RADIATIONS EMITTED BY LIVING ORGANISMS

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According to our present knowledge, three different ranges of radiations are emitted from living organisms. These ranges can be classified according to their wave lengths or their place in the general electromagnetic spectrum. First, practically all organisms emit infra-red radiation, the wave length of which depends, as far as we know, entirely upon the temperature of the body. The second group of radiations belongs to the visible range of the spectrum; these radiations are produced by bio-luminescent phenomena. This emission of visible light by living organisms has been known for a long time. Ever since the great philosopher Aristotle mentioned the light emitted by certain fish, this so-called "cold light" has held the interest of biologists, physicists, and chemists. Many organisms in both the animal and the plant kingdoms are bio-luminescent, the best known being the firefly, the glowworm, and luminescent bacteria. Though bio-luminescent radiations can be satisfactorily analyzed as far as their spectral distribution is concerned, we know as yet very little about the way in which they are produced. Fundamentally speaking, certain substances formed within the cell are oxidized, but neither the composition of these substances nor the essential processes of their oxidation are known.

The third group of biologic radiations, the so-called mitogenetic rays, are perhaps of greatest interest to medicine. Emission of mitogenetic radiation, according to their discoverer, Alexander Gurwitsch[1], a Leningrad histologist, is universally connected with growth in general and notably the process of mitosis of cells. Cell division had been studied widely in the past before Gurwitsch's experiments, but there were certain inexplicable phenomena which did not fit into the various theories proposed. For instance, an often observed increased mitosis caused by the stimulus of an unknown exogen factor was never satisfactorily explained. One such example was the "regeneration mitosis" occurring around damaged tissues. Neighboring tissues attempted to repair the damage and consequently an increased rate of cell division around the damaged tissue occurred. It is on this point that Gurwitsch's experiments and theories hinge. In one experiment, he inflicted a small wound on the corneal epithelium of a frog's eye. The eye tissues were later removed and stained and it was found that the areas surrounding the wound contained many more mitotic figures than the unaffected regions. The simultaneous production of an additional wound in the neighborhood of the first wound caused peculiar distribution of the mitotic changes. The second wound acted as a barrier to the stimulus emanating from the first wound.

Gurwitsch concluded from this experiment that the stimulus must be

oscillatory in character and that probably a "mitogenetic radiation" emitted from the original wound was responsible for the effect. Gurwitsch[2] proceeded on this hypothesis and tried to learn first whether this radiation could also be transmitted through space and not only within the tissues. Most of his earlier experiments were conducted with onion roots, the actively growing end portion of which was selected as the most suitable place for determining the effect of a stimulus to cell division. This onion experiment, which became the foundation of all later work on problems of mitogenetic radiation, was performed with two onion roots, one serving as a "sender," the other as a "detector" of the stimulating radiation. When, after the exposure, the induced region of the detector root was examined histologically, it was always found that there was an increase in the number of mitotic figures on the side exposed to the sender root. A stimulating effect had been exerted through space without direct contact. This cause of a stimulation through space was found to pass easily through quartz but was stopped by glass. Gurwitsch therefore concluded that the stimulation was of a wave character and that its wave length lay in the ultraviolet region of the spectrum, around 2000 Angström units (2000 times 10^{-8} centimeters).

Following Gurwitsch's original publications, numerous investigations have been conducted to study the various aspects of the phenomena, biological, chemical, and physical[3]. Among the many biologic experiments, the studies on the sensitivity of amitotically reproducing organisms such as beer yeast to mitogenetic radiations which were carried out by Baron in 1926, have led to the most important results. In the yeast organisms, an increasing rate of budding of yeast cells with a subsequent increase in the total number of individual cells was observed after exposure to mitogenetic senders such as the onion root. The yeast method subsequently replaced almost entirely the more laborious methods of preparing onion root sections and counting mitoses.

We have felt for over ten years that if Gurwitsch's fundamental experiments and theories could be confirmed they would be of immense value to the clinician in studying many medical problems. We therefore proceeded to study the mitogenetic problem and among other methods we used a modification of Baron's original yeast method to detect mitogenetic radiation. Our modification of this method may be described shortly[4]. Pure cultures of Saccharomyces cerevisiae and ellipsoideus in liquid beer-wort and a peptone glucose medium were used. Equal quantities, 0.5 to 2.5 cc. of this yeast suspension were measured accurately into quartz and glass test tubes. The lower ends of the test tubes were then placed in direct contact with the various biological radiators and rotated continuously but slowly during the irradiation in order to prevent settling of the yeast. After the irradiation, the tubes were placed in an incubator and kept at 20° C. for periods up to 24

hours. Then sulfuric acid was added to kill the yeast cells and after the tubes were thoroughly shaken, the amount of yeast present was determined in the following way: The suspensions were introduced into small hematocrit tubes which were rotated rapidly in the centrifuge for five minutes. The height of the packed yeast cell columns in the hematocrit tubes which had previously been calibrated carefully was then determined and the percentage difference between the columns of cells irradiated in the quartz tube and the glass tube were calculated. With this method, the emission of radiation from various biological tissues (notably rat cancer) and organs was studied.

Later on this method was revised after receipt of further information and also of two strains of yeast from the laboratories of Gurwitsch in Leningrad[5]. Cultures of this yeast were prepared in strict conformity with the procedure outlined by Gurwitsch. The agar beer-wort cultures were homogeneous at the time of exposure and could be detected only microscopically. After a period of incubation not exceeding two hours, the yeast was gently removed with a loop, fixed on a glass slide, and stained with methylene blue. The percentage of small buds was then counted in groups of 1000 unselected cells. The Russian workers advised that an increase in buds was more directly related to the mitogenetic effect than increasing volume. Again biological, chemical, and physical "senders" were used for the radiation of the yeast. With a few exceptions our results did not substantiate those of Gurwitsch and his co-workers.

Gurwitsch's conclusions may be summarized briefly: Mitogenetic radiation has been found to be given off by simple organisms, bacteria, and yeasts; by plant tissues; by embryonal animal tissues; by skeletal and cardiac muscle in contraction; by nerve fibers, spleen, corneal ciliated and gut epithelia, by blood and urine, and by tumors.

The study of tumor tissue is of special interest since the radiation from malignant tumors is said to be stronger than that from benign tumors. Moreover, in cancerous conditions, Gurwitsch maintains that normally appearing blood radiation is absent. These properties peculiar to tumors suggest the possibility of utilizing the methods of mitogenetic study for the early diagnosis of cancer.

Naturally these observations called the attention of the whole medical world to the great importance of using the Gurwitsch effect for early diagnosis in certain disease and it is for this reason that a large number of investigators devoted their time to a thorough study of the problem. We, like many others, turned our attention to the construction of physical detectors for the radiation in order to avoid the complications often inherent in biological methods. We first employed photographic methods to detect mitogenetic radiation and later resorted to the photoelectric Geiger-Mueller counter tube[6]. We soon had to abandon the

photographic method as being unreliable. The various Geiger counters which we built and with which we experimented were described in previous communications[4,7,8]. In brief, they consisted of cylindrical quartz tubes containing a photo-electric electrode and central tungsten wire anode. They were connected through a multi-stage vacuum tube amplifier to a magnetic counter or a loud speaker. The photo-sensitive materials which we mostly used were copper, aluminum, and cadmium. We used the same "senders" which we and others employed in the biological yeast test methods. The results of our investigations with the physical detector methods may be stated briefly. The counts obtained with the photo-electric counter, when exposed to biological or chemical materials, did not fall outside the limits of fluctuation in the control of background counts. In experiments with yeast, as stated before, an apparent increase in growth rate was noted occasionally, but for a large series of observations fell within the range of variation in the control culture.

All in all, our experiments thus far failed to confirm the observations concerning the existence of mitogenetic radiation as reported by Gurwitsch and his co-workers. These negative results have also been obtained by a large number of other investigators. But we have not yet abandoned the study of the problem. We still feel that we might have worked with boundary methods which fall just short of the required sensitivity to detect mitogenetic radiation or that the Gurwitsch effect possibly represents a new phenomenon which does not easily lend itself to study with routine biological or physical testing methods.

References

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