HARD AND SOFT X RAYS.

A FACT of great interest has emerged from the use of hard X rays therapeutically, namely, the entirely different effects which hard and soft X rays have upon the skin.

If the normal human skin be exposed to soft X rays, a pastille dose (1 B.) is sufficient to produce erythema, and twice this quantity causes a painful blistering, which may be the beginning of a dermatitis. Now consider what happens in an exposure to hard X rays, such as occurs in the modern treatment of fibromata or internal new growths, the rays being first filtered through 3 or 4 mms. of aluminium. The dose is usually measured by the colouring of a pastille exposed to the unscreened rays, and doses amounting in all to 50-100 B or more are thus administered. The action upon the skin is to produce a slight discoloration, which gradually disappears. The contrast to the effect of soft X rays is at once striking and fortunate.

Before we may say, however, that the response of the cells in the two cases is different, we must satisfy ourselves that the skin has, when subjected to the hard X rays, absorbed at least as much X-ray energy as in the former case.

When filtered rays are administered recourse is naturally had to a hard bulb; a spark gap between points of 15-16 cms. indicates a fairly hard bulb. Now if we allow the unfiltered rays from a bulb running at this spark gap to enter a gold-leaf electroscope, they expend a certain amount of their energy in ionising the air contained inside the electroscope, and this can be measured by noting the rate at which the gold-leaf moves across a graduated scale. If the bulb be screened by 4 mms. of aluminium, it will be found that the gold-leaf now moves at about one-fifth of its previous rate; the ionisation is reduced to 20 per cent. of its initial value. Transferring our ideas back to the skin receiving the radiation, we may say that if the skin be given a pastille dose of soft and of hard X rays, *i.e.*, the rays being filtered through 4 mms. of aluminium, then the amount of X-ray energy absorbed by the topmost layers will be about five times as much in the former as in the latter case; hence, in the administration of a total dose of 50-100 B of hard X rays the skin absorbs about ten or twenty times as much as would produce a serious lesion if the rays had been soft; and this, be it noted, with far less injury to the cells.

Recent research bids us think of X rays as ether vibrations of various wave-lengths, hard X rays being of shorter wave-length than soft rays. Not only so, but the wave-lengths of two beams of X rays may be compared from the way in which they are absorbed by interposed screens of some substance such as aluminium.

Confining our attention to the two cases under consideration, we find that the unscreened soft X rays are about five or six times as easily absorbed as are the filtered hard rays. Moseley and Darwin have found that a certain relation exists between the amount of absorption and the wave-length of the rays; for the case in question it results that the wave-length of the soft X rays is just about twice that of the hard X rays. This statement refers to the major

portion of the radiation in the two cases ; actually both beams are heterogeneous to some degree.

The fact that such rays act so differently upon the living cell will perhaps not appear so puzzling if we recall what happens in a different region of the spectrum. Enlarge the scale of the wave-lengths about five thousand times and we are in the visible part of the spectrum. From the infra-red to the ultra-violet is about an octave, at one end we are at the entrance of the region of dark heat, at the other in the full glare of actinism. We need not insist upon the profoundly different effects that these forms of radiation have upon the living cell, yet one is but twice the wave-length of the other.

It is interesting to note that between the visible octave, as we may term the visible part of the spectrum, and the clinical (X-ray) octave, there are about nine octaves of radiation which represent only partially explored physical territory. Can it be doubted that the living cell will reveal some of the mystery that surrounds it when viewed in the radiation that awaits application ?

Let us turn now to certain physical aspects of the question upon which we started. However desirous we may be to see the extension of purely physical methods in the measurement of X rays for clinical purposes, it is well to recognise that a blind adherence to physical measurements is an inadequate guide to the effect of different rays upon the tissues. The case in question exemplifies this in a striking manner. Arguing from the physical data alone, it would have been predicted that much more profound changes in the skin would have resulted from 50-100 B of filtered rays than 1 to 2 B of soft rays, yet the reverse is the case. Granted the fact, the natural tendency is to find some rational and adequate explanation of this reversal of one's anticipation.

The term "selective action" has been used to indicate that the rays have a particular action upon certain cells, but it is worth considering whether "selective absorption" would not be a more appropriate term, indicating that such cells absorb certain rays unduly, in consequence of which there is a more marked effect upon them.

When a beam of white light passes through sodium vapour, it is only a small portion of such light, namely, a part of the yellow constituent, which is stopped by the sodium vapour ; it is in fact "selectively absorbed." Exactly analogous behaviour is known to occur in the X-ray spectrum, for Barkla has shown that metals exert a "selective absorption" upon X rays whose wave-length is a little shorter than the characteristic X rays which they severally emit.

When we try to push the matter a stage further, and prove, for instance, that the cells forming the skin do exert a selective absorption upon soft X rays, certain experimental difficulties make their appearance. One is soon reminded of the complexity of tissue, and it will be readily recognised that although such an absorption might occur in certain vital parts of the cell, yet if the bulk of the tissue performed no such function, then the ordinary absorption measurements would give little or no indication of the action which locally might exist.

If we accustom ourselves to think of X rays in terms of wave-length, and keep before us a mental picture of their place in the spectrum, which is ever widening in front of us, and even occasionally hazard the probabilities that spectral lines suggest, it will perhaps avail us something in elucidating the nature of the changes induced in the living cell when it is "X-rayed."

SIDNEY RUSS.