Biophotonics Dr. Hugo Niggli und Dr. Max Bracher

The term biophotonics is made up of two Greek words: “bios” and “phos”. “Bios” means life and “phos” stands for light.

Biophotonics addresses medical and human science questions in the form of light based technologies. Both microscopic and spectroscopic methods belong to this, as well as the use of lasers to explain biological processes on a cellular level.

The main point of biophotonic research is the application of the characteristics of light on food production, pharmacy, bio-technology and medicine. With the help of light, images of microscopically small processes within living cells can be observed quickly and undisturbed.

At the international institute for biophotonics, fundamental research about biophotonic analysis (IBB) is being carried out under the direction of Professor Popp.

All living organisms consist of cells, whether bacterium, plant, animal or human. In the case of unicellular protozoa, the entire organism is constituted by a single cell, whereas in the case of multi-cellular metazoans, cells form the fundamental structural unit of which the entire body is made up. The shape and size of cells are dependent on function and location within the cellular aggregation. Cells are generally between 0,1 and 100 µm in size (1 µm = 1 thousandth of a millimeter). Some of the largest cells are animal egg cells. The numbers of cells in an organism are, of course, related to body size. An adult human being should consist of around 100 trillion (100 x 10^12) cells. Cells can be grown outside of the organism, a technique developed by the Nobel Prize winner for medicine in 1912, Alexis Carrel (1873-1944). Cell cultures have become more and more important since the beginning of the twentieth century, particularly in medical, biological and biochemical research.

As an example, this technique was used to study the biological effect of ultraviolet light (UV light) on cells. UV light is subdivided into three bands: UVA (320-400 nm), UVB (290-320 nm) and UVC (<290 nm). UVC is filtered out by the ozone layer of the stratosphere and therefore practically never reaches the surface of the earth. UVC and UVB are able to induce mutations of the genome and can easily cause skin cancer after intense exposure to sun in individuals suffering from XerodermaPigmentosum, a well known genetic disease. Interestingly, such genetic mutations are reversible by UVA and violet light by means of the so-called photo repair.

Cell culture technique allows human or animal cells to stay alive outside of the organism and to proliferate during many generations. As an example, skin cells are very easy to cultivate. The dermis contains mainly fibroblasts, which are most suitable to grow. Skin fibroblasts experience a differentiation similar to the development of blood cells. Starting from an omnipotent stem cell, a highly differentiated, specialized cell develops which is not able to divide any more. A complete fibroblast model for differentiation, aging and cancer was developed by the above-mentioned German cell biologist Klaus Bayreuther at the end of the 1980´s.

The light in the cells: Biophotons Some years before, in 1983, the two natural scientists Nagl (cell biologist) and Popp (biophysicist) introduced an electromagnetic model of cell differentiation. This model was based on the conclusion, that the radiation of cells can be measured by the above-mentioned technique of photomultipliers. With this technique, an electron is emitted after the absorption of a photon by a photomultiplier cathode. This electron is amplified like an avalanche by several, series-connected, dynodes. Then the resulting electron stream hits the anode and is registered as an electric measurement. With this technique, the Italian scientists Colli and co-workers were already able to provide evidence of ultra-weak light in plant cells in the middle of the 1950´s. Even earlier, at the beginning of the1920´s, the scientist Alexander G. Gurwitch (1874-1954) discovered this ultra-weak cell radiation by dividing onion cells in a biological experiment without a light-measuring tool and postulated that live organisms communicate by means of light. This concept was corroborated by the Austrian physicist Erwin Schrödinger, who obtained the Nobel Prize in physics in 1933, and who is actually considered as the originator of quantum theory. He claimed that a live organism can only conserve its high level of organization because it is perpetually obtaining order from the environment. According to Schrödinger it is sunlight which finally provides this order. In the1950´s, the physicist Herbert Fröhlich (1905-1991) completed this idea by introducing the concept of coherence of living systems. It is a question of light with a high degree of organization, of so-called biological laser light. The radiation of such a system is very calm, featuring a stable intensity. The fluctuations normally occurring with light are minimal. Based on the stable field strength of its waves, they are able to superpose; whereby certain effects are enabled that don't occur with normal light. The light field of such a laser exhibits a high degree of order and therefore is able to generate order and to transfer information. In the early 1970´s, the German biophysicist Fritz-Albert Popp, the Japanese researcher Inaba and the Australian natural scientist Quickenden independently provided evidence for these postulated light fields in various live organisms, using highly sensitive photomultipliers. This was the confirmation of cell radiation by modern scientific experiments. Fritz-Albert Popp named this cell radiation biophotons (derived from the Greek "bios": life and "phos": light, power). His new research on biophotons led to the conclusion, that all live cells emit a weak light which generates order (so-called coherent light), and this contains information on the condition of the organism, its inner processes and actions.

Fritz-Albert Popp, the theoretical biophysicist from Marburg, was mainly interested in the interactions of light and biological systems. As a student, he worked in the same house, sometimes even in the same room, as Wilhelm Röntgen (1845-1923) who discovered that X-rays (in German: Röntgenstrahlen) are able to generate images of our body's skeleton. There he developed a method of irradiation that could predict which chemicals had a carcinogenic potential: which were those absorbing ultraviolet A-light (UVA) in the range of 380 nm and which were, at the same time, changing the frequency. He summarized his findings in a publication of a reputable scientific journal. His hypothesis, that ultra-weak UVA-light was produced somewhere in the body, was revolutionary. If light does exist in the body, why hasn't natural science discovered this yet?

To prove that cells are emitting light, Popp constructed a highly sensitive device for the detection of light, together with the young physicist Bernhard Ruth who, under his

supervision, carried out the first PhD thesis in the field of ultra-weak radiation. With the aid of a very sensitive photomultiplier the two scientists were able to measure light emitted by a firefly at a distance of 10 km. In 1976 the first experiment with plant cells was performed. Ruth had grown cucumber seedlings and put them into the measurement chamber of the highly sensitive apparatus, which indicated that the germinated seeds emitted light of an astonishingly high intensity. Ruth was extremely skeptical and ascribed this to the light converting chlorophyll, which is responsible for the green color of plants. Therefore, the researchers decided to use potato seedlings for the next experiment, which could be cultivated in the dark. However, the sensitive photomultiplier registered light quanta as well, their intensity being even higher. Thus the theory of the interfering photosynthesis in the chlorophyll could be excluded.

This was the hour of birth of biophotonic analysis, and at the beginning of the eighties of the twentieth century Popp and his coworkers developed a model to demonstrate, why there was needed only a minuscule part (about 2 %) of the genetic material (DNA) in the cell nucleus for the buildup and maintenance of the body. They have shown by experiments and calculations, that these genetic structures, which were thought to be without a specific function up until to now, were responsible for the controlling of the highly complex mechanisms inside the cell by the auto-radiation of their own. Following the findings of Popp, in the nucleus the helically shaped genetic material acts as a biological laser obtaining its energy from the food in the form of photons (via the so called radical reactions as proposed by the Russian chemist Vladimir Voeikov). It became clear as well, that normal human cells have the capacity to accumulate the ultra-weak energy of light transferred to them and to utilize it for their own complex processes of life. Morbid cells for instance, loose this ability and indicate by increased emission of biophotons, that their capacity to store energy of light is defective. Similar events are happening in the cells during the processes of aging. As in the case of cancer cells, the cellular toxins accumulated during the years, and often leading to deposits of cellular debris in the tissues (e.g. arteriosclerosis in blood vessels), induce the increased emission of biophotons.

To propel forward the science of biophotonics, Fritz-Albert Popp and Karl-Heinrich Müller established in the mid-nineties a Center of Biophotonics at a former rocket station close to Neuss (nearby Düsseldorf, Germany), constituting a worldwide network of scientists from China, Holland, India, Italy, Japan, Russia, Switzerland and the United States of America. Karl-Heinrich Müller is also the founder and initiator of the nearby Island of Museum and Art “Hombroich”, a paradisiacal garden and dreamland of bewitching beauty.

Due to this scientific network, since 2001 the analysis of biophotonics was brought to the highest level of photomultiplier technique with the ARETUSA method in cooperation with the biophysicist Francesco Musumeci from Catania (Italy) at the Sicilian Center of Nuclear Science (LNS-INFN). ARETUSA is a new highly sensitive method allowing for the first time to measure the spectrum of ultra-weak photon emission in human cells, which was made possible by a crucial improvement of the technique of light measurement. The spectral distribution of biophoton emission after laser irradiation in the ultraviolet range was measured with a sensitive filter system. The maximum excitation was found in the visible light range of 500 – 600 nm, confirming the earlier findings of Popp and his coworkers concerning the differences between normal and cancer cells.

At present, there is a cooperation with the photo- and cell biologist Lee Laurent-Applegate from the University Hospital of Lausanne (Switzerland) to demonstrate, how the light is trapped by the cell and then utilized for the regulation of biochemical reactions. In this procedure probably similar photochemical processes are playing a decisive role as they are known for more than 30 years in the human eye, where tiniest light particles are trapped by vitamin A and then transformed to biochemical reactions. In the cell, the equivalent of the eye is represented by the genetic material (DNA), which can activate a cascade of biochemical reactions by sunlight-induced photobiological rearrangements. In connection with this, the American dermatologist Barbara Gilchrest has discovered in the mid-nineties, that sunlight-induced photochemical reactions in the DNA can activate e.g. the synthesis of melanin, a pigment responsible for our natural sunlight-activated tanning. With this she laid the essential foundation for a biochemical cascade model, which demonstrates, how biochemical reactions can be started with the help of cell light, to control the cell functions and our physical health, at last.

Biophotons as a bridge to vitality? By the insights of biophotonics, the conventional conception of the organism as a being well separated from the environment can be replaced by the vision of openness and transparency of the individuals existing in a state of permanent exchange or interdependence actually. Moreover, the presumption is corroborated that in our organism as well as in the environment, in addition to electromagnetic fields there are probably existing further largely unknown and immeasurable fields as they were already proposed by Carl Huter. This German anthropologist assumed in the year of 1904 already, that all living existence is based on radiation, and as a vision he saw the light controlling and coordinating all processes in the living cell. Brilliantly, he postulated that matter consisted not only of the two qualities of static (magnetic force in the atomic nucleus) and dynamic energy (electrical power in the electron sheath of the atomic model), but also carried a spiritual energy. As a hypothesis, he positioned this “sensitive energy” as an elementary power into the physical matter, and according to his opinion this energy evolved into an increasing consciousness, developing from elementary particles via atoms and molecules up to the vital force of the living cell. With his hypothesis of the “sensitive energy” as a third elementary power besides the static and dynamic energy, a door was opened to the “subtle fields” as proposed by Albert Einstein. Also the energy of life “Chi” in the Chinese medical science and acupuncture belongs to this area. Similar views are found in all medical traditions of the cultures all over the world. Also the occidental medicine, from Hippokrates, the Greek founder of medical science, up to the romantic period of the early 19th century, acted on the assumption of the existence of such a vital force, and it was thought to be the principal duty of medical practitioners to support the modulating and healing power of it. The radiation of biophotons seems to be strongly coupled with this vital force of all creatures and represents its content of high-grade energy and potential information as a physical quantity to be measured.