BIOLOGICAL RESONANCE – RESONANCE IN BIOLOGY

Gabor Lednyiczky and Olga Zhalko-Tytarenko
Hippocampus Research Facilities
e-mail: office@hippocampus-brt.com
web: www.hippocampus-brt.com

The notion of resonance is one of those notions that are often employed not only in their direct physical meaning but also rather intuitively in order to express a kind of general echoing of a complex event. Biology and medicine are among such close-to-scientific-but-not-exact customers of this notion. In physics, resonance means a condition in which an oscillating system shows the maximum amplitude response to an alternating driving force. Everyone is quite familiar with the mechanical resonance usually studied in the classrooms: the oscillations of a pendulum or a string would initiate the oscillations of another pendulum or string that have the same length. In case when an oscillatory electric circuit is under consideration, it responds with maximum amplitude to an external signal with an appropriate angular frequency. Quite simple condition for resonance to occur in mechanics (just one parameter - the length - is under consideration) transforms into something not really definable in biology, since in this latter case one deals with enormous amount of self-adjustable and interdependent parameters.

There is a crucial discrepancy in the modern science: the more deep insight it makes into the mystery of life the farther it moves from the life itself. Fantastically sophisticated equipment makes it possible actually “to see” - and influence! - a particular chemical bond. Nevertheless, it leaves the motivating forces for these bonds to organise themselves into a willing, thinking and reproducing creature deeply hidden. Meanwhile, the inherent wholeness of the living matter and our attachment to the environment is felt by everybody and is actually observed and measured by specialists. If one doesn’t want to be stuck to a certain biochemical process, he/she should bear in mind that life cannot be treated as a sequence of events. Any living organism is an open dynamic system. Plenty of parameters can be assigned to the entire set of its behavioral elements from psychological (through biochemical) to biophysical. In general, no parameter can be treated separately. Hence, a particular state of a living organism we can consider as a point in a multidimensional space, where every coordinate corresponds to a certain parameter. Stability and individuality of such a space is maintained through dynamical interrelations amongst these parameters.

Billions of various biochemical reactions in living cells turn out to be correlated to each other and to the functioning of the whole organism even though they are characterized with very different timescales (Fig. 1). Moreover, their characteristics of energy exchange are also very different. This means that there should be ways of energy sharing within such dynamically unisothropic systems. The occurrence of different timescale dynamics may suggest a kind of “secondary” correlation between the collective (correlated within a certain timescale domain) processes of different timescale dynamics. This, in turn, may imply that these various timescale dynamics are organised in a kind of “spherical” fractually structured

hierarchy of the dynamics of biological processes (Fig. 1). Faster processes are embedded into slower ones. The fractal (self-similar) structure of the dynamic pattern of the organism ensures the inter-level correlation of dynamics within this hierarchical organisation: the laws that determine relationships between different processes within any level (a domain that encompasses the dynamics of a certain timescale) are similar to the laws which determine the relationships between different levels (different timescale domains) within the hierarchy. This, in turn, means that even weak influence occurring at more general level of dynamical hierarchy (i.e. at the level of slower processes) may induce more substantial changes in the system as compared with a stronger influence which corresponds to a characteristic rate of a particular biochemical process.

Therefore, the reliance on natural (i.e. non-separated from each other) forces of an organism constitutes a great advantage of holistic medicine (and bioresonance therapy as a method of it). It deals not with a set of elements and events but with a complex hierarchy of them (from quantum chemical to social). Environmental fluctuations (also from cosmic irradiation to social events) perturb the multi-dimensional spatial pattern of an organism which, in what is called ”physiological” state, usually dissipates such protuberances within its hierarchical framework. However, when the extent of the perturbances or their duration exceed a certain level, the system of coupling of this framework (needed for effective dissipation) may be damaged or an effect of ”saturation” will occur to gain failure in organism’s withstanding to surrounding circumstances.

In the modern science, there is a strong belief that the most comprehensive knowledge is the truest. Natural philosophy was set apart from the ancient philosophy to give birth to what we call now physics, chemistry, biology and so forth. Further bifurcation’s of these sciences are essential to teach students as well as to run routine - though extremely sophisticated - research in the body of nature. However, these bifurcation’s omit the actual soul of nature, the deep inherent interconnections, i.e. the self-creative integrity of the world. This obliterated wholeness is mostly evident in conventional medicine which is the “youngest science” (as Lewis Thomas named it [1]) and probably the eldest art. By telling the story of his professional life (starting from the 20s of our century), Dr.Thomas shows how the old art of the continuous personal communication of doctor and patient expires in favour of x-ray analysis and manifold measuring of the more and more vast variety of species in the organism. Are these hills of numbers really worth that subtle web between a doctor and its patient - a kind of spiritual navel that harmonises the curative endeavour. . ?

The rapid development - and substantial victories - of the methods of biochemical analysis and chemotherapy at the beginning of the century resulted in a firm viewpoint that it is possible to discover certain species which are characteristic for every particular disease and cure these diseases with appropriate drugs. Meanwhile, in the mid 30s, the trial to estimate what is being sick in general, a search for non-specific signs of illness yielded the concept of stress with the notion of adaptation energy. The author of this concept Dr. Hans Selye writes: “The study of stress differs essentially from research with artificial drugs because it deals with the defensive mechanisms of our own body. ...The significance of this kind of researches

is not limited to fighting this or that disease. It has bearing upon all diseases and indeed upon all human activities...” [2].

The efficacy of stress against conditionally acting disease producers [2], points out the endogenous defence mechanisms which perform on a more general level than that of a particular mental or physical disorder. The concept of stress was invented thanks to the discovery of hormones and their role in the organism. The general theory of electromagnetic vibrations of Maxwell and inventions of Marconi and Tesla [3] as well as numerous observations of radiation from organisms and separate cells brought about the concept of the cosmic harmony of vibrations and the Universion which carries these vibrations. The Universion, according to Lakhovsky [4], is the synthesis of the infinitely great and the infinitely small.

His threefold principle: “Life is created by radiation,
Maintained by radiation,
Destroyed by oscillatory disequilibrium” [4]

and the studies of animal instinct as well as the geological and geographical distribution of cancer yielded the creation of Multiple Wave Oscillator (generating all fundamental frequencies from 750 kHz to 3 MHz and numerous harmonics which may extend as far as 300 GHz, i.e., the infra-red and visible light regions). It was built by Lakhovsky and Tesla and successfully applied in the treatment of cancer and various metabolic disorders in plants, animals and human patients (some medical reports from the 30s are quoted in [4]).

“The foregoing facts show that in a healthy organism, every tissue must contain, in constant proportions, conducting and insulating constituents which I have named biomagnomobile units.

“It is essentially due to the energy of its own oscillation that the cell is able to summon for its needs all these insulating and conducting substances which are distributed to the location where they are required for the maintenance of the life of the cell itself ”, wrote J.Lakhovsky in the mid 30s [4]. In the late 30s, Wilhelm Reich summarised his studies of sexual functions and bioelectrical experiments with primitive micro-organisms (protozoa) by introducing the concept of the “bion” (a pattern formed in a colloid solution which is so similar to living organisms structure-formation behaviour that it is not clear whether here one deals with the primitive forms of life or with some physical and chemical changes in the solution) and the “Organo” (the subtle biophysical energy which is irradiated by living organisms and bion structures and which permits them) [5].

The study (initially made by W. Reich in the Institute for Botanics at Oslo University) reveals the principle: any substance that is important for cell structure tends to organise itself in a certain manner to form cell-like patterns. What is very important - such patterns are dynamic. The oscillative formula:

mechanical stress - electrical charge ⇔ electrical discharge - mechanical relaxation

turns out to be universal. Bions (the smallest units of living matter that arise spontaneously from disintegrated matter thanks to universal life energy - organ) were actually considered as Reich's chimeras in the major scientific community of his time. Nevertheless Reich's experiments with pollen and colloid solutions were not only reproduced in the Analytical Laboratory in Nizza and in the Physiological Laboratory in Sorbonne, but also made it possible for Reich to develop a healing device the "organ-accumulator" which he used successfully for treating patients [6]. According to Reich, health is characterised by the vital pulsation of this "basically new cosmic energy" (organ) in all the organs, whereas in a dying organism, "first the organ energy field shrinks, and then the tissues lose their organ" [7].

We do not have in mind to make a deep excursion into the historical background of the holistic viewpoint of health and healing (a brief survey of Reich's forerunners may be found in [8] and followers - in [6]). These are only two examples of the notion of the "cosmic" and "vital" energy, which is bound to come whenever someone tries to define health and illness in general. Despite the obvious positive results, both inventors had problems introducing their devices into general curative process, to a great extent owing to the failure to directly detect this energy. This energy is supposed to be akin to - however not completely - electromagnetic energy. This incomplete paring, the occurrence of "something else", is reflected also in the notion of field in biology. For instance, A. Gurvich introduced the notion of the morphogenetic field as a field of a group of cells, which exhibit coherent behaviour in shape-forming processes in order to describe changes in the processes of cell differentiation and morphogenesis during evolution [9]. This concept is used in Wolpert's theory of positional information [10], according to which, during the evolution of multicellular organisms, the spatial organisation of cell differentiation changes rather than the cells themselves; any further step of development depends on the spatial network of molecules, cells and tissues at the previous step. This theory does not include electromagnetic interactions explicitly because positional information is considered to be determined by the chemical and mechanical relationships between cells. However, both mechanical and chemical changes involve charge rearrangement within a cell or organism and thus give rise to electromagnetic field changes.

Electromagnetic cues

Westerners have considered electricity and magnetism to be vital to life processes for at least 200 years (e.g., by Mesmer and the 18th-century vitalists). Almost 200 years later, further development of the understanding of electric forces in biology - healing processes above all - opens a new pathway for organ regeneration in humans (numerous examples can be found in the book by Robert O. Becker [11], a pioneer in this field. Who incidentally started his career as a doctor at the same New York's Bellevue Hospital as Dr. Thomas whom we quoted at the very beginning). C. W. Smith (from the Department of Electronic and Electrical Engineering, University of Salford) describing the results of his co-operation with R. Choy and J.A. Monro

(from the Allergy and Environmental Medicine Unit at the Lister Hospital in London) over the past three years writes: “Man has evolved in an environment flooded with electromagnetic radiation of all frequencies, but during the past century various forms of highly coherent electromagnetic radiation’s have appeared in the environment. Living systems may already utilise coherent oscillations for their own control purposes, thus there are many ways in which coherent oscillations in the environment may interfere with a living system to give rise to an abnormal reaction which may be considered as an allergic response in the widest usage of the term” [12]. In this work, external electrical stimuli are shown to initiate changes in the body's general homeostasis, including electrical. In a given patient, the symptoms provoked electrically are similar to those provoked chemically and those provoked by the patient's environment. Electrical and chemical stimuli and neutralisation appear to be interchangeable [12].

Despite direct observations of the changes in the skin's resistance [13] or Kirlians’ electrography (named after its Russian inventors) [14], the naturally occurring fields around biological objects were taken into consideration mostly for nervous system or ECG studies until recently. However, EMF sensitivity is found to be a real phenomenon in some environmentally sensitive patients. For example, a multiphase study was performed at the Environmental Health Centre in Dallas to find an effective method to evaluate the electromagnetic field sensitivity of patients. Square wave frequencies from 0.1 Hz to 5 MHz were tested and signs of neurological (most common), musculoskeletal, cardiovascular, respiratory, gastrointestinal, dermal and ocular changes were checked [15] to show that the preponderance of reactions occur at 1 - 10 Hz, though many reactions also occurred at 50 and 60 Hz and some up to 5 MHz. M. Blank in [16] discusses two types of electromagnetic (EM) field effects: 1) the environmental aspect, where the alarming possibility of cancer development in children occurs, and 2) a medical aspect, where one can accelerate growth and healing. He cites the results of a very-well-controlled study from Sweden, based on actual electrical power used, which has shown that leukaemia increases to an odds ratio of approximately 2.7:1 at a magnetic field strength of 0.2 μT (the background exposure is on the order of 0.1 μT in homes in the USA). And at a value of 0.3 μT, the odds ratio jumped from 2.7:1 to 3.8:1. Also included were data on adult occupational exposure that indicated health effects. However, it may be that very high exposures (e.g., for those who live directly underneath high power transmission lines) do not have large biological effects because of so-called “windows effects”, i.e. there appears to be specific (and restricted) ranges of frequency and amplitude where effects occur [16].

Human beings’ attachment to the natural environment is most explicit from the everyday-life observations of circadian rhythms that are shown to be of endogenous origin [17]. Multiple studies of light emission from unicellular organisms up to primates [18, 19] make it possible to introduce (by F. -A. Popp) the notion of biophotons (in order to emphasise their endogenous origin and substantial role in biological communication) as well as to apply the optical part (visible, ultraviolet and infrared light) of the electromagnetic spectrum for therapeutical purposes [14, 20].

Meanwhile, in [21] the circadian rhythms of two groups of human subjects (one of the groups living in a room carefully shielded against natural electric and magnetic fields) are studied to show that natural electromagnetic fields (of lower than optical range frequency) can accelerate the free running rhythm, reduce inter-individual differences and prevent internal desynchronization. The same effects are found by applying a weak alternating electric field [21]. This supports the occurrence of the endogenous mechanisms of the modulation of the electromagnetic signals in a broad range of frequencies (at least, from the order of 10^{15} Hz (ultraviolet light) to the order of single units of Hz (Schumann earth/ionosphere cavity resonance [22] that come into play at the threshold of biological communication.

The endogenous modulation of electromagnetic signals gives rise to natural ac electrical oscillations in cells. Cells, which grow in a polar manner, are known to develop endogenous electric currents [23]. These currents still exist even after the time of pole induction [24]. Protons or Ca^{2+} ions are identified as the main charge carriers in different cells [24, 25]. Electric currents being a consequence of the non-uniform distribution of ion transport systems in plasma membranes.

It is important that static fields around cells will drop to zero within a few nanometers) while alternating fields may extend to some micrometers [26]. Extraordinary long-range electromagnetic interactions between living erythrocytes are found in [27]. The formation of periodic acidic and alkaline patterns along the basal part of bean roots at distances of a few centimetres which remain stable over more than 2 hours is revealed in [28] in good accordance with electric loops in this region.

Experimental methods of detecting endogenous ac electrical oscillations in cells are developed in the works of C. Smith, S. Webb, H. Pohl, etc., by directly measuring the dielectrophoresis (the action of non-uniform electric ac fields on neutral particles) or electrorotation of cells [13, 29-32 and references therein]. In order to study the signals detected by Smith and Pohl in yeast cells in more detail, a measuring system with an improved signal-to-noise ratio using a high impedance preamplifier for electronic detection of the endogenous ac fields was developed by R. Hölzel. Discrete bands of endogenous oscillations in the range of 1.5 MHz to 34.8 MHz with the amplitudes of 0.5 - 7.0 mV in various yeast cells were detected [23]. These studies revealed that the endogenous fields are strongest when cell metabolism is most active. No signs of ac oscillations are found in dead or heavily poisoned cells [23]. The measurements of ac electric fields around cells make it possible for H. Pohl to assume that endogenous oscillations must accompany cellular reproduction, and vice versa - the reproductive process cannot proceed without endogenous ac oscillations [32]. This may be due to the deep involvement of electromagnetic field interactions (within and between cells and organisms) in metabolic energy exchange and transformation.

At the microscopic level, numerous attempts to elucidate the extremely-low-frequency (ELF) signal transduction pathways of the interactions with cell membranes and subcellular components are made by measuring various cellular and subcellular

characteristics while exposing the studied systems to experimentally generated external ELF fields. Physically, magnetic field exposure results in an internal magnetic field, internal electric fields and internal currents [33]. A system which makes it possible to generate magnetic fields from the μT range up to 0.14 T and separate the bioeffects of magnetic and induced electric fields in the frequency range of 4-100 Hz is described in [34].

It is noteworthy that observable responses of biological systems to electromagnetic field treatment occur from altering field exposure, as no marked difference in various cell characteristics (rate of cell proliferation, histogram of the nuclear DNA content, rates of lactate production and glucose consumption and the ATP content) of exposed and intact cells is obtained by using static magnetic fields [35]. Moreover, many processes turn out to be frequency dependent with thresholds or some peculiarities at certain values of external fields. Some of these results are summarised in the table below (EMF = electromagnetic field; MF - magnetic field; DC - direct current; AC - alternating current). (More experimental evidence of the EMF influence on metabolic, genetic and general structure formation processes in cells and cell populations may be found in [51] and in the proceedings of the meetings of the American Bioelectromagnetic Society [44].)

Feature studied	EMF range studied	Parameters of the applied EMF at which the effect occurs	Reference
The inhibition of human lymphoblastic and human carcinoma cell growth	60 Hz, 430-1200 V/m	950 V/m, (no effect at 700 V/m)	[36]
Stimulation of polypeptide synthesis		occurs below 300 Hz	[37]
Na, K-ATPase inhibition	30-300 Hz	100 Hz	[38, 39].
Increase in H2B and *c-myc* transcript basal levels in HL-60 cells	60 Hz, 1 mV-1V, 0.07-70 μA/cm2	depends both on field strength and time of exposure	[40]
Distribution patterns of proteins synthesised by *Sciara* salivary gland cells	60 Hz, 0.8 - 800 μT	fraction ratio in the 30 kDa and 70 kDa ranges shows alternating zigzag pattern as a function of stimulus intensity	[41]

Rb^+ accumulation in erythrocytes	60 - 3000 Hz	occurs at 1000 Hz	[42]
Incidence of mammary tumours in rats Increase in the weight of tumours	AC 50 Hz - MF DC MF and gradient MF	AC-MF, 30 mT DC-MF, 15 mT (no effect at grad. AC-MF 0.3-1 mT)	[43]

Information obtained thus far is still insufficient to offer a reasonable mechanism for EMF interaction with biological tissue. Nevertheless, we would like to emphasise some general features of such kinds of interactions, above all, frequency and power windowing in tissue interactions with weak EMF. W. Adey [45] realised the windowing effect after studying the behavioural and neurophysiological effects of extremely low frequency (ELF) and modulated radio frequency (RF) fields as well as the responses of calcium ion binding in tissues to ELF and RF fields [46, 47]. The occurrence of such “biological” electromagnetic windows [48, 49] testifies to the necessity of the application of the natural (endogenous) EMF in the studies of the role of electromagnetic oscillations in the organism's processes. The natural dynamic complement of the inherent and environmental electromagnetic signals (frequency, amplitude, phase and the composition of complex signals) ensure a very fine selectivity of the available information from the electromagnetic noise as well as preventing a “dissolving” in the environmental electromagnetic fields.

Alternating currents are shown to affect also ion transport and ATP splitting via changes in the activation of the membrane of Na, K-ATPase. Both processes vary with frequency [48], and can be explained by the effects of the ionic currents on ion binding at the enzyme's active sites. These could account for the effects of EM fields on cells, as the transmembrane enzyme can convey the effect of an extracellular signal into the cell via ionic fluxes.

The works of M. Blank and co-authors from Columbia University (New York) deal with EM field effects on protein synthesis and the Na, K-ATPase function in cells. They emphasise that in the debate on the biological effects from environmental, non-ionising electromagnetic waves, probably the strongest experimental evidence has come from studies of changes in biosynthesis. The magnetic field, or more likely induced currents, may effect certain processes when the DNA is already unravelled to some extent and in the process of forming messenger RNA (mRNA). An effect may also occur in the cell when this message is read and different amino acids are being added to the growing protein chain. Changes occur at the level of transcription (formation of mRNA) or translation where the message is made into a protein.

Results of [52] show that the steady state levels of some RNA transcripts are increased when cells are exposed to ELF electric or magnetic fields. Experiments have exposed a variety of cell types, including dipteran salivary gland cells, yeast and

human HL-60 cells. These data suggested that the physiological mechanism involved in the cellular response to ELF electromagnetic fields may be similar to or mimic the response to heat shock and that one effect of EM fields is directly at the transcription level. As expected, the transcription response was similar to the generalised response of cells to stress (these results point to a possible link between EM field exposure and malignancy through the over-expression of stress genes and increases in stress proteins). Both electric and magnetic fields appear to stimulate the same genes.

The authors of [53] also support the idea that integral membrane enzymes may couple to the electric field vector of an alternating electromagnetic field. This is limited to membrane-bound proteins that undergo large conformational changes during catalysis [53]. However, the results in [54] show that an intact membrane is not an absolute requirement for transducing magnetic bio-effects. In this work, plasmids containing the α, or both the β,β' sub-units of the RNA polymerise from E.coli were placed into a cell-free expression system which was exposed to a 72-Hz sinusoidal magnetic field in the range of 0.07 to 1.1 μT for periods of 5 min. to 1 h to show the elevated level of gene expression. For 10 min. of field exposure, the threshold for an effect is 0.1 μT. According to the authors of [54]; it is not immediately evident whether the increased levels of protein observed are a result of alterations in transcription, translation, or both. Alternatively, the stability of the mRNA might also be affected by field exposure.

Higher magnetic fields can affect fast biochemical reactions of electron and spin transfer. A change in radical pair recombination rates is one of the few mechanisms by which a magnetic field can interact with biological systems. More than 20 enzymes are thought to incorporate radical chemistry in the conversion of substrates to products [55, and references therein]. The enzymes, which utilise spin-correlated radical pair intermediates, should be sensitive to an applied magnetic field. Another example of a biological system that is sensitive to an applied magnetic field through electron spin sensitivity is the triplet yield and emission intensity of the bacterial photosynthetic reaction center [56]. For instance, the magnetic field dependence of geminate radical pair recombination following the photosis of adenosylcob (III) alamin (AdoCblIII, relevant to B12 enzymes - natural antioxidants) has been studied in [56].

The rate or product distribution of reactions that involve geminate radical pair or biradical intermediates can be altered by a magnetic field which changes intersystem crossing (ISC) rates between singlet and triplet spin-correlated states [55]. A geminate radical pair born in the singlet spin states after bond homolysis will readily recombine to reform starting material. If ISC to the triplet Spin State occurs, the Pauli exclusion principle prohibits recombination to the starting material. To allow for electron spin recombination, a geminate radical pair must be held close for 10-10 - 10-6 s. In exceeding this time, interactions with solvent and neighbouring atoms will lead to spin randomisation. Thus, only biochemical reactions that occur in this time domain may exhibit a magnetic field dependence through the radical pair spin exclusion mechanism [55].

The quoted examples basically employ the so-called lock-and-key paradigm of biochemistry [57], according to which, any biochemical reaction needs a specific

arrangement of the reacting molecules. We do not have in mind to argue this paradigm (per se, it is rather well proved) however, it overestimates the "chemical essence" - moreover, the local specific features of life processes, healing among them. Meanwhile, a living organism and its functions cannot be reduced to a set of chemical reactions, even if it were possible to account for all of them. Continuous adaptation to changing conditions - hence continuous readjustment of the parameters of the biochemical reactions inside the body - is characteristic for living matter. Any fast change (with a rate exceeding a certain threshold determined by the adaptability of a particular organism) is considered as a perturbance of a living system, irrespective of whether this change is intended to cause or prevent illness. This constitutes a serious problem of any acute treatment. Any illness - actually illness in general - generates a kind of communicational gap within the organism's functional network. Since living beings are highly integrated open dynamic systems, their health - all health in general - is supported by a permanent mass, energy and information exchange. The dynamics of communication thus is vital for organisms. As one can see from the shown examples, the communication between cells, organs and even organisms has an essentially electromagnetic nature.

SYSTEM INFORMATION PATHWAYS AND BIORESONANCE THERAPY

Unfortunately, in modern medicine there still exists another sort of communicational gap: an artificial separation into so-called conventional and complementary medicine. This seems to be mostly due to the fact that usually physicians are only human and would like to succeed socially and thus prefer to organise a more or less closed community to support their corporate interests. Both gaps should be avoided, the latter above all, since it creates unnecessary boundaries for the understanding of the interconnections of each particular process within the organism. Actually, all medicine should be holistic, even though this may be achieved based on the knowledge about many local events in the body. Though 'holism' is quickly becoming the most over-used and ubiquitous notion in recent years, it is difficult to argue against its importance. Paradoxically, nearly everyone has a different construct of what exactly holism means as perception, cultural values, spiritual beliefs, and knowledge vary from individual to individual. There is an ever-growing body of evidence, which suggests that electromagnetic fields (EMFs) are not simply a passive aspect of the environment and that the electromagnetic state of an organism contributes to its 'wholeness'.

The basis for a holistic theory in medicine is made by Alfred Pischinger [58], a professor of histology and embryology at the University of Vienna, and his forerunners [59, 60] within the framework of what now is called conventional medicine. These authors coined a concept about the "ground regulation system" which is defined as a functional unit of the final vascular pathway, the connective tissue cells and the final vegetative-nervous structure, with extracellular fluid being the field of these activities [58]. This system is essentially non-specific; it penetrates

the entire organism and is responsible for all basic vital functions. Thus, both diagnosis and therapy may be based on the estimation and improvement of the parameters of this system (such as the content of glycosaminoglycans and proteoglycans, collagen, fibronectin and laminin, etc.; as well as the level of energy flow in the extracellular matrix and so forth). The estimation of such kinds of parameters is usually considered a prerogative of conventional medicine. However, since this is done essentially non-locally, it also conforms to the main approach of complementary medicine, which is aimed at the treatment of the essentially non-specific regulative systems of the body. When an organism is treated on a more general level of its functional dynamic hierarchy, it is easier to restore the physiological communication pathways within it and thus activating the endogenous healing processes. In short, following up of a number of biochemical estimates (in the blood, lymph or ground regulation system) in-patients employing complementary medicine techniques (massage, acupuncture, various kinds of eastern healing gymnastics or meditation, etc.) will not reduce the effacy of the complementary treatment. Actually, this is the essence of autogenic feedback training and psychotherapy. Various modern biofeedback techniques are based on the permanent follow up of certain measured parameters of the body (EEG or ECG signals, blood pressure, temperature, etc.) [61 and references therein].

The alterations in the biophysical parameters - electrophysical above all - occur at substantially general levels of the organism's functional hierarchy. Therefore, they are responsible for very subtle intimate mechanisms of the organism's self-regulation and interlevel communication through resonance interactions.

Electromagnetic resonance interactions between the endogenous electromagnetic oscillations of organisms are suggested [62] to occur in living systems; however, an attempt to detect them is a rather complicated problem. Nevertheless, a still growing number of therapeutic devices, which use such kinds of interactions, are elaborated on in [63]. For example, more than 11 years of the utilisation of Brügemann (Germany) devices in various European clinics evidence their efficacy in treatment of many diseases [64-69]. Some of these devices (such as the "MULTICOM"- an abbreviation for Multiple Communication) have inner generators while others have only antennae (e.g., the "Strahler" - a German word for ray or jet) or boards (e.g., the "BICOM" - an abbreviation for Biological Communication) designed to acquire, modulate and transduce endogenous electromagnetic oscillations of organisms. As they are designed to use resonance interactions between natural electromagnetic oscillations, they are given a general title of 'devices for bioresonance treatment' [63, 65].

Every particular level of an organism's hierarchy possesses a characteristic spectrum of endogenous electromagnetic oscillations originating from various processes. Intra- and interlevel resonances should occur, more or less providing correlation's between these processes. Thus, certain interference patterns of endogenous electromagnetic oscillations can be attributed to every particular organism.

From this point of view a pathology, which may be born at any level, will perturb all oscillations via wave interactions irrespective of the origin of such waves. The distorted interference pattern of the endogenous waves of a sick organism reflects incorrect relations between biochemical processes in it. Numerous positive experiences in the application of electromagnetic therapy devices makes it possible to assume that device-induced restoration of the interference pattern will renovate physiological order in a sick organism.

One approach to this problem is to isolate basic processes (and frequencies which correspond to their time scales) which are common to all levels of an organism's hierarchy in certain frequency ranges and can thus open pathways of interlevel signal transduction. Another approach is an attempt to "get above" the details of the exact physical and chemical nature of the processes in living systems and coin out most general relation.

While studying a living system with conventional though very sophisticated methods; we try to adopt it to our usual three- or not too much more-dimensional space (depending on how many parameters can be followed-up simultaneously). Usually, the intersection of spaces of different dimensions yields inadequate laws of cause and effect from the point of view of an observer in a lower-dimensional space. Thus, when we are "sitting" in our two-, three- (or a little bit more) dimensional space and studying a living organism (which is a much more high-dimensional system with respect to the interrelations amongst what we call its features), we try to find functional dependencies of characteristics that may influence each other mostly occasionally. On studying a particular process in an organism, we should understand that we artificially separate it from the others and take care about the assumptions, which we make for this. That is why, one should not exaggerate the results of even extremely sophisticated and thorough investigation from the point of view of the conventional science. Actually, the deepest insight into the most intimate characteristics of any biological process cannot be generalised.

Life cannot be treated as a sequence of events. From this point of view, the speculations about "biological" or "morphogenetic" fields and "aura" etc. look more correct though less "scientific" since they do not operate with any equation (and we adopt that calculations reduce the versatility of the world owing to simplifying assumptions needed to cut off interrelations and treat a process of interest separately). Therefore, the reliance on natural (i.e. non-separated from each other) forces of an organism constitutes a great advantage of holistic medicine (and bioresonance therapy as a method of it). Contrary to "traditional" medicine, it deals not with a set of elements and events but with a complex hierarchy of them (from quantum chemical to social). Environmental fluctuations (also from cosmic irradiation to social events) perturb the multi-dimensional spatial pattern of an organism, which, in what we call "physiological" state, usually dissipates such perturbances within its hierarchical framework. However, when the extent of the perturbances or their duration exceed a certain level, the system of coupling of this framework (needed for effective dissipation) may be damaged or an effect of "saturation" will occur to gain failure in organism's withstanding to surrounding circumstances.

There are many works on quantum effects in biology which give rise to the speculations about quantum states of living organisms, so-called ”quantum biology” and ”quantum medicine”. However, in these works, investigators deal rather with quantum events in biological systems, which are more or less involved into biological development and communication. In other words, many axes of an organism-specific multi-dimensional spatial pattern may be essentially quantum mechanical, but this cannot be true for an organism as a whole. Like in physics, where ”quantum” refers to the smallest amount of a physical property, in biology, this term should refer to the smallest amount of ”biological” property, i.e. to the unit cell of multi-dimensional space pattern of every particular biological object, which may include electromagnetic, gravitational, weak and strong force and consciousness etc. axes.

Speculations about quantum biology are developed on the basis of essentially non-linear response of living systems to various influences. However, such non-linear response is also characteristic for deterministic chaos systems, in which even smallest fluctuations may induce crucial qualitative changes. As we deal with the projection of a system of higher dimension on the lower dimension system of our perception, we may observe (in the projection) different parts of this higher dimension system as separate states and thus find analogy (which is essentially wrong) with quantum mechanical transitions, when a particle can be transferred from one state to another by escaping all other in-between.

Quantum charter of biological systems, in turn, gives rise to the speculations about resonance’s and endogenous oscillations that usually are treated as the oscillations of the endogenous electromagnetic fields of living organisms. Of course, endogenous oscillations of organisms are essentially - though not exclusively! - electromagnetic since all organisms carry diluted aqueous solutions with many electrolytes, semipermeable membranes, conductive protein chains and a set of biochemical reactions of electron transfer and free radical formation etc. However, from our everyday life we know about circadian rhythms in living matter; at least, we can feel our own mental, physical, sexual or social rhythms which are substantially interdependent. This means that all these much more sophisticated (than electromagnetic) features alter (oscillate) with time. Returning to our analogy with the interception of lower- and higher-dimensional space patterns, we see that while the accounting for all parameters (axes of space pattern) simultaneously is extremely complicated deal yielding incorrect results, the study of temporal behaviour of one parameter (i.e. the study of the dynamics of its changes) can be really informative since it includes only estimated errors of measurements. Chaotic systems may be compared through the behaviour of trajectories in the corresponding phase space. There are special - bifurcation - points in such trajectories. In these points a transition from chaos to order (or vice versa) occurs and a system may ”jump” from one branch of solutions to another (this may refer to a quantum transition). Chaos-order conflict governs all levels of existence. As it is well formulated by Murray Hope ”all creation oscillates between order and chaos” [70].

We believe that bioresonances occur just within such kind of oscillations. Living organisms and all constituting them processes are essentially nonequilibrium chaotic systems capable for self-regulation that is manifested in order/chaos

oscillations. The motive force for such oscillations is of electromagnetic nature to a great, however not exclusive, extent. Any chaos/order transfer is accompanied with a symmetry brake. Thus, what we call ”biological” resonance occurs in the case of the complementarily of the phase space patterns of two or more systems. Under bioresonance conditions, simultaneous chaos/order transfers occur in a set of interacting systems with respect to the studied parameter (or parameters) to gain higher coherency of systems' behaviour.

Among the modern models in medicine - the model of genetic predisposition of the physical state of the organism, environmental influence and chaos theory - the latter is gaining now still more evidence and explanation. The application of this theory of non-linear processes in medicine includes the same approach that was conventionally employed for different descriptions of bioresonance therapy: pathology is an inherent component of the health, there is no “health” without “pathologies” and vice versa. There is no absolute, universal health or pathology - both notions are extremely organism-related, they are most intimate individual notions. Not pathology *per ce* is that crucial to the organism, but the ability of the organism to cope with the whole set of processes - both physiological and pathological - that keep it alive. This is provided with the appropriate and sufficient conductivity of the informational channels within the body. The organism gains a problem in case either informational channel is blocked or wrong information passes through. Both cases mean the deficiency in the resulting biological resonance.

Own experience as well as the analysis of numerous data available in the literature convinces that actually any parameter measured in living beings can deliver particular information about the whole system (organism). This is suggested to be due to “biological resonance's” even though there is no kind of an agreed - say, “standard” - definition of the notion of biological resonance. We believe that the dynamic information being transmitted makes it possible to adjust the rhythm of a certain function in order to fit into a regular metabolic pattern.

The notion of bioresonance therapy (BRT) was first coined out by Dr. Morrel in Germany in the 70-ties, who combined the findings by Hanneman about the dramatic influence that substantially non-material information (homeopathic dilution) on the organism and the findings by Dr. Voll about the role of acupuncture in therapy and diagnosis. As a result, a new method of therapy - bioresonance therapy - was introduced. Thus, 70-ties and 80-ties was, o one hand, a period of massive acquiring new data in the field of BRT application for treatment of different disorders, on the other hand, various types of the devices for BRT were established. Most such devices, nevertheless, employ the endogenous electromagnetic fields of the organism and the electromagnetic fields of its stressors and environment. The fundamentals of such type of devices can be showed by presenting the Cell-Com Europe™ device, elaborated at the Hippocampus Institute in Hungary. Cell-Com Europe™ device acquires electromagnetic oscillations of a biological system situated at the input field sensors of the device in the total frequency range of 1Hz -1 MHz, with the accuracy of max. 1 Hz. For further modulation, one can chose the bandwidth of 5-30% of the whole range of the applied frequencies. Any parameter in this device can be pre-programmed. The acquired signal may be then modified: phase may be changed,

some frequencies may be filtered out or one can amplify a signal (from 0 to 80 dB). The modified signal is then sent back too the organism. In order to avoid random errors, the device usually works with differential signals measured between two electrodes connected to a patient.

It is substantial that the method of bioresonannce therapy necessitates a bioresonance-based diagnostic method. A kind of ECG biofeedback compilation with environmental and endogenous EMF interactions is used in the Cerebellum Multi channel Instrument (CMMI) developed by the Hippocampus Institute (Hungary).

- The CMMI is a 12 or 16-channel biofeedback device that produces ECG-like vectors by using large surface electrodes instead of point ones. This makes it less dependent on the peculiarities of a single active point which supports gate functions with respect to the anatomical submit or metabolic process. This means that the CMMI's signals are less topologically determined than other electrophysiological testing equipment.
- The CMMI provides dynamical testing of the patient's electrophysical parameters through a very fast sampling rate (~ 10^{-4} s) and sophisticated software for the analysis of 12 or 16 x 80 sets of acquired data. Manual adjustment of any step in the process of measurement is available.
- The measuring of various electrophysical characteristics (not only conductivity) enables more exact monitoring and makes it possible to carry out real adaptation tests.

The CMMI reflects the response of patient's electrophysical characteristics to the test substances inserted into the measurement circuit while the patient is not mentally aware of the actual sequence of the examination. Bearing in mind that the obtained data are not restricted topologically, this proves the field character of what is called consciousness. Such testing equipment make it possible to estimate the patient's response to a cure (or any other substance and - more generally - electromagnetic field-carriers) essentially in advance (before its direct application) and thus forecast the future of the patient.

In summary, it should be outlined that BRT is actually the most holistic approach ever possible: to treat the organism it applies nothing but the organism itself manifested through its electromagnetic field. By facilitating the endogenous regulative mechanisms, such electromagnetic fields support both the integrity and adaptability of the organism that constitute the notion of its wholeness.

References:

1. L. Thomas: The Youngest Science, Oxford University Press, Oxford, Melbourne, 1985, 276 p.
2. H. Selye: The Stress of Life, McGraw-Hill Book Company, New York, Toronto, London, 1956.
3. R. A. Ford, Tesla Coil Secrets, Lindsay Publ., Inc: Bradley, Il, 1985, 74 p.

4. G. Lakhovsky: The Secret of Life: Electricity, Radiation and Your Body, Noontide Press, Costa Mesa, 1992, 214 p.
5. D. Boadella: Wilhelm Reich, Fischer Taschenbuch Verlag, Frankfurt am Main, 1983, 366 p.
6. R. Gebauer, S. Müschenich: Der Reichsche Orgonakkumulator, Nexus Verlag, Frankfurt, 1987. (in German)
7. W. Reich: The Cancer Biopathy, Orgone Institute Press, New York, 1948.
8. W. Mann, E. Hoffman: Wilhelm Reich: The man who dreamed of tomorrow, J. Tarcher, Inc., Los Angeles, 1990, 295 p.
9. A. Gurvich: Selected Works, Meditsina, Moscow, 1977.
1. L. Wolpert: J. Theor. Biol., 1969, vol. 25, 1-47.
11. R. O. Becker, G. Selden: The Body Electric, Morrow, New York, 1985.
12. R. Choy, J. A. Monro, C. W. Smith: Electrical sensitivities in Allergy Patients, Clinical Ecology, 1987, vol. 4, n. 3, p. 93-102.
13. Smith C. W., Best S. (1990): Electromagnetic Man, Edited by J. M. Dent & Sons, Ltd. London, p.26.
14. F.-A.Popp: Neue Horizonte in der Medizin, Haug, Heidelberg, 1983.
15. W. J. Rea, Y. Pan, E. J. Fenyves, I. Sujisawa, H. Suyama, N. Samadi, G. H. Ross: Electromagnetic field sensitivity, J. Bioelectricity, 1991, vol. 10, No. 1-2, p. 241-256.
16. M. Blank (1993): Biological effects of electromagnetic fields, Bioelectrochemistry and Bioenergetics, v. 32, p. 203-210.
17. J. Aschoff: Comparative Physiology: Diurnal rhythms, Ann. Rev. Physiol., 1963, vol. 25, p. 581.
18. U. Warnke: Influence of Light on Cellular Respiration, In: Electromagnetic Bio-Information (F.-A.Popp *et al*. ed.), Urban & Schwarzenberg, Munchen, 1989, p. 213-220.
19. Recent Advances in Biophoton Research and its Applications, (F.-A. Popp, K. H. Li and Q. Gu eds.), World Scientific, Singapore, 1992, 504 p.
20. W. Kroy: The Use of Optical Radiation for Stimulation Therapy, In: Electromagnetic Bio-Information (F.-A. Popp *et al*. ed.), Urban & Schwarzenberg, Munchen, 1989, p. 200-212.
21. R. Weaver: The effect of electric fields on circadian rhythms in men. Life Sci. Space Res., 1970, vol. 8, p. 177.
22. W. Schumann: Uber die strahlunglosen Eigenschwingungen einer leitenden Kugel, die von einer Luftschicht und einer Ionosphärenhülle umgeben ist, Zeitcshrift für Naturforschung, 1954, b.&a, s.149-154. (in German)
23. R. Hölzel, I. Lamprecht: Electromagnetic fields around biological cells, Neural Network World, 1984, vol. 3, p. 327-337.

24. N. A. R. Gow: Transhyphal electrical currents in fingi, J. Gen. Microbiology, 1984, vol.130, p.3313-3318.

25. N. A. R. Gow, D. I. Kropf, F. M. Harold: Growing hyphae of Achlya bisexualis generate a longitudinal pH gradient in the surrounding medium, J. Gen. Microbiology, 1984, vol. 130, p. 2967-2974.

26. H. A. Pohl: Natural electrical RF oscillation from cells, J. Bioenerg. Biomembr., 1981, vol. 13, p.149-169.

27. S. Rowlands: J. Biol. Phys., 1982, vol. 10, p. 199.

28. K. Toko, K. Hayashi, Yamafuji K.: Spatio-temporal organization of electricity in biological growth, Trans. IECE Japan, 1986, vol. e. 69, p. 485-487.

29. S. J. Webb: Phys. Rep., 1980, vol. 60, p. 201.

30. H. Pohl: Dielectrophoresis: The Behavior of Matter in Non-uniform Electric Fields, Cambridge University Press, 1978.

31. H. A. Pohl: Natural oscillating fields of cells, In: Coherent excitations in Biological Systems. (H.Frölich, F. Kremer, eds.), Springer Verlag, Berlin, 1983, 199-210.

32. H. A. Pohl: Natural ac electric fields in and about cells, Phenomena, v. 5, 1983, p. 87-103.

33. Dan Bracken T. (1992): Experimental Macroscopic Dosimetry for Extremely-Low-Frequency Electric and Magnetic Fields, Bioelectromagnetics Supplement, v. 1, p. 15-26.

34. Mullins R. D., Sisken J. E., Hejase H. A. N., Sisken B. F. (1993): Design and Characterization of a System for Exposure of Cultured Cells to Extremely Low Frequency Electric and Magnetic Fields over a Wide Range of Field Strengths. Bioelectromagnetics, v. 14, p. 173 - 186.

35. Yamaguchi H., Hosokawa K., Soda A., Mizamoto H., Kinouchi Y. (1993): Effects of seven months exposure to a static 0.2 T magnetic field on growth and glycolytic activity of human gingival fibroblasts, Biochem. Biophys. Acta, v. 1156, p. 302-306.

36. Azadniv M., Miller M. W., Cox C., Valentine F. (1993): On the mechanism of a 60-Hz electric field induced growth reduction of mammalian cells *in vitro*, Rad. Environ. Biophys, v. 32, p.73-83.

37. Goodman R., Henderson A. S. (1988): Exposure of salivary gland cells to low frequency electromagnetic fields alters polypeptide synthesis, Proc.Natl.Acad.Sci., USA, v. 85, p. 3928-3932.

38. Blank M., Soo L. (1992): Threshold for Inhibition of Na, K-ATPase by ELF Alternating Currents. Bioelectromagnetics, v. 13, p. 329-333.

39. Blank M., Soo L. (1993): The Na, K-ATPase as a model for electromagnetic field effects on cells. Bioelectrochem. and Bioenergetics, v. 30, p. 85-92.

40. M. Blank, L. Soo, H. Lin, A. S. Henderson, R. Goodman (1992): Changes in transcription in HL-60 cells following exposure to alternating currents from electric fields. Bioelectrochemistry and Bioenergetics, v. 28, p. 301-309.

41. M. Blank, O. Khorkova, R. Goodman (1994): Changes in polypeptide disribution stimulated by different levels of electromagnetic and thermal stress, Bioelectrochemistry and Bioenergetics, v. 33, p. 109-114.

42. Serpersu E. H., Tsong T. Y. (1984): Activation of electrogenic Rb+ transport of Na,K-ATPase by an electric field. J.Biol.Chem., v. 259, p. 7155-7162.

43. Mevissen M., Stamm A., Buntenkötter S., Zwingelberg R., Wahnschaffe U., Löscher W. (1993): Effects of Magnetic Fields on Mammary Tumor Development Induced by 7,12-Dimethylbenz(a)anthracene in Rats. Bioelectromagnetics, v. 14, p. 131-143.

44. Abstract Book of the 17th Annual Meeting of BEMS, Boston, MA, June 18-22, 1995, The Bioelectromagnetics Society, Frederick, MD, 1995.

45. W. R. Adey: Frequency and Power Windowing in Tissue Interactions with Weak Electromagnetic Fields. Proceedings of the IEEE, 1980, vol. 63, no. 1, p. 119-125.

46. S. Lin-Liu, W. R. Adey: Low frequency Amplitude Modulated Microwave Fields Change Calcium Efflux Rates From Synaptosomes, Bioelectromagnetics, 1982, vol. 3, p. 309-322.

47. S. M. Bawin, A. R. Sheppard, M. D. Mahoney, W. R. Adey: Influences of Sinusoidal Electric Fields on Excitability in the Rat Hippocampal Slice, Brain Research, 1984, vol. 323, p. 227-237.

48. W. R. Adey: "Tissue interactions with nonionizing electromagnetic fields", Physiol. Rev., 1981, vol. 61, p: 435.

49. A. F. Lawrence, W. R. Adey: Nonlinear Wave Mechanisms in Interactions between Excitable Tissue and Electromagnetic Fields, Neurological Research, v. 4, n. 1/2, 1982, p. 115-153.

50. M. Blank (1992): Na, K-ATPase function in alternating electric fields, FASEB Journal, v. 6, p.2434-2438.

51. Biological Effects and Dosimetry of Static and ELF Electromagnetic Fields, (M. Grandolfo, S. M. Michaelson and A. Rindi, eds), Plenum Press, New York, London, 1985.

52. R. Goodman, M. Blank, H. Lin, R. Dai, O. Khorkova, L. Soo, D. Weisbrot, A. Henderson (1994): Increased levels of hsp70 transcripts induced when cells are exposed to low frequency electromagnetic fields. Bioelectrochemistry and Bioenergetics, v. 33, p. 115-120.

53. M. Blank (1992): Na, K-ATPase function in alternating electric fields. FASEB Journal, v. 6, p.2434-2438.

54. E. M. Goodman, B. Greenebaum, M. T. Marron (1993): Altered protein synthesis in a cell-free system exposed to a sinusoidal magnetic field, Biochim.Biophys, Acta, v. 1202, p. 107-112.

55. T. T. Harkins, C. B. Grissom (1994): Magnetic Field Effects on B12 Ethanolamine Ammonia Lyase: Evidence for a Radical Mechanism. Science, v. 263, p. 958 - 960.

56. S. G. Boxer, C. E. D. Chidsey, M. G. Roelofs (1982): Use of large magnetic field to probe photoinduced electron transfer reaction: an example from photosynthetic reaction center. J. Amer. Chem. Soc., v. 104, No. 5, p. 1452-1454.

57. A. J. Clark: Mode of Action of Drugs on Cells, Arnold, London, 1933.

58. A. Pischinger: Matrix and Matrix Regulation, Haug, Brussels, 1991.

59. F. Perger: Kompendium der Regulationspathologie und -Therapie, Sonntag, München, 1990. (in German)

60. Normal Matrix and Pathological Conditions, (H. Heine, P. Anastasiadis eds), Gustav Fischer, Stuttgart, Jena, New York, 1992.

61. E. Green, A. Green: Beyond Biofeedback, Knoll, Ft. Wayne, IN, 1989.

62. Popp F.-A. (1989): Coherent photon storage in biological systems, Electromagnetic Bioinformation, Edited by Fritz-Albert Popp, München-Wien-Baltimore, p. 144-167.

63. Ludwig H. W. (1988), Die Debatte um die Magnetfeldtherapie aus der Sicht der Biophysik. Erfahrungsheilkunde, Acta medica empirica, v. 12, p. 735- 739.(in German)

64. Schumacher P. (1994): Biophysikalische Therapie der Allergien, Sonntag Verlag, Stuttgart, 300 p. (in German)

65. Bioresonance and Multiresonance Therapy (BRT), H. Brügemann ed., Brussels, Haug International, 1993, 277 p.

66. Proceedings of the Annual Meetings of the International Medical Society of BRT and International Therapeutic Society of BRT, RTI Heft I-XVII. (Brügemann Inst. ed.), Lochhamer Schlag 5, 82166, Gräfelfing (Germany).

67. Acta Medica Empirica (Special issue for BRT), 1994, 3/1.

68. H. Lehmann: Elfolgreiche Behandlung primärer Dysmenorrhoe - fast ohne Therapieversager. Der Freie Arzt, 1993, No. 4. (in German)

69. G. Lednyiczky, Cs. Miklós: Bioresonancia Terapia (Bioenergetics, Piliscsaba 1998)

70. M. Hope. Time: The Ultimate Energy. Element Books Ltd., Longmead, Shaftesbury, Dorset, 1991, 200 p.