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Quantum: May be a new-found messenger in biological systems

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Summary **Current studies on biological communications mainly focus on chemical signals. Since organisms are extremely complex, different kinds of signals may exist in the process of cell communication. The most probable candidate for alternative forms of organism communications is electromagnetic radiation, as many experiments have confirmed that electromagnetic radiation widely exists in cells, tissues, organisms and even between organisms and their surroundings. The well-known connection between electromagnetic radiation and quantization of the energy transfer makes us to suggest a bold, but fresh view that quantum can serve as a biological messenger. This view also coincides with the medium of Qi in the human body according to traditional Chinese medicine (TCM). Relating Qi with quantum may further explain a number of phenomena that cannot be explained solely by conventional chemical signaling systems.**

Keywords: Quantum, electromagnetic radiation, non-chemical, non-electrical, messenger, human body

Current studies on biological communications mainly focus on chemical signals like first, second, and third messenger signaling (*1*). As organisms are extremely complex, different kinds of signals may exist in the process of cell communication. Recently, electromagnetic radiation has been considered as the most probable candidate for alternative forms of organism communications (*2*), as many experiments have confirmed that electromagnetic radiation widely exists in cells, tissues, organisms and even between organisms and their surroundings. Electromagnetic radiation could contribute to a series of basic activities such as cell division and proliferation, oxidative metabolism, photosynthesis, and carcinogenesis (*2*). What follows is a brief review of studies on electromagnetic radiation effects in biological systems.

Scientific experiments related to the discovery of electromagnetic radiation in biological systems can be traced back to the 1920s and the work of Alexander G. Gurwitsch (*3*). Gurwitsch monitored the number of mitoses in a set of chemically isolated onion root cells that were near a group of actively dividing cells. He found that the number of mitoses increased if the chemically isolated roots were separated from actively dividing roots by quartz glass but not by normal glass. This suggested the existence of a form of cellular radiation in biological systems that Gurwitsch named "mitogenetic radiation." This study was the first to suggest that the emanation of light might play an important role in biological communication. Gurwitsch's observations stimulated early research on the ability of electromagnetic radiation to induce cell division. Moreover, a typical experimental model was set up to observe electromagnetic interactions in organisms (Figure 1) (*2*). Since then, many studies have observed quantum communication in biological systems.

Inspired by Gurwitsch's work, many researchers conducted experiments to confirm that electromagnetic radiation widely exists in cells of organisms. Kaznacheev *et al.* (*4*) found that the cytopathic effects of a cytopathic stimulus (*e.g.* UV radiation) in a cell culture plate could be observed in a distinct cell culture

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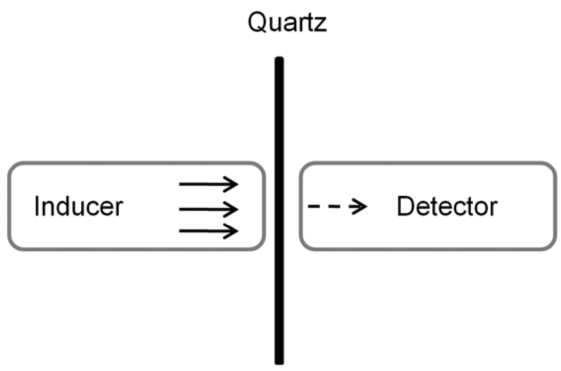

Figure 1. Typical model used in experiments to measure electromagnetic radiation communication in an organism. Inducer: a source of electromagnetic radiation; an organism emits electromagnetic radiation or is stimulated to emit electromagnetic radiation). Detector: detects how an organism reacts to electromagnetic radiation from the inducer. Quartz: a separator that ensures a chemical separation of the organism and detector to determine which part of the electromagnetic radiation spectrum is mediating the organism's interaction with the inducer and detector.

plate that was separated by quartz glass and not exposed to the cytopathic stimulus. Kaznacheev *et al*. called this phenomenon a "mirror cytopathic effect". They also found that cytopathic effects in the detector cells were only observed in those cells that were separated from the stimulus by quartz glass and not by regular glass. Their findings suggested that the mirror cytopathic effect was most likely due to ultraviolet or infra-red radiation emanating from the inducer. Grasso *et al*. (*5*) and Musumeci *et al*. (*6,7*) also observed a similar phenomenon in yeast cells. Furthermore, Albrecht-Buehler pioneered a series of experiments in which he used various cell culture models to investigate the effect of artificial and cellular infra-red electromagnetic radiation on cell functions and properties (*8*). He observed the interaction of baby hamster kidney cells separated from an inducer by a thin glass film. The cells (detector) on one side were able to determine the spatial orientation of the cells (inducer) on the other side through electromagnetic signals and the cells responded by adjusting their own orientation. He also found that 3T3 and CV1 cells were able to extend their pseudopodia towards microscopic infrared light sources nearby. Taken together, these findings suggest that the cells were able to sense specific infrared wavelengths and to determine the direction of light from individual sources.

Several experiments have also shown that electromagnetic radiation could contribute to cell proliferation and carcinogenesis in human cells. Zhang *et al*. (9) found that the quantum radiation emitted by rapidly proliferating osteoblasts promoted the proliferation of other osteoblasts. Farhadi *et al*. (*10*) found that exposing inducer cells (colon cancer cells CaCo-2) to H_2O_2 resulted in a significant reduction in total protein content, an increase in nuclear NFκB activation, and structural damage in detector cells that were placed in separate containers near the inducer cells but were not exposed to H_2O_2.

Influences of electromagnetic radiation in biological systems exist not only at the cell level but also at the level of tissues, organs, and organisms and even between organisms and their surroundings. In a study by Galantsev *et al*., two mammary explants of lactating mice were separated by quartz glass in a dish. One explant was treated with oxytocin, acetylcholine, epinephrine, or norepinephrine and the level of thiobarbituric acid-reactive substances (TBARS) that it produced changed; although separated by quartz glass, the untreated explant was also affected (*11*). Analysis of the level of TBARS formation in the two explants showed that their interactions might be associated with light emission resulting from lipid peroxidation processes. In a study by Yang *et al*., the biophotons from the palm and back of the hand of healthy people and stroke patients were observed and measured for a year (*12*). They found that the left-right balance of biophoton emission was maintained for normal subjects in contrast to the severe imbalance for stroke patients.

Electromagnetic radiation also plays an important role in other species, including bacteria and plants. Fels showed that *Paramecium caudatum* can interact in darkness *via* ultra-weak photon emission in both the UV and visible regions of the electromagnetic spectrum. He found that cells affected cell division and energy uptake in neighboring cell populations (*13*). Galle *et al*. suggested that using ultra-weak photon emission was an important way for insects to communicate. He found that adolescent *Daphnia magna* exhibited ultra-weak photon emission and that the intensity of electromagnetic radiation had a non-linear dependence on the population density with distinct maxima and minima (*14*). Kuzin *et al*. suggested that plant seeds also appeared to use ultra-weak photon emission to communicate (*15*). They stimulated *Raphanus sativus* seeds with low-dose gamma ray irradiation and found that the resulting germination and growth were also observed in detector seeds that were separated from the inducer seeds by quartz glass and not exposed to gamma rays. This effect was eliminated when the experiment was repeated using regular glass, which blocks the passage of ultraviolet photon emission.

In physics, a quantum is the minimum amount of any physical entity involved in an interaction (*16*). It reflects the fundamental notion of quantization of physical properties. Max Plank, who had been trying to understand the emission of radiation from heated objects, first discovered the concept of quantization of energy transfer in electromagnetic radiation in 1900 (*17*). This well-known connection between electromagnetic radiation and the concept of quantum, together with the various effects of electromagnetic

Table 1. Effects of electromagnetic radiation in biological systems

Researchers	Organism	Methods	Findings from detector	References
Gurwitsch	Onion root cells	Quartz or normal glass separation	The number of mitoses increased	(*3*)
Kaznacheev *et al*.	Fibroblasts (human & chicken), monkey kidney tissue	Various separator materials tested (*e.g.* quartz and glass)	Transfer of effect of high dose UV irradiation	(*4*)
Grasso *et al.*	Yeast cells	Air separation	The growth rate increased	(*5*)
Musumeci *et al*.	Yeast cells	Quartz glass separator	The growth rate increased	(*6,7*)
Albrecht-Buehler	BHK, CV1 and 3T3 cells	Various separator materials tested	Orientation to detector	(*8*)
Zhang *et al*.	Osteoblasts	Copper net separator	Proliferation promotion	(*9*)
Farhadi *et al*.	Colon cancer CaCo-2 cells	Kept in a distant laboratory with separation by walls and doors	A significant reduction in total protein content, an increase in nuclear NFκB activation, and structural damage	(*10*)
Galantsev *et al*.	Mammary explants of lactating mice	Quartz glass separator	The level of TBARS changed	(*11*)
Yang *et al*.	Palm and back hand of healthy people and stroke patients	Biophoton radiation	The left-right balance of biophoton emission was maintained for normal subjects in contrast to the severe imbalance for stroke patients.	(*12*)
Fels	*Paramecium caudatum*	Quartz or normal glass separator	Cell division and energy uptake	(*13*)
Galle *et al*.	*Daphnia magna*	Organisms in water environment	The intensity of electromagnetic radiation had a non-linear dependence on the population density	(*14*)
Kuzin *et al*.	*Raphanus sativus* seeds	Quartz glass separator	Seed germination and development	(*15*)

Abbreviation: TBARS: thiobarbituric acid-reactive substances.

radiation in biological systems (which have been summarized in Table 1) makes us to suggest a bold, but fresh view that quantum may be a new-found messenger in biological systems.

Interestingly, the view that quantum can be a biological messenger coincides with the medium of Qi in the human body according to traditional Chinese Medicine (TCM). Because, on the one hand quanta are considered to be discrete packets with energy stored in them, on the other hand, according to TCM, Qi is one of the most fundamental substances in the human body and in its maintenance of biological activities. In particular, Qi connects the viscera (Zang-Fu) with meridians or channels (Jing-luo) of the body that promote and stimulate the physiological functions of the human body (*18*). Although still in a preliminary stage, the quantum explanation of biological communications has been used to explain much of the TCM theory related to Qi, including "adaptation of the human body to the natural environment" and "treatment based on syndrome differentiation" (*19*). Furthermore, by combining Qi and quantum theories, maybe we can establish a discipline called Qunatum TCM theory in the future, which may provide a new direction for research on biological systems including human bodies.

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