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Bio-Photon Research and Its Applications: A Review

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Abstract: **This topic is aimed to lead the reader into an understanding of what biophotons are, how they are generated, and how they are involved in life. Having established this basis, the role of bio-photons in health and disease is reviewed and the basics of ultra-weak bio-photon emission need to be scientifically discussed in the hope that their importance will become more widely utilized**

Keywords: **Biophoton Image, Bio-photon Therapy, Infrared, Ultraviolet, Light, Cancer, Bio-communication, Poisson distribution.**

I. INTRODUCTION

Bio-photon emission is a type of biologic chemiluminescence in which photons are emitted as part of chemical reactions, occurring during metabolic processes. This radiation is not stimulated by chemical or optical markers. It exists in all living organisms and persists at a steady-state level as part of living metabolic processes and has been measured in all types of plant, animal, and human cells. This radiation is strongly correlated with cellular function. Unhealthy, stressed, and injured cells emit more photons than healthy cells [1]. BE exists in all living organisms and persists at a steady state level as part of living metabolic processes. Its amplitude can be orders of magnitude below that of chemiluminescence and has been measured in all types of plant, animal and human cells. Gurwitsch put forth the idea that “radiation generates cell division” as early as 1911.

His studies utilized onion roots as both radiation emitters and biological detectors. He noted that the cellular division increased exponentially on the sides of the roots facing one another while in shadow areas the cellular division rate was less. To show that it was due to effects of radiation rather than chemical, quartz plates were placed between the roots. In later studies it was shown that the radiation passed through quartz plates and not through glass indicating that the stimulating radiation was in the UV portion of the spectrum. A photon will be absorbed by a transparent material if it has enough energy to promote an electron from the valence band to the conduction band. The difference in these energy levels is known as the band gap. The band gap of quartz depends on the crystal structure, but is around 6 eV, which corresponds to photons well into the ultraviolet, with a maximum wavelength of 180 nm. The band gap of glass depends on the glass composition, but is generally around 3-4 eV, and so the maximum wavelength of absorption is around 275–350 nm [2].

These studies focused much more on the mechanisms generating the light than on the informational or functional aspects of the light. Different researchers pointed out that most biochemists considered photon emission as a waste product of the chemical reaction that didn’t serve another purpose. He also asks how could Gurwitsch have seen variations in cell division rates if there wasn’t some informational or functional aspect to the emission? Gurwitsch was looking at effects that were large enough to be seen with the naked eye. Sensitive photon detectors were not available when Gurwitsch reported his findings. In the last 30 years a number of different researchers have begun to more fully investigate the information aspects of biophoton emission [2].

Much of this research has been has been led by Fritz-Albert Popp at the International Institute of Biophysics in Neuss, Germany. Popp is the one who coined the modern usage of the word “bio photon” to refer to biological chemilumine-scence emitted by cells as part of metabolic processes. When looking at a system as a whole, if there are informational. These studies were performed before sensitive photon detectors existed. Many years later these and other studies utilizing biological detectors were corroborated using photomultiplier tubes (PMTs). With the development of PMTs in the late 1940's research concentrated on quantifying weak luminescence from plants and determining its spectral qualities. Emission in the UV was correlated with cell division and emission in the red was found to be related to photosynthetic, chlorophyll and other oxidative metabolism [2].

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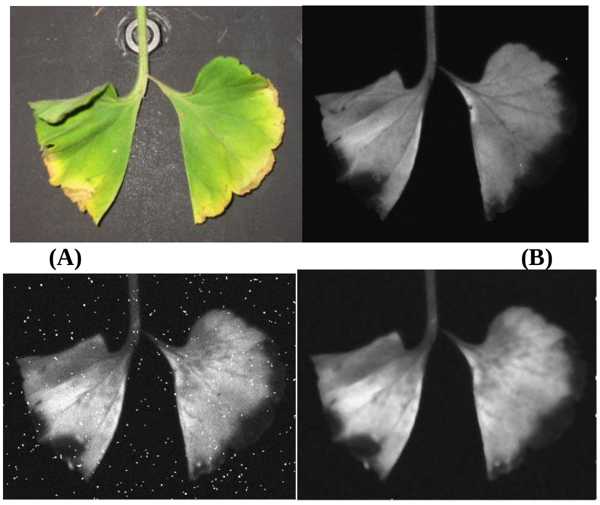
Much of this research has been has been led by Fritz-Albert Popp at the International Institute of Biophysics in Neuss, Germany. Popp is the one who coined the modern usage of the word "biophoton" to refer to biological chemiluminescence emitted by cells as part of metabolic processes. When looking at a system as a whole, if there are informational aspects to the radiation there should be some correlation between processes and BE. VanWijk and co-workers have shown that there is a difference in BE for increasing number of cells and whether they are normal cells or tumor cells. Normal cells show a decreasing emission with increasing number of cells, while tumor cells show increasing emission with an increasing number of cells. Furthermore this emission is dependent on cell type and the decay of illumination with time depends upon whether the cells are normal or tumor.

The difference in the decay law has been attributed to the coherence of the radiation by applying the coherence theory of Dicke. Normal cells have greater coherence in their emission than do tumor cells. These theories have led to more studies of the quantum properties of bio-photon emission including theoretical properties and energy states. Up until a few years ago it was not possible to create images of BE from a biological system. The first images presented in the literature utilized multichannel PMTs or multianode PMTs and only had a few pixels of resolution in each direction. Only recently have high-resolution low-noise super-cooled CCD arrays been available. Cameras originally developed 10-20 years ago for long exposure images through telescopes have proven to be very useful in studying biophoton emission. Over the past 2-1/2 years we have observed variations in BE patterns produced by various plant parts such as leaves and vegetables as a function of time and noted that injury (such as cutting) and unhealthy tissue is associated with clearly visible increased bio-photon emission.

Many studies of thousands of images have shown that there were patterns in the "noise" surrounding the plant parts. It appears as if not only did the bio-photon patterns extended beyond the plants, but that patterns were strengthened between plants when they were in close proximity [2].

Some of these images point out the patterns surrounding plant parts creating "auras" as well as those between plant parts that fall off with distance. Fig. 1. shows some bio-photon images for geranium leaf in total darkness [2].



(A) (B) (C) (D)

Fig. 1. Cut geranium leaf on black stage platform. (A) White light image. (B) Chlorophyll fluorescence image. 1-minute exposure in total darkness. (C) Two-hour biophoton image after five hours in total darkness, Bright spots are high-energy "cosmic" ray hits. (D) Biophoton image (C) after a 5x5 median filter to remove cosmic rays [2].

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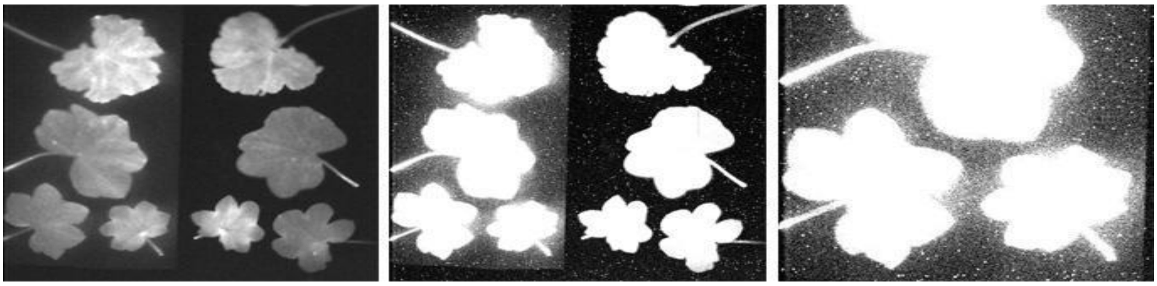
Fig. 2.(A) shows a two-hour biophoton image of geranium leaves with the gray scale scaled as a photograph. The leaves on the left side of the image are on non-fluorescing white paper to enhance the light around and between the leaves while those on the right side of the image are on black paper. The white paper reflects and scatters the biophotons emitted from the leaves so we can more easily see what is in the areas around and between the leaves [3]. Fig. 2.(B) was enhanced in software by stretching the gray scale. This enables seeing areas between and around the leaves more clearly. This scaling shows that more light can be seen in the areas between and around the leaves on the white paper than those on the black paper [3]. Figure 2(C) is an enlargement of the lower left quadrant of the middle image. Close inspection of this image shows a "halo-like" pattern around the leaves (i.e. an "aura"). Furthermore there is noticeably more light between adjacent leaves than around leaf edges without an adjacent leaf and this signal is stronger when leaves are closer together [3].



(A) (B) (C)

Fig. 2. shows a two-hour biophoton image of geranium leaves with the gray scale scaled as a photograph

Fig. 3.(A) and 3(B) show two images from an experiment we performed studying effects of distance between plant parts. Sections of string beans were pinned in place a known distance apart in millimeters on non-fluorescing paper and a series of one-hour biophoton images were taken. As expected, the bean sections were brighter in the first hour than in the fourth hour. When the gray scales are enhanced as shown in Figures 3(C) and 3(D) the amount of light between the sections falls off with their separation and as a function of time. It can be seen that the closer the cut pieces of beans are, the brighter the emission between them [3].

(A) (B) (C) (D)

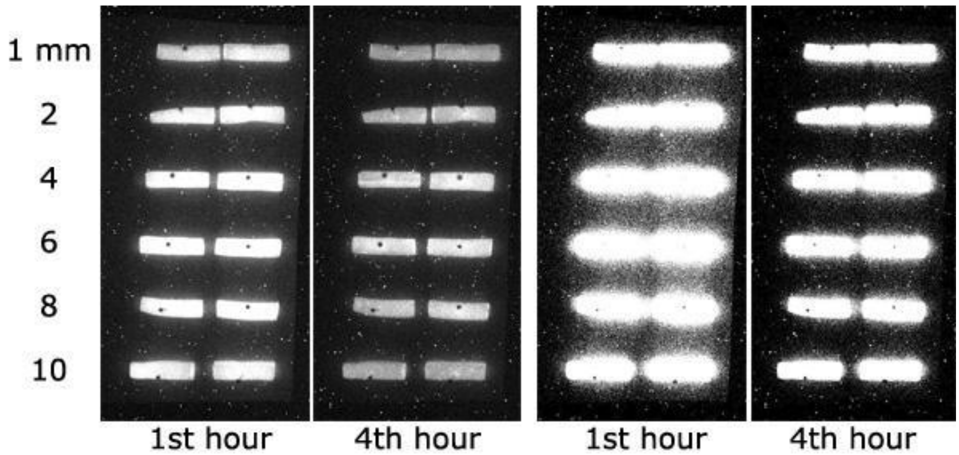


Fig.3.: shows effects of distance between plant parts[3].

When plant parts are closer together they are receiving more photons from other plant parts. These photons can be absorbed by the adjacent plant parts and cause areas closer to other plant parts to glow more. Because each plant part glows a different amount depending upon its current state of health and hydration, we can only make relative comparisons of outputs of adjacent plant parts. We can infer and hypothesize from the images shown that there is some type of dynamic feedback mechanism at work as the plant parts interact with one another over time. This dynamic feedback appears to be stronger when the plant parts are closer together. It's a process where plant part A illuminates plant part B which absorbs and re-emits a portion of the light back to A creating a mutual positive feedback loop. Photons passed back and forth between plant parts will pass energy back and forth as well as biophotonic information[3].

These images, and thousands of others recorded in the laboratory, reveal not only that plants "glow in the dark" but that the patterns of light emitted by the plants extend beyond them creating "aura-like" structures around them. Moreover, the patterns appear stronger when the plant parts are closer together, suggesting a dynamic feedback communication process involving mutual absorption and re-emission. Whether or not the biophoton emission between and around plant parts we have observed has a functional purpose remains to be further tested. As stated in the introduction many researchers have been studying the properties of this light, however there remains much research to do to determine what functionality and informational aspects the emission may have. As more research on the bio-informational aspects of light in biological systems will provide a better understanding of the role the photon plays in biological functioning and a greater insight into the nature of light [3].

II. BIO-PHOTONS AND BIO-COMMUNICATION

The research on bio-informational aspects of bio-photons in the IR to UV range can be traced back to Alexander G. Gurwitsch more than seventy years ago. He emphasized that fundamental biological functions such as cell division are triggered by a very weak ultraviolet photo-current originating from the cells themselves. In a review article by [4] introduced the present activities of research groups on three different main questions concerning this bio-photonic information. The first question deals with the developments in the evidence for photons originating from cells. Despite serious experimental difficulties it is now clear to every scientist working in this field that photon emission could be detected from nearly all living cells.

The second question considers the origin of photon emission. Very weak photon emission has been looked upon so far mainly from the possible reactions and biochemical pathway that could be responsible for this phenomenon. In general, those studies were carried out without considering Gurwitsch's idea of bio-information of photon emission. An alternative search for the origin of photon emission has been carried out incorporating the informational aspect of photon emission. This type of explanation proposes the existence of a coherent electromagnetic field within cell populations and has led to the introduction of the term bio-photons. Bio-photons are characterized by their quantum character and are supposed to escape from a coherent field. This alternative explanation is supported by several arguments[4]

The third question is the most decisive one from an empirical point of view. It is directed to the existence of bio-photon emission in relation with cellular interactions and biological function. In general the idea that beside, or even below, the biochemical level of control very weak electromagnetic interactions play a regulatory role in the living state has received relatively little attention. The present research has not yet reached the state required for the ultimate verification or falsification of the hypothesis on bio-photonic information in cell division and other cell physiological processes, as originally investigated and suggested by Gurwitsch[4].

It has been scientifically proven that every cell in the body emits more than 100,000 light impulses or photons per second. These biophotons which are not only emitted by humans but by all living things, and have been found to be the steering mechanism behind all biochemical reactions. A biophoton is always emitted before every biochemical reaction. Without the biophoton signal, there can be no chemical reaction; they are like a steering system for all the biochemistry that takes place in the body.

Some recent theories consider the possibility that this radiation helps regulate biologic and biochemical functions within and between cells. A possible means of releasing energy when an electron changes energy states during a biochemical reaction is via bio- photon emission. An example of energy transfer in biological systems is the process of photosynthesis [1]. Other researchers postulate that bio-photon emission may be a potential mechanism responsible for intra- and intercellular communication (information transfer) as well as for regulation of biological and biochemical functions within cells and living systems. Measurements by other researchers of this emission have shown it has the properties of coherent light and is measurable from the UV through the near IR. Experimental evidence gathered by various researchers since the 1920's indicates that light plays an important role in certain biological functions and processes [1].

Living biological systems, including humans, constantly and spontaneously emit a very small amount of photons in the visible and UV part of the electromagnetic spectrum (200-800 nm). Terms such as ultra-weak photon emission and spontaneous ultra-weak, low-level, or dark bio-/chemi-luminescence or bio-photon are used to describe this phenomenon. Human ultra-weak photon emission (UPE) is not seen by unaided eye due to its ultra-low intensity corresponding to 10^{-16}-10^{-18} W/cm^2. The threshold sensitivity of a human eye ranges from 10^{-12}-10^{-14} W/cm^2 [5].

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Research converging from many fields of investigation indicates that the body is a complex energy system, rather than the mere clockwork machine of biological gears and parts that is often espoused in conventional medicine. The concept of a system requires that the components be connected energetically. Energy can be thought of as the force that maintains each system and also enables it to emerge and evolve into a higher level system. Examples of energy transmission within the body are *metabolic energy* conversions of fats and sugars into ATP (adenosine-tri-phosphate), *bioelectrical energy* triggered by charged ions which influence the heart, nerves and brain, and *biophotonic energy* from ultraviolet bio-photons which are located in the nucleus of cells [6].

The electromagnetic spectrum spans a broad range of frequencies and wavelengths and living systems have evolved within the context of this energy spectrum (see figure 4). The low-level light known as bio-photon emission, a type of internally produced electro-magnetic radiation, is important in understanding bioregulation, membrane transport, and gene expression [6]. One of the most difficult problems was associated with the mechanisms of the generation of UV photons in living systems. The emission of electromagnetic radiation with the energy $E = h\upsilon$ and the corresponding wavelength = c/υ occurs when an electric charge oscillates at the frequency υ . In the spectral range 180–1000 nm covering the UV, visible and near IR, corresponding oscillation frequencies are 3×10^{14}–1.6×10^{15} Hz. Emission in the UV was correlated with cell division and emission in the red was found to be related to photosynthetic, chlorophyll and other oxidative metabolism.

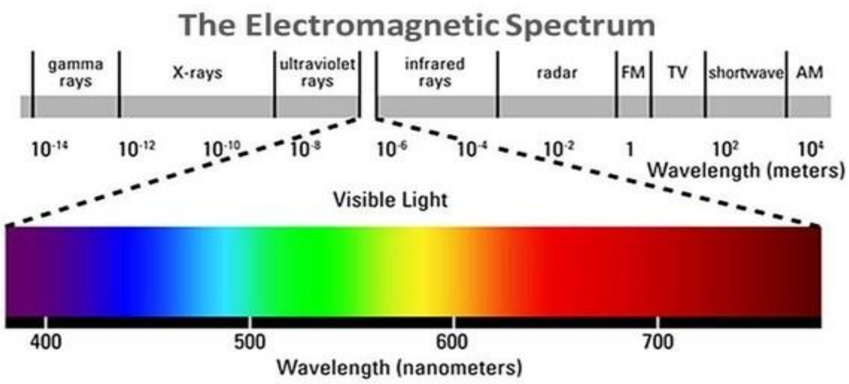


Fig. 4. Shows the visible light spectrum range

Bio-photon emission (BE) was first discovered in 1923 by Russian medical scientist Professor Alexander G.Gurvich (who named them "mitogenetic rays"). In 1974 German biophysicist Fritz-Albert Popp has proved their existence, their origin from the DNA and later their coherence (laser-like nature), and has developed bio-photon theory to explain their possible biological role and the ways in which they may control biochemical processes, growth, differentiation etc. Popp's bio-photon theory leads to many startling insights into the life processes and may well provide one of the major elements of a future theory of life and holistic medical practice based on such an approach[7].

The importance of the discovery has been confirmed by eminent scientists **and** since 1992, the International Institute of Biophysics, a network of research laboratories in more than 10 countries, based in Germany, is coordinating research in this field which promises rapid development in the next decade[7].

Nobody is quite sure how cells produce bio-photons but the latest thinking is that various molecular processes can emit photons and that these are transported to the cell surface by energy carrying excitons. A similar process carries the energy from photons across giant protein matrices during photosynthesis. Whatever the mechanism, a growing number of biologists are convinced that when you switch off the lights, cells are bathed in the pale fireworks of a bio-photon display that is distinct from conventional bioluminescence.

Recently, Sergey Mayburov at the Lebedev Institute of Physics in Moscow adds some extra evidence to the debate. Mayburov has spent many hours in the dark watching fish eggs and recording the patterns of bio-photons that these cells emit. The question he aims to answer is whether the stream of photons has any discernible structure that would qualify it as a form of communication[7].

The answer was that it does, he says. Bio-photon streams consist of short quasi-periodic bursts, which he says are remarkably similar to those used to send binary data over a noisy channel. That might help explain how cells can detect such low levels of radiation in a noisy environment and could help to explain a number of interesting phenomenon that some biologists attribute to bio-photon communication. In several experiments, bio-photons from a growing plant seem to increase the rate of cell division in other plants by 30 per cent. That's a growth rate that is significantly higher than is possible with ordinary light that is several orders of magnitude more intense.Other experiments have shown that the biophotons from growing eggs can encourage the growth of other eggs of a similar age. However, the biophotons from mature eggs can hinder and disrupt the growth of younger eggs at a different stage of development. In some cases, biophotons from older eggs seem to stop the growth of immature eggs entirely[7].

Through a series of experiments resonance effects have been observed between plant parts measured using a highly sensitive, low noise, cooled CCD in total darkness in a light-tight chamber. Dynamical systems theory offers a plausible explanation for resonance effects have been observed [1]. There are still many outstanding questions. One important problem is to better understand the cellular mechanisms at work–how the molecular machinery inside cells produces photons and how it might be influenced by them. Another is to understand the kind of evolutionary pressures that are at work here–how has this ability come about[7]. The role of photonic interaction at the systemic level in biological systems has received relatively little attention. Yet, a better understanding of these processes would help in deciphering the nature and role of light in biological systems[1]. An Improved knowledge of fundamental mechanisms of EM field interactions could lead directly to major advances in diagnostic and treatment methods[6]

III. MATERIALS AND METHODS

Up until a few years ago it was not possible to create images of BE from a biological system. The first images presented in the literature utilized multichannel PMTs or multianode PMTs and only had a few pixels of resolution in each direction. Only recently have high-resolution low-noise super-cooled CCD arrays been available. Cameras originally developed 10-20 years ago for long exposure images through telescopes have proven to be very useful in studying bio-photon emission [2].

POISSON DISTBUTION:

Poisson distribution is main concept of theoretical distribution which is invented in 1837 by the French mathematician Siméon-Davis Poisson (1781-1840). The Poisson distribution describes complete randomness and independence. It can model the number of events occurring in a unit of time interval or space. The events have to occur randomly and independently in time or space. Unlike normal distribution, Poisson distribution is not symmetrical but instead is skewed to the left of the median. Poisson distribution is an extension of binomial distribution and can be used as its approximation. One of its unusual properties is that its standard deviation equals the square root of the mean.

If we let X = the number of events in a given interval, and the mean number of events per interval is λ,

The probability of observing x events in a given interval is given by

$$P(X) = \frac{e^{-\lambda}\lambda^{x}}{x!} \qquad x = 0,1,2,3\ldots. \qquad (1)$$

By convention, 0! = 1. There are however, four conditions for data are likely to arise from a Poisson distribution.

1. The probability of observing a single event over a small interval is approximately proportional to the size of that interval.

2. The probability of two events occurring in the same narrow interval is negligible.

3. The probability of an event within a certain interval does not change over differnt intervals.

4. The probability of an event in one interval is independent of the probability of an event in any other non-overlapping interval [8-11].

IV. THE MAIN CONCEPTS OF BIO-PHOTONS COHERENCE

The word coherence is derived from a Greek word *cohere* that means to act together. Coherence of a system therefore, implies that the system has sub units, which act together to produce one or more observable effects. The sub units need not be identical and may not act simultaneously. The concept has been extended to include acts of different characters by different sub units. Coherence in the extended form is essentially the observation of correlation of some quantity at different space-time points. The concept in the extended form was first formulated in the context of photon signals, where it is classified into two categories-spatial and temporal. The spatial coherence is detected by measuring the intensity at different spatial locations as in interference and diffraction experiments, and temporal coherence is detected by measuring the number of photons at different time in a fixed detector as in single photon counters in bio-photon experiments.

The concept of coherence can be introduced by considering a gas enclosed in a vessel containing free atoms having a number of energy levels, at least one of which is metastable[13]. By shining white light into this gas, many atoms can be raised, through resonance, from the ground state to excited states. As the electron drop back, many of them will become trapped in the metastable state. If the pumping light is intense enough , more electrons in the metastable state than in the ground state[13]. Metastable state is an excited state of an atom or other system with a longer lifetime than the other excited states. However, it has a shorter lifetime than the stable ground state. Atoms in the metastable state remain excited for a considerable time in the order of 10^{-6} to 10^{-3}.

When an electron in one of these metastable states spontaneously jumps to the ground state, it emits a photon of energy $h\upsilon$. This is called fluorescent radiation. As the photon passes by another nearby atom in the same metastable state, it can by the principle of resonance, immediately stimulate that atom to radiate a photon of the exact same frequency and return it to its ground state. Amazingly enough this stimulated photon has exactly the same frequency, direction, and polarization as the primary photon (spatial coherence) and exactly the same phase and speed (temporal coherence). Both of these photons may be considered primary waves, and upon passing close to other atoms in their metastable, they stimulate them to emission in the same direction with the same phase. Thus if the conditions in the gas are right, a chain reaction can be developed, resulting in high-intensity coherent radiation[13].

Bio-photons are photons emitted spontaneously by all living systems. It is well known at present that bio-photons are emitted also in the range from visible up to UV [14]. The intensity of "bio-photons" can be registered from a few photons-per-second per square-centimeter surface area on up to some hundred photons from every living system under investigation. It was suggested by Fritz-Albert Popp that the question of coherence can only be answered if the spectral distribution of the light emission is known [14]. The bio-photon emission will provide the experimental evidence of either the coherent or the chaotic nature of the bio-photon field.

If an evidence of an extraordinary high degree of coherence of bio-photons is experimentally shown, it can be concluded that this universal phenomenon of biological systems is responsible for the information transfer within-and-between cells, including the regulation of the metabolic activities of cells as well as of growth and differentiation and even of evolutionary development [14].

To reveal the importance of the experimental research and the significance of the results which have been obtained up to now, Fritz-Albert Popp has characterize some essential activities of a cell concerning the necessity of optical transitions and then confines to the main experimental results on the physical problem of coherence[14].

Fritz-Albert Popp suggested that an understanding in terms of the coherence of bio-photons is consistent with all the observations that explain all the physical and biological effects under study, that in accordance to coherence concept. Fritz-Albert Popp was even convinced that experimental evidence of the coherence of bio-photons can be drawn from the experimental results [14]. In addition, Fritz-Albert Popp, provided two important points concerning bio-photons as follows:

- the biological system is far away from thermal equilibrium, and
- Bio-photons may well provide the necessary activation energy for triggering all biochemical reactions in a cell at the right time at the right place.

On the other hand, Fritz-Albert Popp explained that the permanent electromagnetic interaction of radiation and matter in the optically dense medium of a cell, cannot be ruled out that an electromagnetic field of a surprisingly high degree of coherence may accumulated to such an extent that each molecule in the system is connected (or has the capacity to get connected) to every other one. [14].

V. RESULTS

Experimental data have shown that in a quasi-stationary state, all biological systems under study approach rather accurately a Poissonian (see figure5) [14].

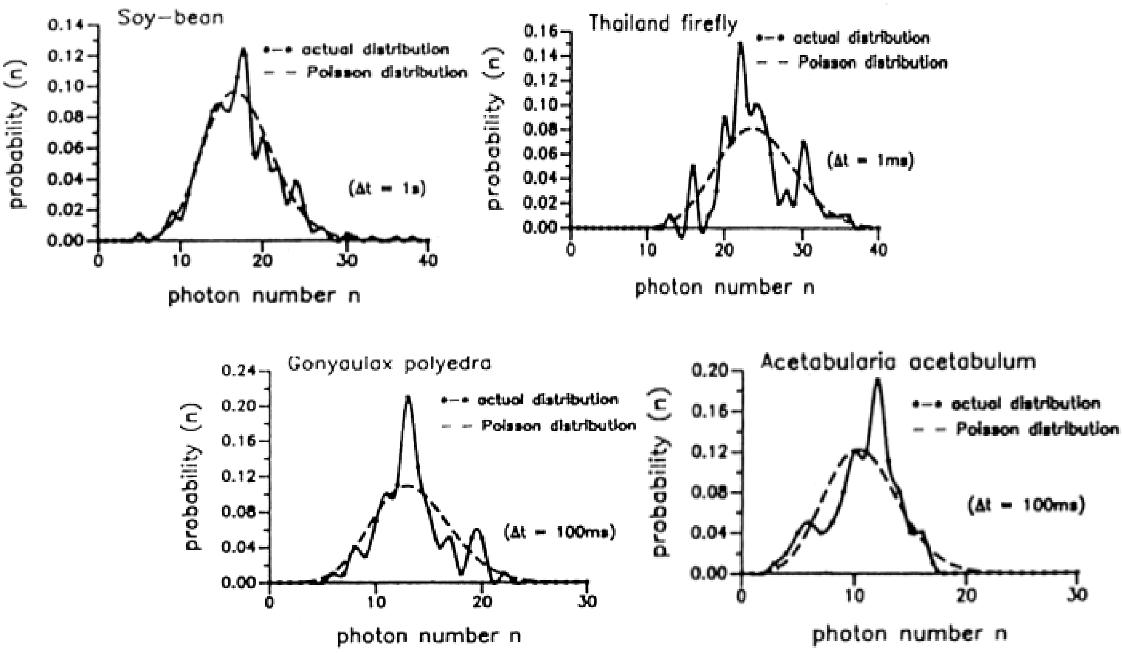


Fig. 5. Agreement of the Photocount Statistics of different biological systems with a Poissonian distribution[14]

It is important to know whether the Poissonian distribution is only some kind of an average over the measurement time interval or whether it is valid at any instant. In the first case, it could be an indication of a chaotic field which in a small time interval (compared to its coherence time) follows a geometrical distribution. But with increasing measurement time, it approaches more-and-more a Poissonian distribution [14] .

VI. APPLICATIONS

All living systems display ultra-weak photon emissions (UPE) that can be easily discerned by modern photomultiplier units. The human body is composed of several tens of trillions of cells and bacteria. Photonic fields have the capacity to mediate large amounts of information that reflect the states of the human volume. Several researchers have suggested that the primary communication between cells and bacteria involves UPE. This is evidence of photon radiation suggests that the presence of bio-photons may play a role in cell regulation.

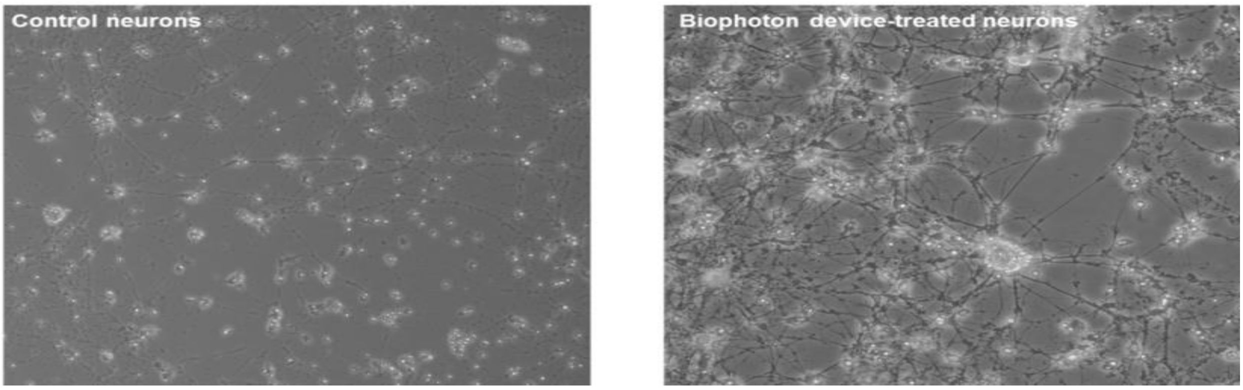
Fritz-Albert Popp, along with others, later developed a device to easily detect biophotons from both plants and animal cells [15]. It is now being used to ascertain the quality of food. Interestingly enough, the healthiest food had the lowest bio-photon emission. Popp and others also found that simple organisms emitted the most photons, and that complex organism, such as humans, emitted the least. Popp was able to demonstrate that the helix configuration of DNA was the source for bio-photon emission and absorption. He considered this to be the process behind bio-communication throughout the bod [15].

It was suggested by Luc Montagnier that the association of DNA with water is known since the deciphering of its double helical structure by X-Ray diffraction in 1953. However the power of DNA for organizing water seems to go far beyond the direct filling of water molecules within the grooves of the double helix. It was stated by Luc that recently discovered some DNA sequences – so far belonging to pathogenic bacteria and viruses – are able to induce specific structures of Nano metric size in water. When sufficiently diluted in water, these structures are emitting a spectrum of electromagnetic waves of low frequencies. This is a resonance phenomenon which is dependent on excitation by very low frequency electromagnetic waves, usually provided by the ambient background. In agreement with recently obtained evidence that some specific DNA sequences can be transmitted through waves in water. This raises the interesting possibility that living structures are able to communicate through waves [16]. Popp also examined healthy people and found that their light output was balanced and followed biological, repeating rhythms of 7, 14, 32, 80 and 270 days. Cancer patients lacked these rhythms and lost their coherence. Patients with multiple sclerosis exhibited too much light and it was too ordered. The result, as he concluded, was that health was a delicate balance between chaos and order. Too much coherence would cause the system to collapse [15].

In recent years the low level analysis of ultra-weak photon emission in human cells is achieved using sophisticated Photomultiplier Technique (PMT). The basis of photonic measurements goes back to the theoretical finding of Einstein that a photon, which hits a metal plate, causes an electrical impulse. This current can be detected by single photon detection device. A variety of analytical laboratories worldwide using these sensitive detection devices have shown that all cells from plants over animals up to humans emit a low level bio-photonic emission. From bio-photonics investigations, the origin of ultra-weak photon emission is the DNA as well as proteins coupled with radical reactions. In order to determine this radiation in human cells, a fibroblastic differentiation system was developed using dermal fibroblasts of skin. Since normal cells store efficiently ultra-weak photons, it has been shown that older cells as well as cancer tissue tend to lose this retention capacity. From all these results it seems evident, that this low level radiation serve as bio-photonic signals in order to transfer information in biological systems. Further intense basic research is needed in order to show evidence that ultraweak electromagnetic radiation plays the key role in life [17].

Other application of bio-photons is to test Bio-photon Therapy on human blood. Bio-photon Therapy is an energetic therapy method; there will be given no physical tangible treatment, such as drugs, herbs or any other substances, to the body of the person that receives treatment. This research consists of observing red blood cells in blood samples of test persons that receive Bio-photon Therapy or a placebo-treatment. The observation of the red blood cells in the blood samples of the test persons is done with a Dark field microscope. The analyzed results are also derived from the visual effects that are being seen in the characteristics in the behaviour of the red blood cells in the blood samples. It can be concluded that Bio-photon Therapy does have a perceptible effect on the red blood cells in the blood of the test persons, since the red blood cells of test persons treated with Bio-photon Therapy are showing significant perceptible differences in the before and after blood samples, and the red blood cells of test persons treated with a placebo-treatment are only in one case showing a very slight perceptible difference and for the rest none at all [18].

Other main objective study of bio-photons was to see if an effect on isolated rat cortical neurons could be observed upon treatment with through the Bio-photon device. Results have shown that a significant increase in neuronal growth and synaptic interactions between neurons were found (see figure 6) [19].



Control (untreated) neurons **normal culture medium treated only[19]**

Figure 6: shows a significant increase in neuronal growth and synaptic interactions between neurons

As shown in the above pictures, there was a significant increase in possible neuronal interactions as was shown by an increase in the number of synaptic contacts between treated neurons as compared to the untreated control neurons. The fact that Bio-photon device treatment showed such a strong impact on the neurons could be due to the fact that neurons are highly communicating cells [19].

The last decade has seen increasing use of micro and nanotechnology for biological and biomedical applications. This can be attributed to several reasons. Firstly, there is tremendous advancement in the research and development of micro and Nano-technological tools and devices. Secondly, much progress in cell and molecular biology and biomedical sciences has also been made. Thirdly, there is a huge push towards multidisciplinary research that involves close collaboration among researchers from several disciplines including physics, chemistry, engineering, biology, and medicine. In fact, it is through this collaboration that we are starting to see how micro and nanotechnology are catalyzing and even accelerating research in the biological and biomedical sciences [20].

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Over the last 100 years, technology has always been seen to play an important contributing role in advancing biological and biomedical research and to its eventual applications in the clinics and hospitals.The last decade has seen an enormous surge made in research on bio-magnetism and magnetic biosensors based on molecular recognition processes [20]

Biophoton images of tumors transplanted in mice with a highly sensitive and ultra-low noise CCD camera system were measured. Biophoton images of each tumor were measured 1 week after carcinoma cell transplantation to estimate the tumor size at week 1 and the bio-photon intensity. Some were also measured at 2 and 3 weeks to compare the bio-photon distribution with histological findings. Comparison of microscopic findings and bio-photon intensity suggested that the intensity of bio-photon emission reflects the viability of the tumor tissue. The experimental set –up is shown in figure 7[21].

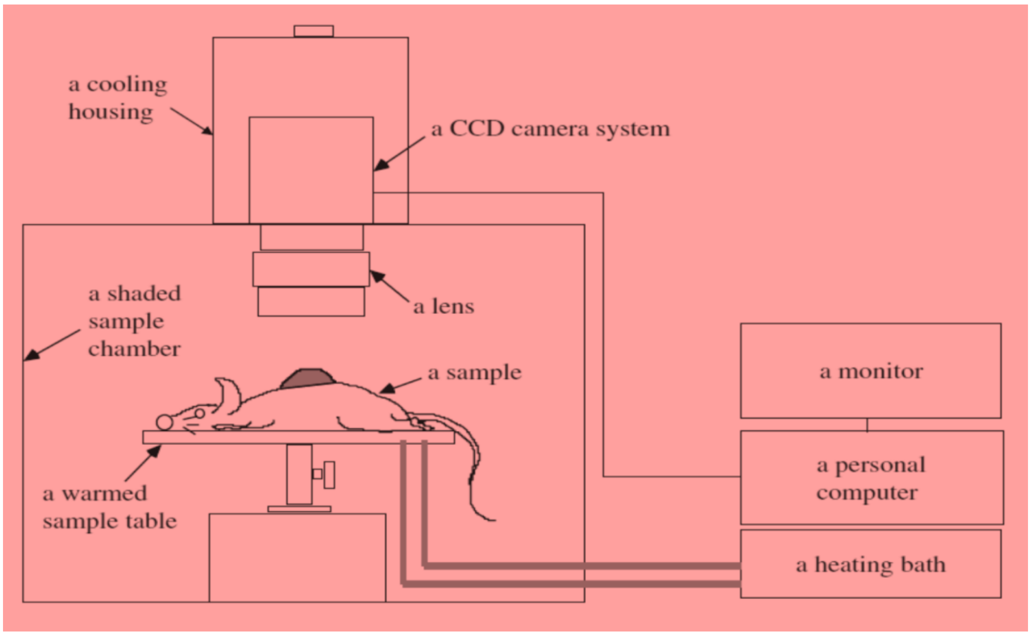
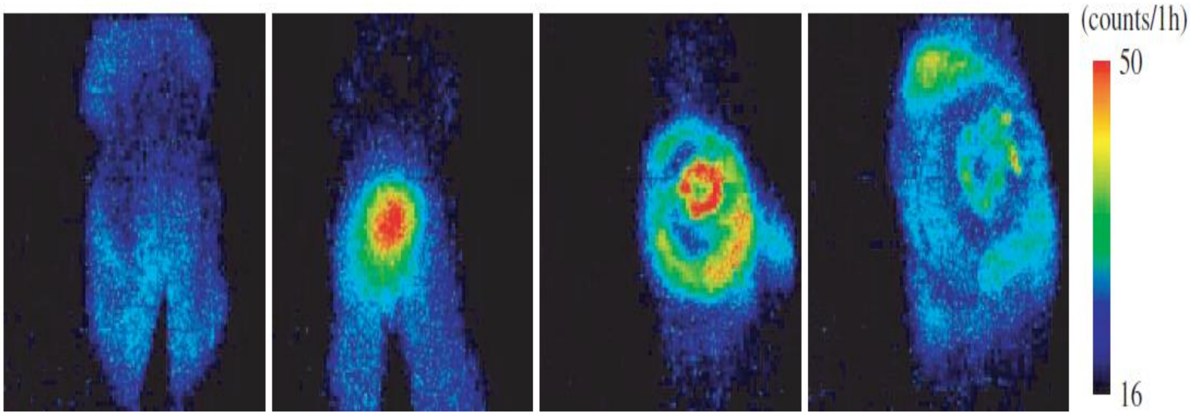


Fig. 7.(a): Schematic of the biophoton imaging system. [21]. The biophoton imaging system consists of a liquid nitrogen-cooled highly sensitive CCD camera system (ATC200C, Photometrics), a completely light-shielded sample chamber, a thermostat heater to warm the mice, and a set of computers [21].



Before Transplantation 1W 2W 3W

Fig. 7.(b): biophoton images of tumors transplanted in mice with a highly sensitive and ultra-low noise CCD camera system were measured [21]..

This method could be useful to assess not only malignancy, but also the efficacy of chemotherapy or radiotherapy in terms of viability, rather than tumor size. This procedure may thus provide a non-invasive or minimally invasive optical biopsy as an adjunct to or replacement of existing diagnostic methods [21].

VII. CONCLUSION

The aim of this project was to collect and gain more information about the physics of biophotons. Since the data concerning the generation and emission of biophotons from plant animal and human found in the literature are rather scarce. Living cells emit in the surroundings ulta-weak electromagnetic energy in the form of photons. This peculiar phenomenon was discovered in 1920 by the Russian embryologist Alexander Gurwitsch. After its discovery, Gurwitsch suggested emission and reception of photons. This concept was ignored by the scientific community, and was “rediscovered” after the end of the second world. Experimental evidence gathered by various researchers since the 1920’s indicates that light plays an important role in certain biological functions and processes. Measurements by other researchers of bio-photon emission have shown it has the properties of coherent light and is measurable from the UV through the near IR. Light holds an important key in our understanding of biosystems and gives us a window into an invisible part of the mystery of light and life. Research in biophoton phenomena opened wide multiple disciplines. There are many opportunities for researchers to understand the nature and function of this bio-photon radiation better, and to look at its potential applications within biosystems, and therapeutic effects in patients as well as diagnostic tool.

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