Impaired Glucose Tolerance in the Squirrel Monkey (*Saimiri sciureus*).* (31057)

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Abnormalities of carbohydrate metabolism in a number of animal species have been reported(1,2). The prevalence of a naturally occurring glucose tolerance "impairment" in the squirrel monkey (*Saimiri sciureus*) is reported here.

Method. The 200 monkeys used in this study were supplied by the Tarpon Zoo, Tarpon Springs, Fla., from their supply source at Leticia, Colombia, So. America. In this group, 65 were juveniles and 135 were adults. The monkeys were held at the Tarpon Zoo for periods varying from 3 weeks to 4 months during which time they were fed Pablum† mixed with diluted condensed milk, Purina Monkey Chow, fresh fruit, and one-half egg per monkey per week. This group included only monkeys free of apparent disease.

Blood samples were obtained after an 18-hour fast and immediately afterwards, glucose (4 g/kg of body weight)(3) was administered to the monkeys through a stomach tube.‡ Blood samples were obtained at 1 hour and at 4 hours following administration of glucose. Blood glucose values were determined using an Auto-Analyzer§ procedure.

One of the difficulties in the statistical evaluation of glucose tolerance data has been the inability to express the glucose tolerance curve with a single numerical description. However, to examine the distribution of these data it was necessary that a single value be used that was descriptive of each animal's glucose tolerance curve. In order to arrive at such a single value the difference between the 1-hour blood glucose level and the fasting blood glucose level was added to the difference multiplied by 3 between the 4-hour blood glucose level and the fasting blood glucose level and this sum was divided by 4 to give a mean difference value. The glucose tolerance data were weighted in this way because the 4-hour sample most nearly reflected the animals' tolerance for carbohydrate.

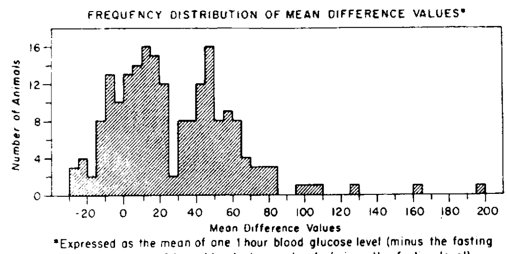

FIG. 1.

Results. The glucose tolerance levels were variable; some of the animals returned to fasting levels at the fourth hour while others were either significantly elevated or intermediate at the same time. When these weighted averages for all animals were plotted, as shown in Fig. 1, it appeared that the distribution was bimodal suggesting the existence of 2 populations of glucose tolerance values among squirrel monkeys. The distribution was tested for normality (unimodality) with Chi square(4). Because of small expected numbers in the extreme groups the animals were grouped by increments of 10 for statistical analysis. The results of this test support the inference that two populations of glucose tolerance values occur among squirrel monkeys ($\chi^2 = 22.31$; $P = 0.01 - 0.02$). The antimode of this distribution is 28.75; therefore, all values below this point are considered as "normal" and all values above are considered as being "impaired." The animals were grouped without respect to age or sex (Fig. 1) because of the small number of animals in some of the groups and because

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† A mixed grain cereal with vitamin and mineral fortification.

‡ Infant feeding tube, no. 5 French, Sterilon Corp., Buffalo, N. Y.

§ Auto-Analyzer procedure N-2a, Technicon Instruments Co., Chauncey, N. Y.

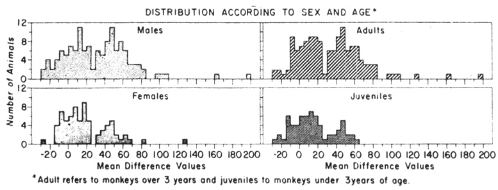

FIG. 2.

of a comparable antimode (Fig. 2). The mean glucose levels of the 2 populations are presented in Table I.

The possibility that glucose tolerance levels might be age dependent was examined (Table II). Using the antimode from the overall distribution, the animals were divided into those having higher and those having lower glucose tolerance values and were further subdivided into juvenile and adult groups. The frequency of adults with high glucose tolerance values was significantly greater than the corresponding frequency among juveniles ($\chi^2 = 11.02$; $P = < 0.001$). These data suggest that "impaired" glucose tolerance is age dependent.

The possibility of sex difference was also examined (Table III). The animals were divided in the same manner as was used for determining the effect of age. There was no significant difference in the sex distribution

TABLE I. Mean Glucose Levels of Normal and Impaired Monkeys.*

Group	No. of animals	One hr	Four hr
"Normal"	111	50.423 ±3.999	-11.135 ±1.505
		P=<.001	P=<.001
"Impaired"	89	146.000 ±5.771	26.674 ±2.873

* Expressed as mg glucose/100 ml of blood at the hour specified minus the fasting level (mean value ± standard error).

TABLE II. The Effect of Age on Glucose Tolerance Impairment.

Group	Juveniles*	Adults†
"Normal"	72.31% (47/65)‡	47.41% (64/135)
"Impaired"	27.69% (18/65)	52.59% (71/135)

* Juvenile: under 3 yr of age.
† Adult: over 3 yr of age.
‡ Expressed as percentage (No. of animals affected/No. in group).

of juveniles ($\chi^2 = 0.014$; $P = > 0.9$). However, significantly more adult males had high glucose tolerance values than did adult females ($\chi^2 = 4.773$; $P = 0.02 - 0.05$).

Discussion. The squirrel monkey *(Saimiri sciureus)*, as revealed by this study, is susceptible to an "impairment" of the carbohydrate metabolic system. A genetic basis could be postulated for this "impairment" in animals such as squirrel monkeys, which experience alternate seasons of food surplus and shortage(5). "Impaired" animals would be more likely to accumulate depot fat when food is plentiful which would help them to survive the dry season whereas the "normal" animals without these reserves would be more susceptible to dehydration, protein depletion and subsequent death.

TABLE III. The Effect of Sex on Glucose Tolerance Impairment.

	Male	Female
	I. Juveniles*	
"Normal"	72.73% (16/22)†	72.09% (31/43)
"Impaired"	27.27% (6/22)	27.91% (12/43)
	II. Adults‡	
"Normal"	42.45% (45/106)	65.52% (19/29)
"Impaired"	57.55% (61/106)	34.48% (10/29)

* Juvenile: under 3 yr of age.
† Expressed as percentage (No. of animals affected/No. in group).
‡ Adult: over 3 yr of age.

The data support the existence of two populations—"normal" and "impaired." This "impairment" is much more prevalent in adults than juveniles which would indicate an age relationship. It is also sex related with adult males having a greater frequency of this "impairment" than adult females.

Winborn(6), by light and electron microscopy, has shown that the pancreas of the squirrel monkey is very similar to that of man. Although the "impairment" mentioned here is not construed to represent diabetes mellitus, as seen in man, these similarities would suggest the squirrel monkey as an excellent experimental model for the study of carbohydrate utilization.

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Transplantation of Pituitary "Mammotropic" Tumor ($MtT.F_4$) from Fischer to Sprague-Dawley Rats.*† (31058)

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The $MtT.F_4$ pituitary tumor was originally induced by diethylstilbestrol treatment in inbred Fischer rats(1,2). This tumor was initially dependent on estrogen, since it could be transplanted only in estrogen-treated rats. After 4-5 serial passages in the Fischer rat, it became autonomous and could be transplanted and grow without estrogen treatment (2). The $MtT.F_4$ has been shown to secrete large amounts of prolactin, growth hormone (GH) and adrenocorticotropin (ACTH), but apparently no FSH, LH or TSH(3,4).

Earlier attempts to transplant $MtT.F_4$ in other strains of rats have been unsuccessful (Furth, personal communication). Since the $MtT.F_4$§ available to us had already undergone 40-41 passages, about half of them in our laboratory, it was of interest to determine whether by this time it could be transplanted successfully into randomly bred Sprague-Dawley (S-D) rats. The S-D strain was selected because it is not related to the Fischer strain (Dr. W. Dunning, personal communication), and because mammary tumors can easily be induced in this strain of rats by chemical carcinogens(5). Also, the Sprague-Dawley strain is much more readily available and less expensive to purchase than the Fischer strain.

Methods. S-D female rats, 7-8 weeks old, were obtained from Hormone Assay Lab., Chicago, Ill. Inbred female Fischer rats (CDF strain), approximately 75 days old, were obtained from Charles River Breeding Labs., Brookline, Mass. $MtT.F_4$ (passages 40 and 41) were transplanted subcutaneously, in the back of the neck. The tumors were removed by sterile technique, cut into fine pieces with iris scissors, and injected in a 0.1-ml volume of medium 199 (pH 7.4). In one group of S-D rats, each was injected subcutaneously with 10 μg estradiol in corn oil, 3 times weekly, beginning one day before tumor transplantation. In another group of S-D rats, each was injected subcutaneously with 50 IU PMS (Upjohn Co., Kalamazoo, Mich.), and 3 days later with 25 IU HCG (Nutritional Biochemicals Corp., Cleveland, Ohio); on the following day they were each given a tumor transplant.

Beginning 3 weeks after tumor transplantation, each rat was palpated once weekly for tumor development. The average time at which 50% of the rats from each group developed palpable tumors was considered to be the mean latency period. At termination of the experiment, approximately 10 months after tumor transplantation, the surviving rats were killed and all tumors were removed and examined histologically. The mammary glands, adrenals and other internal organs were also examined. Animals with palpable

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