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individual identification and the law enforcement officer

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INDIVIDUAL IDENTIFICATION
and the
LAW ENFORCEMENT OFFICER

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Foreword

THE PROBLEM of identification of individuals who are victims of some criminal act, or victims of some disaster caused by nature or man-made operations, or for various other reasons have lost their identification is a complex matter which requires high technical skills and the use of a wide variety of scientific tools.

Professor Nash in this book on individual identification attempts to bring together in a brief form the various practical matters for identifying individuals. To this endeavor Professor Nash brings a wealth of experience and qualifications. He is nationally recognized as one of the leading experimental geneticists in the country. He is known for his study of birth defects resulting from genetic and from environmental factors. He has applied his wealth of knowledge of human heredity to practical problems that one runs into in the criminal justice system.

When all conditions are ideal, it is possible to use the virtually infallible method of fingerprinting to identify individuals. However, in many instances, the fingerprints are unobtainable because of mutilation due to decomposition of the body or as a result of planned removal of hands and feet on the part of some felon. In many instances where clear fingerprints are obtainable, there may be on record no reference set of fingerprints against which one can compare the unknowns. So, despite the fact that fingerprints do indeed provide a positive method of identification, even if everything is just right, there are many instances where other methods must be used.

In this book, Doctor Nash addresses himself to those other methods as well as to the method of fingerprinting. The promise of lipprints is one which must not be overlooked.

The book makes no pretense of being a laboratory manual for the officer who is going to involve himself immediately in the bench-level activities associated with identification. Rather, the

book is more broadly focused so that all levels in the criminal justice system can benefit by it. It stresses principles, and it stresses how various methods work and what answers they can give. It is truly a book which can be read profitably by all echelons of the criminal justice system.

This book, if supplemented by an actual laboratory manual, should prove to be an outstanding textbook for individuals who want information on the methodology.

An illustration of the importance of identification comes to mind in the case of unidentified remains recovered from a fire. The first point to ascertain is whether the remains are human. Such determination begins with a complete x-ray examination of the entire remains. Bones and teeth resist the action of fire better than any other part of the body. If an adequate amount of bone is left, it is simple after examination of the x-ray film to arrive at a tentative conclusion concerning the sex and age of the individual. Various kinds of debris, such as buckles, hairpins, zippers, and the like, also will give some kind of indication as to sex of the individual. If any significant amount of bony structure can be recovered from the remains, one can then estimate the height, the weight, and even the build of the person. The determination of race is difficult unless a rather complete skull remains. Teeth, of course, are important in identifying remains down to the individual level. One must never forget that various articles of clothing such as shoes, belts, key rings, and so forth may give a clue to the identity of the individual.

In any case involving an unknown body, an accurate and detailed description is mandatory. Such a description is needed in the process of identification. An adequate description includes the extent of livor mortis, the condition of rigor mortis, signs of decomposition, sex, race, estimated age, height and weight. Various scars and evidence of operations or trauma should be noted. If the remains are that of a male, the presence or absence of circumcision should be noted. Dental charts should be prepared by a competent dentist. Artificial dentures often have a serial number or the actual name of the victim imbedded in the plastic material. Tattoos should be photographed or, if necessary, cut out and preserved. There are certain tattoo experts who can tell

the country of origin of the tattoo, the port at which the tattoo was made and, in some instances, the specific artist who did the tattooing. Although fingerprinting of bodies that have been recovered from the water, for example, may require special methods, such techniques are available and should be used as part of the identification process. Again it must be emphasized that clothing and other articles found on or near the remains often contain important information. The size, brand names, vendor's label, laundry marks, and other identifying aspects of articles of clothing should be recorded. Cigarette packages quite often will have a serial number which can tell the approximate time of death or immersion and may even indicate where the package of cigarettes was found.

Quite often the identification process is aided if there is information concerning the approximate time that a body was immersed in water. An examination of the skin will give some information. For example, the fingertips begin to shrivel up or show the "washer woman's characteristics" somewhere between two and four hours after immersion. This shrivelling up of the fingertips is fully developed at the end of twenty-four hours. The skin on the palms of the hands begins to shrivel between twenty-four and forty-eight hours. The shrivelling of the soles of the feet begins at about forty-eight hours. The skin at various parts of the body begins to slip off somewhere between four and eight days, depending upon the water temperature. The skin and the nails can be pulled off in a glovelike fashion somewhere between two and three weeks of immersion. It becomes obvious, then, that identification of an unknown body is a technical process, but it is one which can be done with a high probability of success, assuming that investigators are competent and that they use a battery of the latest methods available for the identification of unknown human remains.

The tragedy in the summer of 1976 associated with the flood through the Big Thompson Canyon in Colorado shows the effectiveness of high-quality identification procedures. In that disaster, over 100 individuals are known to have lost their lives. All bodies that were recovered have been identified and have been disposed of according to law and wishes of next of kin.

The problem was complicated by the wide range of ages involved and the large area over which the bodies were strewn as a result of the flood action. However, it was possible, using modern identification techniques, to arrive at the identification of each set of remains.

Professor Nash brings to the reader's attention in a straightforward, useful way the various devices and procedures that aid in the identification of humans. In view of the fact that aircraft accidents, fires, explosions, floods, and other disasters still plague man, it is important for law enforcement personnel and indeed for all segments of the law enforcement community to be aware of the techniques and possibilities of identification of single remains as well as numerous remains which may result from mass disasters.

The book which Professor Nash has created should prove useful to a wide audience. It is hoped that it will serve as an effective text for a short course in identification to be given to law enforcement personnel and other members of the legal system in the United Stares so that all will have an appreciation of the fact that no set of human remains need go unidentified except under the most unusual circumstances.

CHARLES G. WILBER, Ph.D.

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INDIVIDUAL IDENTIFICATION
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CHAPTER 1

Introduction

THE LITERATURE of forensic science is filled with unusual applications of science to the identification of individuals. The person who is charged with the identification of an unknown body may have to resort to numerous techniques in order to reach a successful identification. A case described by Stevens (1966) illustrates briefly but elegantly the problems involved in the identification of humans.

The case involved victims in the crash of a small civilian plane. The plane, containing a student pilot and a flight instructor, had crashed into the sea. The body of the student was recovered and identified a few days after the crash, but the instructor was not found. Three and one-half months following the crash, a headless and limbless torso was washed ashore several miles from the site where the student's body had been discovered.

The incomplete nature of the body obviously eliminated many of the usual methods of identification. The corpse was x-rayed, as x-rays of the missing instructor were available from the previous year. The postmortem x-rays of the unknown body had many points of similarity with the antemortem films of the pilot. Stevens mentions that

> the similarities included scoliosis of the spine with slight convexity to the right, maximal at dorsal 8 to 9 level, marked spondylosis of the right eighth and ninth costo-transverse joints, unusually large and shaped tubercles on the first ribs and in particular on the left second rib, and distinctly shaped and splayed left sixth, seventh and eighth ribs.

It was felt that the x-ray comparisons alone were sufficient to make a positive identification. However, an additional line of evidence was available which, although it could not by itself provide identity, did provide a strong contributing force.

Samples of several organs from the unknown body were typed for their ABO blood group system. All samples gave strong group B reactions. Prior to the determinations, the pilot's wife had in-

dicated her husband had been blood group B. In the British population, type B occurs at a frequency of 8 in 100. The fact that the unknown had the same blood type as the pilot thus could be considered as an additional step in the direction of a positive identification. Blood groups by themselves may be of limited value in identification but, in cases such as this, may provide evidence for confirmation.

One other important point was raised by Stevens in the above case. He noted that the police had acted surprisingly slowly in seeking pathological or medical assistance in the identification of the body. In effect, they had assumed it was beyond identification. Law enforcement personnel should realize that in difficult cases, different types of medical evidence may lead to a successful identification.

One additional study will be described as an introduction to the ever-fascinating work of individual identification. A most interesting case of identification requiring the utilization of several methods was described by Spitz et al. (1970). The study involved the identification of two individuals killed in an explosion of an automobile. Two bodies were recovered at the scene of the explosion. One of the victims was identified readily on the basis of direct visual identification by relatives and friends. Fingerprints later confirmed the identification of the victim. The second body presented many problems because of the extensive mutilation of the body. There did not appear to be any identifying scars, deformities, or tattoos. Additional interest was generated in the case by the possibility that the second victim might have been H. Rap Brown, a militant black leader due to stand trial.

The efforts to identify the victim included an intense search for fingerprint fragments and a reconstruction of the facial features along with subsequent photographs and drawings of the reconstructed contours. Personal papers found at the scene of the accident also were processed. A follow-up of one of the names found on an identification card and military discharge papers led the search to the military dental records of a William H. Payne. However, the military dental charts of W. H. Payne did not compare with the postmortem dental examination of the blast vic-

tim. It was concluded that the two persons were not the same because of the discrepancy in the dental patterns. It should at this time be noted, however, that the blood group of the victim was O+ and was similar to that reported for W. H. Payne.

Considerable effort was directed towards the reconstruction of the facial features. An artist sketched the reconstruction, and a facsimile of the face was prepared with the aid of an Identi-kit®. Photographs of the reconstruction were taken from different angles. The photographs revealed that the frontal hairline was grossly irregular. In addition, there were numerous well-defined areas of alopecia (hairlessness). These areas were scattered throughout the black, coarse, cropped hair.

Comparison of photographs of the left ear of the victim with those of H. Rap Brown revealed discrepancies. The hairlines also revealed some obvious differences.

A detailed search of the scene of the explosion did turn up three fragments of skin, including the right thumb and left little finger. Comparison of prints of two of the fragments with prints of the right thumb and left little finger of W. H. Payne revealed that they were identical. As indicated above, the dental records of the unknown victim had not matched those of Payne. However, the identification of the unknown as Payne was confirmed by personal identification by a friend and members of the family. Two of the features mentioned earlier played a major role in the personal identification. These features were the patches of baldness and the shape of the hairline.

The artist's sketch and Identi-kit reproductions also turned out not to be consistent with the features of the deceased. In spite of the discrepancy in the dental records, it was concluded that the identification of the unknown blast victim was, in fact, Payne.

The above two cases illustrate very well the variety of techniques that may have to be utilized in the identification of individuals. The techniques include examination of the skeleton, teeth, blood groups, fingerprints, personal appearance identification, drawings, Identi-kits, and hair. The remainder of this book will be devoted to an examination of these methods as well as

some others. The case described by Stevens also emphasizes the point that good techniques in the hands of the inexperienced or the careless experienced worker can lead to erroneous results and conclusions. Where so much may be at stake in the identification of individuals, there is no substitute for carefully thought-out, meticulous procedures.

CHAPTER 2

The Biological Basis of Individual Uniqueness

MOST PERSONS are fully aware that no two individuals ever seem to be exactly alike. Human beings, not only among different populations around the world but also within even a relatively homogeneous population, differ from each other in a variety of features. The uniqueness of individuals includes physical, biochemical, psychological, and behavioral features. Even in the case of identical twins, who may appear virtually identical at first glance, detailed observation and familiarization soon establish differences. Philosophers for a long time have written extensively about the importance and significance of the individual. The great advances in the biological sciences during the past century have served to underscore the biological nature of individuals. Numerous books and treatises attest to this philosophical and biological vein, including *The Uniqueness of Individuals* by the British biologist and Nobel Prize winner Sir Peter B. Medawar. Individual identification, on whatever basis is used, relies on the above observations and rests on the most important assumption that every human being is, in fact, unique.

Since the uniqueness of each person is the key to successful identification, it would be well to examine briefly the means by which such uniqueness is achieved. It would be impossible to identify and isolate all the factors and influences that shape a living organism. An answer to the question "What is the basis of individual uniqueness?" can be expressed easily in general terms, but complete understanding remains one of the most difficult and most fascinating areas of contemporary biological research. Unfortunately, the law enforcement officer often is faced with seeking out and identifying individuals on the basis of partial pieces or clues to identity.

Development of the Individual

The appearance of an individual is a result of a combination of genetic and environmental forces acting upon him from the

time of conception. Each individual commences his development from a fertilized egg or zygote in which is provided the genetic framework or blueprint which will set the limits as to the range of potential characteristics which the individual will develop. The sperm from the father and the egg or ovum from the mother, which together form the zygote or fertilized egg, contain equal amounts of genetic information so that an individual's genetic heritage is provided in equal amounts from both the mother and the father. People thus possess features of both parents, and resemblances may be seen on both sides of the family. Often, as a result of the specific genetic factors that are involved, a person may show a much more pronounced resemblance to one parent than to the other.

The appearance of an individual, whether it be his entire nature or some specific aspect of his physical, physiological, or behavioral makeup, is referred to as his phenotype. Many human traits and individual differences are known to be governed by genetic factors or can be said to have an inborn basis. The genetic constitution of an individual is referred to as his genotype. Some genetic traits, such as eye color, blood types, albinism, fingerprints, the ability to roll one's tongue, and many others, are modified little if at all by the environmental conditions in which the person is raised. Other traits, which also may have a genetic basis, may be markedly influenced and modified by a variety of environmental factors. For example, concerning weight, two persons may both have a genetic predisposition to be heavy. If one has been on an extremely restricted diet and the other on a copious diet, the resulting phenotypes (in this case, body weights) are likely to be quite different. There are thus numerous ways in which hereditary and environmental factors may interact with each other. Geneticists have tried to emphasize the importance of this interaction—as Medawar (1957) has so aptly put it, "Heredity proposes and development disposes." The end result is that human traits may show an almost endless variety of form and thus lead to the vast variation of individuals.

The Genetic Material—Genes and Chromosomes

The genetic material consists of molecules of nucleic acid which are contained within the nucleus of every cell of the body.

The genetic material can be considered to be organized into units called genes. These genes are themselves organized into larger groupings called chromosomes. The chromosomes, as well as the genes contained in them, occur in pairs in the zygote from which a new individual will develop. The number of chromosomes in man in the zygote, as well as in most cells in the adult, is forty-six and is referred to as the diploid or 2N number. The ovum and sperm each contain the haploid or 1N number, or twenty-three chromosomes. Each person has received one set of chromosomes from the mother via the ovum and one set from the father via the sperm. Thus, the chromosomal number is kept constant from generation to generation, being maintained as 2N in all cells except the sex cells, in which the number is reduced to 1N and then the 2N number is restored at fertilization through the union of ovum and sperm.

Utilizing relatively easy technical procedures, it is possible to obtain slides of human chromosomes. For detailed examination of the chromosomes, photographs are taken, and after enlargement, the chromosomes are cut out and positioned in pairs in descending order of length. This systematic arrangement of the chromosomes is termed a karyotype. In man, the forty-six chromosomes (or twenty-three pairs) fall into seven general classes based on the size of the chromosomes and on the position of the centromere, which appears as a constricted region along the axis of the chromosomes.

Certain individual differences can be traced directly to differences in the number and/or kinds of chromosomes. For example, of the twenty-three pairs of chromosomes of each cell, one pair contains genes which determine the primary sexual features of the individual. In the female, the members of this pair of chromosomes (the so-called X or sex chromosomes) are of equal size (Fig. 1). The other twenty-two pairs of chromosomes are called autosomes. In the male, there also are twenty-two pairs of autosomes and one pair of sex chromosomes. However, in the male, unlike the female, the members of the pair of sex chromosomes are unequal in size. One member of the pair is similar in size to the X chromosome of the female, and the other, the Y chromosome, is much smaller (Fig. 2). It is possible to determine the sex of a normal individual from the karyotype alone,

females having twenty-two pairs of autosomes and one pair of X chromosomes and males having twenty-two pairs of autosomes and an XY pair. As a result of "mistakes" occurring during the formation of the sex cells or after the fertilized egg has commenced division, resulting cells may end up with abnormal chromosomal numbers. A variety of different phenotypic abnormalities and malformations are known in humans which are due to

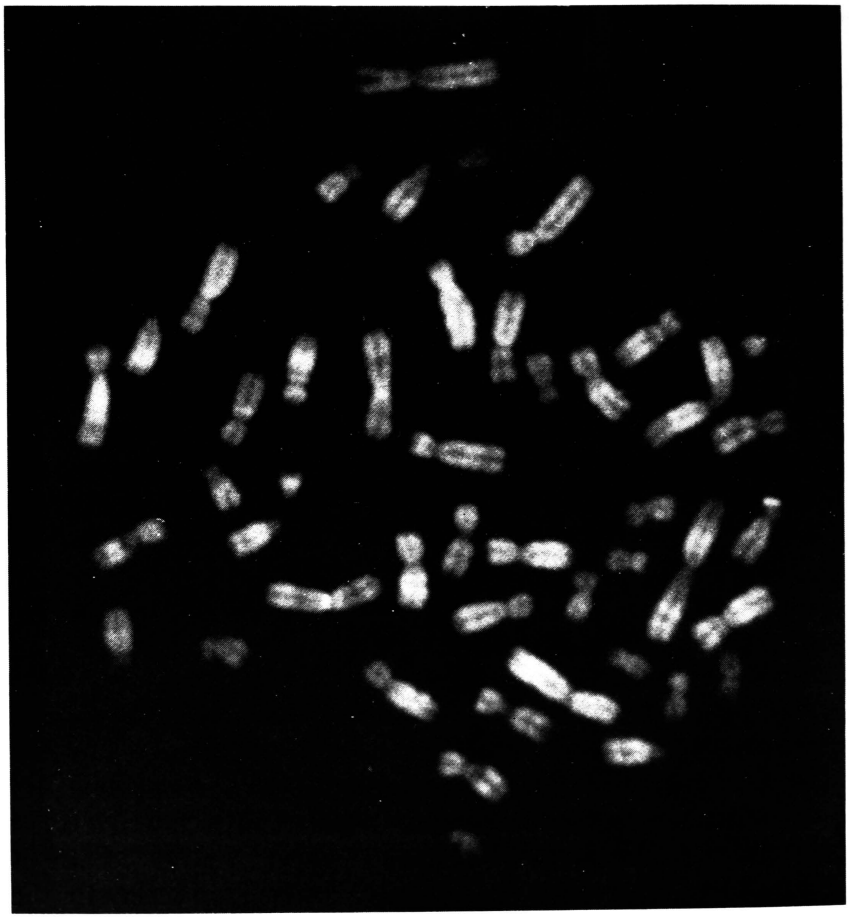

Figure 1. Metaphase cell from a normal human female, showing forty-six chromosomes including one pair of X chromosomes. Photograph by Daniel Chavez.

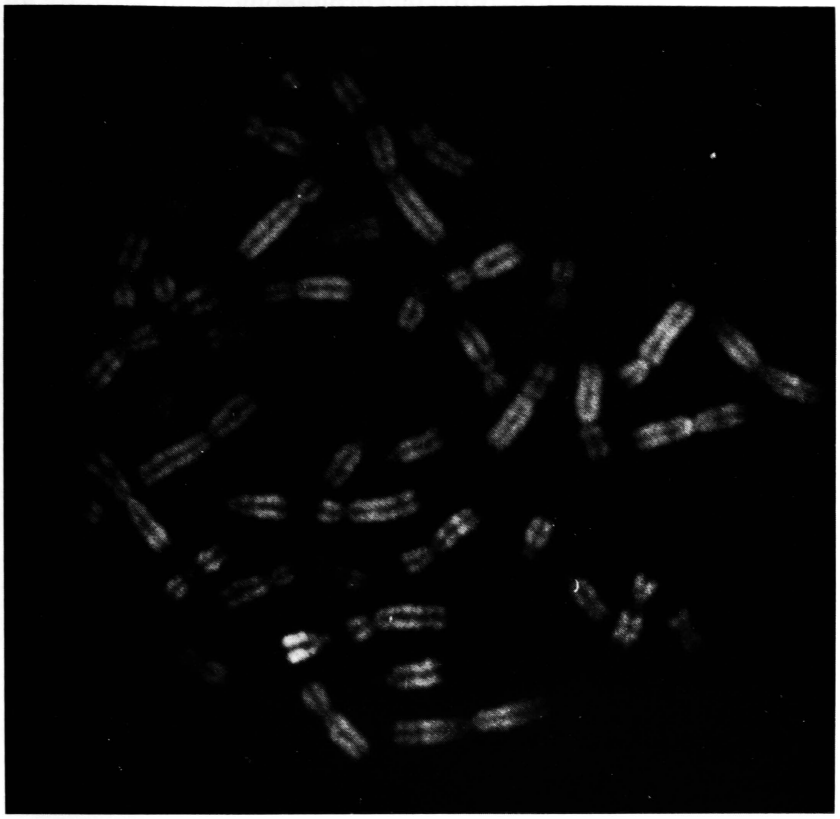

Figure 2. Metaphase cell from a normal human male, also showing forty-six chromosomes but differing from the female cell in that there is only one X chromosome and there also is one Y chromosome. Photograph by Daniel Chavez.

chromosomal abnormalities, including such well-known defects as Down's syndrome, Turner's syndrome, Klinefelter's syndrome, and the XYY condition.

Genetic Variation

During the formation of the sperm or egg cells the twenty-three pairs of chromosomes separate independently of each other. In other words, the set of chromosomes originally furnished by the mother and the set furnished by the father are not in-

herited together, but the pairs of chromosomes can separate in any combination. In the human with twenty-three pairs of chromosomes, there are over 8 million possible combinations of chromosomes in the formation of the egg or sperm. Looking at this variation in another way, it would mean that the chance of two brothers having received the same combination of chromosomes from their parents is 1 out of 64 million.

However, the genetic variation that is possible as a result of the independent separation of the twenty-three pairs of chromosomes during the formation of the germ cells is by no means the only source of genetic variation. Considering the genes that are located on some particular pair of chromosomes, they may be similar or quite often they may be of a variant or alternative form for some specific trait. It is estimated that in the human, on the average, individuals are variant or heterozygous for 30 percent of their genes. When one considers that there are over 100,000 genes in man, it may be realized that the likelihood of any person producing genetically identical sperm or egg is for all practical purposes zero.

Are Identical Twins Identical?

The closest thing to an exception to the generality that no two people possess the same genetic information would occur in the case of identical twins. Identical or monozygotic twins come about as a result of a single fertilized ovum having split early in development into two parts. Each part receives a complete set of genetic information which is identical in each part. In this sense, the two cells which are theoretically destined to develop into two identical twins are initially identical. However, in the course of development from the one-cell stage to the time of birth, various genetic and environmental factors may exert their influences so that what may have been programmed to be genetically identical may come to differ in appearance. Mutations or changes in the genetic information may occur and cause even the "identical" twins to not be genetically identical. Subtle maternal influences may also operate during development to cause differences in the appearance of identical twins. It should be kept in mind that for all individuals, identical twins included, the genes are

always operating in some specific environment and that the potential expression of a gene may be markedly influenced by the environment.

Single Gene Inheritance in Man

The usual manner of describing or identifying someone is by specifying certain components or traits of his overall phenotype. A number of phenotypic characteristics are known in humans in which the trait is governed by genetic factors. Of these genetically determined traits, certain of them are governed by so-called simple Mendelian inheritance. That is to say, the pattern of inheritance of the trait can be followed readily in different family histories. A few specific examples of Mendelian inheritance in man may be useful to illustrate the role of heredity in human individuality.

Certain humans have the ability to roll the tongue in a U shape (Fig. 3), whereas others cannot do so. For this particular phenotype then, there are two alternative forms or characteristics—the ability to roll the tongue or the inability to roll the tongue—and people fall into one of these two categories. In the United States, for example, about 70 percent of the people have the ability, whereas 30 percent lack it. The alternative forms of this particular trait are determined by a single pair of genes. The two genes are located at the same spot or region of one of the

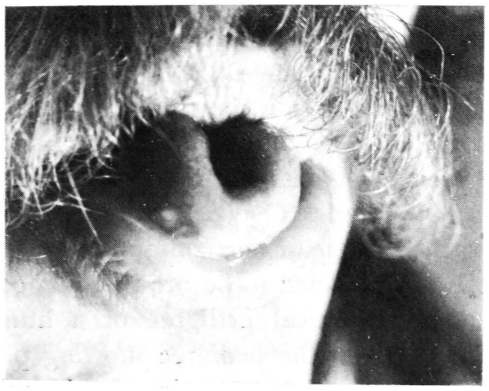

Figure 3. A person demonstrating the ability to roll his tongue into a U shape. *Note:* Recent evidence indicates that this trait may not be inherited in a simple manner.

twenty-three pairs of chromosomes which the human possesses. Each of these locations on the twenty-three pairs of chromosomes is known as a gene locus, and there are thousands of gene loci.

Upon studying the tongue trait in a number of families, a definite pattern of inheritance may be deduced. It turns out that a person who cannot roll his tongue in the above manner has two identical or similar genes at the locus in question. We say that the individual is homozygous for the gene since he bears two copies of the same gene—tt, for example. On the other hand, persons who can roll their tongues turn out to be of two types genetically. They either have two genes which are alike, TT, and phenotypically have the ability to roll, or else they have one gene for the ability and one gene for the inability. In the second case, they are said to be heterozygous for the gene. Since in this specific example the heterozygous genotype Tt has the same phenotype as the homozygous TT, we say that the gene which governs the ability to roll is dominant to the gene responsible for the inability to roll. The latter gene is referred to as a recessive gene.

Referring back to our discussion of chromosomes, an individual receives one each of the two genes from the set of chromosomes that came in from the maternal egg and paternal sperm. Depending on the genotype of an individual (TT, Tt, or tt) and the genotype of his mate, different types of children may result from the different combinations of mating. The two types of homozygous persons can produce only one type of sex cell each. If a person is TT, the sex cells, be they sperm or egg, will contain a chromosome with the T gene. If the person is tt, only the t gene will be present. A heterozygous individual, Tt, will produce two types of sex cells. They will contain either a chromosome containing the T gene or one containing the t gene, and the two types of cells are expected to be produced in equal numbers. As an example, a theoretical pedigree of a human family is shown in Figure 4. Given the pedigree showing phenotypes and based on our knowledge of the genetics of this trait, we can say certain things about the genotypes of the individuals. Since we know that the nonroller phenotype comes about as a result of a

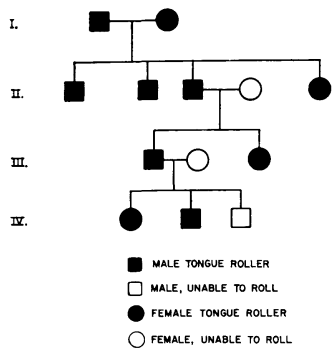

Figure 4. Pedigree of a family in which the tongue-rolling trait is found.

person being homozygous for the t gene, we can assume that all nonrollers have the genotype tt. In the case of the roller phenotype, without any additional knowledge, all we know is that the person must have at least one dominant T gene, since either TT or Tt will give the same phenotype. Looking at the rollers in generations I and II, that is all we can say for certain. Concerning generation III, we could deduce that the male roller must be heterozygous Tt. This would be evident on two counts. First, one of his parents is a nonroller and must have contributed a t gene to his makeup. The second line of evidence comes from the observation that when mated to a nonroller woman, one of their children was a nonroller. The only regular way in which two rollers would have a nonroller child would be if they were, in fact, heterozygous Tt. The roller children in generation IV could be either homozygous TT or heterozygous Tt, but there is no way of telling without additional information.

The above example is a simple demonstration which shows how a knowledge of heredity may help to explain why children resemble their parents for certain traits and why they may be different from one or both parents.

Biology and Genetics of the ABO Blood Groups

As an example of the mechanism of inheritance of a somewhat more complex trait in humans, the ABO blood groups might be discussed. The ABO blood groups have found the