuilders, adaptation changes, basic and isolation exercises, training programs, biochemical indicators.

Introduction

The mechanisms of the training process optimization in bodybuilding and the search for effective training programs and workload modes, taking into account the stage of training, have been paid close attention by leading coaches and scientists in this field (Slavitiak, 2015; Blasio et al., 2016; Dubachinskyi, 2019) in recent decades. The mechanisms of the training process influence in bodybuilding and other power sports on the body functional capabilities of people with different level of training, sex and level of resistance to power training loads are actively studied by researches (Cintineo et al., 2018; Titova et al., 2018; Shibata et al., 2021). An important aspect of improving the training system in this sport is the search for effective markers for assessing the adaptive-compensatory reactions of athletes to power training loads of different volume and intensity (Chernozub et al., 2020). Despite the use of a wide range of physiological, biochemical methods for diagnosing the body systems of bodybuilders, the problem of prompt correction of training loads and determining the optimal set of informative criteria for assessing adaptive changes and performance dynamics remains unresolved (Weakley et al., 2017; Becker, L & Semmlinger Rohleder, 2021).

The development of effective training programs for bodybuilding is one of the most pressing issues considered by coaches and scientists throughout the period of development of this sport. A significant amount of research is connected with the development and improvement of training programs using various sets of

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exercises, principles and methods, variability of the ratio of load components and their parameters at different stages of training (Slavitiak, 2015; Titova et al., 2018; Dubachinskyi, 2019).

The issue of optimizing training activities at the stage of specialized basic training is especially acute taking into account the large amount of load, training with maximum weight, the use of special principles and methods of training (Hatfield, 1993). Moreover, the conditions of intense muscular activity with a constant increase in the volume and intensity of the load increase the risk of overtraining and even failure of adaptation (Chernozub et al., 2020; Benavente et al., 2021). According to research results of several scientists, one of the ways to solve this problem is to use the principle of premature fatigue. The basis of this training principle is the consistent use of isolation and basic exercises. Using this principle allows maximizing the load on the main muscle group due to premature fatigue of the auxiliary muscle groups (Hatfield, 1993). Appropriate mechanisms will reduce the projectile mass in the basic exercises by 25-30% and the total amount of work (Slavitiak, 2015; Chernozub et al., 2018). These actions positively affect not only on the parameters of the load, but also provide a reduction in injuries. The impact of training programs with different variability of sequential use of isolation and basic exercises on the nature of adaptive-compensatory reactions of bodybuilders has not been studied yet.

Purpose. To study the features of the influence of training loads in bodybuilding with the sequential use of basic and isolation exercises on the nature of adaptive body changes in athletes.

Material & Methods

Participants

A series of experimental studies was conducted during 2020 on the basis of the following fitness centers and sports clubs in Mykolaiv (Ukraine): Fight House, Septem Fitness, Gym Style, Gold Gym. The research included 60 bodybuilders aged 18±0.23 years old, who used various combinations of basic and isolation strength exercises during 4 months at the stage of specialized basic training. These athletes were divided into 3 groups, 20 people in each. In the course of training each muscle group of the first group athletes was first loaded with a series of basic exercises, and then with a series of isolation exercises. The second group used a series of basic exercises in each mesocycle in the first two microcycles, and isolation exercises in the next two microcycles. The third group of athletes loaded each muscle group with a series of isolation exercises, and then – with a series of basic exercises. The experimental study was approved by Petro Mohyla Black Sea National University Ethics Committee for Biomedical Research in accordance with the Ethical Standards of the Helsinki Declaration. The participants gave written consent to the study in accordance with the recommendations of the Biomedical Research Ethics Committees *(WHO Regional, 2000).*

Measurements

Circumferential measurements

Measurement of body circumference (chest, shoulder, thigh, shin) in athletes of the surveyed groups took place at the beginning of the study and during the next 4 months with a control interval of every 30 days. All measurements were performed at the same time before the start of the training session according to the generally accepted method (Martyrosov, Nikolayev & Rudnev, 2006).

Body composition

In the course of 4-month study, we used a non-invasive biophysical method of bioimpedansometry to determine the body composition of three groups of bodybuilders. The basis of this method is to determine the level of electrical resistance of body tissues. Determination of the body composition parameters occurs in the process of computer processing of the obtained data. Using this method, we determined the following indicators: body cell mass (BCM, %), body fat (BF, %), fat-free mass (FFM, kg), body mass index (BMI, cond. units). A bioimpedance analyzer was used to evaluate the studied parameters: diagnostic computer-software complex KM-AR-01 complete set "Diamond - AST" (body composition analyzer) (VYUSK. 941118.001 PE) (Martyrosov, Nikolayev & Rudnev, 2006).

Biochemical indicators

The activity of lactate dehydrogenase (LDH) in the blood serum of the athletes was determined by the kinetic method on the equipment of the company "High Technology Inc" (USA) with a set of reagents PRESTIGE 24i LQ LDH (Poland). The concentration of the steroid hormone cortisol in the blood serum was determined by enzyme-linked immunosorbent assay, using a set of reagents SteroidIFA-testosterone on the equipment of the company "Alcor Bio". The blood sampling procedure was performed according to the general requirements of biomedical research (Tietz, 1995). Blood sampling from the veins of the subjects was performed by a medical professional before and after training at the beginning and end of the fourth month of the study in compliance with all standards. Physiologically acceptable levels of cortisol concentration in the blood serum of healthy people are in the range of 150-660 nmol / l and LDH - 195-462 units / l.

Statistical analysis

Statistical analysis of the study results was performed using the software package IBM * SPSS * Statistics 26 (StatSoftInc., USA). Methods of descriptive statistics were used to calculate the arithmetic mean and the error of the mean. The non-parametric Wilcoxon test was used to assess the reliability of paired differences, and Friedman's ANOVA was used to analyze repeated measurements.

Results

Table 1 presents the results of changes in the circumference of the body size (chest, shoulder, thigh, shin) of athletes in all 3 groups during 4 months of using different training programs with variable sequences of basic and isolation exercises.

The largest increase in the circumferential size of the chest by 6.3 ($p < 0.05$) was observed in athletes of group 3 during 4 months of the study. The lowest dynamics of the studied indicator by 3.2 ($p < 0.05$) was found in bodybuilders of group 1. The dynamics of the circumferential dimensions of the shoulder showed that the highest growth of this indicator by 9.9% ($p < 0.05$) was in athletes of group 3, which is almost twice the results of group 1 athletes. The difference between thigh circumferential size in groups 3 and 1 was more than 2 times during 4 months of control. The shin circumferential size indicated that the largest increase by 7.3 ($p < 0.05$) was observed in athletes of group 3. At the same time, we observed positive dynamics of circumferential body size growth by an average of 5.2% ($p < 0.05$) in group 2 athletes during the study, which is 30% less than the results of group 3 bodybuilders.

Table 1. **Changes in the circumferential body size parameters of group participants during the study, n = 60**

Indicator	Group	initial data	Term of observation, months				χ^2, p df=4
			1	2	3	4	
circumferential size of the chest, cm	1	106.85 ± 0.32	108.17±0.34[1] Z=-3.9; p<0.000	109.03±0.32[1] Z=-3.9; p<0.000	109.68±0.37[1] Z=-3.9; p<0.000	110.36±0.38[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=80.0 p<0.000
	2	107.74 ± 0.36	109.81±0.36[1] Z=-3.9; p<0.000	111.30±0.35[1] Z=-3.9; p<0.000	112.11±0.35 Z=-3.9; p<0.000	112.67±0.36[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=80.0 p<0.000
	3	106.66 ±0.23	108.88±0.28[1] Z=-3.9; p<0.000	110.45±0.22[1] Z=-3.9; p<0.000	111.55±0.20[1] Z=-3.9; p<0.000	113.40±0.19[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=80.0 p<0.000
circumferential size of the shoulder, cm	1	37.52 ±0.22	38.25±0.22[1] Z=-4.0; p<0.000	38.70±0.23[1] Z=-3.8; p<0.000	39.16±0.24[1] Z=-4.0; p<0.000	39.58±0.24[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=79.63 p<0.000
	2	37.35 ±0.16	38.22±0.16[1] Z=-3.9; p<0.000	38.97±0.15[1] Z=-3.9; p<0.000	39.53±0.14[1] Z=-3.9; p<0.000	40.02±0.13[1,2] Z=-3.7; p<0.000 Z=-3.9; p<0.000	χ^2=80.0 p<0.000
	3	37.32 ±0.17	38.59±0.18[1] Z=-3.9; p<0.000	39.40±0.18[1] Z=-3.9; p<0.000	40.29±0.19[1,] Z=-4.1; p<0.000	41.01±0.19[1,2] Z=-4.0; p<0.000 Z=-3.8; p<0.000	χ^2=80.0 p<0.000
circumferential size of the thigh, cm	1	56.92 ±0.17	57.58±0.16[1] Z=-3.9; p<0.000	58.07±0.15[1] Z=-3.9; p<0.000	58.54±0.16[1] Z=-3.9; p<0.000	58.88±0.15[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=80.4 p<0.000
	2	55,89 ±0.14	56.87±0.12[1] Z=-3.9; p<0.000	57.71±0.13[1] Z=-3.9; p<0.000	58.41±0.13[1] Z=-3.8; p<0.000	59.07±0.11[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=80.0 p<0.000
	3	56.17 ±0.21	57.63±0.19[1] Z=-3.8; p<0.000	58.58±0.17[1] Z=-3.9; p<0.000	59.46±0.19[1] Z=-3.9; p<0.000	60.24±0.18[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=79.2 p<0.000
circumferential size of the shin, cm	1	37.52 ±0.14	38.13±0.13[1] Z=-3.9; p<0.000	38.64±0.12[1] Z=-4.2; p<0.000	39.12±0.12[1] Z=-4.1; p<0.000	39,35±0.12[1,2] Z=-4.0; p<0.000 Z=-3.9; p<0.000	χ^2=80.0 p<0.000
	2	37.10 ±0.17	37.79±0.15[1] Z=-4.0; p<0.000	38.30±0.15[1] Z=-3.9; p<0.000	38.76±0.14[1] Z=-4.0; p<0.000	39.04±0.14[1,2] Z=-3.8; p<0.000 Z=-3.9; p<0.000	χ^2=79.8 p<0.000
	3	36.79 ±0.13	37.60±0.13[1] Z=-4.0; p<0.000	38.23±0.13[1] Z=-3.9; p<0.000	38.89±0.13[1] Z=-4.0; p<0.000	39.47±0.13[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=80.0 p<0.000

Note: [1] - the difference in comparison with the previous results is significant according to the Wilcoxon test ($p < 0.05$); [2] - the difference in comparison with the initial values is significant by the Wilcoxon test ($p < 0.05$); df is the number of degrees of freedom; p is the level of significance.

Table 2 presents the features of changes in body composition of participants of all surveyed groups in the given conditions of muscular activity during 4 months of research.

The obtained results analysis showed that the largest decrease by 9.1% ($p < 0.05$) in the rate of body fat during 4 months was in athletes of group 3. At the same time, group 2 representatives had the smallest decrease in the studied indicator by 2.8% ($p < 0.05$). We observed that during the study the rate of fat-free mass greatly increased by 8.5% ($p < 0.05$) in athletes of group 3 compared with baseline. The least pronounced positive changes in this indicator of body composition by 4.0% (p <0.05) were recorded in representatives of group 1. The same character of intergroup changes during all period of research was observed in the indicator of body cell mass.

Table 2. **Changes in body composition parameters in athletes of all groups during the study, n = 60**

Indicators	Group	The term of observation, months initial data	1	2	3	4	χ^2, p df=4
BCM (body cell mass, %)	1	62.54 ± 0.20	61.96±0.21[1] Z=-3.9; p<0.000	62.64±0.17[1] Z=-3.9; p<0.000	62.84±0.17 Z=-2.8; p<0.004	63.38±0.18[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=65.4 p<0.000
	2	62.12 ± 0.21	62.89±0.22[1] Z=-3.9; p<0.000	63.13±0.22[1] Z=-3.9; p<0.000	62.76±0.22 Z=-3.9; p<0.000	63.51±0.24[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=80.0 p<0.000
	3	62.03 ±0.25	62.42±0.22[1] Z=-3.6; p<0.000	62.75±0.17[1] Z=-2.6; p<0.009	63.15±0.13[1] Z=-3.6; p<0.000	63.58±0.13[1,2] Z=-3.5; p<0.000 Z=-3.7; p<0.000	χ^2=56.6 p<0.000
BF (body fat, %)	1	18.17 ±0.59	17.82±0.57[1] Z=-3.9; p<0.000	17.71±0.54 Z=-0.5; p>0.575	17.72±0.52 Z=-0.2; p>0.808	17.30±0.51[1,2] Z=-3.9; p<0.000 Z=-3.1; p<0.002	χ^2=20.9 p<0.000
	2	17.83 ±0.51	18.11±0.52[1] Z=-3.9; p<0.000	18.29±0.52[1] Z=-3.8; p<0.000	17.77±0.51[1] Z=-3.8; p<0.000	17.33±0.49[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=75.4 p<0.000
	3	18.20 ±0.39	18.16±0.39[1] Z=-3.1; p<0.001	17.68±0.38[1] Z=-3.9; p<0.000	17.24±0.36[1,] Z=-3.9; p<0.000	16.55±0.36[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=77.7 p<0.000
FFM (fat-free mass, kg)	1	69.05 ±0.74	69.97±0.73[1] Z=-3.8; p<0.000	70.76±0.75[1] Z=-3.9; p<0.000	71.27±0.74[1] Z=-3.9; p<0.000	71.84±0.74[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=79.2 p<0.000
	2	69.74 ±0.63	70.78±0.64[1] Z=-3.9; p<0.000	71.42±0.63[1] Z=-3.9; p<0.000	72.58±0.69[1] Z=-3.8; p<0.000	73.73±0.67[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=79.2 p<0.000
	3	68.69 ±0.75	69.96±0.75[1] Z=-3.9; p<0.000	71.48±0.74[1] Z=-3.9; p<0.000	73.01±0.75[1] Z=-3.9; p<0.000	74.54±0.75[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=80.0 p<0.000
BMI (body mass index, cond. units)	1	26.07 ±0.28	26.33±0.29[1] Z=-3.9; p<0.000	26.59±0.29[1] Z=-3.9; p<0.000	26.79±0.29[1] Z=-3.8; p<0.000	26.86±0.29[1,2] Z=-3.4; p<0.001 Z=-3.9; p<0.000	χ^2=78.5 p<0.000
	2	26.40 ±0.33	26.88±0.34[1] Z=-3.9; p<0.000	27.33±0.34[1] Z=-3.9; p<0.000	27.47±0.35[1] Z=-2.4; p<0.016	27.71±0.35[1,2] Z=-3.8; p<0.000 Z=-3.9; p<0.000	χ^2=75.0 p<0.000
	3	26.39 ±0.27	26.90±0.28[1] Z=-3.9; p<0.000	27.31±0.27[1] Z=-3.9; p<0.000	27.74±0.27[1] Z=-3.9; p<0.000	28.09±0.27[1,2] Z=-3.9; p<0.000 Z=-3.9; p<0.000	χ^2=80.0 p<0.000

Note: [1] - the difference in comparison with the previous results is significant according to the Wilcoxon test (p <0.05); [2] - the difference in comparison with the initial values is significant by the Wilcoxon test (p <0.05); df is the number of degrees of freedom; p is the level of significance.

Analysis of the results found at the beginning of the study showed that cortisol concentration in the blood serum of group 1 athletes in response to exercise decreased by 26.8% (p <0.05) and LDH activity simultaneously increased by 37.4% (p <0.05) compared with the state of rest. The cortisol concentration in group 2 athletes increased by 50.4% (p <0.05) together with LDH activity, which increased by 16.6% (p <0.05) in response to stress stimuli. A similar increase in cortisol concentration by 37.9% (p <0.05) and LDH activity in the blood by 8.8% (p <0.05) was recorded in bodybuilders of group 3 in response to power training in given conditions of muscular activity.

The results of biochemical analysis of blood revealed that after 4 months of research the controlled indicators had changes similar to the previous stage of control, but almost 2 or in some cases 5 times less pronounced reaction to a physical stimulus. Thus, in athletes of group 1, the concentration of cortisol in the blood serum decreased by 14.1% (p <0.05), and LDH activity increased by 23.1% (p <0.05) in response to physical stimuli. In athletes of group 2 we observed an increase in cortisol concentration by 13.6% (p <0.05) and LDH activity – by 12.7% (p <0.05) in response to stress stimuli. At the same time, bodybuilders of group 3 at this stage of the study showed only a tendency to increase this indicator by 4.5% (p> 0.05) in response to power training loads. However, the activity of LDH in the blood of group 3 athletes significantly increased by 7.5% (p <0.05).

Table 3 presents the results of changes in the activity of LDH activity and cortisol concentration in participants of all groups during 4 months of the study, taking into account different combinations of sequential use of isolation and basic exercises in training.

Table 3. **The results of biochemical blood indicators of group participants during the study, n = 60**

Biochemical indicators	Group	At the beginning of the study		After 4 months of the study	
		before exercise	after exercise	before exercise	after exercise
Cortisol, nmol / l	1	480.53±14.72	351.62±12.75* Z=-3.2; p<0.000	466.40±20.70 Z=-0.5; p>0.05	400.81±22.11* Z=-2.4; p<0.05
	2	362.79±13.46	545.66±22.49* Z=-3.9; p<0.000	478.21±18.49** Z=-3.2; p<0.000	543.62±17.60* Z=-3.5; p<0.000
	3	428.41±21.69	590.78±17.67* Z=-3.5; p<0.000	404.13±19.92 Z=-0.4; p>0.05	422.33±17.43 Z=-0.6; p>0.05
LDH, c.u.	1	290.44±11.32	455.31±9.54* Z=-3.9; p<0.000	336.75±13.47** Z=-2.8; p<0.05	414.77±10.98* Z=-3.0; p<0.000
	2	348.35±7.24	406.29±15.61* Z=-2.3; p<0.05	393.35±12.72 Z=-0.8; p>0.05	443.65±12.85 Z=-2.2; p<0.05
	3	368.40±7.72	400.29±15.06 Z=-1.3 p>0.05	392.95±13.47 Z=-0.6; p>0.05	422.71±12.38 Z=-0.9; p>0.05

Note: * the difference in comparison with the previous results is reliable according to Wilcoxon's test (p <0.05); ** the difference between the basal parameters (before loading) in comparison with the previous results is reliable according to Wilcoxon's test (p <0.05).

Discussion

Solving the problem of constant increase in power load training at the stage of specialized basic training in bodybuilding to ensure accelerated growth of muscle mass of athletes requires scientists to find not only mechanisms to optimize the training process, but to study the nature of changes in criteria for assessing adaptive-compensatory responses to physical stimuli (Slavityak, 2015; Chernozub et al., 2020; Shibata et al., 2021). In bodybuilding there is no clear understanding of what criteria (morphometric parameters, bioimpedansometry data, results of testing the development of strength, blood biochemical indicators) reflect the course of adaptation processes, rather than demonstrate the maximum activation of the body reserves to provide compensatory mechanisms.

The results of bioimpedance measurement obtained by us indicated that in the conditions of premature use of isolation exercises before the basic ones allows bodybuilders to almost double the indicator of fat-free mass on the background of a significant decrease in body fat, compared to standard training conditions. At the same time, the long-term usage of this variety of training exercises contributes to the accelerated growth of body circumferential dimensions by 80-90%, compared to the results found in other training conditions of bodybuilders. The corresponding changes in circumference and fat-free mass indicate an accelerated growth of muscle mass mainly due to hypertrophy of fast-twitch muscle fibers (Hatfield, 1993; Titova et al., 2018). Premature fatigue of small muscle groups that additionally take part in the process of performing basic exercises affects not only the reduction of the projectile mass and the amount of work, but also allows using the maximum number of mobile units, which will contribute to pronounced processes of long-term adaptation. Redistribution in the training load of large and small muscle groups, in combination with sequential use of basic and isolation exercises, requires a significant level of energy supply of muscle activity, which contributes to the accelerated reduction of body fat (Chernozub et al., 2015; Titova et al.., 2018; Dubachynskyi, 2019).

The peculiarities of changes in cortisol and LDH in the blood serum of athletes in the given training conditions, confirm the results of research in power fitness where different intensity training load regimes are used (Butova, & Masalov, 2009; Chernozub, & Radchenko, 2016). A significant decrease in cortisol concentration in the blood serum occurs in response to power loads with a large amount of work due to significant energy consumption and indicates the manifestation of compensatory reactions (Jones et al., 2016; Becker et al., 2021; Benavente et al., 2021). At the same time, in the given conditions of muscular activity, a significant increase in LDH activity also indicates a significant usage of energy resources and indicates the inadequacy of the load to the functional capabilities of the body. At the end of the study, we found an unreliable tendency to increase the concentration of cortisol and LDH activity in the blood serum to stress stimuli, which indicates the processes of athletes' long-term adaptation to power loads and increasing their level of resistance (Titova et al., 2018; Martorelli et al., 2021).

Conclusion

Using first a set of isolation exercises and then basic exercises at the stage of specialized basic training in the process of a particular muscle group training contributes to the most pronounced increase in circumferential sizes and fat-free mass due to increased muscle mass on the background of a significant decrease in the level of body fat of athletes.

Despite the positive dynamics of morphometric parameters and body composition of athletes of all groups, regardless of the characteristics of training activities, only the results of biochemical blood tests can clearly determine the manifestation of adaptive-compensatory reactions to physical stimuli.

Implementing the proposed mechanism of the training process correction at the stage of special basic training in bodybuilding allows not only to optimize the parameters of the training load, but also to achieve pronounced adaptive body changes in athletes and their muscle growth.

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