Ray Peat's Newsletter

Love of power, operating through greed and through personal ambition, was the cause of all these evils. Thucydides

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X-rays, estrogen, and the brain

Even a single set of dental x-rays causes permanent systemic damage.

MRI (magnetic resonance imaging) and ultrasound imaging are much safer than x-rays and can provide better images of tissues, and can also provide detailed information about tissue functions and metabolism.

Diagnostic x-rays for dentistry, for measuring bone density, for mammography, for examining the brain, lungs, and heart, for "virtual colonoscopies," for shopping mall whole-body scans, should be abandoned immediately.

Their continued use is based partly on their profitability, partly on ignorance, and partly on the fear of legal liability for the death and disability already inflicted, if the truth is admitted.

The US Public Health Service has become deeply involved in scientific malfeasance over the last half century, and can be expected to marshal its minions to defend the present practices. Only public awareness can stop the radiological abuses.

The excitation of electrons in the tissues by radiation has catalytic effects that produce long-lasting changes in biological functions that are more important than any immediate genetic mutations.

Activation of phospholipase by radiation releases arachidonic acid and DHA, which act as biological signals. One enzyme activated by the arachidonic acid signals is estrogen synthetase. An early effect of irradiation is the stimulation of cell division, and this action is prolonged by the release of free unsaturated fatty acids and the formation of estrogen.

Chronic inflammatory changes, fibrosis, and amyloidosis are produced by ionizing radiation, even when the increased incidence of cancer or heart attacks is relatively small. Mental retardation, birth defects, senile dementia, immunodeficiency and the degenerative amyloidoses must now be taken into account in assessing the costs of radiation exposure.

The changes produced by high energy radiation overlap with those produced by excess polyunsaturated fats, excess serotonin, and excess estrogen.

Antioxidant, antiinflammatory, and antiestrogenic substances are protective against radiation damage. Aspirin, vitamin E, progesterone, saturated fats and thyroid have these functions.

For a century, science has been barbarized by greed. Early insights into the subtle electronic nature of life have been suppressed, allowing a crude mechanical concept of biochemistry to justify medical, military, and industrial practices that were convenient and profitable.

The observations of Gurwitsch, Crile, Tromp, Bernal, Barnothy, Szent-Gyorgyi, and others were disregarded, because they would have required science to confront the phenomenon of life with respect and humility, postponing the technological bio-engineering approach to organisms, in favor of caution and a recognition of the profundity of our ignorance.

Simplicity is nice, except when a simple model is claimed to accurately represent the complex reality. The 20th century saw the take-over of science by reductionism, and--not coincidentally--by the Corporate State. The field of biophysics in general, and radiation biology in particular, developed under the most extreme economic and political pressures, producing some dangerous distortions and delusions.

In the earliest years of the twentieth century, a few people like Thomas Edison had rejected the medical use of x-rays, because they had seen the rays' terrible effects on the body. But by the 1920s the US medical establishment was claiming that radiation was not only an essential diagnostic tool, but that it was the best way to treat more than eighty different conditions.

By the middle of the century, there were two views of the way that ionizing radiation such as the x-ray affects the body. One was that it accelerates the aging process, causing the degenerative diseases to occur at an earlier age. The other view was that it caused random mutations of the genes. (Although some people held that somatic mutations caused aging, there just wasn't much

interest in the scientific establishment in pursuing the question of aging.)

After 1945 the influence of the medical establishment coalesced with that of the developing military industrial atomic energy clique, to argue that ionizing radiation's "beneficial effects" far outweighed the trivial risks that large doses could produce. This medical-military culture found it useful to argue that there was a threshold for the harmful effects of radiation, and that below that dose, radiation had no harmful effect at all. That threshold dose was often considered to be the dose that caused radiation sickness to develop within a few days following exposure, in a way analogous to a sunburn that develops several hours after exposure to the sun. There was often an assumption that the threshold for mutation of genes was quite high, in the vicinity of the dose that produced radiation burns, but the outstanding thing about medical opinion regarding radiation's harmful effects was its fundamental optimism--if a treatment made you feel better for a couple of weeks, then it was unquestionably good for your health.

If anyone suggested that caution was appropriate in the absence of long-term evidence, that person was a danger to the livelihood of physicians and a threat to national security. Literally; that was the tone of the scientific-political culture. Even someone as famous as Linus Pauling was ostracized for saying that it was dangerous to test atomic bombs in the air. A few years ago, one of the Atomic Energy Commission's chief apologists for radioactive fallout in the 1950s, John Gofman, described his behavior at that time as simply stupid. Contemporary observers who didn't have a financial stake in radiation would have emphatically agreed with that assessment of his behavior, though at that time they assumed that he was dishonest rather than stupid. Although he still thinks nuclear weapons are good, he has done a great amount of good in the last 35 years by his careful studies of the harmful effects of radiation. But government and industry, and even some of his academic colleagues have done their best to destroy his reputation. Sternglass, Tamplin, Stewart, MacMahon, Mangano, and a few others have persisted in trying to warn the public about radiation's dangers, but government and the radiation industries have been able to limit their ability to publish, while investing hugely in a continuing campaign to discredit them and to convince the public that "a little radiation is harmless."

When any radiation interacts with a substance, the electrons are the most responsive parts of the material, and some electrons are susceptible to being significantly changed even by low energy radiation, such as red light. As the energy of the radiation increases, more electrons are susceptible to activation. Blue light interacts with more electrons than yellow light, and ultraviolet light activates even the electrons in fairly stable molecules. X-rays and gamma rays will radically disrupt electrons in all biological molecules.

Several decades ago, it was conventionally taught that visible light is "chemically inert," and that ultraviolet, x-rays and gamma rays are "chemically active." I don't think there was ever any good scientific reason for that dichotomous belief, except that it was obvious that the more energetic rays were chemically active to a dangerous degree. Blue light is now known to be toxic to the eye, by activating the oxidation of polyunsaturated fatty acids; it has been known to be toxic to various cells, including plant cells, for more than 50 years. In the eye, blue light creates free radicals in melanin, which catalyze the oxidations. Other molecules, including porphyrins and vitamins, produce free radicals when exposed to blue light, ultraviolet, and the higher energy rays. For example, riboflavin, vitamin B2, when exposed to white light, can cause the vitreous body of the eye to liquefy by causing the depolymerization of hyaluronic acid, and in the skin it probably contributes to the age-related and sun-related loss of hyaluronic acid in the connective tissue. Ultraviolet light can attack the same molecules as blue light, but in addition it can dislodge electrons from many more molecules, including the tryptophan, tyrosine, and cystine in proteins.

The pro-oxidant effect of riboflavin in ordinary light is increased by its reactions with tryptophan, folic acid, vitamin B6 (pyridoxine), and tyrosine (Grzelak, et al., 2001). Higher energy radiation causes a spreading excitation of even more substances.

Although each part of an organism has its own complex ways of responding to the disturbance of its electrons by radiation, I think it's useful to think of some simple physical examples of how substances are changed by radiation.

Some topaz crystals that are colored when they are mined, quickly fade when they are exposed to bright light. Over a very long time, natural radiation displaced some electrons from the atoms in the buried crystals, and trapped them in "color centers," where they can absorb certain frequencies of low energy visible light, creating colors, without immediately escaping their traps. Bright light can gradually free the electrons from their "traps," bleaching the color. Glass that was made around 1900 often turned purple when it was left in the sun, because ultraviolet light had enough energy to create trapped electrons in that material; heating the glass to a few hundred degrees was enough to bleach the color. Diamonds, salt, and many other materials can be colored artificially with high energy radiation, and they can be bleached by the lower energy of another type of radiation, or by heating, or by ultrasound.

When trapped electrons are released by heating, and return to their relaxed ground state, they give up energy as thermoluminescence. The amount of thermoluminescence can be used to measure the dose of radiation the material was exposed to.

The intensity of the color induced by radiation is another way of judging the material's radiation exposure.

Another way to measure the accumulated dose of radiation is to use an instrument that measures the resonance of unpaired electrons, color centers or free radicals, with a microwave field--these EPR or ESR (electron paramagnetic resonance or spin resonance) machines can measure unpaired electrons in living tissue, and can distinguish different environments of the electrons, analogous to the colors seen in transparent materials.

EPR and thermoluminescence can be used to determine the accumulated radiation exposure of teeth, bones, and rocks. Since natural radiation from minerals and cosmic rays is steady over long periods of time at a particular location on the earth, these techniques can be used for archeological and geological dating. After radiation accidents, tooth enamel can accurately determine the dose received, except that the person's dental history must be known, so that dental radiation can be subtracted from the accidental exposure.

In liquids, trapped electrons quickly return to the ground state, because of the greater mobility of atoms and ions in liquids, but while water is being exposed to intense gamma rays, the "solvated electrons" give the water an intense blue color. In ice, the trapped electrons have a long life-time.

In hair, skin, plant materials, and other tissues, the trapped electrons decay much more quickly than in teeth and bones, but their effects can be seen for 50 years or more, as for example the increased amount of amyloid seen in Japanese survivors of the atomic bomb.

Hours after a person has been in the sunlight, EPR can detect free radicals in the melanin pigment in hair. In the skin, the melanin radicals decay more quickly, but the ultraviolet-induced spreading free radicals can still be detected in the skin hours later, during the time in which the sunburn injury is reaching its peak. Applying antioxidants and red light to irradiated tissues soon after exposure can profoundly decrease the injury. The beneficial effects of sunlight are largely the result of the red part of the spectrum, which penetrates deeply into tissues, and helps to inactivate toxic electrons.

When a dose of radiation similar to a diagnostic x-ray is given to cells in culture, they are still emitting induced light after an hour or more (Vicker, et al., 1991). The genetic mutations produced by radiation are still occurring hours or days after the exposure; the observations in the Japanese suggest that they might keep occurring years after the exposure. In cell culture, they can appear in unirradiated cells after 30 cell-doublings, the equivalent of a person's lifetime. In a form of imprinting, the radiation injury can be passed to a later generation. The radiation creates genetic instability, rather than just immediate direct mutations. Stress and estrogen exposure cause genetic instability, probably because of the lingering metabolic effects, which

are similar to those caused by radiation. The metabolic changes causing delayed mutations seem to be those involved in inflammation (Wright, 2004).

The electrons which are physically excited by high energy radiation are absorbed by various molecules, causing chemical excitation and chemical reactions, which produce "chemiluminescence" similar to that seen after any injury. In some cases these abnormally reactive chemicals cause the familiar kinds of damage, such as broken chromosomes or chain reactions of lipid peroxidation in the polyunsaturated fats. Various stresses and metabolic conditions are known to be passed on to daughter cells and to germ cells and offspring as alterations in the degree of methylation of certain genes, but this process of "epigenetic inheritance" and imprinting has hardly been investigated, because of the fear of "Lamarckism" that dominated biomedical research in the U.S. in the twentieth century.

Between chemiluminescence and the actual biological processes of growth, differentiation, movement, inheritance, and disease there is an immense zone of ignorance, that has been excluded from organized scientific investigation, because corporate financial interests have preferred mechanical reductionist dogmas such as "neodarwinian molecular biology."

The experiments of Alexander Gurwitsch (or Gurvich) and his wife in the 1920s and 1930s that showed that growing cells stimulated waves of cell division in cells in a nearby compartment, separated by a thin quartz glass partition, and that the stimulation occurred only when the partition glass was able to transmit ultraviolet rays, had immense implications for medicine and biology. Fritz Popp and Mae-Wan Ho have validated and extended the discoveries of the Gurwitsches, using new devices that confirm the nature of the radiation.

Everyone working with radiation now recognizes that external ultraviolet rays, at different wavelengths and intensity, can stimulate or inhibit cell division, and can cause cells to die prematurely or to become immortalized tumor cells, but only a very few researchers, in the last six years, have begun to see the intimate connections between ultraviolet light and the cells' systems of interaction and self-regulation. The universities have inculcated the doctrine that "radiation damages by mutating genes." People talk about DNA being altered when it is "hit" by radiation, and everyone who has taken a biology course has probably heard that the "target size" of a gene or a virus determines the likelihood that it will be damaged by a given dose of radiation. That quaint relic of primitive radiation biophysics is useful for nuclear power corporations, and for dentists, and for anyone who wants to sell whole body scans to the public. But that dogma has now been very firmly knocked out by hundreds of direct hits by experimental data, that show that irradiated cells transmit something to other cells that weren't exposed to the radiation, in a "radiation bystander effect."

In the 1950s, Alice Stewart began a series of studies that showed that medical x-rays were causing a large number of cancers in children. At that time, physicians were taught that the "threshold" of safety for fetal x-ray exposure was ten rads. (In animal studies, that dose reduces brain size, and causes mental retardation.) In her first study, she and David Hewitt, a statistician who had noticed that leukemia deaths in children had recently increased by 50%, found that leukemia deaths were twice as high among children whose mothers had received pelvic x-rays during their pregancy, compared to other women. The supposedly safe dose of a half to one rad was producing those effects. Even a single x-ray was harmful. If the fetus was x-rayed during its first three months, the leukemia rate was increased 10-fold. Miscarriages, malformations and brain cancers were also more common in the x-rayed patients. Even having been x-rayed before pregnancy was found to harm the babies a woman would later have. Stewart's study was widely denounced, and she lost her funding and staff at Oxford.

Her results probably understated the actual harm of medical x-rays, since the control patients who didn't receive x-rays were still being exposed to the radioactive fallout from the testing of atomic bombs.

For many years, it has been clear that low birth weight (below 5.5 pounds) was associated

with subnormal mental abilities. Recently, studies of women who had dental x-rays while pregnant show that their risk of having a low birth weight infant was increased. Those whose radiation dose was in the 90th percentile of the group studied were 3.61 times as likely as the unexposed women to have a full-term low birth weight baby (Hujoel, et al., 2004).

Estrogen excess during pregnancy is known to retard fetal development. The effects of dental x-rays on the brain, pituitary and thyroid gland probably played a role in causing the pregnancy abnormalities, but any tissue which is exposed to x-rays will tend to begin producing estrogen. With aging, most tissues begin to form estrogen synthetase, the enzyme that converts androgens into estrogen, and radiation accelerates that process. Many years ago, researchers noticed that x-rays or gamma rays would cause a female animal to go into estrus, as if it had been treated with estrogen, and it was assumed that the radiation had stimulated the brain and pituitary to produce gonadotropic hormones that activated the ovaries. However, other researchers found that simply irradiating an animal's foot would induce estrus. Radiation activates many of the mediators of inflammation, including interleukin-6, which activates estrogen synthetase.

Estrogen does many things to retard intrauterine growth and development, and most of those effects are prevented by adequate progesterone, which keeps estrogen out of cells even when the blood level of estrogen is very high. Animals that gestate under the influence of excessive estrogen (if they survive) have a small brain, and the cortex, the highest part of the brain, is thinner than normal. Just by acting on the mother's metabolism, reducing her ability to deliver oxygen and glucose and other nutrients, radiation and the estrogen it induces will damage the fetal brain.

In the brain, interleukin-6 is associated with cognitive decline, progressive dementia, so if the dental x-rays are acting primarily through the brain, the mothers who bore under-developed infants will probably suffer an increased incidence of Alzheimer's disease.

Ernest Sternglass and Jay Gould showed clearly that declining SAT scores (especially the absolute number of students reaching the highest scores) followed the intensity of radiation from nuclear fallout in each region of the country, with a lag of 18 years, indicating that the students taking the tests were affected during their gestation.

The Nuclear Energy Institute, and other agents and apologists for the nuclear industry, are still engaged in an intense campaign to discredit Sternglass, by quoting denunciations by "important" newspaper editorial writers and government officials. (And by hiring ghost writers to provide articles for professors to submit to their local newspapers as their own work.) Irrational and dishonest "arguments" of that sort, unfortunately, are effective in controlling the public's behavior. It probably doesn't help that the generations most affected by the brain damaging radiations are now at the age--41 to 56--that has the most social, political, and economic power.

Studies of prenatal radiation exposure in Japan show clearly that it reduces brain size, intelligence, and school achievement (Fujiwara, et al., 1994; Miller, 1988; Mole, 1990; Otake and Shull, 1993; Shigematsu, 1994; Yamazaki and Shull, 1990)

Academic scientists know where their money comes from, and so the enemies of corporate/governmental/military science are adopted as enemies by academic science, and students aren't given the opportunity to examine the alternative ideas.

The functions of proteins are governed by their complex shapes. Enzyme activity depends on particular conformations of the protein, to create catalytic fields in the right places. The conformation of the protein depends on both external conditions (solvent and solutes, pH, temperature, oxidation-reduction potential of the system, for example) and internal fields within the protein itself. Simply changing the state of an electron can change the function of an enzyme, leading to widespread changes in cellular physiology.

The cell, especially the cytoplasm, functions as a system, and disturbance of its electrons will affect it systematically, modifying regulatory processes at all levels, and coordinating the

activities of enzymes. A certain intensity of stress will activate the processes of inflammation.

Three important kinds of enzymes that are activated by stress and radiation are phospholipases (that release fatty acids), tryptophan hydroxylase (that controls the conversion of tryptophan to serotonin), and aromatase (estrogen synthetase, that converts androgens to estrogen). The products of these enzymes stimulate cell division, and produce features of the inflammatory process, including the leakiness of capillaries.

Since these processes are similar, regardless of the source of the disturbance, the basic antistress and antiinflammatory systems that protect against common imbalances (such as fluctuations in glucose and oxygen) will also be somewhat protective against radiation injury.

The thyroid hormone is probably the basic protective hormone against radiation, as it is against other stressors. Besides helping to provide the energy needed to repair genetic damage and to protect against calcium overload, the thyroid hormones help to dissipate excited electrons, and reduce lipid peroxidation and the chemiluminesce produced by radiation. A dose of thyroid 50% larger than the normal physiological daily production can reduce radiation damage by 30% to 40% (Antipenko and Antipenko, 1994).

Progesterone has antioxidant functions, as well as suppressing the mediators of inflammation, and inhibiting the enzymes that produce free fatty acids (and the associated prostaglandins), serotonin and estrogen. Cortisol is protective against the acute inflammatory effects of radiation (Beetz, et al., 1997), but progesterone has those effects without the harmful effects of excess cortisol.

Aspirin and vitamin E are protective against toxic radiation, and the consequent inflammatory processes.

Saturated fats have many of the same functions, inhibiting inflammation, capillary leakiness, and the free radical chain reactions.

Niacinamide, by reducing lipolysis, would be another antiinflammatory agent that could help to interrupt the degenerative processes initiated by exposure to radiation.

Radiation stops repair processes in the brain, but there is evidence that treatment with an antiinflammatory drug (indomethacin) can restore the reparative process of nerve cell formation (Monje, et al., 2003).

The normal sequence in aging, proceeding from inflammation to atrophy and then to disordered repair or cancer, is accelerated by radiation exposure. Harry Rubin demonstrated that cancer precedes genetic change, rather than being "caused by genetic mutations," as the dogmatists have claimed. The existence of a "cancer field" has been known for a long time, but the doctrine of the "mutant cancer cell" has held that a single mutation, or a series of mutations, in a single cell is the cause of all cancers, and has denied that the cell's interactions with its neighbors are responsible for its properties. Recent radiation research is showing that "inflammatory imprinting" precedes both cancer and mutations.

In recent years, inflammation's role in cancer and heart disease has been acknowledged to some extent, and simple antiinflammatory treatments such as aspirin have been more widely accepted in the prevention and treatment of both heart disease and cancer. I think the next step is to recognize the importance of preventing all sorts of inflammation during the reproductive years, to protect the brains of the unborn, and the inheritance of future generations.

If the Gurviches, and Fritz Popp and Mae-Wan Ho are right, the investigation of light's role in life has hardly begun, and the possible therapeutic uses of light haven't been imagined yet. Their idea of "the coherent organism" is giving an expanded meaning to the idea of a biological "field."

But for the present, we should know enough to avoid all exposure to x-rays and radioactive isotopes, and to make sure that we get enough sunlight, without too much sunburn.

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J Photochem Photobiol B. 2001 Nov 1;64(1):62-8. **Ultraweak photon emission in assessing bone growth factor efficiency using fibroblastic differentiation.** Niggli HJ, Scaletta C, Yu Y, Popp FA, Applegate LA. Department of Obstetrics, Laboratory of Oxidative Stress and Aging, University Hospital, CHUV, CH-1011, Lausanne, Switzerland. Biofoton@mail.swissonline.ch Photons participate in many atomic and molecular interactions and changes. Recent biophysical research has shown the induction of ultraweak photons in biological tissue. It is now established that plants, animal and human cells emit a very weak radiation which can be readily detected with an appropriate photomultiplier system. Although the emission is extremely low in mammalian cells, it can be efficiently induced by ultraviolet light. In our studies, we used the differentiation system of human skin fibroblasts from a patient with Xeroderma Pigmentosum of complementation group A in order to test the growth stimulation efficiency of various bone growth factors at concentrations as low as 5 ng/ml of cell culture medium. In additional experiments, the cells were irradiated with a moderate fluence of ultraviolet A. The different batches of growth factors showed various proliferation of skin fibroblasts in culture which could be correlated with the ultraweak photon emission. The growth factors reduced the acceleration of the fibroblast differentiation induced by mitomycin C by a factor of 10-30%. In view that fibroblasts play an essential role in skin aging and wound healing, the fibroblast differentiation system is a very useful tool in order to elucidate the efficacy of growth factors.

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(thermal) field and those of an ordered (fully coherent) field with the actual experimental data, one finds ample indications for the hypothesis that 'biophotons' originate from a coherent field occurring within living tissues. A direct proof may be seen in the hyperbolic relaxation dynamics of spectral delayed luminescence under ergodic conditions. A possible mechanism has to be founded on Einstein's balance equation and, under stationary conditions, on energy conservation including a photochemical potential. It is shown that the considered equations deliver, besides the thermal equilibrium, a conditionally stable region far away from equilibrium, which can help to describe both 'biophoton emission' and biological regulation.

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