

# The History of Bacteriology

*By*  
WILLIAM BULLOCH, M.D., F.R.S.

# The History of Bacteriology

UNIVERSITY OF LONDON HEATH CLARK LECTURES, 1936  
*delivered at The London School of Hygiene  
and Tropical Medicine*

*By*

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DOVER PUBLICATIONS, INC.  
NEW YORK

*In memory of my former teachers*

D. J. HAMILTON, *Aberdeen*

F. V. BIRCH-HIRSCHFELD, *Leipzig*

ÉMILE ROUX, *Paris*

C. J. SALOMONSEN, *Copenhagen*

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Published in Canada by General Publishing Company, Ltd., 30 Lesmill Road, Don Mills, Toronto, Ontario.

Published in the United Kingdom by Constable and Company, Ltd., 10 Orange Street, London WC2H 7EG.

This Dover edition, first published in 1979, is an unabridged republication of the work originally published by Oxford University Press in 1938. The present edition is reprinted by special arrangement with Oxford University Press.

*International Standard Book Number: 0-486-23761-3*  
*Library of Congress Catalog Card Number: 78-73065*

Manufactured in the United States of America  
Dover Publications, Inc.  
180 Varick Street  
New York, N.Y. 10014

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## PREFACE

It is a curious fact that, in spite of the vast and growing proportions of almost every branch of bacteriology, so little has been written on the history of the science. Indeed, the only attempt at presenting the historical development of the subject was the book by Friedrich Löffler, published in 1887, and entitled, *Vorlesungen über die geschichtliche Entwicklung der Lehre von den Bakterien . . . Erster Theil bis zum Jahre 1878*. In his preface, Löffler announced that the work would be completed by the publication of the second part at the end of the year 1887. That is more than half a century ago, but the complete book has not yet appeared, and will not appear because its author has been dead nearly a quarter of a century.

In 1930 I wrote the chapter on the 'History of Bacteriology' for the Medical Research Council's *System of Bacteriology*, and this article met with a considerable amount of approval both at home and abroad, and apparently supplied a want. In 1936 I was asked to deliver the Heath Clark Lectures in the University of London, and it was suggested to me that I should deal with the 'Development of Bacteriology'. I delivered the Heath Clark Lectures in the London School of Hygiene and Tropical Medicine in January and February 1937. As part of these lectures traversed the same ground as my article in the *System of Bacteriology*, I applied, through Sir Edward Mellanby, F.R.S., Secretary of the Medical Research Council, for the permission of the Controller of H.M. Stationery Office to utilize the said article as a basis for the present book. This request was very generously granted by H.M. Stationery Office, whose property it was, and permission was also given to utilize the illustrations which had appeared in the *System of Bacteriology*. For this generosity I desire to thank the Controller of H.M. Stationery Office. I have added a good deal to what I already wrote in the *System of Bacteriology*, making the subject more complete and up to date. I have



also supplied an extensive bibliography and biographical notices of some of the early workers in bacteriology, a subject which apparently is very little known among bacteriologists. The collection of material for a history of bacteriology is a work of years and is not always easy or possible unless one has access to the largest libraries. Had it been easy it would not have been left so long undone. I have gone carefully through the literature contained in this book. At the same time I should like to express my thanks to Clifford Dobell, F.R.S., for help and advice generously given over many years, and for the loan of valuable papers and rare books which I could not have obtained otherwise without a great deal of trouble. A word of thanks also remains to the Oxford University Press for their share in the production of this book in its final form.

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*June 1938*

# I

## ANCIENT DOCTRINES ON THE NATURE OF CONTAGION'

THE results of investigations of the last century showed that a very large number of diseases of man and animals result from the entry into the body of certain living agents invisible to the naked eye but capable of being seen by the aid of the microscope. These diseases are spoken of as infective, and they occur either sporadically or infecting numbers of individuals in epidemics or epizootics. Many epidemics are of national or international importance, and they may be in the form of world-wide pandemics. Such occurrences have been witnessed at all periods of written history, but it should be realized that an exact diagnosis of many outbreaks incompletely described hundreds or thousands of years ago is not possible to-day. The words *λοιμός*, *λοιμώδης*, *νόσος*, *pestis*, *pestilentia*, were applied by the ancients to any epidemic disease irrespective of its symptoms or nature. Duclaux has truly said that 'even in science homonyms are not synonyms thirty years apart; the same tinsel covers very different small models', and Greenwood has correctly emphasized the same fact that popular medical history 'catches at words or phrases in ancient literature which seem to suggest that the author had an inkling of what we now suppose to be the truth'.

The idea of communication by contact—in other words 'contagion'—is exceedingly old and did not originate in connexion with disease at all. Physical properties such as heat or cold are communicable, and this must have been an observation of primitive man thousands of years ago. When we come to written medical history it has been doubted by many scholars whether the classical writers of Greece and Rome had any clear conception of what we now call 'infection' or 'contagion'. This is the view of writers like C. G. Gruner, K. Sprengel, Choulant, Daremberg, Hirsch, and Haeser, and with special reference to the theory of

contagion by Marx, Yeats, Omodei, Francis Adams, Puschmann, and Bernheim. C. F. H. Marx (1796-1877) in his *Origines contagii* (1824) has dealt with this subject exhaustively, and considers that the most ancient traces of the opinion that disease may be communicated by touch is found among the customs of the Egyptians and Jews.

In the Bible there are several references to contagious diseases. Thus the Mosaic regulations in regard to leprosy were minutely described in Leviticus (chaps. xiii and xiv), where an interesting account of the diagnosis of the disease is given. When leprosy is probable the priest 'shall look on him and pronounce him unclean', and he shall be shut up and inspected at the end of seven days. If the disease has not progressed the patient shall be shut up for another seven days and examined again, and 'if the plague be dim and the plague be not spread in the skin the priest shall pronounce him clean, and he shall wash his clothes and be clean' (Lev. xiii. 6). If the disease has spread the patient is pronounced to be leprous, 'and the leper in whom the plague is, his clothes shall be rent and the hair of his head shall go loose, and he shall cover his upper lip and shall cry, Unclean, unclean. All the days wherein the plague is in him he shall be unclean; he is unclean: he shall dwell alone: without the camp shall his dwelling be' (Lev. xiii. 45). The disease was also believed to be spread by the garments which were unclean, and the order was given that the garments should be destroyed in the fire (Lev. xiii. 52). The curious law of the leper is fully described in Leviticus (chap. xiv) and is mixed up with sacrifices, burnt offerings and inunctions. Personal hygiene and the hygiene of the house is also dealt with. When a house was infected the order was that it should 'be scraped within round about, and they shall pour out the mortar that they scrape off without the city into an unclean place' (Lev. xiv. 41). After being reconditioned the house may still be infected, and if this be so the house shall be broken down and all its parts shall be carried into an unclean place, and those who take part in the demolition must wash their clothes. Very

strict rules were also laid down in Leviticus (chap. xv) in connexion with discharges from various parts of the bodies of men and women and the necessity of purifying clothing that had become soiled.

The origin of disease was also referred to in the Bible and was closely connected with punishment for rousing the wrath of the Lord. Miriam, the sister of Moses and Aaron, took a prominent part in the exodus, but at Hazeroth, after leaving Sinai, Miriam and Aaron spoke against Moses 'because of the Cushite woman he had married' (Num. xii. 1), and the Lord spake unto all three of them and came down in a pillar of cloud and called Aaron and Miriam out of the tent and showed he was on Moses' side, and the anger of the Lord was kindled against them (Num. xii. 9); and the cloud removed from over the tent, and 'behold, Miriam was leprous, as white as snow'; and Aaron was horrified and said 'Oh my lord, lay not, I pray thee, sin upon us, for that we have done foolishly, and for that we have sinned: let her not, I pray, be as one dead, of whom the flesh is half consumed'; and Moses interceded for Miriam his sister, and the Lord said 'Let her be shut up without the camp seven days, and after that she shall be brought in again'. And apparently she was healed and the people journeyed on from Hazeroth.

Azariah, son and successor of Amaziah, King of Judah, was smitten by the Lord with leprosy (2 Kings xv. 5), but he was not so fortunate as Miriam, for we are told that 'he was a leper unto the day of his death, and dwelt in a several house' (i.e. a lazar house).

These quotations clearly indicate that the Jews had sound beliefs in regard to the possible spread of disease by contact, but their ideas of causation were connected with supernatural things. Much of the idea of contagious transmission of disease was lost in the Greek and Roman period, and most scholars agree that in the Hippocratic treatises there is no certain reference to contagion as we understand it to-day. It is indeed strange, as Marx has pointed out, that apparently lay writers like the historians, philosophers, and even the poets, came to understand the propagation of pestilence by

touching the diseased and by fomites before the medical profession adopted this idea.

Thucydides appears to have been one of the first to make any positive allusion to the contagious nature of certain plagues. In his history of the great Athenian pestilence of 430 B.C. he relates that the disease first attacked (ῥῆστω) the men of the Piræus, and it was thought that the Peloponnesians had poisoned the wells. At the siege of Potidaea, Thucydides also described a disease which destroyed the Athenian army. It was believed to have been brought from Athens.

References of a similar kind are to be found in the writings of Dionysius of Halicarnassus, who tells us that in a great epidemic those who wished to alleviate the sufferings of others by touching, or had communication with the sick, caught the same distemper, so that many houses became desolate for want of attendants.

Diodorus Siculus, Dion Cassius of Nicaea, Appian and Livy have also referred to epidemics of contagion, and even poets like Lucretius and Virgil referred to epidemics and epizootics. Of a particular pestilence in the reign of Commodus, Dion Cassius relates that many persons not only in the city but in the whole Roman Empire were killed by wicked wretches, who for a stipulated reward dipped small needles into the pestilent poison and thus communicated the disease to others.

The causes of epidemic diseases continued to be a great mystery in ancient times. For centuries these diseases were regarded as supernatural and mainly as divine judgements to punish the wickedness of mankind. Sin was the work of a spirit or demon who possessed the power of evil over men. The divine punishments were to be avoided by sacrifices and lustrations to appease the anger of incensed heaven. Thus, in the *Iliad*, Apollo was the deity who with his darts inflicted epidemic sickness on the army before Troy, and the disease could only be allayed by the supplication of Chryses. The Israelites also had a theurgical theory of pestilence, for we are told that 'the Lord sent a pestilence upon Israel from the morning even to the time appointed:

and there died of the people from Dan even to Beer-sheba seventy thousand men' (2 Sam. xxiv. 15).

This supernatural theory of disease lasted for many centuries but was gradually displaced by the idea that pestilence is due to natural, especially cosmo-telluric, phenomena such as eclipses, comets, earthquakes, inundations, and particular changes in the air which was believed to be polluted or defiled by 'miasms' (μῑασμα, stain). The modifications of the atmosphere as a result of climate or season was a favourite doctrine of Hippocrates. Just as heat and cold, moisture and dryness, succeed each other throughout the year, he believed that the body underwent analogous changes which influence the diseases of the period, and from this was elaborated the doctrine of pathological 'constitutions'—a doctrine held for centuries and not yet extinct. In the Hippocratic treatise 'on winds' air is regarded as the cause of disease, and it is stated that when air is infected with miasms which are inimical to mankind people become ill. In fact, bad air was the main aetiological agent in the Hippocratic pathology. The miasmatic theory, as has been pointed out by Greenwood, differs, however, from the modern idea of *contagium animatum* in that the latter assigns an active role to the successive recipients. This was not included in the medical doctrines of the ancients.

After the fall of Rome and the decline of civilization there was a cessation in the acquisition of knowledge. At the most the writers of successive centuries contented themselves with verbose commentaries on the works of Hippocrates, Galen, and other early medical writers. Even as late as the sixth century of the present era the pandemic of plague which devastated the earth in the reign of Justinian was regarded as caused essentially by the vitiation of the atmosphere engendered from the putrefaction of animal substances. This was supposed to have begun in the neighbourhood of Pelusium between the Serbonian bog and the eastern channel of the Nile.

While the Arabian physicians of the East and West added a good deal to our knowledge of different contagious

diseases it cannot be said that they advanced beyond the Hippocratic and Galenical doctrines of aetiology.

During the Middle Ages an unbroken series of great epidemics and epizootics gave much opportunity for observation and reflection, and by degrees the doctrines of infection and contagion began to emerge and again it was a lay writer who emphasized the belief in contact or contagion. This was the great Giovanni Boccaccio (1313-75), who, in his famous *Decameron*, completed in 1358, referred to the plague of 1348 when, as he tells us, there came to Florence the death-dealing pestilence 'which through the operation of the heavenly bodies or of our own iniquitous dealings being sent down upon mankind for our correction by the just wrath of God had some years before appeared in the parts of the East'. As every one knows, the *Decameron* is a series of tales told by seven ladies and three gentlemen who left Florence and betook themselves to a country villa to escape the plague of the town and they whiled away ten days with their stories. Boccaccio gives an account of the swellings in the groin and armpits, and speaks of the plague as a contagion. He tells us that not only to talk with the patients or to deal with them in any way brought about the disease in the healthy. 'To touch their clothes or whatever other object had been used by those who had been ill caused the communication of the disease' (*Decameron*, 1st day).

According to Omodei, among the first to spread the knowledge of contagion in plague were Jacopo da Forlì (Jacobus Foroliviensis) (died 1413), and at a later period Alessandro Benedetti (1460-1525), professor at Padua. In his treatise on plague Benedetti not only maintained that the disease may be contracted by touch, but that the morbid principle is imbibed and retained in articles used by the sick. From these observations he inculcated the necessity of purifying the clothes.

Studies on epidemics of small-pox, typhus, measles, the English sweats from 1485 to 1551, the great pandemic of syphilis in the fifteenth and sixteenth centuries, resulted in the advancement of our knowledge of infection and contagion. The merit of placing this knowledge on a surer

basis we owe to Girolamo Fracastoro, commonly known by the latinized form of his name as Hieronymus Fracastorius. He was a scholar, poet, and thinker, and was born in Verona about 1478. He died in 1553, being then about 75 years of age. Like other Veronese youths Fracastorius went to the University of Padua, where he met students from all parts of Europe including the famous astronomer Nicholaus Kopperrnigk (Copernicus), Marcantonio della Torre, professor of anatomy, and Pietro Pomponazzi, astronomer and physician. In 1501 Fracastorius was appointed lecturer on logic at Padua and continued in the post for about six years, when he left as a result of the political disturbances which culminated in the League of Cambrai (1508), between Louis XII of France and the Emperor Maximilian, for the dismemberment of Venice. Pope Julius II and Ferdinand the Catholic were mixed up in the turmoil which ensued. The league included Verona among the cities which were to be the spoil of Maximilian. Bloodshed followed, Padua was sacked and the university closed its doors. Fracastorius betook himself to Pordenone (in the Udine) with other refugees from Padua under the Venetian general Alviano, whom he accompanied to Verona in 1509. Alviano was defeated and Verona was handed over to Maximilian. Fracastorius lived some years in Verona and witnessed a great epidemic of plague there. He then settled with his family in a villa at Incaffi on the shores of Lake Garda, between the river Adige and the lake. Here in his villa he spent a life of study and reflection and wrote his famous Latin poem *Syphilis sive morbus Gallicus* (published at Verona 1530). From time to time he made short stays in Verona when things were quiet politically. In 1528 Giberti, Bishop of Verona, became the patron of Fracastorius, and in 1534 gave him a villa at Malcesine at the upper end of Lake Garda, and here he lived some years. In 1538 he published at Venice his *Homocentrica sive de stellis*. In 1547 he took part in the famous Council of Trent, being appointed medical adviser to the Council, but he left after an outbreak of typhus which caused the Council to transfer its activities to Bologna. On 6 August 1553 Fracastorius had a stroke



and died the same evening. The place of his burial is unknown.

The chief work of Fracastorius which concerns us here is a small quarto book of 77 pages of text and was published at Venice in 1546 under the title 'De sympathia et antipathia rerum / liber unus / De contagione et contagiosis / morbis et curatione / libri III.'

This work is rare and is written in Latin in a condensed style not always easy to translate or to interpret. There is an extensive literature upon the book and French, German, and English translations, the last being the most accurate and complete by Wilmer Cave Wright, Ph.D., Professor of Greek at Bryn Mawr College, Philadelphia, and published in 1930.

Fracastorius' work on contagion is in three books of which the first and most important deals with the theory of contagion, the second contains accounts of different contagious diseases, while the third book is concerned with their cure. In the first chapter contagion is defined as an infection which passes from one individual to another. It is something different from the corruption which occurs in milk or meat. Contagion presents three different types: (1) contagion by contact alone; (2) contagion by fomites; and (3) contagion at a distance. In the second type the contagion leaves a *foyer* which may disseminate the contagion, as e.g. itch, phthisis, area, or elephantiasis. Fracastorius uses in a special sense the word 'fomes', which was used by classical writers to denote 'touchstone' or 'tinder'. He says: 'I call "fomites" clothes, wooden things and other things of that sort which in themselves are not corrupted but are able to preserve the original germs of the contagion and to give rise to its transference to others.' In a third category he includes disease, which may be contracted at a distance, such as pestilent fevers, phthisis, lippitudes (blear eyes), and exanthemata like small-pox. Not all contagions are transmissible at a distance but all are communicable by contact. He thinks (chap. iii) that the infection which appears among fruits, e.g. grape to grape, apple to apple, operates in the same kind of fashion as that produced by