The results of these experiments on the dog and cat are in agreement with those obtained in man.

Cardio-respiratory interference waves particularly of the double type with alternating beats occur simultaneously in sacrifice experiments in dogs and cats. We therefore point to our work as occasionally explaining pulsus-alternans and blood pressure waves of the third order.

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Experimental rickets.

By **J. F. McCLENDON** and **HARRY BAUGUESS** (by invitation).

[*From the Laboratory of Physiological Chemistry, University of Minnesota, Minneapolis, Minnesota.*]

In a large number of experiments on feeding albino rats in which white wheat flour was used as the main part of the ration, bone abnormalities were absent or transitory. Since Sherman showed that rickets could be inhibited by simply adding phosphate to the diet we concluded that the normal condition of the bones of our rats was due to the phosphoric acid content of the casein used in the diet. After substituting casein by lactalbumin or edestin, bone abnormalities appeared in one hundred per cent. of our rats. If casein was fed to the extent of 6 per cent. of the ration bone abnormalities were reduced and apparently the disturbance was transitory, since the bones became hard and cast dense shadows with the x-rays without changing the diet, yet some of the deformities were preserved. With a basic ration of white flour containing 6 per cent. sea salt, the addition of edestin or lactalbumin to improve the protein did not in any way decrease the abnormalities. The edestin carries vitamine B and if wheat germ extract is added to the lactalbumin in order to furnish vitamine B, the abnormalities still persist. The addition of spinach up to 5 per cent. of the ration did not decrease the ab-

normalities, whereas 0.2 per cent. furnished sufficient vitamine A to keep the animal alive for 3 or more months. The addition of 0.5 gram of butter fat per day did not lessen the abnormalities. In order to determine the growth of the bones x-ray plates were made by photographing a large number of animals on the same plate and comparing the density of the shadows of the bones. In addition, determinations of calcium intake and output and calculations of the calcium retention were made. Considerable individual variation was found, but when long metabolism periods (about a week) were used and all our animals with abnormal bones were averaged we found that rats which were weaned and placed on the diet at the age of twenty-one days and left on this diet at least three days before commencing the metabolism study showed a retention of 2.7 milligrams of calcium per rat per day for the first two weeks, 1.7 for the third week and 1.5 for the fourth week. In some individual rats shortly before death we obtained negative calcium balances. It would indicate, therefore, that the disturbance of calcium metabolism is increasing in severity from the first to the fourth week. We do not know the average calcium retention of the normal rat but we assume that it is close to 5 milligrams per day for the ages corresponding to our rats. This is based on calcium content of whole rats. It seems probable, therefore, that calcium retention can be used throughout the course of the disorder as an index of the severity of the disease, provided adequate methods are used to determine the calcium retention. In order to avoid errors due to transfer of the excreta we have made round cages with quarter-inch-mesh wire screen bottoms that sit in silica dishes six inches in diameter and have two bird-feed cups attached, one for water and one for food. Any food spilled from the container into the dish does not cause an error because it does not affect the difference between the intake and the outgo of calcium. At the end of the metabolism period the cage is lifted from the dish and the excreta ashed in the dish. In order to separate the calcium from the dissolved ash as calcium oxalate we have used a bromphenol blue as an indicator for hydrogen ion concentration. If the solution which is acid is neutralized until it reaches $P_H = 4$ the calcium oxalate will not be appreciably soluble and yet no calcium will precipitate as

phosphate. In case of adding too much alkali it is best to use acetic acid to bring the solution back to $P_H = 4$, because the danger of overstepping the end point is very small, since the mixture of sodium acetate and acetic acid can vary considerably in composition with little change in the hydrogen ion concentration. This is McCrudden's method in principle, but the indicator makes us more certain of the P_H. The calcium oxalate was titrated with potassium permanganate.

We do not wish to discuss the diagnosis of rickets, although our animals showed the same appearances as those described in the papers of Sherman, McCollum and Hess. Dr. C. M. Jackson has very kindly offered to work out the morphological changes in great detail and publish them so that they will be available. From a practical standpoint, however, types of non-rachitic osteoporosis caused by calcium deficiency do not seem to be very common among human beings. Bone abnormalities which are possible on human diets at present in use deserve considerable study whether they are called rickets or not and we use the word rickets merely for convenience. Some of our rats getting more phosphoric acid than that contained in the wheat flour seemed to recover from the disturbance of metabolism just as infants may recover from rickets, with the reservation that the diets of our rats were unchanged in percentage-composition and only changed in the quantity eaten per day, whereas very little exact data is to be had on the diets of human beings. In case the abnormalities are not great enough to cause permanent deformities we do not know of any means of detecting the previous history of rickets without diagnosing it at the time of its occurrence. The x-rays and calcium balances, however, may be used for diagnostic purposes on rats without killing the animals. Rats die easily under ether and it is difficult to get them absolutely quiet without danger of killing them unless they are held mechanically. They may be stretched out by tying their feet to a stiff ring of suitable size after slightly etherizing them.