it was in the organ of fish accustomed to freshwater.

The transport function of the gill changes dramatically when euryhaline teleosts accustomed to fresh water enter seawater. In fresh water the bidirectional flux of sodium and chloride is low, and the gill actively absorbs small amounts of Na^+ and Cl^- from the dilute external medium (*14*). In salt water (*9*, *15*), the flux of sodium across the gills is increased by several orders of magnitude. The gills of *Fundulus* must transfer 4 to 5 percent of the body's exchangeable Na^+ per hour (an amount of Na^+ equal to that contained in the seawater drunk) into the hypertonic external medium against an electrochemical gradient (*9*). The impressive augmentation of Na^+- and K^+-activated adenosine triphosphatase activity that accompanies the increase in active sodium outflux strongly suggests that this enzyme plays an important role in the active transport of Na^+ across the gill.

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Food Intake Controlled by a Blood Factor

Abstract. *Intake of food by hungry rats was reduced 50 percent below normal after their blood had been mixed with that of satiated rats. Intake of food by deprived rats was not reduced when the donor rat was deprived of food for 24 hours prior to mixing of the blood or when a deprived donor was fed to satiety immediately before such transfusion.*

Blood factors have been of prime importance in many theories of the control of food intake. The glucostat (*1*), lipostat (*2*), and aminostat (*3*) theories of hunger assume monitoring (by the central nervous system) of glucose, lipid, or protein reserves of the body, respectively. When these reserves are low, quantities of these substances in the blood or products of their metabolism are assumed to be low, thereby activating a feeding center or inhibiting a satiety center. However, we are aware of no evidence in the literature indicating that blood-borne factors control food intake.

If the blood of satiated and food-deprived animals differs in hunger or satiety factors, the crossing of blood between satiated and deprived animals should affect their subsequent food intake; the hungry animal would then be expected to eat less than normal, and the satiated animal would be expected to eat more than normal.

Techniques of crossing blood by using parabiotic animals or by transfusion under anesthesia were unsuitable for our study. With parabiotic rats it is impossible to control the blood composition of the two members of the pair independently; in techniques requiring anesthesia, tests of food intake cannot be made until the effects of anesthesia have disappeared. We used a technique that avoids these problems (*4*). Cannulas were permanently implanted in the right external jugular vein of a pair of rats 2 days prior to blood mixing. The cannula, which terminated in the superior vena cava, extended subcutaneously from the point of entry into the vein along the ventral midline up the side and emerged, through an incision on the back, 2 or 3 cm below the neck of the animal. Immediately before the transfusion, both animals received heparin intravenously (0.15 ml, 1000 unit/ml) through the cannulas. The rats were then placed side by side in restraining tubes. The distal ends of their cannulas were connected to a valve system that permitted blood to be withdrawn from each animal and to be injected into the other animal of the pair without exposing the blood to air. This blood was withdrawn in 2-ml portions crossed and reinjected until a total of 26 ml had been transferred; this is an adequate amount to insure thorough mixing of the blood of rats weighing 350 to 400 g (*5*). At the completion of transfusion, 50 percent of the blood in each animal was his own, and 50 percent was his partner's.

Sprague-Dawley albino male rats (16 pairs, 90 to 120 days old) were used. One member of each pair was given free access to a milk diet (sweetened condensed milk diluted, 2 parts milk to 1 part water); the other had access to this diet for only 30 minutes of each 24 hours for 10 days of adaptation. All animals had continuous access to water except during transfusions. During this adaptation period, we recorded milk intake of both groups of animals. By the 5th day, the daily intake had stabilized.

On the experimental day, the blood of a pair of rats, one deprived and one satiated, was mixed 30 minutes prior to the time the deprived animal was usually fed. Immediately after this procedure, both members of the pair were given access to the diluted sweetened condensed milk for 30 minutes, and the amount ingested was recorded.

The mean intake and standard deviation of the distribution of intakes of the 16 deprived animals in the 30-minute feeding period on the day prior to blood mixing were 15.8 and 5.2 ml, respectively; in the 30-minute feeding period immediately after blood mixing, the mean and standard deviation were 8.0 and 5.9 ml, respectively (Fig. 1). The difference in the mean intake on these two successive days, representing a reduction of 50 percent, is statistically significant ($t = 4.01$, $P < .001$).

The intake of the satiated animals immediately after blood mixing with the hungry animals was not increased.

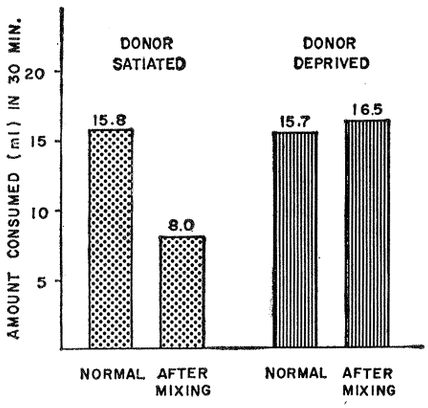

Fig. 1. Mean intake of food in 30 minutes by deprived animals. (Left) Mean intake on the day prior to transfusion (normal) compared with mean intake of the same animals immediately after mixing of their blood with that of a satiated donor (after mixing). (Right) Same comparison for animals whose blood was mixed with blood of donors deprived for 24 hours.

Only two of the 16 satiated rats did any drinking in the 30 minutes after transfusion (one drank 2.0 ml; the other drank 0.5 ml). We then investigated the possibility that our method of blood mixing caused debilitation which resulted in reduced intake of food. For 2 weeks, male albino Sprague-Dawley rats (14 pairs) were adapted to the milk diet and feeding schedules of the above-mentioned study. Twenty-four hours prior to blood mixing, all food was removed from the cages of the free-feeding animals. Blood was transferred 30 minutes prior to the usual feeding time of the animals on the deprivation schedule. Blood mixing in this experiment was thus between a pair of hungry rats rather than between a hungry and a satiated rat (Fig. 1). The difference in the intake before and after transfusion is not statistically significant ($t = 1.09$). The mean intake of the animals which had free access to food until 24 hours before blood mixing was 13.9 ml in the 30-minute period immediately after blood mixing.

Our two studies clearly indicate that the blood of an animal given free access to food contains a factor inhibiting food intake. We also investigated the possibility that a humoral factor might control food intake in animals fed only once a day for 30 minutes (*6*). In this experiment all rats were maintained for 2 weeks on a deprivation schedule with access to diluted condensed milk for 30 minutes in each 24 hours. Then, immediately before blood mixing, one member of each of ten pairs of rats was permitted to drink diluted milk for 30 minutes, by which time drinking had stopped. The blood of these animals was then mixed with that of the animals that had not been permitted to drink. Mixing in this case was between freshly satiated rats and those that had been hungry for 24 hours. Immediately after transfusion, each animal was given access to milk for 30 minutes. The mean 30-minute intake of the hungry animals on the 5 days before transfusion was 13.7 ml; this intake immediately after blood mixing with freshly satiated rats was practically identical (13.8 ml). The mean intake of the animals permitted to eat before blood mixing was 2.1 ml in the 30-minute period after blood mixing.

We found no evidence for the existence of humoral factors that increase food intake. When animals are permitted to eat for only 30 minutes a day, the volume ingested is probably limited by satiety of oral and gastric origin (*7*) rather than by humoral factors. However, our studies strongly suggest that humoral factors acting to limit food intake accumulate in animals with free access to food and that these factors disappear from the bloodstream during a 24-hour fast. Lack of evidence for a factor that increases food intake indicates that this intake is regulated by satiety rather than hunger factors. When animals are maintained on a free feeding schedule, they apparently start to eat when a blood factor falls below a critical level and not when a hunger factor builds above a threshold level.

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Strophanthidin-Sensitive Transport of Cesium and Sodium in Muscle Cells

Abstract. *Uptake of cesium-134 ions into muscle cells is reduced to very low values by the presence of 10^{-5}M strophanthidin in the Ringer solution. Cesium ions can induce extrusion of sodium from muscle cells in which the intracellular sodium content is elevated. The cesium-induced extra efflux of sodium-22 is inhibited by the external presence of 10^{-5}M strophanthidin. The coupling between inward movement of cesium and outward movement of sodium appears to be chemical in nature. The evidence suggests that cesium ions are transported into muscle cells by a system of sites or carriers that requires a source of metabolic energy for ion turnover to occur.*

The cesium ion crosses muscle- and nerve-cell membranes at rates much lower than those observed for the potassium ion, even though their aqueous mobilities and electrochemical behaviors are similar. Muscle cells, for example, undergo only a slight amount of swelling when placed in Ringer solutions containing elevated concentrations of CsCl, whereas, in similar solutions containing KCl, great and rapid swelling occurs (*1*). Also, cesium ions carry only small ionic currents across the membranes of giant nerve cells from the squid (*2*).

Though cesium movement is slow in frog skeletal muscle, the membrane specificity to potassium and cesium ions is similar enough for the two ions to show competitive effects during their entry into the cells (*1*). Rubidium ions compete with cesium ions for entry and it seems likely, therefore, that the mechanism of penetration is the same for both ions.

Adrian and Slayman (*3*) have demonstrated inhibition by the drug strophanthidin of entry of rubidium ions into sodium-enriched muscles. Sjodin (*1*) showed that rubidium ions can