

MONOGRAPHS ON EXPERIMENTAL BIOLOGY

# THE BIOLOGY OF DEATH

Being a Series of Lectures Delivered at the Lowell Institute  
in Boston in December 1920

BY  
RAYMOND PEARL  
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TO  
MY WISEST COUNSELLOR  
M D P.



## EDITOR'S ANNOUNCEMENT

THE rapidly increasing specialization makes it impossible for one author to cover satisfactorily the whole field of modern Biology. This situation, which exists in all the sciences, has induced English authors to issue series of monographs in Biochemistry, Physiology, and Physics. A number of American biologists have decided to provide the same opportunity for the study of Experimental Biology.

Biology, which not long ago was purely descriptive and speculative, has begun to adopt the methods of the exact sciences, recognizing that for permanent progress not only experiments are required but that the experiments should be of a quantitative character. It will be the purpose of this series of monographs to emphasize and further as much as possible this development of Biology.

Experimental Biology and General Physiology are one and the same science, by method as well as by contents, since both aim at explaining life from the physico-chemical constitution of living matter. The series of monographs on Experimental Biology will therefore include the field of traditional General Physiology.

JACQUES LOEB,  
T. H. MORGAN,  
W. J. V. OSTERHOUT.



## AUTHOR'S PREFACE

IN preparing the material of a series of lectures, given at the Lowell Institute in Boston in December 1920, for book publication, I have deemed it on the whole best to adhere rather closely to the original lecture mode of presentation with all its informality. Except for the fact that the matter is here set forth in somewhat greater detail than was possible under the rigid time limitations of the Lowell Institute, and that the breaking into chapters is slightly different, the whole is substantially as it was presented in Boston.

What I tried to do in these lectures was to bring together under a unified viewpoint some of the more important contributions which have been made to our knowledge of natural death, from three widely scattered sources: namely general biology, experimental biology, and statistical and actuarial science. It will be obvious to anyone who knows the literature from these fields regarding natural death and the duration of life that in such an amount of space as is here used, no one could hope to cover a field so wide with anything approaching completeness. To do so would require a series of volumes in place of one small one. But this has in no wise been my object; I have instead hoped that the very incompleteness itself of this work, necessitated by my limitations of space and knowledge, might stimulate the reader to penetrate for himself further into the literature of this fascinating and important field of biology. To help him to start upon this excursion a brief bibliography is appended. It by no means completely covers the field, but may perhaps serve as an introduction.

I am indebted to a number of authors and publishers for permission to use illustrations and wish here to express my great appreciation of this courtesy. The individual sources for these borrowed figures are in every case indicated in the legends. To Dr. J. McKeen Cattell I am especially grateful for allowing me the use of the blocks from the magazine publication of this material in the *Scientific Monthly*; to Dr. Alexis Carrel for permission to use unpublished photographs of his tissue cultures; and, finally, to Professor T. H. Morgan for critically reading the manuscript and making many helpful suggestions.

R. P.

BALTIMORE,  
April 19, 1922.



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# THE BIOLOGY OF DEATH

## CHAPTER I

### THE PROBLEM

PROBABLY no subject so deeply interests human beings as that of the duration of human life. Presumably just because the business of living was such a wonderfully interesting and important one from the viewpoint of the individual, man has endeavored, in every way he could think of, to prolong it as much as possible. He has had recourse to both natural and supernatural schemes for attaining this objective. On the mundane plane he has developed the sciences and arts of biology, medicine and hygiene, with the fundamental purpose of learning the underlying principles of vital processes, so that it might ultimately be possible to stretch the length of each individual's life on earth to the greatest attainable degree. Recognizing pragmatically, however, that at best the limitations in this direction were distinctly narrow, when conceived in any historical sense, he has with singularly wide-spread unanimity, deemed it wise to seek another means of satisfying his desires. Man's body plainly and palpably returns to dust, after the briefest of intervals, measured in terms of cosmic evolution. But, patent as this fact is it has not precluded the postulation of an infinite continuation of that impalpable portion of man's being which is called the soul. With the field thus open we

see some sort of notion of immortality incorporated in an integral part of almost all folk philosophies of which any record exists

Now, perhaps unfortunately, perhaps fortunately, it has up to the present time proved impossible absolutely to demonstrate, for reasons which will presently appear, by any scientifically valid method of experimentation or reasoning, that any real portion of that totality of being which is an individual living man persists after he dies. Equally, for the same reasons, science cannot absolutely demonstrate that such persistence does not occur. The latter fact has had two important consequences. In the first place, it has permitted many millions of people to derive a real comfort of soul in sorrow, and a fairly abiding tranquility of mind in general from the *belief* that immortality is a reality. Even the most cynical of scoffers can find little fault with such a result, the world and human nature being constituted as they are. The other consequence of science's present inability to lay bare, in final and irrefragable terms, the truth about the course, if any, of events subsequent to death is more serious. It opens the way for recurring mental epidemics of that intimate mixture of hyper-credulity, hyper-knavery, and mysticism, which used to be called spiritualism, but now usually prefers more seductive titles. We are at the moment in the midst of perhaps the most violent and destructive epidemic of this sort which has ever occurred. Its evil lies in the fact that in exact proportion to its virulence it destroys the confidence of the collective mind of humanity in the enduring efficacy of the only thing which the history of mankind has demonstrated to contribute to the real advancement of his intellectual, physical, spiritual and moral well being, namely that orderly progression of ascertained knowledge which we now call *science*.



The reason why science finds itself helpless to prevent spiritualism's insidious sapping of the intellectual fiber of the race is because it is asked to prove a negative, upon the basis of unreal data. How difficult such a task is is obvious as it is proverbial. Until science has demonstrated that there is *not* a continuation of individual supernatural existence after natural death, the spiritualist can, and will, come forward with supposed demonstrations that there is such a continuation. But the most characteristic feature of science is its actuality, its reality, its naturality. Pearson has pointed out, in characteristically clear and vigorous language, the reason why, in the minds of uninformed persons, science appears helpless in this situation. He says:

Scientific ignorance may either arise from an insufficient classification of facts, or be due to the unreality of the facts with which science has been called upon to deal. Let us take, for example, fields of thought which were very prominent in medieval times, such as alchemy, astrology, witchcraft. In the fifteenth century nobody doubted the "facts" of astrology and witchcraft. Men were ignorant as to how the stars exerted their influence for good or ill, they did not know the exact mechanical process by which all the milk in a village was turned blue by a witch. But for them it was nevertheless a fact that the stars did influence human lives, and a fact that the witch had the power of turning the milk blue. Have we solved the problems of astrology and witchcraft today?

Do we now know how the stars influence human lives, or how witches turn milk blue? Not in the least. We have learnt to look upon the facts themselves as unreal, as vain imaginings of the untrained human mind, we have learnt that they could not be described scientifically because they involved notions which were in themselves contradictory and absurd. With alchemy the case was somewhat different. Here a false classification of real facts was combined with inconsistent sequences—that is, sequences not deduced by a rational method. So soon as science entered the field of alchemy with a true classification and a true method, alchemy was converted into chemistry and became an important branch of human knowledge. Now it will, I think, be found that the fields of inquiry, where science has not yet penetrated and where the scientist still confesses

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