Health, has raised the possibility that stilbestrol may remain in treated meat in some changed form. He advocates banning the drug from animal feed.

Robert K. Enders and Carl G. Hartman, U.S. Department of Agriculture consultants, testified before the Delaney committee about the deleterious effects of stilbestrol and its ability to make meat retain water. Enders called the practice of using it for this purpose "an economic fraud."

The Livestock Reporter reported that cattle buyers had down-graded by as much as 5 cents a pound cattle fed with stilbestrol. These cattle were described by buyers as deformed, covered with fat, and "undesirable."

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Perception of Apparent Motion

Walter and Francis Kaess have shown [*Science* **132**, 953 (1960)] in their exemplary experiments that toads have perception of apparent motion. One could also say it this way: that experiments can be so devised that conditions of movement-perception required for the feeding of a toad can be fulfilled without the actual motion of either toad or food.

These experiments also bring additional evidence for something else. When the toad is placed on a 1-, 2-, and 3-day food deprivation schedule, it will not feed on food in front of it unless movement of food, or at least the conditions of food movement-perception, are fulfilled. Thus the drive of hunger, like other familiar drives, can be satisfied only within a distinct, particular configurational frame. As Tinbergen has shown [N. Tinbergen, *The Study of Instincts* (Oxford Univ. Press, London, 1951)], drives are not amorphous vague impulsions in living things but specific tension systems in search of specific configurations.

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Life Shortening and Production of Tumors by Strontium-90

The recent report by V. E. Archer and B. E. Carroll [*Science* **131**, 1808 (17 June 1960)] includes two figures that are intended to demonstrate that the degree of life shortening and the production of tumors increase linearly with increasing absorbed dose of radiation from strontium-90. Since the data they used were those I had published in *Science* and elsewhere, I am obliged to call attention to several features of their analysis that may influence the acceptability of their conclusions.

The basic alteration applied by Archer and Carroll in their analysis concerns time, and by this alteration they changed *injected millicuries per kilogram* to *millicurie-days per kilogram*. Their approach was in the proper direction, but they oversimplified by using average survival time, and their values would have been more accurate if they had employed the power function for retention. The necessary data and formula have been published in an Argonne National Laboratory Report by S. A. Tyler (No. 5841, p. 132, 1958).

There is no question but that a correction for the time during which the radiation dose accumulates is required for a complete evaluation of the long-term toxicity of any internal emitter. With the present state of knowledge, however, we do not know over what period of time the dose should be integrated. One major problem concerns the length of the latent period between injection and neoplastic change since any radiation received after a tumor has been induced is wasted as far as that tumor is concerned. Another concerns the relative contributions of dose-rate and total accumulated dose to the response, whether it be tumor induction or life shortening or any other effect. But this is not the place to discuss the variety of complications that stand in the way of accurately assessing the absorbed dose that is responsible for a particular response. Nor is this the place to discuss the series of studies now in progress that should help resolve these complications. Archer and Carroll state: "It is hoped that Finkel will calculate an accurate dosage for the different groups in rads." That is my hope as well. However, until this can be done, I feel that we add very little by playing with numbers. Actually, the survival data uncorrected for continuing exposure fit a linear dose-response curve just about as well, or as poorly, as Fig. 1 in Archer and Carroll's report.

What is true for the survival data, however, is not true for the osteogenic sarcoma data. The incidence of malignant bone tumors increases approximately as the square of the injected dose. Since the higher incidences are associated with shorter survival times, correction for continuing exposure makes the curve even steeper and, consequently, more nonlinear. Archer and Carroll's Fig. 2, however, presents an apparently linear relationship between tumor incidence and millicurie-days. This result was obtained by a combination of two fundamental errors.

The first error was the inclusion with the osteogenic sarcomas of a variety of