TIME, SPACE AND THE MENTAL MACHINE

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SOME years ago as a result of putting together a large number of results obtained by me through stimulating beating hearts with adrenaline I discovered a new law of natural stimulation which reads as follows:—"In living structures their natural stimulation according to its strength causes a corresponding development of energy which first remains in being and then dissipates after the stimulant has ceased to act."[4] But, after discovering that law as the result of stimulating living structures, I found that my motor car and bicycle obeyed it. So do all other inanimate structures which move on the face of this earth as the result of impressed force. And since these inanimate objects obey this law because of friction, I deduced that living structures obeyed it likewise. That is to say, the natural stimulation of living tissues gives rise to increased movements of structures with surfaces.[3]

This law can be verified physiologically by the non-physiologist through his vision. He already takes it for granted that the energy developed within him as a sensation has some accordance with the strength of the stimulant, which is light. He probably knows that the cinema depends on the capacity of the sensation-energy developed thereby first to remain in being after the stimulant has ceased to act. Thereafter it dissipates. To verify the law with a motor car one simply puts the 'phenomena' of motoring into the terminology of physiology.[3]

Now it is typical of the reaction of a living tissue to stimulation that the energy of discharge is out of all proportion to the energy used in stimulation. This 'property', it may be observed, is possessed by motor cars wherein the energy of stimulation, as pressure on the accelerator pedal, is out of all proportion to the energy discharge or momentum thereby developed by the car. There is, therefore, no question of the stimulating agent supplying energy by its own oxidation. Moreover, sodium chloride is a stimulating agent,[1] and it is certainly not combustible even by living tissues. I have consequently to seek self-propelled bodies as the units which move faster when living tissues are stimulated to increased activity, or increased capacity for function.

So far as the agency of propulsion is concerned, I have got down to structures at the most of the size of a colloidal particle, and that rules out all organised propulsive agents such as flagella, etc. In fact, one is only left with surface tension, the probable source of movement of the amœba. This is a perfectly feasible agent of propulsion, and to utilise it we require units which can oxidise foodstuffs, and in doing so, give rise to metabolic products which can alter surface tension. It is further feasible that Nature should have evolved a unit which produced two classes of metabolic products. The one class should ooze out over the unit's front half and lower surface tension, the other class should ooze out over the posterior half and raise it.

When I first discovered that friction is concerned with natural stimulation then, in view of the overwhelming evidence that colloids have determining roles in excitation processes, I sought in the movement of colloidal particles, because they have surfaces, the source of that friction.[3] Considering also that there is law and order in a beating heart in that it regularly undergoes a cycle of operations comprised of contraction, relaxation, and rest, I visualised something corresponding to this in movements. I, therefore, suggested that these colloids had regulated movements corresponding to those of a body of troops performing drill on a barrack square, as opposed to the 'Brownian' movements of a crowd disporting itself over the same area.[3]

To regulate these movements, however, requires something of the nature of a commanding force to enforce the regulating. One required also something corresponding to change of direction to explain alternations of state corresponding with alternation of contraction and relaxation. But it was also the case that a change of direction, provided movements were in straight lines, required still another force to change the direction. On the other hand, if there were not changes of direction, the setting up of a high state of functional capacity, as such movements in one part of a nerve, say, should automatically be succeeded by a loss of functional capacity in that part, and such is definitely not the case. Moreover, the restriction of travel of these moving elements cannot be brought about by walled boundaries, because a single collision between moving particles in such a confined space would eventually confer on living matter the properties of a gas. Motion in orbits, thus, emerges by exclusion as the nature of these regulated, restricted movements.

Having deduced that, one can straightway consider whether the conclusion is probable, and I consider that the answer to this is yes. At any rate, it seems to me more likely that Nature has a fundamental plan of construction than several. Biologists, however, have no more suspected that living matter is built up on the lines of the solar system any more than physicists and chemists originally suspected that the atom was. Yet, such a structure is the only one that can supply an answer to that obedience of living tissues to Burridge's Law. The protoplasmic atom is one where the satellites move in a medium subjecting them to friction, and Nature conferred what we term life on that system when the satellites were made self-propelled.

We have next to observe that a self-propelled circular body subjected to friction will not keep its orbit, because the outer edge will move faster than the inner and the differences of friction will provide a rotational force. In turn, this will change the direction of propulsion, and so the satellite will move out of its orbit. The actual form of satellite that would tend to keep its orbit in a frictional medium, I leave to the mathematicians to work out. For the present it suffices to rule out circular bodies because that rules out colloidal parti-

cles as the satellites. But, as already mentioned, the evidence that colloids have determining roles in excitation processes is overwhelming. I, therefore, assign to a charged colloidal aggregate the functions of a nucleus.

A colloidal aggregate is capable of reacting in two ways to what physiologists would term a change of environment and what the physical chemist will term a change in the composition of the dispersing phase; it can react either through adsorption phenomena or through changes of colloidal aggregation, or, and more probably, by both. In my book, *Excitability*,[1] I have summed up an abundance of evidence that living tissues do react to an environmental change in such manners as had the marks of an absorption reaction and a change of aggregation, respectively. My findings further indicated that changes of colloidal aggregation and adsorption reactions were the sources of energy for the excitation processes of living structures. There was, however, a significant difference following on change of the composition of the dispersing phase *in vivo* and a change *in vitro* in that with the former there were marked changes in the energy manifestations of the system. An orbital system explains those differences.

According to other work done by me, calcium is the exciting agent of the cardiac exciting apparatus; also, when it does excite; it exercises a coagulative change in the colloids concerned in excitation processes.[1] Earlier work by Macdonald,[3] however, showed that these colloids have abundance of potassium salts adsorbed on them, and that the shedding of these potassium salts into the dispersing phase automatically causes re-dispersion of the colloidal aggregates. That is to say, the nucleus of the living solar system is capable of undergoing alternations of neutralisation and re-charging. At the same time it should be observed that calcium does not appear to be the neutralising agent in all excitable tissues. Nicotine is the agent which reveals where calcium acts as the neutraliser, and it provides the evidence that something other than calcium neutralises in the nerve trunk.[1]

Neutralisation of the nucleus of this physiological atom will be followed by disruption of that particular atom, the satellites of which will fly off in all directions, and, since they hold charges opposite in sign to the nuclei, they can be expected to be drawn towards and exert a neutralising action on neighbouring nuclei. That is to say, all neighbouring systems should undergo neutralisation and disruption. This is another way of stating that an excitation should be conveyed in all directions, and it is. We have to note, however, that if the structural conformation of any satellite helps it to keep to a particular orbit, it will not travel in straight lines after nuclear neutralisation, but some wider orbit determined by its own proper configuration and propulsive force.

From this point of view the propagation of the nerve impulse along a nerve is to be visualised as a wave of advancing disruption of physiological atoms followed by their restitution in the rear. We may well indeed find some day that the wider orbit made possible to a satellite by a nuclear neutralisation does not extend beyond one or two atoms, and that it may tend automatically to return to its old orbit as the nucleus recovers its charge. In any case, with all atoms being disrupted and all being reconstituted, any atom should on an average recover as much as it originally lost.

Another point to note about these systems is that adsorption phenomena and aggregation changes taking place at the nucleus are both expressed as changed motion or momentum of the satellites. That is to say, we ought to be able to obtain some evidence that both of these changes ultimately appear to be the same thing. There is evidence to that effect, but before considering it the reader's attention is drawn to certain psychological aphorisms given by me elsewhere. Those aphorisms are:

(1) We do not know what things are, we only know what we believe them to be.

(2) What we believe a thing to be is determined for each of us by the nature of the processes working in our organs of mind and thereby mediating that belief to us.

(3) We are born to believe in the existence of external realities corresponding to the processes at work in our organs of mind, but things are not necessarily so.

Applying these aphorisms to the case of the drunk man, we appreciate that he is drunk because he must believe as faithfully in the results of the altered working of his mental machinery produced by a drug as he did in its normal workings when sober. Likewise, the insane man is insane because he cannot help believing in the truth of what abnormal working of his mental machinery appears to him to reveal.

It is not, however, the habit of men to reflect on the fact that Nature has provided them with a definite type of machinery wherewith to do their thinking, and that in consequence the machinery must be a factor determining what is produced from the facts which are put into it. So far as I can judge, philosophers and mathematicians are the men who have probed most deeply into the workings of this mental machinery. The former have reached the conception that the great realities of nature are time and space. In my book, *A New Physiological Psychology*,[2] however, I have pointed out that our conception of time as a great reality is based on adsorption reactions taking place in the nerve cells of our brains, whereas the conception of space is based on changes of colloidal aggregation taking place in those same colloidal systems which form the machinery for our thinking. I have consequently pointed out that there may be other great realities about which we can gain no conception simply because we have not got the thinking machinery which makes this possible. We should, therefore, be prudent in our negations. Even the importance which scientists are wont to attach to comprehensive theories is an automatic consequence of the mental machinery working as it does.[2]

According to these findings, then, the philosophers have looked outside themselves for external realities corresponding to the capacities of the nuclei of our physiological atoms. The mathematicians have done the same with-

out taking into consideration the point that the machinery with which they do their calculating is a factor determining the products or proofs at which they eventually arrive. Considering also that the seeming importance of comprehensive theories is automatically derived from the nature of this machinery,[2] it seems likely that this machinery will more likely mislead us in the realm of higher mathematics than in ordinary arithmetic, though even in respect of the latter very little deviation from the normal is required to render the machinery incapable of calculating the correct change from a five-rupee note. But what it does then calculate is believed to be the truth! In contrast with this, the existence of lightning calculators, could be held to indicate that the normal machinery is a slow-motion affair.

A whole volume, in fact, could be written relative to the part played by the mental machinery in arriving at a mathematical result. It is enough, however, to observe here that the machinery does play a part. We have to observe further that the events taking place in the physiological nucleus are eventually expressed in the one form of altered momentum of satellites. It seems to me, therefore, that the machinery is also built as to lead its possessor eventually to 'discover' that time and space are one. Which point being noted, the reader is left to ponder over the possibility that the modern doctrine of relativity may illustrate the much more ancient Hindu doctrine of Maya.

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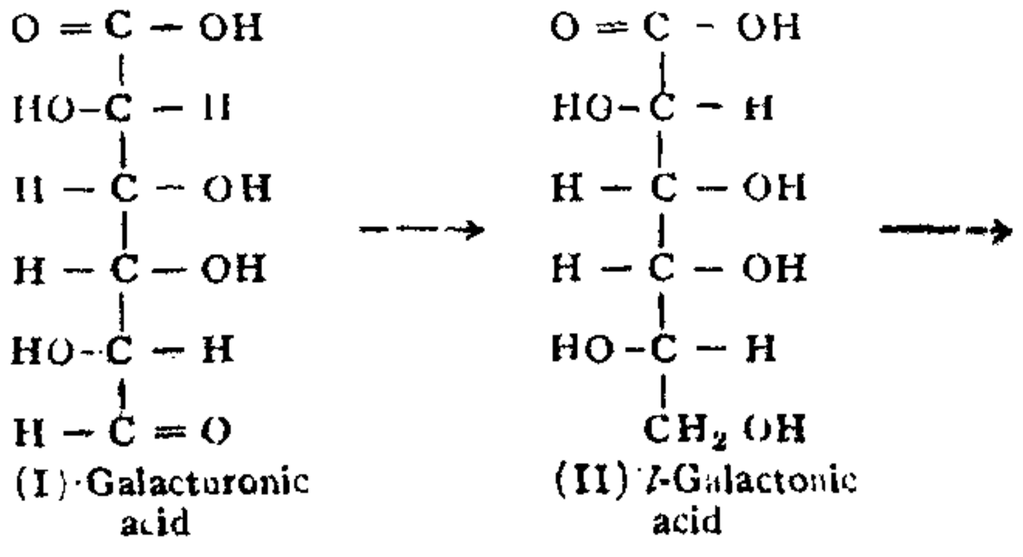
SYNTHESIS OF VITAMIN C FROM PECTIC SUBSTANCES

THE present requirement of vitamin C or *l*-ascorbic acid (V) is met by isolating the substance from fresh fruits and vegetables or preparing it synthetically from sorbitol. A new and a comparatively easier process for the preparation of vitamin C from pectic substances like beet-pulp has recently[1] been developed. The pectic substance is hydrolysed with a commercial pectinase and the resulting galacturonic acid (I) is separated in the form of a difficultly soluble calcium or strontium salt (15-20 per cent. yield). This salt is almost quantitatively reduced with Raney nickel and hydrogen under pressure and the resulting salt of L-galactonic acid (II) is converted by subsequent treatment with oxalic acid to the corresponding γ-lactone (III) (m.p. 134°, $[\alpha]_D^{20} = 78°$) in over 90 per cent. yield. The above lactone is then oxidised in presence of sodium chlorate and vanadium pentoxide to 2-keto-L-galactonic acid (IV) (m.p. 170°; $[\alpha]_D^{20}$ + 5·2°; 25-30 per cent. yield), which by usual treatment with anhydrous methyl alcohol and hydrogen chloride produces the methyl ester (m.p. 145-150°, $[\alpha]_D^{20} = +4·7°$, over 90 per cent. yield); when the latter substance is treated with alcoholic sodium methylate and subsequently ecidified with N-sulphuric acid, it is lactonised and enolised to L-ascorbic acid (vitamin C) (V), identical with the natural product.

The preparations of 2-keto-D-galactonic acid (m.p. 170°, $[\alpha]_D^{20} = 5·2°$), its methyl ester



(I) d-Galacturonic acid → (II) l-Galactonic acid → (III) γ-l-actone → methyl ester → (IV) 2-Keto-l-galactonic acid → (V) L-ascorbic acid (Vitamin C)

(m.p. 145-150°, $[\alpha]_D^{20} = -4·6°$ and D-ascorbic acid (m.p. 191°, $[\alpha]_D^{20} = -23·8$) have also been described in this paper.

It is very interesting to note that 2-keto-L-galactonic acid (IV) and its methyl ester on lactonisation and enolisation yield natural ascorbic acid rather than an isomer thereof.

Many of the reactions of this paper and also the formation of furfural and reductic acid from pentoses and heuronic acids have been interpreted in terms of electronic displacement.

The main importance of the paper lies in the fact that it opens a vast possibility for the utilisation of beet-pulp, obtained from sugar industry, as an easily available raw material for the manufacture of vitamin C. If the yield in the oxidation of L-galactono-γ-lactone (III) to 2-keto-L-galactonic acid (IV) is improved, the process will compare favourably with the sorbose process, now utilised for the synthetic production of this important compound.

S. C. B.

1. Isabell, H. S., *J. Research NBS*, 1944, **33**, 45.