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Biophotons, microtubules and CNS, is our brain a "Holographic computer"?

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Summary Several experiments show that there is a cell to cell communication by light in different cell types. This article describes theoretical mechanisms and subcellular structures that could be involved in this phenomenon. Special consideration is given to the nervous system, since it would have excellent conditions for such mechanisms. Neurons are large colourless cells with wide arborisations, have an active metabolism generating photons, contain little pigment, and have a prominent cytoskeleton consisting of hollow microtubules. As brain and spinal cord are protected from environmental light by bone and connective tissue, the signal to noise ratio should be high for photons as signal. Fluorescent and absorbing substances should interfere with such a communication system. Of all biogenic amines nature has chosen the ones with the strongest fluorescence as neurotransmitters for mood reactions: serotonin, dopamine and norepinephrine. If these mechanisms are of relevance our brain would have to be looked upon as a "holographic computer".

Introduction

Photon emission from unicellular and multicellular organisms has been studied for decades. The phenomenon is referred to by a variety of names, such as mitogenetic radiation, dark luminescence, low level chemoluminescence, ultraweak photonemission (UPE) and biophotons. There have been long discussions as to whether or not this emission has a biocommunicative role, or is just a byproduct of metabolism. Gurwitsch [1], Dicke [2], and later Popp [3], and Albrecht-Buehler [4] have developed concepts that photons play a role in cell to cell communication.

Gurwitsch, Popp, Shen and Albrecht-Buehler have published experiments that actually show a biocommunicative role of light in several cell populations.

Experiments showing biophoton communication

Cell to cell communication by light is basically an old story. In 1926, the Russian scientist Gurwitsch [5] published an experiment, where he could show the induction of mitosis from the tip of an onion root to the shaft of a second onion root. The induction worked when the second root was in a quartz tube but not when it was in a glass tube. From this he concluded that it was UV-light causing the effect, which he called "mitogenetic radiation".

Half a decade later the German physicist Popp [6] performed experiments with goniaulax polyedra, a single cell maritime bacterium capable of luciferin – luciferase reaction.

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He placed two cuevettes with these bacteria on two highly sensititive photomultipliers and recorded a dramatic increase of synchronised photon emission upon removing an optical separation between the two cuevettes.

In 1995, Shen [7] performed experiments with pig neutrophil granulocytes in a similar design.

Two cuevettes with pig neutrophils were placed on two photomultiplier tubes. Bacterial extracts were put into one cuevette causing degranulation and light emission. Upon removing the optical seperation light was also emitted from the other cuevette indicating the induction of degranulation by light.

In 1992, Albrecht-Buehler [8] published a tissue culture experiment, where he inoculated baby hamster kidney (BHK) cells on one side of a glass film whose opposite side was covered with a 2—3 days old confluent layer of BHK cells. After 7 h of attaching and spreading in the absence of visible light, most of the cells had traversed with their long axes in the direction of the whorls of the confluent cells opposed. The effect was inhibited by a thin metal coating of the glass films. In contrast, a thin coat of silicon on the glass did not inhibit the effect, suggesting that the effect was caused by red or near infrared light. He called the phenomenon "cellular vision".

Now that we realise that cell to cell communication by light takes place in several cell populations it might be useful to summarize which mechanisms might be involved in this effect.

Physical aspects

From an elementary physical point of view, photons are electromagnetic field quanta whose fundamental nature is to interact between electrical charges like electrons or aggregations of electrical charges like atoms, molecules, macromolecules, etc. Feynman 1988 [9]. Therefore, one can assume or even state that communication on a fundamental biophysical and biochemical level should be based on the exchange of photons.

How could it work ?

A biophoton communication system would first of all need sources for the generation of light, then it would need possibilities for this light to penetrate tissue, an impact which would be increased by possibilities to modulate a photon signal, possibilities to modulate a photon signal would increase its impact, lastly it would need targets that can be influenced by light signals.

Sources of light in the cell are mainly metabolic processes. Every metabolic reaction has a specific light emission spectrum that is determined by the energetic steps involved. The subcellular fraction with the highest metabolic activity are the mitochondria. The oxidation of NADH has a high capability to generate photons. According to Albrecht-Buehler [4,10] mitochondria are the best candidates for a cellular light source.

From his investigations of ultraweak photonemission Popp [11] found that, DNA plays an important role in this emission. Cells emit light even when the cytoplasm is damaged, but when the nuclei are removed there is no UPE any more. Ethidium bromide destroying the DNA also reduces the UPE. From the photon count statistics, from the spectral distribution, from the behaviour of the emission after external illumination, and from its passage through optically thick materials he concludes that, the emission is cohaerent light. He describes DNA as "exciplex laser system" collecting photons and emitting them as cohaerent light.

Another light source would be environmental light transported along the blood vessels by albumin, the main plasma protein, that exhibits in our own experiments, illumination of this protein was followed by an intense long lasting chemiluminescence of 30 min duration.

Propagation of photon signals in the organism could take place by direct tissue penetration, along cellular processes, e.g., axons and dendrites and inside the hollow core of cytoskeletal microtubules. Jibu and Hameroff [12] conclude from the constant inner diameter of 15 nm that microtubules are capable of guiding light, free of thermal noise and loss.

And indeed light propagation in the brain depends on the nerve fiber orientation and is better along the axes of white matter tracts [13].

As stated before albumin should be capable of transporting light along blood vessels.

Modulation of photon signals as part of a biophoton communication system could happen in different ways. Absorption-characteristics of endogenous or exogenous pigments changing with physical—chemical processes (concentration, pH, temperature and redox-processes) reduce the energy of the signal. Fluorescence-characteristics changing with physical—chemical processes could reduce the wavelength of the hypothetic communication signal. Polarisation-characteristics of endogenous and exogenous substances also changing with physical—chemical processes may alter the polarisation angle of the signal. Cell membranes could change their optical properties with depolarisation or binding of fluorescent or absorbing

substances to membranes or receptors, e.g., neurotransmitters. Quenchers could inhibit photon emission from free radicals and fluorescent substances. Two photon excitation in proteins could generate UV photons. Diffraction, refraction and reflexion might take place at boundary surfaces.

Targets or *modes of action* for a photon signal could be metabolic processes (laser chemistry is an entirely new branch in industry looking for ways to use light of the appropriate wavelength, to excite modes of vibration or states that lead to a desired reaction). Configurational changes in form of *cis*/*trans* transitions, e.g., rhodopsin, photoactivation of enzymes, e.g., tryptophan-decarboxylase by 337 nm light [14], activation and synchronisation of the cytochrome P-450 dependent monoxygenase system by blue light [15],activation of glutamate-dehydrogenase by red light [16]. Photovasorelaxation could act on the blood circulation by near UV light [17]. Degranulation of neutrophils [7]. Cell orientation by red or near infrared light [8]. Influences on mitotic processes, e.g., "mitogenetic radiation" by UV light [5]. Among many other photochemical and photobiological reactions, also photosensitized singulet oxygen formation and nitric-oxide generation from nitrogen containing substances may play a role.

From laser experiments with 3T3 cells Albrecht-Buehler [18] concludes that the centrosome is an infrared detector, and calls it a "cellular eye".

The role of the nervous system ?

However, if biophoton communication is a general principle in cells especially the nervous system would have excellent conditions for such mechanisms. Neurons are large colourless cells with wide arborisations, they have a highly active metabolism generating photons, contain little pigment and have a prominent cytoskeleton consisting of hollow microtubules. As brain and spinal cord are protected from environmental light by bone and connective tissue, signal to noise ratio should be high for photons as signal.

Absorbing and fluorescent substances should interfere with such a biophoton communication system. Of all natural aminoacids, nature has chosen the aromatic ones with the strongest fluorescence, tryptophan, phenylalanine and thyrosine as precursors for the neurotransmitters involved in mood reactions: serotonin, dopamine and norepinephrine.

Also many hallucinogens have strong fluorescence properties, e.g., LSD, psylocibine and harmine. The capability of neuronal cells to generate a membrane potential enables them to release a lot of energy in short time by depolarisation. If depolarisation energy can be used to generate light, e.g., within the microtubules, the process of depolarisation could scan the information within the microtubules and MAP-proteins and transmit it to the next neuron. When depolarisation reaches the synapses the fluorescent neurotransmitters are released, the transmission is terminated and retrograde transmission inhibited.

Conclusions

From the listed experiments we see that there is strong evidence for a photon mediated cell to cell communication, also intracellular processes could be regulated by these mechanisms. If cell communication/regulation happen by biophoton signals as a general principle many phenomena would have to be reconsidered in the light of this hypothesis. Especially, the physiology of the CNS would have to be seen in a different way.

Apart from their known physiologic and pharmacologic properties, neurotransmitters, psychopharmacological drugs, hallucinogens and other psychotropic agents may act through their fluorescence or absorption characteristics and/or their action on light guiding microtubules, thus interfering with the biophoton communication. The mechanisms might be of little or no relevance under resting conditions but would gain importance in active, aroused, or hyperaroused states, with high metabolic activity generating photons.

These findings may lead to a completely new understanding of cognition and conciousness.

Also the pathophysiology of conditions like hallucinations, schizophrenia and Alzheimer's disease would have to be reconsidered.

If biophoton communication and light guidance in cytoskeletal microtubules takes place in human CNS, our brain would have to be looked upon as an "optocybernetic system", or, as Jibu [12] put it, a "holographic computer".

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