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How Much Radiation Is Around?

There's a Limit to the Number of Units That Can Safely Be Withstood by an Individual

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Any amount of penetrating radiation may cause a germ plasm mutation.

A lethal gene—meaning usually that the individual receiving it never will live to be born—could result from a half roentgen which happened to be rightly placed and timed.

Fifth in a Series of Seven

It makes no difference, so far as the effects on heredity are concerned, whether a person received 100 roentgens all at once, as might be quite likely in an atomic bombing, or over about 25 years—an average human reproductive lifetime.

Here's the Roentgen Rate.

It can be estimated conservatively, says Dr. Herman J. Muller of the University of Indiana, that the amount of background radiation of the earth received by the average individual is about half a roentgen a year. That is, in 25 years one gets somewhere from 10 to 15 roentgens. In some places it is much more, due to increased intensity of cosmic radiation at high altitudes. This fact, Dr. Muller says, makes the mountain dwellers of Tibet and Bolivia particularly interesting subjects for any investigation which may be launched. In some way they must have become adjusted to genetic change, for they are not particularly unhealthy. For the city populations of North America and western Europe the radiation received also is much more, due to the prevalent use of X-rays and various electronic equipment, but this condition has obtained for too short a time to be evaluated.

Now, Dr. Muller's thesis is that 20 roentgens is about the limit the human race—not the short-lived individual to whom it would make no difference—can stand comfortably. Experience with lower animals indicates that this amount will cause about two out of every ten children born to suffer "genetic death." That is, they will be the ends of their lines. The term has nothing to do with individual death.

Americans Near Average.

Dr. Muller's own calculations show that the American people are already quite close to this 20 roentgen average. It requires very little beyond the amount man has received from the beginning from the earth's residual radiation and from cosmic rays. This presumably has acted as a brake on the too-great proliferation of the human race and may have been a wise provision of nature. Primitive man may have been barely able to keep ahead of it.

Increase of this residual radiation, together with radiation from all other sources, would about double the mutation rate, as indicated by fruit fly experiments. There is recent evidence that the rate induced in mice by comparative amounts of radiation, is about five times that in fruit flies. The mouse is a less stable aminal, genetically. Man, it is probable, is still less stable and may have a still higher rate. Also, Dr. Muller points out, a sublethal mutation in man is likely to be more serious than in a mouse because he lives longer, travels about more, and gets his genes more broadly distributed.

A common fallacy, Dr. Muller points out, is that only radiation aimed directly at reproduction cells will result in mutations. This is, of course, far more effective but the calculations are based on whole body radiation which happens to hit anywhere.

How Extinction Might Occur.

With the possible exposure of the average individual to 30 roentgens, Dr. Muller points out, it would require three-and-a-half children per reproductive couple to maintain the population at its present level and the requirement would go up and up as the fitness of individuals went down and down.

This, of course, would result eventually in extinction of the human species—unless there were some way of stopping the process. It might require several thousand years or, according to recent warnings, possibly a much shorter time.

Even now, Dr. Muller says, the average human being carries in the germ plasm at least 60 deleterious genes, received from one parent. Each one is individually of small consequence, but it hampers in some unobservable way the total efficiency of the organism. The 60 are, for the most part, different for each individual. It requires the meeting of two likes for the disadvantageous control to exert its full effect. Theoretical calculations show that each deleterious gene is distributed through the germ plasm of at least 100 individuals before it is eliminated through the process of survival of the fittest.

Nobody actually can locate or count these deleterious genes in man. The calculation is based on extrapolation for the probable greater frequency of mutations in human beings. The geneticist constantly has raised his estimates, as the probability of this greater mutational frequency has been shown to be greater than previously supposed

TOMORROW: THE SCOPE OF THE PROBLEM.

Glossary of Genetic Terms

The following glossary will be found helpful in connection with Science Editor Thomas R. Henry's six-story series exploring the effects of atomic radiation on the human race:

Gene—An invisibly minute particle of protoplasm which is the recognized unit of heredity. It has the unique property of "guiding and bonding together of raw materials around it into an exact duplicate of itself." Each of the trillions of cells which make up the human body contains the full human complement of thousands of genes. Those in the germs cells are passed on to the next generation.

Chromosome — A fine thread thousands of times longer than thick, differentiated along its length into hundreds or thousands of functionally distinct and individual self-reproducing regions—the genes. Every cell in the human body has 26 chromosomes.

Gamete—The mature germ cell of one individual, plant or animal.

Zygote—The union of two germ cells to constitute a new individual.

Homozygote—An individual who receives identical genes from both parents.

Heterozygote—An individual with parental chromosomes which do not completely match.

Mutation—A change in the gene structure of protoplasm which results in changed hereditary characters.

Half-life—The interval during which half of any radioactive originally present will disintegrate. Uranium has a half-life of several billion years. Radioactive iodine used in thyroid treatments has a half life of eight days. After six half lives, it is calculated, only infinitesimal traces of the original substance will remain.

Roentgen—The accepted unit of radiation defined as "the quantity of gamma or X-rays that will produce a certain electrical conductivity in a cubic centimeter of air under constant pressure and temperature.

Gamma Rays—Exceptionally potent X-rays, the principal radiation causing genetic damage.