University of California San Francisco Volume 38 Number 16, January 20, 1994

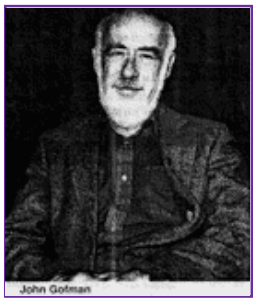
synapse

Gofman on the health effects of radiation:

"*There is no safe threshold*"

John William Gofman is professor emeritus of Medical Physics at UC Berkeley, and lecturer for the Department of Medicine, UCSF. While getting As PhD in physics at Berkeley in the 1940s, Gofman proved the slow and fast neutron fissionability of uranium-233. At the request of J. Robert Oppenheimer, Gofman helped produce plutonium (not even a quarter-milligram existed at the time) for the Manhattan Project. He got his MD from UCSF in 1946 (winning the Gold-Headed Cane Award, presented to the senior who most fully personifies a "true physician") and began his research on coronary heart disease. In 1963 the Atomic Energy Commission asked him to establish a Biomedical Research Division at the Lawrence Livermore National Laboratory to evaluate the health effects of all types of nuclear radiation. By 1969, however, the AEC and the "radiation community" were downplaying his warnings about the risks of radiation . Gofman returned to full-time teaching at Berkeley, switching to emeritus status in 1973.

This interview was conducted by Shobhit Arora and Fred Gardner. It began with discussion of a recent item from the Wall St. Journal *that read, "The White House was surprised and chagrined — by Energy Secretary O'Leary's comment about paying compensation to atomic-testing victims. With a super-tight budget, the White House is now scrambling to head off a costly new entitlement."*


John Gofman

Gofman: Secretary Hazel O'Leary is undoubtedly the first breath of fresh air that we've seen in the atomic era. I think what she's doing is great and I hope millions — hundreds of millions of people back her — because she's going to face a ferocious opposition. It's going to be like a nuclear firestorm in opposition to her, because she's doing something constructive. I have for 25 years been an intense critic of the Department of Energy. I say this because Hazel O'Leary stands for compassion, candor, and credibility — not because I've changed my mind about the DOE, which I think is one of the worst organizations in the history of our government. Unless it's cleaned out we're going to have worse things in the future. The human experimentation that has been done is bad, and it's good that that's being cleared away. But for 25 years the DOE has not shown any concern for the health of Americans. Their concern has been for the health of the DOE. Their falsehoods concerning the hazards of ionizing radiation have put not thousands of people at risk, not millions of people, but billions of people.

Synapse: *What if Clinton doesn't back O'Leary in the days to come?*

Gofman: The worst-case scenario is this. Ever since its inception, the Atomic Energy Commission — then called ERDA, then called DOE — has had one thing in mind: "Our program is sacrosanct." And they recognize, as I've recognized, that their entire program will live or die based upon one thing. If the public should come to learn the truth about ionizing radiation, nuclear energy and the atomic energy program of DOE is going to be dead. Because the people of this country — and other countries — are not going to tolerate what it implies. The key thing — it's everything in the DOE program — is: "We must prove that low doses of radiation are not harmful." They have been conducting a Josef Goebels propaganda war, saying there's a safe dose when there has never been any valid evidence for a safe dose of radiation. Yet the DOE and others continue to talk about their "zero-risk model."

After Chernobyl, I estimated that there were going to be 475,000 fatal cancers throughout Europe — with another 475,000 cancers that are not fatal. That estimate was based on the dose released on the various countries of fallout from Cesium-137. The DOE put out a report in 1987 and I don't think it's any credit to the University of California that part of this report was done in the Livermore Lab, where I once worked, and part in Davis — saying "our zero-risk model says that at these low doses, nothing will happen, because low doses are safe."

How would a safe level of radiation come about? It could come about in theory if the biological repair mechanisms — which exist and which will repair DNA and chromosomes — work perfectly. Then a low dose of radiation might be totally repaired. The problem, though, is that the repair mechanisms don't work perfectly. There are those lesions in DNA and chromosomes that are unrepairable. There are those where the repair mechanisms don't get to the site and so they go unrepaired. And there are those lesions where the repair mechanisms simply cause misrepair. We can say that between 50 and 90 percent of the damage done by ionizing radiation is repaired perfectly. What we are then seeing is harm done by the residual 10 or 40 or 50 percent that is not repaired perfectly.

The evidence that the repair mechanism is not perfect is very solid today. What we wanted to have was evidence that as you go down to very low doses — a rad, or a tenth of a rad — is that going to produce cancer? Determining the answer by standard epidemiological studies would take millions of people, and we don't have that. So it creates a field day for the DOE to say, "Well, we don't know." But

I looked very carefully in 1986 for any studies that could shed light on that all-important question. And I presented that evidence at the American Chemical Society meeting in Anaheim.

> *The lowest dose of ionizing radiation is one nuclear track through one cell. You can't have a fraction of a dose of that sort. Either a track goes through the nucleus and affects it, or it doesn't.*

Synapse: *That the lowest doses will produce cancer?*

Gofman: The answer is this: ionizing radiation is not like a poison out of a bottle where you can dilute it and dilute it. The lowest dose of ionizing radiation is one nuclear track through one cell. You can't have a fraction of a dose of that sort. Either a track goes through the nucleus and affects it, or it doesn't. So I said "What evidence do we have concerning one, or two or three or four or six or 10 tracks?" And I came up with nine studies of cancer being produced where we're dealing with up to maybe eight or 10 tracks per cell. Four involved breast cancer. With those studies, as far as I'm concerned, it's not a question of "We don't know." The DOE has never refuted this evidence. They just ignore it, because it's inconvenient. We can now say, there cannot be a safe dose of radiation. There is no safe threshold. If this truth is known, then any permitted radiation is a permit to commit murder.

What other things does the DOE use as crutches? "Well, maybe if you give the radiation slowly it won't hurt as much as if you give it all at once." Now if you have one track through a cell producing cancer, what is the meaning of 'slowly?' You have the track or you don't. It comes in on Tuesday or it comes in on Saturday. To talk about slow delivery of one track through the nucleus is ludicrous. But they do it anyway.

There is a more radical fringe that says, "A little radiation is good for you. And all this stuff about radiation causing harm is bad for society because it's going to prevent the program we think should be instituted, and that program is to give everybody in the country radiation every day as a new vitamin." This program is called hormesis. "A little radiation will give your immune system a kick and help you resist cancer and infectious disease." The chief exponent is a man named Thomas Luckey, formerly of the University of Missouri. He bemoans the fact

that we can't get this program into high gear.

Synapse: *Is anybody taking him seriously?*

Gofman: The idea is manifestly absurd. But that didn't prevent the DOE from helping to sponsor a conference in 1985 in Oakland on the beneficial effects of radiation, hormesis. And the nuclear enterprise is really at it all the time. They had another such conference in 1987, and another in 1992.

Synapse: *What are the implications of there being a safe dose of radiation?*

Gofman: They don't have to worry about nuclear waste. No problem — there's a safe dose, nobody's going to get exposed to more than the safe dose. The clean-up and disposal of waste has been estimated to be in the billions, if they're really going to clean up Hanford and Savannah River and all the rest. Recently, Dr. Robert Alexander in an exchange of letters in the *Health Physics Journal* — he was with the Nuclear Regulatory Commission, and former president of the Health Physics Society — said there's no proof that low-level radiation is harmful... Anybody who gets half a rad a year from waste disposal shouldn't be counted, they don't matter. They don't matter for somebody who's apologizing for the nuclear industry. But they matter! And they're going to matter in the millions, tens of millions and hundreds of millions if, because of statements like Alexander's, it becomes okay to give people 10 rads. You won't have to bury things in these fancy vaults. You won't have to worry about transport. You can even dispose of it in ordinary landfills. That will be the result. That's what the future will be. If low doses don't matter, the workers can get more and their families can get more by being in the vicinity. That's what we face.

Synapse: *What are the limits for lab technicians and other workers wearing badges? What's the limit now?*

Gofman: 5 rems per year. That's going be cut down to one or two rems per year. By the way, medical radiation, from x-ray machines, is roughly twice as harmful per unit dose as Hiroshima-Nagasaki radiation.

Synapse: *Why is that?*

Gofman: It's the effect of linear energy transfer. When gamma rays or x-rays set electrons in motion, the electrons are traveling at a lower speed than the electrons coming out of Cesium-137. And as a result, when they're traveling at a lower speed, they interact much more with each micrometer of path they travel. Therefore the local

harm is much greater. So medical x-rays set in motion electrons that are traveling at a lower speed and hence producing about twice the linear energy transfer, and hence twice the biological effect. That's why alpha particles from radium or plutonium are so much more devastating than beta rays set in motion from x-rays. The alpha particles, with their heavy mass and plus-2 charge, just rip through tissue so strenuously that they don't go very far. A deception of the crassest sort are the lectures by pro-nuclear people showing a plutonium or radium source and putting up a piece of paper and showing that the alpha-particle radiation on the other side is zero. "You see, a piece of paper will stop those alpha particles, folks, there's no problem with plutonium." Except when that alpha particle is lodged next to an endosteal cell in the bone and producing a horrendous amount of interaction. Or that alpha particle is lodging on the surface of the bronchi — that's why we've got an epidemic of lung cancer among the uranium miners! The fact that they don't travel far is because they interact like hell!

Synapse: *Do you think medical professionals really appreciate how much potential there is for damage? Regardless of who you are, you go into the hospital and you get a chest x-ray as a routine diagnostic procedure.*

Gofman: I'm sad to say, I don't think 90% of doctors in this country know a goddamned thing about ionizing radiation and its effect. Somebody polled some pediatricians recently and said, "Do you believe there's a safe dose of radiation?" And 45% said, "Yes." They weren't asked, "What papers have you ever read on this subject that led you to conclude there's a safe dose?" I think medical education on the hazard of radiation is atrocious. What have they taught you in radiology?

Synapse: *Basically, whenever it's not necessary, don't do a radiological procedure. But they have qualified that with the implication that most radiological procedures really aren't that dangerous — a tenth of a rad here really isn't too bad. It's better to get the information from a procedure than not.*

Gofman: Part of that is okay. If you ask me, "Do you stand against medical x-rays?" the answer is no. And I've written a book with Egan O'Connor on the health effects of common exams. We take the position: if there's a diagnostic gain for you — something that can really make a difference in your health and your life — then don't forego the x-ray. But there's another part of the picture. Up until recently — it may be a little better now than it was — government studies show that most hospitals and most offices of radiologists didn't have the foggiest notion of what dose they were giving you for a procedure. Nor did they know that the procedure could be accomplished with a third or a tenth of the dose. Joel Gray, a health

physicist at the Mayo Clinic, said there are places giving you 20 times the dose needed for a given picture. And, he said, "If you ask those people and they can't answer, you can be fairly confident that they're giving you a bigger dose than necessary." So Egan and I, in *The Health Effects of Common Exams*, took the data on what the average doses were in the United States, versus what has been accomplished by some elegant work in Toronto to reduce the dose to one-third of what was the average practice in 1984, and found that about 50,000 fatal cancers per year could be prevented. That' s a million and a half in a generation! So what is this stuff about "Most procedures don't hurt you, they're small?"

Let me say one more thing about the medical profession. It's my view that we have a really crazy situation with respect to x-rays. You go to a physician — your internist, or a GP, or an obstetric gynecologist, or an orthopedic surgeon — these are the people who send you out for an x-ray. They represent, or should, your ombudsperson. And they, not you, should have to find out whether the facility they're sending you to uses five times the dose needed, or a decent dose of radiation. But if you ask that so-called ombudsperson, "Where you're sending me, do they know how to keep the dose down? What dose will I get?" He'll mumble, "Don't worry about it, no problem." That's the fault of medical education in our universities. If we turn out physicians who don't have the attitude that they're the ombudsman for things like that, I think they're not doing the job.

Synapse: *A friend who had a melanoma was told there had been a 20-fold increase in the past 50 years, but "We don't really know what's causing it." It's as if many in the medical profession don't want to make the obvious connection between radiation, pollution, pesticides and the cancer rates.*

Gofman: The medical profession is implicated directly. I've spoken to Andre Bruewer, who practices in Tucson. He's a first-class radiologist who does nothing but mammography. And he said, "John, I shudder to think of what we were doing 20 years ago." We were touting mammography when the dose was four to five rads, and in some cases 10 rads. Now if you give enough women four to five rads, at something of the order of a 2 percent increase in breast-cancer rate per rad — that's what my analyses show, and I've analyzed the world data on x-rays very carefully with respect to breast cancer in particular — it has to be that women irradiated 15, 20 years ago got horrendous doses from mammography compared to now. And therefore, some of the present increase in breast cancer has to be from the radiation they got; but they don't like to talk about it.

Women irradiated 15, 20 years ago got horrendous doses from mammography compared to now. And therefore, some of the present increase in breast cancer has to be from the radiation they got.

There was a time, 20 to 30 years ago, when there were mobile x-ray units that gave x-rays of the chest. They didn't give the 20 millirads [a 50th of a rad] that is possible today. They gave about five rads. Children went through those things by the thousands. And we just say, "We don't know why this cancer epidemic is taking place now." Nobody's taken account of it. It's hard to know how many children got it and who they were and follow them up. But you know that a certain number of people are having cancers now as a result of what was done 15, 20 years ago.

Back in the '50s one woman brought a child in in the middle of the night having real difficulty breathing, and a resident said, "Maybe the thymus gland is enlarged and pressing on the trachea. Let's give this child 100 or 150 rads of radiation in the neck." And as with many disorders, the child got better by morning. And so this resident put two and two together and said, "I gave the radiation, the child got better, therefore I cured him." And so this became the rage and all kinds of hospitals were using radiation to treat an enlarged thymus.

Synapse: *What's the danger from an enlarged thymus?*

Gofman: There have been careful studies now of these kids that had the irradiation for enlarged thymuses — which, by the way, is no longer believed to have been a disease that existed in the first place — and they're having an excess of thyroid cancers, an excess of salivary gland cancers. One hospital in Pittsburgh said, "Why should we wait till these children come into the emergency room at night with croup?" And they, for a period of over a year, gave x-rays to every child leaving the nursery...

There is this wall that prevents us from relating past experience to the occurence of cancer. The full effects are not known. It's not just what the average dose was back then, some places were giving horrendous doses. Sometimes they'd get a picture that was too faint. So they'd take another one, with a longer exposure — when the problem was that their developing solution was getting spent. And all

they had to do was change the developer. But instead of that they gave the person an extra x-ray with a bigger dose.

Synapse: *What general principles should a patient bear in mind when considering a procedure?*

Gofman: If I were a member of the public, knowing what I know: if the establishment told me that something had a certain risk, I'd assume that the true risk was at least 10 times worse. Part of the problem comes from the patient. If a patient goes to a doctor — especially if he's covered by a health plan — and the doctor doesn't give him any procedures, they feel cheated. "You didn't even take an x-ray!" But the medical profession has to be regarded as culpable, along with the DOE. They both have the same conflict of interest: their work exposes people to radiation. For the DOE there have been all kinds of people of shady character in all kinds of government posts. But damn it, the medical profession shouldn't be shady and corrupt. I'd like to see them really apply the Hippocratic oath to this field.

Synapse: *Could you describe your work regarding the retroactive tampering with databases?*

Gofman: For years I've tried to believe that what was going on in Hiroshima-Nagasaki in what was called the Atomic Bomb Casualty Commission — subsequently renamed the Radiation Effects Research Foundation — was the only place where we had a huge body of data that addressed the question of what happens to people who have been exposed to varying doses. If there is an event like Chernobyl, or Hiroshima, we have to insist on the sacred meaning of collecting an honest database concerning what happens to people — **(A)** doing the very best job of determining what dose they got, and **(B)** doing a follow-up study that is beyond reproach. That is an obligation to humanity that is virtually sacred. If you do anything less than the best in that kind of endeavor, you're a scoundrel. So all this time I wanted to believe in the work that was being done in the Hiroshima-Nagasaki studies. In 1986, because of some questions about what the neutron dose was relative to the other forms of radiation — gamma rays, primarily — they did a revision of the doses. Now I don't have any objection to the revision of doses, provided that you obey the cardinal rules of medical research. The first cardinal rule of medical research is: never, but never change the input data once you know what the follow-up shows. So because they had this idea of changing the doses, they didn't just change the doses, they shuffled all the people from one dose category to another, with a new dose. So there was no continuity with everything that had been done up to 1986.

The first cardinal rule of medical research: never change the input data once you know what the follow-up shows.

Synapse: *Who's 'they?'*

Gofman: The Radiation Effects Research Foundation in Japan. The-director is Itsuzo Shigematsu. The associate director is a guy by the name of Joop Thiessen, who's from the DOE. It's a DOE-sponsored endeavor — DOE and the Japanese Ministry of Health. There couldn't be a worse set of sponsors.

Synapse: *The Japanese have the same kind of commitment to nuclear energy?*

Gofman: Absolutely. So I said, "You can't do this. You want a new dosage, keep the old groupings and just assign the new dose and study [the results]." I call that "constant cohort, dual dosimetry." So I wrote a letter to Shigematsu and said, "This is a violation of the cardinal rules of research. There is a way to do this correctly, and you can keep changing doses all your life, provided you just stick them alongside what you've done originally." Shigematsu's reply is in my book. [*Radiation-Induced Cancer from Low-Dose Exposure*, 1990] It's simple. He said, "Trust us." Well, the reason for the cardinal rule of research is, nobody ever has to say, "Trust me." Because you set things up with blinding, with appropriate procedures, so that your database is immaculate. You don't go changing things and say, "Well we did it objectively." I said, "Report in the old way — the old dosage — and the new way." They said, "We won't do that. But we'll consider it. And we will give you the data in the old way for three more years." What's the shape of the cancer curve with the latest data from Hiroshima-Nagasaki? If I use the old data, it's like this (diagonal, rising line). What's the shape of the curve with their new dosimetry? It's like this (slowly rising line that then goes up abruptly).

If a crook makes the database, Einstein will get the wrong answer out of it.

Synapse: *Making it look as if the low-level of radiation is acceptable?*

Gofman: Exactly. Their ultimate goal is fulfilled.

Synapse: *How did they determine who received what dosage at the time of the explosion? Was it based on how far away people were from ground zero?*

Gofman: Distance was the biggest factor, but also whether you were outdoors or indoors, whether you were in a concrete or wooden structure. They tried to do a lot of that. And they shouldn't keep changing the placement of people! You take people with cancer and say, "Well, I guess the dose they originally got must have been a lot higher. We'll put that person here [in this dose category] and this one there." And with that sort of approach, you can make truth whatever you want it to be. And there's a very important additional lesson. Humanity needs to insist on the immaculate construction of databases concerning any accident or major event. If a crook makes the database, Einstein will get the wrong answer out of it. And then what happens? The Einsteins, with the best credentials, using this lousy, fabricated, false database, will put their findings in the medical journals. And then they get into the textbooks. And then it's taught to medical students for the next 100 years. And what happens? Hundreds of millions of people will suffer from cancer and genetic diseases because the answer will be wrong. The key thing is getting an honest database.

To be continued next week

University of California San Francisco Volume 38 Number 17, January 27, 1994

synapse

Interview with John Gofman. continued:

Challenging The Nuclear Establishment

This is part two of an interview with John Gofman, lecturer emeritus for the Department of Medicine. On the day part one appeared (Jan. 21), the Chronicle *ran a story about "that dependable fellow, Mr. Pluto" a perky little cartoon character created by the Japanese Power Reactor and Nuclear Fuel Development Corp. In the Mr. Pluto video, a youngster drinks a plutonium-laced soda and declares himself refreshed. Gofman comments on Mr. Pluto: "This is their opening salvo in a huge campaign of `A little radiation is good for you, and besides, most of the plutonium goes through your gut.' Never mind the fact that as it goes through the large intestine, it gives the colon cells a dose of alpha radiation. The Japanese are the biggest promoters today of nuclear breeders and reprocessing. Reprocessing increases the hazard of nuclear power by a thousand. If you do it just leaving it as fuel rods, the possibility of an accident is bad enough. If you reprocess, you have to dissolve the fuel rods, and then you've got to handle the plutonium chemically."*

Synapse: *How did you make the transition from being a respectable member of the `radiation community' to being an independent critic?*

Gofman: I was criticized and denounced by the Atomic Energy Commission (AEC) for one thing. I said that radiation was more harmful than was previously thought.

Synapse: *When was that?*

Gofman: In 1969 — after they had given me $3 million a year for seven years to take time off from my teaching and set up a biomedical division at Livermore. One week after I gave the talk! If you say something they don't want to hear, they make a pariah out of you.

Synapse: *They certainly managed to marginalize Linus Pauling. Way back in the 1950s he was describing the effects of fallout, Strontium-90 in the milk, the dangers to the people of Nevada and Utah.*

Gofman: Linus's 1954 estimates were all pretty near to the mark...

Synapse: *Are we getting honest data about Chernobyl?*

Gofman: Evgeny Chasov, who shared the Nobel Peace Prize with the International Physicians for the Prevention of Nuclear War, made a public statement that nobody has been harmed in the population at large. He obviously wasn't referring to the people who got killed immediately. There've been all kinds of statements to the that effect. Alla Yaroshinskaya, a journalist in Zhitomirsk, a small city in the Ukraine, became very suspicious of the sort of things that were being said. She found out that some of the people who were being moved had been moved to a place that was even hotter sometimes — it was all just for show! Her paper wouldn't publish her investigation, and they told her she'd be in big trouble... But she persisted, and she got *Izvestia* to publish it, and she became well known. She got elected to the Supreme Soviet. And she demanded to see the protocols of government meetings on the Chernobyl situation. She managed to get all 40 protocols, and she wrote an article, which is now in book form in Russian and, there's a French edition: "The 40 Protocols of the Wise Men of the Kremlin." And it shows that at every one of their meetings, what they were saying internally was the exact opposite of what they were saying publicly...

[Yaroshinskaya is now vice minister of mass media in Russia and a personal advisor to Boris Yeltsin. Gofman has written the introduction to an English-language edition of her book. For their work on the longterm health effects of Chernobyl, Gofman and Yaroshinskaya shared the 1992 "Right Livelihood Award," given by a Swedish foundation. In his acceptance speech, Gofman proposed that a network of scientists who don't have to answer to government serve as "watchdogs" and participate in every stage of the construction of the Chernobyl data base.]

Synapse: *Did anybody pick up on the watchdog idea?*

Gofman: I met with Yuri Shcherbak, the minister for the environment for the Ukraine. Yuri was a journalist and a physician, who also had revealed some of the things that had been going on with the Chernobyl data. In the new government in Ukraine he was made minister of the environment. He liked the watchdog concept, but he said, "If I'm going to propose that to the Ukrainian government, could you get some more scientists who would endorse it?" So I wrote letters to about 50 people around the world, and about 47 said they would serve on a commission to set this up in Ukraine. And I sent this off to Yuri, but I never heard back. One of his aides was in town and called me up with a message from Yuri. He said, "As soon as Yuri got back from seeing you, the Ukrainian government set up a special division to handle Chernobyl, and that was moved out of Yuri's environmental department." And a little later Yuri was moved over to become the ambassador to Israel — it might have been to the North Pole. So that died. I have some hopes that Alla might be able to get the idea through in Russia, but the nuclear mafia in Russia is very strong. They're proposing to go gung ho on nuclear power. I wouldn't be surprised if a lot of them are members of the nationalist group around Zhirinovsky.

Synapse: *How would the watchdog concept work in the United States?*

Gofman: What I'm proposing is that if the Department of Energy spends $100 million on health-related activities — and they have their fingers in every university department of statistics and radiology — $10 million should go to a grass roots organization of scientists to make sure that the studies being carried out are honest.

Take the worker population in America. Do you believe what the DOE says about the doses workers are getting? I don't. I think a lot of scientists would be interested and willing to do that work, if it were honored rather than — you know, you get thrown out for saying something. The scientists who were funded by the DOE at Los Alamos, Livermore, Berkeley, Brookhaven — they're self-censored. They know what's okay to say, and they know what's not okay. They know my history. And they're not about to repeat it. Which brings us back to where we started. When I saw Hazel O'Leary come an the scene, I just got the impression that this lady is for real. She faces a tremendous task — just on the human experimentation, the suggestion that people be made whole and receive apologies. I'd like to see this lady get 100 million Americans behind her so that she can't be weakened. I think there's a chance that in her administration the

watchdog idea could fly. If we don't get it through in her administration, I thinly DOE will go back to just what it was before. And then there's not much hope for humanity.

Synapse: *Could you comment on the human experimentation that was conducted?*

Gofman: I think it was unethical. And I think that any statements such as, "But the doses were low" — that's a fraud. The doses in Cal 1, Cal 2, and Cal 3 [the three people who received injections of plutonium at UC Med Center] were very high — 11,000 rems to the bone for Albert Stevenson [Cal 1]. Albert Stevenson was injected with a huge dose of plutonium at UC Hospital because he had a supposed cancer of the stomach. Now some are saying, "Well, we didn't know whether plutonium could hurt anybody." They should watch out, because they're going to be caught in a lie of profound proportions.

The radiations that we have are x-rays, gamma rays, beta rays, alpha particles, and neutrons. Neutrons you only get near a bomb or a reactor. Alpha particles are emitted by many elements high in the periodic table as you get up above lead: uranium, thorium, protoactinium, neptunium, plutonium — all are alpha particle emitters. An alpha particle is a plus-2 charged helium atom in high-speed motion. We describe them by how much energy they're carrying off from the emission. Four and a half million electron-volts — 4.7, 5.2 — the various alpha emitters are all in that range. And you can say that what one alpha emitter does, any alpha emitter will do if it gets to the same place. So for somebody to say, "We didn't know about the alpha particles from *plutonium*." It's the same as saying "We know how it works in New York, Chicago, Philadelphia, but what about *Peoria?*"

In the '20s we had a radium-dial painting industry to paint the dials of wristwatches and clocks. Women sat at tables with a little pot of radium paint, painting these dials by hand. Their brushes would get diffuse and they'd take the brush and twirl it in their mouths to get a fine tip to paint with. And these women came up with the most horrible bone destruction due to the alpha particles from radium in their bone. Osteogenic sarcomas. It was all written up by 1929, by Harrison Martland, the coroner in New Jersey who examined their bodies. The whole world knew that alpha particles from radium had done this to humans. Now an alpha particle, really, doesn't ask who its mother or father was. An alpha particle is an alpha particle.

In Germany and Czechoslovakia there are regions where it was long known that 50 to 75 percent of the miners died of what was called "mountain sickness." In

the late 19th century Hartung and Hesse discovered that this mountain disease was lung cancer. In the 1930s, Peller and another group determined that the reason for the lung cancer in the miners was breathing radon with alpha particles from the uranium in the mines. So alpha particles had been proven to produce cancer. So to say that the effects of alpha particles from plutonium were unknown — it's just not true. The AEC, which approved of some of that experimentation, knew precisely what the results would be. Merril Eisenbund, a pro-nuclear environmentalist, was working for the AEC in 1947. He went out west to inspect what was going on in the uranium mines in Arizona, New Mexico, and Colorado. He came back and wrote a report saying the mines are not being ventilated, and if we don't get them ventilated, we're going to have a lung-cancer epidemic worse than Germany and Czechoslovakia. He was told to move over to another division, never to say anything more about the mining situation in Colorado. The mine operators were not informed, the mine workers were not informed, and we had the lung-cancer epidemic that had been predicted. The AEC knew all this. Can you tell me there's any evidence that the AEC, ERDA or DOE ever gave a damn about human health? They were the same people who approved the human experimentation. And to try to justify it in the name of the Cold War and things like that, that's ridiculous. The Cold War did not require knowing where plutonium went in people's bodies!

Synapse: *Do you think the mechanisms that are in place today, such as the human subject committees, are sufficient to keep this kind of research from taking place?*

Gofman: I think they're better than having no committees, and that [unethical experimentation] is not as likely now. But it just seems to me that when grants are involved, and the prestige of the institution is involved, if some research is exciting but maybe off-color, I wouldn't be surprised if some of the committees would overlook it. I'm not impressed by the integrity and forthrightness of the medical establishment. I wouldn't have said this 10, 15 years ago, but today, when I look at an article in a medical journal — peer review means nothing to me, that's just an old boys' club — I say to myself, "Why should I believe this?" I've watched stuff get in that was peer reviewed that was absolute rubbish, and they had to know that it was absolute rubbish.

I just have lost my confidence in their integrity. A case in point. I recently read a study that if you treat breast cancer by lumpectomy and radiation, that's better than without the radiation. How carefully was that study set up? Who oversaw the choice of people and the outcomes? It's a very important issue. If you irradiate the chest of women who've had lumpectomies, with the kind of doses they're giving, you will produce a lot of cancers in the future. Not necessarily the

cancer they had, but you're going to produce new cancers. Those new cancers are going to come 10, 15 years from now. If indeed the radiation prevents [patients] from dying of the original cancer, which would have killed them in a year or two, then I say, with their fully informed knowledge, they may choose to take the radiation therapy. But I really want to be sure that the data collected on this benefit is right. So my answer to your question is: I hope it's better; I think it's better than it was; I would like to see better mechanisms still, that didn't involve grants and the prestige of the university when the university passes on whether research is okay.

Synapse: *What do you know about the release of radiation at Hanford, Washington that, it now turns out, was many times worse than Three Mile Island?*

Gofman: When it became known that there had been these big releases, the government finally promised to own up. So a big study is in process now, it's called the Hanford Environmental Dose Reconstruction Project, fully funded by the government. And they're trying to involve the Indian tribes, and various downwinders. The amount of iodine released at Three Mile Island was estimated at 15 curies — Iodine-131. The amount of iodine first estimated on this Hanford reconstruction was 425,000 curies. The most recent estimate has it up to 725,000 curies. I calculated the true release of radioiodine from Chernobyl at 12.3 million curies. So the amount that was released at Hanford can cause a lot of trouble.

Synapse: *What kind of trouble? What does radioiodine do?*

Gofman: In big enough doses it produces thyroid cancer and severe hypothyroidism. In 1992, Kazakov, Demidchik, and Astaskhova of Minsk put out a paper in *Nature* saying, "We have 131 cases of thyroid cancer in Byelorus alone (since Chernobyl). The curve started up in '89-'90, and the curve is staying up there." This has now been confirmed in Ukraine. After the paper in *Nature* came out, a UN team went there to check their diagnoses, and confirmed that they were right in 102 out of 104 cases. And still, Shigematsu and Thiessen (of the Japanese-DOE Radiation Effects Research Foundation), had a letter in the next issue of *Nature* saying "We can't really trust this, these cases are coming up too soon, they're not really thyroid cancer. Maybe they're looking harder now..." And in the *Journal of Nuclear Medicare* some of the nuclear pundits ridiculed the word from Byelorus. These people never stop!...

There will inevitably be thyroid cancer from the releases at Hanford, Washington. Whether they'll be able to reconstruct it and admit it I don't know...

There's an investigator named Holm at a Swedish hospital. They've done 38,000 radioiodine scans to test thyroid function. He wrote a series of papers showing that even though people got 50 rads to the thyroid, there was no excess of thyroid cancer. When I first heard about it I thought, "Wow, you can give 50 rads to the thyroid and cause no cancers? Does it mean I'm wrong?" And this was trumpeted an over the United Nations Atomic Effects Committee and everybody in the establishment cites it. Well, I analyzed those papers — I devoted a chapter to it in my 1990 book (*Radiation-Induced Cancer from Low-Dose Exposure*). And you know what I this guy did? He threw 135 cancers out of the study, because they occured before five years had elapsed. He said, "We know they can't occur before five years." The evidence in Byelorus is that they're coming in four, five, six years after the exposure. If you take the 135 cases and add them back, you've got a big effect from radioiodine. That's what's being said about radioiodine: not to worry, no problem.

Synapse: *How do they refute your analysis?*

Gofman: They're smart — they don't refer to it.