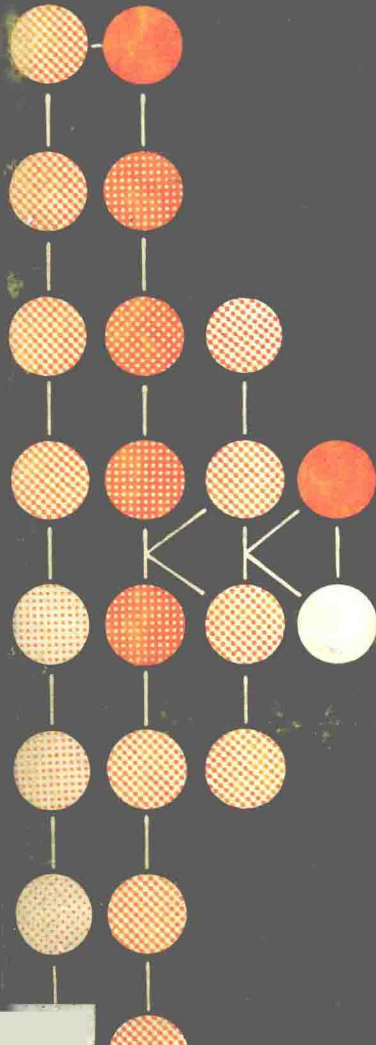

HUMAN HEREDITY

JEAN ROSTAND

HUMAN HEREDITY

by JEAN ROSTAND

THE WISDOM LIBRARY

A *division of*

PHILOSOPHICAL LIBRARY

New York

15 East 40th Street, New York

Library of Congress Catalog Card No. 60-13656

Translated from the French L'Hérédité Humaine
by WADE BASKIN

Printed in the United States of America

FOREWORD

For more than a quarter of a century Dr. Jean Rostand has been absorbed in the study of hereditary and acquired anomalies. He speaks with authority on a wide range of subjects and has pioneered in research directed toward establishing laboratory techniques for controlling and modifying genetic processes. Like many of his colleagues, he has contributed significantly to the advancement of science by conducting exhaustive research within his field of specialization—in his case, parthenogenesis in batrachians. Unlike many of his colleagues, however, he has long recognized the significance of popularization in science and has written intelligently about complex issues in which the general public has a vested interest. For his efforts to "introduce the greatest number of people into the sovereign dignity of knowledge," he has won international acclaim.

The words just quoted, one part of his definition of popularization, are taken from an address recently delivered on the occasion of his acceptance of the 1959 Kalinga Prize for "outstanding contributions to the dissemination of scientific knowledge to the general public." His efforts reflect both his concern over the awesome role of science in the modern world and his awareness of the scientist's responsibility to society.

More than fifty volumes, mainly on scientific and technical subjects, have resulted from Dr. Rostand's investigations and reflections. Unfortunately, readers on this side of the Atlantic have had access to only three of his works: *Adventures before Birth* (Ryerson, 1936); *Life, the Great Adventure* (Scribner's, 1956); and *Can Man Be Modified?* (Basic Books, 1959). As the titles suggest, his enthusiasm for the pursuit of knowledge never wanes, but his guarded optimism is tempered always by his concern over the uses to which individuals or nations may put the results of scientific discoveries.

Dr. Rostand is known to the American public mainly through journalistic accounts of his studies of virgin births among frogs and of his statements concerning the moral implications of recent developments in genetics. For example, his studies of fatherless frogs have enabled him to posit fatherless—and even motherless—children. Staggering indeed are the philosophical and moral problems that would of necessity arise in a society of artificially conceived offspring.

Son of the celebrated author of *Cyrano de Bergerac* and brother of another reputable dramatist, Dr. Rostand has earned many citations and awards, both literary and scientific. The present work evidences his sure grasp of the basic facts of human heredity and—in the French version, at any rate—his talent as a writer. More than this, it reveals him as a humanitarian deeply disturbed by the philosophical and moral implications of scientific intervention in the process of reproduction.

I am glad to have had a hand in making available to the English-speaking public this timely work on an issue in which each of us has a vested interest. Explanatory notes, unless otherwise specified, are to be attributed to the author. For the convenience of readers, English titles have been substituted for the French works listed by Dr. Rostand in footnotes and at the end of the last chapter.

To all those who shared with me the joys and pains entailed by our task, a word of appreciation is in order: to Dr. Wayne Silver, Professor of Biological Science, who read the translation in its entirety and offered many constructive suggestions; to Dr. Leslie Dwight, Professor of Mathematics, and to Arnold Walker, Instructor in Physical Science, who clarified certain technical points; and to Amy Aston, Robert Burton, Whulen Cox, Edyth Ebel, Joe Fox, Betty Swearengin, and Joe Vaughan, who contributed in their several ways to the completion of the undertaking. For any inaccuracies or shortcomings, I alone am responsible.

Southeastern State College Wade Baskin

HUMAN HEREDITY

CONTENTS

Chapter I

HEREDITY

It is customary in speaking of human heredity to recall the famous passage from Book II of Montaigne's *Essays:*

> How strange that the drop of semen from which we spring bears in itself the impression not only of the bodily shape but also of the thoughts and inclinations of our fathers! Where does that drop of fluid harbor such an infinite number of forms? And how do they convey those resemblances, so bold and unpredictable in their course that the great-grandson will be like his great-grandfather and the nephew like his uncle?

Indeed, this passage, which dates from the sixteenth century, is in every respect remarkable. It poses not only the problem of the transmission of physical characters or somatic heredity but also that of psychic heredity; it calls attention to the apparently capricious or unpredictable nature of this transmission; and, most important, it expresses vividly the surprise and bewilderment of a mind confronted by the great phenomenon of heredity.

More than four hundred years have passed since it was written, and we obviously know now much more than Montaigne about the mechanism and principles that relate to the transmission of characters; but in spite of the progress of our science, we are still impressed, and no less vividly than the author of the *Essays*, when we consider the great number of things, both physical and moral, contained in the minute seed responsible for the birth of a human being. Our astonishment today is simply predicated on more facts and a better understanding of heredity than was then possible. We know that the human being is not produced by a drop of semen but by a *zygote*, that is, by a *cell* or minute vesicle of living matter, and that the formation of the zygote—the sole link between generations—requires the co-operation of two distinct cells, each from a different source.

These two cells—called *sex cells, reproductive cells*, or *gametes*—are emitted, respectively, by two individual parents: one of them, the *egg* or the *ovule*, by the mother; and the other, the *sperm* or the *spermatozoon*, by the father (Fig. 1).

Here it is impossible to describe in detail the structure and constitution of these cells. We know that in them must be sought the origin of all hereditary resemblances and of all likenesses between procreator and procreated, between the parent and the child. For the moment, however, we need only observe that the two reproductive cells differ strikingly, both in size and in shape.

The male cell, equipped with a long tail or flagellum, looks remarkably slender in comparison with the spherical female cell. Whereas the ovule is barely visible to the naked eye (0.2 millimeter in diameter),

Fig. 1 Human ovule and Spermatozoa
(After Scheinfeld)

the spermatozoon is only 0.07 millimeter (or 70 *micra*) long and can be seen only with the aid of a powerful microscope. Its size is only 1/500 that of the ovum.

The ovule is perfectly motionless; a woman produces but one each month. Spermatozoa are extremely active; they swim rapidly through the seminal fluid, like tadpoles in water; a small drop of semen probably contains several million of them.

Following coition, a single spermatozoon penetrates and fertilizes the ovule. Shortly after fertilization has occurred, the ovule—which has become a zygote—divides into two cells, each of which divides into two more cells, and so on until through a series of such bipartitions trillions of cells are formed, constituting the body of the new individual.

This cursory review of a few elementary concepts shows that the problem of heredity is reduced in the final analysis to a cellular problem.[1] If a child resembles his parents, this is because he owes his origin to a cell resulting from a joint contribution made by his father and his mother: the union of a paternal cell and a maternal cell.

The zygote is not an ordinary, commonplace cell, for it is capable of producing a complete individual. But here we cannot take up the problem of the nature of the zygote, which is the central problem in embryology. In the present work we are concerned with another problem: Why does the zygote necessarily produce an individual with traits similar to those of its parents? We begin by trying to define more precisely the notion of *germinal* or *hereditary determination.*

One does not have to be a biologist to know that human zygotes will produce only human beings, just as canine zygotes will produce only dogs, and just as zygotes from whales will produce only whales.

On this point heredity defies any infraction of the rule: *Specific heredity* is absolute, at least under present conditions of relative fixity of living species. One individual can never give birth to another individual belonging to a different species.

Clearly defined racial characters follow a similar pattern. From a zygote produced by a Negro man and a Negro woman can come only a Negro child. From a zygote produced by a white man and a white woman can come only a white child. There is no possible exception to this rule of *racial heredity.*

Nor does one have to be a biologist to know that heredity is not merely specific or racial but also individual in the sense that it determines characters and traits peculiar to certain individuals. As a matter of fact, this is the sort of heredity that the layman generally has in mind when he speaks of human heredity. He generally thinks of the resemblance between children and their parents, grandparents, collateral ancestors, etc.

To be sure, no one is surprised if a child has his father's nose, or his mother's or his grandfather's eyes, or even if there is but a vague resemblance between the child and his ancestors. In the transmission of individual characters there are no absolute rules such as those that determine specific or racial heredity. Later this apparently capricious element in individual heredity will be explained. For the moment we merely call attention to the fact—to be dealt with subsequently at greater length—that many individual characters are already imprinted on the fertilized egg, and that during this early stage are determined not only its species but also its individuality.

In the human zygote there exists not only a potential human being but also a particular human being with eyes of a certain color, with hair of a certain shade, with certain facial features, with blood of a certain type, etc.

The power of heredity to determine individual characters shows up clearly in the study of *human twins.*

There are two types of twins, or individuals born of the same pregnancy.

Sometimes they come from *two distinct zygotes,* produced simultaneously by the mother and fertilized independently of each other. In such cases they are *fraternal twins*—in reality simply brothers or sisters who have developed side by side in the same matrix. They resemble each other no more closely than do ordinary brothers or sisters.

Identical twins, on the other hand, come from a single fertilized egg which splits in two at the beginning of its development and produces two distinct individuals.[2] Identical twins, who have the same origin and consequently the same genetic endowment, are amazingly alike. They are always of the same sex, and have the same eyes, the same hair, the same facial features, the same shape of eye-brows, the same folds in the lingual mucosa, the same blood characters; [3] they resemble each other down to the imprints made by their palms and fingers—details which are generally sufficiently distinctive for legal identification (fingerprint system).[4]

True organic "doubles," identical twins are—according to the apt expression coined by Dr. Alpert—"two copies of the same individual."

Their extraordinary resemblance makes it hard to tell them apart and thus gives rise to misunderstandings. This accounts for the frequent use of identical twins in dramatic literature, ranging from Plautus' *The Menaechmi Twins* to Tristan Bernard's plays.

Professor Newman of Chicago, a specialist in the study of twins, has cited some striking facts concerning identical twins who were separated at birth and knew nothing of each other's existence until their physical likeness caused them to be brought together again as adults.

Edwin and Fred, for instance, lived nine hundred miles apart. At twenty-two, Edwin, passing by chance through the town in which Fred was living, was approached on the street by a person who called him Fred. Astonished, he replied that his name was not Fred; his interlocutor was persistent and finally made him understand that he had been mistaken for a twin whose existence was first revealed to him through this encounter.

Or take a case cited by Vandel. Two conductors, Wolf and Will Heinz, could substitute for each other during a performance, undetected by either the audience or the musicians; a film revealed that their technical movements were identical.

Naturally, we must not carry things too far and pretend, as people sometimes do, that identical twins are alike with respect to intelligence, character, tastes, and behavior, that they think about the same things at the same time, etc. Especially when twins are separated at birth and accordingly exposed to different environmental and educational conditions, marked differences may result, at least from the intellectual and the moral viewpoint. And one of the main advantages in the study of twins is that it helps us to distinguish between the role of *heredity* and that of environment in the formation of the human personality.

Chapter II

HEREDITY AND ENVIRONMENT

We have just seen that there is, in addition to specific heredity and racial heredity, individual heredity in the sense that the human zygote is at the outset strongly individualized and personalized. In many respects the human being is predetermined at conception. This conclusion is inescapable in view of the extraordinary physical resemblance or quasi-identity of individuals born of the same zygote (identical twins). Nevertheless, to avoid grave misunderstandings, we should understand clearly that the individual is predetermined at conception only *potentially.*

The zygote contains no part of the individual, no trace of a rudimentary organ. Nor could the most powerful microscope reveal anything even resembling the shape or features of a man.

For example, we have seen that eye color is determined at conception; still, the zygote contains neither a human eye, nor the outline of a human eye, nor anything that could possibly be said to develop into an eye or contribute to the formation of an eye. All that we know is that the zygote contains certain materials, certain substances whose nature or arrangement are such that when the eye is formed during the developmental process, it will take on a certain color. Between the *initial* stage of the zygote and the *final* stage of the individual equipped with brown or blue eyes is a whole series of complex events—chemical reactions, we might say—about which we now know practically nothing. The same holds true for every other character and for every other part of the organism. It is assumed, however, that during the long formative or *developmental* period bridging germinal potentialities and the realization of physical characters, external factors (*environment*) can intervene and exert a strong influence on the formation of the individual. That is why the term germinal determination, which we have used up to this point, might lead to confusion unless satisfactorily defined.

In the case of human beings, first comes the *maternal environment* in which the embryo develops, then, after birth, the *external environment.*

It is important to note that the role played by the environment in shaping characters varies considerably according to the character studied.

For instance, we know of practically no condition capable of modifying eye color. Theoretically, there is nothing to rule out the possibility of the discovery of an artificial means of influencing eye color, but within the frame of our present state of knowledge, we can state that when a human zygote receives a certain genetic endowment, it unfailingly produces an individual with eyes of a certain color. Eye color is then irrevocably determined at conception, as are many other characters still to be considered: facial features, blood group, etc.

Here environmental conditions have absolutely no effect; heredity is everything. But in addition to such