FOOD POISONING
and
FOOD HYGIENE

by

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PREFACE

Food hygiene is a much debated subject in these days of increased food poisoning hazards. It is belittled by some and over-emphasized or the emphasis given to irrelevant points by others.

It was with a genuine desire to bring essential facts about food poisoning and its prevention to all those at work in the kitchen of every type of establishment that this work was undertaken.

The facts are derived from the practical experience and knowledge gained by many workers in the field of public health during the past century. The method of presentation has been influenced by more recent experience gained in efforts to interest the food-handling public in a technical subject which should be so much their concern.

It was hoped that the knowledge given in this way would lead to a better understanding of the necessity for cleanliness in the preparation and service of food, so that the incidence of food poisoning might be much reduced.

This book is written, therefore, for all those who are keenly interested in their work in the kitchen or food shop, and also for those who teach the principles which govern the control of food poisoning; among whom may be included the local authority health officers, canteen supervisors, managers of food stores, and teachers in schools of catering and domestic science.

I am deeply grateful to Mr. L. Kluth, Sanitary Inspector of Wembley Public Health Department for writing Chapters XII and XIII and for designing the three drawings included in these chapters; for his help and criticisms in many ways and not the least for his kindly and persistent encouragement.

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Mr. W. Clifford, Central Public Health Laboratory has spent much time and effort on the design and drawing of charts and diagrams which have proved invaluable for the pictorial illustration of food

poisoning outbreaks and their prevention; many of these illustrations are reproduced, and I thank Mr. Clifford also for certain photographs.

I am grateful to all those who have given their permission for the use of published material and in particular to the Director of the Public Health Laboratory Service and the Director of the Epidemiological Research Laboratory of the Public Health Laboratory Service, for all data relating to incidence of food poisoning from 1939 onwards, and to the Chief Medical Officer of the Ministry of Health for permission to use the food poisoning figures in his Annual Report for the year 1951, to the Ministry of Food for the figures of licensed and operating catering establishments from 1941 to 1951, and also for their permission together with that from Her Majesty's Stationery Office to publish the Target Code from the Catering Trade Working Party Report; to Dr. Williams Smith, The Animal Health Trust, and the *British Medical Journal* for permission to publish the figures given in Tables 7 and 8, and to Dr. Joyce Wright, St. Ann's Hospital, London, for information on the bacteriology of infants' feeds, feeding bottles and teats. I also acknowledge with thanks the help of the Central Council for Health Education who willingly granted permission for the reproduction of many photographs from their filmstrips on the "Hygiene of Food-handling"; Professor G. Knaysi, Cornell University, and his publishers, for permission to reproduce photographs of bacterial division from the book "Elements of Bacterial Cytology"; and the authors and publishers of "The Principles of Bacteriology", Topley and Wilson, for permission to reproduce two micro-photographs; Mr. H. P. Sherwood, Ministry of Agriculture and Fisheries for providing a suitable photograph of the shell-fish purification station, Conway; the British Red Cross Society for taking a new photograph of a First Aid Box; Mr. R. T. Payne for two photographs (Figs. 34 and 37); Dr. J. Sleigh, Andover Public Health Department, for a photograph of an exhibition unit; the Hotels Executive of the British Transport, the Central Office of Information and the Picture Post Library for photographs, and also the many firms who have submitted photographs, charts, pamphlets and other useful material—they are listed below:

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PART I

Food Poisoning and Food-borne Infection

CHAPTER I

INTRODUCTION

Food hygiene is a subject of wide scope. It covers the proper handling of every variety of foodstuff and drink, and all the utensils and apparatus used in their preparation, serving and consumption.

Food should be nourishing and attractive, it must be clean and it must also be free from any noxious or harmful substances. These harmful substances may be poisonous chemicals that have entered the food accidentally during the preparation or cooking, they may be disease-producing germs introduced accidentally by workers during the preparation of the food or from animals, or they may be poisons actually produced by these germs.

This little book has been written for those engaged in food-handling with the purpose of explaining in simple language, in so far as our knowledge permits, what these various dangers are, how they arise, and how they can be prevented.

Noxious substances in food give rise to illness called food poisoning, which is usually characterized by vomiting and/or diarrhoea, and various abdominal disturbances. Food poisoning is no new disease and has been recognized throughout the ages. Centuries ago the laws of the Israelites contained detailed information on foods to be eaten and foods to be abhorred, as well as on their methods of preparation and the cleanliness of the hands of the consumers. About 2000 B.C., as recorded in the Book of Leviticus, Moses not only made many laws which protected his people against the ravages of infectious disease but laid down rules about the washing of hands after killing animals for sacrifices and before eating. Many of these laws were based on a practical knowledge of personal hygiene and the necessity for cleanliness of those suffering from certain diseases.

The accounts of food poisoning recorded in ancient history have generally been associated with chemical poisons—more especially with those deliberately introduced—but there is little doubt that this assumption was due to the fact that our knowledge of non-chemical,

that is bacterial, food poisoning dates back no farther than the latter part of the nineteenth century. Indeed the term ptomaine, i.e. alkaloid, poisoning was often used and may still be seen in the popular press to describe an outbreak of food poisoning which we know to have been caused by a disease-producing germ. The ptomaines are basic chemical substances formed by the breakdown or digestion of putrefying tissues and were previously thought to be poisons formed in tainted food.

There are some naturally occurring substances in plant life, such as Deadly Nightshade and toadstools, which can cause illness if consumed; also food may become contaminated during its preparation, with arsenic, tin, or other heavy metals, with disastrous results. The amount of food poisoning due to these natural or chemical poisons is, however, negligible and it is not intended to deal here with the subject. Nearly all our food poisoning is caused by the contamination of food by germs which grow actively in the food.

The study of germs and especially disease-producing germs is called bacteriology, from the Greek word "bactron", a rod, because the first germs observed through a microscope were tiny straight rods. Bacteria, germs, microbes, micro-organisms, or simply organisms as they are variously called—and all these names will be used interchangeably in this book—were first seen and described in 1675 by a man who was not a professional scientist. Van Leeuwenhoek was a linen draper in the town of Delft in Holland but he was also an enthusiastic maker of lenses and magnifying apparatus. It was his hobby to examine objects of nature through the lenses which he mounted together to form a primitive microscope. One day, looking through his microscope at a drop of pond water, he saw not only a number of tiny animalcules but also tiny rods, many of which moved about actively within the microscope field. He described their size as one thousand times smaller than the eye of a louse. Next he took scrapings from his own teeth, and placing them under the microscope, he saw similar objects to those he found in the water. His drawings leave no doubt that these were the first bacteria to be described, but the significance of his findings was not appreciated at the time. Indeed, it was not until Louis Pasteur, the great French chemist and bacteriologist, demonstrated the essential part that bacteria played in fermentation processes in relation to wines and beers that the scientific world was fully able to understand the significance of van Leeuwenhoek's observations made nearly two hundred years before.

Pasteur developed methods of growing bacteria so that a more intimate study of them could be made. After his work on fermentation

he turned his attention to the silkworm plague which was threatening to ruin the silk trade, then of paramount importance to France. He showed that the disease was caused by a bacterial infection of the silkworm and he was able to suggest successful measures for its control. After this he investigated diseases of animals and man, proving beyond doubt that bacteria were a necessary cause of disease. Pasteur's name will be for ever associated with the dread disease rabies and the method he devised for its prevention, but another aspect of his work is of particular importance in the study of food hygiene. He was able to show clearly and completely that the old theory of spontaneous generation, that is life arising from the inanimate, was false. In other words, if a particular food product was sterilized by proper cooking, living bacteria would not appear in that food unless they came from outside, either from the air, from the hands, or from some other infected material.

About the same time Robert Koch was also making great discoveries in Germany; he found that anthrax, tuberculosis and cholera were caused by bacteria and he devised methods to grow these germs. From this time onwards the march of discovery in the field of bacteriology was rapid. From Europe, America, Japan and other parts of the world bacteriologists were fired with enthusiasm for their new science, and soon the causative microbes of gonorrhoea, erysipelas, diphtheria, typhoid fever, dysentery, plague, gangrene, boils, tetanus and scarlet fever had been found.

After thousands of years of darkness and superstition a great light was thrown on the cause of infection, and the door was opened for a vast study of the relation of bacteria to disease in animals and plants. This study led to a knowledge of the ways in which bacterial infections spread and, as a result, methods of prevention and of cure were found. Joseph Lister applying the methods of Pasteur to surgery discovered that wounds became septic by the action of bacteria. He introduced antiseptics, disinfectants that killed bacteria, and there was an immediate and astonishing reduction in wound sepsis.

The sanitary conditions in England before 1850 were appalling. From 1840 onwards began the Great Sanitary Awakening. Edwin Chadwick belonged to a family which believed in personal cleanliness —a most unusual virtue in those days—and in 1842 he was instrumental in bringing out a Report on the Sanitary Conditions of the Labouring Population of Great Britain. The principle that environment influenced the physical and the mental well-being of the individual was introduced and, as the connection between filth and disease

was gradually realized, measures were taken to control the disposal of sewage and the purity of water supplies.

In 1854 John Snow recognized that drinking water was concerned in the spread of cholera and in the Swiss town of Lauren, an outbreak of typhoid fever in 1874 was traced to polluted water, with the result that water supplies and sewage systems were designed to eliminate this danger. The chlorination of drinking water in Britain was introduced by Alexander Houston in 1905 during a typhoid epidemic in Lincoln, and its use has helped towards the virtual abolition of water-borne disease in this country.

Towards the end of the nineteenth century the danger of infection by milk was discovered and as a result, in cities such as London, the heat-treatment of milk by pasteurization was gradually introduced; this heat-treatment kills any harmful bacteria which the milk may contain. Pasteurization is not yet universal, however, and a number of children still die yearly from tuberculous infection due to drinking raw milk from infected cows. Furthermore, we still hear of epidemics of sore throat, scarlet fever, dysentery, typhoid and paratyphoid fever from infected raw milk, particularly in country districts where much of the milk is still drunk raw. A brief description of such milk-borne and food-borne diseases is given in Chapter VII.

Acute poisoning and infection spread by food contaminated with disease-producing bacteria must have occurred from time immemorial, and it will continue to do so until we learn how to control it. Our food is not protected by the addition of preservatives in the same way as drinking-water supplies are now protected by the addition of chlorine, and we cannot insist on the compulsory heat-treatment of open-pack foods, followed by careful packing, as is used in the pasteurization and bottling of milk. To prevent the spread of infection by foodstuffs, therefore, we must either prevent bacteria from entering food or, if this is impossible, stop their growth when they have entered the food.

The first food-poisoning bacteria to be described were isolated in 1888 by Dr. Gaertner from the organs of a man who had died from food poisoning during an outbreak in Germany affecting fifty-nine other persons. Similar bacteria were found to be present in the meat which had been served to the victims, and throughout the infected carcase of the slaughtered animal from which the meat was cut. About the same time the so-called ptomaines, previously held responsible for food poisoning, were extracted from putrid foods and were found to be harmless if taken by mouth. These discoveries convinced many workers that the ptomaine theory of poisoning was wrong, and, under

the influence of Savage in this country and Jordan in the United States, food poisoning gradually came to be associated with specific bacterial contamination.

In the years 1909 to 1923 many of the bacteria now known to be responsible for food poisoning were grouped together under the generic name *Salmonella*, in honour of Dr. Salmon who discovered the first member of the group, the hog cholera bacillus, in 1885.

From 1914 onwards another group of bacteria, the staphylococci, were found to be concerned with food poisoning. When growing in food certain strains of staphylococci produce a poisonous substance or toxin which, if swallowed, gives rise to quick and violent reactions.

Gradually from year to year other bacteria have been added to the list of those proved to be responsible for food poisoning and no doubt many more will be discovered in the future. Some of these bacteria may be present in small numbers in the raw food, and owing to faulty methods of preparation, cooking or storage they are not killed, but multiply sufficiently to render the food dangerous.

In other cases, bacteria may be introduced accidentally into the food during preparation for the table after cooking, and if there are favourable conditions for growth, the rapid multiplication of the bacteria again makes the food dangerous.

Safe food means food free from dangerous bacteria; it does not necessarily mean clean food. Cleanliness implies freedom from visible dirt and mass bacterial contamination, but both of these may be present and yet the food may be safe, because it is free from those particular microbes which are disease-producing or pathogenic. The aim of food hygiene should be the production and service of food which is not only clean, but which is also free from the risk of causing disease. The problem so presented demands attention to three main factors, the personal hygiene of those responsible for handling food during production and service, the conditions under which food is stored, and the general design of kitchens and their equipment.

The incidence of food poisoning has grown from year to year, as may be seen from the following figures of recorded food-poisoning incidents (Table I). It may be asked why outbreaks of food poisoning are so common today when the average standard of living is higher than in the past, when the general and personal hygiene is much improved, and when the public's knowledge is greater. There are many answers to this question, but they are mostly related to the general change in the way of life which began soon after the turn of

the century. So insidious was the change that it was hardly noticed for several years, but in retrospect it can be dated to a period well before the First World War, when food was cheap and for the most part tastes were simple. Thousands of the working population had of necessity to take their midday meal in some sort of eating-house. The majority of these were small, rather dingy places, often with underground basement kitchens with very inadequate washing and sanitary facilities, yet it was uncommon for intestinal infection to follow meals taken in such establishments. The cost of these meals was very cheap by present-day standards, yet for the most part they were good simple meat meals, generally fresh roast or boiled joints with vegetables, often with nothing to follow. At the slightly more expensive houses there would be a fresh boiled pudding or fruit tart.

TABLE I

Recorded Food-poisoning Incidents
(England and Wales, 1939–1951)

Year													
1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951
83	47	119	73	244	291	433	685	847	804	2431	3979	3347
Number of Incidents													

Although the standard of hygiene observed in these eating-houses might be lower than the level today, the chances of food poisoning following such meals were very small, because the simple meat meal was freshly cooked and quickly served to relatively small groups of consumers.

With the changing tastes of the people came the cinema, public motor transport and the more attractive cheap restaurants. Immediately after the First World War the popularity of the large restaurant serving cheap, pre-cooked meals increased. Attractive cream-filled cakes and made-up meat dishes, on sale perhaps for days after preparation, were ideal culture media for disease-producing bacteria which may have been introduced accidentally from unclean hands; but only occasionally were outbreaks of food poisoning reported after the consumption of such meals. It was not until World War II that almost the whole nation participated in communal feeding, when in addition to the public restaurant, canteens were set up in factories, schools and offices. Although the habit of communal feeding had

been growing for years the nation was entirely unprepared for this enormous change-over. Canteen kitchens, often converted in a hurry, were of unsuitable design and inadequate for the number of meals required. Kitchens originally intended for serving a certain number of meals were forced to provide double or even treble that number, sometimes with limited equipment and inadequate staff. At the same time few of the people in charge of these catering establishments had any knowledge of the precautions necessary in preparing, cooking and serving meals on this large scale.

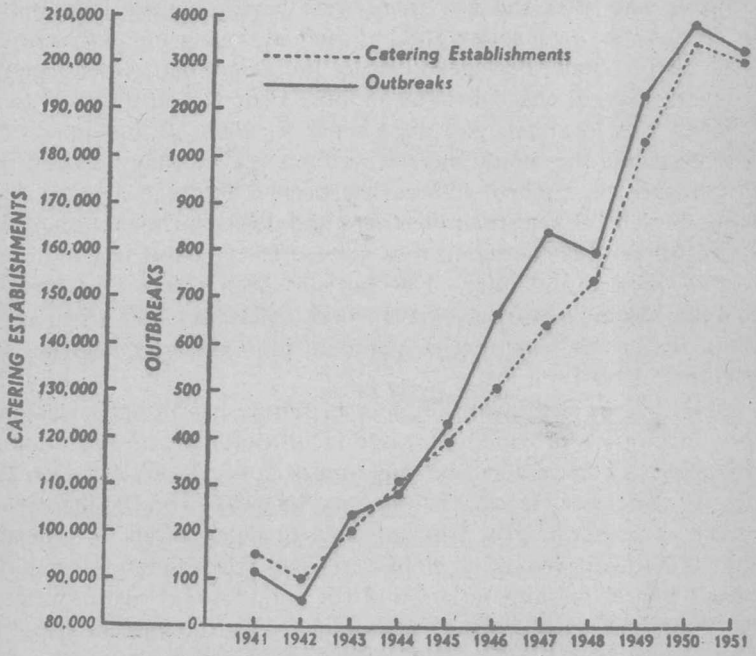

FIG. 2 Outbreaks of Bacterial Food Poisoning and number of Catering Establishments, England and Wales, 1941–1951

Under such conditions it is not surprising that errors occurred in the bulk handling of food. Large numbers of persons were served from one canteen kitchen, and a single infected dish could affect many; whereas a similar incident in a small household would affect one or two persons only.

The association between the figures for the steady rise in licensed catering establishments and the rise in food-poisoning incidents is indicated in Fig. 2.

To add to war-time and post-war problems in Britain there is the shortage of certain food and more particularly of meat. The housewife and the canteen manager can ill afford to throw anything away, and left-overs are harboured from day to day, sometimes under conditions of imperfect storage. Joints of meat are cooked the day before required because they can be sliced more economically when cold. There is also an increase in the consumption of pre-cooked foods, while made-up dishes from left-overs must be used to eke out the small rations. From these new habits there is danger of food infection.

During and after the war there were other changes in national life. We now save our scraps and put them in the pig-bin at the corner of the street. Staff shortages in many municipal departments cause a longer delay in the collection of bins than is befitting for good hygiene. The local cats and dogs knock the lids off and upset the contents, while flies enjoy the rotting food and journey between the pig-bin and the kitchen. There has been a shortage of eggs, and many people have kept their own hens and ducks at the bottom of the garden, thereby encouraging flies as well as introducing conditions suitable for rats and mice. Life has not been easy. Most people including the housewife have been working hard outside their homes, and in the general rush perhaps some of our habits of hygiene and cleanliness have been lost.

Since the war a growing number of public health bacteriological laboratories have provided increased facilities for the investigation of outbreaks. There is a greater measure of co-operation between the Medical Officer of Health, the Sanitary Inspector and the laboratory worker or bacteriologist, who are able to demonstrate to catering authorities the means by which bacteria gain access to food during the various phases of preparation, and the conditions which encourage the multiplication of bacteria to numbers able to cause disease. In 1950, for the first time, the combined recorded food-poisoning incidents from the Public Health Laboratory Service and the Ministry of Health, which receives all notifications of food poisoning from local authorities, were gathered together, so that much food poisoning hitherto ignored was brought to light.

What are the aims, therefore, for personal hygiene, food storage, and the general design of kitchens and their equipment? First, we must realize that the natural host of food-poisoning germs or bacteria is the human and animal body. Second, we must store susceptible foods at a temperature which will not allow bacteria to flourish. Third, kitchens should be designed to provide conditions for well-ordered working, with plenty of space, good ventilation and lighting,

and with equipment easily cleaned and sterilized; and fourth, these kitchens should be staffed by personnel taught the principles of hygiene in relation to themselves and the food they handle.

Before considering these things in greater detail it may be useful to describe the shape, size, habits and requirements of those minute organisms which cause disease and poison food—the bacteria.

CHAPTER II

ELEMENTARY BACTERIOLOGY

The size, shape and habits of bacteria

It is difficult to understand the chain of circumstances which must precede an outbreak of disease caused by the infecton of food by bacteria without knowing something about these bacteria. Furthermore, unless the habits or ways of life of microbes are known we cannot choose the weapons needed to fight them.

How can food be kept free from dangerous bacteria? If it is suspected that food is contaminated how can we prevent the germs multiplying? Furthermore, when it is known that a foodstuff may be contaminated how can we ensure that the germs are killed and their poisonous toxins destroyed before the food is eaten? All these questions can be answered from a study of the organisms that cause the trouble.

Bacteria are organisms of extremely small size and variable shape. They are minute single-celled plants placed in botanical classifications with the algae, amongst which are to be found the lowest forms of plant life, the fungi or moulds, and the lichens.

Bacteria are everywhere in the world, in soil, water, dust, and in the air we breathe. There are thousands of different types; many perform useful functions, e.g. some may turn decaying vegetable matter into useful manure, others, within the human or animal body, may assist in the development of certain vitamins essential to health. Some can be harnessed to produce drink and food for the benefit of mankind, such as in the fermentation of beer or wine and the manufacture of cheese. Others in recent years are being used to produce substances called antibiotics, of value in the cure of disease. Only a very small proportion of the total bacterial population cause disease of man and animals.

Bacteria are so minute that they cannot be seen with the naked eye and it may be impossible to tell by inspection when food is dangerously contaminated. The bacteria which cause the spoilage of food are usually harmless when taken by mouth. The dangerous bacteria are those which harm man but do not change the appearance, taste, or smell of the food.

Bacteria may be as small as 1/1,000 mm. and clusters of a thousand or more are only just visible to the naked eye. Thirty thousand placed side by side may measure barely an inch. Seen under the

high-powered lens of a microscope with a magnification of five hundred to a thousand times they appear in one or other of the following three forms according to the type of organism.

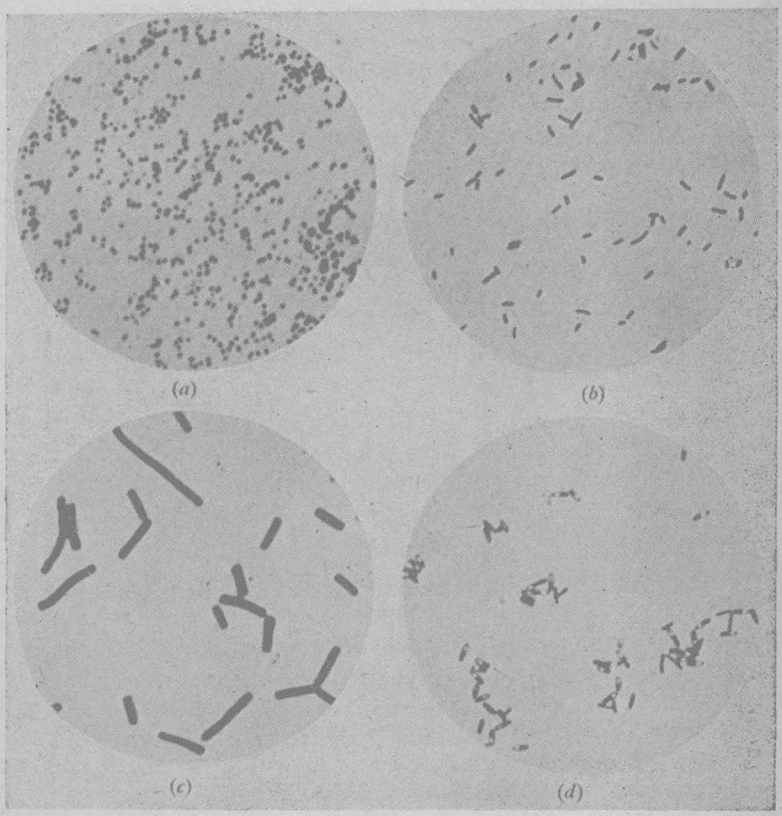

FIG. 3 Food-poisoning bacteria
(*a*) *Staphylococcus.* (*b*) *Salmonella.* (*c*) *Clostridium welchii.*
(*d*) *Clostridium botulinum*—showing spores

Round	= Coccus	for example	*Staphylococcus* *Streptococcus* *Gonococcus*
Rod-shaped or cylindrical	= Bacterium or Bacillus	for example	*Salmonella* Diphtheria bacillus *Bacillus anthracis* *Clostridium welchii*
Spiral	= Spirillum or Spirochaete	for example	*Treponema* of syphilis