

substances prednisone and prednisolone, and then discussed still more recent developments. An unsaturated linkage between C₆ and C₇ converts prednisone and prednisolone into even more potent glucocorticoids. Halogenation at C₉ and methylation at C₅ have yielded 9 α -fluoro-6 α -methylprednisolone, which is stated to have a glucocorticoid activity some two hundred times that of hydrocortisone. 9 α -Fluorohydrocortisone is now well known for its potent mineralocorticoid activity. Mr. Hartley referred to numerous other derivatives which have been produced by the steroid chemists, including steroids with additional hydroxyl groups at carbons 2, 5, 12, 14 and 16. The potential value of these remains to be explored. The 19-nor analogues of cortisone and hydrocortisone are less potent than the parent substances.

Mention has already been made of studies on 19-nortestosterone and its derivatives as anabolic agents; esterification with benzoic, *cyclopentylpropionic* or *phenylpropionic* acids prolongs their effectiveness by intramuscular injection. Recent work has shown that 4-chlorination or 6-methylation of testosterone derivatives increases their anabolic/androgenic ratio. The androgenic activity of 11 β :17 β -dihydroxy-9 α -fluoro-17 α -methylandroster-4-en-3-one (fluoxymestron) is stated to be ten times greater than that of methyltestosterone, but in spite of the presence of the 11-hydroxy group, it is said not to give rise to oedema or to hypertension.

In concluding, Mr. Hartley pointed out that every natural steroid hormone possesses not one but a whole range of biological activities, some of them unnecessary or even undesirable in their application therapeutically. Consequently, the need has arisen for steroids 'tailored' to a particular therapeutic requirement. Progress towards meeting this need has been mentioned above. Some of the substances thus artificially created are often many times more active than the natural substances they replace. For the future, Mr. Hartley felt that the most important application of steroids would be in the field of gerontology, neuroendocrinology and population control. This progress will be achieved by the continued close collaboration of steroid chemists, biologists, pharmacists and clinicians. G. I. M. SWYER

RADIO RESEARCH 1956

THE annual reports of the chairman of the Radio Research Board and of the director of radio research are contained in the publication "Radio Research 1956"*. With the completion and occupation of the new buildings at the Radio Research Station, Slough, in the late summer of 1956 (see *Nature*, 180, 163; 1957), the final transfer of the former Radio Division of the National Physical Laboratory at Teddington to Slough has now been completed. In addition to the work at the main Station at Slough, ionospheric observatories have continued to be maintained at Inverness, Port Stanley and Singapore, and further work is carried out under contract with the Department at the Universities of Cambridge, London and Wales. An ionospheric station has also been equipped and

* Department of Scientific and Industrial Research. Radio Research 1956: The Report of the Radio Research Board and the Report of the Director of Radio Research. Pp. iv+47+4 plates. 3s. net. (London: H.M. Stationery Office.)

staffed at the Royal Society base at Halley Bay, Antarctica, in connexion with the International Geophysical Year.

The main emphasis of the research programme has been concerned with ionospheric and tropospheric radio-wave propagation over a very wide frequency band. The efficient forecasting of ionospheric transmission conditions is an important practical task, which has continued to be the concern of the Department. In addition to the routine ionospheric recordings made at the Department's observatories, studies of long-distance communications in the high-frequency band (17-24 Mc./s.) have been made on fixed frequencies, using signals from distant pulse transmitters. A variable-frequency sounding apparatus, which operates in increments of 10 kc./s. every 0.4 sec. in the frequency band 5.5-25 Mc./s., has also been constructed for studying long-distance propagation and given preliminary trials. Another aid to this study, which is now being pursued from the practical point of view, is the technique of back-scatter sounding. In this, conditions for transmission over long distances are investigated by a radar method in which the signals are returned by back-scatter at the ground, obviating the need for a distant transmitter. Good results have been obtained, and an operational equipment has now been built for routine use.

The study of forward-scatter in the ionosphere (*E*-region) of signals in the very-high-frequency band (> 30 Mc./s.) has continued. Measurements of both the amplitude and the angular spread and direction of arrival of the scattered energy have been made in an attempt to elucidate the mechanism responsible. Definite conclusions are not yet possible, but it appears that the night-time signals are more likely to arise from weak reflexions from a large number of trails of ionization produced by low-magnitude meteors, rather than from scattering from turbulent irregularities in the ionosphere. In this work, strong steady signals are frequently received in the summer, due to direct reflexions from sporadic *E*-ionization. Investigations of the forward-scatter in the troposphere of very-high and ultra-high-frequencies have also been started at Slough, in collaboration with the Post Office. Experiments on a frequency of 1,370 Mc./s. received over a path of 150 km. are in progress, with the object of elucidating the propagation process and developing practical communication links based on the phenomenon. The study of the statistical correlation between certain meteorological features and field-strength measurements beyond the horizon of the transmitter has continued, as have also the effects of radio noise due to atmospherics on radio communications.

The possibilities of using very low frequencies (10-20 kc./s.) for long-distance navigational aids are being investigated in co-operation with the Admiralty. It is intended to develop a system which functions on the phase-difference between signals received from two or more widely separated phase-locked transmitters, and preliminary investigations of the variable phase changes introduced by the ionosphere are in progress.

Apart from a summary of the many studies of radio wave propagation undertaken by the Department, "Radio Research 1956" includes a brief description of some of the work sponsored at universities, and of theoretical work on the characteristics of the ionosphere. A particular aspect of the latter is a

study of the effect of solar eclipses on the ionosphere, which yields information on the brightness of the Sun's disk and on the physical properties of the ionized layers. Work has also continued on the development of power-measuring standards for continuous-wave and noise powers in the cm. wave-band. Another aspect of work of the Department which is described is a study of semi-conductors and ferrites. Silicon is assuming an increasingly important

role in the development of transistors, and particular attention has been paid to operation at high frequencies (up to 100 Mc./s.).

"Radio Research 1956" is thus a brief survey of the investigations for which the Radio Research Station has been responsible during the year. A complete list of papers on its work published in scientific journals during 1956 is given as an appendix to the report. GEOFFREY M. BROWN

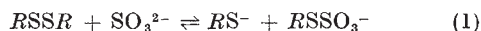
THIOLS, DISULPHIDES AND THIOSULPHATES: SOME NEW REACTIONS AND POSSIBILITIES IN PEPTIDE AND PROTEIN CHEMISTRY

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THIS communication is concerned with the conversion of thiols and disulphides to organic thio-sulphates, and with various reactions of the thio-sulphate group, both in simple compounds and in proteins. A recent method for the specific and symmetrical fission of disulphide bonds has led to a new process for dissolving keratins, and to a method for tagging proteins reversibly with radiosulphur. Convenient syntheses of mixed disulphides, especially unsymmetrical cystine peptides and peptide intermediates, a simple method for studying thiols and disulphides on paper chromatograms, and reactions which may lead to the specific fission of peptide chains at cystine or cysteine residues are also described.

Cystine is known to react reversibly with aqueous sulphite to give cysteine and an equimolar amount of 'cysteine *S*-sulphonic acid' (β -amino- β -carboxyethyl thiosulphate) (reaction 1; $R = \text{HO}_2\text{CCH}(\text{NH}_2)\text{CH}_2-$). The latter compound is more conveniently termed *S*-sulphocysteine, since this allows the corresponding residue to be easily named in a peptide sequence. This reaction seems to be general for water-soluble disulphides, although the point of equilibrium may be very different in different cases¹⁻³.



Kolthoff and Stricks⁴ have shown that trace amounts of cystine and cysteine can be estimated in alkaline solution by amperometric titration with cupric ions in the presence of sulphite. The cupric ions are reduced to cuprous, and the sole product from both cysteine and cystine is *S*-sulphocysteine:



Both reactions go to completion rapidly and offer a number of possibilities in preparative chemistry and in the study of peptides and proteins containing cysteine or cystine.

Extraction of keratin derivatives. The cystine disulphide bonds in wool are broken symmetrically by reaction with cupric-ammonium-sulphite (reaction 2). A typical example is as follows: when 1 gm. cf merino 64's wool is treated overnight at room

temperature with 200 ml. of a solution which is 0.02 *M* in cupric ammonium hydroxide, 0.05 *M* in sodium sulphite and contains also 8 *M* urea to swell the wool and assist penetration of the other reagents (*pH* of solution 9.8-10.5), about 75 per cent of the wool substance is dissolved. With a reaction time of 2-6 days, 85-90 per cent of the wool can be dissolved. The reagent will also dissolve chicken feathers and powdered horn to the extent of 95 per cent and 85 per cent, respectively. The protein ('*S*-sulphokerateine') can be precipitated from the extracts by acidification and dilution, or by addition of ammonium sulphate. It may be freed from copper without precipitation by dialysis against citrate or ethylenediaminetetraacetate at *pH* 7-9. The protein derivative is soluble down to *pH* 5, and further study of this material is in progress. Urea may be omitted from the cupric-ammonium-sulphite reagent; extraction of the protein is then slower, but 70-90 per cent can be brought into solution over a period of about six days. The ammonia may be replaced by ethylenediamine, and the extraction process can be carried out at +2°. The thiol-rich protein ('kerateine') obtained from wool by extraction with alkaline thioglycollate⁵ is rapidly transformed by cupric-ammonium-sulphite (reaction 2) to an *S*-sulphokerateine similar to the protein obtained directly from wool as described above.

Labelling proteins with sulphur-35. If sulphite containing sulphur-35 be used in the above reactions, the protein acquires a radioactive label in the thio-sulphate group. In addition to the obvious usefulness of such a label, for example, in following fractionation procedures, the reaction should provide an extremely sensitive test for the presence of thiol or disulphide in a protein or other compound. In order to study the stability of the protein thiosulphate radical, *S*-sulphokerateine containing sulphur-35 was first dialysed for ten days at 2° against 0.1 *N* potassium hydrogen carbonate, *pH* 7.9, until the radioactive material dialysing during each 24 hr. amounted to only 0.08 per cent of the total. Aliquots of this solution were then dialysed for 40 hr. at 2° against various reagents. Over the *pH* range 1-9, the measured decomposition was quite small (0.9-3.2 per