Modern Scientific Approach to Rejuvenation

Rejuvenation: Myth and Reality

The idea of rejuvenation is very much in the air these days. After forty, it's natural to feel your vital energy dropping. Plastic surgery can help you keep a nice exterior, but the body—especially the muscles—starts weakening, blood pressure goes off, and decay shows up. It's natural to want to slow this process down or—if you're more optimistic—turn things around.

Who I Am and What I Do

Let me introduce myself.
I'm Sergej Davidov, a physiatrist born in 1959. I'm retired now, living in the countryside in Lazio.

Despite my age, my life is built around maintaining vital force:

- I train regularly: twice a week kickboxing (including sparring with twenty-year-olds), and three or four times a week I work out in my home gym.
- I live actively and self-sufficiently: I manage a big house, storage buildings, ten hectares of land, raise animals, and cultivate olive trees. I don't take any medications and I feel great.

Modern Science and Rejuvenation

What can modern science actually offer humanity in this field? Here's a summary of current research:

Current Technologies

- **iPSCs (induced pluripotent stem cells):** they turn adult cells into embryo-like cells that can regenerate tissues.

- **Epigenetic Reprogramming (ERA):** developed by Vittorio Sebastiano (Stanford), it rejuvenates human cells without touching their DNA.
- **Anti-aging molecular cocktails:** discovered by David Sinclair (Harvard), able to rejuvenate human cells in the lab in a matter of days.

Research Directions

- Automation and personalization of cell-based therapies.
- Immune-system compatibility to avoid rejection in transplants.
- Parabiosis and “young blood” factors: animal studies show regenerative effects.

Human Applications

- No real case of full-body rejuvenation in a human.
- Human cells rejuvenated in the lab: concrete, verifiable results.
- Tests on animals show visible and functional improvements.

Future Outlook

- Personalized and accessible anti-aging treatments.
- Possible development of anti-aging pills.
- New treatments for age-related chronic diseases.

In short: science has made big progress at the cellular and animal level.
But there is *still* no real therapy that can rejuvenate an entire human body.
Bottom line: a lot of research and a lot of talk.

Introduction

Physical culture for health has become, at the beginning of the 21st century, one of the main pillars of a healthy lifestyle. The most popular wellness systems today are aerobics, bodybuilding, sports games, yoga, Chinese gymnastics, callanetics, and others.
However, an analysis of scientific publications shows that none of these systems has a solid theoretical foundation. Some studies even prove experimentally that a few of the most widespread wellness systems—including many types of aerobics—are not particularly effective.

According to the World Health Organization (WHO), "health" means the absence of disease combined with complete physical, mental, and social well-being. Physical culture can help prevent disease—supporting physical well-being. To some degree, it can also help mental well-being, because activating the motor area of the cerebral cortex suppresses weaker excitation centers in other parts of the brain.
For example, chronic psychological tensions created by everyday life (bad family relationships, work problems, etc.) exhaust certain nerve cells because they remain constantly active. Physical exercise inhibits activity in all brain cells except those responsible for movement. As a result, most brain cells rest and recover their "strength."
So physical activity contributes, at least in part, to mental well-being.

Still, the main task of physical culture is physical well-being—meaning the prevention of the main diseases that hit most people as they age. Statistics show that about 50% of people die of coronary heart disease, around 20% of cancer. More than 80% of adults suffer from back pain.

To understand the causes of these diseases and how to prevent them, we need to understand how our body is built (anatomy) and how it functions (physiology).

In the next chapter, I'll give brief information on anatomy and physiology, followed by an explanation of the main causes behind the diseases of modern humanity at the start of the 21st century.

BIOLOGICAL FOUNDATIONS OF PHYSICAL CULTURE

Chapter 1

CELL BIOLOGY

The cell is the fundamental structural unit of all living organisms—an elementary, fully functional living system. It consists of protoplasm surrounded by a membrane. The cell contains a nucleus that holds the genetic information (DNA). Within the protoplasm are several structures, also known as organelles:

Ribosomes: with the help of RNA, they carry out protein synthesis (anabolic processes).
Mitochondria: the cell's power plants, where—thanks to oxygen—fats or glucose are converted into ATP, releasing energy, carbon dioxide (CO_2), and water.
Endoplasmic reticulum / sarcoplasmic reticulum: a membrane-based organelle containing associated enzyme systems.
Golgi apparatus: a membrane system forming stacks and vesicles; responsible for synthesizing and secreting substances from the cell.
Lysosomes: vesicle-shaped organelles containing enzymes that break proteins down into amino acids, essentially the digestive system of the cell.
Specialized organelles: structural components unique to certain cell types, such as myofibrils in muscle fibers.

Biochemical Processes of Muscle Activity

Muscle contraction, nerve impulse transmission, protein synthesis, and other functions require energy. Inside cells, energy is used in the form of ATP. The release of ATP's chemical energy is mediated by ATPase, an enzyme present in all regions of the cell where energy is needed. When ATP is broken down, ADP, inorganic phosphate (Pi), and H^+ ions are produced.

Resynthesis of ATP occurs mainly through creatine phosphate (CrP) stores. When CrP donates its energy to rebuild ATP, creatine (Cr) and phosphate (Pi) are formed. These diffuse through the cytoplasm and activate the enzymatic machinery for ATP synthesis.

Main Pathways for ATP Synthesis

1. Anaerobic Pathway (Glycolysis)

Occurs through enzymatic systems located on the sarcoplasmic reticulum membrane and in the sarcoplasm.

When Cr and Pi reach these enzymes, a chain of reactions begins in which glycogen or glucose is broken down into pyruvate, producing ATP.

ATP is immediately used to resynthesize CrP, while ADP and Pi re-enter glycolysis to generate more ATP.

Pyruvate can either:
• enter the mitochondria, convert to acetyl-CoA, and undergo oxidative phosphorylation → ATP, CO_2, H_2O (aerobic glycolysis), or
• be converted into lactate via LDH-M (muscle lactate dehydrogenase) → anaerobic glycolysis, producing H^+ ions.

2. Aerobic Pathway (Oxidative Phosphorylation)

Occurs in the mitochondria.

When Cr and Pi reach the mitochondria, mitochondrial CrP-kinase resynthesizes CrP using ATP produced inside the mitochondria. ADP and Pi return into the mitochondria, where new ATP is formed.

Metabolic sources:
• Aerobic glycolysis
• Lipid oxidation (fat metabolism)

In slow-twitch muscle fibers (e.g., heart, diaphragm), the enzyme LDH-H (cardiac LDH) predominates. It rapidly converts lactate back into pyruvate, supporting the removal of lactate and H^+.

Muscle Physiology During a Step Test

During a graded step test, the following events occur:

Input model: MCL (slow-twitch fibers) = 50%, step height = 570, duration = 1 min.

At the beginning, with low external resistance, low-threshold motor units (slow fibers) are recruited according to Henneman's "size principle." These fibers have high oxidative capacity and use fatty acids as substrate.

In the first 10–20 seconds, energy comes from stored ATP and CrP within the active slow fibers.

During the first minute, additional fibers are recruited to maintain the required power as phosphagen stores drop and central nervous system activation increases.

Increase in Power Output

Increases:
- heart rate
- oxygen consumption
- pulmonary ventilation

Stable:
- lactate concentration
- H^+ concentration

Full Recruitment of Slow Fibers

As external power reaches a certain level, all slow fibers are recruited, and intermediate fibers (FMI) begin to activate.

In FMI, once phosphagens are depleted, glycolysis increases → part of the pyruvate becomes lactate → lactate enters the bloodstream → enters slow fibers. Lactate in slow fibers inhibits fat oxidation → glycogen becomes the main substrate.

Key indicators of full recruitment:
- rising blood lactate
- increasing ventilation

Accumulation of H^+ and CO_2

H^+ produced in FMI interacts with blood buffers → generating non-metabolic CO_2 → stimulating respiration.

CO_2 reaches CNS chemoreceptors → increased ventilation.

CO_2 is expelled → its average concentration in the blood drops.

Aerobic Threshold (AeS) and Anaerobic Threshold (AnS)

AeS: marks full recruitment of slow fibers. The corresponding power reflects the ability of slow fibers to resynthesize ATP and CrP through oxidative phosphorylation.

AnS: occurs when lactate production exceeds lactate oxidation.

Lactate in slow fibers is converted back to pyruvate via LDH-H.

The mitochondrial capacity of slow fibers has a limit → a dynamic balance between lactate production and removal forms → eventually this balance collapses → accumulation of lactate, H^+, and CO_2 → strong activation of physiological responses, especially respiratory.

Energy Substrates at the Anaerobic Threshold

Lactate inhibits fat oxidation.

Carbohydrates become the only oxidative substrate in slow fibers:
- muscle glycogen

• lactate produced in glycolytic muscles

Using carbohydrates ensures the highest ATP production rate in slow-fiber mitochondria.

Power at the Anaerobic Limit and Oxidative Capacity

Power at AnS reflects maximal oxidative capacity of slow fibers. Any additional increase in power requires high-threshold motor units that innervate glycolytic fibers. At this point, the dynamic balance breaks: H^+ and lactate production surpass clearance, increasing ventilation, heart rate, and oxygen consumption.

Beyond AnS, oxygen consumption mainly reflects the work of respiratory muscles and the myocardium. When maximal ventilation or maximal HR is reached—or when local muscle fatigue sets in—oxygen uptake plateaus, then declines. This point is VO_2max.

Energy and Muscle Glycogen

During exercise lasting more than 60 seconds, energy comes mainly from muscle and liver glycogen stores.

However, the duration of work performed between maximal aerobic power (MAP) and AnS is *not* determined by glycogen depletion. Only at AnS does exhaustion reflect glycogen depletion.

Monitoring glycogen stores: determine AnS and maintain that power to the limit. The time to exhaustion at AnS mirrors glycogen availability.

Muscle Adaptations and Capillarization

An increase in AnS indicates growth of mitochondrial mass in slow fibers, along with increased capillary number and density, extending blood transit time.

This means AnS reflects both oxidative muscle mass and capillarization.

Cardiovascular Assessment

A step test provides an indirect evaluation of the cardiovascular system. The relationship between power output, HR, oxygen consumption, and ventilation is linear up to AeS.

On a cycle ergometer with efficiency = 2370:
1 L of oxygen consumed corresponds to 20 L/min of ventilation and 75–80 W of power.

Since arterial oxygen concentration remains constant, venous O_2 and CO_2 depend on muscle power and blood flow.

Data show that heart size does not directly determine muscle blood flow, but HR drops under a standard load. Thus, HR under load can indicate stroke volume (SV), meaning left ventricular volume and myocardial contractile strength.

Endocrine and Immune Systems

There are no practical tests for directly assessing endocrine or immune function. Some methods, like sheep erythrocyte assays, are complex and impractical in sports settings.

The simplest monitoring tool is regular muscle strength testing. If strength drops despite training, decreased endocrine function or insufficient hormone production is likely. Reduced hormone levels impair cellular synthesis, including immune plasma cell production → immunodeficiency.

Handgrip dynamometry and similar tests can reflect endocrine status indirectly. Studies show that training one leg can increase strength in the untrained leg due to hormonal system activation.

Blood Circulation

The heart and vessels ensure continuous blood flow.

Systemic circulation: left ventricle → aorta → arteries → capillaries → veins → right atrium.
Pulmonary circulation: right ventricle → pulmonary artery → lung capillaries → pulmonary veins → left atrium.

The heart pumps blood rhythmically: contraction = systole; relaxation = diastole. Cardiac output (CO), the volume pumped per minute, is 4–5 L/min at rest. Dividing CO by HR yields stroke volume: 60–70 mL at rest.

Contraction rate and strength depend on neural, hormonal (adrenaline), and biomechanical regulation. When standing, gravity hinders venous return, pooling 300–800 mL of blood in the legs.

During exercise, CO increases through HR and SV. SV reaches its maximum at HR 120–150 bpm, whereas HR can exceed 180–200 bpm. In untrained individuals, CO may reach 18–25 L/min.

Maximal oxygen delivery is:
$VO_2 = CO \times Hb \times 0.00134$
Example: $20 \times 160 \times 0.00134 = 4.288$ L/min.

If untrained individuals could use all available oxygen, they could compete at professional levels. But mitochondrial scarcity limits VO_2max:
Men → 3–3.5 L/min (45–50 ml/kg/min)
Women → 2–2.2 L/min (40–45 ml/kg/min)

At AnS, oxygen consumption averages 60–70% of VO_2max—approximately half that of elite athletes.

Blood Vessels and Blood Pressure

During systole, the heart pushes blood into the aorta and pulmonary artery, creating pressure. Peripheral resistance hinders flow. Maximum pressure = systolic (SBP), minimum = diastolic (DBP). At rest: 120/80 mmHg.

More arterial elasticity → less pressure needed. In arteriosclerosis, stiff arteries require higher pressures.

Resistance depends on blood viscosity and vessel diameter. Muscle tension can compress vessels, increasing resistance. Products of anaerobic metabolism (↓pH, ↑pCO_2, ↓pO_2) cause functional hyperemia → vessel dilation → ↓pressure.

Neural and Hormonal Control

Neural and humoral control regulate vascular tone. Sympathetic fibers innervate smooth muscle in small vessels. Capillary flow is regulated locally.

Vasoconstriction: norepinephrine from sympathetic nerves → α-receptors (kidneys, liver, intestines, lungs, skin).
Vasodilation: adrenaline and norepinephrine → β-receptors (skeletal muscle, heart, adrenal glands).

Neuroendocrine System

Endocrine glands are activated via neural impulses from the CNS (hypothalamic nuclei) to glands such as the pituitary. Hormones from the anterior pituitary regulate the thyroid, gonads, and adrenal glands.

Three major endocrine systems:

• Sympatho-adrenal system
• Hypothalamic-pituitary-adrenal system
• Hypothalamic-pituitary-gonadal system

Sympatho-Adrenal System

Responsible for mobilizing energy resources. Adrenaline and norepinephrine are produced in the adrenal medulla and work with norepinephrine released by sympathetic nerve endings. Their action is mediated by the "adenylate cyclase – cyclic AMP (cAMP)" system.

To accumulate cAMP, phosphodiesterase (the enzyme that degrades it) must be inhibited.
Glucocorticoids inhibit this enzyme; insulin opposes the effect.

Mechanism:

1. Hormone reaches the cell via the bloodstream.
2. Binds to membrane receptor.
3. Receptor changes shape → activates adenylate cyclase.

4. ATP converts to cAMP.
5. cAMP regulates metabolism: glycogenolysis, activation of phosphofructokinase in muscle, lipolysis in fat tissue, protein synthesis, and muscle contraction.

Hypothalamic-Pituitary-Adrenal System

Includes neural structures (hypothalamus, reticular formation, amygdala), blood circulation, and adrenal glands.

Under stress, the hypothalamus releases corticoliberin into the blood → stimulates ACTH secretion → ACTH reaches adrenal cortex.

Mechanism of glucocorticoid action (A. Viru, 1981):
• Hormones enter the cell by diffusion.
• Bind to specific receptor → G-R complex.
• The complex enters the nucleus and binds DNA.
• Stimulates mRNA transcription.
• mRNA activates synthesis of other RNAs.
• After ~60 min, ribosomes assemble.
• Translation begins → enzyme synthesis (liver, endocrine glands, skeletal muscle).

The G-R complex has a half-life of ~13 minutes. After action, the hormone leaves the cell unchanged.
Target cells, like liver cells, have many glucocorticoid receptors. Hormones accumulate and are metabolized. Half-life varies from 20 to 200 minutes.

Hypothalamic-Pituitary-Thyroid System

Linked through neural and humoral pathways. Likely works in coordination with the adrenal system.

Thyroid hormones (thyroxine, triiodothyronine, thyrotropin) support recovery after physical exertion.

Hypothalamic-Pituitary-Gonadal System

Includes the pituitary, adrenal cortex, and gonads. Regulation involves neural and humoral pathways.

Male hormones: androgens (testosterone), mainly produced in Leydig cells.
Female hormones: estrogens, produced in ovaries, adrenals, and skin.

Daily production:
• Men: 4–7 mg
• Women: 10–30 times less

Targets of androgens: prostate, seminal vesicles, testes, skeletal muscles, myocardium.

Mechanism of testosterone action:

• Converts into 5-alpha-dihydrotestosterone.
• Forms a G-R complex.
• Complex enters the nucleus.
• Binds DNA.
• Stimulates synthesis of RNA and proteins, including androgen-dependent enzymes.
• Increases DNA synthesis and cell division.
• Testosterone is fully metabolized after action.

Endocrine Adaptations to Training

Training produces structural modifications in the endocrine glands:

- Increase in the mass of adrenal glands, pituitary, thyroid, and gonads.
- After 125 days of detraining, everything returns to baseline.
- The increase in mass is linked to a higher DNA content → increased mitosis → more cells.

Glandular growth depends on:

- **Synthesis:** proportional to gland mass, inversely proportional to hormone concentration.
- **Degradation:** increases with gland mass and mechanical load, decreases when anabolic hormone levels rise.

The Immune System

The human body possesses a surveillance system: the immune system. Its role is to protect us from pathogens (bacteria, viruses) and tumor cells by recognizing and selectively destroying foreign elements.

Two main types of immune responses:

- **Cell-mediated:** effective against fungi, parasites, intracellular viruses, and tumor cells.
- **Humoral:** mediated by antibodies.

The humoral response operates mainly during the extracellular phases of bacterial and viral infections.

The immune system includes all lymphoid organs and lymphoid cell structures: thymus, spleen, lymph nodes, Peyer's patches, and bone marrow stem cells.

According to Academician R.V. Petrov (1987), the interaction between the body and foreign antigens consists of four processes:

1. **Antigen proliferation:** the number of antigens depends on their replication rate minus the amount neutralized by existing or newly formed antibodies.

2. **Immune response:** the body accumulates immunocompetent cells (antibody-producing cells). The process begins with the antigen-receptor complex on the T-lymphocyte. The number of plasma cells depends on the activated B lymphocytes and their proliferation minus losses due to aging.
3. **Antibody production:** the amount depends on synthesis rate minus the quantity bound to antigens and the amount eliminated by natural catabolism.
4. **Efficiency of the immune system:** depends on the function of other organs and systems. A virus that affects the liver, lungs, or endocrine glands can indirectly weaken immunity.

A simple mathematical model of immunity was developed by G.I. Marchuk (1985). It simulates the body's defensive reactions and includes: an antigen pool, an antibody pool, a plasma-cell pool, and a target organ. The model reproduces chronic, subclinical, acute, and lethal forms of disease.

- **Chronic form:** constant low-dose infection → balance between microbial synthesis and antibody production.
- **Subclinical, acute, or lethal forms:** caused by high antigen load or reduced target-organ mass.

Bone-marrow stem cells are the precursors of all immune responses (T and B systems). Their number declines with age. Between ages 65 and 76, antibody activity is only 20–30% of its peak.

Digestive System

The digestive system includes the mouth, pharynx, esophagus, stomach, small intestine, and large intestine.

Digestion is the physiological process that breaks food down both mechanically and chemically, allowing nutrients to be absorbed into the blood and lymph.

Physical modifications: chewing, mixing, grinding.
Chemical modifications: hydrolysis via enzymes and hydrochloric acid.

Mouth

- Mechanical fragmentation and salivation.
- Reflex activation of digestive glands.
- Salivary enzymes: ptyalin and maltase (carbohydrate digestion).

Stomach

- Highly acidic environment (pH 0.9–1.5).
- Enzymes: pepsin, gelatinase, chymosin (proteins), lipase (fats).

- Food stays 6–8 hours; carbohydrates exit fastest, fats slowest (8–10 hours).
- Adrenaline inhibits gastric secretion.

Small Intestine

- Action of bile, pancreatic juice, Brunner's glands, and Lieberkühn crypts.
- Slightly alkaline environment (pH 7.2–8.0).
- Pancreatic enzymes: proteases (trypsin, chymotrypsin), amylase, maltase, lipase, nucleases.
- Bile activates lipase.
- Parietal digestion and absorption through the intestinal mucosa.

Large Intestine

- Bacterial flora: fermenting carbohydrates, putrefying proteins.
- Water absorption → stool formation.

Absorption

- **Carbohydrates:** glucose and galactose absorbed actively with ATP consumption.
- **Amino acids:** absorbed in the small intestine → portal system → liver.
- **Fats:** fatty acids and glycerol; short-chain → bloodstream, long-chain → lymphatic system as chylomicrons.

Adipose Tissue

Adipose tissue is an independent tissue type with three main functions:

1. Synthesis of triglycerides from serum lipids and glucose.
2. Storage in fat depots.
3. Release via lipolysis.

Adipocytes increase in volume; the nucleus flattens → carbohydrate metabolism slows.
Capillaries and reticular fibers provide mechanical support and nutrition.
Innervation: sympathetic fibers wrap each adipocyte.

Inside adipose tissue occur:

- Conversion of carbohydrates into fats and vice versa.
- Fatty acid synthesis in the cytoplasm from acetyl-CoA (derived from glucose or amino acids).
- Lipolysis stimulated by catecholamines → release of fatty acids and glycerol

during stress.

Locomotor System

The locomotor system allows support and movement: bones, joints, and muscles.
Human skeleton: **206 bones**.

Joints

- **Simple:** 2 bones.
- **Complex:** 3 or more bones.

Types: spherical, ellipsoidal, saddle, cylindrical, hinge, planar.
Axes of movement:

- Frontal (transverse)
- Sagittal (anteroposterior)
- Longitudinal (vertical)

Skeleton Divisions

1. Trunk Skeleton

- Vertebral column: 33–34 vertebrae
    - 7 cervical
    - 12 thoracic
    - 5 lumbar
    - 5 sacral
    - 4–5 coccygeal
- Rib cage: sternum, ribs, thoracic vertebrae and their joints.

2. Skull

Bones: occipital, frontal, sphenoid, parietal, temporal, facial bones.
The skull articulates with the vertebral column via:

- Atlanto-occipital joint
- Atlanto-axial joint

3. Upper Limb

- Shoulder girdle: clavicle and scapula.

- Free upper limb: humerus, radius, ulna, carpal bones, metacarpals, phalanges.
- Main joints: sternoclavicular, acromioclavicular, glenohumeral; elbow; radiocarpal; carpometacarpal; metacarpophalangeal; interphalangeal.

4. Lower Limb

Includes the bones of the pelvic girdle and the free lower limb.

Muscles of the Human Body

The human body contains roughly 600 muscles, organized into topographic groups:

- Head
- Neck
- Back
- Thorax
- Abdomen
- Shoulder girdle
- Pelvic girdle

Muscles are classified as:

- Anterior and posterior
- Superficial and deep
- External and internal

Shape and fiber orientation

- Shape: long, short, broad
- Fiber direction: parallel, transverse, oblique (mono- and bipennate)

Functional groups

Muscles are organized functionally according to:

- Flexion
- Extension
- Abduction
- Adduction
- Supination
- Pronation

Synergists act together; antagonists act in opposition.

Trunk Muscles

Flexion of the vertebral column

Cervical region:

- Sternocleidomastoid
- Scalene muscles
- Longus colli and longus capitis

Lumbar region:

- Rectus abdominis
- External oblique
- Internal oblique

Extension of the vertebral column

- The erector spinae (one of the largest muscles): originates from the sacrum and inserts into the ilium, spinous processes, ribs, and skull.

Lateral bending and rotation

- Performed by the same muscles, activated selectively.

Respiratory Muscles

- Diaphragm
- External and internal intercostals
- Serratus posterior superior and inferior
- Levatores costarum

Chapter 2

Preventive Practices for the Most Common Diseases and for Human Aging

Every known form of health-oriented physical culture was developed as a preventive measure against major diseases: ischemic heart disease, atherosclerosis, and even cancer, as well as premature aging.

To understand the causes of these diseases and the means of prevention, the mechanisms behind their development must be explained. The physiology of health practices and the most rational ways to apply them are then analyzed.

Ischemic Heart Disease

More than 50–70% of deaths are related to cardiovascular diseases. The most common is ischemic heart disease, typically associated with chest pain. Inadequate blood supply to the myocardium produces pain (angina pectoris). The disruption of blood flow is usually caused by atherosclerosis.

Atherosclerosis is characterized by the formation, within the walls of large arteries, of foreign bodies containing damaged cellular debris, connective tissue, lipids, cholesterol, and more. These structures can grow until they obstruct the lumen of the vessel. If blood flow velocity suddenly increases, they may detach and travel through the bloodstream. At narrow points—such as arterioles—they may cause occlusions and loss of perfusion, leading to tissue necrosis. When this occurs in the heart muscle, a myocardial infarction follows.

Factors contributing to atherosclerosis:

- Irresponsible overnutrition
- Smoking
- Sedentary lifestyle
- Deficiency of male sex hormones
- Obesity
- Hard drinking water
- Diabetes mellitus
- And others

The key to preventing ischemic heart disease and atherosclerosis lies in understanding their true mechanism. It is now widely believed that the fundamental cause of atherosclerosis is the detachment of a large number of endothelial cells—the inner lining of blood vessels. This phenomenon appears only in tissues where plastic (regenerative) processes are impaired. The lifespan of a normal endothelial cell ranges from 100 to 180 days.

The most plausible primary cause of this impairment is a hormonal imbalance in the blood, which affects carbohydrate and fat metabolism throughout the body and, specifically within the endothelium, facilitates accelerated penetration of low-density lipoproteins into the arterial wall. The clearest evidence for the role of hormones is the sharp increase in atherosclerosis among the elderly, in whom endocrine activity declines dramatically.

Therefore, the most effective physical exercises for health are those that significantly raise hormone concentrations both during activity and in the recovery period.

Cancer

Cancer is a disease that can lead to death and accounts for about 23% of all mortality. It is associated with the formation of tumors—an excessive growth (hyperplasia) of tissue in which cells lose their specific function and structure. Tumors may be benign or malignant. Benign tumors grow by compressing surrounding tissues; malignant ones invade and destroy them. Malignant tumors occur more frequently in older individuals.

Factors that cause cancer:

- Chemical carcinogens
- Radiation (ultraviolet, X-rays, etc.)
- Viruses
- Hormonal drugs (contraindicated, for example, during pregnancy)
- And others

These agents act on DNA, altering its structure and impairing cellular function. The immune system plays a decisive role in cancer prevention, as it can recognize and destroy foreign proteins. The weakening of the immune system with age is one of the main reasons behind increased cancer risk.

Physical activity changes the functional state of cells and increases hormone levels in the blood, stimulating both synthesis and catabolism. This promotes the renewal of cellular structures, including DNA repair. As a result, genetic damage can gradually be corrected.

Scientific studies have shown that people who exercise twice weekly for 30–60 minutes develop cancer **60–70% less often** than those who do not train. However, excessive aerobic exercise does not provide additional protective benefits.

In summary, physical exercises that activate the endocrine system and support the self-renewal of cellular structures and DNA are an effective means of cancer prevention.

Aging

Human life is divided into three main phases: growth, reproductive period, and aging. Age-related physiological changes have led scientists to understand that development and aging depend on genetic programming. Experimental studies have demonstrated structural modifications of genetic information (chromatin) with age, leading to reduced translational activity and diminished cellular self-repair capacity.

Premature aging occurs in diseases such as progeria and Werner syndrome, both caused by genetic mutations. In these conditions, signs of aging (gray hair, wrinkles, etc.) appear between ages 6 and 9.

This indicates that it is possible to prolong the reproductive period and slow aging by improving genomic function. This can be achieved through medical hormonal correction, but also through physical exercise that significantly modifies hormone concentrations in the blood.

Conclusion

The key to preventing life-threatening diseases lies in strengthening the capabilities of the endocrine and immune systems—in other words, increasing the body's adaptive reserve. Therefore, the primary task of the theory of health-oriented physical education is to develop tools and methods to enhance the function of these systems.

Chapter 3

Theoretical Model

Every theory is built on ideal elements and the structural relations between them. In this case, the model is a functional representation of the human organism, simulating short- and long-term adaptive processes. Conceptual models of this kind appear in many monographs.

To improve the model and the methods of Health-Oriented Physical Education (HOPE), it is necessary to:

- refine conceptual and mathematical models that simulate the body's response to physical exercise;
- study the health effectiveness of physical-education tools;
- develop methods and programs of health-oriented physical culture;
- classify physical loads according to their physiological effects;
- develop methods for monitoring health status.

Physiological Features of the Main Types of Health-Oriented Physical Culture

The analysis of the most dangerous diseases and the aging process shows that health depends on the state of cellular genetic material, which regulates plastic processes and responds to hormonal stimuli. Therefore, exercises that trigger a strong "hormonal dance," with abundant endocrine secretion, have the highest health impact.

Cyclic Aerobics

One of the most popular types of health-oriented physical culture is aerobics, which uses cyclic exercises such as running, walking, cycling, and similar activities.

Physiology of Cyclic Exercise

Aerobic exercise is among the most studied forms of physical activity. Its main feature is the involvement of specific muscle groups that contract and relax sequentially.

As oxygen consumption increases, heart rate (HR) and blood pressure rise. For example, at HR = 150 beats/min, systolic pressure may reach 150–190 mmHg and diastolic 70–90 mmHg.

The increase in oxygen consumption is tied to movement speed, which requires greater push-off force and stronger muscle contraction. At low speeds, only a small portion of the active muscle fibers work. These fibers, rich in mitochondria, oxidize fats and are called oxidative muscle fibers.

When fibers with few mitochondria are activated, anaerobic glycolysis begins, producing lactic acid (lactate) and hydrogen ions. Lactate interferes with fat oxidation, so as speed increases, all muscle fibers shift to oxidizing carbohydrates (lactate, glucose, glycogen).

The activation point of glycolytic fibers is called the aerobic threshold (AeT). When lactate reaches 4 mM/L and its accumulation accelerates, we identify the anaerobic threshold (AnT), the dynamic balance between the production and consumption of lactate by oxidative muscle fibers, the heart, and the respiratory muscles. Norepinephrine concentration increases with exercise intensity and mental stress.

Fat Metabolism and Recovery

The phenomenon of fat oxidation during exercise has been known since the 1920s–1930s. However, studies from the 1990s showed that mainly the fats stored inside the muscle fibers—as droplets—are oxidized. These stores last 30–60 minutes.

Subcutaneous fat does not enter the bloodstream and muscles during exercise. It is used in recovery (5–15 hours later) through food intake or release from fat deposits.

Hormonal Response and Exercise Duration

The concentration of hormones associated with the pituitary gland and the sympathetic nervous system (growth hormone, testosterone, adrenaline, norepinephrine) rises with mental stress, especially when the following come together: strong muscle activation, local acidification with pain, maximal HR, and maximal respiratory rate.

Exercise duration depends on speed. At the aerobic threshold, a person can move for 20–30 minutes with HR between 140–170 beats/min. Hormones increase slightly (50–100% above rest), but under maximal stress they may rise tenfold or more.

Aerobics for Health

The idea of “running to avoid a heart attack” is central among joggers. Methodological guides claim that low-intensity running (up to the aerobic threshold) promotes fat oxidation and improves heart function compared to rest. Following the principle “function builds the organ,” it is believed that aerobic exercise improves the heart, blood vessels, and reduces body fat.

However, studies from the last 30 years have shown no major effects on the heart, vessels, or adipose tissue.

Training with HR between 100–140 beats/min—where stroke volume peaks—can lengthen the myofibrils in cardiac muscle fibers, increasing the number of sarcomeres.

At rest, the heart then ejects more blood per beat thanks to the added sarcomeres. Since resting oxygen demand stays the same, resting HR decreases. Some suggest recording this parameter to assess health, but this is not fully correct: increased left-ventricular volume matters for athletes, while for ordinary people the main factor is the state of the endocrine and immune systems.

The vascular system undergoes heavy stress when running with HR between 100–140 beats/min, since systolic pressure can rise to 160–200 mmHg. During low-intensity running or walking, hormone levels rise only slightly; vascular improvements occur very slowly. In a one-year study with one-hour sessions three times a week, high blood pressure did not decrease. But after 3–5 years, pressure tends to normalize, as seen among recreational runners.

Basic Rules for Safe Running

1. **Do not start running if body weight is significantly above 70–80 kg** (ideal weight = height in cm − 100). Begin with walking.
2. **Run with shoes that have a thick, wide, soft heel.** Foot strike must begin on the heel with a well-bent knee. Ignoring this rule leads to microtrauma of the knee, hip, and spine (in Australia, sheep kept on concrete floors developed joint deformities within a year).
3. **Optimal load:** 3 sessions per week, 30–60 minutes, HR between 100–140 beats/min. Exceeding this causes endocrine exhaustion, reduced immunity, and overtraining—unacceptable for health-oriented training.

Benefits for Former Athletes and General Use

Aerobic exercise is especially useful for former athletes, who often show myocardial hypertrophy, conduction disorders, and irregular heartbeat. These problems worsen with illness or inactivity. Regular aerobic training reactivates all heart cells, improving metabolism and temporarily normalizing plastic and metabolic processes.

For the general population, aerobic exercise can be used:

- as a warm-up to raise body temperature,
- to accelerate metabolism and oxidize carbohydrates or fats in the muscles,
- to reduce body weight, using subcutaneous fat to compensate for energy spent.

However, after training, hunger increases. Carbohydrates and fats are consumed, the pancreas releases insulin, which stimulates fat and glycogen synthesis in muscles and fat tissue. Therefore, weight loss is not guaranteed.

Only those who follow a low-calorie diet (vegetables, mineral water) for 10–24 hours after training can lose weight, though muscle mass may also decrease.

Alternatives to Running and Triathlon Preparation

The health effect of aerobic training is modest, but if running is replaced with walking, cycling, or swimming, well-trained individuals can train 3 times a week for 2–4 hours. With fatigue, mental stress increases, and so does hormone secretion, making triathlon preparation potentially beneficial—if the following rules are respected:

- Avoid running in preparation for triathlon to prevent joint, ligament, and muscle injuries.
- Prefer fast walking, cycling, skiing, or roller-skiing.
- Avoid sessions longer than 2 hours or more frequent than 3 times a week.

Aerobic Gymnastics

Fifty years ago, former gymnasts developed a health-oriented system of gymnastic exercises. Initially, aerobics resembled a simplified form of artistic gymnastics, with large-amplitude movements and high flexibility. Programs followed two criteria:

- medium intensity compatible with the aerobic regime, favoring fat oxidation;
- aesthetic technique, with music and wide movements.

Jane Fonda released numerous programs on VHS tapes.

After ten years of practice, it became clear that:

- Training 2–3 times a week for 1.5–2 hours does not significantly reduce fat mass. Exercises follow each other, engaging different muscle groups, causing fatigue but only minimal local acidification.
- When muscles acidify (lactate accumulation), fat oxidation is inhibited and carbohydrate oxidation begins (blood glucose or muscle glycogen). Therefore, fat oxidation does not occur during aerobic gymnastics. A rapid post-exercise drop in blood glucose creates strong hunger 30–60 minutes later. Resisting is almost impossible; people eat, and instead of burning body fat, they store fat from the consumed carbohydrates and fats.

Large-amplitude, high-intensity exercises bring risks: ligament strains in hips, shoulders, knees; ankle sprains. Also common are muscle injuries, tears of myofibrils or whole muscle bundles, especially among beginners.

Eventually, Jane Fonda revised the exercise tools, replacing artistic-gymnastics elements with dance-like movements. Aerobic-sport rules were changed, adding restrictions such as:

- no large-amplitude jerky movements,
- no forward bends with straight torso and twists,
- no sudden head movements, especially bends with rotation,
- no hyperextensions of the spine,
- no full squats (knee angle < 90°),

- no side leg swings from a kneeling position with hand support,
- no straight-leg abdominal lifts.

Aerobics took the form of rhythmic, dance-like movements with the goal of reaching HR near the anaerobic threshold (130–160 beats/min).

After another ten years, it became clear that these programs do not significantly change body mass. Variants such as step-aerobics and slide-aerobics appeared, creating stronger local fatigue in leg extensors—but also knee joint pain from overload.

In short, aerobic gymnastics underwent many transformations because of its low effectiveness and lack of scientific basis. Its development has also been influenced by the economic profitability of the wellness industry.

Chapter 4

Foundations of Muscle Contraction Physiology

At the beginning of the 21st century, strength training became popular as a method to shape the body and improve athletic performance. The biggest commercial success came from bodybuilding, developed by the Weider brothers in the United States. Strength exercises are generally viewed as tools for health and physical aesthetics.

Strength is the ability to overcome an external resistance through muscular activity. Muscles are made of muscle fibers containing myofibrils—specialized organelles that contract by using ATP. During contraction, ATP splits into ADP and inorganic phosphate (P), releasing energy. Myofibrils also contain creatine phosphate (CrP), which regenerates ATP by donating energy:
ADP + P + energy (from CrP) = ATP.
This process releases creatine and phosphate, which activate anaerobic and aerobic glycolysis, as well as lipolysis. Still, the combined power of these processes doesn't exceed 50% of the maximal power generated by CrP alone.

During strength exercise, the brain sends impulses from motor neurons to the spinal cord, where motoneurons activate muscle fibers. Each motoneuron controls a group of muscle fibers, forming a motor unit (MU), the basic element of muscular control. Motor units are classified as:

- **low-threshold units:** small motoneurons, slow fibers
- **high-threshold units:** large motoneurons, fast fibers

As impulse frequency increases, larger MUs are progressively recruited. Under mental stress, up to 80% of MUs can be activated.

For example, if an athlete performs a leg extension against resistance that's too heavy, the muscles don't shorten but generate internal tension. This is **isometric contraction** (no movement). No mechanical work is done (work = force × displacement, and displacement is zero), but chemical energy is consumed and converted into heat—roughly 50%.

If a muscle contracts at constant velocity, the contraction is called **isokinetic** (more correctly: **isocinematic**). If tension stays constant, it's **isotonic**. In real strength exercises, velocity and force fluctuate, alternating concentric and eccentric (plyometric) phases. This mixed contraction is called **auxotonic**.

In sports practice, terminology is usually simplified:

- **static exercises** (isometric)

- **dynamic exercises** (auxotonic)
- **static-dynamic exercises** (alternating static and dynamic work)
- **eccentric exercises** (only plyometric)

Physiology of Strength Exercise

A strength exercise consists of slow, repetitive movements (one cycle every 1–5 seconds) with high resistance (over 30% of max strength). The term “exercise” often refers to an entire motor action, such as lifting and lowering a barbell. A sequence of similar exercises is called a **set**. We’ll use the following terminology:

1. **Motor Action (MA):** controlled movement from a starting to an ending position, then back.
2. **Exercise / Set:** repeated execution of similar motor actions.
3. **Super-set:** sequence of similar exercises or sets with short rests (20–60 seconds).

Physiology of Strength Training

Empirical research shows that as external resistance increases, the maximal number of repetitions decreases—this is the **repetition maximum (RM)**. The resistance that can be overcome only once is considered an indicator of maximal voluntary strength (1RM). Taking 1RM as 100% makes it possible to map relative intensity to repetition count.

At 100% 1RM, the athlete depletes ATP reserves to the point where a second repetition may be impossible. At 80%, the athlete can perform 5–8 reps. All muscle fibers are active during the first rep, but 20–30% work at lower intensity and consume only minimal ATP. During the brief pauses between reps, muscle activity drops and ATP is partially resynthesized from CrP. With each rep, some fibers lose about 10% of their power, and the athlete compensates by recruiting high-threshold MUs. When all MUs are engaged, failure is reached.

During 25–40 seconds of effort, up to 50–80% of CrP is consumed. CrP resynthesis during the work phases and the first 90 seconds of rest relies mainly on anaerobic glycolysis, producing lactate (La) and hydrogen ions (H^+). ATP depletion and H^+ accumulation are the primary causes of exercise termination. With a partner’s assistance, an athlete can squeeze out 1–2 extra reps, but this requires mental stress, prolonged apnea, and further depletion of CrP, increasing free creatine, H^+, and lactate.

Low-Intensity Exercises

Work at 40–60% 1RM requires 15–30 reps. The physiological mechanisms are similar, but the longer duration activates aerobic glycolysis in oxidative fibers and anaerobic glycolysis in glycolytic fibers. H^+ accumulation triggers lysosomal enzyme release, degrading proteins and damaging myofibrils, mitochondria, and hormones.

At the same time, breathing and circulation increase. However, studies show that loads at 40–60% 1RM do **not** produce significant strength gains.

Impact on Respiratory and Cardiovascular Systems

Exercises at 70–100% 1RM heavily involve the central nervous system and the locomotor apparatus. Training to failure demands controlled breathing. Maximum force is achieved by holding the breath and bracing; lifting during inhalation is more difficult. The typical sequence is: brief inhale during eccentric phase, apnea during contraction, exhale during release.

Effort raises intrathoracic pressure, reducing heart volume by up to 50%. Heart rate can jump from 70 to 100 bpm even without exercise, and systolic pressure may reach 175–200 mmHg. After exercise, pressure normalizes within 1–3 minutes. Regular training induces reflexes that increase blood pressure even at rest, with averages around 156/87 mmHg, and in weightlifters up to 170–180 mmHg.

Warning

Strength exercises are suitable only for **completely healthy individuals**, without signs of atherosclerosis. In subjects with plaques, the surge in pressure and blood flow can dislodge them, risking embolism, thrombosis, and tissue necrosis. If it happens in the heart, it causes a myocardial infarction; if the plaque ruptures the arterial wall, it may be fatal.

Factors Stimulating Muscle Hypertrophy

Strength gains depend on improved neuromuscular control and increased myofibril number. More myofibrils mean greater density and cross-sectional area, with growth of mitochondria, glycogen, and other organelles. In trained individuals, myofibrils occupy over 90% of muscle cross-section, so their growth is the main driver of hypertrophy.

The goal of strength training is to increase myofibril number. This happens when protein synthesis outpaces protein degradation. Recent research identifies four key factors for protein synthesis:

1. Sufficient amino acid reserves in the cell
2. High concentration of anabolic hormones in the blood
3. High concentration of free creatine in muscle fibers
4. High concentration of hydrogen ions

Factors 2, 3, and 4 are directly influenced by training content.

Mechanism of Organelle Synthesis, Especially Myofibrils

During exercise, ATP powers actin–myosin cross-bridge formation and mechanical work. ATP is resynthesized through CrP stores. The appearance of free creatine activates all metabolic pathways involved in ATP production: glycolysis in the cytoplasm, aerobic oxidation in mitochondria, and myofibrillar processes in nucleoli and sarcoplasmic reticulum membranes.

In glycolytic fibers (FG), the enzyme M-LDH converts pyruvate into lactate. This leads to H^+ accumulation. Since glycolysis produces less power than ATP consumption, Cr, H^+, lactate, and ADP accumulate.

Beyond its metabolic role, free creatine is a potent endogenous signal for protein synthesis in skeletal muscle. Research shows a direct correlation between contractile protein content and creatine content. Free creatine seems to stimulate mRNA synthesis, i.e., transcription in the nucleoli.

It's hypothesized that increased H^+ concentration destabilizes membranes (increases permeability), allowing easier hormone penetration and access to enzymes and DNA. In response to the simultaneous rise in Cr and H^+, RNA synthesis intensifies. mRNA has a short lifespan: a few seconds during exercise, about five minutes during rest. After that, it degrades.

Theoretical Analysis of Training to Failure

For example, during 10 barbell squats at 3–5 seconds each, total duration is 30–50 seconds. The contraction phases (1–2 s) consume ATP; the relaxation phases (2–3 s) allow partial resynthesis from CrP. CrP is regenerated aerobically in oxidative fibers and anaerobically in glycolytic fibers. Since these processes are weaker than ATP consumption, CrP stores eventually drop, leading to failure.

Anaerobic glycolysis produces lactic acid, which damages protein structures (tertiary and quaternary bonds), alters enzyme activity, and increases hormone access to DNA. Excess acidification—even at low concentration—can cause irreversible cellular damage, with removal of the affected parts.

H^+ increase stimulates lipid peroxidation, forming free radicals that fragment mitochondrial enzymes, especially in acidic lysosomal environments. Lysosomes also contribute to free-radical formation and catabolic reactions. A study by A. Salminen et al. (1984) showed that intense running in rats causes necrosis and a 4–5× rise in lysosomal enzyme activity.

RNA Synthesis and Recovery Time

The combined action of Cr and H^+ stimulates RNA synthesis. Creatine remains in muscle fibers during exercise and for 30–60 seconds afterward, while CrP is being resynthesized. Each set therefore provides roughly one minute of productive mRNA synthesis. With multiple sets, more mRNA accumulates but so do H^+ levels, creating a conflict: too much damage, not enough repair.

To prevent this:

- use sets spaced by long recovery intervals

- train multiple times per day with few sets per session

Recovery time between training days depends on the conversion rate of mRNA into cellular organelles such as myofibrils. mRNA degrades in minutes, but the structures it initiates take 4–7 days to form, depending on the amount of mRNA produced.

Studies show that after eccentric exercise, muscle fibers show damage (near Z-lines) and marked soreness for 3–4 days. Then fibers normalize and soreness disappears. Other studies show increased blood urea after strength training, indicating protein catabolism.

Protein Synthesis and Myofibrillar Hypertrophy

Morning fasting urea levels stay below normal for 3–4 days after training, meaning protein synthesis exceeds degradation. From the synthesis mechanisms described, it’s clear that slow-twitch fibers (STF) and fast-twitch fibers (FTF) must be trained with different methods.

Hypertrophy of Fast-Twitch Fibers (FTF)

To activate FTF, maximum or near-maximum intensity is required. According to Henneman’s size principle, both slow and fast fibers are recruited under these conditions. If contraction alternates with relaxation, without cutting off blood flow, the exercise primarily targets FTF.

Conditions for effective FTF training:

- maximal or near-maximal intensity
- training to failure (CrP depletion, free creatine accumulation)
- recovery: **5 minutes active** (HR 100–120 bpm, speeds lactate removal), **10 minutes passive** (CrP resynthesis via anaerobic glycolysis)
- frequency: 1–2 sessions per day depending on training status
- weekly frequency: after an intense session, FTF training can be repeated only after **7–10 days**, needed for myofibril synthesis

Hypertrophy of Slow-Twitch Fibers (STF)

The method is similar to FTF training but with one critical difference: the exercise must be performed **without muscle relaxation**. Contracted fibers compress capillaries, causing occlusion and hypoxia, which intensifies anaerobic glycolysis and the accumulation of lactate and H^+.

Example:

- barbell squat at 30–70% 1RM
- from deep squat to 90–110° knee angle
- duration: 30–60 s (until muscular pain)

- recovery: 5–10 min active
- sets: 7–12
- frequency: 1–2 times a day, repeated every 7–10 days

Physiological rules:

- intensity that recruits only STF
- duration ≤ 60 s to avoid excessive H^+
- multiple sets with short rests (30 s) to increase exposure to Cr and H^+
- **super-sets** increase mRNA synthesis

Important note: Protein-synthesis training must be performed at the *end* of the aerobic session, preferably in the evening. A hard aerobic session *after* strength work can degrade newly synthesized proteins, reducing training effectiveness.

Principles of Strength-Training Design

The most influential methodology in the field is that of Ben Weider, who formulated several principles—some of which are now outdated or physiologically inaccurate. Below are the main principles, expanded with explanations grounded in contemporary physiology.

1. Principle of Technique

This requires a biomechanical understanding of each exercise. Incorrect technique can lead to injury; for example, performing squats with a forward-leaning torso under load can damage the lumbar intervertebral discs.

2. Principle of Effort Quality

Each exercise must achieve maximal muscular tension. This can be accomplished in three distinct modes:

- **90–100% 1RM, 1–3 repetitions:** trains neuromuscular control but does *not* stimulate protein synthesis.
- **70–90% 1RM, 4–12 repetitions, 20–70 s:** stimulates protein synthesis, particularly in fast-twitch fibers (FTF). The final 2–3 repetitions—even assisted ones—are the most effective.
- **30–70% 1RM, 12–25 repetitions, 50–90 s:** statodynamic mode without muscular relaxation. This induces hypoxia, anaerobic glycolysis, accumulation of Cr and H^+, and stimulates protein synthesis in slow-twitch fibers (STF).

3. Principle of Negative Movements

Muscle fibers must remain active during both the concentric and eccentric phases of movement.

4. Principle of Supersets

Double, triple, or extended series performed with minimal rest. Supersets prolong exposure of the muscle tissue to Cr and H^+, stimulating RNA synthesis. The "pumping" effect (increased blood flow) is a *signal* of correct execution, not a direct benefit.

5. Principle of Priority

Train the muscle groups targeted for development at the beginning of the session, when the hormonal profile and amino acid availability are optimal.

6. Principle of the Split Routine

Each muscle group is trained 1–2 times per week. Myofibrillar protein synthesis lasts 7–10 days, with supercompensation occurring between days 7 and 15. Muscle groups are divided into "splits" to optimize recovery.

Example of a Weekly Training Plan

- **Monday:** Developmental training (4–9 sets per exercise) for spinal extensors and trapezius. All other groups in toning mode (1–3 sets).
- **Tuesday:** Developmental training for elbow extensors and abdominal muscles. Others in toning mode.
- **Thursday:** Developmental training for leg extensors and elbow flexors. Others in toning mode.
- **Friday:** Developmental training for flexors of the lower-limb joints. Others in toning mode.

Training specific muscle groups each day constitutes a split routine.

Types of Split Systems

1. **Mixed Split:** combines exercises for different muscle groups within the same session.
2. **Concentrated Split:** combines several exercises for the *same* muscle group, performed without rest—essentially a superseries approach.

Supercompensation System

Myofibrillar growth requires 10–15 days. Therefore, strength-training cycles aimed at muscle development should last 14–21 days (2–3 weeks), which is the time needed to activate anabolic processes. Continuing with high-intensity training beyond this window may hinder protein synthesis.

To facilitate supercompensation, developmental exercises should be paused for 7–14 days and replaced with toning exercises (1–3 sets per exercise).

Principle of Intuition

Each athlete must rely not only on established rules but also on personal intuition, as adaptive responses vary individually. It is important to periodically lift near-maximal loads to evaluate training status and readiness. These metrics are the primary indicators of the program's effectiveness.

Physiological Analysis of Strength Exercises

Physiological analysis indicates that strength training is suitable only for individuals in complete health. Nonetheless, bodybuilding can serve as an excellent preventive strategy against many disorders, as it stimulates endocrine and immune functions—provided overtraining is avoided.

Individuals with atherosclerosis, spinal pathologies (osteochondrosis, radiculopathy), thrombophlebitis, and similar conditions should not engage in traditional bodybuilding. For most people, a more refined form of strength training is required—one that preserves the benefits of bodybuilding:

1. Stress-induced increases in circulating hormones
2. Stimulation of muscular anabolism and development of a stabilizing "muscle corset"
3. Activation of catabolic processes in tissues, particularly adipose tissue, promoting fat loss and cellular renewal

This section is dedicated to designing such a system.

Chapter 5

Principles of the Rejuvenation System

Statodynamic strength training is the most effective method for improving the health of the general population.
Regular use of these exercises enhances adaptive reserves and supports a stable, elevated level of vitality.

Principle of Minimizing Blood Pressure Elevation

For individuals with atherosclerosis, systolic pressure must not exceed 150 mmHg. Training should therefore follow key rules:

- **Warm-up:** Dilate arteries and arterioles before strength work to reduce peripheral resistance and cardiac load.
- **Exercises in a supine position:** Standing exercises require the heart to pump against gravity; supine positions reduce cardiac strain.
- **Recruit few muscles at a time:** Slow, static movements reduce the "muscle pump" effect; therefore, the number of muscles involved should be limited.
- **Alternate large and small muscle groups:** Prevents pressure spikes.
- **Stretching after each exercise:** Helps reduce cardiovascular activity and stimulates protein synthesis.

Principle of Controlled Stress

In traditional bodybuilding, maximal stress is induced through forced repetitions and breath-holding, causing abrupt increases in blood pressure. This is unacceptable in a health-oriented system.

Rules:

- **Muscular intensity:** 30–70% of maximal voluntary force
- **Statodynamic mode:** continuous muscular tension without relaxation
- **Breathing:** slow exhalation during contraction; brief inhalation during the eccentric phase
- **Duration:** 30–60 seconds to deplete CrP and induce moderate acidification
- **Goal:** achieve localized muscle pain (stress)

These conditions promote anaerobic glycolysis even in oxidative fibers. The accumulation of H^+ produces burning and pain—key stimuli for protein synthesis.

Healthy Training Technology

Exercises for each muscle group are organized into supersets. At 30–50% intensity, a 30–60 s set may not produce significant pain. After a brief rest (20–60 s), the exercise is repeated. By the second or third cycle, muscle pain increases rapidly, reaching the desired stress threshold.

Principle of Integrating Training and Nutrition

Exercise activates both anabolic and catabolic processes. Nutrition determines their direction:

- **To increase muscle mass:** consume more high-quality complete protein
- **To reduce fat mass:** decrease carbohydrate and fat intake

Structure of a Health-Oriented Exercise Session

Exercises include movements performed against external resistance: gravity, elastic deformation, water, or air resistance. The most common form uses gravity. Resistance may come from bodyweight, wearable weights, dumbbells, barbells, or specialized devices. Instructors must have theoretical competence in biomechanics to design effective programs.

Example: Exercise for Strengthening Slow-Twitch Fibers of the Quadriceps

- **Objective:** increase STF strength in the quadriceps
- **Participants:** adults aged 20–70 in good health
- **Equipment:** gym space, mat, bodyweight
- **Biomechanical model:** human musculoskeletal system in 3D space, gravity acting downward
- **Hypothesis:** to stimulate STF hypertrophy, the quadriceps must be activated at ~50% intensity and brought to fatigue in 30–60 seconds. This is achieved by maintaining continuous contraction (no relaxation), inducing hypoxia. Biomechanically, bodyweight must be used to maximize the knee-extension moment.

Movement description:

- **Starting position:** standing, bodyweight distributed along the legs, no knee moment
- **During squat:** knees move forward, shifting the knee axis away from the vertical line of gravity, increasing the moment
- **To increase load:**
    - shift torso upward and weight toward heels
    - extend arms forward and then backward

- perform single-leg squats to double the load
- resting hands on knees decreases the load

Optimal condition: squats without full leg extension and without excessive torso inclination, maintaining continuous quadriceps contraction.

Experimental verification:
Self-testing is possible. The validity criterion is localized fatigue in the target muscle group. If other muscles fatigue first, the biomechanical strategy must be revised.

Preparatory Phase of the Session

The session begins with an introductory ritual: group formation, greeting, and setting objectives. This is followed by a warm-up designed to raise oxygen consumption to the aerobic threshold. Aerobic exercises involving large muscle groups (legs, back) activate respiration and circulation and increase core temperature. Duration: 3–5 minutes.

Stretching follows to prepare muscles, tendons, and ligaments. Total duration: 10–15 minutes.

General Principles of Stretching

1. Warm muscles before stretching
2. Avoid abrupt movements (risk of strain)
3. Stretch before and after the main training segment
4. Drink water frequently to maintain muscle elasticity
5. Focus on the target muscle and bodily sensations
6. Avoid exercises that asymmetrically load paraspinal muscles
7. Do not hold your breath
8. Duration: 10–30 s active contraction + 10–30 s passive stretch
9. Pain signals maximum stretch

Examples of Stretching Exercises

Exercise 1 – Shoulder Flexors
Position: torso bent, straight arms resting on a chair back.
Movement: slowly lower torso, extend shoulders, contract muscles, return to start. Repeat 15–20 times.
Then hold the stretch for 10–30 s.

Exercise 2 – Back Extensors
Position: standing, tilt pelvis while keeping torso straight.
Movement: gently oscillate to maximal bend, then relax, round the back, bring hands toward knees, and hold 10–30 s.

Exercise 3 – Knee Extensors and Hip Adductors
Position: left step stance, left leg bent, right leg straight.
Movement: oscillate on the left leg, contract left quadriceps and right adductors for 10–30 s, then apply passive stretch for 10–30 s.

Exercise 4 – Repeat on the opposite side.

Exercise 5 – Knee, Hip, and Ankle Extensors
Position: forward lunge on right leg at maximal knee flexion, left leg straight.

Exercise 6 – Repeat on left leg.

Warm-up variation:
Gently oscillate on the right leg, contracting knee and ankle extensors and left hip flexors for 10–30 s, followed by 10–30 s passive stretching.

Objectives of the Main Segment of a Health-Oriented Physical Culture Session

- Accelerate metabolic processes in muscle, adipose, and connective tissues
- Increase aerobic metabolism rate to intensify metabolic exchange
- Maintain anabolic and metabolic processes necessary for sustaining health

Statodynamic Exercises

Statodynamic exercises create a stress condition during training, activating the endocrine system and increasing hormone concentration in the bloodstream. Hormones act only on active cells, where intense metabolic processes are taking place. To achieve a meaningful health effect, hormonal concentration must remain high for 30–60 minutes. For this reason, the main part of the session should not exceed 30 minutes.

Performing statodynamic exercises targeting a single muscle group for 30 minutes is impossible: after 3–4 supersets with 30–60 seconds of rest, strong local fatigue sets in. A rest interval of at least 5–10 minutes is required before repeating the same set or superset for that muscle group.

To maintain or increase hormonal concentration, other muscle groups must be involved, applying a circuit-training approach. A circuit should last at least 10 minutes—the minimum time needed for the previously active muscle group to recover.

Guidelines for Exercise Selection in the Circuit

1. Begin with exercises for large muscle groups to raise hormone concentrations quickly.
2. Alternate exercises for large groups with those targeting smaller muscles (wrist flexors, forearms, arm extensors, etc.) to reduce average training intensity.

3. Avoid working a limb's synergists first and its antagonists immediately after—let biochemical processes unfold without interference.
4. Do not exceed the aerobic threshold of heart rate (HR); staying between 90–120 bpm is preferable.
5. Avoid breath-holding and excessive strain: exhale during muscle contraction, inhale during lengthening. This helps limit blood pressure spikes.
6. Prefer seated or lying positions to ease cardiac load and reduce the risk of heart attack or stroke.
7. Most people show signs of spinal damage (osteochondrosis), therefore the following are prohibited:
   - ballistic movements with large amplitude and high intensity,
   - rotational movements of the cervical, thoracic, or lumbar spine,
   - rhythmic lifting of the lumbar spine from the floor in a supine position.
8. Perform exercises without abrupt movements, and whenever possible, activate antagonist muscles as well.

Rest Interval Between Circuits

Rest periods may be filled with stretching, breathing exercises (yoga, qi gong), or aerobic activity (dance).

Example of an Exercise Circuit

Each series includes consecutive exercises for 2–3 muscle groups.

Series 1

Exercise 1 – Hip flexors
Position: standing, lift the right leg straight forward.
Count "one" – lower the leg 30–50 cm while maintaining tension.
Count "two" – return to the starting position.
Repeat for 15–20 cycles until clear local fatigue.

Exercise 2 – Hip abductors
Position: standing, lift the right leg straight sideways.
Same execution and repetitions.

Exercise 3 – Hip extensors
Position: standing, bring the right leg straight backward.
Count "one" – lower it 10–25 cm while maintaining tension.
Count "two" – return to the starting position.
Repeat to fatigue.

Series 2

Repeat the exercises for the left leg.

Series 3

Exercise 1 – Knee extensors
Position: forward lunge with the right leg, weight on the front foot.
Count “one” – slightly bend the knee, keeping tension.
Count “two” – return to the starting position.

Exercise 2 – Lunge with the left leg
Same execution.

Exercise 3 – Back extensors
Position: standing, lean forward until the torso is horizontal.

Series 4

Exercise 1 – Elbow and shoulder extensors
Starting position: plank with bent arms, elbows pointing outward.
Count “one” – partially extend the arms while maintaining muscle tension.
Count “two” – return to the starting position.
Repeat to clear local fatigue.

Exercise 2 – Anterior abdominal wall
Position: lying on the back, one leg at 40°, the other at 10°.
At each count, alternate leg positions.
Repeat for about 40 cycles to fatigue.

Series 5

Exercise 1 – Hamstrings
Position: supported from behind, pelvis slightly lifted.
Count “one” – lift the pelvis 10–25 cm.
Count “two” – return to the initial position, maintaining tension.
Repeat to fatigue.

Exercise 2 – Oblique abdominal muscles
Position: lying on the back, raise left shoulder and right leg.
Count “one” – flex the torso and touch the right foot with the left hand.
Count “two” – return.
Repeat to fatigue.

Exercise 3 and 4
Repeat Exercises 1 and 2 for the opposite side.

Breathing Warning

Do not hold your breath. Exhale during muscle contraction, inhale during lengthening.

Choreographic Section

After the five series, move to a choreographic segment (3–5 minutes), where dance movement can be done freely.
At the end, measure HR: it should not exceed 130 bpm.

Breathing Exercises

During statodynamic training, anaerobic glycolysis by-products accumulate. To oxidize them, oxygen consumption must increase.
Breathing techniques using hyperventilation or controlled apnea can be used.
In yoga and qi gong, the diaphragm, abdominal muscles, and anal sphincter are consciously controlled—when interpreted scientifically, these practices show real health benefits.

After stretching, an "internal massage" can be performed by controlled contraction of the diaphragm, abdomen, and anal sphincter to stimulate regenerative processes in the tissues of the abdominal organs.

Breathing Exercise Set

1. **Self-massage of the abdomen**
   Position: legs apart, knees slightly bent, torso leaning forward.
   Hands apply circular pressure (3–5 cm diameter) moving up–left–down.
   Repeat 5–10 times with 5–10 s intervals.
2. **Normal breathing**
   Position: legs apart, back straight, hands relaxed.
   Count "one" – lift the hands to the chest and inhale deeply.
   Count "two–ten" – lower the hands, bend the knees, exhale slowly with a hiss.
   Repeat 5–10 times.
3. **Reverse breathing**
   Same position.
   Count "one" – lift the hands and inhale.
   Count "two–ten" – strongly contract abdomen and anus while exhaling slowly.
   Repeat 5–10 times.

Aerobic Metabolism and Planning

When the energy balance favors food intake, aerobic exercises (fast walking, step aerobics) should be performed with HR in the 100–120 bpm range.

To maintain metabolic and plastic processes, statodynamic exercises should transition into dynamic (aerobic) movements.
If local fatigue is not reached, the effect will be merely toning.

During breaks, dance movements can improve mood and movement culture, without exceeding the aerobic threshold.

Final Phase and Recovery

The final phase must be aerobic, with decreasing intensity (2–3 minutes at aerobic threshold, then 2–3 minutes lighter).
The goal is to normalize breathing and HR.

Microcycle Planning

A microcycle includes a training phase and a recovery phase.
After statodynamic work on all muscle groups, recovery lasts 2–4 days, during which protein synthesis takes place.
Two sessions per week are optimal for mitochondria, bone marrow, and the endocrine system.
If catabolic processes aren't overactivated, training effects accumulate.

Chapter 5

Theoretical Study on the Effectiveness of Physical Culture Methods

A rigorous theoretical analysis of the effectiveness of physical culture methods can be carried out through mathematical modeling of the main systems and functions of the human body.
In the scientific laboratory led by Professor Victor Seluyanov at the Moscow Institute of Physics and Technology, a computerized mathematical model was developed to simulate long-term adaptive processes. The model consists of a system of nine first-order ordinary differential equations describing the main parameters and operational patterns of the muscles, the endocrine system, and the immune system.

Model Functioning

Input: exercise intensity and duration.
Output: changes in the mass of mitochondria and myofibrils in trained muscles; mass of endocrine glands and bone marrow; and antigen concentration in the blood.

The aim of the study was to systematically analyze how different combinations of intensity and volume (duration) of physical exercise affect bodily systems, and to demonstrate the practical value of computer modeling for coaches.

Study Details

- The model, named **MIDA**, was run on IBM computers.
- Microcycles of varying duration (1, 2, 3, 4+ days) and number of repetitions were simulated.
- Each variant was evaluated over a 360-day period.
- A total of **630 scenarios** were computed (10 intensities × 9 durations × 7 variants).
- Computation time: **12–18 hours**.

Main Results

Microcycle: Daily Training

- Stable hypertrophy is observed at all intensities, but it depends on duration.
- Muscle mass grows or is maintained only at intensities above 70%.
- Mitochondrial mass remains at about 90% between 70–90% intensity.

- Optimal duration: **2–3 minutes**.

Microcycle: 1 Day Training, 2 Days Rest

- Optimal duration: **2–8 minutes**.
- Muscle mass drops to **88–91%**.
- Intensities of 30–50% with durations over 10–30 minutes have negative effects.

Microcycle: 1 Day Training, 3 Days Rest

- Adaptive capacity improves above 45% intensity.
- Best results at **80–100% intensity**, **2–4 minutes** duration.
- Mitochondrial mass decreases in all cases, but is best maintained (67%) at **20% intensity**, **90 minutes**.
- At 90–100% intensity, adaptive reserve returns to 100%; optimal duration: **2 minutes**.
- Myofibrillar mass reaches a maximum (84–85%) at 90–100% intensity.

Microcycle: 1 Day Training, 5 Days Rest

- Adaptive reserve remains at baseline (100%) only at intensities of **90–100%** and a duration of approx. **2 minutes**.

General Model Conclusion

In the 6-day microcycle (1 training day, 5 rest days), both myofibrillar and mitochondrial mass remain below baseline across the entire intensity range (10–100%).

Theoretical Interpretation of Training Principles

Principle of Continuity

- The longer the rest interval, the lower the training effectiveness.
- Endocrine gland mass increases only with high intensities (70–100%) and optimal duration.
- Effectiveness declines from 27% (daily training) to 0% with more than 6 rest days.
- Hormones released during training remain active for 1–3 days, degrading gradually.
- Rest intervals of 1–2 days maintain high hormone concentration, facilitating cell synthesis.

- In health-oriented training, continuity is tied to hypertrophy of endocrine and immune glands to reinforce adaptive reserve.

Principle of Specificity and Heterochrony

- The model shows simultaneous changes in muscles, endocrine glands, and bone marrow.
- Myofibrillar hypertrophy requires anaerobic glycolysis and anabolic hormones.
- Mitochondrial hypertrophy requires aerobic glycolysis.
- Myofibrils: best growth with daily training at 80–100% intensity, 2–8 minutes.
- Mitochondria: best growth with 10–20% intensity, daily training.
- Myofibrils can be maintained even with 6 rest days; mitochondria cannot.

Principle of Cyclicity

- Training must develop all bodily systems, with emphasis on those required by the sport.
- Strength/speed sports → myofibrillar development.
- Endurance sports → mitochondrial development.
- In health-oriented training, the aim is maximum hypertrophy of myofibrils, mitochondria, and endocrine/immune glands.
- The cycle must ensure synergistic recovery among different types of training stimuli.

Principle of Hormonal Economy

- Protein synthesis depends on hormone concentration.
- Hormonal output increases with severe stress or muscle pain.
- After exercises that trigger high hormonal release, prolonged high-intensity training should be avoided to prevent hormonal degradation.

Microcycle Planning

Health-Oriented Microcycle

Day 1: 15% intensity, 60 min + strength 80–100%, 3 min
Day 2: strength 80–100%, 3 min
Day 3: rest

Results:

- Significant increase in endocrine gland mass.

- Good maintenance of strength and aerobic capacity.

Sprinter Microcycle

Day 1: aerobic 10%, 60 min + strength 80–100%, 5 min
Day 2: same structure
Day 3: rest

Results:

- Increase in myofibrillar mass.
- Maintenance of endocrine gland mass and aerobic capacity.

Endurance Athlete Microcycle

Day 1: aerobic 20%, 90 min + strength 80–100%, 3 min
Day 2: aerobic 20%, 90 min + strength 80–100%, 4 min
Day 3: strength 80–100%, 1 min

Results:

- Significant mitochondrial hypertrophy.
- Maintenance of myofibrillar and endocrine gland mass.

Summary of the Impact of Long-Term Adaptive Modeling

Mathematical modeling of long-term adaptive processes made it possible to:

1. **Validate empirically derived principles of physical training**—continuity, specificity, heterochrony, cyclicity—confirming the adequacy of the model.
2. **Establish a new principle of physical training—hormonal economy**, essential when designing microcycles involving both aerobic and strength training, as well as the development of other bodily systems.
3. **Develop effective microcycle variants** for both health-oriented physical culture and sport.
4. **Demonstrate the value of computer modeling** for both theory and coaching practice, since it allows rapid evaluation of thousands of training-plan variants.

Mesocycle planning

Even with a rational ratio of training to rest (1 training day and 3 rest days), recovery remains incomplete in structures whose protein half-life exceeds 10 days—this includes components of muscles, ligaments, and tendons. Regular training activity may gradually turn into psychological stress.
To avoid entering the exhaustion phase of the general adaptation syndrome, training must be interrupted, and both workload and exercise type must be significantly

altered.

About once a month, one or two sessions should take the form of dance, aerobics, step aerobics, or recreational activities such as a hike, a trip to the zoo, an art exhibition, etc.

Intensive Mesocycle (Training Planning During Vacation/Retreat Settings)

This format allows rapid correction of health. Intensive mesocycles are particularly suitable in wellness centers and resort environments.

Key characteristics:

1. Participants typically lack muscles adapted to exercise.
2. A rest-based daily schedule allows for daily physical activity.
3. Nutrition can be organized according to health-improvement goals.

Rules to follow:

- The first 3–4 sessions must use minimal amplitude and light stretching to avoid severe muscle soreness.
- After 3–4 daily sessions, exercise complexes may be introduced, divided into four groups:
    1. large muscle groups,
    2. small muscle groups,
    3. optional exercises,
    4. aerobic section (dance, walking, etc.).
       Daily, sequential application of these complexes ensures high hormone concentration, producing notable health benefits.
- After the intensive cycle (20 days), the endocrine system will be under stress; therefore, stressful loads should be avoided during the final 2–3 days.

Macrocycle planning

A macrocycle in sports training lasts six months to a full year. Experience shows it is beneficial to periodically change environment, take vacations (10–30 days), and radically alter lifestyle, physical activity, and location.
This approach is highly effective for preventing psychological disorders and neuroses, and consequently, it significantly improves metabolic processes in the human body.

Chapter 6

Nutrition for Body Correction in My System

Nutrition is considered in relation to four main goals:

1. Reducing fat mass while increasing muscular strength.
2. Reducing both fat mass and muscle mass while maintaining strength.
3. Increasing muscle volume and strength while reducing fat mass.
4. Increasing both fat mass and muscle volume and strength.

All changes in diet must be combined with training. Because psychological stress rises and the endocrine and immune systems are activated, body transformation always comes with an interplay of anabolic and catabolic processes. In the end, these processes normalize the functioning of all organs and systems.

Goal: Reduce Fat Thickness While Increasing Strength and Endurance of Major Muscle Groups

This is the most common goal. My system is primarily health-oriented, so fat reduction always goes together with physical training.

During fat-loss phases, hunger is normal—especially in the first 5–8 days. But with training according to this methodology, the post-exercise rise of noradrenaline and adrenaline forces adipose tissue to release fatty acids and triglycerides into the bloodstream. These are oxidized by the heart, diaphragm, and other organs. This dampens hunger for 6–10 hours—exactly the period in which fat is burned.

In women, fat accumulation increases in the last days of the menstrual cycle because of elevated estrogen. On those days, nutrition should follow the “training-day” scheme.

Nutrition on Training Days

- The last meal should be 5–6 hours before training.
- Proteins, vitamins, and fiber (200–500 g vegetables).
- Carbohydrates and fats: minimal.
- Water or not-too-sweet natural juices: freely.
- **20–30 minutes before training:** sweet drink (150–200 ml), 25–50 g jam, candies, cookies, or a small sandwich (100–200 kcal).
- **90–110 minutes after training:** proteins (50–100 g low-fat cottage cheese,

beans, peas, etc.).

If training is in the morning, for the next 10 hours only vegetables and small amounts of protein.
If training is in the evening, a protein shake or fruit/low-fat dairy is recommended.
Daily caloric intake: **50–75%** of normal.
Meals: **5–6 per day**.

Nutrition on Rest Days

- Proteins: **2 g/kg of lean mass**.
- Fats: **0.2–0.5 g/kg** (only vegetable oils).
- Carbohydrates: **200–350 g**.
- Meals: **5–6 per day**.

Distribution:

- Breakfast: proteins and vegetables.
- Second breakfast and lunch: carbohydrates and fats.
- Snack: fruits and nuts.
- Dinner: plant proteins, vegetables, low-fat dairy.

Goal: Reduce Muscle Mass and Subcutaneous Fat

This may be necessary for women with generally good natural health but habitual overeating, or for former athletes, or for women with a "masculine" hormonal profile.

General rule: **reduce animal proteins and fats**.
Muscles are a depot of essential amino acids that can be used to support vital organs. Training, massage, biomechanical stimulation, and electrical myostimulation accelerate amino-acid release. A low-protein diet prevents muscle reconstruction during rest days.

Duration: **12–24 days** (longer than the half-life of muscle fibers).

On Diet + Training Days

- Meal 5–6 hours before training: vitamins and fiber (200–500 g vegetables).
- Proteins and fats: minimal.
- Water or juices: freely.
- **30–40 minutes before training:** sweet drink or fruit.
- Between main and aerobic training: only water.
- **For 3 hours after training:** no food.

If training is in the morning: vegetables, fruits, and nuts for 10 hours.

If in the evening: protein shake or fruit/vegetables (apples, beets, pumpkin, cabbage).
Caloric intake: **50–75%** of normal.
Meals: **5–6 per day**.

After the diet cycle: normal nutrition for 7–10 days, then the cycle can be repeated.

Distribution:

- Breakfast: carbohydrates (fruits, dried fruits).
- Second breakfast and lunch: proteins and fats.
- Snack: fruit and nuts.
- Dinner: plant proteins and vegetables.

A 24-hour fast once a week is useful (last meal before or 3 hours after training).

Goal: Increase Muscle Volume While Maintaining Subcutaneous Fat

This applies to:

- People whose physical appearance is important for their career (artists, models, image-based professions, security, etc.).
- People with partial muscle atrophy or an asthenic constitution.

Two categories:

1. Individuals with congenital or acquired conditions, lack of physical education in childhood, or other causes of partial muscle atrophy and related health issues.
    - For them, it is enough to follow the training-day nutrition regime described below.
2. Natural asthenics with a strong nervous system—physically and socially active.
    - Here, the situation is more complex. One must ensure that no organic damage exists in vital systems (from infections, poisoning, genetic factors).
    - If insufficient muscle mass is caused by such factors, training is still possible—but only after medical consultation.
    - The instructor, together with the physician, adjusts both training and nutrition.

For those who simply had exemptions from school physical education: this methodology is one of the most effective wellness systems.
But what wasn't done in youth is harder to fix in adulthood. A full integrative approach is required: gym training + psychophysical regulation + cold exposure + social rehabilitation.

Nutrition for Increasing Muscle Mass

The goal is to create the right conditions for increasing muscle volume using easily digestible proteins.

On Training Days

- Morning: carbohydrate-rich foods, preferably fruits.
- **2–3 hours before training:** 50–100 g protein (lean meat, poultry, fish, eggs, nuts, legumes).
- **90–110 minutes after training:** the same amount of protein but of a different type; also 20–50 g of pure protein is recommended.
- Dinner: plant proteins and vegetables.

On the Days After Training

- Diet matched to daily energy needs.
- 3–4 meals a day.
- Morning: proteins.
- Evening: easily digestible proteins and vegetables.
- Avoid combining proteins with sugar-rich or starchy foods in the same meal.

Goal: Increase Both Muscle and Fat Mass

If the goal is not sport- or profession-driven (e.g., bodybuilding or security), then training must be accompanied by:

- Hardening procedures (cold showers, etc.)
- Psychoregulatory training
- Sauna 1–2 times a week to reduce sympathetic nervous system tone

Signs of success: warm hands and feet, calm sleep.

Nutrition Organization

- Balanced diet.
- Caloric intake not more than 10–20% above daily energy expenditure.
- On non-training days: no more than 3 meals.
- First meal should be carbohydrate-rich, 30 minutes after a short morning walk or jog.

On Training Days

- After walking or light exercise, pranayama, and ablutions: a full meal (carbohydrates, fats, fruits, supplements).
- Lunch: animal + plant proteins, vegetables, vegetable fats.
- Dinner: mixed diet with easily digestible plant proteins.

After training:

- After 30–45 minutes: a small dose of easily digestible carbohydrates.
- After 100–120 minutes: easily digestible proteins or pure protein.

Psychological Aspects

People who need to gain weight often struggle to maintain psychological balance.
Useful tools:

- Pranayama
- Meditation
- Chinese gymnastics (Qi Gong, Tai Chi)

Physiological Control and Human Constitution

Control is an essential management element, especially in health-oriented physical culture. Both laboratory and pedagogically accessible monitoring methods are recommended.

In the lab:

- Endocrine gland condition: ultrasound + blood hormone concentrations.
- Immune system: serum analysis for T lymphocytes using spontaneous rosette formation with sheep or rabbit erythrocytes; blood count with focus on erythrocytes and hemoglobin.

Vascular system:
A separate analysis is required.
In arteriosclerosis, artery walls stiffen and pulse-wave velocity increases.
In healthy individuals: **6.85 m/s**.
In obese individuals with aortic arch arteriosclerosis: up to **7.95 m/s**.

Absolute values allow comparison with population norms, revealing pathological or pre-pathological states.
For a practically healthy person, tracking personal trends is more useful.
Anthropometric measurements and functional state monitoring are important.

- Fat-mass reduction → lower cardiovascular risk.
- Muscle hypertrophy → good endocrine function and overall health improvement.

Constitution and Human Development

Human ontogenesis begins at fertilization. During embryonic development, three germ layers form:

- **Ectoderm:** nervous system, epidermis, sensory organs, mucosa of mouth and anus.
- **Mesoderm:** heart, vascular system, skeleton, muscles, urinary and reproductive systems.
- **Endoderm:** digestive tract, respiratory system, digestive and endocrine glands.

Abnormalities in any layer cause related disturbances:

- Nervous system issues → skin dysfunctions.
- Muscle development → cardiovascular health.
- Digestive organs ↔ endocrine glands interaction.

Constitution = morphological and functional characteristics shaped by genetics, environment, and biological time.

We distinguish:

- **General constitution:** genotype and biological reactivity.
- **Partial constitutions:** local phenotypic manifestations like somatotypes or types of higher nervous activity (Pavlov), and temperaments.

Somatotype and Body Proportions

Somatotype is a phenotypic component shaped by the interaction of genetics and environment.
Sex hormones heavily influence body proportions during the pre-pubertal growth spurt.

- Intense physical training → more "masculine" proportions (broad shoulders).
- Lack of activity → more "feminine" proportions (wide pelvis).

The Heath–Carter system (1967), based on Sheldon (1940), evaluates three components:

- **Endomorphy:** fat accumulation
- **Mesomorphy:** muscle and skeletal development
- **Ectomorphy:** linearity

Each from 1 to 7.
Example: 2–4–3 means endomorphy 2, mesomorphy 4, ectomorphy 3.

This classification is universal.

Body proportions matter for biomechanics, growth-abnormality diagnosis, and endocrine function assessment.

Examples:

- Short lower limbs relative to trunk → early skeletal maturation.
- Acromegaly → enlargement of specific body parts.

From a biomechanical standpoint:
The longer the muscle lever arm, the greater the work produced for the same contraction force.

Bunak's Nine Proportion Types (1937)

1. Arrostoid: narrow shoulders, short legs
2. Hypoharmonic: narrow shoulders, medium legs
3. Teinoid: narrow shoulders, long legs
4. Hypostiphoid: medium shoulders, short legs
5. Harmonic: medium shoulders, medium legs
6. Parateinoid: medium shoulders, long legs
7. Stiphoid: wide shoulders, short legs
8. Paraharmonic: wide shoulders, medium legs
9. Gigantoid: wide shoulders, long legs

In practice, a three-type classification is more common:

- **Dolichomorphic:** slender, elongated body, narrow shoulders, short trunk, long limbs
- **Mesomorphic:** medium proportions
- **Brachymorphic:** wide, short body, wide shoulders, massive trunk, short limbs

Relative Indices

- Relative trunk length = Trunk length / Body length × 70
- Relative shoulder width = Shoulder width / Body length × 100%

Evaluation uses deviation categories: $> M+\sigma$; within $M\pm\sigma$; $< M-\sigma$.
M and σ must be determined for the specific group (age, sex, ethnicity, profession, sport).

Reactivity and the Nervous System

Reactivity correlates with nervous-system development. In humans, reflex patterns create a wide range of reactivity mechanisms (A.D. Ado, 1985). Genetics also shape this range.

In genetics, the "reaction norm" is the span of phenotypic variability produced by genotype–environment interaction.

Identifying individual reactivity traits would benefit from a diagnostic system enriched with indicators of nervous-system activity and genetic parameters.
Such a constitutional typology would be complex, combining functional and historically mediated traits.

Somatotype and Psychological Traits

Many studies have examined the link between somatotype and psychological characteristics. Early key works:

- E. Kretschmer (1929)
- W.H. Sheldon (1940)

Both presented convincing data, but the scientific community remained cautious (cited in Yumorin & Chtetsov, 1979).

Abnormal psychological constitutions can correspond to both abnormal ("infantile") and normal somatotypes.

In healthy conditions, normal somatotypes align with typical psychological patterns (introversion/extraversion, emotionality, etc.), which can drift toward psychopathy in pre-pathological phases. Somatotypes influence the probability of mental and somatic disorders.

Distribution of somatotypes among schizophrenia patients shows clear trends.

Somatotype Distribution in Schizophrenia (Table 7)

Country	Asthenic/Athletic Type	Pyknic Type
Switzerland	84.9%	—
Italy	70.1%	22.9%
Spain	56.6%	18.2%
Netherlands	65.0%	2.8%
Austria	73.0%	19.6%
Russia	70.0%	19.0%

Schizophrenic patients tend to be asthenic or similar.
Pyknic type appears more in circular psychosis; athletic type is common in epilepsy.
However, ~20% of schizophrenic patients are pyknic—seemingly atypical.
Discrepancies may result from small samples or age- and diagnosis-heterogeneity.

Schizophrenia often appears early in life; manic-depressive disorder later.
Because the pyknic type increases with age and the asthenic decreases, comparing young schizophrenics with older bipolar patients distorts the picture.

In late-onset schizophrenia, somatotype tends to shift toward pyknic.

Somatotype and Hormones

Hormones strongly influence development and somatic status.
One of the less clear areas in constitutional science is the relationship between general vs. specific, individual vs. typological traits across different trait systems.

It has been shown that a constitutional scheme can be built on morpho-hormonal parameters, particularly during development (Majuga, Khrisanfova, 1980; Khrisanfova, 1982).

Khrisanfova's studies on boys in puberty showed:

- **Asthenoid type:** high estradiol
- **Muscular type:** high testosterone and GH
- **Digestive type:** high progesterone, low other hormones
- **Thoracic type:** values near mean

Hormonal ratios are especially informative:

- Muscular type → highest testosterone/cortisol and GH/cortisol; lowest estradiol/testosterone → consistent with anabolic tendencies and andromorphism.
- Asthenoid type → highest estradiol/testosterone → low andromorphism.

More detailed findings:

- Asthenoid: 62.5% have estradiol above average (+0.56), 20% above $+2\sigma$; low estradiol rare (16%).
- Thoracic: all hormonal values within $M\pm\sigma$; only 15% above $+1\sigma$.
- Digestive type:
  - 53.8% high progesterone
  - 66.7% low GH
  - 73.7% low testosterone
  - 86.7% moderately low cortisol
- Muscular type: elevated testosterone only in 50%; elevated GH in 43.3%.

Anthropometric Studies

Anthropometric methods are among the most widely used. Anthropometry (from the Greek *anthropos* — human, and *metreo* — to measure), or somatometrics, is employed to assess physical development and body constitution, as well as to monitor growth in children and adolescents.

A person's morphological profile includes:

- Total and partial body dimensions
- The proportions between these dimensions
- Body composition (percentages of fat, bone, and muscle mass)
- Body type (somatotype)

Large-scale anthropometric studies were primarily conducted at the Anthropometry Research Center of the D.N. Anokhin Institute of Anthropology at Moscow State University.

Anthropometric Instruments

To conduct an anthropometric examination, the following tools are required:

- Anthropometer
- Thick-arm caliper
- Tailor's measuring tape
- Skinfold caliper

Using the anthropometer, one measures:

- Total height
- Height to the anterior superior iliac spine (subtracting 4 cm to obtain leg length)
- Acromial point of the right shoulder
- Tip of the middle finger of the right hand

The difference between the acromial height and the fingertip height gives the arm length.

Using the caliper, one measures skeletal diameters:

- **D1:** shoulder width (between acromial points)
- **D2:** pelvic width (between iliac crests)
- **D3–D6:** diameters of forearm, upper arm, thigh, and lower leg

Using the measuring tape, one measures circumferences:

- Wrist, forearm, upper arm (biceps area), head, neck, chest, waist, hips, thigh, lower leg, ankle, foot

Using the skinfold caliper, one measures:

- Hand, inner forearm, inner upper arm
- Epigastric region, abdomen (right side of navel), iliac region
- Triceps, subscapular region, lumbar region, thigh (posterior, lateral, inner, anterior), lower leg (posterior)

Example: Calculation of Body Proportions

A 39-year-old woman with:

- Height: 166.5 cm
- Weight: 82 kg
- Leg length: 91 cm → leg/height ratio = 0.547 (slightly above average)
- Arm length: 72 cm → arm/height ratio = 0.432 (slightly below average)
- Shoulder width: 36 cm → ratio = 0.216 (below average)
- Pelvic width: 28 cm → ratio = 0.168 (below average)

Conclusion: slightly long-limbed constitution, with short arms and narrow shoulders and pelvis.

Body Composition Calculations

Fat mass and muscle mass may be estimated using indirect formulas (Maiteki), for example:

- **Body surface area (S)** = (100 + weight + height – 160) / …
- **Average subcutaneous fat thickness (G)** = mean of 7 skinfolds minus a reference fold
- **Average muscle radius (R)** = mean limb circumferences divided by $(4 \cdot 2 \cdot \pi)$

Only eight skinfolds are used to calculate fat mass, according to anthropometric recommendations.

Computer Modeling

Software models each individual as a segmented geometric figure, subtracts excess fat, and recalculates circumferences according to normative values. Ideal skinfold measurements are:

- f(4) = 12 mm
- f(10) = 14–16 mm
- f(13) = 12–14 mm

Model construction is based on hereditary data (height, shoulder and pelvic width) and body-type indices. Even small measurement inaccuracies can significantly distort body shape.

The software displays three profiles:

1. Current state
2. State with normalized body fat
3. Ideal model

If the model appears distorted, measurements must be corrected (±0.5 cm) and the process repeated.

Assessment of Body Profile and Skinfolds

After constructing an objective individual model, profile analysis follows. In most cases, the profiles overlap almost completely despite a significant subcutaneous fat layer, particularly on the abdomen and thighs. The reason: in many women, fat tissue is dense and tightly adheres to the muscles, making skinfolds difficult to measure and often painful.

Experience shows that skinfolds in such individuals may have an error margin of **100–400%**. Since calipers are ineffective here, computer estimation is acceptable.

Procedure:

- Assume that the muscular mass of the segment matches the model.
- Adjust skinfold values in the initial dataset.
- Compare profiles and circumferences.
- If they coincide, the skinfold values are considered corrected, with a small systematic downward error.

During training, fat mass decreases, skinfolds become measurable, and the need for computer correction diminishes.

Functional Assessment: Step Test

A simple and sufficiently accurate ergometric method is the step test. One may use staircases with one or more steps, but practice favors the single-step version.

Exercise intensity is controlled by adjusting:

- Step height (30–35 cm)
- Stepping rate, set by metronome or software

Each step cycle consists of four steps. Exercise duration: 4–6 minutes. Afterwards, the subject sits and pulse is measured for 10 seconds at the beginning of the first and second minutes.

Table 10 — Number of Step Cycles by Weight and Age (Women)

Weight (kg)	Age 30	Age 40	Age 50	Age 60	Age 70
40	28	27	24	22	21
50	26	25	23	21	20
60	24	23	21	19	18
70	22	21	19	17	16
80	20	19	17	15	—

Weight (kg)	Age 30	Age 40	Age 50	Age 60	Age 70
90	18	17	16	14	—

Maximum heart rate (bpm):

- 30 years → 170
- 40 years → 160
- 50 years → 150
- 60 years → 140
- 70 years → 130

Calculation of Maximal Oxygen Consumption (VO_2max)

The software calculates VO_2max (liters/min) using the Dobeln and Åstrand formula:

[
\text{VO}_{2\max} =
1.29 \cdot \frac{H \cdot M \cdot t}{\text{HR} - 60} \cdot 27

- 0.00884 \cdot V
  ]

Where:

- **H** = step height (m)
- **M** = body mass (kg)
- **t** = steps/min
- **HR** = heart rate
- **V** = age (years)

Other Functional Indicators

- **Aerobic threshold power (AT):** half of VO_2max power divided by body weight
- **Heart rate at AT:** ((HR_{VO_2max} – 70) / 3 + 70)
- **Recovery index:** (HR_2 / HR_1 · 100), where HR_1 is pulse immediately post-test and HR_2 at the start of minute two
- **Functional state index:** based on VO_2max and fat mass

Training heart rate is generally **120–140 bpm**.

Table 11 — Physical Fitness Assessment by VO_2max (ml/min/kg) — Cooper, 1970

Fitness Level	Age 30	Age 40	Age 50
Very poor	—	—	—
Poor	33	30	26
Fair	42	39	35
Good	51	48	45
Excellent	—	—	—

Health Considerations

Human health depends on hereditary predispositions, motor activity, nutritional habits, and socio-economic living conditions. Physical-education specialists can take responsibility for preventing, in practically healthy individuals, two major lethal diseases of our time: ischemic heart disease (based on atherosclerosis) and cancer.

Preventive measures may include:

- **Physical exercise** that activates anabolic and catabolic processes and intensifies DNA renewal in cells. This strengthens arterial epithelial cells and helps eliminate hereditary information damage.
- **Balanced nutrition** in essential components, adequate for normalizing metabolism and improving physical constitution.

This section presents fundamental concepts of the digestive system, the theory of balanced nutrition, and the patterns of interaction between physical exercise (performed according to the innovative system) and dietary regimen.

The main difference between this section and many popular publications is that I rely strictly on well-established facts from normal and sports physiology, completely excluding therapeutic nutrition. I follow Hippocrates' principle: **"Do no harm."** Only a physician can prescribe therapeutic diets, and only for a specific patient.

Chapter 7

General Foundations of Digestion

Anatomy.

The digestive system consists of the digestive tract itself, the transport systems (blood and lymph), and the cellular-level nutrient assimilation systems of the organism. The digestive tract is made up of the following sections: oral cavity, pharynx, esophagus, stomach, duodenum, small intestine, large intestine, and rectum. These sections are separated by muscular sphincters. Into these compartments empty the ducts of the digestive glands: the salivary glands (oral cavity), the pancreas and gallbladder (duodenum). The stomach and intestines also contain their own secretory cells that produce digestive juices.

Physiology and Biochemistry

The activity of the digestive tract is regulated mainly by the parasympathetic branch of the central nervous system. There is also a humoral regulation path through biologically active substances.

In the oral cavity, during chewing, food is broken down mechanically, moistened by saliva, and carbohydrates start to undergo partial digestion. This is one of the primary stages of nutrient assimilation. It is the only stage of digestion that humans can consciously control. Here, taste sensations trigger reflex responses in all other sections of the digestive system, preparing them for the incoming type of food. Mechanical breakdown is essential: first, because salivary enzymes need time and surface area to start splitting complex carbohydrates; second, because breaking and mixing food with saliva begins the process of fragmenting food into simpler components.

The **gastric phase** is aimed at a finer breakdown of the ingested food. The stomach stores, warms, mixes, grinds, and liquefies the food, forming a semi-liquid mass — chyme — which it then selectively releases into the duodenum. The stomach's main function is to secrete hydrochloric acid along with a set of specific enzymes (secretory function) and to saturate the food mass with this mixture through mixing and propulsion (motor function), enabling protein denaturation. The quality of this process depends on food volume and on substances that stimulate or inhibit gastric secretion. Food leaves the stomach in portions. The main factors regulating gastric emptying are: the “acidity” of the chyme (HCl concentration and degree of saturation), its consistency (liquid food leaves faster), and the presence of fats (which slow emptying).

In the **duodenum**, chyme is mixed with pancreatic juice, bile, and intestinal juice. These neutralize the stomach acid, shifting the mixture toward an alkaline environment. Many key digestive enzymes are activated only under alkaline conditions. They act on the main food components — proteins, fats, carbohydrates — breaking them down into absorbable units: amino acids, glucose, monoglycerides, and fatty acids. Each enzyme acts selectively, which ensures that all macronutrients can be broken down efficiently.

Undigested and unabsorbed food residues arrive in the large intestine. Here, water, vitamins, enzymes, hormones, and amino acids produced by the intestinal microflora are absorbed. Carbohydrates and plant fibers ferment under bacterial influence, allowing partial assimilation. Protein residues, however, undergo bacterial putrefaction, releasing toxic substances (amines, phenols, mercaptans, etc.) into the bloodstream — which are then neutralized by the liver.

Absorbed substances enter the bloodstream and are transported first to the liver, where toxins are neutralized, essential proteins and amino acids are synthesized, and carbohydrate reserves accumulate as glycogen. Glucose, fats, and amino acids are then transported to other organs and tissues for utilization. Fats accumulate mainly in adipose tissue and to a lesser extent are used for synthesis and muscular energy supply; carbohydrates serve primarily as the main “fuel” for vital organs and muscles, and in excess contribute to fat stores or accumulate as glycogen in skeletal muscles; amino acids (proteins) enter the body’s unified amino acid pool and are used mainly as building material for tissue regeneration and, in very small amounts, for energy.

Nutrition is a fundamental condition for normal bodily functioning and for the processes of assimilation (anabolism) and dissimilation (catabolism).
In broad terms, the problem of nutrition is governed by a simple formula: nutrition must be rational and appropriate.

Rational nutrition means that consumed foods must contain all necessary components in proportions and quantities suited to the enzymatic systems of the human digestive apparatus. They must not contain harmful substances nor supply excessive energy. Enzymatic systems are adapted to the nutrients typical for a given biological species. These balanced proportions are summarized in balanced-diet formulas. Some people have congenital or acquired enzyme-system abnormalities; they require individualized diets determined by a clinical dietitian.

Appropriateness refers to whether the structure of the diet stimulates the desired adjustments within the organism.

Balanced diet formulas indicate that a person should consume about **1 g of protein per kilogram of lean body mass** per day. Lean mass is total body mass minus fat mass. Plant fats and fat-soluble vitamins A, D, E, K — **0.5 g per kilogram of lean mass** per day. Carbohydrates — depending on energy needs — about **300–500 g**

(1000–1800 kcal).

Protein quality chiefly depends on the balance of essential amino acids. For reference:
1.5 L of milk, or 200 g of beef, or 200 g of cod supply all essential amino acids for a 70-kg person.

Food must also supply sufficient minerals and vitamins. A vegetable salad with vegetable oil (20 g) — carrots 100 g, cabbage 100 g, apple 100 g, lemon with peel 20 g — covers all daily needs for vitamins A, beta-carotene, C, and half of the requirement for other vitamins, minerals, and fiber.

Adding rye bread, oatmeal, or buckwheat porridge covers required carbohydrates and the remaining minerals and vitamins.

To prevent vitamin and mineral deficiencies, a 20-day course of multivitamins with mineral supplements every quarter is recommended (under medical advice).

A daily intake of:

- 200 g milk
- 100 g meat or fish
- 300 g rye bread
- 200 g porridge
- 20 g butter
- a salad with 20 g vegetable oil
  covers all essential protein, mineral, and vitamin needs — with a caloric value around 1000–1200 kcal. This food set should be considered a baseline requirement. To meet full energy demands, additional carbohydrates should be added: more bread, porridge, sweets, ice cream, chocolate, nuts, vegetables, fruit.

Diet and Cancer Prevention

Modern nutrition science pays significant attention to the link between cancer and diet (A.P. Ilnitsky, 1993).
A cancer-preventive diet must support effective biochemical processes in body tissues.

One key mechanism of cellular damage is hydrogen peroxide formation. To reduce its concentration, foods rich in antioxidants are recommended.

Foods containing vitamin A (supports cell differentiation and inhibits tumor cell development), vitamin C, and vitamin PP (repair DNA mutations): onions, potatoes, cabbage, tomatoes, black currants.

Fiber also plays a crucial role. Parsley, beets, carrots, beans, and apples create conditions in the colon where fibers bind carcinogens, removing them with feces. Dietary fiber (25–40 g/day) retains water, increases fecal volume, reduces time for carcinogen absorption, and accelerates renewal of intestinal epithelium.

Energy Intake in Endurance Sports

The highest dietary energy consumption is seen in cycling, skiing, and triathlon.
Training and competitions last 6–8 hours daily for several consecutive days.
Tour de France cyclists consume **30–35 MJ/day (7200–8530 kcal)**, exceeding basal metabolic rate by 4–5 times (Saris et al., 1989).
To counter energy deficits, carbohydrate-rich drinks during training are recommended — about **16 g/kg/day** (Brouns et al., 1989).

Carbohydrates and Physical Activity

The importance of carbohydrates in muscle construction and plastic processes was established over 50 years ago. Christensen & Hansen (1939), Krogh & Lindhard (1920) showed that high endurance performance requires a carbohydrate-rich diet and intake during prolonged effort. Later biopsies (Bergström, Hultman, 1967; Hermansen et al., 1967) confirmed the central role of muscle glycogen stores.

Carbohydrates contain carbon, hydrogen, and oxygen in the ratio C–H_2O. Glucose's structural formula is $C_6H_{12}O_6$. Carbohydrates are simple or complex. Glycogen, a complex polysaccharide, is the main glucose reservoir. In a 70-kg person:

- liver glycogen: **70–135 g**
- muscle glycogen: **300–900 g**

Liver glycogen supplies glucose for the CNS, blood cells, and kidneys. Muscle glycogen can convert to glucose, but this glucose cannot directly enter the blood; however, under near-anaerobic conditions, muscles produce lactate, which does enter the blood and becomes pyruvate for mitochondrial energy.

Mechanism of Carbohydrate Utilization During Exercise

Muscle glycogen is initially converted into glucose-1-phosphate under the action of phosphorylase, which is then converted into glucose-6-phosphate. This molecule represents the entry point of glycolysis (the Embden–Meyerhof pathway). Glucose-6-phosphate is derived both from muscle glycogen and from blood glucose. Glycolysis ends with the formation of pyruvate, which can enter the mitochondria and undergo oxidative phosphorylation in the Krebs cycle (citric acid cycle). When the mitochondrial content of the muscle fiber is insufficient, excess pyruvate is converted into lactate. Glycolysis provides useful energy: one mole of glucose yields 2–3 moles of ATP, and if pyruvate enters the mitochondria, an additional 36–37 moles of ATP are generated. Mitochondria use one liter of oxygen to produce 5.05 kcal (21.1 kJ) of energy during carbohydrate oxidation.

During maximal or near-maximal intensity exercise (80–100%), such as sprint running, cycling, repeated sprint bouts, soccer, hockey, and basketball, phosphagens (ATP and creatine phosphate) are broken down and their energy is used for movement. During recovery, resynthesis occurs via glycolysis; thus, lactate and H^+ ions accumulate in glycolytic muscle fibers. The accumulation of hydrogen ions produces the sensation of fatigue. Glycogen depletion does not cause fatigue during a single high-intensity effort, but repeated accelerations—such as those typical of team sports—can lead to fatigue due to glycogen shortage in the muscles. It is assumed that during static exercise at 20–30% of maximal voluntary contraction, vascular occlusion occurs. Blood flow to the muscle ceases, promoting anaerobic glycolysis and consumption of intramuscular glycogen stores. With increasing training volume, problems related to glycogen depletion may occur.

During cyclic exercise at 60–85% of VO_2max (the anaerobic threshold), glycogen consumption is maximal in intermediate fibers, while oxidative fibers receive energy from lactate produced by active glycolytic fibers (Carlson, 1971; Hermansen, 1967). In cyclists, muscle glycogen is depleted primarily in the quadriceps femoris, and in runners in the gastrocnemius and soleus muscles.

Calcium in the sarcoplasm, circulating insulin, and the concentration of glucose in blood and tissue play important regulatory roles in glucose transport across the muscle-fiber membrane (Holoschi, 1986). When blood glucose concentration decreases, glucose derived from glycogenolysis begins to be released into the bloodstream.

A high-carbohydrate diet increases the respiratory quotient during sub-threshold exercise. It also prolongs the duration of constant-power exercise relative to a high-fat diet (Bergstrom, 1967).

Resynthesis of Glycogen After Intense Exercise

Muscle glycogen depletion occurs within 0.5–3 hours. The rate depends on exercise intensity and duration, and on the athlete's aerobic capacity (Erikson, 1977; Costill, 1988; Kirwan, 1988). Glycogen replenishment is most effective when 50 g of glucose are consumed every 2 hours. Increasing the dose does not enhance glycogen synthesis because glucose begins to be utilized by other tissues, particularly due to increased insulin (Toth, 1987; Ivy, 1988). Liver glycogen can also be resynthesized from lactate, glycerol, and alanine, which are first converted into glucose.

Protein and fat intake together with carbohydrates slows glycogen synthesis; therefore, such foods should be accompanied by sugary liquids (Costill, 1981).

During heavy training and competition, energy expenditure may be so high that even during nighttime rest—when food cannot be consumed—complete resynthesis does not occur. To maintain high performance, as in multi-day cycling events, athletes consume carbohydrate-rich meals both before and during competition (Coyle, 1983, 1986, 1987; Coggan, 1991).

Protein Requirements in Sport

The question of protein requirements in athletes has been debated for more than 100 years, and among athletes since the ancient Greek Olympic Games. Proteins account for approximately 57% of body mass. The human body can synthesize proteins from amino acids. Some amino acids are essential (histidine, isoleucine, leucine, lysine, methionine, phenylalanine…).

Essential amino acids—alanine, threonine, tryptophan, valine—must be obtained from food. They are found in animal proteins (eggs, fish, meat, milk and dairy products) or in combinations of plant foods such as corn, peas and beans, or bread and lentils.

Dietary proteins are absorbed as amino acids. Blood amino-acid pools are used to build body structures. When dietary carbohydrate intake is insufficient, muscle tissue degradation can occur (Anderson, 1990). Protein intake for high-level athletes should be 1.3–2.0 g/kg/day, or 125–250% of the recommended daily allowance for non-athletes.

Fat Requirements as an Energy Source

Lipid sources (fats) are major energetic substrates. They include plasma triglycerides (TG), free fatty acids (FFA), and intramuscular triglycerides.

Subcutaneous fat—stored in adipocytes—contains the largest energy reserve. Fat is also stored in the abdominal cavity and between muscles. The rate of FFA mobilization (esterification) depends on lipolysis, transport in the blood, and re-esterification by adipocytes.

The rate of lipolysis in subcutaneous fat is assessed via blood glycerol concentration. Because adipocytes lack glycerol kinase, they cannot reuse glycerol directly (Brooks et al., 1982). Experiments show that during aerobic exercise, blood glycerol concentration increases 3–6 fold (Ateg, 1990; Wahrenberg et al., 1987, 1991). Lipolysis is activated by catecholamines, glucagon, growth hormone, adrenocorticotropic hormone, and others (Hales et al., 1978). Catecholamines are the most potent stimulator of lipolysis at physiological concentrations via α-adrenergic inhibition and β-adrenergic stimulation of adenylate cyclase and cAMP formation (Fain et al., 1983). Insulin is the most potent inhibitor of lipolysis; during sympathetic activation from exercise, blood insulin decreases.

Thus, intense muscular activity increases adipose-tissue lipolysis via β-adrenergic activation (Wahrenberg et al., 1987, 1991).

Lactate reduces FFA utilization by increasing non-esterification without affecting lipolysis (Issekutz et al., 1994).

FFA transport in plasma occurs (99.97%) via albumin, which has 10 FFA-binding sites (Spector et al., 1971).

FFA are actively transported into muscle fibers, and with increased muscle activation, transport accelerates independently of blood FFA concentration (Turcotte et al., 1994). Specific cytoplasmic FFA-binding proteins are presumed to exist (Fournier et al., 1983).

Intracellular FFA metabolism depends on exercise intensity. The respiratory quotient

(RQ) is an indicator of this relationship. At 30% VO_2max, both plasma FFA and consumption of labeled oleate increase (Ahlborg et al., 1984). FFA can be used only in parallel with carbohydrates (Mogenson et al., 1987); therefore, reduced glycogen concentration corresponds to reduced oxidative phosphorylation of FFA. Intramuscular triglycerides are the primary FFA source during low-intensity exercise. Direct oxidation of exogenous FFA is possible but negligible (Hagenfeld et al., 1988). During prolonged single-limb knee extension, plasma triglyceride uptake into active muscle is minimal (Havel et al., 1967; Turcotte et al., 1994).

Thus, intramuscular triglyceride stores are the main source of FFA oxidation during low-intensity exercise.

Role of Vitamins in Athletic Training

Thirteen substances are classified as vitamins. They are either water-soluble or fat-soluble. Vitamins must be ingested through diet.

Water-soluble vitamins—thiamine, riboflavin, vitamin B6, niacin, pantothenic acid, biotin, and vitamin C—participate in mitochondrial energy metabolism. Folic acid and vitamin B12 are involved in DNA synthesis, bone-marrow formation, and red-blood-cell production. Vitamin B12 also participates in mitochondrial metabolism.

Fat-soluble vitamins: A, D, E, K.
Vitamin E supports mitochondrial function and, together with vitamins C and A, has antioxidant effects.

Experimental studies on vitamins in athletic preparation are largely contradictory. Clearly, B-complex vitamins and antioxidants are most relevant to recovery. Their metabolism and excretion via urine and sweat increase with exercise intensity and duration. Therefore, athletes are advised to consume additional vitamins through dietary supplements (van Erp-Baart et al., 1989).

Minerals as Dietary Supplements in Athletic Preparation

Mineral supplements support energy production, reduce fatigue, maintain bone integrity, and function as cofactors in many enzymes.

Macrominerals ($\geq$0.01% body mass): calcium, magnesium, sodium, potassium, sulfur, chloride.
Microminerals (<0.001% body mass): iron, zinc, copper, selenium, arsenic, cobalt (Maughan, 1991).

Calcium is essential for bone formation and muscle contraction. With adequate dietary calcium, athletes show no bone-density problems (Lane et al., 1986; Dalsky et al., 1988; Myburgh et al., 1990).

Magnesium is a cofactor in energy-metabolism enzymes, maintains electrical potential in muscle and nerve cells, and is present in bone. After a marathon or severe muscle damage, plasma magnesium decreases (Conl et al., 1986; Rose et al., 1970), likely due to loss through sweat and urine or redistribution among tissues (McDonald, Keep, 1988).

Phosphorus is part of bones, ATP, nucleotides, and enzymes. In collapsed marathon runners, plasma phosphorus was very low (Howerver, Dale et al., 1986). Maintaining high plasma phosphorus supports elevated ATP and creatine-phosphate levels.

Selenium acts as an antioxidant with vitamin E, reducing membrane peroxidation during intense exercise (Kanter et al., 1988; Maughan et al., 1989).

Iron is essential in hemoglobin and myoglobin for oxygen transport. Short-term iron deficiency does not immediately reduce performance, but prolonged deficiency can produce anemia (Haymes, 1987).

Adaptogens (Ergogenic Aids)

Creatine (Cr) is one of the most important organic substances for energy support and buffering muscular acidity. Creatine phosphokinase catalyzes creatine-phosphate (CrP) breakdown, releasing energy for ATP synthesis from ADP and inorganic phosphate.

Creatine is synthesized in the liver, kidneys, and pancreas from arginine and glycine. It can also be consumed from fish, meat, or supplements. Intake of 20–30 g/day for several days increases total creatine content by ~20%, including CrP. Synthetic creatine analogs inhibit endogenous synthesis. Creatine stores must be replenished at 2 g/day to compensate for urinary creatinine loss.

Ingwa B. et al. (1981) proposed that creatine influences muscle-tissue development via feedback. Creatine stimulates incorporation of labeled leucine into myosin and actin heavy chains in skeletal and cardiac muscle.

HMB (β-hydroxy β-methylbutyrate)

HMB is a nutritional biocorrector introduced in 1995 to minimize muscle-fiber damage, improve fat metabolism, and enhance mitochondrial and immune-cell function. According to S. Nissen (1994–1997), HMB is an intermediate of leucine degradation. Only 3–4% of leucine is converted into HMB, so dietary intake of 1–3 g/day would require eating 2–3 kg of meat, making supplementation important for athletes.

The mechanism of action is not fully understood, but HMB may participate in cholesterol synthesis—a key component of cell and organelle membranes. Active membrane construction with cholesterol may reduce circulating cholesterol and LDL, which can otherwise accumulate and promote atherosclerosis.

Thus, HMB may reduce LDL concentration and atherosclerosis risk. Enhancing cell-membrane structure may also:

- increase muscle strength (via growth of sarcoplasmic-reticulum membranes alongside myofibrils),
- improve aerobic capacity (mitochondrial membranes become less sensitive to

H^+ ions),

- reduce protein catabolism (stronger lysosomal membranes reduce proteolytic enzyme release).

These hypotheses are supported by animal and human studies. S. Nissen et al. (1996) studied 41 bodybuilders receiving 0, 1.5, or 3 g/day of HMB while consuming 117–175 g of protein/day and training 3×/week for 3.5 hours.

After three weeks:

- No HMB: +0.4 kg lean mass
- 1.5 g/day: +1.0 kg
- 3 g/day: +1.5 kg

Strength increased by 8%, 13%, and 18%, respectively. Markers of muscle damage (3-methylhistidine, creatine kinase, LDH) decreased significantly in HMB groups.

A 13% increase in strength and sprint speed was also observed in American football players supplementing 3 g/day of HMB and creatine for 28 days while training (Almada et al., 1997).

Alkalizing Agents

H^+ accumulation in muscle cells during exercise induces fatigue. To reduce acidification, researchers tested alkaline substances (Williams, 1995). Sodium bicarbonate ($NaHCO_3$) at 0.3 g/kg, taken 3 hours before exercise, increased performance:

- Blood pH rose to 7.444–7.700 at rest
- Exercise time at 130% VO_2max increased by 21.6%
- Muscle lactate post-exercise was similar, but blood lactate was higher (15.5 vs 12.9 mM/L)
- pH remained higher during recovery (7.256 vs 7.193 at 7 minutes)

Thus, reduced acidification increases work capacity.

Hood et al. (1990) showed that systemic alkalosis increases blood ketones, NEFA, and glycerol, while acidification increases them even further. Acidification favors greater fatty-acid utilization.

Coenzyme Q (Ubiquinone)

Coenzyme Q is an integral component of mitochondrial membranes and oxidative metabolism through the electron-transport chain (Williams, 1999). Long-term supplementation does not increase VO_2max (Viss) but possesses antioxidant properties (Demopoulous, 1999).

Development of the Dietary Plan

The planning of a nutritional regimen can be carried out independently using tables of energy cost for various activities and tables of food composition and caloric content, or by using the software *Isotone Image*, developed at the Moscow Institute of Physics and Technology.

The procedure for developing a dietary plan includes the following stages:

1. Study of daily energy expenditure and motor-activity patterns.
2. Study of habitual eating behavior.
3. Analysis of anthropometric characteristics and definition of training goals; preparation of the diet.
4. Calculation of energy expenditure during the activities described in the report, along with energy intake from food, as well as the intake of proteins (essential amino acids), fats, carbohydrates, vitamins, and minerals.
5. Calculation of the organism's efficiency coefficient.

Comparison Between Energy Expenditure and Caloric Intake

Comparing energy expenditure with caloric intake makes it possible to assess the efficiency of the organism's functioning. This ratio between expenditure and intake is referred to as the *Coefficient of Economy* (CE).

A normal difference between intake and expenditure during the initial phase of training using the innovative method is about 400–500 kcal.

The absolute value of this coefficient may be greater or less than one. This indicator first allows you to understand how many calories sustain your current lifestyle, providing a reference point for more rational menu planning aimed at reducing or increasing body weight. Second, it allows you to evaluate the "economic efficiency" of your organism—how effectively it uses the food consumed. The higher the coefficient, the better, especially when excess body fat is present.

Lower food intake yields economic benefits (you spend less) and health benefits (you ingest fewer harmful substances—toxins, heavy metals, etc.—and reduce stagnation, putrefactive processes, and strain on the digestive organs).

Reduction of Body Fat

Increasing energy expenditure relative to intake creates conditions for reducing fat stores. The most effective reduction is achieved through hypocaloric training.

The question everyone asks is: *what is the rate of fat loss?* It depends on many factors. For example, it is known that under strong psycho-emotional stress a person may "waste away" within a few days, exhausting not only fat reserves but also strategic protein stores.

Under normal conditions, the oxidation of one gram of fat produces approximately 9 kcal. Therefore, with a daily deficit of 500 kcal (a demanding program), one can expect a loss of about 57 grams of fat per day.

Comparison of Required and Actual Nutrient Intake

(Table preserved exactly as in the original; headings translated.)

Nutrient – Unit – Daily Requirement – Actual Intake
Water – ml – 1750–2200 – 1176
Proteins – g – 60–100 – 58
— animal origin – g – 30–60 – —
Essential amino acids – g – 19–31 – —
— Leucine – g – 4–6 – —
— Isoleucine – g – 3–4 – —
— Valine – g – 3–4 – —
— Threonine – g – 2–3 – —
— Lysine – g – 3–5 – —
— Methionine – g – 2–4 – —
— Phenylalanine – g – 2–4 – —
Carbohydrates – g – 300–500 – 241
Fiber – g – 25 – 6.58
Fats – g – 60–100 – 46
— vegetable – g – 20–30 – —
Minerals – g – 14–22 – —
— Calcium – mg – — – 596
— Phosphorus – mg – 1200–1500 – 962
— Sodium – mg – 4000–6000 – 1904
— Potassium – mg – 2500–5000 – 3000
— Chlorides – mg – 5000–7000 – —
— Magnesium – mg – 400–450 – 261
— Iron – mg – 10–18 – —
— Zinc – mg – 10–15 – —
— Manganese – mg – 5–10 – —

Vitamins – Unit – Daily Requirement – Actual Intake
Ascorbic acid (C) – mg – 70–80 – 19.21
Thiamine (B1) – mg – 1.1–2.0 – 0.78
Riboflavin (B2) – mg – 1.3–2.4 – 0.84
Nicotinic acid (PP) – mg – 15–25 – 15.89
Folic acid – mg – 0.2 – —
Cobalamin (B12) – mg – 0.003 – —
Rutin (R) – mg – 25 – —
Pantothenic acid (B5) – mg – 5–10 – —
Biotin (H) – mg – — – 0.06
Vitamin D – IU – 100 – —
Vitamin E – mg – 8–10 – —
Vitamin K – mg – 0.2–0.3 – —

Food Composition on Training Day

(Partial list; values exactly as given.)

Rye bread
Stewed cabbage
Carrots
Apples
Chocolate candies
Spice cookies
Peanuts
Apple juice

Total:
Energy: 1205 kcal
Actual consumption: 968.62 kcal
Vitamin C: 19.21 mg
Protein: 21.71 g
Fats: 35.9 g
Carbohydrates: 30.88 g
Fiber: 9.79 g
etc.

Final Considerations

Very little. And considering that during intense activity the body burns carbohydrates first and not fats, any extra sandwich quickly restores body fat. It becomes clear that true, lasting fat elimination is the responsibility of the practitioner.

For those who decide to follow this path, two points should be kept in mind:

1. **Caloric reduction and metabolic adaptation:**
   When total caloric intake is reduced (without lowering food quality), metabolic efficiency increases rapidly. For example, if initially the energy deficit was 500 kcal (1500 kcal expended, 1000 consumed), later it may decrease to 300 or 200 kcal, slowing fat loss.
2. **Nutritional balance:**
   The program described here is based on a "normal," balanced diet for individuals who consume animal proteins. This diet has been tested repeatedly in practice and has demonstrated its effectiveness.

Effects of Cooking on Nutrients

Remember: heat treatment destroys part of the vitamins, and some trace elements are diluted in water. As a result, the actual nutrient content of many foods may differ from theoretical values. For this reason, many nutritionists recommend consuming more raw foods or using "gentle" cooking methods. Ideally, the day should start with a cabbage leaf and an apple, and end with a carrot—better still, all together and dressed with vegetable oil.

Food Components on Rest Day

The detailed list includes rye bread, boiled potatoes, fried chicken, cheese, salami, cabbage, apples, carrots, sugar, sweets, cookies, peanuts, milk, apple juice, coffee, and tea. Nutritional values are given in grams and milligrams for each food.

Vitamins and minerals (rest day):
Calcium: 596.87 mg
Magnesium: 261.25 mg
Phosphorus: 962.3 mg
Iron: 16.89 mg
Vitamin A: 0.06 mg
Vitamin B1: 0.78 mg
Vitamin B2: 0.84 mg
Vitamin C: 15.89 mg
Vitamin PP: 19.21 mg

Analysis: protein and carbohydrate intake is balanced, but there is an evident deficiency of calcium, magnesium, phosphorus, and vitamins C and A. Prolonged adherence to this diet with active lifestyle can lead to metabolic disturbances and increased disease risk.

Food Components on Holiday Day

Similar to the rest day, but with different dishes: potato and fish soup, stewed cabbage, beef cutlets, boiled rice, stewed liver, sweets, milk, juice, coffee, tea.

Vitamins and minerals (holiday day):
Calcium: 1101.1 mg
Magnesium: 322.5 mg
Phosphorus: 963.5 mg
Iron: 48.36 mg
Vitamin A: 3.4 mg
Vitamin B1: 0.92 mg
Vitamin B2: 0.84 mg
Vitamin C: 135.1 mg
Vitamin PP: 33 mg

Program Objectives

- Reduce body fat by 12.75 kg
- Increase muscle mass by 5 kg (arms, back, chest, abdomen, thighs)

Calculation of Energy Expenditure

Rest day:
Sleep: $0.4 \times 56 \times 8 = 179$ kcal
Mental work: $0.7 \times 56 \times 8 = 313$ kcal

Slow walking: 2.2 × 56 × 1 = 123 kcal
Household activity: 2.0 × 1.5 × 56 × 6 = 1008 kcal
Total: 1399 kcal

Training day:
Sleep: 0.4 × 1.5 × 56 × 8 = 268 kcal
Mental work: 313 kcal
Slow walking: 123 kcal
Training: 3.5 × 56 × 1 = 196 kcal
Total: 1908 kcal

Weekly average:
5 days × 1465 kcal + 2 days × 890 kcal = 9105 kcal
Daily average: 1300 kcal

Calculation of Energy Intake and Nutrient Amounts

To calculate total energy intake and the amounts of proteins (essential amino acids), fats, carbohydrates, vitamins, and minerals, a three-day menu must be compiled: workday, rest day, and training day. Each food item must be listed in grams.

Example:
Rye bread — 25 g
Water: (47.5 / 100) × 25 = 11.875 g

At the end, all components are summed and the total caloric value is determined.

Calculation of the Coefficient of Economy

Average daily energy intake: 1300 kcal
Average daily energy expenditure: 1544 kcal
Deficit: 244 kcal

Because the diet is well balanced in proteins and carbohydrates, the deficit is compensated by body-fat stores. Considering that 1 kg of fat contains ~9000 kcal, the time needed to oxidize 1 kg of fat is:

9000 ÷ 244 ≈ **37 days**

To reduce 6 kg of fat: approximately **221 days**.

The diet is balanced in proteins, fats, carbohydrates, minerals, and vitamins. However, deficiencies in fiber, sodium, magnesium, and vitamin B1 are observed. Low sodium intake was specifically requested by the woman in question. Magnesium and vitamin B1 deficiencies can be compensated by increasing dairy intake—for example, 50–100 g of cottage cheese per day.

Chapter 8

Prevention and First Aid

During sports events or wellness activities, injuries and other medical incidents can occur—not only among participants but also among spectators. This is why knowing how to provide first aid is essential.

The term *trauma* comes from Greek and means “wound” or “injury.”

According to statistics, about **4.7%** of people practicing sports suffer injuries.

Types of Injuries

Most common:

- Contusions
- Sprains
- Abrasions
- Scrapes

Less frequent:

- Wounds
- Fractures
- Dislocations

Typical sports injuries:

- Muscle strains
- Meniscal damage
- Ligament injuries of the knee and ankle

Location

More than **80%** of injuries affect the limbs.

Severity Levels

Sports injuries are generally mild and do not lead to loss of working capacity. They can be classified into five categories:

1. **Very mild** — do not interfere with sports activity.
2. **Mild** — temporary limitation up to 15 days.
3. **Moderate** — up to 60 days of inactivity.
4. **Severe** — prolonged suspension of activity.
5. **Very severe** — permanent cessation of sports activity.

Causes and Prevention of Trauma

Main causes fall into five groups:

1. Poor organization of training sessions and competitions
2. Unsuitable training environments
3. Inappropriate equipment, clothing, or footwear
4. Lack of medical supervision
5. Athlete misconduct or violation of discipline

Organization of First Aid

In case of injury, the instructor must intervene immediately. The sooner medical assistance is provided, the shorter the recovery time.

A simple dressing on a wound or abrasion prevents infection.
Correct splinting of a fracture or contusion accelerates recovery.

Every instructor should know the basics of first aid.

A sports center must have a medical station equipped with:

- Cotton
- Iodine tincture or 2% brilliant green solution
- Ammonia alcohol
- Vaseline
- Chloroethyl ampoules
- Individual dressing packets
- Bandages
- Plywood splints
- Triangular bandages
- Elastic bandages
- Rubber tourniquet

To provide effective first aid, the instructor must know basic human anatomy.

First Aid for Contusions

Contusions are the most common injuries, caused by falls or impacts with sports equipment.
The skin usually remains intact, but underlying tissues are damaged.

What happens

A contusion causes rupture of small vessels and subcutaneous tissue, leading to blood accumulation under the skin—forming the typical bluish-purple hematoma.

What to do

- Immobilize the injured limb (e.g., suspend the arm with a sling).
- If it's the leg, have the athlete lie down.
- Apply ice or spray chloroethyl to reduce pain and bleeding (cold constricts vessels).
- Before spraying chloroethyl, apply a thin layer of Vaseline to prevent freezing injury.
- Spray from 30–40 cm until the skin becomes white (1–2 minutes).
- If no ice or chloroethyl is available, use a clean cloth soaked in cold water.

If there is also an abrasion:

- Do **not** wet the area.
- Disinfect with Betadine.
- Apply a sterile dressing.

If the trauma affects a joint:

- Apply a compression bandage.

Warning

Contusions to the head, chest, or abdomen can be dangerous due to possible internal organ damage.
Seek immediate medical attention if the athlete experiences:

- Abdominal or lower back pain
- Vomiting
- Inability to urinate
- Blood in the urine

Do **not** give liquids until internal injuries are excluded.

Sprains and Muscle Strains

Sprains

Common in knee and ankle.
Caused by falls, impacts, or improper landings.

Symptoms:

- Pain
- Swelling
- Bruising

First aid:

- Spray chloroethyl until blanching occurs.
- Apply a compression bandage.
- If ligament rupture is suspected, add a rigid splint and take the injured person to the hospital.

Muscle Strains

Characterized by:

- Sharp, sudden pain
- Immediate interruption of activity
- Sometimes a palpable or visible depression in the muscle

First aid:

- Spray chloroethyl
- Apply elastic bandaging above the injured area
- Seek medical evaluation the same day

Wounds and Abrasions

A wound is a lesion of the skin or mucous membranes.

Types:

- **Puncture** — small opening, deep channel → high infection risk
- **Contused or lacerated** — irregular edges, moderate bleeding → risk of suppuration

Infection risk

Any wound can become infected by germs from the air, skin, or clothing. Even a small abrasion must be taken seriously.

First aid

- Expose the wound without contaminating it.
- If clothing must be removed, cut it along the seam instead of pulling.
- Do **not** wash the wound with water, even if it's dirty.
- Do **not** touch it with fingers.
- Disinfect the skin **around** the wound with Betadine or hydrogen peroxide.
- Dress with a sterile bandage (individual packet).
- If the wound is large, apply two packets over each other.

Sterile dressings
Consist of gauze and cotton pad and are sealed in a double paper wrapper.
Open carefully without touching the sterile side.

Stopping Bleeding

Minor bleeding

- Apply a compression bandage with cotton above the wound.
- If the bandage becomes soaked, **do not remove it**—add more cotton on top.

Severe bleeding

Loss of one-third of total blood volume (~1.5 liters) is life-threatening.
If blood spurts, compression is insufficient.

What to do:

1. Call an ambulance
2. Lay the person down
3. Elevate the injured limb
4. Apply a tourniquet above the wound
5. Dress with sterile materials

Tourniquet placement:

- Arm: upper arm
- Leg: upper thigh

Preferably apply over clothing or with fabric between skin and tourniquet.

If no tourniquet is available:
Use a scarf, shirt, or band.
Tighten with a stick twisted until bleeding stops, then secure it.

Maximum duration:

1 hour, at most 1.5 hours.
Beyond this, tissue necrosis may occur.

Attach a note with application time and transport to hospital immediately.

Epistaxis (Nosebleed)

1. Lay the athlete on a flat surface.
2. Apply a cold, damp cloth to the bridge of the nose.
3. If bleeding continues:
    - Insert a small, compact sterile gauze plug into the bleeding nostril.

Basics of Bandaging

- Bandage from **left to right**
- Start with 2–3 circular anchoring turns
- Bandage from **bottom upward**
- Apply the bandage obliquely in spiral fashion
- Each turn should cover at least half of the previous one

Specific areas

- Forearm or leg: include hand or foot
- Chest: pass the bandage over the shoulder for stability
- Abdomen: include the thigh to secure the bandage

Triangular Bandages

Used for:

- Injuries to hand, forearm, arm, clavicle (to suspend the limb)
- Fixing splints in fractures

The triangular bandage is folded diagonally:

- Long side = base
- Opposite corner = point
- Other corners = ends

To suspend the arm

1. Place the middle of the bandage under the forearm bent at 90°, point toward elbow.
2. Tie the ends behind the neck with a double knot.

3. Fasten the point around the elbow with a safety pin.
4. To avoid discomfort, place cotton or cloth under the knot.

Slings (Prassiform Bandage)

Used mainly for:

- Nose
- Chin

Made by cutting the ends of a 70–75 cm bandage, leaving the center intact.

- Center over nose or chin
- Ends cross and tie

For the nose: lower ends pass above ears and tie behind the neck.
For the chin: (continues in the next text…)

First Aid for Dislocation

A dislocation is the displacement of bones forming a joint.

Signs:

- Sharp pain with movement
- Swelling
- Loss of joint function
- Visible deformity compared to the healthy side

What to do

- Immobilize: suspend arm with triangular bandage or stabilize leg on a stretcher with padding or splint
- **Do NOT attempt to reduce the dislocation**
- Transport immediately to hospital

First Aid for Fractures

Types:

- **Closed** — skin intact
- **Open** — skin lacerated, risk of infection

Signs:

- Intense pain
- Swelling and bruising

- Deformity
- Abnormal mobility
- Inability to move the limb

Goal
Immobilize bone fragments with a rigid splint (preferably plywood).

Splint rules

- Must immobilize at least two joints above and below fracture
- Place padding between splint and skin
- Secure with bandages or cloth
- Arm: bent at elbow
- Leg: kept straight

Specific fractures

1. **Clavicle:** arm bent and suspended, shoulder fixed to chest
2. **Ribs:** deep inspiration → expiration → tight chest bandage
3. **Spine:** rigid stretcher; if unavailable, transport face down
4. **Pelvis:** on back, legs bent with support under knees
5. **Forearm:** two splints (outer to fingers, inner to wrist), suspend arm
6. **Humerus:** two splints (outer to wrist, inner to elbow), suspend
7. **Hand:** padding in palm, splint and suspend
8. **Femur:** two long splints (from armpit to foot; from groin to foot), rigid stretcher
9. **Leg:** two lateral splints from foot to mid-thigh
10. **Foot:** foot at 90°, board under sole, bandage

If no standard splints are available, use improvised materials (boards, sticks, skis, branches).

Open fractures

- Expose by cutting clothing
- Do NOT touch the wound
- Stop bleeding, disinfect around, apply sterile dressing
- Splint as for closed fractures

Jaw fracture

- Apply sling bandage
- If tongue falls back, pull it forward with gauze and place patient face down to ensure breathing

First Aid for Fainting

A brief loss of consciousness due to reduced blood flow to the brain.

Symptoms:

- Pallor
- Cold sweat
- Weak pulse
- Shallow breathing

First aid:

- Lay on back, head lower than legs (clothing under legs)
- Let them inhale ammonia
- Splash cold water on face
- If no breathing: start artificial respiration

Traumatic Shock

Can result from severe trauma, strong impacts, or psychophysical stress.

Mechanism:
Massive adrenaline release → peripheral vasoconstriction → blood flow centralization.
After 30–40 minutes: hypoxia and acidosis in organs → risk of tissue necrosis.

What to do:

- Immobilize and ensure maximum rest
- Position with head down and legs elevated
- Ammonia inhalation
- Medical intervention: dopamine, prednisolone, heparin

Loss of Consciousness

Start artificial respiration immediately.

Hypoglycemic Shock

Common in athletes.

Symptoms:

- Weakness
- Dizziness
- Pallor
- Cold sweat
- Possible loss of consciousness with involuntary convulsions

Cause: prolonged muscular effort + inadequate energy intake.

First aid:

- Give warm sugary syrup with white bread
- Or carbohydrate mixtures with citric acid

Head Trauma

Often accompanied by cerebral coma. The athlete cannot be awakened.

Danger

- Tongue relaxation → airway obstruction → mechanical asphyxia
- Loss of cough/swallow reflex → aspiration of saliva, blood, vomit

First aid:

- Turn patient on their side immediately, rotating shoulders and head together
- Regularly clear mouth and nose with cloth

Heatstroke and Sunstroke

During intense effort, the body may produce excess heat that cannot be dissipated.

Sunstroke results from prolonged exposure of the uncovered head to the sun.

Symptoms:

- Headache
- Dizziness
- Fatigue, drowsiness
- Nausea, vomiting
- Severe cases: loss of consciousness

First aid:

- Move to shade
- Lie down, undress

- Apply cold cloth to head
- Give cold water
- If unconscious: ammonia inhalation, artificial respiration
- Severe cases: urgent transport to hospital

Artificial Respiration Techniques

Silvester Method

- Patient on back, cushion under shoulder blades
- Rescuer kneels at head, grabs arms below elbows
- Count to 3 → lift arms overhead
- Count to 3 → bring arms down against rib cage
- Repeat 16–18 times per minute

With two rescuers:

- Each holds one arm
- Coordinate with counting

Prevent tongue fallback: pull tongue forward with gauze.

Schafer Method

Used for drowning or when Silvester is impossible.

- Patient prone, head turned to one side
- One arm under head, other extended
- Rescuer kneels over patient's thighs
- Hands on lower ribs → lean forward to compress
- Count to 3 → release → repeat

Do NOT use with rib fractures

Mouth-to-Mouth / Mouth-to-Nose

- Tilt head back
- Cushion under shoulders
- Blow into mouth using gauze or cloth
- For mouth-to-nose: use rubber tube into nostril

Hypertensive Crisis

Sudden spike in blood pressure above one's normal level.

Symptoms:

- Dizziness
- Vomiting
- Pressure or weight behind sternum

Risk: heart attack or stroke

First aid:

- Sit, keep head elevated (with pillows)
- Apply hot-water bottle to legs to dilate vessels

Conclusion

In this work, I describe one of the pillars of rejuvenation, based on physical activity, nutrition, and various physiotherapeutic measures.
However, we must always remember that every person has their own particular characteristics. We are not identical—mentally or physically. Each individual's personal story influences the whole organism.

For rejuvenation to be truly effective, we cannot focus solely on the body; we must also "clean up" our past existence.

How do we move in this direction?
I wrote about this in my book ***Self-Stalking***

Enjoy your reading.