truly basic problems of stereochemistry at the geometrical level were solved a very long time ago indeed by van't Hoff, Le Bel, Kekulé *et al.* and that a great deal of what has followed is elaboration rather than fundamental advance. Perhaps we shall know that something extraordinary has arrived when the authors of a radically new concept receive the kind of abuse which was heaped upon van't Hoff and Le Bel by chemists of the day, for daring to suggest that carbon atoms might combine in geometrically describable structures. But, if one's instincts are correct, this honour may well be reserved for someone in a field altogether remote from chemistry as we know it, and perhaps from physics too.

from our Molecular Physics Correspondent

New light on old reflexes

THE voluntary muscles that move our limbs are full of sense organs, a fact in itself not surprising, although the use the central nervous system makes of the information they send it is perhaps more of a mystery than is the case for any other major group of sense organs in the body.

The most obvious manifestation of their action, the familiar knee jerk, obtained by striking the tendon below the knee cap with a hammer, was described independently and almost simultaneously by Erb of Heidelberg and Westphal of Halle just on a century ago. In this reaction the tap to the tendon briefly stretches the muscle spindles (the most important of the sense organs in the muscle) and their discharge reflexly causes the muscle to twitch. Slower stretch of a human muscle that is already contracting, by forcible bending of the joint it acts on, also causes a reflex increase in contraction. Stretch reflexes of this general type were first described by Liddell and Sherrington in 1924 in animals rendered insentient by removing the cerebral hemispheres, whose muscles are unnaturally susceptible to stretch. The stretch reflex has long been a favourite object of research from the belief that it is an important and accessible element in the complex nervous mechanisms by which the muscle sense organs make the muscles, by some kind of feedback action, do what we ask of them. This belief is reinforced by the observation that stretch reflexes, as well as tendon jerks, are abnormal in neurological diseases such as stroke, in which the muscles conspicuously do not do what we ask of them.

The muscle spindles are the most elaborate sensory structures in the body other than the eyes and ears. Each consists of a bundle of fine modified muscle fibres with sense endings, sensitive to extension of these muscle fibres, wrapped around a central region. There are two different kinds of sense endings on the spindles, the primaries, connected to the central nervous system by fast conducting nerve fibres, and the secondaries, whose nerve fibres conduct at only a half or a third of the speed.

The latency of the knee jerk—the time from contact of the hammer with the tendon to the first sign of reflex activity in the muscle extending the knee—is about a sixtieth of a second, so short that the sense endings responsible must be the primaries with their fast nerve fibres. Even so, there is only just time for nerve impulses to get to the spinal cord and back. Until quite recently it was always supposed, following Sherrington's unhesitating identification of the knee jerk as a "fractional manifestation" of the stretch reflex, that the stretch reflex proper used the same sense endings and the same rapid spinal reflex pathway as the tendon jerk. This attractive but dangerous simplification is now under attack on two fronts.

First, P. B. C. Matthews discovered that the stretch reflex in the soleus (a muscle extending the ankle) of the cat was larger than the reflex contraction obtained by vibrating the tendon, a mode of stimulation that is believed on good grounds to excite the spindle primary endings powerfully and selectively. This strongly, if indirectly, suggests that the secondaries take part in the stretch reflex. There is no reason why they should not, for the stretch reflex has long latency components as compared with the tendon jerk. Now Kirkwood and Sears in this issue of *Nature* (page 242) present the crucial evidence that the nerve fibres from spindle secondaries, on entering the spinal cord, excite directly (monosynaptically) the motor nerve cells of the muscle in question (in these experiments a muscle of the rib cage). They have similar evidence for the secondary endings in cat soleus muscle (*J. Physiol, Lond.*, in the press). The involvement of the slow-conducting spindle secondaries in the stretch reflex of the decerebrate cat can now scarcely be doubted.

On the second front, Marsden, Merton and Morton (*Nature*, **238**, 140; 1972; *Lancet*, **i**, 759; 1973) working on human subjects, found that in some muscles, for example the muscle that bends the top joint of the thumb, only long latency components are present in the stretch reflex. Following suggestions by Hammond and by Phillips, they argued that in such muscles the stretch reflex may not be spinal at all, but may travel over a pathway to the cerebral cortex and back. This theory may seem far-fetched at first sight, but trans-cortical reflexes from the limbs are not, in fact, a new idea in either physiology or neurology. A number of observations already fall into place on the trans-cortical theory of the stretch reflex, but much will have to be done to establish the theory firmly. In particular, there remains at present the possibility that the latency is long because only the spindle secondaries (to the exclusion of the primaries) take part in a spinal reflex. Results from muscles of the shoulder should throw light on this question.

These two new notions, that the secondary spindle endings take part in stretch reflexes and that some stretch reflexes may have a cortical reflex arc (notions, incidentally, by no means mutually incompatible), have a twofold significance. First, in clinical medicine, neurologists have long been puzzled that the stretch reflexes (measured as the resistance or 'tone' felt in a limb during passive movement) and the tendon jerks, which physiologists originally told them had the same mechanism, did not always go hand in hand when they altered in disease, and sometimes indeed changed in opposite directions. Now that there are at least two possible ways in which the mechanism of tendon jerks and stretch reflexes may differ, the way is open for a resolution of these problems and for a completely new approach to the whole nature of 'tone' in normal muscle and its alterations in spastic and other abnormal states.

More generally, any new information about the detailed mechanism of the stretch reflex is particularly welcome at this time when the work of Marsden *et al.* already referred to on the servo-like stretch-reflex-based responses of human muscles during voluntary movements has turned up several other new phenomena not foreshadowed in animal work on the stretch reflex and badly in need of explanation.

from a Correspondent

An uphill route for climatic cycles?

IF climate is the summation of weather over a period of time, then it makes sense to predict climatic changes in the same way as weather—that is by looking at present sequences of events and assuming that similar sequences will persist in the future. Such a method has been applied principally by Lamb and it is one of the concerns of his now rescued Climatic Research Unit (*Nature*, **251**, 568; 1974). But the detection of cycles alone does not indicate the causes of either regional or global climatic changes. As realistic experiments are clearly impossible and