Radioactivity was first discovered in 1896, and its development for medical purposes has been one of humanity's proudest achievements. By various means, the nucleus of an atom can be made unstable and it becomes "radioactive." Once something becomes radioactive, it continuously gives off energy in small packets or "rays." These bundles of energy (called nuclear or atomic radiation, or, more generally, ionizing radiation) have many useful characteristics; for example, they can pass through the human body and thus allow shadowy pictures of our bones to be created on sensitized film; these are called "x-rays" and nearly everyone in the U.S. has benefited from an x-ray at one time or another. [The ionizing radiation from X-rays is produced by a high-energy electric source, not by a radioactive source such as uranium, which gives off ionizing radiation spontaneously and continuously without any external source of power necessary.]

The penetrating power of ionizing radiation makes it useful but also makes it dangerous. When radiation penetrates human tissue (which is composed of billions of cells), the radiation pierces the cells like a tiny but powerful bullet, disrupting the structure of any cells that take a direct hit. Under certain circumstances, which are still not understood, some disrupted cells start multiplying without limit, and this is a condition known as cancer. By direct observation of humans exposed to radiation, it has been definitely proven that radiation causes cancer in humans; only the exact mechanism of causation remains in doubt.

Americans began creating radioactive wastes shortly after 1896, but no special precautions were taken for handling such wastes until 1954 when the federal Atomic Energy Commission began licensing all radioactive materials. During this period of neglect, many places, including large sections of whole states (for example, New Mexico and Colorado, where uranium mining occurred), were contaminated with low-level radioactive trash.

As radiation became more widely used in industry and even in consumer products, the public has become concerned about possible hazards and about the carelessness of the people who handled and regulated radioactivity in the past. Since tighter restrictions on radioactivity could result from such concerns, and since tighter restrictions would inevitably cost money, people who profit from radioactivity have mounted a campaign in recent years to convince the world that there is some "safe" dose of ionizing radiation. These people argue that there is a "threshold" dose of radiation below which no damage occurs, and above which someone might be hurt. Existence or non-existence of this threshold is the key point in the radiation debate today. Pictures explain this story best.

Figure 1 represents the "threshold theory." Look across the bottom of Figure 1. As you move your eye from left to right, the numbers represent an increasing dose of radiation. However, until you get to a dose of 4, the line doesn't begin to move upward. When you get to 4 or more, the line moves upward, representing an increase in the number of cancers being caused by the dose. Four represents the "threshold dose" in Figure 1. If Figure 1 accurately represents reality, it means you could give everyone a small dose of radioactivity without any ill effects whatsoever. Many people in the nuclear power industry favor this theory.

Figure 2 shows a competing theory of how radiation affects people. It is called the "linear theory" and it indicates that any dose of radiation causes some consequences. Notice that, as soon as you move your eye to the right across the bottom of the figure, the line rises, indicating some cancer effect. The only way to get zero cancer effect is to administer zero dose. (This does not mean that a low dose will cause cancer in everyone who receives the dose; it means that a low dose administered to a large group of
people will cause cancer in some number of those people—but everyone in the group is at risk.) This is the theory that health authorities have used to set today's allowable limits for radiation exposure.

Figure 3 represents a different theory (called the "supra-linear theory" of how radiation affects humans. It shows that low doses cause greater damage, per unit of dose, than do high doses. For example, look across the bottom of Figure 3 until you get to a dose of 4; you can see that this causes a cancer effect of between 6 and 7. But if you move your eye to the left, to a dose of 2, the cancer effect has not been cut in half; it is still up around 5. The "supra-linear theory" indicates that low levels of radiation will cause more cancers, per unit of radiation, that will large doses. This view of radiation chills the hearts of those who profit from using radioactivity because it means "low level" radioactive waste is more dangerous than previously thought, and must be handled with greater care (and therefore greater expense).

Two new books have just been published showing, from studies of humans, that the supra-linear theory is the one that best represents the actual facts. We will explore the human consequences of this information as our series continues.

Get: John Gofman, RADIATION-INDUCED CANCER FROM LOW-DOSE EXPOSURE: AN INDEPENDENT ANALYSIS (San Francisco, CA: Committee for Nuclear Responsibility [P.O. Box 11207, San Francisco, CA 94101. First copy, $29.95; $15.00 each copy thereafter.], 1990). This is one of the most careful and thorough pieces of technical writing we have ever read.