Use of Blood Groups in Human Classification[1]

William C. Boyd

Boston University School of Medicine, Boston, Massachusetts

> Will he not fancy that the shadows which he formerly saw are truer than the objects which are now shown to him?
>
> —PLATO, *The Republic*

IN RECENT YEARS there has been an increasing feeling, on the part of both geneticists and physical anthropologists, that genetical methods ought to be applied to the problems of the classification of man, and a number of proposals to this effect have been made. Nevertheless, new books of anthropology, as they have been published, have been found to contain much the same old classifications based on morphological characteristics, skin color, etc., even though the authors may have started with the announced intention of making use of the newer methods. It is clear that many a worker, attempting to apply genetical methods of taxonomy to man, has been disappointed, and, in fact, one scientist, formerly quite active in the field of physical anthropology, has now given it up, and announced in a letter to me: "I tried to see what blood groups would tell me about ancient man, and found the results very disappointing."

A careful analysis of the situation will show that such disappointment is based largely on two circumstances. First, there is the fact that the blood grouping genes affect invisible serological characteristics of the individual, and are thus never visible to the naked eye. It is to be feared that we are all too much inclined to be impressed by the visible as opposed to the invisible. Second, there is the fact that the layman's concept of race (which is that the human species can be divided up by valid, scientific methods, into various groups that are pretty different from each other and which will *look* pretty different from each other) has been unconsciously retained by many scientific workers, and the hypothetical dissenting readers are unconsciously expecting that the new systematics we propose to introduce will also provide us with startling differences in the appearance and behavior of the different "races" we define, and will feel let down to discover that the new classification does not, when all is said about it, reveal any very dramatic results.

If the blood grouping genes *had* affected, not characteristics of the blood, but prominent morphological or physical characteristics such as the shape of the head, color of the skin, etc., there cannot be the slightest question that they would already have been made the chief basis of a racial classification and would have been considered entirely adequate for that purpose.

EQUIVALENCE OF GENES

From our knowledge of genetics we may see that there is nothing fundamentally different between the blood grouping genes *as genes,* and the genes which do affect morphological features. It is simply a historical accident that fairly adequate information was obtained about the mode of transmission of blood grouping genes before any information at all equivalent in amount or value was obtained about the genes affecting physical appearance.

In view of these facts, and since there seems to be no reason to suppose that the location of a gene in a chromosome, or the nature of the particular chromosome in which the gene resides, determines in advance the main or even the subsidiary characteristics which are to be influenced by the gene, it might be instructive to let our imaginations roam a bit. The outwardly observable effects of the blood group genes are, so far as we know, zero. Therefore let us make some arbitrary assumptions as to the sort of effect which the blood grouping genes could have produced, supposing them to have affected some of the external and visible char-

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acteristics instead of serological characters, which are ordinarily tested for only in a laboratory. The insight we shall thus acquire will throw considerable light on the real nature of anthropological genetic classification and the sort of information which can be expected from it.

Hypothetical Worlds

Let us suppose for the moment that the genes which at present operate to affect skin color and stature were to affect, instead, obscure serological properties of the blood or other relatively imperceptible physiological traits; and let us suppose that the present blood grouping genes affected, instead of the blood type, various morphological characteristics, easily distinguished by the casual observer. We now have considerable information about three series of serological allelomorphs. We can select three visible or measurable characteristics of the human being and suppose that each is affected by one of these series. It will probably be wise to oversimplify the picture considerably, and not try to take account of all the subtle serological differences and subgroups which can actually be identified within the blood grouping series of genes. It is clear, however, that if we were to take these into account we could, if we wished, considerably refine and complicate the picture which we are going to present now.

Since this situation is purely hypothetical we can make any assumptions we like and we shall probably do better to make some of the simpler ones. Let us suppose that individuals of the genetic constitution OO (which in actuality causes their blood to possess the properties which we know as group O) would possess a skin color about the Spanish, Italian, or Arab degree of pigmentation; and that those possessing the gene A were somewhat darker in appearance; and that those possessing gene B were a somewhat dark yellow, such as certain Mongoloids of today; and that those who possessed the genetic constitution AB were quite dark, but not actually "black" in color. Genotype AO would be a brown lighter than AA, and the genotype BO would be browner and less yellow than the genotype BB.

The way in which the A and B genes, when both present together in the genotype AB, would interact in producing skin color would, of course, really depend upon the exact mechanism of their action in the organism, the various enzyme systems which they controlled, etc.

Polymorphism

One consequence of supposing the skin color was mainly determined by such a simple mechanism as this is, of course, that our various races would be polyphenic or "polymorphic" for skin color. This admission may at once cause some revulsion on the part of the reader who believes that all individuals of a given race should be alike in regard to the characters used in racial classification. Many examples of this tendency could be combed from the writings of early anthropologists, or from statements made by laymen today, but we may restrict ourselves to one. Franz Boas, in a book published in 1928, stated: "When we speak of racial characteristics we mean those traits that are determined by heredity in each race and in which all members of the race participate" (*2*). It is only fair to mention that Boas, one of our greatest anthropologists, later came to see the error inherent in this distinction of race. (In earlier pages of this book, we quoted the opinions of geneticists such as Dobzhansky that such a definition of race is impracticable.)

In reply to the objections raised by people who still take this old-fashioned point of view, we may point out that groups classified as "races" by physical anthropologists of the past, and even of the present day, are, in fact, often "polymorphic" for skin color. Examples are found in Russia and Arabia, China, etc. It is true that polymorphism may be the result of the mixture of racial groups of different degrees of pigmentation, as with American Negroes, and in hybrids in South Africa (*9*), but this is not always the case, and "pure" races are not always homogeneous for skin color. Polymorphism in regard to other characteristics is often found in ethnic groups regarded as homogeneous, but is hardly commented on. Eye color (blue, brown, gray, etc.) is an example; type of body build ("somatotype") is another. In a number of racial groups several varieties of body build are found, as has been pointed out by Weidenreich (*24*). Stature also varies considerably, even in a relatively homogeneous group such as the Japanese (*23*).

If we were to suppose a somewhat different series of pigmentation effects to be produced by the blood group genes, and particularly if we were to suppose that gradations in skin color corresponding to the allelomorphic genes (O, A_4, A_3, A_2, A_1, B) determining the subgroups were produced, then the polymorphism which we should have to suppose as a result would be little, if any, greater than that which can actually be observed in many existing ethnic groups. So in all probability we may safely go ahead with our construction of hypothetical ethnic groups composed of individuals whose visible characteristics are determined chiefly by the blood group genes.

Let us further suppose specific hypothetical effects for the M and N genes. Let us imagine that the effect of the M gene was generally the production of a tall individual, whose stature, in the male, we may suppose would range from 168 to 172 centimeters or,

in other words, from about 5 feet, 6 inches, to about 5 feet, 7¾ inches.

Let us suppose that the gene for N resulted in short individuals with a height, in the male, varying from 148 centimeters to 158 centimeters—in other words, about 4 feet, 10¼ inches, to 5 feet, 2¼ inches. Let us further suppose that the heterozygotes MN would be intermediate in stature. (We may recall that there is some evidence that, serologically, the heterozygote MN gives reactions intermediate in strength between the two homozygotes MM and NN.)

There are men in the world today taller than our hypothetical MM, and others shorter than our hypothetical NN, but the suggested range of height would, nevertheless, be impressive, if human psychology remained the same, for stature has always been considered a character of utmost importance. There can be few of my readers who have not experienced the emotion which results from looking up at a taller person, or looking down to a shorter person. Probably we could afford to let this case rest entirely on the testimony of tall female readers of this book who have found themselves, at parties and other gatherings, obliged to dance with men shorter than themselves. Eisenhower (*7*) recorded the indignation of Marshal Zhukov over the reports that he was shorter than his wife.

We shall here assume that there would be no sex differences in stature in our imaginary people, for, although sex is known to affect the expression in the individual of a number of autosomal genes (*4*), it does not affect blood group genes.

Passing to the Rh series of genes, we shall restrict ourselves, since the actual situation is rather complex, to supposing that the Rh negative gene would in this case act as a dominant, producing an eye structure similar to what is called the Mongolian (or epicanthic) eye fold. Individuals homozygous for the Rh positive gene would have European-type eyes.

Imaginary Races

Remembering that these various assumptions are purely imaginary, let us consider what sort of race classification would have grown up as travelers from "civilized" countries gradually explored the rest of the world and finally tried to summarize and systematize their observations.

There can be hardly any doubt that the situation would have been considered very striking and, from the point of view of physical anthropologists who were writing fifty years ago, very satisfactory. In western Europe people varying in skin color from brown to dark-brown would predominate. (The darker brown would be uncommon.) In Asia and related regions individuals of a rather dark-yellow color would be the common type, with a certain mixture of brown and dark brown. The frequency of very dark individuals would be at its height somewhere in central Asia. There would be good evidence that the yellow skin color found occasionally in Europeans had been brought by direct migration from Asia. There would be a fairly high incidence of very dark brown individuals in certain parts of Africa.

The lightest colored skins would be found in the various races of western Europe and certain parts of central Europe, in the East Indies, in the Australian aborigines, and in certain tribes of North American and South American Indians.

All the Indian tribes of both of the Americas would agree in being considerably taller than the average for the rest of the world, whereas the aboriginal inhabitants of Australia would agree in being distinctly shorter than the average. These differences would probably be considered very marked. (Serological characters of the blood, if differences were eventually discovered, would probably be found to vary so much with climate and environment that they would probably be considered useless for purposes of racial classification.)

One of the most notable observations would be that only in Europe and in the white inhabitants of America who are of European stock would the Mongoloid eye fold be observed to any extent. It would, therefore, be considered quite proper to mark off the European race as being absolutely distinct from all the other races of the world because of this striking morphological characteristic. The Basques would have a higher incidence of the eye fold than any other known people.

It would be observed that in the various great "racial" groups the skin color was not absolutely uniform. Nor would stature be found to be absolutely uniform within the groups in different parts of the world. In Asia and Europe, for instance, we should find that the majority of the inhabitants were of medium height, but that a certain number, of the order of 25 percent of the total, would be rather tall, and a certain number, also about 25 percent, would be rather short. "Clines" in stature would be found in Australia and up through the Pacific islands. Also, when the laws of heredity of these characteristics were investigated, it would be found that two individuals of medium height did not necessarily produce children who all grew up to a similar height. Instead, it would be possible for them to produce tall or short children, in addition to children of medium stature. This situation might be considered somewhat perplexing, but could easily be explained once the hereditary mechanism of the characteristic had been ascertained

It would also be found that light-brown individuals

might result from a mating of dark-brown parents. The genetic analysis would not prove too difficult to carry out (contrary to the situation which actually prevails in regard to skin color in the world today).

In the actual world we know, the skin color of individuals is influenced—at least temporarily—by exposure to the sun, and this, in turn, may be related to their occupation. Also, there can be hardly any doubt that stature is importantly influenced by diet. We should therefore remind ourselves that in our hypothetical world, where we have given the serological genes the role of affecting skin color and stature, the climate, environment, occupation, and diet might also exert their influence and thus possibly complicate the genetic analysis. Let us oversimplify once more and suppose that this did not happen.

Hypothetical Classifications

Given the hypothetical situation which we have just outlined, it may hardly be doubted that physical anthropologists would not have hesitated to classify mankind more or less as follows: (1) The European race, characterized by relatively light color and the presence of the Mongolian eye fold; (2) the Asiatic race, characterized by the predominance of yellow individuals, not having the epicanthic fold, but of about the same average stature as the European race; (3) the primitive American race, characterized in general by tall stature, no epicanthic fold, but varying from tribe to tribe in its skin color, which would range from brown to light-brown; (4) the aboriginal Australian race, a relatively light-colored people, but practically pygmies in stature, with no epicanthic fold; and (5) an African race, possibly characteristic of the equatorial regions of Africa, dark but with somewhat lighter skin than typical Asiatics, and having the epicanthic fold to a less extent than Europeans.

The European and Asiatic races would be imperfectly separated, but would be connected by a series of clines or intermediates in central Europe and Russia. This would be easily explained, however, as the result of repeated Asiatic invasions and migrations which had taken place in prehistoric and early historic times. The light color of certain individuals in southeastern Africa would be somewhat more difficult to explain, but the answer to all these questions might depend a good deal on the region in which anthropologists in our hypothetical world supposed mankind to have originated.

Two other questions would come up which would be not quite so easy to answer as the above: (*a*) why the aborigines of the American continent should be so tall, and (*b*) why the Australian aborigines should be so short. Archaeological evidence would indicate that the people who migrated to America came across the Bering Strait region and were, on the whole, of medium height. In the early days of physical anthropology, in our hypothetical world, a good deal of loose speculation as to the effect of climate on stature would have been indulged in. As the science of anthropology advanced further, however, such explanations would be frowned upon, for the anthropologists would begin to insist that the only valid characters for racial classification are those which are nonadaptive and which are not affected by the environment. Investigations designed to test this point would probably not be found to detect any selective advantage or disadvantage characterizing either the A, B, M, or N genes.

The possession of the Mongolian eye fold by the Europeans and their North American descendants would be somewhat of a puzzle also. One would be obliged to suppose that it was the result either of mutations or of early mixtures of the European groups with some early *nonsapiens* or *sapiens* type of man.

The hypothetical distribution of morphological characteristics which would result from the imaginary effects of the blood grouping genes, which we have made up pretty much at random, would give each continent, on the whole, a clear-cut characteristic racial picture. Intergradations would be relatively infrequent, and it would be fairly easy to classify by inspection groups of individuals as coming from Europe, Asia, Africa, or Australia.

Back to Reality

The foregoing paragraphs are not meant to be a jest, but are intended to illuminate the contrast in our attitude toward visible, physical characteristics such as skin color and stature and our attitude toward the invisible serological characteristics of the blood. If the blood grouping genes known at present really had the effects we have imagined, and if it were known how they were inherited, they would undoubtedly be considered highly satisfactory for racial classification. The average person is so impressed with skin color that he would doubtless be entirely satisfied of the importance of the pigmentation distinctions created by the A, B, O series of genes; and the hypothetical effect of the M and N genes on stature would be considered proof that these genes were of great importance in racial classification since they affected the characteristics of the skeleton.

We now leave the dream world we have just created, and try to face the apparently less exciting facts of the real world. There is no evidence that skeletal characteristics are more stable, in an evolutionary sense, than other inherited characters. The blood group genes do not affect, so far as we know, the skin

color, or the stature, or structure of the eye fold. Instead, they control the production of certain chemical substances in the blood. Since we have seen, however, that in fundamental importance to the organism, probably all genes are nearly equivalent, there is no reason why the blood group genes should not be just as important for purposes of racial classification as if they had in reality the hypothetical effects we have ascribed to them above. It is, in fact, rather puzzling that blood group genes have not been more often used for classification.

Why Were Genes Neglected

The genes which could be most useful to us in anthropology are, in the present state of our knowledge, the blood group genes. But they have not been used much by the average physical anthropologist in recent years. There are a number of reasons for this.

(1) Physical anthropologists have preferred when possible to deal with skeletal material. This preference is partly due to the pious hope that characters of the skeleton, since it represents the harder and more permanent part of the human frame, will, therefore, on the whole be more permanent and less subject to modification in the course of evolution (*16*). There is no reason for believing that this actually is the case, however, and, actually, many of the mutations observed to occur frequently in *Drosophila* affect the skeleton, which in this species is on the outside. The chief reason for depending upon skeletons, of course, is their relative availability, especially for the study of ancient man. Although it has been possible to discover the blood groups of people who lived as long as 5,000 years ago (*5*), we cannot expect to push such investigation much farther back than this, and as to the color of the skin, the artistic ability, the musical sense of early man, or his capacity for adapting to a social group, we shall always be pretty much in the dark.

Most of the material available for the study of early man is skeletal, and a scientific study of this material certainly has its value. It is not the place of genetics to discourage the exploration of another field of science, but rather to offer checks on the hypotheses and assumptions which are used to examine and order that material. Most of the tie-up between archaeology and physical anthropology depends on the skeleton, and this is an important tie-up. Genetics can never replace the study of fossil remains, from the morphological standpoint in human or other paleontology. But it can do much toward the proper conceptualization of that study (*26*).

The geneticists have long realized the advantage of a classification based on known genes, and Dobzhansky (*6*), one of our leading workers in the field of genetics, has stated clearly his own opinion that the study of geographic variation of a single human gene series, such as that which determines the blood groups, is capable of giving more information about the nature of races than could decades of mensuration and computing of racial averages. He does not deny, however, that the methods used by anthropologists in the past have some usefulness; he only insists that the limitations to these methods be understood.

(2) The second reason for the lack of interest in blood groups for classification was that the genetic variation from race to race was discovered only after other methods of anthropological classification had already been introduced and had enjoyed extensive use. Scientists, like other people, are conservative. (3) Many physical anthropologists, even today, do not understand the science of genetics well enough to appreciate the advantages which characteristics such as blood groups offer, and so have preferred to base their classification on traditional measurements, and on statistical averages determined from these. (4) A fourth reason was that the first advocates of blood group studies (*18, 27*), in their enthusiasm, claimed too much for their methods, and the physical anthropologists of today are still somewhat influenced by the reaction which resulted from the inevitable disappointment. (5) The fifth and perhaps most important reason is that the study of blood group frequencies very often does not confirm ideas about race which have already been developed on the basis of metrical and other observations, and the resulting classifications in many cases cut entirely across the traditional categories. Classifications according to blood group frequency can be entirely independent from that which results from classification based on the cephalic index or on skin pigmentation. (6) It is unfortunately true that one of the pioneers of the use of blood groups in anthropological classification (*12*) was partly responsible for diminishing the confidence in the method by proposing a "biochemical index," $I = \frac{A + AB}{B + AB}$, for use in racial classification. It was early pointed out that this index, since it took no account of the amount of group O in a population, could not tell the whole story, but in spite of this it is still sometimes referred to. Its use restricted still further the information which serology could offer anthropologists, and this was already rather limited (see below).

An increasing knowledge of human genetics offers us a new method of classification which may be of more fundamental importance than the old one, and we cannot, just because its implications are startling, reject it. We must ascertain what the facts are, define physical races as the gene frequencies show them

to be, or, if the data force us to such a conclusion, declare that the term "race" has no physical meaning.

Racial Classification by Blood Groups

Ottenberg (*18*) attempted one of the earliest racial classifications based on blood groups. There were available at that time data on only one set of genes, the O, A, B blood groups, and consequently the result was not an adequate classification of races by modern standards (one criterion is not enough). Ottenberg's races were six: European; Intermediate—Arabs, Turks, Russians, etc.; Hunan—Japanese, South Chinese, Hungarians, Roumanian Jews; Hindu-Manchu—Koreans, North Chinese, Gipsies, Hindus; Afro-South Asiatic—Negroes, Madagascans, Malayans; Pacifico-American Indian—Indians, Australians, Filipinos, Icelanders. Snyder (*27*) made the Australians a separate race from the Pacific race.

It will be apparent to any student of anthropology that this classification makes some very strange bedfellows. Ethnic groups which can be related only in the remote way we are all related to each other are included in the same "race." It is not surprising that anthropologists took one look at this list, shuddered, and said, in effect, "No thanks; I'll take vanilla."

Maps of gene frequencies show that the O, A, B frequencies can be nearly the same in different parts of the world, in ethnic groups which can be only distantly related. As examples, we may consider the data shown in Table 1 (*21*).

Table 1

Similar Blood Group Distributions in Different Peoples

People	Place	Percentage of groups				Frequency of gene		
		O	A	B	AB	p	q	r
Eskimo	Labrador and Baffin Island	46.5	53.5	0	0	.318	0	.682
Aborigines	W. Australia	48.1	51.9	0	0	.306	0	.694
Chinese	Canton	45.9	22.8	25.2	6.1	.154	.168	.678
Katangas	S. Belgian Congo	45.6	22.2	24.2	8.0	.156	.169	.675
Russians	Kazan	41.9	27.3	23.3	7.5	.194	.169	.648

A more recent attempt to use serological characters in anthropology is found in a book by Lahovary (*14*). This author makes some use of the M and N genes, and occasionally other blood factors, in addition to the classical O, A, B groups, and he distinguishes the following races: (1) European (Nordics and Alpines of Europe and the Near East); (2) Mediterranean; (3) Mongolian (Central Asia and Eurasia); (4) African (Blacks); (5) Indonesian; (6) American Indian; (7) Oceanic, including the Japanese; (8) Australian (a subvariety of the Oceanic).

Lahovary was aware that a racial classification based merely on the O, A, B groups would in many cases give results which would not fit well with older ideas about race. He did not wish to abandon the older points of view, however, so he attempted a compromise. In some cases he made use of information about the M, N types, and occasionally other blood factors, to help separate populations not clearly distinguished by A and B. In other cases, where populations probably not closely related proved to have about the same frequencies for A and B, he postulated that the A or B in one of these populations was "of different intensity." It is not too clear what this means, and it is not true that the A or B antigens differ in any detectable way from population to population (except for the different proportions of the subgroups, A_1 and A_2 of the A antigen). The idea probably goes back to the speculations of Hirszfeld (*11*) about an "evolution" of the A and B antigens from O, and this, in turn, is largely based on the old idea, now disproved, that American Indians belong only to group O.

The classifications of Lahovary do not violate ordinary anthropological notions so much as those of Ottenberg, but at the same time it must be admitted that Ottenberg, somewhat like Dixon in the metrical field, showed more courage in following his premises to their inevitable conclusions. Lahovary hedges at numerous points.

Most of Lahovary's book is restricted to a consideration of the races of Europe, where there are found, it is true, certain well-marked gradients or clines in the gene frequencies of A and B. This enabled him to make subdivisions at practically any point, and thus devise "serological races" which did not agree too badly with European races as defined on morphological, pigmentation, and linguistic grounds. But a classification based on the B gene, for instance, will never agree well with one based on the cranial index or on skin color. In other words, Lahovary failed to realize that the characters by which we define races are independent of each other, and we must not expect a classification by one character to agree with another very closely, even in Europe, where the present populations are to a large extent traceable back to a few sources, and even these could not have been too different. It does not seem, therefore, that Lahovary has made a very great advance in methods of classifying races, in spite of his espousal of the genetic method, which, in his case, amounts mainly to the use of the classical A, B, O blood groups.

We have already implied that a valid and sensible classification of human races, based on genetic data, is possible. Suppose we show the same audacity as Ottenberg, but make use of the great amount of data

which has accumulated since. What sort of racial categories shall we be led to create, and will they be utterly different from the older ideas which were based on morphology and physical appearance?

Wiener (*28*) has proposed the following racial classification, based largely on the O, A, B, and the Rh factors:

Caucasoid group—highest incidence of the Rh negative gene, relatively high incidence of genes for Rh_1 and A_2, moderate frequencies of other blood group genes.

Negroid group—highest incidence of gene Rh^o, moderate frequency of the Rh negative gene, high relative incidence of genes A_2 and the rare intermediate A and Rh genes.

Mongoloid group—virtual absence of Rh negative gene and gene A_2, highest incidence of the rare gene Rh^z.

Wiener's classification, as first enunciated, distinguished only three races, and it seems likely from past experience that we shall find it convenient to divide the human species into rather more than three races (recall that the number of races to be recognized in a species may be to a large extent arbitrary). However, it must be admitted that this classification makes much more "sense" than those just referred to. But by making more use of M, N data, we can improve it still further. Wiener, in fact, attempted this (*30*) and as a result subdivided his Mongoloid group into an Asiatic subgroup, a Pacific Island and Australian group, and a group including the American Indians and Eskimos.

From what has been said already, and particularly from our hypothetical example in which we allowed certain blood grouping genes to be supposed to have effects on morphological and other physical characteristics of man, it is obvious that we could, if we liked, find ample justification for classifying men into a larger number of different races on the basis of blood groups. The races which would result from such a classification, however, would coincide only in part with the races of man as they have previously been delineated by anthropologists, and in some cases would appear even to be inconsistent with the known history of the people. The American Indian, for instance, known to be derived by direct descent largely, or at least partly, from Mongoloid ancestors emigrating from the Asiatic mainland, would have to be placed in a quite different race on the basis of blood groups. This only serves to emphasize the meaning which is being given the term "race" in this book. Serological factors are almost the only human characteristics of which we know the exact mechanism of inheritance, and it has been shown here that only the use of characters inherited in a known manner will satisfy our criteria for a satisfactory classification of races. The very idea of racial differentiation implies that geographically isolated groups, although ultimately *of the same origin,* may eventually come to differ, and we have explained the mechanisms by which such differentiation can be brought about. Therefore, there is no reason why the Mongoloid appearance of many American Indians should in itself prevent our placing them in a racial category different from that of contemporary Asiatics. Aside from blood groups, we do not know what proportion of Mongoloid genes they really have, for we have not solved the problem of how many genes cooperate to produce the "Mongoloid" appearance.

The Races Defined Here

I have previously suggested (*3*) the following tentative racial classification based on gene frequencies. It differs only slightly from Wiener's.

1. Early European group (hypothetical)—possessing the highest incidence (over 30 percent) of the Rh negative type (*17*) (gene frequency of $rh > 0.6$) and probably no group B. A relatively high incidence of the gene Rh_1 and A_2. Gene N possibly somewhat higher than in present-day Europeans. Represented today by their modern descendants, the Basques.

2. European (Caucasoid) group—possessing the next highest incidence of rh (the Rh negative gene) (see Table 2), and relatively high incidence of the genes Rh_1 and A_2, with moderate frequencies of other blood group genes. "Normal" frequencies of M and N, i.e., M = *ca.* 30 percent, MN = *ca.* 49 percent, N = *ca.* 21 percent. (The symbols in italics stand for the genes, as opposed to the groups.)

3. African (Negroid) group—possessing a tremendously high incidence of the gene Rh^o, a moderate frequency of rh, relatively high incidence of genes A_2 and the rare intermediate (*29*) A ($A_{1,\ 2}$, etc.) and Rh genes, rather high incidence of gene B. Probably normal M and N.

4. Asiatic (Mongoloid) group—possessing high frequencies of genes A_1 and B, and the highest known incidence of the rare gene Rh^z, but little if any of the genes A_2 and rh (the Rh negative gene). Normal M and N. (It is possible that the inhabitants of India will prove to belong to an Asiatic subrace, or even a separate race, serologically, but information is still sadly lacking.)

5. American Indian group—possessing varying (sometimes high, sometimes zero) incidence of gene

TABLE 2

APPROXIMATE GENE FREQUENCIES IN THE SIX GENETICALLY DEFINED RACES

Gene	1 Early European	2 European (Caucasian)	3 African (Negroid)	4 Asiatic (Mongoloid)	5 American	6 Australian
A(p)						
$(A_2 + A_1)$ Ratio	*ca.*0.25	0.2–0.3	0.1–0.2	0.15–0.4	0–0.6	0.1–0.6
A_2/A_1*	> 0.5?	0.1–0.3	*ca.*0.4	0	0	0
B(q)	< 0.01?	0.05–0.20	0.05–0.25	0.1–0.3	0	0
N *n*	> 0.5?	0.3–0.5	*ca.*0.5	0.4–0.5	0.1–0.2	0.8–1.0
Rh neg.(r)	> 0.5?	0.4	*ca.*0.25	0	0	0
Rh^o (R^o)	< 0.1?	*ca.*0.1	*ca.*0.6	*ca.*0.1	*ca.*0.01	*ca.*0.01
PTC†	*ca.*0.5	0.55–0.7	*ca.*0.45	0	0	0
Nonsecreting‡	?	*ca.*0.5	> 0.6	0?	0?	0?
Other genes§	?	rh'	$A_{1,2}$	Rh^z	Rh^z	Rh^z

* For convenience in calculation, the ratio of the two subgroups, A_2 and A_1, and not the ratio of the gene frequencies, p_2/p_1, is given.

† The recessive gene for *not* tasting phenyl-thio-carbamide.

‡ The recessive gene for *not* secreting water-soluble blood group substances into the gastric juice, saliva, etc.

§ Other genes the frequency of which seems to be higher in this population than in other races.

A_1, no A_2, and probably no *B* or *rh*. Low incidence of gene *N*.

6. Australoid group—possessing high incidence of gene A_1, no A_2, no *rh*, high incidence of gene *N* (and consequently a low incidence of gene *M*). Possessing Rh^z.

Table 2 shows world distribution of these races.

Such a classification corresponds well, omitting the inevitable intermediates, *with geography*.

In addition to the blood group genes, the frequencies of two other genes, neither strictly serological, help us in making our new racial distinctions. These are the genes for tasting PTC and related compounds (*19*), and the "secreting gene" (*20, 22*). The information we possess about the world distribution of these genes is not very great, but it will be seen that some, at least, of our new races differ in respect to the incidence of these genes. Further study should add many such new genes to our list, and enable us to subdivide our present races. We do not propose to make a racial analysis of all the various populations of the world at the present time, however, but, having indicated the general method, leave the more detailed application of it to future students, who will find more adequate and more precise data at their disposal.

GENERAL CONSIDERATIONS

Our six genetically determined races certainly conform in a broad way to geography. Striking differences in certain gene frequencies mark off the inhabitants of the various continents. This is not surprising, since the evolutionary mechanisms which can produce racial differentiation are unlikely to do so unless we have at least a certain degree of geographic isolation. Genetic interchange between the inhabitants of the different continents was probably, during the days of prehistory, relatively minor.

It must not be thought that the divisions between our genetic races will be absolutely sharp, any more than is the difference between races which are characterized by any other method. Isolation has not been absolute enough for that. Also, we must recall that, although isolated groups originally alike may diverge from each other in regard to a number of characteristics, there is no law which says that they *must* diverge, especially in regard to characters having only slight adaptive value. In any case, migration and mixture have been going on, at a greater or less rate, throughout most of human history.

To consider some special difficulties, it will be noted that our scheme of six genetic races makes no provision for a Pacific race, unlike some of the earlier schemes. The reason for this is that the Pacific peoples do not agree in exhibiting any distinctive combination of frequencies of the genes which we have thus far identified. The aborigines of certain islands near Australia show M and N frequencies similar to the Australians and are thus intermediate in this respect. However, they mostly have considerable amounts of the gene B, and we have seen that this is not a characteristic of the Australians. Also, the M frequencies of the Pacific peoples gradually rise to the European-Asiatic norm as we travel northward and westward. These Pacific peoples do not have gene frequencies constant enough for us to lump them with either the Australians or the Asiatics, or to define them as a separate race.

As we travel toward the Americas, we find the M frequency begins to rise, and the frequency of B drops off rapidly to zero, thus giving us populations (*25*) which are intermediate between the Asiatics and the

American Indians. Nevertheless, there is no special reason to suppose that this is due to the introduction of any Polynesian blood into America, and/or American Indian blood into Polynesia.

Similarly, we shall have a very hard time deciding just where the boundary is to be drawn between European and Asiatic, unless subsequent study reveals some sharp discontinuity in the frequency of the Rh negative gene, perhaps somewhere between the former German-Polish border and central Siberia. But gene interchange has been so easy on the great Euro-Asiatic continent that we can hardly expect to find a sharp racial boundary.

On the other hand, if we examine populations in regions where the geography has enforced rather complete isolation, we often find, as we might expect, that they differ sharply from the inhabitants of neighboring continents. Thus the natives of the Aleutian Islands (*15*), although they, like other American aborigines, are mongoloid in appearance, differ just as sharply as do the other Americans from any Asiatics yet tested, by having characteristically low frequencies of N (Table 2). And the Greenland Eskimo, although not too far from Europe, and exposed for centuries to European influence, also prove to be characteristically American in regard to their lack of B, high frequency of A, and low N (*8*).

Data are insufficient for discussion of other transitional peoples, such as the inhabitants of North Africa, but it can hardly be doubted that many examples of intermediate races will be found. We should do well to consider that there may never have been any pure races, before we call such peoples "mixed races."

Similarity to Older Classifications

It will be noted that our proposed racial classification, although it is based upon gene frequencies, as we decided a valid classification must be, does not really differ in any very startling way, insofar as the ultimate categories are concerned, from some of the older classifications based on skin color, hair form, etc. Far from discouraging us, this should be a sign that our new methods are not doing so badly. For, in spite of all protestations that they were considering race and not geography, most writers on anthropology have generally tried to set up classifications that made sense geographically. For this reason, they emphasized—often in the course of a single work—various things at various times: sometimes skin color, sometimes head form, sometimes something else. Consequently they always reached, except when some bold worker like Dixon took the bit in his teeth and ran past all warning signals, a final goal of human races distributed roughly according to geography and common descent. All we have done is to show that the same thing can be accomplished more simply, and without so many inconsistencies in the application of our method, by considering gene frequencies.

Advantages of the Gene Method

But it must not be thought that the use of the genetic method has merely served to confirm what was already known. This method has advantages which we have already pointed out and which we may go over briefly again.

(1) The method of gene frequencies is completely objective (subject to the qualification that our decision as to what boundary between frequencies is to separate two races remains always a man-made and arbitrary decision); (2) the gene method is quantitative rather than qualitative, so the observed frequencies give us some idea of how much different races differ from each other, and the consequences of race mixture can be accurately predicted.

As an example of point (2), we may mention the Australian aborigines and the Ainu. Both these peoples have been called by some authors "basic white" (*1, 13*). However, in the present state of our knowledge of the inheritance of skin color, we cannot state how much the very dark skin of the Australian marks him off from the European. But a glance at his blood group frequencies tells us at once that he is pretty similar in regard to the original absence of B, but different in regard to M and Rh negative. We can probably account for the acquisition of the Rh negative gene by the Europeans by the hypothesis of mixture, and the peculiar M frequencies of the Australian by random genetic drift. Thus it is not impossible to see a common origin for these diverse peoples, although they have by this time differentiated into separate races.

In regard to the Ainu, we find a frequency of B which suggests considerable Mongoloid mixture, but the M frequency is closer to that of Europeans. Random genetic drift has apparently not affected the M of the Ainu much. The B observed (*ca.* 30–40 percent) is, however, so tremendously high that we cannot consider the Ainu, in spite of his light skin color, to be as closely related to Europeans as are the Australian aborigines (unless, of course, we consider it probable that random genetic drift or repeated mutation has raised the B frequency). It seems more plausible to suppose that the darker skin of the Australian has been acquired since his arrival in Australia, probably by the action of natural selection.

Racial Superiority

The genetic classification of races is more objective, and better founded scientifically, than older classifications. The differences we find between races are in-

herited in a known manner, not influenced by environment, and are thus pretty fundamental. But the new criteria differ from some older criteria in an important respect. In certain parts of the world, an individual will be considered "inferior" if he has, for instance, a dark skin, but in no part of the world does the possession of a blood group A gene, or even an Rh negative gene, exclude him from the best society. There are no prejudices against genes. And since we have absolutely no reason to think that the possession or lack of any of the genes we have considered here confers on its possessor any advantage as a potential contributor to the advance of cultures and civilizations, there is no reason that any prejudice should exist. We have already pointed out that there are actually no grounds, other than prejudices and emotions, for objecting to a dark skin, but it is not very easy to convince certain individuals of this (*10*).

So, although we have found a method of race classification which gives promising results, we have found no indication of the existence of any inherited racial superiority or inferiority. In the present state of confusion about racial issues, this is a point which deserves to be underlined.

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