between the beginning of rigor and the attainment of its maximum is in the stimulated animals again shorter than in the controls.

We shall not burden our present statements with figures or other details. The essential point in our results is that with regard to the cardiac rigor, stimulation of the inhibitory nerves had the same effect as that obtained by stimulation of motor nerves upon skeletal muscles, although the two kinds of nerves have opposite functional characters. How is this puzzling result to be explained? We are inclined for the present to give our results the following interpretation. It is known that anemia and venous stasis hasten rigor. The onset of rigor in the lower extremities of a living animal following compression of the abdominal aorta is a well-known experiment. We believe that the frequent standstills and slowing of the heart with its attendant anemia, venous stasis and asphyxia of the tissues is the cause of the hastening of cardiac rigor in the animals whose vagi were stimulated. In support of this interpretation we may cite the fact that the rigor of the skeletal muscles also sets in earlier in the animals whose vagi were stimulated than in the controls, a fact for which the disturbance of the circulation seems to be the only possible explanation.

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The antagonistic action of calcium upon the inhibitory effect of magnesium.

By **S. J. MELTZER** and **JOHN AUER.**

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Calcium and magnesium are chemically closely related elements. They are also close companions in the tissues of the animal body. It is the prevailing view that the physiological effect of both elements is similar in character. Many physiologists are at present of the opinion that calcium as well as magnesium exerts an inhibitory influence in the functions of the animal body. Loeb published in 1899 his observations of the inhibitory action of calcium upon the twitchings of frog muscles brought on by solutions of sodium chloride. It was then assumed by Loeb that all

the members of the group of alkali earths possess inhibitory properties including at first even barium. In the numerous subsequent papers by Loeb and his pupils the discussion turned, however, essentially around the inhibitory effect of calcium. Outside of the effect of calcium upon the heart, with reference to which Howell and his followers insist, contrary to the teachings of Loeb and his school, that calcium is an exciting and not an inhibiting agent, the opinion is now widely accepted that calcium is an inhibiting factor in the animal organism. It found its way also into pathology. For instance, a number of German and Italian writers hold the view that tetany of children is due to a diminution of the calcium content of the brain.

As to magnesium we have within the last few years published several studies in support of the hypothesis that magnesium salts favor inhibitory processes. The first fact which gave rise to that hypothesis was demonstrated in 1899 to the American Physiological Society when an intracerebral injection of a few drops of a solution of magnesium sulphate caused a state of paralysis in a rabbit while the injection of other solutions brought on convulsions.

In a series of recent studies which we have carried out upon the relations of the effects of calcium to magnesium, many remarkable facts came to light, all of which demonstrate unmistakably that calcium is the most available agent to neutralize the inhibitory effect of magnesium. We shall not enter here upon details; we wish to show only the following striking and instructive experiment.

By subcutaneous injections of a magnesium salt rabbits are brought to a profound state of anesthesia and paralysis. The slow and shallow respirations indicate the approaching danger. Now 6 or 8 c.c. *m*/6 or *m*/8 solution of a calcium salt is given through the ear vein. Within a few seconds the respiration becomes quicker and deeper and within one minute the animal turns over, sits up and appears normal.

Here calcium not only did not add an inhibitory effect but completely neutralized the profound inhibitory effect of magnesium. The companionship of calcium and magnesium within the body means, at least in many instances, not a concerted action of similar effects but rather a resultant effect of antagonistic actions.

We may add that the experiment calls to mind similar relations

existing in plant physiology ; the retardation of growth on account of the presence of too much magnesium in the soil is promptly corrected by the addition of a calcium salt ; the process is termed "liming." In animals, therefore, as well as in plants calcium is antagonistic to magnesium.

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Remote result of the transplantation of a segment of popliteal artery from a man to a bitch.

By **ALEXIS CARREL.**

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I have shown that a segment of carotid artery of a dog transplanted onto the aorta of a cat can act as artery for one year at least. In order to ascertain whether the same result is obtainable when the animals are zoologically more distinct than cat and dog, segments of human arteries have been transplanted in dogs. One of these animals was shown to the Society.

Seven months and twelve days ago, the abdominal aorta of the bitch shown to the society was severed, and a short segment of human popliteal artery was sutured to its cut ends. This popliteal artery belonged to a young man whose thigh was amputated by Dr. Ellsworth Eliot for an osteosarcoma. The vessel had been preserved in Locke's solution and kept in cold storage during the twenty four days which elapsed between the amputation and the transplantation.

After the transplantation, the bitch remained in excellent health and the pulse of the femoral arteries was normal. Five months and twelve days after the operation, an exploratory laparotomy was performed. The circulation of the aorta was found normal and the popliteal artery in about the same condition as at the time of the operation. Seven months and twelve days after the operation, the pulse of the femoral arteries is still normal.

This experiment shows that an artery, transplanted under certain conditions from man to dog, can act as artery for seven months at least.