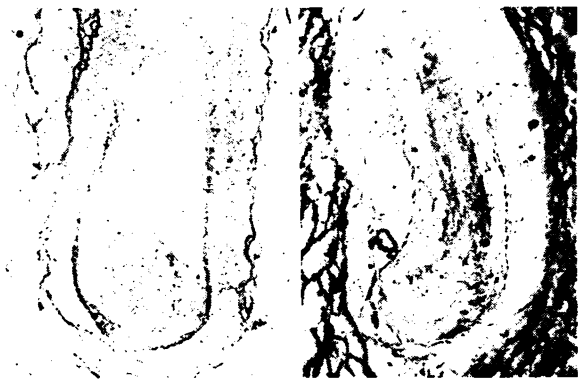

Fig. 2. (Left) Autoradiograph of a human albino hair bulb that has been incubated in C^{14}-labeled tyrosine. No evidence of radioactive melanin formation is seen in the area of the matrix. (×89) Fig. 2. (Right) Autoradiograph of the hair bulb of a 56-year old male with gray hair. No tyrosinase activity is noted in the area of the matrix. (×155)

the same autoradiograph of human white scalp skin containing tyrosinase-active melanocytes in the black hair bulb revealed that the *epidermal* melanocytes did not convert labeled tyrosine to labeled melanin.

Melanocytes located in the albino hair bulb failed to convert labeled tyrosine to labeled melanin, as is evidenced by the absence of silver grains in the area of the matrix (Fig. 2, left). Thus, albino melanocytes in the hair matrix lack the enzyme tyrosinase necessary for melanin synthesis. In a previous study (*6*), melanocytes were identified in human albino epidermis with gold impregnation. The absence of melanin in albino epidermal and hair matrix melanocytes is, therefore, the result of a genetically transmitted tyrosinase deficiency and cannot be attributed to lack of melanocytes.

Figure 2 (right) is a tyrosine-C^{14} autoradiograph of the hair matrix of a gray hair bulb. The absence of silver grains in the area of the matrix indicates a lack of tyrosinase in the human gray hair matrix.

The autoradiographic tyrosinase method has revealed that an important difference exists between the state of the tyrosinase system located within melanocytes of the human epidermis and the melanocytes of the human hair matrix. Previous histochemical studies (*1*) with irradiated and unirradiated human white skin established the existence of an *inhibited* tyrosinase system in epidermal melanocytes. The autoradiographic studies reported here have shown an uninhibited tyrosinase system in the melanocytes of the human black hair matrix and an inhibited tyrosinase system in the epidermal melanocytes. These basic facts are in agreement with the clinical findings of heavily melanized (black) hair and coexistent white skin. It appears that the large amount of melanin that is required to pigment rapidly growing black hair is supplied by the active-functioning tyrosinase system in the hair matrix melanocytes. Tyrosinase-active melanocytes have been previously observed only in irradiated skin and in malignant melanomas (*7*). To repeat, the tyrosinase system in *epidermal* melanocytes remains in a relatively dormant state unless it is activated by ionizing radiation.

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Effect of Feeding Dogs the Flesh of Lethally Irradiated Cows and Sheep

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To our knowledge, there have been no reports of studies concerning the possible toxicity of the ingested flesh of animals receiving lethal doses of gamma radiation. Based on biophysical conceptions of the interaction of radiation and matter, it was the consensus that the flesh of these animals would not prove harmful if it were consumed (*1*). The present experiments were designed to test these opinions (*2*).

Lewis *et al.* (*3*) and Witt *et al.* (*4*) have shown that sterilization by high levels of irradiation does not impart toxic properties to foods. This would indicate that, if deleterious compounds occurred in the flesh of irradiated animals, they would be the result of the effects of ionizing radiation on living systems. Several workers (*5*) have implicated toxic humoral factors as a constituent of the total-body irradiation syndrome. Thus, the possibility existed that the ingestion of flesh from irradiated animals might prove injurious.

Cobalt-60 sources of gamma radiation, arranged at a site described by Wilding *et al.* (*6*), were used for the exposures. The rate of irradiation was approximately 40 r/hr. One cow received 6400 r and another 7000 r of continuous total-body radiation, and they were destroyed *in extremis*. Sheep died from exposures of 90 hr (3600 r) to 132 hr (5280 r). An initial hyperirritability followed by complete physical collapse were the only gross symptoms noted in the irradiated animals. The cattle had a slight increase in erythrocytes, together with the near annihilation of leukocytes and a 70-percent reduction in platelets *ante mortem*. The flesh of the boned carcasses of the two irradiated and two control cows and the nine irradiated and nine control sheep was ground twice and maintained in a frozen state until used.

Fifteen weanling pure-bred male beagle pups were used in the irradiated cow study. In trials I and II, seven and eight pups, respectively, were divided into two groups by weight and litter (Table 1). The basal

Table 1. Effect of ingestion of flesh from irradiated animals on the growth of dogs.

Trial	Breed	Source of flesh	Number of animals	Length of experiment (days)	Average initial weight (kg)	Average final weight (kg)	Average daily gain* (g)
I	Greyhound	Irradiated sheep	4	128	2.7	20.0	135 ± 3
I	Greyhound	Control sheep	3	128	3.0	20.1	134 ± 2
I	Beagle	Irradiated cattle	4	129	1.4	7.4	47 ± 7
I	Beagle	Control cattle	3	129	1.4	6.8	42 ± 3
II	Beagle	Irradiated cattle	4	129	2.1	8.6	50 ± 3
II	Beagle	Control cattle	4	129	2.3	8.3	46 ± 5

* Mean ± standard error of the mean.

diet, in percentages, consisted of ground beef (fresh weight), 56.6; sucrose, 29.5; cornstarch, 4.7; hydrogenated vegetable fat, 2.9; salts (USP XIV), 3.9; and nonnutritive fiber, 2.4. The vitamin supplement contributed the following in milligrams per 100 gm of ration: thiamine, 0.36; riboflavin, 0.36; pyridoxine, 0.36; folic acid, 0.36; calcium pantothenate, 10.8; *p*-aminobenzoic acid, 10.8; nicotinamide, 7.2; inositol, 90.0; choline chloride, 180.0; and biotin 0.018. Vitamins A, D, and E, at levels of 5600 IU, 700 IU, and 700 IU, respectively, were administered twice weekly to each dog. The groups received the ground beef from either the irradiated animals or the nonirradiated control. The pups were fed at a level estimated to provide an adequate caloric intake for maintenance and growth (*7*).

In the experiment in which irradiated sheep were used, seven weanling pure-bred male greyhound pups were divided into two similar groups by weight. The experimental diets consisted of ground meat from either irradiated or nonirradiated sheep mixed with an equal weight of granular commercial dog ration. The mixed ration, stored under refrigeration, was fed to all pups in amounts that varied from 50 gm per dog each day, initially to 400 gm per dog each day at the end of the experiment. A pelleted commercial dog ration was constantly available for *ad libitum* intake.

All the dogs were fed their respective diets for the length of time indicated in Table 1. Periodic weight measurements were made during this time. Immediately before the termination of the experiment, blood samples from all animals were obtained for hematological and blood chemical determinations. Dogs from each group were sacrificed for gross and histopathological examination. At autopsy, the weights of various organs were obtained.

Total and average daily gains of the beagles and greyhounds are shown in Table 1. The growth curves of the six groups are shown in Fig. 1. No difference in weight gain attributable to the ingestion of ground meat from either the irradiated beef or sheep was apparent. Subtle nutritional differences in the diets could not be assessed under the conditions of this experiment.

Hematological examination of the blood samples from all groups revealed no statistically significant differences in leucocytes, hemoglobin, erythrocytes, or platelets. No differences were noted in the following blood values: thymol turbidity, bilirubin, serum protein, serum albumin, cholesterol, inorganic phosphorus, glucose, creatinine, uric acid, and nonprotein nitrogen.

At autopsy, no pathological changes were observed in the organs of any beagle or greyhound that received ground meat from the irradiated beef or sheep. Preliminary histopathological examination also showed no adverse effects attributable to treatment. Comparisons of the weights of lungs, heart, spleen, liver, kidney, brain, thyroids, and adrenals indicated no statistical difference between any given treatment and its corresponding control.

Under the conditions of this short-term experiment, the data indicate that the flesh from lethally irradi-

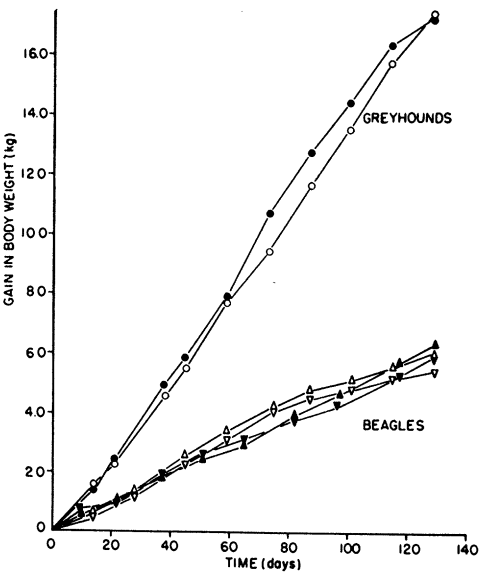

Fig. 1. Rate of gain of greyhound and beagle pups. Source of ingested flesh: ○ irradiated sheep; ● control sheep; △ irradiated cattle, trial I; ▽ control cattle, trial I; ▲ irradiated cattle, trial II; ▼ control cattle, trial II.

ated cows or sheep is not grossly injurious or toxic to the canine when it is ingested. These results were confirmed in other species, that is, in albino rats and chicks when they were fed the flesh or selected organs from irradiated animals (*8*).

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Inheritance of High Total Carotenoid Pigments in Tomato Fruits

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The red-colored variety Webb Special has been observed to have approximately twice the amount of total fruit pigments that are found in normal red tomato varieties. Genetic variation in the color of tomato fruits depends basically on the interaction of two nonallelic genes: red, r^+ _ t^+ _; yellow, rrt^+ _; tangerine, $r^+ - tt$; and light tangerine, *rrtt*. Table 1 indicates the extent of variation in total carotenoids in the four basic color classes. For analytic procedures, see (*1*). These data confirm those reported by several workers (*2*). The dominant gene r^+ is necessary for production of carotenoid pigments in quantity, while the gene t^+ and its recessive allele *t* determine the qualitative nature of the pigment system. The dominant gene t^+ produces the lycopene, beta-carotene system found in red and yellow fruits, while the recessive allele *t* produces the zeta-carotene, prolycopene system found in tangerine and light tangerine fruits.

Crosses were made between Webb Special and the pale-yellow variety Snowball and the tangerine variety Orange King. Table 2 presents the F_2 segregation for the two crosses. The high-pigment segregates are relatively easy to classify, since the increased fruit pigmentation appears to be positively associated with a dark-green plant and fruit color.

The high-pigment character segregated as if it were conditioned by a single recessive gene in the Webb Special × Snowball cross. The 15 : 1 ratio obtained in the Webb Special × Orange King cross indicates that two nonallelic recessive genes are necessary for high-fruit pigmentation. Progenies of all the high-pigment F_2 segregates were classified and observed to breed true for high-fruit pigmentation in the F_3 generation.

The two recessive high-pigment genes from Webb Special have been designated tentatively as hp_1 and hp_2. The recessive high-pigment gene isolated from Snowball has been designated as hp_1. Progress is being made in the isolation of the hp_2 gene. Data in Table 2 indicate that the two nonallelic genes for high pigmentation are inherited independently of the r^+ and t^+ genes. The hp_1 and hp_2 genes also appear to be independent of the y^+ gene that conditions fruit skin color.

It is of interest to note that Snowball, which has the lowest total pigments of any variety tested, has one of the two recessive genes necessary for high-fruit pigmentation. An interaction of the two recessive genes (hp_1 and hp_2) is necessary to obtain the quantitative increase in carotenoid pigment production. The individual functions of the two nonallelic genes have not been determined. The two genes appear to have little or no qualitative effect on the two pigment systems conditioned by the r^+ and t^+ genes. Pigment production in the yellow (rrt^+t^+) genotype is markedly reduced, even in the presence of the two high-pigment genes. The quantity of pigment produced appears to be slightly increased over that of the normal yellow varieties.

The practical implications of increased pigmentation in tomato fruits are important. This is especially true of the red-fruited varieties. The consumer demands a deep-red color in processed tomato products as well as in the fresh fruit. The lycopene and the beta-carotene contents are both increased by the high-pigment genes, which thus increase the nutritive value of the tomato fruit as well as the visual appearance.

Table 1. Variation in total carotenoid pigment content of tomato varieties (mg/100 g fresh weight).

Variety	Flesh color	Genotype	Total carotenoids
Rutgers	Red	$r^+r^+t^+t^+$	6.76
Stokesdale	Red	$r^+r^+t^+t^+$	7.12
Webb Special	Red$^+$	$r^+r^+t^+t^+$	12.96
Orange King	Tangerine	r^+r^+tt	7.36
Golden Jubilee	Tangerine	r^+r^+tt	7.00
Snowball	Yellow	rrt^+t^+	0.12
Golden Queen	Yellow	rrt^+t^+	0.24
U of I Acc. 36	Light tangerine	*rrtt*	1.08
U of I 1007-129-54	Light tangerine	*rrtt*	0.70