tables are a good selection and are up to date, the discussion in the text is still too closely modeled on that of the first edition, which was written when many important facts were yet unknown and the significance of certain of the older data was still unappreciated. In particular there are several paragraphs, tables and graphs which might lead the unwary reader to suppose—falsely, I think—that Dr. Wiener holds the now abandoned theory that all American Indians, before white contact, possessed only blood group O. The data of Rahm, Golden, Matson and Schrader, and the calculations of Wyman and Boyd, which combined to render this theory untenable, are however referred to, and one may feel sure that the imperfection will be corrected in future editions.

The book is characterized by very complete references to the literature, in the form of footnotes to the text, as well as a bibliography of works of general reference. There is a very excellent subject index. Typography and format are of the same high quality as in previous editions, and the paper and binding appear to be excellent.

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CHEMISTRY

Physical Chemistry. By FRANK H. MACDOUGALL. Revised edition. 709 pp. New York: The Macmillan Company. 1943. $4.25.

THE good reception of the first edition (1936) of this text-book has led to the publication of its second edition (see preface). One who is familiar with the first edition will find the second almost unchanged, for "the author has not considered it necessary to make many substantial changes in the material discussed or in the manner of treatment." In particular, many will be glad to see that the large section devoted to chemical equilibrium has been retained without an alteration.

The principal revisions are the following: The table of natural isotopes has been brought up to date, the table of standard E.M.F.'s has been enlarged, three pages on liquid crystals and glasses have been added, the section on artificial radioactivity has been rewritten, one page on the glass electrode has been added, and the derivation of the Gibbs adsorption equation has been made more rigorous.

Several smaller improvements have been made. Equation II–(11) and Equation VII–(20), which contained errors in the first edition, have been corrected. Three problems have been added. The symbol E has been used instead of U for the energy of a system, so the text now follows the Lewis and Randall notation used by most American thermodynamics texts (including that of the author). The numerical values of the general physical constants have been brought more nearly up to date, though those given do not agree with Birge's latest (1941) values.

Since so few major revisions have been made in the text, several deserving topics have been given no more space in the second edition than they had in the first. For example, quantum mechanics has not been treated at any great length, while the theory of reaction rates has been omitted entirely. It is to be hoped that the author will devote additional space to some of these topics in future revisions.

It is disappointing to see that the old bombardment theory of osmotic pressure has been retained.

The decomposition of N_2O as an example of a second order reaction (p. 415 and Problem 7 on p. 446) should be abandoned, since experimental work more recent than that cited in the text has shown the reaction to be of 3/2 order (*cf.* Pease, "Equilibrium and Kinetics of Gas Reactions," Princeton University Press, 1942, pp. 129–134). In fact, a portion of the chapter on kinetics might well be devoted to 3/2 order reactions.

If the old equation of Bodenstein and Fink for the kinetics of oxidation of SO_2 on platinum is quoted, mention should also be made of the recent and much more satisfactory equation of Uyehara and Watson.[1]

These few omissions do not, of course, seriously impair the value of the book. The first edition was, and the revised edition remains, a well-written and useful text-book for beginning physical chemistry.

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SPECIAL ARTICLES

THE SEROLOGICAL ACTIVITY OF DENATURED ANTIBODIES[1,2]

As a logical sequence to recent investigations on the effects of regeneration on the antigenic activity of serum albumin,[3,4] we have studied the influence of denaturation and regeneration on the immunolgical functions of antibodies.

The source of antibody was a concentrate of diva-

[1] This work was supported by the Rockefeller Foundation and by the Lederle Laboratories, Inc.

[2] Taken from a thesis to be presented by J. O. Erickson to the Graduate School of Arts and Sciences of Duke University, in partial fulfilment of the requirements for the degree of doctor of philosophy.

[1] *Ind. Eng. Chem.*, 35: 541, 1943.

[3] J. O. Erickson and H. Neurath, *Jour. Exp. Med.*, 78: 1, 1943.

[4] D. S. Martin, J. O. Erickson, F. W. Putnam and H. Neurath, *Jour. Gen. Physiol.*, 26: 533, 1943.

lent types I and II antipneumococcus horse serum, obtained through the courtesy of the Lederle Laboratories, Inc. Over 80 per cent. specifically precipitable antibody of type I was isolated by successive precipitations with SSS I in the antibody excess region, and subsequent dissociation of the specific precipitate with 15 per cent. NaCl solution.[5,6] Guanidine hydrochloride, whose action on normal horse serum globulin, GI, has previously been studied,[7] was used as a denaturing agent.

Irreversibly denatured and regenerated antibody were prepared by treatment of a 2 per cent. solution of the native antibody with 8 M guanidine hydrochloride, removal of the denaturing agent by dialysis and separation of the irreversibly denatured fraction by isoelectric precipitation.[7] The regenerated protein, remaining in the supernatant solution, was readily soluble in water and in physiological saline; the highly insoluble irreversibly denatured protein could be dissolved in 2 per cent. NaCNS in saline, to the extent of about 0.3 mg of protein N per ml, at pH 6.5.

After it was found that all fractions were specifically precipitable by the homologous antigen (SSS I), quantitative precipitin titrations were performed, using the method of Heidelberger and Kendall.[8] Comparison of the serological activity of native and regenerated antibody was made in physiological saline solutions, that of native and irreversibly denatured antibody in 0.9 per cent. solutions of NaCl containing also 2 per cent. NaCNS. Representative data relating to the equivalent combining ratios of mg antibody N to mg antigen, R, and to the per cent. of specifically precipitable antibody nitrogen, N, are given in Table 1.

TABLE 1

Preparation	Solvent	R	Per cent. antibody N specifically precipitable
Native antibody ..	0.9 per cent. NaCl	3.3	80
Native antibody ..	0.9 per cent. NaCl + 2 per cent. NaCNS	2.9	37
Irreversibly denatured antibody .	0.9 per cent. NaCl + 2 per cent. NaCNS	1.3	50–60
Regenerated antibody	0.9 per cent. NaCl	6.0	70

The data reveal no significant difference in the equivalent combining ratio of native antibody in saline and in the presence of NaCNS. When the supernatant of the specific precipitate, obtained at the equivalence point in the presence of NaCNS, was dialyzed against saline, no additional precipitation occurred unless more antigen was added, indicating that NaCNS had shifted the equilibrium between antigen and antibody rather than inhibited the precipitation of the antigen-antibody complex.

The difference in combining ratio between native, irreversibly denatured and regenerated antibody may be ascribed either to a change in effective antibody valence or else to changes in their molecular dimensions, as they have been found to occur when normal horse serum globulin GI is treated with concentrated solutions of guanidine hydrochloride. Molecular weight studies on these fractions are under way.

It is of considerable significance that the denatured and regenerated antibody were serologically active, and the general theoretical and practical aspects of this finding will be discussed elsewhere.

The fact that the regenerated antibody is nearly as fully precipitable by the homologous antigen (70 per cent.) as the native (80 per cent.), and the irreversibly denatured material even more so, when measured under comparable external conditions (50 to 60 per cent. as compared to 37 per cent.), suggests that, contrary to Pauling's hypothesis,[9] the difference between antibody globulin and normal globulin is not merely one of steric arrangement but probably one of amino acid composition. If denaturation of normal serum globulin, followed by regeneration in the presence of an antigen, should give rise to a fraction of a material possessing antibody activity,[10] then, conversely, regeneration of a denatured antibody in the absence of the specific antigen should, in keeping with that hypothesis, yield a material essentially devoid of serological activity. This, however, is not the case.

It remains to be seen whether the denatured and regenerated antibodies are effective in animal protection; requisite experiments are under way. Experiments on the relative antigenic activities of these fractions and on their antigenic relation to native and denatured normal serum globulins will be reported elsewhere.

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[5] B. F. Chow and H. Wu, *Chinese Jour. of Physiol.*, 11: 161, 1937.

[6] M. Heidelberger and F. E. Kendall, *Jour. Exp. Med.*, 64: 161, 1936.

[7] H. Neurath, G. R. Cooper and J. O. Erickson, *Jour. Biol. Chem.*, 142: 265, 1941.

[8] M. Heidelberger and F. E. Kendall, *Jour. Exp. Med.*, 61: 559, 563, 1935.

[9] L. Pauling, *Jour. Am. Chem. Soc.*, 62: 2643, 1940.

[10] L. Pauling and D. H. Campbell, *Jour. Exp. Med.*, 76: 211, 1942.

PROTECTIVE EFFECT OF SEPARATE INOCULATION OF SPOTTED FEVER VIRUS AND IMMUNE SERUM BY INTRADERMAL ROUTE

THE purpose of the present work is to investigate the possibility of protecting a susceptible animal against spotted fever by using minute doses of specific