spinal transection we can obtain in a comparatively simple way information as to the powers of the purely local or segmental reflex mechanisms.

The so-called “ flexion-reflex ” of the limb is one of the most accessible of the local reflex reactions which can thus be studied with an isolated portion of the spinal cord as its centre.

Let it be supposed that the limb observed is the hind limb. The three main joints of the limb are the hip, the knee and the ankle. Each of these joints is provided with muscles which flex or bend it, and others which extend or straighten it. It is found that the reflex throws into contraction the flexor muscles of each of these joints. It matters little which of all the various afferent nerves of the limb is stimulated, whichever of these the afferent nerve may be, the centrifuged discharge from the cord goes to practically the same muscles, namely, always to the flexors of the joints.

The centrifuged discharge does not go to the extensor muscles of the limb. However strong the stimulus and however powerful the afferent nerve chosen the spinal centre does not discharge impulses into the extensor muscles, though these muscles receive motor nerves issuing from the very same region of the cord as that supplying motor nerves to the flexor muscles. Not only does the reflex action not discharge motor impulses into the nerves of the extensor muscles, but if the spinal cord happens to be discharging impulses into these nerves when the reflex is evoked this discharge is suppressed or diminished *(inhibited).* The result is that when the reflex occurs not only are the flexor muscles made to contract, but their antagonists, the extensors, are, if in contraction at the same time, thrown out of contraction, that is, relaxed. In this way the latter muscles are prevented from impeding the action of the contracting flexors. This inhibition occurs at the beginning of the reflex action which excites the muscles and continues so long as the flexion-reflex itself continues. It thus prevents other reflexes from upsetting for the time being the due action of the flexion- reflex, for it renders the muscles opposing that reflex less accessible to motor discharge through the spinal cord whatever the quarter whence incitation to that discharge may come.

A feature of this reflex is its graded intensity. A weak stimulus evokes in the flexor muscles a contraction which is weak and in the extensor muscles a relaxation which is slight. Not only is the contraction weak in the individual flexor muscles, but it is limited to fewer of them, and in large muscles seems to involve only limited portions of them.

The duration of the reflex similarly varies directly with the duration of the exciting stimulus applied to the afferent nerve. The time relations of electrical stimuli can be controlled by the experimenter with much precision. In the single induction shock he has at command a stimulus of extreme brevity, lasting only a few millionths of a second. With such stimulus a lower limit is soon found to the brevity of the reflex effect as expressed by muscles. It is found difficult to evoke with brief stimuli reflex contractions so brief as those evoked from the muscle by similar stimuli applied direct to the motor nerve of the muscle. There is reason to think that such stimuli applied to a nerve may evoke one single nerve-impulse. A single nerve impulse generated in a motor nerve causes in the muscle a brief contraction which is called a twitch, and lasts a tenth of a second. A single nerve impulse generated in an afferent nerve sometimes fails on arriving at the spinal centre to evoke any observable reflex effect at all, but if it is effective the muscle contraction tends to be longer than a “ twitch,” often much longer. It is therefore questioned whether the spinal centre when excited even most briefly ever discharges one single centrifugal im­pulse only; it seems usually to discharge a short series of such impulses.

Allied to this character is the tendency which even simple spinal reflexes exhibit to continue discharging for a certain time after their exciting stimulus has ceased to be applied. This after-discharge succeeding a strong stimulus may persist even for several seconds.

*Refractory Phase.—*Besides characters common to all or many spinal reflexes certain spinal reflexes have features peculiar to themselves or exhibited by them in degrees not obvious in other reflexes. One of these features is refractory phase. The scratch­reflex exemplifies this. In the dog, cat, and many other ani­mals the hind limb often performs a rapid scratching movement, the foot being applied to the skin of the shoulder or neck as if to groom the hairy coat in that region. This movement is in the intact animal under control of the brain, and can be executed or desisted from at will. When certain of the higher centres in the brain have been destroyed, this scratching action occurs very readily and in, as it were, an uncontrolled way. When the spinal cord has been severed in the neck this scratch­ing movement of the hind limb can be elicited with regularity as a spinal reflex by merely rubbing the skin of the side of the neck or shoulder, applying there a weak electric current to the skin. In this reflex the stimulus excites afferent nerves con- nected with the hairs in the skin and these convey impulses to the spinal centres in the neck or shoulder segments, and these in turn discharge impulses into nerve fibres entirely intraspinal passing backward along the cord to reach motor centres in the hind limb region. These motor centres in turn discharge centrifugal impulses into the muscles of the hind limb of the same side of the body as the shoulder which is the seat of irritation. The motor discharge is peculiar in that it causes the muscles of the hind limb to contract rhythmically at a rate of about four contractions per second, and the discharge is peculiar further in that it excites the flexor and extensor muscles of the joints alternately so that at the hip for instance the limb is alternately flexed and extended, each single phase of the movement lasting about an eighth of a second. Now this rhythmic discharge remains the same in rate whether the exciting stimulus applied to the skin be continuous or one of many various rates of repetition. Evidently at some point in the reflex arc there is a mechanism which after reacting to the impulses reaching it remains for a certain brief part of a second unresponsive, and then becomes once more for a brief period responsive, and so on. And this phasic alternation of excitability and inex- citability repeats itself through the continuance of the reflex even when that endures for minutes. The phase of inexcit­ability is termed the refractory phase. It is important as an essential element in the co-ordination; without it the scratching movement would obviously not be obtained for alternation of flexion and extension is essential to the act. A similar element almost certainly forms part of the co-ordinating mechanism for many other cyclic reflexes, including those of the stepping of the limbs, the movement of the jaw in mastication, the action of the eyelids in blinking, and perhaps the respiratory movements of the chest and larynx.

*Fatigue.—*Nerve trunks do not easily tire out under stimulation even most prolonged. Reflex actions on the other hand relatively soon tire. Some are more resistant, however, than are others. The flexion-reflex may be continued for ten minutes at a time and the scratch-reflex can be maintained so long. As a reflex tires, the muscular contraction which it causes tends to become less intense and less steady. The relatively rapid onset of fatigue in reflexes is counterbalanced by speedy recovery in repose. A long flexion-reflex, when from fatigue it has become weak, tremulous and irregular, will recommence after 30 seconds’ repose with almost the same vigour and steadiness as if it had not recently been tired out.

This character of reflexes is in accordance with their executing movements which for the most part are not under natural circumstances required to last long. Such movements are the taking of a step by a limb, the movement of the jaw in masti- cation, the descent of the diaphragm in breathing, the withdrawal of the foot or the pinion from a noxious stimulus or the movement of the eyelids to wash off a particle touching the cornea, in all these no very prolonged reflex discharge is required. These natural movements to which the artificially provoked reflexes seem to correspond do not demand prolonged motor activity, or when they do, demand it in rhythmic repetition with intervening pauses which allow repose.