Disinfection and Sterilization

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With a Foreword by

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FOREWORD

by

SIR GRAHAM WILSON

In my foreword to the first edition in 1958, I gave a brief review of the history of disinfectants during the last 100 years, and noted the comparatively recent introduction not only of new germicidal agents but of new ways of sterilization, disinfection and preservation of materials in common use. Because Mr. Sykes had fulfilled his task admirably, I had no hesitation in commending his book to those who, whether engaged in medicine, pharmacy, sanitary engineering, dairying, brewing or the food industry, wanted reliable and up-to-date information to help them in the multitude of problems that beset them in their various fields of activity. The fact that a second edition has been called for in so short a time leaves no doubt that the book is meeting a widespread need.

It would probably be true to say that more attention is being paid now to the use of physical than to chemical methods of removing, immobilizing, or destroying unwanted micro-organisms. Experience of chemical disinfectants, particularly in medicine and the dairy industry, has shown their inferiority to heat in the destruction of bacteria; and it is only right therefore that Mr. Sykes should expand, as he has done, the sections of his book dealing with such physical means of sterilization and disinfection as heat, filtration, and the various forms of irradiation and ultrasonic treatment now available.

He is wise too to set his face against the use of such imprecise terms as "Sterilant" and "Sanitization". The definitions that he has given of the terms he employs are ones that are etymologically correct and will be accepted by other scientific workers. To call a substance a sterilant that does not sterilize is misleading; and what the term sanitization means beyond mere cleansing it is impossible to say. It throws no light on the degree of bacterial destruction involved, if any, and it is but one more example of the use of a long, inexact word of Latin derivation to obscure the mental haziness of those who have never troubled to think what they mean.

Personally I welcome the publication of this new and enlarged version of Mr. Sykes's original book. It is an expression of his erudition and his literary ability to which all will pay tribute. It is doubtful whether anyone else in this country could have dealt so competently with so many controversial issues in so many different fields; and I hope the book will meet with the success that it deserves.

GRAHAM S. WILSON

PREFACE TO SECOND EDITION

ALTHOUGH it is less than six years since the first edition of this book appeared, investigations in nearly all of the fields has continued at an increasing rate and much new thinking has taken place. This second edition is, therefore, something more than the first edition "brought up to date". Most of the chapters, although retaining substantially the same titles and order of presentation, have been largely rewritten with emphasis on the revised outlooks and the newer evidences without sacrificing unduly the earlier foundational references.

In particular, attention is drawn to the changing attitudes towards the testing of disinfectants and antiseptics, as given in Chapters 3 and 4, and the substantial new information which has come to light concerning methods of sterilization, with special emphasis on several aspects of sterilization by heat and by radiations; new agents for gaseous sterilization has also been introduced.

In Part V dealing with Chemical Disinfectants the sections on 'germicidal' soaps and disinfectant fluids has been completely remoulded and new data has been added in other section. Similarly in the chapter on surface active compounds a new section on amphoteric compounds has been added, together with some new information on quaternary ammonia compounds. The chapter on the heavy metals salts has also been extended.

Finally, a great deal more is now known about various aspects of preservation, particularly in relation to foods and pharmaceutical materials and this has been mainly included in a rewritten chapter (17) on the subject.

Again I wish to thank my various colleagues and associates who have given valuable assistance and information. In particular I would commend Miss Barbara Hooton and Mr. R. Smart for their help in preparing the manuscript and in checking the proofs.

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July, 1964

PREFACE TO FIRST EDITION

With the many advances which are being made in the broad fields of hygiene, sanitation and medicine and the profound changes which are taking place in our everyday mode of living, more and more emphasis is being placed on the need for adequate and reliable methods for disinfection, preservation and sterilization. It is a matter which impinges on the social and economic welfare of the whole community and is seen in the continuous scientific and technical progress being made in the various sections of the food, pharmaceutical and chemical industries as well as in the several disciplines of medicine and public health.

The greatest advances have undoubtedly occurred during the last two or three decades and it is the purpose of this book to present a considered appraisal of these developments. In approaching the subject I have confined myself – if confined is still the right word to use in such a large field – to the chemical and physical aspects of disinfection and sterilization to the almost total exclusion of any discussion on chemotherapy or the role of antibiotics; these topics are now almost separate subjects in themselves and have already filled several volumes.

Perhaps it may appear that an unduly large proportion of the book is taken up with discussions on the theory and mode of action of disinfection, not only in the chapter bearing that title but also in other chapters; but this is deliberate, for this aspect of the subject is gradually assuming greater importance, and it seems that future developments are likely to take place from such considerations rather than from the erstwhile more empirical approach. It also seemed desirable to collect together as many as possible of the tried and proved methods of testing disinfectants and antiseptics, and this is done in Chapters 3 and 4; attention is also given in these chapters to some of the more historical methods of testing and to other potentially useful ones. With regard to the techniques available for disinfection, preservation and sterilization, I have endeavoured to cover the most recent developments in both the chemical and physical fields as completely as possible, devoting individual chapters to the important topics of radiation sterilization and the disinfection of viruses.

The usual abbreviations have been adopted for expressing units of time, volume, etc., and temperatures are quoted in degrees Centigrade except in the few places where they are specifically stated to be in degrees Fahrenheit. For bacterial nomenclature I have used the Topley and Wilson system, preferring *Pseudomonas pyocyanea* to *Pseudomonas aeruginosa*, *Chromobacterium prodigiosum* to *Serratia marsescens* and so on, but using *Escherichia coli* instead of *Bacterium coli*.

In preparing the text I have made frequent reference to the literature, and in this respect have greatly appreciated the facilities available through the libraries of Boots Pure Drug Co. Ltd. I wish to record thanks to Dr. R. S. Hannan and Dr. Margaret Thornley for their useful criticisms of the manuscript of the chapter on Radiation Sterilization, and to Dr. Löis Dickinson who has given similar help with the chapter on the Disinfection of Viruses. I am also indebted to several authors and publishers for permission to reproduce certain Tables and Figures, in particular to the editors of the *Proceedings of the Royal Society* for permission to reproduce Plate 1, to Dr. Harriette Chick and the editors of the *Journal of Hygiene* for Figure 1 and Table 1, to Dr. R. M. Savage and the editor of the *Journal of Pharmacy and Pharmacology* for Figure 6, to Dr. G. E. Stapleton, Dr. M. Levine and the editor of the *Journal of Bacteriology* for Figures 10, 15 and 16, and to the editors of the *Journal of Applied Bacteriology* for Figure 17 and Table 16. The help given by Mrs. Maureen Pole, Miss Pamela Chapman, Mr. D. V. Carter, Mr. H. M. Bunbury and other colleagues in assembling the manuscript and checking the proofs has been invaluable and I thank them all. Finally, I must mention Mr. C. E. Coulthard, under whose guidance I first began to learn something of the subjects about which I now venture to write.

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March, 1958.

LIST OF LITERATURE ABBREVIATIONS

Acta microbiol., hung.	Acta microbiologica, Academicae Scientiarium Hungaricae
Acta path. microbiol. scand.	Acta pathologica et microbiologica scandinavica
Adv. appl. Microbiol.	Advances in Applied Microbiology
Adv. food Res.	Advances in Food Research
Amer. J. clin. Path.	American Journal of Clinical Pathology
Amer. J. Hyg.	American Journal of Hygiene
Amer. J. med. Sci.	American Journal of the Medical Sciences
Amer. J. Obstet. Gynec.	American Journal of Obstetrics and Gynecology
Amer. J. Ophthal.	American Journal of Ophthalmology
Amer. J. Path.	American Journal of Pathology
Amer. J. Pharm.	American Journal of Pharmacy
Amer. J. Physiol.	American Journal of Physiology
Amer. J. publ. Hlth	American Journal of Public Health
Amer. J. Surg.	American Journal of Surgery
Amer. Rev. Tuberc.	American Review of Tuberculosis
Analyst	The Analyst
Ann. appl. Biol.	Annals of Applied Biology
Ann. Inst. Pasteur	Annales de l'Institut Pasteur
Ann. N.Y. Acad. Sci.	Annals of the New York Academy of Sciences
Ann. Rev. Biochem.	Annual Review of Biochemistry
Ann. Rev. Microbiol.	Annual Review of Microbiology
Antonie van Leeuwenhoek J. Microbiol. Serol.	Antonie van Leeuwenhoek Journal of Microbiology and Serology
Antibiot. Chemoth.	Antibiotics and Chemotherapy
Appl. Microbiol.	Applied Microbiology
Arch. Biochem.	Archives of Biochemistry
Arch. Dermatol. Syphylol.	Archives of Dermatology and Syphylology
Arch. ind. Hyg.	Archives of Industrial Hygiene and Occupational Medicine
Arch. Mikrobiol.	Archiv für Mikrobiologie
Arch. Surg., Lond.	Archives of Surgery, London
Aust. J. exp. Biol. med. Sci.	Australian Journal of Experimental Biology and Medical Science
Bact. Rev.	Bacteriological Reviews
Biochem. J.	Biochemical Journal
Biochem. Z.	Biochemische Zeitschrift
Biodynamica	Biodynamica
Biol. Abs.	Biological Abstracts
Biometrics	Biometrics
Boll. Ist. sieroter. milan	Bollettino dell'Istituto sieroterapico milanese
Brit. J. exp. Path.	British Journal of Experimental Pathology
Brit. J. ind. Med.	British Journal of Industrial Medicine
Brit. med. J.	British Medical Journal
Brit. J. Pharmacol.	British Journal of Pharmacology and Chemotherapy

Brit. J. Urol.	British Journal of Urology
Brit. Vet. J.	British Veterinary Journal
Bull. Acad. méd., Paris	Bulletin de l'Académie de médecine
Bull. Hyg.	Bulletin of Hygiene, London
Canad. J. med. Sci.	Canadian Journal of Medical Sciences
Canad. J. Microbiol.	Canadian Journal of Microbiology
Chem. Abs.	Chemical Abstracts (American)
Chem. Fabrik	Chemische Fabrik
Chem. & Ind.	Chemistry and Industry
Compt. rend. Acad. sci.	Comptes rendus hebdomadaires des séances de l'Académie des sciences
Compt. rend. Soc. Biol.	Comptes rendus hebdomadaires des séances de la Société de biologie
Dansk Tidss. Farm.	Dansk Tidsskrift for Farmaci
Deut. med. Woch.	Deutsche medizinische Wochenschrift
Drug Stds	Drug Standards
Elect. Engng, N.Y.	Electrical Engineering, New York
Electronics	Electronics
Exp. cell Res.	Experimental Cell Research
Food Ind.	Food Industry
Food Mfg.	Food Manufacture
Food Res.	Food Research
Food Technol.	Food Technology
Gen. elec. Rev.	General Electrical Reviews
Gesund. Desinf.	Gesundheitswesen und Desinfektion
Heat. air Treat. Engr	Heating and Air Treatment Engineer
Heat. Pip. air Cond.	Heating, Piping and Air Conditioning
Heat. vent. Engng	Heating and Ventilating Engineering
Hosp. Engr	The Hospital Engineer
Ind. Chem.	Industrial Chemist
Ind. engng Chem.	Industrial and Engineering Chemistry
Ind. engng Chem. (Anal.)	Industrial and Engineering Chemistry (Analytical Edition)
Int. J. appl. Rad. Isot.	International Journal of Applied Radiation and Isotopes
Iowa engng exp. Sta. Bull.	Iowa Engineering Experimental Station Bulletin
Iowa State Coll. J. Sci.	Iowa State College Journal of Science
Johns Hopkins Hosp. Bull.	Johns Hopkins Hospital Bulletin
J. Amer. chem. Soc.	Journal of the American Chemical Society
J. Amer. diet. Ass.	Journal of the American Dietary Association
J. Amer. med. Ass.	Journal of the American Medical Association
J. Amer. pharm. Ass. (Pract.)	Journal of the American Pharmaceutical Association (Practical Edition)
J. Amer. pharm. Ass. (Sci.)	Journal of the American Pharmaceutical Association (Scientific Edition)
J. Amer. vet. med. Ass.	Journal of the American Veterinary Medical Association
J. Amer. Water Wks Ass.	Journal of the American Water Works Association
J. appl. Bact.	Journal of Applied Bacteriology
J. appl. Chem.	Journal of Applied Chemistry
J. appl. Phys.	Journal of Applied Physiology

J. Ass. off. agric. Chem.	Journal of the Association of Official Agricultural Chemists
J. Bact.	Journal of Bacteriology
J. biol. Chem.	Journal of Biological Chemistry
J. cell. comp. Physiol.	Journal of Cellular and Comparative Physiology
J. chem. Soc.	Journal of the Chemical Society
J. clin. Path.	Journal of Clinical Pathology
J. Dairy Res.	Journal of Dairy Research
J. Dairy Sci.	Journal of Dairy Science
J. exp. Med.	Journal of Experimental Medicine
J. gen. Microbiol.	Journal of General Microbiology
J. gen. Physiol.	Journal of General Physiology
J. Hyg., Camb.	Journal of Hygiene
J. Immunol.	Journal of Immunology
J. ind. Hyg.	Journal of Industrial Hygiene
J. infect. Dis.	Journal of Infectious Diseases
J. Inst. chem. Engrs	Journal of the Institution of Chemical Engineers
J. Inst. Water Engrs	Journal of the Institution of Water Engineers
J. invest. Dermatol.	Journal of Investigative Dermatology
J. lab. clin. Med.	Journal of Laboratory and Clinical Medicine
J. Milk Tech.	Journal of Milk (and Food) Technology
J. Obstet. Gynaec. Brit. Emp.	Journal of Obstetrics and Gynaecology of the British Empire
J. Nutrit.	Journal of Nutrition
J. oil col. Chem. Ass.	Journal of the Oil and Colour Chemists Association
J. Path. Bact.	Journal of Pathology and Bacteriology
J. Pharm. Pharmacol.	Journal of Pharmacy and Pharmacology
J. pharm. Sci.	Journal of Pharmaceutical Sciences
J. Pharmacol.	Journal of Pharmacology and Experimental Therapeutics
J. phys. Chem.	Journal of Physical Chemistry
J. roy. san. Inst.	Journal of the Royal Sanitary Institute
J. Sci. Food Agric.	Journal of the Science of Food and Agriculture
J. Text. Inst.	Journal of the Textile Institute, Manchester
Lancet	The Lancet
Med. norsk farm. Selsk.	Meddeleleser fra Norsk farmaceutisk Selskap
Mich. State Coll. Tech. Bull. Agr.	Michigan State College Technical Bulletin Agriculture
Milchwiss.	Milchwissenschaft
Nature, Lond.	Nature
Nord. hyg. Tids.	Nordisk hygienisk Tidskrift
Nucleonics	Nucleonics
Pharm. Acta Helv.	Pharmaceutica Acta Helvetiae
Pharm. J.	Pharmaceutical Journal
Pharm. Monat.	Pharmazeutische Monatshefte
Phil. Mag.	Philosophical Magazine
Physiol. Rev.	Physiological Reviews
Phytopath.	Phytopathology

Phytopath. Z.	Phytopathologische Zeitschrift
Practitioner	The Practitioner
Proc. nat. Acad. Sci.	Proceedings of the National Academy of Sciences, Washington
Proc. Roy. Soc.	Proceedings of the Royal Society
Proc. roy. Soc. Med.	Proceedings of the Royal Society of Medicine
Proc. Soc. agric. Bact.	Proceedings of the Society of Agricultural Bacteriologists
Proc. Soc. appl. Bact.	Proceedings of the Society for Applied Bacteriology
Proc. Soc. exp. Biol., N.Y.	Proceedings of the Society for Experimental Biology and Medicine
Publ. Hlth Rep., Wash.	Public Health Reports
Quart. J. Pharm.	Quarterly Journal of Pharmacy and Pharmacology
Radiology	Radiology
Rad. Res.	Radiation Research
Research, Lond.	Research
Rev. sci. Inst.	Review of Scientific Instruments
Science	Science
Soap	Soap and Sanitary Chemicals *later* Soap and Chemical Specialities
Soap, Perf. Cosm.	Soap, Perfumery and Cosmetics
Surgery	Surgery
Surg. Gynec. Obstet.	Surgery, Gynecology and Obstetrics
Trans. Faraday Soc.	Transactions of the Faraday Society
Trans. Inst. chem. Engrs, Lond.	Transactions of the Institution of Chemical Engineers
Tubercle	Tubercle
U.S. publ. Hlth Rep.	United States Public Health Report
Vet. Rec.	Veterinary Record
Virology	Virology
Yokohama Med. Bull.	Yokohama Medical Bulletin
Zent. Bakt.	Zentralblatt für Bakteriologie, Parasitekunde und Infektionskrankheiten
Z. ges. Hyg.	Zeitschrift fur die gesamte Hygiene und ihre Grenzgebiete
Z. Hyg. InfektKr.	Zeitschrift für Hygiene und Infektionskrankheiten
Z. physiol. Chem.	Hoppe-Seyler's Zeitschrift für physiologische Chemie

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