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FOREWORD

This paper is intended to be a popular account of the work that is being done in the field of blood grouping, with special reference to the Navajo and Pueblo Indians of the Southwest, with which the authors have been particularly concerned. The authors have drawn no conclusions concerning the significance of the blood group distribution but rather have presented the discussion as given by Lattes in addition to their own results and the reader is left to decide for himself the value of blood groups in anthropology.

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(Signed) AUTHORS.

THE DISTRIBUTION OF THE HUMAN BLOOD GROUPS AMONG THE NAVAJO AND PUEBLO INDIANS OF THE SOUTHWEST

Human beings can be divided into four groups according to the kind or type of blood they possess. This individual difference in bloods was noticed long ago in connection with blood transfusions.

That blood has long been used as a therapeutic agent is shown by Pliny and Celsus when they describe the custom of the people who rushed into the arena to drink the blood of dying gladiators. During the middle ages the drinking of blood was much recommended for rejuvenation and treatment of disease.[1] As early as 1492, three youths supplied blood for Pope Innocent VIII. It was reasoned that if blood was beneficial by mouth, it would be more so in the blood stream; so, as early as 1505-1576 Hieronymus Cardanus and Magnus Pegelius suggested the possibility of transferring blood directly from the blood vessels of one individual to those of another. As early as 1615 Andreas Libavius described a method for blood transfusions in the following words:

> Let there be a young man, robust, full of spirituous blood and also an old man, thin, emaciated, his strength exhausted, hardly able to retain his soul. Let the performer of the operation have two silver tubes fitting into each other. Let him open the artery of the young man and put it into one of the tubes, fastening it in. Let him immediately after open the artery of the old man, and put the female tube into it, and then the two tubes, being joined together, the hot and spirituous blood of the young man will pour into the old one as if it were from a fountain of life, and all of his weakness will be dispelled.

1. Weiner, *Blood Transfusions.* 1935.

Whether Libanius ever actually carried out his proposed transfusion is not definitely known.

In 1616, William Harvey discovered the circulation of the blood and, in 1628, published his immortal monograph, *Exercitatio Anatomica de Motu Cordis et Sanguinis in Animalibus.*

Following this, in 1658, Christopher Wren, an astronomer and architect, injected medicaments into the veins of dogs by means of slender quills fastened to bladders.

The first authentic blood transfusion was performed in England by Richard Lower in 1665. In his experiments, dogs which had been previously bled, were kept alive by transfusions of blood from other dogs. As explained by Lattes, Lower accomplished his blood transfusions by connecting the carotid artery of one dog (the donor) with the jugular of another dog (the recipient) by means of quills. Fundamentally, the technique used by Lower does not differ from one of the methods used some 250 years later for transfusions in human beings.

The first attempt at a blood transfusion in a human being was in 1667 when Denys and Emmerez transfused nine ounces of blood from the carotid artery of a lamb into the vein of a young man. This transfusion was successful and following that, Denys performed other similar operations. Denys, in his writings of these transfusions, records the fact that "the patient passed urine as black as soot" following the transfusion. At about the same time, Lower, who had previously done successful transfusions on dogs, working now with King, performed a successful transfusion in England in which nine ounces of the arterial blood of a sheep was transferred to the veins of a man.

All of the blood transfusions performed thus far on man had been successful but following the fourth transfusion performed by Denys in France, the patient died. This accident led the French Academy of Science to decide against transfusions, and the performance of this operation was absolutely prohibited by an official act of the French parliament,

unless it met with approval of the Faculty of Medicine. This was in 1670.

This fatality, along with the restrictions placed on investigators, was enough to kill whatever interest had been aroused in transfusions.

It was about 150 years (1820) before any further progress was made in blood transfusions. About this time, the medical profession was experiencing many distressing cases of death from hemorrhage occurring especially from childbirth. In an attempt to do something about this situation, James Blundell attempted to revive the operation of blood transfusion. The method he employed, although crude, served to revive the interest of the profession in blood transfusion.

Although it was noted that the transfusion of blood of domestic animals into man was often followed by hemgolobinuria (black urine), fever, and even death, animal's blood was used up to the end of the 19th century.

In 1875, the first scientific advance in blood transfusions was made when Landois and Panum in a series of experiments showed that while an animal which had been depleted could be saved by transfusion of the blood of another animal of the same species, it would die if the blood of an animal of a different species was used. This was the first work that even suggested that blood was not alike in all animals, and that the fatalities of the past might be due to blood incompatibility. Landois also showed by experiment that if human blood was mixed with the blood of other animals the human red blood cells would become hemolyzed (dissolved) and the white blood cells would cease their ameboid motion and die.

Ponfick concluded from his experiments that the blood of animals belonging to the same species was identical since he was able to transfuse blood from one animal into another animal of the same species with safety, whereas if the donor and recipient were of different species, anuria or hematuria, coma, and even death often followed.

While the work of Landois, Panum, Blundell, Ponfick and others did much to bring blood transfusions back into good repute, it still did not explain the dangerous and often fatal results that followed transfusions in humans when *human* blood was used. It seemed that something more than species relationship had to be taken into account in transfusions.

In the few years that followed, according to Weiner, in a recent publication,[1] many ideas arose and reasons were given why transfusions were not successful even between animals of the same species. Transfusions were first carried out with whole blood but it was soon observed that there was a possibility of a dangerous coagulation of the blood, especially when the indirect method was used. Failures were also attributed to the fibrin, which was thought to have toxic properties. Then, more accurately, the fibrin was thought to have some mechanical action causing the formation of emboli. This led to the use of defibrinated blood and was adopted by almost all operators. During the Franco-Prussian War of 1870, defibrinated blood was used almost entirely and occasionally good results were obtained. But, still, death was altogether too frequent an occurence.

Defibrination itself was then accused of being the cause of these mishaps and surgeons stated that it lessened the usefulness of transfusions from the therapeutic point of view. Many observers then gave up the use of defibrinated blood, since, in spite of a number of successful results, it was also responsible for a number of fatal accidents. Kohler and Blaizot put forward the view that defibrinated blood was dangerous because the excess of fibrin-ferment injected increased the risk of intravascular coagulation. Bergemann, after carefully going through the literature, came to the conclusion that the irregular results obtained were, in fact, due to the varying quantities of fibrin-ferment injected in each case; that defibrination was contra-indicated; and that only whole blood transfusion was permissible.

1. Weiner. *Blood Groups and Blood Transfusions.*

These and even more fantastic ideas were advanced, but added nothing of much value to the problem at hand.

The final solution to the problem first came in 1900 when Shattock published his observations that the blood serum of persons suffering from certain diseases has the power of clumping together, that is, agglutinating the corpuscles of healthy persons. In the same year Dr. Karl Landsteiner, who is at present associated with the Rockefeller Institute for Medical Research, accidentally observed the same fact. After this, the number of observations speedily increased. The fact that this phnomenon was first observed in the sick helped to give a wrong direction to subsequent research. Most workers tried to establish some connection between the agglutination of corpuscles and disease and even to ascribe some diagnostic significance to it.

At the present time, the view that agglutination of corpuscles is related to disease of any kind is definitely abandoned and is only of historical interest. Landsteiner has the merit of being the first to point out that this agglutinating power of the blood is regularly found in normal individuals.

As a result of the work of Landsteiner, the cause of the shocks and fatalities of blood transfusions was shown to be due to the fact that the bloods of certain individuals were not compatible and would not mix. When a transfusion in such cases was attempted the blood corpuscles would clump together (agglutinate). This led Landsteiner to inquire into the character of the blood of different people, with the result that he was able to segregate people into three groups on the basis of the kind of blood they possessed.

In 1902, De Castello and Sturli described a fourth group, overlooked by Landsteiner, probably because of its rare occurrence.

In 1907, Jansky was the first to attempt to show *why* when certain bloods were mixed, they agglutinated and others did not.

In order to follow Jansky, we must accept his theoretical assumption that the blood contains certain substances two of which are found in the blood corpuscles and are called agglutinogens and two of which are found in the blood serum and are called agglutinins. The following chart shows the distribution of these substances in each of the four blood groups.

FIGURE 1

JANSKY GROUPING

	Cells		Serum	
Group 1	—	—	a	b
Group 2	A	—	—	b
Group 3	—	B	a	—
Group 4	A	B	—	—

Thus, according to Jansky, if a person belongs to Group I, the corpuscles (cells) do not contain any agglutinogens but the serum contains agglutinins (a) and (b). If a person belongs to group II, the blood cells contain agglutinogen (A) but not (B) and the serum contains (b) and not (a). In a group III individual, the cells contain (B) but not (A) and the serum contains (a) but not (b), and in a group IV individual, the cells contain both (A) and (B) agglutinogens but the serum contains no agglutinins. It should be remembered that agglutinin (a) will cause the agglutination (clumping together) of cells that contain agglutinogen (A), hence blood cannot contain both (a) and (A). Likewise cells containing agglutinogen (B) will be agglutinated by agglutinin (b). Therefore (B) and (b) cannot exist together in the same blood stream. They are not compatible.

In a blood transfusion there are at least two persons concerned: the one giving the blood or the donor, and the one receiving the blood or the recipient. The rule in giving a transfusion states that: "The cells of the donor must not be agglutinated by the serum of the recipient."

By referring to Fig. 1, it will be noticed that a person belonging to group I and containing no agglutinogens in his

corpuscles could with safety *give* blood to any of the other four groups. There is nothing in group I cells to be agglutinated. Hence, a person belonging to group I is said to be a *Universal Donor*, that is, he can *give* blood to anyone.

Likewise, a person belonging to group IV can *receive* blood from any of the four groups, since his serum contains no agglutinins, which are necessary to cause agglutination. A person belonging to group IV is, therefore, called a *Universal Recipient*, since he can receive blood from anyone.

A group I person can give blood to any group but can receive blood only from his own group.

A person belonging to group II can *give* blood to his own group and to group IV but can *receive* blood only from his own group and group I.

A person belonging to group III can give blood to his own group and to group IV and can receive blood from his own group and group I.

A group IV person can give blood only to his own group but can receive blood from any group.

Thus, by assumnig the presence of the agglutinogens and agglutinins, Jansky was able to explain why some bloods would "mix" and others not.

In 1910, Moss, independent of Jansky, also classified bloods, and, strangely enough, he used the same system as Jansky, except that groups 1 and 4 were reversed while groups 2 and 3 remained the same.

In other words. Jansky's group I is the same as Moss's group IV and Jansky's group IV is the same as the Moss group I. A chart showing the Moss system is given for comparison.

FIGURE 2

MOSS SYSTEM

	Cells		Serum	
Group 1	A	B	—	—
Group 2	A	—	—	b
Group 3	—	B	a	—
Group 4	—	—	a	b

Both of these systems are in common use. The Moss system is used mostly in France, England, and the United States. While there is very little danger in causing a fatal accident in transfusions as they are done today, it is very confusing to have the two systems used side by side. This led to the recommendation of the Jansky system because of priority. Unfortunately, the recommendation was not generally accepted and the two methods of grouping were used just as before. A few years ago another attempt was made to adopt a single method of grouping. This time it was recommended to discontinue the use of both the Jansky and Moss systems entirely and a new system of classification was proposed.

This new classification has been approved by:

Army Medical School
American Association of Immunologists
Committee on hygiene of the League of Nations
Medical authorities of England, Holland, Norway, Austria, Italy, France, and Germany

The change to the new classification is simple. It merely involves the use of letters instead of numbers to designate the group of an individual. As compared with the Jansky and Moss system the army method looks like this:

FIGURE 3

Jansky	1	2	3	4
Moss	4	2	3	1
Army	0	A	B	AB

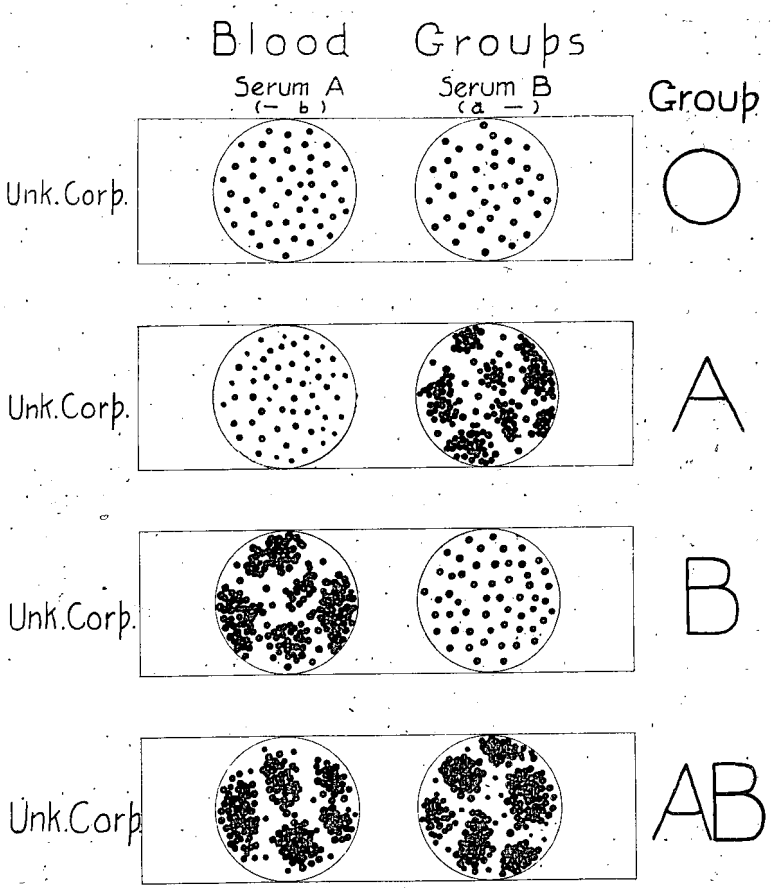
It is apparent that that this "new" (Army) method is, in reality, the Jansky system, and the letters refer to the agglutinogens present in the corpuscles. So, today, the group to which a person belongs is expressed in terms of the substances (agglutinogens) in his cells.

To determine the group to which an individual belongs is relatively simple. All that is needed is serum from a type (A) and a type (B) individual and some corpuscles from the person you wish to type. The corpuscles are collected in about 1cc of normal salt solution from a finger prick. A glass slide is cleansed and on the left side is placed a drop of known serum (A) and on the right side is placed a drop of known serum (B). To each drop of serum is added a drop of the unknown corpuscles. When this test is made at room temperature, a period of about 5 minutes is allowed for the reaction to take place. The chart on page 14 shows the reactions that might occur and how they are interpreted.

By observing the chart (Fig. 4), it will be seen that serum (A) contains agglutinin (b) and that serum (B) contains agglutinin (a). When corpuscles of the person to be typed are added to each of the two testing sera, the reaction that follows will depend upon which of the agglutinogens the unknown corpuscles possess. Thus, if the corpuscles of the person to be typed are not agglutinated by either Serum (A) or Serum (B), the corpuscles contain no agglutinogens and the person is said to belong to group (O). If the corpuscles are not agglutinated by Serum (A) but are agglutinated by Serum (B), the person is said to belong to group (A), and, if agglutination occurs with Serum (A) and not with Serum (B), the person is said to belong to group (B). If agglutination occurs in both sera, the person's corpuscles must contain agglutinogens (A) and (B) and the person is said to belong to group (AB).

Until about 1914, the only interest in blood groups was their relation to, and importance in, blood transfusions and skin grafts. It never occurred to any one to investigate their frequency in different peoples. The first investigations into the frequency of the groups showed the constancy of their relative proportion and a very significant agreement in population far apart from each other, such as the Germans examined by Hirszfeld, and the Americans of the United States studied by Moss.

FIGURE 4



The notion arose later that the distribution of the groups might be related to certain ethno-anthropological factors. L. and H. Hirszfeld were able to show the correctness of this view owing to a series of investigations which exceptionally favorable circumstances enabled them to undertake.

These observers, who were in the Medical Service of the allied armies in the East, were able to examine numbers of soldiers and civilians, some 8,000 in all, from the most diverse countries and belonging to many different races but who were at the time living in the same surroundings and for the most part, on the same diet.

One advantage of these investigations was that all the individuals were tested with the same test sera and therefore uniform conclusions could be drawn. The results of this study showed beyond a doubt that the distribution of the blood groups differed widely in the various nationalities and races. This study, owing to its wide extent, was of fundamental importance for the question of the ethnogeographical distribution of the blood groups.

Since then the numbers of both individuals and of peoples examined have grown enormously and so have especially the investigations in various regions and among different ethnological groups in one and the same country.

Much of the early work has been discarded on two grounds: first, the sera used and the technique in doing the test was not as reliable as we know today it should have been, and secondly, observations were carired out on too small a scale, thereby introducing a source of extensive variation. In order to obtain a reliable basis for comparison, at least 500 individuals of the same race should be included. In this way, according to Wellishch's calculations, the mean error does not exceed 2%. The more recent data, collected on larger numbers of individuals, and by improved methods show that, on the whole, the distribution of the blood groups in a given population is related to its ethnic constitution.[1]

1. Lattes. *Individuality of the Blood Groups.*

In reviewing the literature, it became apparent that very little work had been done on the American Indian and much of what had been done was open to criticism.

For example, much of the work was done in Indian schools, where many tribes were assembled and no discrimination was made among them. They were all listed as American Indians.

Likewise, in much of the work no effort was made to eliminate the pure bloods from the highly, and often obviously, mixed individuals; they were all listed as pure-blooded Indians. According to the government records, all Indians that attend schools are pure bloods. This, obviously, is not correct, as white and negroid characters are in evidence even to the casual observer, and many admit on questioning that they are only one-fourth to one-thirty-second Indian.

And, last but not least, in much of the work on Indians the number of individuals recorded was so small that the error could easily have been as much as 20-25 per cent.

For these reasons, it was evident that data of a more accurate nature were needed on Americn Indians and that the University of New Mexico was a natural laboratory for that type of study because of its close contacts with the Indians.

Had it not been for private funds and for excellent cooperation on the part of Indian Commissioner Collier, and the medical director's office, the work in collection of blood samples for testing could not have progressed as rapidly as it has. These funds have entirely covered living and travel expense going to and from the pueblos for the authors and assistant.

In the last 18 months 1,794 individuals have been blood typed, of which 622 were Navajos and 1,172 were pueblo Indians. Any obvious or admitted mixtures were not included in our results.

At first we would question the Indians as to their names, ages, pueblos, and to what tribe their parents belonged. It was our experience that most of them do not

know the answers to these questions so this practice was very soon discontinued. Information was obtained from a more reliable source, viz: teacher, doctor, superintendent, etc.

In each case the blood was typed by the approved Army Medical School Method, by use of known (A) and (B) typing sera from single sources, and the results recorded in terms of per cent of (O), (A), (B), and (AB).

A separate card was filled out for each individual, giving name, age, sex, tribe, and blood group. The following table shows the results obtained for the Navajo and Pueblo Indians and how they compare with those found by other investigators.

FIGURE 5

INDIAN BLOOD GROUPS

Author	People	No.	O	A	B	AB
Coca-Diebert	N. America	862	77.7	20.2	2.1	
Nigg	Navajo	457	72.7	26.7	.2	.2
Gates	Canadian	300	86.7	12.7	.2	
Ride-Furuhata	Canadian	203	74.8	23.6	1.5	
Matson-Schrader	Blackfeet (Pure)	115	23.5	76.5		
Matson-Schrader	Blackfeet (Mixed	235	45.5	50.0	2.1	1.8
Matson-Schrader	Alberta (Pure)	24	16.7	83.3		
Matson-Schrader	Flatheads (Pure)	23	78.3	8.7	4.3	8.7
Matson-Schrader	Flatheads (Mixed)	258	51.5	42.2	4.7	1.6
Matson-Schrader	Sioux (Pure)	48	89.6	10.4		
Matson-Schrader	Sioux (Mixed)	31	84.0	16.0		
Matson-Schrader	Oregon (Pure) (Many tribes)	33	78.8	15.2	3.0	3.0
Matson-Schrader	Oregon (Mixed)	64	54.7	32.8	9.4	3.1
Nigg	Haskell I. S.	316	70.7	27.2	1.6	.3
Snyder	Many Tribes (Pure)	453	91.3	7.7	1.1	
Snyder	Many Tribes (Mix.)	409	64.8	25.6	7.1	2.4
Allen-Korber	Navajo	622	69.13	30.6	.16	
Allen-Schaefer	Pueblo	1175	83.6	14.3	1.7	.25

DISCUSSION [1]

In the mixed American or European population the distribution of the four blood groups is (O)=45%; (A)=40%; (B)=10%; (AB)=5%. By referring to the results of the present Indian study it will be noted that the Indian does not follow such a distribution and is characterized rather by a preponderance of groups (O) and (A) with practically no (B) or (AB).

The frequency of Group (O) would seem to remain fairly stationary, from 35 to 45 per cent in European and African races. In the Asiatic groups (Chinese, Japanese, Koreans, Manchus, Indians, Ainos, and also in the Hungarians and Gipsies who are undoubtedly of Asiatic extraction) the figures for group (O) come to 20 to 35 per cent.

On the other hand, in certain ancient "races"[2] in which, owing to historical circumstances, very little admixture with other "races" has occurred, particularly in the North and South American Indians, the Australian Aborigines, the Malays of the Philippines, the Eskimos, the Lapps, and the Icelanders, the percentage of Group (O) is very high, invariably over 50 per cent and even, in some cases, over 90 per cent, e. g., 91.3 per cent in the Red Indians,[3] 100 per cent in the Indians of Peru and in some Aruacan tribes.

It would seem that the primitive and characteristic constitution of some of these "races" was probably that of Group (O). Snyder and Nigg found that, in the Indians, the figures for the half-breed approximate those for the white "races," whereas, in those of pure blood, the figures for

1. In order to point out how the Indians compare with the other races, we have freely drawn from Lattes on the discussion of other races.

2. According to Hooton, "A race is a great division of mankind, the members of which, though individually varying, are characterized as a group by a certain combination of morphological and metrical features, principally non-adaptive, which have been derived from their common descent." The term "race" in this Bulletin is not used in the strict anthropological sense, but is meant to refer to "racial types" as given by Ottenberg, p. 21.

3. American Indians, as reported by Snyder in *Blood Grouping in Legal and Clinical Medicine*. 1929.

Group (O) are much higher. Similarly, Heinbecker and Pauli noted that all those Eskimos who did not belong to group (O) were half-breeds, due to cross-breeding with whites. According to Coca and Deibert, and Snyder, the Indians branched off from the main trunk of mankind before agglutinogens were developed, so that the presence of these in certain individuals must be due to cross-breeding with whites. That cross-breeding does have an influence on the percentage of the blood groups is quite clear from the investigations of Lewis and Henderson on African and American negroes; the figures of the latter (American) are much nearer to those for the particular European "races" with whom they have most freely intermingled. The relative proportions of (A) and (B) agglutinogens are also closely related to ethno-anthropological considerations. In order to obtain an accurate estimate of the frequency of (A) and (B), we must add to each of these groups the figures indicating the frequency of Group (AB), in which both properties are united. The relative frequency of (A) and (B) has been studied for many different "races."

A marked predominance of (A) over (B) is characteristic of the western European "races," and of those derived from them throughout the world, e. g., The white "races" in the United States of America and in Australia. In the United States of America, Buchanan and Higley obtained very similar results even after eliminating all foreigners and restricting their investigations to American citizens, who were, of course, ultimately of European descent.

In western Europe the percentage of Group (A) works out, on an average, at 40 to 45 per cent. It decreases slightly as we go towards east and southwestern Europe (Poland, Russia, the Balkans, etc.) and much more rapidly in Africa and Asia (Arabs 37 per cent, Madagascans 30 per cent, Indo-Chinese 29 per cent, Negroes 27 per cent, Hindus 27 per cent, Chinese, Koreans, Manchus 24 to 30 per cent.) The Japanese show a percentage of (A's) comparable with that found in Europeans.

On the whole, we may say that property (A) decreases as we go east and south from western Europe.

Property (B) follows the reverse order: it is relatively uncommon in the west of Europe (10-12 per cent in Portugal, Holland, and Belgium; 14 per cent in France, Italy, and England; 12-16 per cent in Scandinavia and Germany. In the Balkans it rises to 20-30 per cent, in the Turks and Arabs to 25 per cent, in the Russians and Poles to 28-30 per cent).

In Africa and Asia, property (B), which is, in the main, relatively uncommon in Europe, increases considerably; up to 28 per cent in the Madagascans, 34 per cent in Negroes and Indo-Chinese, 47 per cent in the Manchus, and up to 49 per cent in the Hindus.

The marked prevalence of Group (O) among the Filipinos, Indians, Lapps, and the Australian Aborigines reduces the percentage of groups (A) and (B). Nevertheless, in these "races," which are so definitely separated from the others, (B) is extremely uncommon, so that, though (A) is also uncommon, it far exceeds (B). Thus Cleland failed to find a single example of (B) or (AB) in 101 South Australian Aborigines; neither did Landsteiner and Levine find any in 205 Indians in the United States, nor Gates in 75 Indians in Canada. Heinbecker and Pauli found two individuals with property (B) out of 166 Baffin Island Eskimos and Downs; Jones and Koerber also found 2 (B's) out of 120 United States Indians.

The predominance of (A) over (B), apart from these particular cases is the more marked the nearer we get to the west of Europe, whereas, in Africa and Asia, and especially in India and the Far East, the two frequencies tend to become more nearly equal, and (B) even comes to exceed (A). The "races" living between Europe on the one side, and Asia and Africa on the other, show intermediate figures.

Ottenberg believes that the ratios of the three properties, (O), (A), and (B), give rise to a number of racial

types, which he classifies under six headings in the following manner:

FIGURE 6

	O	A	B
I. European	39	43	12
II. Intermediate (Arabs, Turks, Russians, etc.)	40	33	20
III. Hunan (Japan, South China, Hungary, Roumanian Jews)	28	39	19
IV. Hindo-Manchu (Corea, North China, Gipsies, Hindus)	30	19	39
V. Afro-South Asiatic (Negroes, Madagascans, Malayans)	42	24	28
VI. Pacifico-American (Indians, Australians, Filipinos, Icelanders)	67	29	3

Snyder further subdivides the Pacifico-American type, by making a separate type of the Australians.

The first question to be asked in this connection and one which is clearly of great importance from the anthropological point of view, is whether the distribution of the groups is really due to the ethnological origin of the various peoples, i. e., to the "race" in the anthropological sense; or whether it is the result of climate, diet, or of the general environment. Since we know, however, that the blood groups are hereditary and are not affected by the environment, it is hardly probable that the surroundings would exert much influence on their distribution in a given population. They are more likely, therefore, to be due to cross-breeding. This idea is substantiated by an abundance of evidence.

Without wishing to trespass on the field of anthropology in the strict sense, it is clear that the study of the blood groups must be of immense importance to that science, and amply justifies the concentrated efforts of the serologists for the rapidly increasing extension of our knowledge on this subject. For this study, bringing out as it does the relative frequency of hereditary characters, allows us to perceive more clearly the mixed character and the ethnical overlap-

ping of present day nationalities. Moreover, it may help to clear up the problems relating to the origin of certain "races," such as the Indians of North and South America, as to whose ultimate origin, whether Asiatic or Australo-Pacific, discussion is still rife. Mazza and Franke rightly remark that the infrequency of Group (B) in American aborigines is an argument against their being of Asiatic extraction, since this group is usually common in Asia.

The ultimate cause of the varying distribution of the blood groups in relation to anthropology is not yet clear. The Hirszfelds put forward the theory of a separate origin for Groups (A) and (B), the former having arisen in the West, the latter in the East; in this way the present day distribution of the groups would be due to the migration and consequent infiltration in varying proportions of one group by the other, especially, according to Stecan, of the European races by the Mongols. In order to account for the relative infrequency of Group (AB), Dyke supposed a lethal factor (owing to which certain gametes would be sterile) as has been done for other problems in heredity. This would, by selection, alter the distribution of the groups so that it would no longer correspond to what it would have been if the laws of heredity had had free play. Nino showed, however, that this supposition was unnecessary.

Bernstein supposes three primitive "races," (A), (B), (O), corresponding to the three hereditary factors. "Race" (O) is the most numerous in almost every country and is found in a nearly pure state in some remote peoples, such as the Indians, the Filipinos, the Australian Aborigines, and the Eskimos. Bernstein, therefore, believes that "race" (O) is the original "race," and that "races" (A) and (B) were developed later.

The almost total absence of (B) in the Indians would suggest that they separated off from the main Asiatic trunk before the development of this property, or that this race was developed autochthonously, which would imply a polygenetic origin for the various races.

Property (A) decreases from West to East but is not uncommon even in Asiatic peoples; conversly (B) decreases very rapidly from East to West. This might lead us to think that property (B) was more recent than (A), unless, according to Bernstein, we suppose that mutation (A) occurred in a larger number of individuals than (B), or, possibly, independently in Europe and in Asia, or that the migrations of European races into the East have been more numerous than those in the opposite direction. On the other hand, the view that (O) is the original race is difficult to fit in with the fact that properties (A) and (B) have been found in animals, and particularly in anthropoid apes.

The investigations on the ethno-anthropological values of the blood groups are being carried out on a very large scale, but, for the present, only temporary conclusions are warranted.

Quoting from Hirszfeld:

> There can be no doubt that serology has provided us with an instrument which, with the other sciences, may help to solve the most difficult problems relating to the origin of the various races of mankind, but the evidence at our disposal is as yet too fragmentary and too heterogeneous to permit of synthetic treatment. Postulates as to three or more primitive races, discussions as to whether the Indians separated from the Mongols before or after the development of Property B, or whether the Northern Mongols remained unaffected by Mutation B; whether the Indians are autochthonous in origin; whether exactly similar mutations have occurred in various places, etc., all raise important questions which can only be answered when we know which was phylogenetically the more primitive condition; the presence or the absence of agglutinogens; i. e., whether Group O arose by Mendelian inheritance from the cross-breeding of races A and B, or whether it was due to a mutation by default; or again, whether the dominant properties were developed in the human

species by mutation, or are due to some specific relationship between each race of mankind and certain species of anthropoid apes. The results obtained so far are sufficiently important to make it highly desirable that homogeneous investigations should be organized on an international basis. From now on, it is clear that any statistical investigations on the blood groups must take into account the ethnological origin of the persons examined. These racial differences alone, and not alterations in environment or disease, can, in the present state of our knowledge, account for the variations in the frequency of the blood groups in man.

LINGUISTIC STOCKS		BLOOD GROUPS			
Tanoan	No.	O	A	B	AB
Tiwa Taos Picuris Sandia Isleta	203	75.36	19.21	5.42	0
Tewa San Juan Santa Clara San Ildefonso Nambe Hono Tseque	142	90.14	9.85	0	0
Towa Jemez Zuñi Pecos (Ext.)	170	78.23	19.41	2.35	0
Keresan Cochiti Domingo San Felipe Santa Ana Zia Laguna Acoma	353	88.04	11.66	0	.28
Total Pueblos	868				
Athapascan Navajo Apache	622	69.13	30.61	.16	0

The above chart shows the various linguistic stocks and how their blood groups compare. It is quite obvious that the Tewa are not racially the same as the other linguistic groups. Many anthropologists, of course, make no claim that because certain groups belong to the same linguistic stock they are necessarily related—but some do. This chart shows the fallacy in assuming blood relationship merely on the basis of language.

It will also be noted that the blood group distribution among the Navajo and Apache is not the same as among the Pueblo Indians.

Since the blood groups have been found to be inherited according to Mendelian laws, they have been used in certain medico-legal cases wherever the problem of determining blood relationship occurs. This particular phase of blood grouping was not a part of the research reported here, but because of its rather general interest, the following table is included to show the possibilities:

If Parents Are	The Children Can Be Only	The Children Cannot Be
O+O	O	A, B, AB
O+A	O, A	B, AB
O+B	O, B	A, AB
O+AB	A, B	O, AB
A+A	O, A	B, AB
A+B	O, A, B, AB	None
A+AB	A, B, AB	O
B+B	O, B	A, AB
B+AB	A, B, AB	O
AB+AB	A, B, AB	O

It must be remembered that the blood group, when used in determining parentage of illegitimate children, are only of negative value. That is, one cannot tell who the parent *is*, but you can occasionally tell who the parent *is not*. Certain individuals can be ruled out as being the possible parent.

In practice it is usually obvious who the mother is and the test is run on the paternal suspects. Theoretically, of course, the mother's identity is as important as the father's.

Since the inheritance of the blood groups is a large field in itself, it cannot be considered here in any detail, and we suggest that for further information the reader see Chapter VI, *Individuality of the Blood* (Lattes).

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NOTES: Some of the more recent papers, although mentioned in the Bibliography, have not been considered or referred to directly in the text.