... And wherever she thinks that she will behold the beautiful one, thither in her desire she runs. And when she has seen him, and bathed herself in the waters of beauty, her constraint is loosened, and she is refreshed, and has no more pangs and pains; and this is the sweetest of all pleasures at the time, and is the reason why the soul of the lover will never forsake his beautiful one, whom he esteems above all; he has forgotten mother and brethren and companions, and he thinks nothing of the neglect and loss of his property.

Plato: Phaedrus
FOREWORD

How is it that the mortality increases among people who were forcibly retired and those who have lost their husband or wife? How can you explain the miraculous healings of people whom the doctors have already given up, and have sought help by healers? They did nothing else than convince them that their "treatment" will help. Generally recognized is that ulcers of the stomach or duodenum develop in nervous people. Slowly is regaining force the awareness that the psyche has its role in the development of each disease. That the disease is influenced by genetic, endocrine, nervous, immune, emotional and behavioral factors. That the psyche as a factor in health and disease was completely neglected, a neglect of spirituality in general is the cause. Emotions were sometimes treated as a disease, or at best as a harmful, unnecessary relic of evolution, which should soon disappear, so that we can all act only with the help of reason. But in the songs we nevertheless always sing about feelings.

Psychoneuroimmunology has been developed, the science that explores relationships between the nervous and immune systems. But still every researcher deals with the substance from his own point of view, psychologist from a psychological, immunologist from immunological, neurologist from neurological and endocrinologist from endocrinologic one. No one has tried to assemble in one place all the findings which relate to the influence of emotions on the changes in the body, and to also consider the effects of the environment. This contribution is of course far from covering everything, but it can help everyone get to know himself. It is written for wide audience, but I think it will be interesting to experts as well.

I take this opportunity to thank the parents who supported me as unemployed, and the nurses and doctors in the dialysis department, without whom this book would never have been written. I also thank all those who peer-reviewed the text and improved it with their proposals.
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THE BODY IS A COMMUNITY OF CELLS

There is no life without cells. Molecules of deoxyribonucleic acid (DNA) in them determine the composition of all their proteins. As DNA is duplicated, it ensures that properties of a cell are maintained after cell division, while potential errors in the duplication create diversity, which is the basis of natural selection and adaptation of species to environmental change. Proteins give the cell its shape and function as enzymes that direct chemical reactions in the cell. Membrane from double layer of lipid molecules prevents the cellular molecules to scatter and lose contact with each other, or separates parts of the cell in which chemical reactions can take place only if they are spatially separated. The membranes include proteins that act as pores that let certain ions to pass through at certain stimuli. Others are receptors that bind certain molecules and change the course of chemical reactions in the cell after that. Still others have many other roles.

The body, such as human, contains billions of cells. Each has its own DNA with enough information to begin to reproduce indefinitely. However, since this would mean the collapse of the body and thus also of the freely dividing cells, each cell in the body has to act so as not to harm each other, and to share the work with others. They need to communicate, to work in unison.

People are social beings and we live in a community of many individuals. We also have to communicate among ourselves in order to share the work with others, so that we do not need to make everything by ourselves, from food and clothing to cars and houses. We communicate with sound, produced by the air squeezed out between the vocal cords, with movements that others perceive with the eyes, or we can also perfume ourselves and the molecules that others perceive by the sense of smell, proclaim our desire. Cells do not have vocal cords and the body is dark. Their molecules remain, which can be produced and excreted. Molecules can alter the functioning of other cells when they bind to their proteins. No cells in the body may reproduce freely. They grow and reproduce when other cells stimulate them with their secretions. But if sensory cells at one end of the body want to tell cells at the other end to move as they
would otherwise be eaten, they should excrete a lot of messenger substance to act on distant cells. And this substance would affect all body cells that have receptors for it. Therefore special elongated cells have developed. Since their membrane can be electrically polarized through their proteins which act as ion pumps, they can operate much like telephone wires. They transmit messages in the form of electrical impulses. At one end they excite when a stimulus triggers flow of ions through the membrane and changes the electrical voltage. This

1: The nerve cell. Peptide neurotransmitters are formed by linking amino acids in the endoplasmic reticulum (ER). Amino acid sequence in the peptide is determined by the nucleic acid in the cell nucleus. Peptides are formed in the same way as proteins, but with a smaller number of amino acids. In the Golgi apparatus proteins and peptides, which are intended for secretion, are packed in the lipid vesicles. Vesicles travel to the nerve endings, where they accumulate. When the cell is excited, calcium ions enter the endings, which promote the action of certain enzymes. The consequence of activity of these enzymes is the fusion of vesicle membranes with the cell membrane, and with this the neurotransmitter molecules are released that have been stored in the vesicles. Formation and secretion of different neurotransmitters is performed in the same way, except that in the ER the neurotransmitter molecules do not form directly, but the enzymes that promote their formation later in the vesicles. Other cells form and secrete substances in the same way. However, since they do not have axons and endings, substances are secreted from the vesicles on the surface of their bodies.
surge of electric currents is spreading rapidly along the membrane and quickly reaches the other end of the elongated cells. There, ions, which enter the cell, trigger the release of substances stored in the vesicles gathered in the cell endings. Vesicles are formed near the nucleus of the cell and travel to the ending. At electrical impulse they open outwards and release their contents. The substance is secreted only at the end of the cell, only in small quantities, and only affects the adjacent cell. These elongated cells are nerve cells and substances secreted from the nerve endings are neurotransmitters. Since it is necessary to coordinate messages from different senses for different

2: When a nerve cell is excited, a few vesicles fuse with the outer membrane and release their contents. Mitochondria are also in the ending, organelles in which glucose is degraded, which is needed to generate energy for chemical reactions in the cell. Released from the vesicles, the neurotransmitter molecules bind to receptors in the membrane of target cells. Receptors activate with this and induce changes in the target cells. They can cause stimulation of the target cell, or reduce its sensitivity to stimuli.
muscle and other cells, nerve cells are connected into a complex network, the nervous system.

Some stimuli, however, require altered functioning of many cells in the body. Therefore, it is appropriate then to secrete the messaging substances into the bloodstream. Because the quantity of such substances, called hormones, must be relatively large, some cells adapted almost all of their activity to the manufacturing of hormones. These are the glandular cells. However, substances that act on other cells secrete virtually all cells in the body, as well as all the cells receive messenger substances from others.

Body is constantly threatened by many dangers, which could destroy it. If the body is not defended, the bacteria, viruses, unicellular and multicellular parasites would multiply rapidly in it, and use it for food. Cells which are tightly bound in the tissue and have a special role, cannot fight against the attackers. Therefore, special cells exist in the body, traveling with blood and lymph, and when necessary, they gather in the infested tissue to cope with the enemy. These are the cells of the immune or defense system, white blood cells and various cells in the tissues, which call the white blood cells to help with specific substances they secrete when attacked. Immune cells destroy also the body's own cells which began to multiply uncontrollably due to genetic changes. They remove the remains of dead cells and excess or defective molecules in the body. So they are also a kind of dustmen.

Germ tissue of immune system cells is the bone marrow. This lifelong forms new cells, which are released into the bloodstream. Among them are the monocytes, which later develop into macrophages or phagocytes, B lymphocytes, which upon contact with the antigen form antibodies and cells that travel by blood to the thymus, the second important organ for the maturation of immune cells. Nested in its cortex, they reproduce. Thymus cells that surround them, secrete substances necessary for their development. They come from the thymus into the blood as T cells, which have different roles. Some encourage the operation of other immune cells, others inhibit them, and thirds destroy cells infected with viruses and cancer cells. Each cell of the immune system responds only to a single antigen, a fraction of a molecule with a definite structure. Therefore, a lot of
these cells exist and enormous is the diversity of antigens to which they respond. There is a problem, however. Immune cells must immediately destroy any enemy, but not attack healthy cells of the body. Therefore, all those T cells that respond to the body's own antigens perish in the thymus. Nevertheless, sometimes the defense cells attack the body's own tissue and the autoimmune disease develops.

Immune cells stimulate or inhibit each other with a multitude of different substances. And because their performance may not be independent of other cells in the body, they are stimulated or inhibited by substances secreted by many other cells. The nervous system has an important role in this, affecting the immune system directly by its own substances or by stimulating the secretion of hormones from the glandular cells. Naturally, the influence is also in the opposite direction. The immune cells exhibit influence on the entire organism with secreted substances.

3: When an ingesting cell detects bacteria, it surrounds it with its cytoplasm (1,2). It closes it in a vesicle (3). Vesicle with the bacterium fuses with another vesicle (4). In it are enzymes that break down bacteria (5).
When viruses or bacteria enter the body, or when body's own cells degenerate into tumor cells, the fight between them and the defense system of the body starts. Those more successful will win. Defense system will be the winner, if it destroys the enemy faster than it is reproduced. However, this attempts to hide or even destroy immune cells. Therefore, our defensive system should work as good as it can to beat infections. However, its efficacy is influenced by many factors.

Modern medicine has long considered man as a machine to be lubricated and in the disease to have worn parts replaced. Impact of the psyche on the body was not recognized, as if believed in the separation of soul and body. It is no wonder that the various healers, hand touchers and other "bio-energetics" found fertile ground for their operations. It is clear that between them and official medicine could not be understanding. Despite the fact that science cannot attribute any direct therapeutic effect to their therapies, they achieved successes. Physicians who treat patients with cancer, found that who is diagnosed with cancer depends also on their emotional state and not just from the radiation, diet, carcinogens and genetic predisposition. They also found that only those can cure who believe they will recover and have the will to live. This has led to psychotherapy for cancer patients, which has proven to be successful.

Awareness of the link between the soul and the body is not something new. Antique doctors already knew it. Greco-Roman physician Galen noted that depressed women are more likely to contract cancer. In the 19th century, physicians have agreed on the strong connection between emotions and disease. But later the psychology and medicine separated. Knowledge of one profession was ignored by the other, it did not even become aware of it. Cooperation was restored by the nervous system and hormone researchers who discovered the flight or fight response, the emotional response to stimuli from the environment that cause large changes in the body. In a recent study, blood was tested in students after the holiday and during exams. The immune system fared much worse during exams. Killer cells that destroy tumor cells responded weakly,
while others produced a lot less protein interferon, which inhibits viral replication. Activities of herpes virus that causes frequent ongoing infection has increased. Also, colds were frequent during the exams. Isolated students were more severely affected.

Man has always been consciously or unconsciously looking for ways to beat the disease with help of the psyche. Folk healers invented a multitude of ways to affect the patient’s mood and his faith in healing. Of course, their treatment is usually complemented with natural remedies. In India, yoga was developed, elsewhere in more recent times, autogenic training. The testers of new drugs realized the importance of beliefs, as they must give to the control group of patients a seemingly identical product, but without the effective substance. Let us examine in detail what is changing in the body under the influence of emotion, mood and expectations.

FEELINGS AND EMOTIONS

Our behavior and our decisions depend not only on the cold assessment of the facts, often emotions have a crucial role. We say that the heart prevails over the head. Today of course we know that everything happens in the brain. There also the emotions form that affect the heart through the nervous system. What is their origin and meaning?

Imagine you are walking down the road, and a true dinosaur comes to face you. Your heart will start to beat as insane, the pupils will expand, you will begin to breathe deeply, to sweat, blood will flow to the muscles, blood sugar will increase. If you do not numb with fear, you run without reasoning. Later you will learn that dinosaurs from faraway China are new pets to replace a little too headstrong dogs. You may sometime later, when re-meeting, stroke its head and ask the owner where you could buy such a lovely animal.

The same stimulus, a dinosaur in the street for example, can therefore lead to quite different responses in the same man. In humans, responds to stimuli from the environment are usually taught. But often the respond to stimulus is an inborn response that has evolved in natural selection. This prevails in many animals, but can change by learning. This allows greater flexibility when the environment changes. In humans and other vertebrates many stimuli,
in inborn or learned response, operate through the emotions. Emotions are then what forces us to certain actions which are not always identical, but are tailored to each situation. If a dinosaur calls the feeling of love in us, we want to pet it and take it to our home. Under the influence of emotions many things in our body also change. Thus in the case of fear the sympathetic nervous system is aroused that prepares the body for the run. Sympathetic nervous system innervates many body organs and excretes noradrenaline from the nerve endings. Glandular cells in the core of the adrenal gland secrete adrenaline when we are disturbed, a substance similar to noradrenaline, with similar effects. They also secrete noradrenaline. Both substances bind to the same receptors, accelerate the heart rate, extend the pupils, increase blood flow to the muscles and reduce flow to the skin, expand the airways and raise the amount of glucose in the blood. Thus they prepare the body to fight or flight. Sympathetic nervous system is part of the autonomic nervous system over which we have no conscious control, as we have over the motor nerves, which manage the muscles. The second part of the autonomic nervous system, the parasympathetic nervous system, secretes acetylcholine from nerve endings. This slows the heart rate, narrows the pupils and promotes digestion. The organism then rests and restores consumed substances.

If a stimulus acted on the organism through a simple neural link between sensory and motor nerves, the organism would soon become victim of the environment. Imagine a rabbit, which is running away from the fox. A bush obscures his view of the fox and the rabbit stops. Fox hops from the bush and grabs him. Of course, things do not go that way. Rabbit runs as long as it does not feel safe.

Certainly, a patchwork of nerve pathways could exist in the animal brain that causes a similar response in them as in us, without creating a sense of the kind we feel in our consciousness. But you have to admit that it would be quite impossible that the whole evolution up to the human did not create some consciousness, which then came to light in all its glory and complexity. Just as in evolution the wings did not suddenly appear in a bird, but have gradually evolved from the legs, a consciousness could not suddenly appear in humans. It has certainly evolved gradually, initially only with certain feelings. And
the first feelings were certainly those who were most needed for the survival of animals.

Just as awareness of visual, auditory and olfactory senses, the various feelings and emotions developed. The pain was probably one of the first feelings that have developed in evolution. It has a very important role. Draws attention to the damage and therefore prevents it. Animal that was once injured in a certain action and painfully felt this, will avoid that action in the future and so prevent re-injury. Food, which has led to stomach pain, it will no longer try. All animals do not feel pain. We can tear the whole abdomen from an insect, and it will continue to sing and court a female when it is a male, of course. Soon it will die, as it has lost several internal organs. For insects, therefore, we can be sure that they do not have even the most basic elements of consciousness. Not so in vertebrates. All feel the pain. Pain is felt also by the animals in which the cerebral cortex has been removed. So the pain is produced in the lower parts of the brain, probably in the thalamus, to which signals from the sensory nerves run before they enter the cortex. But the cerebral cortex is necessary to detect the location on the body, which is the source of pain. To the initial feelings we can rank also sensations of heat and cold, which allow an organism to stay where the most suitable temperature is. Like the pain they prevent recurrence of acts that would cause burns or frostbite.

Every emotion has its own meaning. Fear enables flight, anger fight. Their effects on the organism are similar because in both cases the sympathetic nervous system is aroused and stress hormones are secreted. In both cases, the organism is to utilize best the power of its muscles and its brain must act as quickly as possible. It must not stop at the beautiful fragrant flowers and smell them. Therefore, the brain only focuses on the most important events, it is deaf and blind for the rest. Love provides the common life of parents needed for upbringing a child and parental care of him. Sorrow generates compassion in others. Hunger compels us to search for food, thirst for drinks. Depression enables us to survive prolonged periods without food, as it reduces energy consumption and allows the use of reserves in the form of adipose tissue and muscle.
Processes in the brain that underlie emotions remain poorly understood. With certain emotions certain neurotransmitters are connected and the stimulation of certain brain areas may cause emotion with all its consequences. But it seems that the whole brain is involved in the feeling. The shares of secreted neurotransmitters are different for each emotion. Differently active brain cells, which are the cause for that, are probably what is detected in our consciousness as emotion.

People have different opinions about the feelings. They speak of noble feelings, which should be given only to humans, but not to cruel animals. And they talk about non-human, animal emotions that humans should avoid. Some are ashamed of any emotion, because they put themselves, men, at the top of the universe, highly rational creatures that emotions should not interfere. Nor former nor latter are right. All feelings are of the same origin, and they facilitate our survival on this planet. Although other animals also have them, we do not need to be ashamed. What sense would our lives have, if not met with little happiness, love, pleasure, and sometimes pleasantly invigorating moments of fear, anger and satisfaction.

WHY NOT BIG INSECTS?

Grunts announce annual deer fight for females. Two horned challengers run against each other and strike with antlers. So they find out who is bigger and stronger. The smaller runs away from sharp antlers to the woods, the larger starts to court females in his harem. This year he will only pass his genes to the offspring, smaller bucks will not win this right.

Suddenly, the herd starts running. A pack of wolves jumps after them. The smallest and weakest hind falls behind the rest. The wolves catch her up and wring her neck.

Being bigger and stronger is without doubt a great advantage. The larger specimens are easier to defend against predators and are more successful in battles with competitors to secure progeny. Is therefore natural selection leading species into continued growth of specimens?

Such a development is showed nicely by fossil remains of many animal species. We can see it in the evolution of horses from the ancestors of rabbit size. But such a development is not the general
rule. It seems that growth stops when the specimens reach the size most suitable for them. Thus, there are still animals of all sizes. Why, for example, there are no big insects, otherwise extremely successful forms of life?

This question is usually explained by insect structure. Insects do not have a continuous vascular system to supply the body with oxygen. They breath with a tracheal system instead through which gases are exchanged by diffusion. This is a transition of molecules from areas of higher concentration to an area with less. Diffusion would be in large animals, when the distances increase, inefficient. But the ancestors of insects had closed vascular system and some insects have haemoglobin, a substance that binds oxygen and transports it by blood through the body in vertebrates. Air exchange in tracheae can greatly speed up with respiratory movements by the bug. If the present insect is expanded, it really could not live. But with such a diverse group with so much ability to adapt, there is little chance that it could not develop as it would be necessary to increase the size. An external skeleton should not prevent that because the pipes are almost as firm as solid bars the same size. After all, insects lived in the past, much larger than today. The giant dragonflies of the Carbon era measured up to 75 cm across the wings.

It is more likely that small size is most appropriate for insects. Each species has a limited amount of food, so the total weight of all specimens of a species is limited. If the specimens are larger, they are less numerous. The fewer there are, more valuable a specimen is for the species survival. There are therefore two possibilities in evolution. Development of large specimens in small numbers that are able to successfully defend against all threats in the environment. Or of small, numerous specimens, where the loss of individuals do not jeopardize the species, since it can rapidly multiply.

When insects among the first animals inhabited the land, the size was an advantage. Therefore large forms have developed. But when the land vertebrates evolved, large insects became an easy prey to them. Because they were limited in number, vertebrates exterminated them. Only species of small size prevailed in which the power lies in abundance. They also much easier adapt to changes in the environment. In more specimens, a larger selection of different genes
exist and therefore higher probability that some of them enable the survival in a changed environment. But why the history did not happen the opposite way, that the insects progressed in size and prevented the development of large vertebrates? Why could not they compete with them?

An important difference exists between insects and vertebrates. It is in the brain. Insects act as a well-programmed computer. To each stimulus in the environment they answer after a prepared program. Many insects feed only with certain foods, such as a particular type of plant. Is it just that edible for them? Researchers have found that they can eat other foods. So why such squeamishness? Brains are simply programmed so that only certain plant species triggers feeding behavior. Switch to another type of food can be triggered only by a genetic modification. Something entirely different from the curiosity of monkeys who try any food that might be edible. With experiences they increase the selection of food they consume and thus increase the chance of survival. Even a single individual can thus adapt to changes in the environment. If a plant species becomes extinct which used to be food of insects and monkeys, monkeys replace it with another, while insects die out. Only those specimens survive that had previously adapted to a different food source with the genetic mutation. What makes monkeys so flexible? To be able to learn what foods are good and which are not, they need a message that reveals this difference. These are the feelings. If a food is bitter, if it smells foul, if after ingestion causes nausea, vomiting, then the monkey will not attempt to eat it again. If it tastes good, smells nice, after ingestion causes pleasure, it will be included in its diet. Insects do not have feelings. Therefore, they cannot increase their food selection by trying. Feelings are what makes the insects incompetent towards vertebrates.

**ACTIVITY AND REST**

Defense of the organism or its immune system is based on the guards that travel around the body with blood and lymph. These are white blood cells. When they encounter a foreign substance, they begin to multiply and produce antibodies. These are proteins that bind to a specific antigen and thereby cripple its owner. Phagocytes then
engulf and digest a substance or a cell to which the antibodies bind. The body cannot know in advance what enemy will attack it. Therefore a wide array of lymphocytes is produced. Individual lymphocytes respond only to a specific antigen, and when the enemy invades the body only a few lymphocytes react to it. But then, these reproduce and many of them remain in the body even after the enemy is defeated. If the same invader is met again, it is quickly destroyed. For cell growth and production of antibodies proteins must be produced quickly in the cells and in large quantities. However, when the organism is active, at risk for example, it requires energy for movement and brain function. Then it is better that the energy is not consumed for the formation of proteins, but is delivered as glucose to the organs that need it for operation. The changes in the use of energy in the body are governed by the hormones.

Cells generate energy for chemical reactions with the decomposition of glucose. Organism gets glucose primarily from carbohydrate foods, such as starch. Glucose can be formed also by conversion of other substances, but that cannot do all cells in the body. Formation of glucose from other substances takes place under the influence of hormones. Glucocorticosteroids are steroid hormones secreted by the adrenal cortex. In most cells they inhibit protein synthesis and accelerate its degradation. In the liver, they cause the formation of glucose from other substances. Amino acids, the building blocks of proteins, are converted into glucose, the adipose tissue releases fatty acids that also serve to produce glucose. All this increases the amount of glucose in the blood, which is available to the muscles and nervous system. Glucocorticoids are secreted when the frontal lobe of the pituitary gland secreted adrenocorticotrophin (ACTH), which causes the secretion of glucocorticoids. The pituitary is a gland of internal secretion, closely related to the brain. It consists of neurohypophysis or rear lobe, which is an extension of the brain and the frontal lobe or adenohypophysis that arose from the wall of the mouth.

Between the blood and nerve cells in the brain a barrier exists, which many molecules hardly transit. It is formed by the capillary walls and extensions of certain nerve supporting cells. Thus, a stable environment for the operation of the brain is maintained. Glucose, the
only substance that the brain can use for energy and amino acids needed for protein formation, are transmitted through the walls with specific membrane proteins. Blood-brain barrier also prevents substances secreted by brain cells to enter the blood and influence other organs. But this limitation is not present at the bottom of the hypothalamus and in neurohypophysis. There the nerve cells secrete their secretions into the blood capillaries. The hypothalamus is a brain area that surrounds the lower part of the third cerebral ventricle. It regulates many of the will independent activities in the body, such as the autonomic nervous system activity and hormone secretion. Veins, which capillarize in the hypothalamus, lead the blood to adenohypophysis, where they capillarize again. It is thus provided that substances secreted by nerve cells in the hypothalamus affect adenohypophysis where they cause or prevent the secretion of its hormones. Hormone ACTH is secreted only when corticoliberin or corticotropin-releasing hormone (CRH) is secreted from the hypothalamus.

Corticoliberin is secreted when we feel cold, fear or pain. Thus, through glucocorticoids glucose is provided for the body to heat, fight, flight or other needs. However, as the protein synthesis is reduced, the immune responses weaken. Thus we catch cold in the cold, for example. The secretion of corticoliberin is also affected by the biological clock. The peak of its secretion is in the morning. Thus sufficient amount of glucose is provided for the movement and brain function. Towards evening, when the amount of glucocorticoids in the blood decreases, the activity of a man wanes, but immunity increases.

Of course, there is also a hormone that promotes the formation of proteins and thus cell growth. So it also promotes immune responses. This is the growth hormone or somatotropin. It also causes degradation of glycogen in the liver, which is a store of glucose to the body. With the degradation of glycogen glucose is released, which passes into the blood. This increases the amount of blood sugar. Growth hormone promotes the degradation of fatty acids that is used to generate energy primarily in muscle cells. Secretion of growth hormone is caused by the hypothalamic hormone somatoliberin or growth hormone releasing hormone (GRH), which is secreted when
the amount of glucose in the blood is reduced. The increased amount of glucose in the blood caused by the glucocorticoids and adrenaline, which are secreted in excitement and in danger, therefore inhibits the secretion of growth hormone. Blood glucose level is perceived by the senses in the hypothalamus. Growth hormone is secreted mainly during sleep, as well as during exercise and the emotional distress. Important role in regulating its secretion has also somatostatin, hypothalamic hormone that inhibits secretion of growth hormone.

Thyroid hormones thyroxine and triiodothyronine, are also needed for immunity. Without them cells cannot convert glucose into energy. Without insulin from the pancreas, glucose cannot enter cells from the blood.

The link between the nervous and immune systems through glucocorticoid hormone secretion from the adrenal gland is known since 1950. Synthetic glucocorticoids have long been used for the

4: The human brain in the longitudinal section. Brain areas that are mentioned in the text are indicated.
attenuation of immune responses in allergies, autoimmune diseases and organ transplantation. Unfortunately, their use is associated with high risk as the organism cannot resist any infection when its immunity is reduced. However, glucocorticoids are not the only inhibitors of the white blood cell activity. S.E. Keller and his colleagues found that stress reduced lymphocyte response to infection even in rats, which had the adrenal glands removed. The finding of neurotransmitter receptors on lymphocytes may explain the matter. They can bind substances secreted by nerve cells, which innervate lymphatic organs. To the lymphocytes in the spleen, where the blood

5: The hypothalamus and pituitary with veins that connect them. Some nerve cells from the hypothalamus send outgrowths to the neurohypophysis where they emit secretions into the blood. Others, however, emit their secretions into the blood in the hypothalamus. This blood drains by portal veins into the adenohypophysis where substances from nerve cells of the hypothalamus promote or inhibit hormone secretion from the glandular cells. (Eckert and Randall 1983)
cells stay, many sympathetic nerve endings lead. Noradrenaline, secreted by them, inhibits lymphocyte function. The sympathetic nerve endings are also in the thymic cortex, together with the nerve cells that secrete vasoactive intestinal peptide (VIP). This substance is a potent inhibitor of T-helper lymphocytes and natural killer cells. The ACTH, which is secreted from the pituitary gland, also inhibits lymphocyte function. However, ACTH is secreted from the pituitary gland together with beta-endorphin, which mainly potentiates lymphocyte function. Both peptides are formed in the same pituitary cells. First a much longer peptide forms, which is then cleaved. From it ACTH and beta-endorphin arise. So they are always produced together, under the influence of the same stimuli. Both are secreted into the blood during stress.

Endorphins are secreted from nerve cells in the brain and prevent the pain there. They bind to the same receptors as morphine, a substance produced in the Opium poppy. Endorphins, which are secreted from the pituitary gland into the blood, affect the metabolism of glucose. In the pancreas they stimulate the release of the hormone glucagon, which raises blood glucose levels by depolymerization of glycogen in the liver and release of glucose. Due to increased amount of glucose in the blood insulin is also excreted from the pancreas which promotes the acquisition of glucose into cells. Both together are part of the fight or flight response which supplies the muscle cells with more energy. Involved are, in addition to glucagon and insulin, also glucocorticoids, which cause the conversion of protein and fat into glucose, adrenaline from the adrenal core and growth hormone that release glucose from glycogen in the liver. Growth hormone promotes the degradation of reserve fat for energy too.

Increased amount of glucose in the blood is very much needed if the organism is really struggling or running away, and this energy is spent. But in our lives we often feel threatened, without being able to do something about it. Normally, the secretion of hormones of the fight or flight response stops in the night. Only growth hormone which releases glucose from glycogen in the liver, ensures that the glucose concentration in the blood does not fall too much. But anxiety and depression cause the secretion of ACTH and endorphin to continue into the night. Because of them glucocorticoids and
glucagon increase the amount of glucose in the blood, which prevents nocturnal secretion of growth hormone. Growth hormone is secreted at night only when the amount of glucose in the blood is reduced.

One of the signs of aging is the increasing proportion of fat in the body and the declining proportion of protein. D. Margules explained that by the action of glucocorticoids and insulin. Glucocorticoids cause protein degradation, thus reducing the protein's share in the body. Diminished secretion of growth hormone certainly contributes to this, as proteins degraded during the day are not replaced at night. While insulin promotes the adoption of free fatty acids from the blood into the cells of adipose tissue and liver, where a reserve of fat is formed.

Increased amount of glucose in the blood causes secretion of the hormone insulin from special glandular cells in the pancreas. Insulin lowers the amount of glucose in the blood and thus is responsible for a stable concentration of glucose in it. If insulin must constantly be secreted because of persistently elevated concentration of glucose in the blood, the glandular cells in the pancreas become exhausted and fail. Diabetes develops in which patients have too much glucose in the blood because they lack insulin.

According to the findings of A. Cerami and colleagues the increased amount of glucose in the blood is harmful also by itself. They found that glucose molecules bind to proteins in the body and slightly change. Such then bind to another amino acid, which may be of another protein. In this way, chemical bonds form between the protein molecules. These may be blamed for making collagen, a protein of the connective tissue, less flexible in older people. Arteries become rigid, and when they are injured, the links made by glucose molecules cause the accumulation of lipoproteins at the site of injury, which can lead to clogged arteries and heart attacks or stroke. Lipoproteins, which are composed of protein and cholesterol deliver cholesterol to cells, which need it as a necessary component of cell membranes and the parent compound for the formation of steroid hormones. In anxiety the amount of cholesterol in the blood increases due to increased synthesis of cholesterol in the liver. Synthesis of cholesterol depends on the biological clock. More of it is formed during the day, when several forms of steroid hormones such as
glucocorticoids are also formed. These are formed also during the fight or flight response, and accelerated formation of cholesterol is logical then. But anxiety can take too long and elevated cholesterol can cause heart attacks or stroke.

Bonds between the molecules are to be blamed also for the thickening of basal membranes of capillaries, leading to poor renal function in elderly people and diabetic patients, where changes occur much faster because they have elevated blood glucose levels. Since stress also increases the amount of glucose in the blood, it accelerates aging. This finding is not new. People have long known that they get gray hair with worries.

In a healthy organism, the chemically linked proteins are removed. They are digested by macrophages, a type of white blood cells. However, in older people macrophages lose their effectiveness, so the amount of modified proteins begins to increase in age. And so we came back there from where we went: to the control of the activities of the immune system.

NERVOUS SYSTEM AND IMMUNITY

In 1934, the book by S. Metalnikov from the Pasteur Institute in Paris, The role of the nervous system, biological and psychological factors in immunity, was published. To Metalnikov it seemed impossible that such an important part of the organism as the immune system is not affected by the nervous system, which connects all organs in the body. The first evidence that this link exists, has been obtained when a damage to certain parts of the brain decreased immune capacity of the organism. He then conducted an experiment with conditional learning. He injected rabbits with a foreign material and rubbed their skin while playing the trumpet. Later, just rubbing of the skin on the ear or the sound of trumpet provoked accumulation of white blood cells and multiplication of antibodies. These experiments clearly confirm the effect of nerve cells on the immune system. Therefore, Metalnikov concluded that the psyche also affects immunity. His findings then unfortunately fell into oblivion.

Acupuncture fast and effectively increases the immune ability of the organism. Twenty minutes after acupuncture a strong increase in the proportion of active lymphocytes can be seen, compared with
inactive prevailing before acupuncture. Active lymphocytes are larger and more irregularly shaped than small, round, inactive lymphocytes. Increased proportion of active white blood cells is preserved 24 hours after acupuncture. Immediate impact of acupuncture on white blood cells cannot be explained by the influence of growth hormone, since it is secreted mainly during sleep and has an effect only then. After all, this hormone allows the immune response only in that it promotes the synthesis of proteins. That the conversion of inactive lymphocytes to active ones is caused by a hormone in the blood have been shown so that the white blood cells taken before acupuncture were added to the serum, which was taken after acupuncture. When they were mixed, the lymphocytes transformed into an active form. Such is the impact of thymic hormones. If thymic hormone thymosin is added to the blood, transformation of lymphocytes is induced. But what causes the secretion of thymosin during acupuncture?

There is evidence that acupuncture affects the autonomic nervous system. If the sympathetic nerves are too excited, it calms them down, if they are not active enough, it stimulates them. A similar effect was also observed in lymphocytes. In people who have too few active lymphocytes, acupuncture increases their number, in those who have higher percentage of active lymphocytes from normal, decreases it. Therefore, acupuncture can cure overactive as well as underactive immune activity.

Karen Bulloch has researched the nerve endings that penetrate deep into the bone marrow and thymus, organs where white blood cells mature. She concluded that most nerve endings in the thymus belong to the parasympathetic nervous system which secretes acetylcholine. Fetal thymus is already well innervated with parasympathetic nerve endings. The researchers found that these endings are essential for proper development of the thymus in the fetus and for its performance in adult specimens. Secretion of thymic hormones is not uniform, but in humans increases in the evening. If we are sick, our body temperature rises in the evening, what is a sign of increased immune activity. In the evening, the body prepares to rest, and the parasympathetic nervous system is active. It is possible that the parasympathetic nerves also promote the excretion of thymic hormones.
Sympathetic nervous system has also many endings in the thymus. But it innervates it only after birth. Thymus is not active in the fetus, so as not to develop an adverse immune response against the mother's proteins, substances foreign to him. Mother's immune system protects embryo from infections. After birth, when the body must defend itself, its thymus begins to operate. Sympathetic nerve endings secrete noradrenaline, which inhibits the action of white blood cells. They innervate also other lymphatic organs such as the spleen. In the lymphoid organs large amounts of white blood cells are kept and probably it would not be good if they were too active in them. Think about how it would be if a pack of wolves is closed in with the sheep in a pen. That would be something like keeping the white and red blood cells in the spleen. Sympathetic nervous system is probably necessary to calm the "wolves" - white blood cells. Researchers have bred a special strain of mice in which the sympathetic nerve endings in the spleen degenerate in the early stage of aging. In them an autoimmune anemia develops, white blood cells destroy the red, which are necessary for oxygen transport. Normally white blood cells swallow and digest the remains of dead red blood cells. Apparently, they can exaggerate in this activity when the nervous system does not inhibit them, and begin to destroy the red cells when they are still alive.

Sympathetic nervous system also stimulates the white blood cells. Enkephalins, which bind to opiate receptors, stimulate the activity of T lymphocytes and natural killer cells. Enkephalins are secreted into the blood from the adrenal core together with adrenaline. Core of the adrenal gland can be counted to sympathetic nervous system. During exercise the effectiveness of the immune system increases, what could be the result of the activity of the sympathetic nervous system, which is active then. Of course, the core of the adrenal excretes noradrenaline as well. However, this does not inhibit the activity of white blood cells in the blood. Its concentration in the blood is much lower than in the lymphoid organs, where it is secreted from nerve cells in the immediate vicinity of the white blood cells. In a small concentration noradrenaline even stimulates lymphocytes. Its effect depends on two types of receptors in the lymphocytes. They have more beta receptors, which act inhibitory. However, noradrenaline is
easier to bind to alpha receptors, and therefore at low concentrations occupies mainly alpha receptors that stimulate. When the concentration of noradrenaline increases, occupies the beta receptors. As these are more numerous, their inhibitory effect prevails. The effect of enkephalins is also concentration-dependent. A high concentration of enkephalins also inhibits the action of white blood cells.

When fleeing or fighting the risk of infection increases, as it may follow an injury. Since the glucocorticoids are secreted then, which prevent the immune response, the organism would remain without defense against microbes. Sympathetic nervous system prevents the loss of resistance with enkephalins and noradrenaline, but also inhibits the immune response in lymphoid organs, since it would be harmful there. Both enkephalins and noradrenaline stimulate only the white blood cells that are on a cruise around the body. During the flight or fight growth hormone is also secreted, which prevents the deleterious effects of glucocorticoids. All the more dangerous is the

6: The endocrine glands, which are important in regulating the immune system.
depression, in which glucocorticoids are secreted, but the autonomic nervous system is not active and growth hormone is not excreted. The organism cannot successfully combat various microbes and cancer cells then. That said, the question remains why the glucocorticoids are secreted in depression. It is clear why they are secreted in cold, pain, fear or rage. Then the body needs a lot of energy for heating, fight or flight. This energy is provided by glucocorticoids, which cause the conversion of proteins and fat into glucose, which is generally used as an energy source. At least at first glance, we do not understand why by the natural selection a similar response evolved in depression, during which the organism is usually motionless, devoid of any will, far from a wish to fight or flee.

If we try to answer this question, we must imagine a situation in which our ancestors lived when they were still naked and totally dependent on what they find in nature. Sometimes the food runs out in the nature. How can the organism survive? In the absence of food,

7: Sympathetic or noradrenergic nerve endings in the thymus. They enter the thymus along with blood vessels and innervate its cortex. (Felten et al. 1985)
the depression overwhelms him. Because of depression the metabolism slows, less energy is consumed because he is not to take any action which is not necessary for survival, such as mating. The secretion of sex hormones is reduced. Metabolism slows down due to decreased secretion of thyroid hormones thyroxine and triiodothyronine, while glucocorticoids allow him to live by its own reserves. Fat and proteins accumulated in the period when he had enough food are slowly consumed. But when he locates food, he eats and resolves depression.

Because the depression passes away after a meal, some depressed people eat a lot and fatten themselves. Due to reduced metabolism they fatten even if they do not eat more than others. Certainly, in abundance this adaptation has no advantage, so we must look for a way of life in which we will be happy.

Researchers of depression found with electrodes that the activity of left frontal lobe of the cerebral cortex is reduced in depression. Damage to this lobe causes depression, contrary to the right frontal lobe damage, which often leads to euphoria. Researchers of the immune response have seen that damage to the left side of the cerebral cortex halves the number of T lymphocytes in the spleen, while the remaining cells are much less responsive to antigens. In contrast, damage to the right half of the cortex increases the number of T lymphocytes and stimulates their activity. So we can explain the results of Metalnikov's experiments now which remained without an echo because they seemed impossible then.

INFLUENCE IN THE OPPOSITE DIRECTION

When helper T cells bind to a foreign substance, they stimulate macrophages, another type of white blood cells to the formation of interleukin-1, a substance that stimulates the activity of T lymphocytes and thus enables the propagation of antigen-driven cell defense system. Interleukin-1 also affects the brain. This influence produces a rise in body temperature. Autonomic nerves, activity of which is regulated by the brain, cause contraction of blood vessels in the skin, thus reducing blood supply to the skin. The result is that blood can no longer cool, and body temperature rises. At higher temperatures, many viruses and bacteria reproduce with difficulty
what facilitates the work of immune cells. According to recent knowledge, this is not the only effect of interleukin-1 on the brain. Scientists have obtained the interleukin-1 and injected it into the cerebral ventricles of rabbits. It was noted that this induced sleep with slow electrical brain waves. The same, only weaker effect was achieved when interleukin-1 was injected into the blood. Now we understand why we are sleepy when we have an infection. But what good is in the fact that the warring defense cells cause sleep? During sleep, the hormone secretion which is affected by the brain, changes. Growth hormone, secreted during sleep, stimulates immune cells. Thus, when immune cells stimulate the brain to sleep, they promote their own activity. The infection also damages or destroys many cells in the body. For tissue repair growth hormone is essential. And it was shown that interleukin-1 really strongly increases growth hormone secretion, but only at low concentrations. If its concentration in the blood rises, its effects on the secretion of hormones disappear.

The accident does not occur alone, states folk saying. And true. When we get sick of a disease, it often happens that we incur a second. When you come into the hands of doctors, they never release you, people say. Since AIDS is scaring the world, any other disease is talked about as much as it is. From the infection to the outbreak of the disease many years may pass. Doctors have found that AIDS very often erupts when the infected is diagnosed with another disease. When the body fights the flu or something similar, the AIDS virus takes the opportunity to reproduce. How to?

It revealed that the infection, followed by an immune response, increases the amount of glucocorticoids in the blood. These are adrenal hormones that suppress the immune response. They are secreted under the influence of the hormone ACTH, which is secreted by the pituitary. This secretes it when stimulated by corticoliberin, a peptide excreted from nerve cells in the hypothalamus. However, elevated glucocorticoid concentration was detected after infection with the virus also in mice, which had the pituitary removed! Source of the ACTH was found in the spleen. In a patient who has suffered the consequences of excessive amounts of the hormone ACTH in the blood, a hormone active tumor, often the cause of such problems, had not been found. Finally, the source of ACTH was found in an...
inflamed tissue, full of white blood cells. When it was cut out, the problems were gone. It has been shown that lymphocytes, white blood cells that fight the virus or other infections, may secrete ACTH which stimulates the secretion of glucocorticoids in the adrenal glands. Glucocorticoids do not affect active lymphocytes, because they lose receptors for them. But they prevent the activation of other lymphocytes and inhibit the action of macrophages. When the body is fighting against one enemy, it is much more vulnerable to others.

Of course this has its own causes. When infection stimulates macrophages they secrete interleukin-1 and other substances that promote lymphocyte function and cause inflammation. Too severe inflammation is harmful, however, and promoted activity of all lymphocytes can lead to autoimmune diseases, white blood cells attack the body's own tissue. It is better that lymphocytes, which are activated first with infection, inhibit other lymphocytes and decrease the excretion of substances that cause inflammation. This is achieved by the secretion of ACTH, which causes the secretion of glucocorticoids.

Lymphocytes can also secrete endorphins, which are produced from the same peptide as the ACTH. Endorphins can stimulate or inhibit other lymphocytes, depending on the type of receptors to which they bind. Moreover, they increase the amount of glucose in the blood needed by white blood cells to function.

These examples show us how closely connected all cells in the body are. They communicate via excreted compounds called hormones, neurotransmitters or otherwise. It was once thought that the nervous and immune systems operate completely separately, without interaction. Today we already know many links that work in both directions, from the nervous system to immune cells and vice versa. Knowledge of these events is growing from day to day and we can expect many more surprises.

MOVEMENT AND SLEEP

Humans who for a long time do not live as they lived when part of nature, have a growing perception that they should care of their health, to adapt their habits to the requests of healthy life. In addition to clean air and water and a healthy diet a lot more is needed. More
and more people are exercising and all claim to feel better afterwards. However, sleep is also inevitable.

Severe emotional turmoil, depression, cold or pain, impair the immunity of the organism. They cause the secretion of glucocorticoids, which prevent the immune response. That stress can be prevented by exercise, we hear often when the benefits of regular exercise are considered. Naturally, it is less clear how motion affects the body's immunity.

Brain researchers have discovered the importance of nerve cells, which have bodies in the brainstem and release dopamine, noradrenaline or serotonin, collectively identified as monoamines, as neurotransmitters. Their axons lead to many parts of the brain, to those that control movements, as well as those involved in the feeling of emotions. They found that the secretion of monoamines in the brain is reduced in depression. In rats an interesting experiment was conducted. They were infected by cancer cells, then only half of them received a substance that prevents depression by increasing the quantity of secreted monoamines in the brain. Rats that received antidepressants did not suffer from cancer, while the majority of rats in the control group became sick. The results can be explained if we know that the noradrenaline was found to prevent the secretion of glucocorticoids.

When the Spanish conquistadors conquered Peru, they were greatly surprised by the effects of coca leaves which are chewed by the Indians. One Spanish chronicler wrote: "This herb is so nutritious and invigorating that the Indians work all day without anything else." The use of coca already had a long history then. Inca culture gave it much importance. Coca leaf was appreciated as a gift by the sun god to the first Inca ruler. They argued: "the angels of God donated coca leaves for man, to satisfy the hungry, tired and weakened to restore power and help the unfortunate to forget their misery." The news of this plant has rapidly spread around the world, and soon won the Coca followers in Europe. Among them was Sigmund Freud, who has experimented with coca on himself and said: "Cocaine causes delight and satisfaction, not a bit different from the satisfaction of a normal healthy person. It increases control over self, gives more vitality and capacity for work. In other words, the man is under its influence just
normal, hard to believe that he is under the influence of drugs. Long mental or physical work is performed without fatigue." Freud, of course, already knew that the effects of coca are caused by the action of cocaine, a substance that affects the brain and the plant contains. He recommended cocaine for the treatment of depression and anxiety, but an example in his proximity soon changed his thinking of it. His friend became addicted to morphine after it was administered to relieve pain. Freud weaned him from morphine so that he prescribed cocaine. But the friend became addicted to cocaine and injected increasing quantities. Injection of cocaine is causing immense satisfaction first, and then a sudden fall into a deep depression. Finally, his friend became mentally ill because of too much cocaine.

Adrenaline, the adrenal hormone, plays an important role in preparing the organism to fight or take flight. Beside other effects, it expands the airways, which facilitates rapid breathing. It is a possible medication to relieve asthma attacks that can cause choking. However, the adrenaline breaks down in the stomach and is very difficult to absorb into the blood, so it cannot be taken in a tablet form. Researchers looked for a replacement, and found it in a man-made amphetamine, a very similar substance. It soon turned out that amphetamine has different effects too. Because it causes alertness and prevents fatigue, students took it when they learned for the exams. But many have become addicted. During World War II, the Germans treated their pilots amphetamine to stay awake during night flights over England. Even to the British soldiers amphetamine has often been given. The Japanese had even given it to workers to increase productivity of the war industry. In 1948 5 percent of Japanese people were addicted to amphetamines.

Cocaine and amphetamine have similar effects. Today we know that amphetamine releases the neurotransmitters noradrenaline and dopamine from nerve endings containing them. Cocaine blocks the pump in the membranes, which pumps the secreted dopamine or noradrenaline back into the nerve endings or glial cells, where they are degraded. In both cases, the number of molecules of dopamine and noradrenaline bound to the receptors on the target cells increases, which leads to the effects that are known. Noradrenaline is released from nerve cells, which have bodies in the brainstem, but their axons
lead to all regions of the brain. The small locus coeruleus contains only three thousand nerve cells. But these send axons to almost half of all other cells in the brain. Some cells have axons in both cerebrum and cerebellum, and lateral outgrowths innervate the remaining areas. Three thousand of these cells affect billions of others. Noradrenaline is secreted also from cells of the sympathetic nervous system and adrenal glands. But it cannot cross the blood-brain barrier, so noradrenaline levels in the blood do not affect the brain. Just as in the sympathetic nervous system in the brain also the noradrenaline is secreted at emotional arousal.

Pathological lack of monoamines in the brain causes diseases such as Parkinson's, which is caused by the death of cells that secrete dopamine. Signs of this disease are tremors, decreased mobility, and depression. Affected start voluntary movements very difficultly since for the start of each voluntary movement the secretion of dopamine is necessary. Dopamine is also essential for the control of slow movements. If you are lacking it, you are shaking. Because dopamine plays an important role in the movement, we can conclude that it is secreted more during motion. The researchers inserted electrodes in the rat brain, which stimulated dopamine neurons with an electrical stimulus. Rats were free to initiate an electrical impulse in their brain by pressing a lever. Stimulation of dopamine nerve cells caused such a pleasure that they just pressed the lever on and on, they did not eat at all. The secretion of dopamine in motion can explain the pleasure that we feel afterwards. Similar pleasure we feel when we experience success. The movement could then get rid of depression, and thus prevents the secretion of glucocorticoids. But overactivation of receptors for dopamine in the brain causes mental illness schizophrenia, its signs are also hallucinations. These arise also in long distance runners, who spend their severe fatigue. Are they due to the secretion of dopamine in motion?

Effects of monoamines on our feelings are not controversial any more and it is also clear that they play an important role in the movement. When a man experienced severe fear, his legs are shaking. Here we can see a similarity with the signs of Parkinson's disease. Are monoamines lacking in his brain? Experiments show that emotional responses, and thus also fear, arouse noradrenaline nerve
cells. They cause us to focus on the most important stimuli, thereby they also improve memorizing of events that caused an emotional response and are therefore important to the organism. So how to explain the lack of monoamines after stress, which is also a sign of depression? In severe emotional turmoil the nerve cells secrete all their stock of noradrenaline, so there is a shortage of it, since the nerve cells cannot produce it fast enough.

A man sleeps over a third of his life so that some have tried to shorten this period. They thought that this way more can be done in life. But they did not succeed. How sleep is essential, people can tell who suffer from insomnia. They are very tired, but unable to sink into a redemptive, invigorating sleep. What is happening in our body during sleep, slowly comes to our knowledge. Even in sleep monoamines play an important role. If any substance prevents the formation of serotonin, sleep is absent, while noradrenaline causes awakening.

Insomnia is often associated with depression. This is understandable as both consequences have the same cause, lack of monoamines in the brain. The result is also an increased secretion of glucocorticoids, which weaken immunity in depressed people, who are prone to diseases. Older people too cannot sleep much. Typically, with age the secretion of monoamines in the brain diminishes, resulting in insomnia and also tremors, frequent age problem.

Healthy sleep is essential to the organism, as most of the growth hormone, which promotes the formation of proteins, is secreted during sleep, when least glucocorticoids are secreted that promote their degradation. Protein synthesis is essential for the restoration of cellular enzymes, growth and reproduction of cells, wound healing and immune function. Children need much sleep as they grow, and grow while they sleep.

Everyone knows that he sleeps well after exercise. If he moved a lot during the day, he will easily fall asleep at night. Serotonin, which is necessary for sleep, is formed from the amino acid tryptophan, which is obtained from food. However, this is a relatively rare amino acid, and its concentration in the blood is low. During exercise, most of the amino acids break down in muscle and liver cells for energy as part of the fight or flight response. This does not apply to tryptophan,
so the proportion of tryptophan in the blood increases compared to other amino acids. Because tryptophan competes with them for places on the transfer molecules by which amino acids are transported across the blood brain barrier, the transfer of tryptophan to the brain increases when the amount of other amino acids in the blood is reduced. In nerve cells it is converted into serotonin, which is produced in greater quantities during movement, and consequently we sleep better. To speed up the manufacture of serotonin, however, the supply of tryptophan is not sufficient. Other nerve cells must stimulate the serotonin nerve cells, and this probably happens during movement.

Some depressed people are sleepy all the time and need much time to sleep. However, their sleep is inefficient because they lack serotonin, without which growth hormone is not secreted at night. It's amazing how important the roles of monoamines are. But it would be an oversimplification if all the effects are attributed to them only. The brain is teeming with other substances and also for sleep additional factors are certainly needed.

Depression represents a major problem in modern society in which people are alienated from each other and constantly compete with each other instead of cooperation. Depression can be prevented in many ways, but few are able to eliminate it by self-persuasion. The movement is so welcome as the simplest way to prevent depression. It should be noted that it is appropriate only for healthy people. Effort would be detrimental to the sick. Growth hormone is secreted during movement, but the glucocorticoids are also secreted then. In motion, growth hormone only prevents the degradation of proteins caused by glucocorticoids. Patients are therefore much more advisable to sleep when a lot of growth hormone is secreted that is needed for healing, while glucocorticoids are not secreted then. The healing power of sleep was known to ancient Greeks. They believed that the god of healing Asklepios or Eskulap, as he was later called by the Romans, heals people during sleep.
8: Noradrenergic nerve cells in the human brain. Their bodies are located in the brainstem, but their axons lead to all regions of the brain. They also descend to the spinal cord.

9: The serotonin neurons in human brain. They have bodies in the raphe nuclei in the brainstem. Their axons also lead into all parts of the brain and the spinal cord.
MOOD AND FOOD

Obesity leads to many diseases of the affluent societies. People fatten since they eat more than they need for life. What drives them to over-eating, why they cannot lose weight simply by eating less, but are devising ever new and new diets, ultimately proving ineffective?

Richard and Judith Wurtman have found that obese people tend to suffer from anxiety. Food intake calms them down, they feel more confident, less depressed. This they interpret by the finding that after eating carbohydrates the formation of serotonin in brain cells increases. Once carbohydrates increased the amount of glucose in the blood after eating, insulin is secreted, which reduces the amount of glucose in the blood. In addition, it promotes the acquisition of most amino acids in the cells that break them down. This increases the proportion of tryptophan in the blood, because tryptophan is not degraded. As it competes with other amino acids for transport to the brain, after a meal of carbohydrates the brain may increase the formation of serotonin, which is formed from tryptophan. When we eat, serotonin neurons are active. Secreted serotonin is needed to quench hunger and bring a feeling of comfort. People who have a lack of serotonin, do not experience these changes in feelings during feeding, so they eat too much. A lack of serotonin in the brain is the consequence of anxiety and depression. In France, antidepressive drug d-fenfluramine is sold, which causes secretion of serotonin in the brain. It was found that it eliminates the excessive food intake in obese people, resulting in weight loss. Unfortunately, d-fenfluramine causes depletion of serotonin reserves in brain cells, as it does not accelerate the formation of new molecules of serotonin. Prolonged administration of this drug therefore aggravates the situation.

With these findings, we question how obesity develops in depression, during which glucocorticoids are secreted that promote the degradation of fats. However, most chemical reactions in the body are in equilibrium. Glucocorticoids really promote the degradation of fat, but less pronounced than the degradation of protein. If a man does not eat a lot, he loses weight. But if he eats more than he consumes, excess matter must be stored somewhere. It is stored as fat in adipose tissue, while the muscles weaken due to the degradation of protein.
Obesity, which is generated at the increased volume of glucocorticoids in the blood, is characterized by thickening the fat in the trunk, face and neck only, while the limbs remain lean.

Epidemic of obesity in modern society is therefore due to depression and anxiety, which people prevent in different ways. Some with alcohol, tobacco or drugs, while others with excessive eating. Both ways are harmful, it would be much better to eliminate the causes of depression that plagued the majority of mankind.

ANXIETY

People with mental health problems are depressed or excitable and apprehensive. All have in common a lack of confidence that is the cause of their problems. Because of anxiety, people cannot sleep, have problems with the heart which is beating too hard, sweat without reason, have problems with digestion. These are all signs of the fight or flight response, which prepares the organism to these activities. However, in nervous humans this response has no apparent reason. Completely innocent incident upsets them.

To live normally, these people often take tranquillizers and sleeping pills. First sedatives, which were produced by the pharmaceutical industry, were barbiturates. Those with a stronger effect were used to induce sleep, while those with milder were tranquillizers. But people who have taken them, were sleepy and so could not do the job well. Later it was discovered that benzodiazepines have better effects. They calm, without causing excessive sleepiness. In addition, excessive amounts of benzodiazepines are not dangerous. Poisoning by barbiturates had become the most common form of suicide. However, if the suicide ate a whole bottle of benzodiazepines, he just slept a few days, then woke up without consequences. But they are just as addictive as the barbiturates. If a man takes them regularly, he cannot calm without them and eventually must take ever increasing amounts to achieve the same effect.

Research has shown that the action of benzodiazepines is associated with the gamma-amino butyric acid (GABA), neurotransmitter in the brain which by binding to target receptors in the membrane of nerve cells leads to the opening of pores for chlorine
ions, which therefore enter the cell. As they are negatively charged, they increase the negative charge inside the cell compared to a positive charge in the exterior. So they hyperpolarize the membrane. In order to excite a nerve cell, the membrane must be depolarized to some extent at which the pores for sodium ions open. If the membrane is hyperpolarized, the depolarizing stimulus must be stronger to excite the cell. The excitation threshold is raised. GABA thus reduces the sensitivity of nerve cells. Therefore, it also prevents epileptic seizures, in which nerve cells turn on without the involvement of consciousness. However, GABA is not applicable as an anti-epileptic drug because it cannot cross the blood brain barrier. For this purpose, we use barbiturates or benzodiazepines. It has been shown that the barbiturates, benzodiazepines and GABA have their own receptors each, but at the same protein set, which includes the chlorine pore. Benzodiazepines have no effect alone, but by binding to their receptor they facilitate the binding of the neurotransmitter GABA to its receptor. Therefore, to open the pores for chlorine a neighboring nerve cell must secrete much less of the GABA. There is also a binding site for barbiturates in the vicinity, which cause the chlorine pore to open. At the same site substances that inhibit the opening of the pores can also attach, so that GABA is without effect. These substances cause agitation and epileptic seizures. Alcohol also affects these receptors. It leads to the opening of the pores for chlorine, so it calms and causes drowsiness. Researchers have predicted that a substance exists in the brain that naturally binds to benzodiazepine receptors and has the same effect. It should be secreted from the same cell as GABA, or come from other parts of the brain. However, this substance has not been found for long.

THE BIOLOGICAL CLOCK

With the alternation of day and night as a result of rotation of the earth, the alternation of periods of activity and rest of living beings coincide. This do not depend only on external factors, but continue also when external conditions change. Brain activity that supports it is called biological clock. If a man travels by plane to the east or west, he faces a situation of another time. Several days are required to adjust his internal clock with the new daily rhythm. Until then, he has
a big problem, because he is sleepy during the day, but cannot sleep at night.

The pineal gland is situated in the upper wall of the third cerebral ventricle. Its main task is the production of the hormone melatonin, which is strongly dependent on the biological clock. It is mainly secreted at night, during the day only barely. Melatonin is produced in the pineal cells from serotonin, which is formed from the amino acid tryptophan. However, the conversion takes place only when the receptors in the pineal cell membrane bound noradrenaline. That is secreted from the sympathetic nerve of the upper sympathetic ganglion near the spinal cord, leading to the pineal gland. It receives a signal for secretion from the biological clock in the hypothalamus. Light affects the melatonin secretion. It inhibits its formation with influence on the retina from which the signal travels to the suprachiasmatic nucleus in the hypothalamus which affects the biological clock. Melatonin is not only formed in the pineal gland, but

![Chemical structure of serotonin and melatonin conversion](image.png)

10: Serotonin forms in the vesicles of the nerve cells from tryptophan under the influence of two enzymes. In the pineal cells the conversion continues to melatonin, but only at night, when under the influence of noradrenaline, which binds to receptors in the pineal cell membrane, the enzyme NAT is activated.
also in the retina of the eye. Here, too, it depends on the time of day, it is secreted only at night. It increases the sensitivity of the eye that is needed at night, when there is less light. Light stops the production of melatonin also here, since the eye, more sensitive because of its influence, can be damaged by bright light. This similarity confirms again that the pineal gland evolved from the third, parietal eye. In some animals it still has its own light-sensing cells, but in mammals this task has been lost completely. Instead, it produces more of the hormone melatonin, which plays an important role. It prevents the secretion of sex hormones, so in terms of shorter day, when more melatonin is secreted, prevents reproduction. In animals that have the pineal removed an increase in blood pressure, more cholesterol, sodium, urea and creatinine levels were detected. Weight of the liver, spleen and thymus was reduced, but of the heart increased. Melatonin plays an important role in the brain. It calms and has a role in sleep. The people who received melatonin, felt sleepy. Melatonin also indirectly stimulates the immune system.

Since the pineal gland lies outside the blood-brain barrier, its operation is affected, in addition to noradrenaline from the sympathetic nerve, by noradrenaline in the blood that comes from the core of the adrenal gland and is secreted with stress. It causes the production of melatonin, which calms the brain aroused by stress and thus constitutes a negative feedback. The studies in guinea pigs found that melatonin causes an increased threshold of excitation of neurons. Their membranes become hyperpolarized. This is a very similar effect as of the GABA and benzodiazepines and Quirion reported that melatonin binds to benzodiazepine receptors. His discovery is not yet confirmed, but it would have been perfectly reasonable. If melatonin increased the sedative effect of the neurotransmitter GABA at night, it would allow us to sleep. That the actions of GABA and melatonin are related is confirmed by the discovery that melatonin counteracts the effects of bicuculline, which blocks the action of the GABA and thus causes epileptic seizures. Melatonin has proved to be an anti-epileptic as it easily passes across the blood brain barrier.
MAGNETISM

That weather affects the human being, is an old truth. When the storm is preparing, people are irritable, each bit bothers them, fights occur without good reason. The number of traffic accidents increases. Pain occurs to people with rheumatism, so they can predict weather without the barometer. People say that any good weather reporter should have rheumatism. Mysterious forces have been used by particularly sensitive people also in searching for water with a forked stick, now they claim that can determine the proper place to sleep, because in places where it should be too much of mysterious energy, a person can fall ill. It's about time that science proves, if there is any truth in this.

Light is not the only environmental factor that affects the synthesis of melatonin. It has been found recently that the earth's magnetic field exhibits an important role. Its intensity varies during the day and throughout the year. It is higher during the day than at night and increasing magnetic field strength decreases the production of melatonin. Earth's magnetic field is asymmetric because of the solar wind, the stream of charged particles from the sun. On the sunny side it is compressed, at night side it extends far into space to form a magnetic tail. This is the cause of a slightly higher magnetic field strength during the day, which living organisms exploit to regulate their daily nocturnal rhythms. When in an experiment people were isolated from the earth's magnetic field, they spread their time being awake and to sleep over 25 hours instead of 24, the length of the day. Man's internal clock is not completely accurate and lags in the absence of external stimuli that control it. If only lighting time was changed, while the earth's magnetic field continued to affect them, the functioning of the internal clock did not change in people.

Nocturnal secretion of melatonin may be stopped by the artificial magnetic field change. It was found that during magnetic storms the number of epileptic seizures is greatly increased, which can be attributed to a small amount of melatonin in the brain. In order to determine how the organism perceives the magnetic field an experiment was conducted with rats. In half of the rats the optic nerve was cut so they were blinded, the other half were left intact. Then an
artificial magnetic field within the limits of natural strength was created with the coil, and rats were kept in it for 30 minutes. Immediately afterwards, their pineal glands were removed and the amount of melatonin measured, as well as the activity of the enzyme N-acetyltransferase (NAT), which is important in its synthesis. The enzyme activity in intact rats was significantly reduced, reduced was also the amount of melatonin. In blind rats NAT enzyme activity and melatonin content remained high. This suggests that mammals perceive a magnetic field with the eyes, though perhaps not with the same cells as the light.

Now we can explain why people are irritable when thunderstorm front is approaching. In its area the electrical current flows from the surface to the planet's ionosphere. Around it creates a magnetic field, like any electrical current. Therefore, in the vicinity the magnetic field strength is greater, which reduces the production of melatonin in humans. In the absence of melatonin which calms the brain, people arouse quickly.

Increased magnetic field strength is above some structures in the earth's crust, such as areas of metal ores, but also in the vicinity of overhead power lines. It is perfectly possible that the man who sleeps

11: The Earth's magnetic field is asymmetric because of the solar wind, the stream of charged particles from the sun. On the sunny side is compressed, at night side it extends far into space to form a magnetic tail.
in the area, has reduced melatonin synthesis and thus cannot sleep well. Good sleep is essential for health. In a statistical study it was found that people living near power lines often suffer from cancer. Theoretically, it is also possible that changes in the magnetic field strength above the flow of water underground are detected by a dowser with the forked stick, and he shows where to dig.

**ACUPUNCTURE**

Ancient Chinese method of treatment with needles that are driven through certain points on the body, acupuncture induced doubts for a long time in the West. Doctors did not believe it, because they did not know how to interpret the way it operates. Recently, however, this treatment came even to us. Finds of Chinese archaeologists have shown that the stone acupuncture needles were used in China already in the Neolithic period. This method of treatment is continued until today, not only that, throughout the time it developed and updated. This alone proves unquestionably high value of this treatment. With acupuncture a hundred different diseases has successfully been treated. Ancient Chinese philosophy explains the effects of acupuncture by restoring the balance between energies in the body, Yin and Yang. Leave us the Chinese philosophy for now, and try to explain acupuncture with the knowledge of physiology, as we have.

Recently, acupuncture is most commonly used to prevent pain. In China acupuncture is even used during surgery instead of chemical anesthesia. When the needle is driven into the body, the sensory nerve cells whose endings are in the vicinity are stimulated. They excite spinal cord neurons that pass the signal on to the brain. But they also prevent the transmission of signals from other sensory cells that neighbor them in the spinal cord. This is the first way in which acupuncture prevents pain in an internal organ, from which sensory neurons lead to the spinal cord at the same level as those who are irritated with the needle. In the brainstem the pain signals excite nerve cells that secrete serotonin. Processes of these cells lead back to the spinal cord, where they arouse short nerve cells that secrete enkephalin. This is one of the substances in the body, which naturally bind to opiate receptors. These also bind morphine, a substance derived from opium poppy, which is used to prevent pain.
Enkephalins bind to receptors on pain sensory cells, and this reduces their sensitivity. Thus a negative feedback loop is created that reduces the sensation of pain. Single serotonergic cell does not affect only a single sensory cell, which caused its excitation, but innervates larger part of the spinal cord. This reduces the sensitivity of the pain sensory cells that lead from other organs. Processes of serotonin neurons lead also to the thalamus, a brain area that is very important for the perception of pain, to prevent pain also there.

In the brain, during acupuncture endorphin is secreted, which also prevents the excitation of those brain cells that are necessary for pain perception. If we administer any substance that prevents the secretion

12: *If the acupuncture needle stimulates the pain sensory cells that have endings in the skin, they secrete their neurotransmitter, substance P (SP) in the spinal cord (SC) and in the walls of blood vessels. Influence is achieved also on the sensory nerve cells leading to the spinal cord at the same level from internal organs, such as the intestine. The sympathetic nervous system, which leads out of the spinal cord at the same level is also affected. To the sympathetic ganglia nerve cells lead that secrete acetylcholine (ACh), from there to the organs cells that secrete noradrenaline (NA). (Bradford 1986)*
of serotonin, endorphin release increases, but if the effect of endorphin is blocked, serotonin secretion increases.

Serotonergic neurons regulate many other brain activities. They cause sleep and prevent hunger. When depressed, we lack serotonin, so we cannot sleep and are hungry. Thus, with acupuncture, which stimulates the serotonin cells, hunger is reduced and insomnia prevented. Serotonin has a powerful effect on the secretion of the hypothalamic hormones, or pituitary hormone releasing hormones, as they are called. Under its influence the pituitary gland secretes more growth hormone and ACTH, which promotes the secretion of glucocorticoids from the adrenal cortex. However, the effect of serotonin on the secretion of these hormones is highly dependent on the time of day. Growth hormone is secreted under its influence during sleep, while ACTH is secreted under the influence of serotonin only during the day, especially under stress.

Serotonin thus increases the difference in hormone levels during the day and night. During the day, under the influence of glucocorticoids enough glucose is provided for the activity, at night growth hormone is responsible for the renewal of the body and among other things, stimulates the immune response. So serotonin affects the functioning of the biological clock. We can support this with the findings of the anatomy. The basis of the biological clock in the brain are the suprachiasmatic nuclei in the hypothalamus, to which nerve cells from the retina directly lead. Light affects the biological clock. To the suprachiasmatic nuclei many processes of the serotonin nerve cells also lead. Serotonin from these cells is necessary for the functioning of the biological clock. Since it is lacking in depression, the biological clock does not work and it does not send the signal for nocturnal secretion of melatonin to the pineal gland. The production of melatonin is thus also influenced by the psyche. In depressed people nocturnal melatonin secretion is almost absent, and they fall asleep with difficulty.

Let us return now to the Chinese interpretation of the effects of acupuncture. Activity of brain cells that are active when we are mentally strong and give us resistance to all external stimuli, can be likened to Yang. Such effects have the serotonin cells. These cells are not active when one is depressed, when he has no power. Then
adverse stimuli cause a much faster response of fight or flight, man is irritable. Energy, which is released then and is the consequence of the activity of certain brain cells, reduces resistance to disease and causes insomnia and high blood pressure. It can be equated with Yin. When we are aroused, noradrenaline nerve cells in the brain are active. The drugs that indiscriminately increase or decrease the effects of all monoamines, therefore, achieve contradictory results. With acupuncture we stimulate the cells that prevent irritability or yin energy and create self-esteem or yang energy.

SENSORY NERVE CELLS

Allergic diseases are becoming more frequent, but the reasons for this are not known. Perhaps environmental pollution or inappropriate nutrition are to blame, or perhaps we do not care much of our mental state, our nerve cells to say. It has long been known that emotional arousal can also cause allergic attack. Recent advances are beginning to explain us how the nervous system influences allergies and other forms of the immune response.

Itching, hives, sneezing, difficulty breathing, watery eyes, sniffles, smooth muscle spasms. These are signs of allergic disease, caused by substances in the environment, completely harmless to most people, but to some the most problematic. Pollen, dander, dust mites, certain foods and many other substances could provoke defensive reaction of white blood cells in humans, although they are not dangerous. Allergy can be caused by very different substances. Proteins act directly on immune cells, other substances may alter the body proteins, so that the defense cells do not recognize them as self. If the allergen enters the skin, redness and swelling occur. In the respiratory system, asthma occurs or hay fever. In food allergy the bowels react with convulsions, vomiting and diarrhea. It is an unnecessary immune response, as well as in autoimmune diseases in which white blood cells attack the body's own tissue. In both cases, the immune response is caused by white blood cells called helper T cells which stimulate B lymphocytes to manufacture antibodies against body's own substance, or allergen. The antibodies also bind to specific cells in blood and tissue, called the blood and tissue basophils. These contain a lot of vesicles filled with a number of substances, which by binding of
allergen to the surface antibodies are released into the environment. One of these substances is histamine, which causes contraction of smooth muscles, increased capillary permeability, which facilitates the entry of white blood cells into the tissue, and increased gastric acid secretion. It is thought that lack of regulatory T cells, which suppress the immune response is to blame for the unnecessary immune activity. So many allergic and autoimmune diseases occur in the old age when the number of regulatory T cells in the blood is reduced. Allergic response may also be triggered by cold, heat, sunlight, emotional excitement or physical exertion. This shows the important role of nerves in allergic reactions.

In the skin, mucous membranes, muscles, joints and blood vessel wall a lot of sensory nerve cell endings are, which cause various feelings when stimulated. Their bodies are in the ganglia at the spinal cord while their processes lead to the spinal cord on one side and to the organ they innervate on the other side. These nerve fibers are of different thicknesses and at stimulation secrete different substances from their endings. Thicker the nerve fiber is, faster it conducts electrical signals. Cells with thick nerve fibers transmit messages of touch to the brain. Adenosine triphosphate (ATP) or glutamate are substances, which are secreted as neurotransmitters. In the cells of the spinal cord they cause a rapid and short-term excitation. Cells with thin nerve fibers cause a slow arousal in the spinal cord, which lasts longer. For the transfer substances they use peptides. The most studied are cells, which secrete a peptide called substance P, and are mainly pain sensory cells. Similar sensory cells also exist for the coldness and heat. Very interesting and, as we shall see, also important is that the sensory cells do not secrete transmitter substances only in contact with the cells of the spinal cord that transmit the signal to the brain. When sensory cells are excited the transmitter substance is secreted from the sensory nerve endings in the skin, mucous membranes or the vessel wall. 90% of the peptide, formed in the bodies of the sensory nerve cells, is transmitted to the sensory endings, where it is secreted upon arousal.

In 1901, Bayliss noted that various mechanical and chemical stimuli can lead to widening of vessels in the skin and that intact sensory nerve cells are needed for that. His research is based on the
earlier discovery that the irritation of the distal part of the cut sensory nerve increases vascular permeability. Hinsey and Gasser discovered that stimulation of thin nerve cells increases blood flow. They cut them close to the body so that nerve endings perished. When this happened, the chemical stimuli could not cause skin inflammation any more.

Today we know that substance P which is released from pain sensory cells, is one of the most effective substances that contract smooth muscle and dilate blood vessels. Its effect is for 100 to 400 times more potent than of histamine. If substance P is injected under the skin, it causes redness, swelling and itching. Some of these effects can be prevented by substances that prevent the action of histamine. So we can conclude that substance P causes histamine release from the mast cells. If histamine is injected under the skin, it causes redness and swelling. However, if prior to this we empty substance P stores in the nerve endings with capsaicin, histamine erythema can no longer be induced, just swelling is caused. Histamine then causes secretion of substance P from nerve endings and thus indirectly achieves many of its effects. Excitation of the sensory cells in inflammation is felt as itching or pain. Secreted substance P stimulates the release of histamine from the basophils. Secreted histamine stimulates the release of substance P from the nerve endings... This is a positive feedback loop, the biological amplifier that enables very weak initial stimulus to cause a strong allergy. The initial stimulus may be an allergen which binds to basophils or excitation of pain sensory neurons from any cause. Pinch yourself, so that you will feel pain. You will notice that the skin is red at the place where you pinched it.

Capsaicin is the ingredient in hot peppers. It makes us feel pain because it excites pain sensory cells. It played an important role in research of substance P and the sensory cells. With heavy doses of capsaicin not only a release of substance P is induced, but also the sensory nerve endings perish. They grow again in the adult, while in the neonate entire nerve cell is destroyed, and therefore lasting insensitivity to pain is caused. Similar experiments we do all when we eat spicy dishes containing hot peppers. Capsaicin also causes intestinal secretion of substance P, which in turn promotes the
contraction of intestinal muscles and dilates blood vessels in it. This is going on regularly in the intestine after administration of food. Then cells in the intestinal wall are stimulated, which in addition to the hormones necessary for the functioning of the intestine also secrete an enzyme that causes the formation of bradykinin in the blood. Bradykinin excites pain sensory cells in the walls of blood vessels that secrete substance P which improves blood circulation in the digestive system. Bradykinin is formed by the split of blood proteins. Split is induced by the enzyme kallikrein that cells secrete into the blood. Bradykinin acts only locally, since kininase enzymes in the blood rapidly degrade it. It forms in large amount at the site of injury. It causes pain, and substance P secreted from the sensory cells expands blood vessels, causing bleeding from the wound to rinse away any dirt. Bradykinin is likely to form in organs which lack oxygen. Lack of oxygen may be due to increased activity of cells. By expanding blood vessels that lead blood to them the supply of oxygen to these cells increases. So we could feel pain in organs that are highly active, such as muscles during strenuous running, the heart at a major effort, or head, when brain is deprived of oxygen.

When the gut is filled with food, it expands. This excites sensory nerve cells in the intestinal muscular wall to secrete the substance P which causes contraction of intestinal muscles that push food forward. Of course, normally we do not feel pain, because the frequency with which the sensory cells excite is too low to arouse brain cells. If you have digestive problems, however, the intestinal wall is stretched more than usual, which increases the frequency of excitation of sensory cells and we perceive pain. Secreted substance P causes spasms in the intestines then. This happens also if we are allergic to food and basophils are aroused in the gut.

Substance P in the airways causes persistent airway narrowing due to contraction of smooth muscle. Even in the respiratory tract the secretion of substance P is often triggered by histamine from the basophils, which is released on contact with the allergen. But the effects of substance P, which is injected artificially, cannot be avoided by the substances that prevent the action of histamine or acetylcholine. So here too, substance P acts directly on smooth
muscle. Excitation of sensory cells in the respiratory system is not perceived as pain, but teases us to cough.

Substance P also affects the immune system cells. Receptors for substance P were found in the T-helper lymphocytes. When substance P binds to them, T-helper lymphocytes begin to reproduce. Substance P also stimulates macrophages to swallowing and causes retention of white blood cells at the site of secretion. So this substance is an important facilitator of a local immune response. This is very useful, as it hurts us usually in places where the work for immune system cells is.

In the body there are also other sensory nerve cells that secrete other peptides. Similar effects as substance P achieves neurotensin. Some peptides can prevent the immune response. Somatostatin prevents the release of substance P from nerve terminals and histamine from basophils. Vasoactive intestinal peptide (VIP) inhibits the action of T-helper lymphocytes and natural killer cells, so suppressor cells prevail. VIP also expands the airways, relaxes the intestinal muscles and dilates blood vessels.

If we could influence which sensory cells are active, we could therefore regulate the immune response at will. And also we do. The cold compresses soothe inflammation, so that they irritate the cold sensory cells. The warm baths heal allergic and autoimmune diseases. With acupuncture the pain sensory cells are irritated, which improves circulation and stimulates the immune response. With acupuncture we can influence the internal organs, to which we do not have direct access. So the stimulation of sensory cells on the surface of the body influences the nerve cells in the internal organs. Still I did not explain how inflammation is induced by feelings, how does the brain affect the release of substances from the sensory nerve cells.

There are many informations about people who are experiencing severe asthma attacks with stimuli, which certainly are not allergens. First experiments in this regard were conducted by Dekker, Groen and Pelser in 1957. They investigated two asthmatic people who were allergic to house dust and grass pollen. In the experiments they had to inhale allergens. After the first series of experiments, the researchers gave them only the solvent, in which allergen was previously dissolved to breathe. The asthmatic attack followed as well. Then
they gave them pure oxygen to breathe. Asthmatic attack was equally strong. This confirms that asthma responds may quickly be learned by conditioning.

Other researchers have subsequently begun to explore the problem in animals. In guinea pigs they provoked asthma-like breathing problems, if they gave them an allergen to breathe. At the same time they played a particular sound or added some fragrance. Later, only the sound or smell provoked asthmatic attack. That an allergy is involved, they confirmed by the detection of histamine in the blood. When the guinea pigs were treated more roughly, asthmatic responses to stimuli were even stronger.

What can we conclude from these experiments? The man who once experienced an allergic attack, later can hardly get rid of this reaction. Sometimes he is successfully being used to allergen by initially very small, and later increasing doses of it. But the therapy is risky. In certain subjects the first, very small dose causes so strong response that the patient's life is in danger. Perhaps it would be advisable to try the way that people are treated who, for example, fear of spiders. Initially pictures of spiders are shown to them, then a dead spider, later living at a distance, but at last a spider is crawling on their hand. For people allergic to grass pollen, images of flowering meadows should be shown, then a bunch of grass in the room and finally we could walk with him across the meadow.

And how does the brain affect the allergic reaction? We recognized that the allergic reaction depends on the pain sensory cells. If stimulated, they promote allergic reaction, if not, they inhibit it. If the brain could prevent the excitation of sensory cells it could prevent the allergic response. If histamine released from basophils by allergen, could not excite sensory cells, allergy would be avoided as the amplificatory mechanism would not work. Is there such a possibility? There is. From the brain to the spinal cord processes of nerve cells descend, which arouse the local short nerve cells, which secrete enkephalin. This binds to receptors on the pain sensory cells and reduces their sensitivity to stimuli. Thus, much stronger stimulus is needed to arouse sensory cells. With practice, which I have previously suggested, the descending cells might learn to arouse in the flowering meadow, and thus prevent the allergic response.
It is known that emotional arousal can cause an allergic attack. How is this possible, may emotions affect the sensitivity of the sensory cells? Nerve cells in the brain control the sensitivity of sensory cells. Serotonergic neurons secrete serotonin from their endings and have bodies in the raphe nuclei in the brainstem. Processes of cells in the large raphe nucleus lead to spinal cord, where they arouse enkephalin inhibitory neurons. Secreted enkephalin reduces sensitivity of the sensory cells. Serotonergic cells are excited also by pain and then serve as a negative feedback loop that prevents excessive pain.

Noradrenaline nerve cells also have bodies in the brainstem. They too send their axons to the spinal cord, but do increase the sensitivity of the sensory cells. Processes of the noradrenergic neurons also lead

13: The pain sensory cell has the body in the spinal root ganglion (G). It can be aroused if the skin is poked (arrow). Substance P (SP), which is secreted in the spinal cord (SC), excites the nerve cells that transfer signal to the brain. Substance P is secreted also from nerve endings in the skin and the walls of blood vessels. Among other things, it causes secretion of histamine (Hi) from basophils (B). Histamine affects the blood vessels directly, and perhaps even through secreted prostaglandins (PG). (Pernow 1985)
to the hypothalamus, where endorphin nerve cells are stimulated. Secreted endorphin reduces the sensitivity of many brain cells, thus preventing their mutual arousal. Brain cells, which are necessary for perception, are aroused then only by the strongest stimuli from the environment that are reinforced by noradrenaline. We say that we focus on the most important stimuli.

Endorphin cells can be aroused even when noradrenaline does not increase the sensitivity of pain sensory cells. Endorphin reduces the sensitivity of brain cells, which arousal is needed to detect pain. When it is secreted, we do not feel pain, although the pain sensory cells are stimulated.

Noradrenaline cells are active, when we are upset, frightened or angry. Since they increase the sensitivity of the sensory cells, they can trigger an allergic attack. If we are nervous, we feel itch all over our body. This means that the pain sensory cells are stimulated.

14: The descending brain serotonin neurons (5 HT) arouse enkephalin neurons in the spinal cord. Secreted enkephalin binds to receptors in the membrane of pain sensory cells, which secrete substance P (SP). This reduces the sensitivity of pain sensory neurons. (Snyder 1986)
Serotonin cells are active when we feel safe, when we are confident. They reduce the sensitivity of the sensory cells, preventing allergic reactions.

So we realized that in the allergy, our mental well being is very important. If an allergic disease develops in our children, we should consider if we gave them sufficient sense of security. If they are left alone whole day, but when they finally see us we criticize them for school failure, they certainly do not feel safe, but vulnerable and alone. This promotes allergic responses. We should devote more of our time to them, more love, and allergies will be alleviated at least.

Similar rules as for allergies apply to autoimmune diseases such as rheumatism, in which the immune system destroys the cartilage in the patient's joints. Susceptibility to autoimmune diseases is highly dependent on genetics, but Moos and Solomon have found that women who suffer from rheumatoid arthritis, are more depressed and irritable than their healthy sisters. They are described as nervous, tense, anxious, mentally unstable persons. Their healthy relatives, who have also had antibodies against their own tissues in the blood, and are therefore susceptible to autoimmune disease, were mentally stronger than people without antibodies on average. For the development of autoimmune disease, in addition to an immune response to the body's own substance the stimulation of this response by the nervous system is also needed. Arthritis affects more severely the joints which contain more pain sensory endings that secrete the substance P, such as ankles and wrists. Sensory cells are more sensitive to pain in people suffering from anxiety. This is part of the fight or flight response during which the attention to stimuli from the environment is increased. Therefore pain sensory cells more frequently turn on and secrete more of the substance P from their endings. Researchers have injected substance P to the knee of animals with arthritis and found that it increased swelling of the joint, decreased bone density and increased loss of cartilage. With nerve stimulation on one leg they caused swelling of the joint on the other leg. This did not happen if nerve on the other leg was previously cut.

Interesting is also the discovery that people with various mental illnesses such as schizophrenia, have antibodies to substances that their own nerve cells contain. Antibodies are a sign of autoimmune
disease that destroys these substances in nerve cells and thus the entire nerve cell. It is not yet clear whether the autoimmune disease develops first that causes mental illness, or nervous system aroused due to the mental illness, triggered the development of autoimmune disease.

AIDS VIRUS MIMICS A HORMONE

Body cells have many protein molecules in their membrane, which are receptors of hormones. These molecules the viruses can use to attach and their nucleic acid to enter into cells. For some time it is known that the HIV virus that causes AIDS, binds to the T4 receptors in the membrane of T lymphocytes, macrophages and other cells. The virus envelope protein, called gp120, binds to the T4 molecule in the membrane of human cells. Without this binding, the virus cannot infect cells. Scientists have found that the binding is dependent on only a short, five amino acids long stretch of the gp120 molecule. Artificial peptide was produced with the same sequence of amino acids and found that its binding to the T4 molecule prevents binding of the virus and prevents infection of human cells. But the peptide also had a chemotactic effect on monocytes. Monocytes are white blood cells, which under the influence of chemotactic substances from the blood enter the tissue and turn into macrophages or swallowing cells.

When amino acid sequence of the hormone vasoactive intestinal peptide (VIP) was investigated, scientists have found that five amino acid long stretch of VIP's and part of the viral gp120 protein responsible for the binding differ in only one amino acid. Therefore, they came to believe that the VIP molecule naturally attaches to T4 receptors in the body. In an experiment, the VIP had also chemotactic effect on monocytes. When VIP and synthetic peptide with the binding sequence of the gp120 molecule were simultaneously added to the cells, the chemotactic effect was as strong as when only one of these was added. So they concluded that they bind to the same receptors. If they bound to different receptors, chemotactic effect would be stronger when both peptides are added simultaneously.

Peptide VIP was first found in the gastrointestinal tract and found that it expands blood vessels, hence its name. It was later found in the
brain and discovered that it has a number of effects in the whole body. It is secreted from the sensory nerve cells. It expands the airways, relaxes the intestinal muscles, promotes the secretion of many hormones and much more. In the brain and spinal cord it acts as a neurotransmitter. It affects also the immune system cells. It inhibits the reproduction and activity of T lymphocytes. In patients with AIDS, the T cells respond poorly to antigens. On the other hand, patients with AIDS have large amounts of antibodies in the blood, which are ineffective against the virus. VIP promotes B lymphocytes to antibody production. Killer cells would be most effective in the fight against the virus, but in patients with AIDS are not active. VIP inhibits the action of natural killer cells. Effects of the VIP on the immune system are therefore identical to certain features of AIDS.

In patients with AIDS just one in the hundreds of thousands or millions of T lymphocytes is infected with HIV. Just because of that the immune system would not be as weakened as in AIDS. But the virus-infected cells secrete large amounts of the viral protein gp120 to the blood. This protein acts like the hormone VIP, and thus weakens the defenses of the organism. Binding of the virus to receptors for VIP could also explain why the virus most easily enters the body through the intestinal mucosa. VIP has an important role in the gut, so a lot of receptors for it are there. Since VIP is also a neurotransmitter, nerve cells have receptors for it too. And it is known that the AIDS virus affects the brain. These findings may lead to new ways of treatment of AIDS. The substance which could bind to the receptors for VIP, but would not lead to its effects, could prevent the binding of viral proteins to them.

MIGRAINE

Headache is probably known to every single human. Its causes are various, but migraine is a very special type of headache. This is a headache that is repeated from time to time and accompanied by nausea, vomiting, drop in blood pressure, swelling, such as puffiness around eyes, low body temperature. Those who suffer from migraine attacks are mostly women, since three quarters of people who have migraines are women. In migraine, blood vessels leading to the brain initially narrow, causing a lack of oxygen to the brain. The brain is
the largest consumer of oxygen in the body when we do not move. This is followed by vasodilation and headache. The brain is without sensors for pain. Pain is produced in the walls of blood vessels supplying blood to the brain. There are nerve endings that cause pain when aroused. Migraines can be triggered by various causes. Often it occurs at menstruation, can be triggered by emotional arousal, or by certain foods.

Chances are that migraine is triggered by a hormone that is then secreted into the blood. Let us try to find a known hormone that causes as many problems as associated with migraine. Substances that cause contraction of blood vessels are many. Among them is certainly interesting as a possible cause of migraine the neurohypophyseal hormone arginine vasopressin (AVP), also called antidiuretic hormone. This hormone causes water retention in the body by increasing the reabsorption of water in the kidney. It causes the contraction of blood vessels, but does not increase blood pressure, because at the same time the parasympathetic nervous system arouses, which reduces the activity of the heart. Vasopressin is secreted when water is scarce in the body. In the hind lobe of pituitary it is secreted into the blood from nerve cells that have bodies in the hypothalamus and send axons to the pituitary gland. Other processes of these cells lead to various parts of the brain, where secreted vasopressin serves as a neurotransmitter. Because vasopressin does not increase blood pressure, researchers have believed that its influence on blood vessels is negligible. But when they cut the nerve cells that translate signals from the senses of blood pressure in the heart, vasopressin caused a rise in blood pressure. They found that sensors in the heart perceived increased blood pressure caused by the contraction of blood vessels due to the secretion of vasopressin. In the brain the signals from the senses aroused parasympathetic nervous system, which reduces the strength of heart contraction and thus lowers blood pressure. The same signals inhibit the sympathetic nervous system, which among other things narrows blood vessels in the skin. Thus, body temperature is lowered, because the blood vessels in the skin expand and the blood cools quickly. Parasympathetic nervous system also promotes the contraction of smooth muscles in the gastrointestinal tract. Lowering of the
temperature and blood pressure, as well as nausea and vomiting, the results of contraction of stomach muscles, are the characteristics of migraine. They are caused also by vasopressin which stimulates the parasympathetic nervous system. Swelling is also a consequence of the action of vasopressin, as vasopressin causes water retention.

Even stimuli that promote the secretion of vasopressin are the same as the stimuli that can trigger migraines. Secretion of vasopressin is caused by anxiety and pain. Intense pain can increase the secretion of vasopressin to a hundred times. If vasopressin really causes migraines, then you can explain why migraine cannot be avoided when the head is already aching. Headache itself further enhances the secretion of vasopressin. More vasopressin is secreted during sleep, causing night-time decrease in urine output. And with migraine we often wake up, it occurs after a period of sleep. The most powerful stimulus for the secretion of vasopressin is of course the lack of water in the body. When the amount of blood is reduced, blood pressure lowers, perceived by the senses in the heart and aorta. They cease to send signals to the brain that inhibit the secretion of vasopressin, so it is secreted in larger amount. Also thickening of the blood, detected by osmoreceptors in the hypothalamus, stimulates the secretion of vasopressin. Sodium from salty foods increases the osmolarity of blood, so it causes the secretion of vasopressin and water retention in the body.

Since during menstruation women lose a lot of blood, it is understandable that vasopressin is secreted then. But migraine often occurs before the bleeding. Estradiol is a female sex hormone that is produced in the ovary. Its blood content increases dramatically before the mature ovum is released from the ovary. Estradiol prepares the uterus for the reception of the ovum. But it has side effects. In the kidneys, it causes retention of sodium and excretion of potassium ions, which is the task of aldosterone, a hormone of the adrenal gland. Both are steroid hormones. Probably because of the similarity estradiol has similar effects as aldosterone.

In the cell membrane of each cell sodium-potassium pumps are that pump sodium ions out of cells and potassium into cells. Therefore, more potassium is found inside cells, and the extracellular fluids contain more sodium. Aldosterone is secreted when blood volume is
reduced. Since it increases the amount of sodium and reduces the amount of potassium in the body, osmolality increases in the blood and other extra-cellular fluids, which contain more sodium, while it is reduced in cells dominated by potassium. Water begins to move from cells to the blood in order to match the osmolarity. In this way, aldosterone prevents the drop in blood pressure. Due to the increased osmolarity of the blood vasopressin is excreted. Effects of aldosterone or estradiol are therefore similar to the effect of salty food. When the amount of estradiol greatly increases in the blood of women it can trigger migraine. It can be triggered also by aldosterone, which is known to be secreted even in the mental arousal. A prerequisite for this is that one has low blood pressure.

High blood pressure, which is a sign that too much water is in the body, inhibits the secretion of vasopressin and thus accelerates the drainage of water through the kidneys. But migraines typically affect humans, characterized by low blood pressure. By drinking water, which increases the blood pressure and reduces blood osmolarity, it might be possible to prevent migraine. But we should give up too salty food.

Suppose we found the causes of the contraction of blood vessels in the brain that causes the brain to be starved of oxygen. But what excites sensory cells to cause pain and also dilates blood vessels? Lack of oxygen in the tissue triggers local vasodilation, and supply of these cells with oxygen increases. Cells may be deprived of oxygen, because they consume more for activities. It is also known that organs ache that are strained, for example muscles at a long course. It is the substance P, released from pain sensory neurons, that most strongly expands the blood vessels. A substance that excites pain sensory cells of blood vessel walls is bradykinin, which is formed in the blood under the influence of the enzyme kallikrein that is secreted by cells into the blood. Bradykinin acts only locally, because it is rapidly degraded in the blood. Probably it forms in the blood vessels in the brain, when it lacks oxygen. Substance P, secreted under its influence, prevents harmful effects of oxygen deprivation, but unfortunately it also causes headaches.

How can migraines be caused by a certain type of food? Vincent Geenen and colleagues found that vasopressin is also formed in the
thymus and according to his findings thymus may produce amounts of vasopressin, comparable to those of the hypothalamus. Howard Johnson and Barbara Torres found that vasopressin causes the formation of interferon-gamma in lymphocytes. This is a protein that inhibits the growth of tumor cells and makes them more vulnerable to lymphocytes. It also inhibits viral replication. It is possible that vasopressin is secreted in allergy to certain foods, which stimulate the immune response.

GASTRIC ULCER

Ulcer of the stomach or duodenum is a wound in the gut wall. Occurs when the mucous lining is destroying faster than it regenerates. The lining is destroyed by too much stomach acid excreted. It has long been recognized that the stomach ulcer is associated with anxiety. When people are nervous stomach acid is secreted even when no food is in the stomach. Acid secretion is promoted by the parasympathetic vagus nerve, which is overactive in the anxiety. One form of treatment of gastric ulcers is the disruption of the vagus nerve.

People who suffer from anxiety have overactive sympathetic nervous system, which narrows blood vessels in the skin and intestine, stimulates contraction rate and strength of the heart, thus increasing the blood pressure. In addition, it inhibits the intestinal muscle contraction. How is it possible that in them the parasympathetic nervous system is too active also? Senses for the blood pressure in the heart and aorta detect high blood pressure resulting from the activities of the sympathetic nervous system, and signals from the senses arouse the parasympathetic nervous system in the brain. This has essentially the opposite effect than the sympathetic. Slows the heart rate and reduces its power of contraction, thus lowering blood pressure. And it promotes the contraction of intestinal muscles. In anxiety these effects only counteract the effects of then active sympathetic nervous system. But on gastric acid secretion the sympathetic nervous system has a minor impact, so the parasympathetic nervous system accelerates acid secretion when activated because of high blood pressure. Thus the
gastric acid is secreted even when we do not eat, and this leads to stomach ulcers.

But this is not the whole truth. All people with high blood pressure just do not suffer from stomach ulcers. When the sympathetic nervous system is aroused, the brain prevents the parasympathetic nervous system arousal. Only in some people the parasympathetic vagus nerve is aroused, which promotes the secretion of gastric acid. Probably the curtailed emotions have a role.

Stomach ulcer may also result from tumors that arose from glandular cells that secrete the hormone gastrin. These cells are scattered in the mucosa of the stomach, duodenum and elsewhere in the gastrointestinal tract. Gastrin is secreted after the food enters the stomach and causes gastric acid secretion. Tumors of the glandular cells are constantly secreting gastrin hormone in large quantities.

PROBLEMS WITH CALCIUM AND PHOSPHORUS

Calcium ions in the body have a very important role in regulating many enzymatic reactions in cells. They must therefore be present all the time in about the same concentration in the blood. This is adjusted by two hormones, the parathyroid glands' parathormon and calcitonin from the thyroid gland. Parathormon is secreted when the concentration of calcium ions in the blood decreases. It causes a reverse absorption of calcium in the kidneys and the dissolution of bone, which is a depot of calcium in the body. This increases the level of calcium in the blood. Calcitonin is secreted when the concentration of calcium in the blood rises. It prevents the dissolution of calcium in the bone and promotes its excretion through the kidneys. In bone, calcium is bound in the form of apatite, which is composed of calcium phosphate molecules. When dissolved the phosphate is therefore also released into the blood. However, its levels must not be too high, because it binds calcium to form insoluble salts that precipitate, which causes hardening of the arteries and forms kidney stones. Therefore, parathormon just like calcitonin promotes phosphate excretion by the kidneys. Problems arise when the amount of phosphates in the blood increases faster than the kidneys can excrete.
Many people, especially older ones, suffer from vascular calcification and kidney stones. Arteries become rigid and can easily burst. In addition, calcium is involved in another related problem, osteoporosis. If calcium is dissolved from the bones and its stock is not replaced, the bones become increasingly brittle and can break easily. This is a feature of aging, which particularly affects women after menopause. Then they cease to secrete sex hormone estradiol, which prevents loosening of the bone. Osteoporosis also occurs in humans with an elevated level of glucocorticoids in the blood. The reason may be hormonal active tumors, but increased secretion of glucocorticoids is also a characteristic of depressed people. Thus, the metabolism of calcium depends on the psychological state of a man. But how glucocorticoids accelerate the excretion of calcium from the bones? They are not known to have a direct effect on calcium metabolism.

In most body cells glucocorticoids promote the degradation of protein and fat, and prevent the formation of new ones. In many cellular molecules phosphates are also bound. With their decomposition they are released, and because they are not used for the binding to new molecules they are secreted from cells to the blood. The increase in the amount of phosphate in the blood can significantly be contributed by the phosphate from food. When calcium ions bind to the insoluble salts, the amount of calcium ions in the blood is reduced. Therefore parathormon is secreted, resulting in the dissolution of calcium phosphate in the bone and accelerated renal excretion of phosphate. Even worse, if the intercellular bonding of protein molecules is degraded, calcium has no place in the bones to deposit. When calcium phosphate in the bone dissolves, protein molecules become available to bone degradation enzymes. In time they degrade, and therefore new must be produced to tie calcium phosphate back to the bone. And glucocorticoids inhibit protein synthesis.

Dissolution of calcium in the bone is a perfectly normal event in the organism. Stocks of calcium in the bones can easily be replaced by the food that contains much calcium, such as milk. However, osteoporosis cannot be avoided even with calcium tablets or with vitamin D needed to absorb calcium from the intestine. The calcitonin
can prevent bone dissolution, but a substance that allows the reconstruction of bones is the growth hormone that is secreted during sleep from the pituitary gland. Growth hormone increases the formation of protein. If everything is normal, under the influence of growth hormone proteins are replaced at night which are degraded during the day. Then, when the body receives enough calcium from food, it may be bound to the newly formed bone. However, if a man is depressed, the secretion of glucocorticoids continues even at night. The secretion of growth hormone is reduced, which is typical for older people. Therefore, the bone does not regenerate, osteoporosis develops. However, if one has a hormone-active tumor which secretes growth hormone, the action is reversed. Because of too much growth hormone his bones are thickening.

Each protein-containing food has a lot of phosphates which cause the formation of insoluble calcium salts in the blood. Therefore, the organism must have substances that dissolve calcium phosphate in the blood. To the vascular calcification certainly the lack of these substances contributes. Such a substance is citric acid, secreted by those bone cells that break down bone. So it causes the dissolution of calcium phosphate even in the bone. If fruit with lots of citric acid is eaten, vascular calcification is prevented. Citric acid or its salt, citrate, is also an intermediate product in the breakdown of glucose in the process of cellular respiration. When cellular respiration is accelerated, more citric acid is secreted from cells to the blood, where it dissolves the precipitated calcium phosphate. This happens with exercise, that's why movement prevents vascular calcification. In depressed people less thyroid hormones thyroxine and triiodothyronine are secreted that are needed to accelerate the degradation of glucose. So it is more likely that their arteries will calcify.

**IMMUNE DEFICIENCY OF OLD AGE**

Diseases are far more common among older people than among the young. Typical are respiratory diseases, cancer, rheumatism and cardiovascular diseases. Many are due to reduced efficiency of white blood cells, which are less successful in fighting viruses, bacteria and cancer cells and can no longer dispose of damaged proteins. Bone marrow cells from which any type of white blood cells develops are...
alive even in old people. However, the thymus, in which these cells are transformed into T-lymphocytes, without which the immune system is greatly weakened, dwindles with age. T-lymphocytes are divided into the killer cells intended to kill tumor and virus infected cells, helper cells, which secrete substances that stimulate the activity of other white blood cells, and regulatory or suppressor cells that prevent the immune response. Without T-lymphocytes the organism is not able to resist tumors, weakened is his defense against viruses and bacteria, but harmful inflammations can develop in the absence of suppressor cells that prevent them.

Thymus is composed of cortex and medulla. In the cortex the blood germ cells are surrounded by the epithelial cells, which secrete thymic hormones. In the medulla the lymphocytes are waiting to be outflowed to the blood circulation. Thymic hormones also stimulate lymphocytes throughout the body. The gland is largest during puberty and then begins to dwindle. Most notably its cortex is reduced, which is replaced by fatty tissue. All activities of the thymus are reduced, resulting in reduced immunity. What is the cause of thymus abortion? Many have assumed that the cells fail because of their own genes, which are programmed so as to cease to express. Another possibility is that the cells in the thymus depend on hormones secreted by other cells.

Growth hormone, secreted by the pituitary, promotes the formation of proteins in the target cells. It is known to promote immunity. Thymus cells have receptors for it, and secretion of growth hormone also decreases with age. Therefore, a team of scientists at the Illinois University tried to prevent the abortion of the thymus or even to achieve its re-growth. Pituitary cells that secrete growth hormone were raised in a culture to a cell line that replicates itself indefinitely. In addition to growth hormone they secreted prolactin also, which is similar in composition of amino acids and in effects. These cells were injected into 18 and 24 months old rats whose average lifespan is 21 months. The amount of growth hormone in the blood increased to a hundred times, the amount of prolactin to ten times. In 18 months old rats only small remnants of the thymus may normally be found at dissection. But rats injected with cells that secrete growth hormone had thymus as large as three months old rats. Clearly it was possible
to distinguish the cortex and medulla, the cortex contained lots of maturing cells. In 24 months old rats thymus did not restore completely, but it still contained more cells and less fat.

In the normal 18 months old rats, reproduction ability of white blood cells is 80-90% lower than in the three-month old rats, but in the 24 months old we cannot induce reproduction any more. 18 months old rats injected with cells that secrete growth hormone had exactly the same ability to reproduce the white blood cells than the young. In the 24-month rats growth hormone renewed the ability to reproduce at 10% capacity of the three-month rats.

Growth hormone works in three ways. Stimulates the activity of already existing white blood cells, promotes thymus growth, which in turn promotes the maturation of lymphocytes with its secretions, and stimulates the secretion of thymic hormones, which stimulate the white blood cells. Restoration of thymus is therefore possible, which indicates that the cause of age-related loss of immunity is not in the thymus. Aborted thymus is probably due to reduced secretion of growth hormone from the pituitary gland, which is typical of aging. It depends on the functioning of the brain that secretes peptide somatoliberin which causes the secretion of growth hormone in the pituitary. As in the aging nerve cells decay in the brain, less of this peptide is secreted, and less of the growth hormone is secreted as a consequence. Because of less growth hormone, however, thymus cells, as well as other body cells cannot regenerate. For the causes of aging, we have to look in the brain.

Aging is inevitable for the old specimens to leave food to their offspring with new combinations of genes, allowing natural selection and adaptation of species to environmental changes. Aging thus cannot be prevented, but from our nature and the way in which we react to the trials of life, depends how long we live. Confident people that are not disrupted by any event in life are more likely to reach old age.
CONCLUSION

People usually rarely care about health until they are healthy. But when we get sick, we straightaway take different tablets. Sometimes they do more harm than good. If pills do not help we resort to various witch-doctors, to assist us with bioenergy, laying on of hands, the pendulum magic, incantation of spells and the like. We are not aware that the greatest force, which solely can overcome the disease, is within us. It is our own immune system. Medicaments can help, but completely we can be cured only with its help. Only white blood cells can recognize and destroy enemy cells without damaging our own body. However, our immune system is not effective without our help. Only with trust, with our confident support, it can cope with the enemy. When we are depressed, hormones are secreted that inhibit immune cells. Depression is the adaptation to the lack of food, at which time the body has to save energy. And the immune system uses a lot of energy. Molecules of each body's cells are constantly forming and breaking down. Hormones that are secreted during depression cause more protein molecules to break down than they form. In this way energy is produced, which the body cannot get with the food when it is lacking. If we remain depressed, a degenerative disease resulting from the exhaustion and fail of certain cells in the body therefore develops.

Sleep is essential to health. Only during sleep the body's cells produce more protein than it breaks down. This is the effect of growth hormone that is secreted during sleep. So the body's cells can be restored. During sleep the functioning of immune cells improves also. Consider these lessons in your life and do not act against your conscience, in favor of the current financial or other benefits. Only if we are upright and confident, with clear conscience, we will sleep well and the immune system will successfully fight the intruders in our body.

We will not need witch-doctors since their treatment does nothing else than to affect our psyche. By evoking the hope of cure in us, the depression, a result of weakness in fighting the disease, is wiped out. This may be enough to slowly regain our health. If we know that we can influence the functioning of immune cells, we can chase the
depression away ourselves, only a sense of life we should find. Do not neglect your mind. This is not something insignificant, but an integral part of our body. If there is something wrong with our soul, it will soon be demonstrated by physical problems. Of course we should also take care to feed healthy food and not poison ourselves from smoking, alcohol and other false comforter of our soul. Good luck!
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Proteus Library

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**Psyche and Health**
Psychoneuroendocrinoimmunology

*Published by* the Natural History Society of Slovenia  
*Reviewed by* prof. Dr. Martin Janko  
and prof. Dr. Kazimir Tarman  
*Computer processing by* prof. Dr. Matija Gogala, MRC PMS  
*Cover design by* Andrej Zajec  
*Press* Irena Ovca Mrkun, Kolarjeva 31, Ljubljana

Circulation 1000 copies

Ljubljana 1989

Original title: *Duševnost in zdravje: Psihonevroendokrinoimunologija*.  
Translated in February 2012.

Author's bibliography – books:  
[http://www2.pms-lj.si/bibliag/knjige.htm](http://www2.pms-lj.si/bibliag/knjige.htm)