muscular relaxation immediately following MgSO_4 injection makes it unlikely that this can be ascribed to a direct action of Mg^{++} on the contractile protein, for two reasons:

(1) It is generally realized that when Mg^{++} is injected and produces muscular relaxation, it does not paralyse the muscle directly. It acts in a similar manner to curare, which interrupts transmission at the neuromuscular junction. Thus following the injection of Mg^{++} or curare, the response to direct stimulation remains when that to indirect stimulation has disappeared¹¹, the latter is temporarily restored after tetanization¹², and similar chronaxie relations are observed¹³.

(2) After the intravenous injection of MgSO_4 into dogs, the Mg^{++} most probably distributes itself through the extracellular fluid of the body¹⁴ and is thus unlikely to come into contact with myosin.

In a paper which has just reached us, DuBois *et al.*¹⁵ put forward as an explanation for magnesium narcosis the mechanism which we have been considering, namely, that Mg^{++} competes with Ca^{++} and prevents the breakdown of adenosinetriphosphate. This hypothesis must be rejected for the reasons given above. The increased adenosinetriphosphate content of the muscles of animals under magnesium narcosis, which is the sole evidence adduced by the American authors, might well be due to the relaxation; it remains to be shown that curare would not give the same effect.

Furthermore, the antagonism between Ca^{++} and Mg^{++} is not unique for myosin. The adenosinetriphosphatase activity of the electric organ of *Torpedo*¹⁶, which is not due to myosin, is activated by Mg^{++} ¹⁷. We have found that here Ca^{++} is inhibitory.

Electric organ extracted with 1.5 vol. of water. In each tube, 0.4 ml. extract, 1 ml. glycine buffer pH 8.2 (37°); 0.42 mgm. adenosinetriphosphate (as 7 min. P_2O_5), total vol. 2.5 ml. 10 min. at 37°.

	—	M/250 CaCl ₂	M/250 MgCl ₂	MgCl ₂ +CaCl ₂
% of 7 min. P_2O_5 hydrolysed	17	6	45	7

It seems probable that this antagonism is widespread, so that when one of these ions is an activator, the other may be expected to be inhibitory. If in neuromuscular transmission some enzyme process is activated by Ca^{++} , and it is noteworthy that a dependence on the Ca^{++} level has been shown¹⁸, Mg^{++} might be expected to suppress it. Thus for magnesium narcosis our observations may serve only as model experiments. There is, however, one phenomenon in the mammal for which they may offer a direct explanation.

Magnesium deprivation tetany in the rat is in some ways the converse of the paralysis following magnesium injection, the hyper-irritability increasing when the calcium level of the diet is raised¹⁹. Since the threshold of response of the leg muscles to galvanic stimulation of the motor nerve is lowered²⁰, and curare does not decrease the severity of the convulsions²¹, it is possible that the hyper-irritability arises in the muscles. Although the mammalian muscle cell is probably impermeable to injected Mg^{++} ¹⁴, its magnesium content is high²¹. Conceivably a lowering of this level by magnesium deprivation might lead to accelerated adenosinetriphosphate breakdown by myosin, with exaggerated response to motor stimuli and the appearance of tetany.

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RECENT ADVANCES IN IMMUNOCHEMISTRY*

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ALTHOUGH methods for protecting man and animals against certain infectious diseases have been known for many years, it is only within the last decade that the nature of the substances that induce this resistance have been at all clearly defined and their composition and structure expressed in terms of the fundamental sciences, chemistry and physics.

At first it was believed that the strict specificity of bacterial antigens—the substances inducing the formation of the immune bodies that protect against infection with the homologous micro-organism—depended largely on the chemical and physical differences that existed between the bacterial proteins of the different kinds of organisms. This view was abandoned when it was shown that filtrates from virulent bacterial cultures contained a soluble specific polysaccharide substance and appeared to be free from intact protein. The specific polysaccharides which were found to be responsible for the characteristic specificity of each organism were, however, shown to be devoid of antigenicity, or at most to show this property only weakly. The results of these researches on the specific polysaccharide components of the whole bacterial antigen were of the greatest importance because later studies, which developed as a direct result of this work, formed the basis of our present knowledge of antigenic structure.

* Substance of a lecture before the London and South Eastern Counties Section of the Royal Institute of Chemistry on June 16.

Until quite recently no attempt to separate the somatic antigens from the bacterial cell had been successful, but within the last ten years several methods for the isolation of fully active bacterial antigens from Gram negative organisms have been elaborated. The earliest practical method to accomplish this was introduced by Boivin, who extracted bacteria at 0° with 0.2 *N.* trichloroacetic acid (*pH* 1.0–2.0). The extract was apparently free from intact protein and was powerfully antigenic. At about the same time and quite independently, Raistrick and Topley found that by the action of trypsin on certain bacteria it was possible to bring the antigenic complex into solution. The digestion was carried out at *pH* 8.2–8.5 for several days at 37°. Methods of isolation that depend on extraction of the bacteria with cold anhydrous organic solvents, such as diethyleneglycol, in which native proteins and many bacterial somatic substances are insoluble, have also been successfully employed to isolate these important biological complexes.

It is certain that as our knowledge of the nature of the bacterial somatic antigens grows, we shall find very different types of chemical structures associated with bacterial and tissue antigenic complexes. We already know, however, that certain groups of bacteria possess antigens that are built up from similar types of molecules arranged together as polymolecular aggregates. As an example of this similarity in structure the *O* somatic antigens of *Bact. typhosum* and *Bact. dysenteriae* (Shiga) may be mentioned. Each antigen is built up of a polysaccharide, specific for the organism and responsible for its characteristic serological reactions, and a polypeptide-like component (most probably a conjugated protein). Other components of the native antigenic complex, such as phospholipin, also occur, and it is possible that further unidentified substances are present.

In certain instances, however, it has been shown that of all the components present in the native antigenic complex only two, the polysaccharide and protein, are essential for the manifestation of antigenicity. It seems probable, therefore, that a bacterial antigen as it exists in the intact bacterial cell is not a simple compound of rigid chemical composition, but consists of a labile molecular aggregate possessing an essential component—such as a polysaccharide—of definite chemical structure and of fixed composition, which determines the strict specificity of the antigen, together with other loosely bound constituents which endow the essential component with antigenic properties. Only part of these physically associated molecules are necessary for the manifestation of the specific antigenic properties, and certain of these constituents can be dissociated from the labile complex during the isolation and purification of the antigen without producing more than a moderate reduction in the antigenic capacity of the active material. More thorough physical disaggregation of the polymolecular complex into single types of molecules will lead to complete loss of the original antigenicity that gives rise to the homologous immune body.

Considerable support for this conception of antigenic structure was obtained when it was observed that the isolated and undegraded specific polysaccharide component of the antigen could be re-combined with the conjugated protein component, under almost physiological conditions, to form an antigenic complex that would give rise to antibodies specific for the polysaccharide component of the newly formed

complex. Neither component showed any specific antigenic properties when tested alone. Furthermore, it has been found that the non-antigenic, specific polysaccharide of one organism will form an antigenic complex when combined with the conjugated protein component derived from the corresponding somatic antigen of another organism that belongs to an entirely different bacterial species. The nature of the bonds that hold the different types of molecules together as a polymolecular aggregate is unknown. Future work will certainly decide whether the association of the various component molecules is due to 'salt-like linkages', hydrogen bonds, van der Waals' forces or to some as yet unknown mechanism. It can only be stated at the present time that the forces concerned give rise to an aggregate with sufficient stability to make it behave as an independent molecular species.

Further evidence in support of these ideas on antigenic structure is derived from the success with which certain non-antigenic polysaccharides of both vegetable and animal origin have been converted to full antigens by combination with the reactive bacterial conjugated protein mentioned above. The artificial antigens again give rise to immune body that reacts specifically with the polysaccharide component used to build the antigenic complex.

Antibodies against the polysaccharides agar-agar, cherry gum and gum acacia have been described, and more recently immune sera capable of specifically agglutinating human *A* red blood cells but not those of groups *B* and *O* have been prepared by combining a naturally occurring but non-antigenic polysaccharide complex that possesses blood group *A* specificity with a bacterial somatic conjugated protein. It is believed that these powerful anti-*A* sera will be useful in certain blood-group determinations and will prove to be of value in the technique of differential agglutination.

It is clear that bacterial and tissue antigens that are largely polysaccharide in nature belong to a class of substances that are characterized as 'large molecules'. They display unusual properties and it will be necessary to develop new methods for handling them and new chemical conceptions to explain their nature and function.

RADIO RESEARCH ON METRE WAVES

THREE papers by members of the staff of the Radio Department of the National Physical Laboratory appear in the March issue of the *Proceedings of the Wireless Section of the Institution of Electrical Engineers*.

The first paper, on a study of the propagation of ultra-short waves between Guernsey and England, by Dr. R. L. Smith-Rose and Miss A. C. Stickland, was referred to in *NATURE* of January 2, p. 31.

Following this is a paper by Messrs. F. M. Colebrook and A. C. Gordon-Smith, entitled "The Design of Ultra-Short Wave Field-Strength Measuring Equipment". This comprises a description of the essential features of design and construction of apparatus for measuring field-strength, and suitable for any radio-frequencies between 30 and 600 megacycles per second; that is, wave-lengths between 10 and 0.5 metres. The equipment is of a relatively narrow