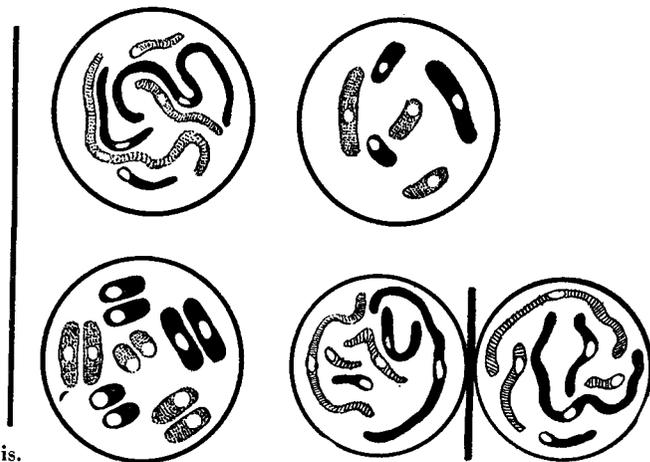


RACE POISONING BY RADIATION



A normal cell (chromosomes showing) undergoing mitosis.

EDITOR'S NOTE: Certainly the most frightening effects of a nuclear reaction are the terrible burns and growths inflicted on living victims of a bombing. But there are subtler and more sinister injuries. Madame Curie died from years of slow radium poisoning. Technicians have been sterilized by improper X-ray procedures. Experiments show how radiation disturbs the genetic material of plants and animals. Below Dr. Muller notes his evidence that even "harmless" radiation shortens the lifespan. All this would be more or less academic were it not for the rapidly increasing volume of fission processes in the modern world: America, Britain, and Russia now possess great stockpiles of A- and H-bombs, and in ten years every nation will be building reactors—for peacetime as well as military uses—all over their countryside.

In case of a war, as Dr. Ralph Lapp, the nuclear physicist, pointed out to Congress on March 20, the "fall-out" from a bombing will be far more of a disaster to the surviving population than any Civilian Defense scheme is yet prepared for. But even the present rate of radiation-production has overtaken scientific knowledge of its significance for the human body. The world-famous biologist Hermann J. Muller of the University of Indiana, who won the Nobel Prize for physiology and medicine in 1946, has been warning us for many months about the dangers of walking blind into the Nuclear Age; this present discussion has been developed by him from remarks before the recent Military-Industrial Conference in Chicago. Dr. Muller is now serving on a commission for the study of this problem as the basis for a public report.

By H. J. MULLER

IN THE atomic bombings of Japan many more people were killed by impact, fire, and heat-rays than by high-energy radiation. (We may however note that this analysis ignores the considerable shortening of life induced by all the radiation.) By contrast, a present-day hydrogen bomb emits radioactive fallout products, derived from its added uranium, that are lethal over an area of thousands of square miles, more than 100 times that ravaged by the blast itself.

It is obvious that to enable these H-bombs to do maximum damage the attempt will be made to space them over populous regions so as to

have their wide marginal areas of fallout overlap. By means of this "pattern bombing" even the margins are brought above the radiation level for lethality and the range of effective fallout is expanded. Moreover, most of the survivors caught far within the group of conjoined fallout areas are compelled to wait much longer underground until the radiation has sufficiently subsided to allow them to take the long journey out. This journey would be necessary, because it would for years be dangerous to live in bombed regions.

It would be surprising if the surviving population of a country that was systematically bombed in this way did not accumulate in the course

of time an average of 100 to several hundred roentgen units of radiation, even though they had been well disciplined for such an attack, and well provided with shelters, radiation counters, facilities for decontamination, essential supplies, battery-powered radios, and so forth. At least, it has been estimated that people remaining all the time in the basements of suburban-type houses, well sealed off from the dust of the outer air, in positions 110 miles downwind from an explosion of the type set off on March 1, 1954, would receive some 100 roentgens of gamma radiation from outside during the first week alone. Moreover, exposure outdoors in that region on the eighth day if

rain or artificial decontamination had not occurred might deliver eighty roentgens more of whole-body radiation to them in twenty-four hours. This would not be enough to give many of them serious radiation sickness if they did not get the dust on their skins or into their bodies. If, however, the population were not well prepared and instructed the survivors might in the course of the first week or two receive an average dose of well over 1,000 roentgens. This is a dose several times that which would have killed them if it had been received all at once, and when received in this somewhat more diffuse form it would still be enough to give most of them pronounced radiation sickness. We shall not attempt to estimate here what proportion of the people in the entire fallout area would, because of less protection or shorter distance from the explosion than this, have had such severe radiation sickness as to kill them. For this proportion would largely depend upon how well the people had been disciplined in advance, provided with shelters, and otherwise equipped.

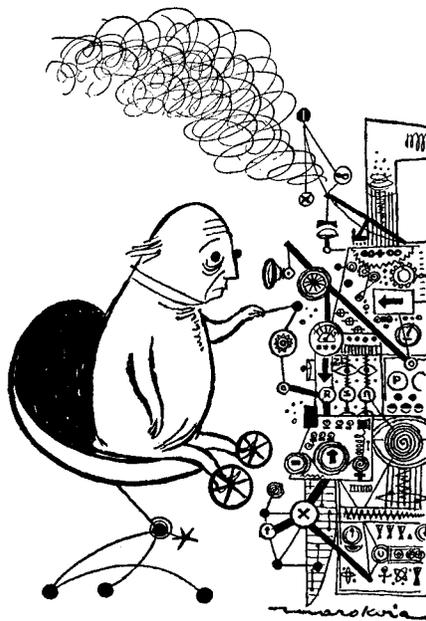
EARLIER EFFECTS OF RADIATION

Many of the well-known symptoms of the group of disturbances known as radiation sickness appear to stem from reduction in the number and efficiency of blood-system cells and of their products, such as the blood platelets that insure clotting. The minute perforations caused by destruction of blood-vessel cells and of intestinal cells lead to internal bleeding and to the entrance of bacteria, while the decimation of the white blood cells reduces the body's ability to overcome bacteria.

This reduction in cell numbers and effectiveness is found primarily in the case of cells that multiply frequently. Included here are not only the diverse blood-system cells mentioned, but also skin and hair cells, the effects on which cause temporary loss of skin color and of hair, and the cells of the reproductive organs, that may be enough affected to enter a period of sterility. Part of the effect, in all these cases, must be a consequence of the temporary checking of cell multiplication that radiation is known to cause. But much of it must be a consequence of the damaging, probably by breakage, of the chromosomes within the cells. These are the minute threads containing the cell's hereditary equipment, its thousands of different, highly specialized genes. It is only when cells divide and there-with transmit their precious cargo of genes to their two daughter cells

that a break in a chromosome, previously produced, may result in a cell that lacks a chromosome fragment, and that is killed or permanently impaired by the absence of certain of its genes. In other words, there is reason to infer that much of the malady known as radiation sickness is really an expression of damage to the hereditary material of many of the body's cells, lying scattered throughout certain strategic tissues that normally are renewing themselves actively.

On this interpretation it is not surprising that if the damage has not been too severe there will be some normal cells remaining, by the multiplication of which the depleted tissues will become in considerable measure restored. The restoration will be incomplete, however, and diverse parts of the body will thereby be left in a somewhat weakened or less effectively operating condition. Since this damage is greater the more rapidly multiplying the cells in the given tissue were, it is evident that the younger the individual is when irradiated the more he will be affected. This will express itself, among other things, in a checking of growth from which he will never fully recover. Moreover, those parts of him that were in a faster growing, more formative state at the time of exposure will be especially retarded and deranged. That is why even doses of fifty to 100 roentgens, if delivered to the young fetus, can give rise to permanent abnormalities such as the condition of small head or microcephaly, resulting in defective intelligence, that was found in some of



If we are careless about radiation-control the man of the future may be a technological wizard but a biological mess.

the children born at Hiroshima several months after the bombing.

DELAYED EFFECTS

One of the kinds of damage to body cells that is sometimes brought about by radiation is the conversion of a normal cell, probably by some kind of mutation in a gene, into a cell with the potentiality of later producing, when the conditions are appropriate for it, a malignant growth, either of blood cells, as in leukemia, or of some other type. These symptoms sometimes become evident only decades after the irradiation. Fortunately, they are induced in only a small minority of people, except in cases in which only a small part of the body has been irradiated with a dose far higher than the whole body could have tolerated. More frequent among the late effects of irradiation of the whole body are the development of minute spots of opacity in the lenses of the eyes. These cataracts, seldom large enough to impair vision seriously, show where individual cells have been permanently damaged, very likely by breaks in their chromosomes. It is only because the lens is a transparent tissue that we can directly detect these points of injury in it, but it may be inferred that the same kind of thing happens in all parts in which there are cells that can divide. This would explain what is by far the most serious of the long-term effects of radiation on the exposed person himself: the shortening of his span of life.

It is remarkable how few people, even among physicians, are yet aware of this effect and of the exact rules it follows. These rules were discovered some ten or more years ago by Dr. R. D. Boche (then at the University of Rochester but shortly afterwards at the University of Chicago) on going over data obtained by a number of investigators during the war, under the Manhattan District project, on the time of death of irradiated mammals of several different species. The principles were further developed by G. A. Sacher and A. M. Brues. The results have been so consistent that there is no reasonable doubt of the application of the same rules to man, especially in view of some confirmatory evidence. *They lead to the conclusion that for each roentgen unit of radiation received by the whole body at a given age, if delivered at a rate of not more than a few roentgens per day, there is on the average a loss of something like five days of life, perhaps as much as two weeks, depending on the age.* There is still some uncer-



tainty about the exact quantity, but not about the principle. No one particular ailment is thereby induced in the exposed group; they are simply made a trifle more susceptible to all causes of death, much as if they had been aged by several days.

Since the effect is proportional to the amount of radiation, if the rate of radiation per day is low a dose of 200 roentgens, received in a dispersed manner over a considerable period, would cause a pseudo-aging of something like 1,000 days. That is, death would on the average occur nearly three years earlier than if there had been no exposure. This proportionality of the effect to dose at low rates of delivery of the radiation is understandable if it has its basis in chromosome changes, for at low dose rates these chromosome effects also follow this rule, unlike most biological effects. If, however, the rate of delivery of the radiation is raised considerably, so that the 200 roentgens here in question are received in a period of hours, the frequency of permanent chromosome changes becomes disproportionately greater, and corresponding with this there will be a more extreme curtailment of the life span.

In view of all this it is rather surprising to read such a statement as that which appeared in the November 1955 issue of the Office of Naval Research's magazine *Research Reviews* in the article featured on the cover as "Fallout True Story."

This article ends with the following statement, referring to the sixty-four natives of Rongelap in the Marshall Islands who had received an estimated 175 roentgens of gamma radiation and additional radiation of a beta type, and who had shown some symptoms of radiation sickness: "Yet, after eighteen months all sixty-four of these natives are still alive, and none suffers any lasting after-effects as the result of their experience with radioactive dust." (Italics mine.) Do we not officially admit the long-known shortening of life, and the fact that any exposure, no matter how small, exerts some permanent damage?

As for larger doses, it can be calculated that people of, say, thirty years of age who have somehow managed to survive 1,000 roentgens, the first third of it received in the first day or two and the rest by the accumulation of decreasing amounts over a period of weeks or months, will probably succumb within something like a decade.

EFFECTS ON THE DESCENDANTS

It is fortunate that such large doses as this usually cause sterility, for the sum total of hereditary damage done to later generations by a given amount of irradiation of persons who later reproduce, if expressed in terms of years of life lost, is very much greater, perhaps more than ten times as great, as the damage done to the directly exposed individuals. This to-

tal damage is spread out over so many generations, however, that even in the most affected generation, that of the immediate children, it would be very difficult to demonstrate it even after a dose of one to a few hundred roentgens. Yet it is nonetheless very real, and hits humanity at its innermost and most precious core.

This damage to later generations, unlike that causing the trouble in the tissues of the exposed individual's own body, does not have its basis mainly in breaks of the chromosomes. It consists mainly of permanent chemical alterations, called mutations, that are produced by the radiation in a haphazard way in one or another of the genes, the hereditary particles, lying within the chromosomes of the reproductive cells. Each of the thousands of different genes in a reproductive cell will have its specialized role to play in the development and maintenance of the offspring that that cell, after fertilization, will produce, and in the intricate system of operations whereby that offspring will live and in its own turn reproduce. Any alteration of a given gene's composition, brought about by some minute collision that was induced blindly by a bolt of radiation, will in the vast majority of cases cause some impairment in the functioning of the body derived from the affected germ cell.

It is an old wives' tale that these mutations frequently take the form of monstrosities. It should be recognized that the impairment will usually be slight, or even unrecognizable, consisting of such traits as a slightly greater than average tendency to rheumatism or gastric ulcer, or high blood pressure, often not evident until the later years of life, or a higher requirement for some vitamin, or a slightly lowered I.Q. One reason for this lack of marked effects is that an offspring containing a mutant gene will almost always inherit from its other parent an undamaged gene of the original kind in question, and this normal gene will usually exert a much stronger effect than the mutant gene, being as we say "dominant." Yet, for all that, the mutant gene and the slight impairment caused by it will be inherited by a succession of generations, and it will hamper them to some small degree at least, even in the presence of the normal gene, until in the end some descendant finds himself in circumstances where just that disability happens to become the deciding factor in causing his death before maturity, or his failure to reproduce. Thus, the mutant gene will at long last be eliminated from the

(Continued on page 37)



SR's Book of the Week

“RUSSIAN JOURNEY”

Author: William O. Douglas

By **LESLIE C. STEVENS**, *who served for two years as U. S. Navy attache in Moscow.*

IT IS, of course, difficult to sense the blending of white and black in the Soviet Union and to express its true shade of gray. Flat statements about that country and simple yes or no answers are usually oversimplifications. The true answer is usually “yes, but—” or “no, but—,” followed by a long explanation of just what is involved in Russia today. One reason for this is that unless the Russian framework is given in detail the listener—or, as in the case of a book, the reader—is apt to draw far-reaching and unwarranted conclusions by relating a simple statement to his own framework—a framework which is vastly different from the Russian one.

Justice William O. Douglas’s “Russian Journey” (Doubleday, \$4.50) is a

record of his observations on his own recent trip to that country, and it is clear from his book that he took his journey with misgivings. He is, of course, far too well-grounded in government and politics to overlook the black. But he seems to have been impressed by the darker side of what he had heard and read about the Soviet Union before he went there, and perhaps that is why he came away with many a vision of dazzling white and seldom attempts to write in terms of gray.

He does have many valid things to say about the USSR: about that country’s nationalities problem, its agriculture, its churches, and its courts; and he gives an excellent picture of the energy and dynamism of the people as well as of the vastness and the complexity of the bureaucracy that is in control. And the last chapter, which is entitled “The New Russian Strategy,” contributes notably to

the stature of his book. This chapter can be read by itself as a separate essay, and it is well worth reading. As it makes clear, Justice Douglas is convinced that although the Kremlin is anxious to avoid war the ultimate aims of Communism have not changed. He believes that Russia has moved into a position of increased strength as a result of her change in policies and that peaceful coexistence will involve a degree of political competition which we have never previously experienced in international affairs. The stakes of this competition are the loyalty and support of the non-Soviet world. He develops well the point that Communism promises not only security to the poor and oppressed of Asia and Africa but also a discipline based on authority for which these peoples have a need.

ALTHOUGH competition will entail for us “massive expenditures and technical and political missions of a nature we have never yet imagined,” he says he “considers our chances good, largely because we consider human beings more important than theoretical humanity.”

Justice Douglas’s ideas about the immediate future in international competition should have a wide hearing. And, considering his book as a whole, he presents a reasonably good picture of the way Russia operates internally. But one might have hoped that a writer with his background would have had more to say of other Soviet concepts, such as consent of the governed, checks and balances, and the nature of totalitarianism. It is regrettable also that Justice Douglas often gives us statistics and figures with no indication of their source.

But there are also other faults. In his book he lays much stress on the similarities between the Soviet lands and peoples and those of the United States—similarities which, in the opinion of this reviewer, are superficial and can lead to many misinterpretations through applying the wrong frame of reference. In fact, he is throughout the entire book prone to generalizations that might better be qualified. In widely separated passages Justice Douglas himself does indeed provide these necessary qualifications, but on the whole one is almost startled when one finds a denial side by side with the broad assertion. One interesting example of this type of side-by-side assertion and denial: he says that once he was allowed to enter a region or a city nothing was kept from him although “some questions were, of course, evaded and others were not answered.” As we have said earlier, flat statements about the USSR are usually oversimplifications.

THE AUTHOR: Associate Justice of the United States Supreme Court William O. Douglas once noted, “Most lawsuits when viewed from the bench are fundamentally fascinating, but there are dull moments even for a judge.” When a friend once caught him wool-gathering Douglas confessed that he was thinking of trout-fishing “in the Big Klickitat of the Cascade Mountains in eastern Washington.” This should come as no surprise to those who know the spate of books he has written about his vacation adventures during the last six years: “Of Men and Mountains,” “Strange Lands and Friendly People,” “Beyond the High Himalayas,” “North from Malaya.” His love of nature goes back some fifty-odd years to his childhood; he explains that it was “infantile paralysis that drove me to the outdoors.” After overcoming the illness he was taunted by the boys for his spindly legs. He determined to build them up by hiking and climbing the Yakimas in his home state of Washington. He’s been climbing ever since. As one of three children he had to help provide for the family on the death of his father, a Presbyterian missionary from Canada, by working in creameries and harvest-labor in the fields. He took to schooling and for two years was a high-school teacher of English and Latin. In 1922 Douglas set out for New York’s Columbia University Law School, paying for his fare by herding a carload of Chicago-bound sheep. His specialty was the relation of law and business and upon being graduated he decided, in anthropologists’ lingo, to do a field study of “the facts of law and life among the natives,” meaning Wall Streeters naturally. His work led to the reorganization of the Stock Exchange. Somehow he also found time to be a member of the law faculties of Columbia and Yale. In 1939, while he was serving as chairman of the Securities Exchange Commission, FDR appointed him to the Supreme Court. On the bench Justice Douglas belongs to the liberal bloc; off the bench six-foot sandy-haired Douglas is an inveterate and observant traveler. One country he had set his sights on was Russia, but it took five yearly tries before he finally got his visa.



—SIEGFRIED MANDEL.