would require a fission yield of Cs^{134} of 7×10^{-3} percent. This is higher by about an order of magnitude than the fission yield one would expect (*5*). Cesium-134 can be formed in nuclear reactors by neutron capture in the fission product, Cs^{133}. Lidén and Andersson cite Prawitz, who calculated that 6 months' exposure of U^{235} to a flux of 10^{13} neutrons per square centimeter per second would give a Cs^{134}/Cs^{137} ratio of 0.33 (*6*). Blomeke and Todd, however, calculate a ratio of 0.03 for these same conditions (*7*). In our study, an elementary calculation was made which was in agreement with the low value of Blomeke and Todd. Lidén and Andersson considered the possibility that the Cs^{134} found in Lapland came from the reactor accident at Windscale in England in 1957. The high reactor yield predicted by Prawitz made this possibility seem reasonable. This hypothesis no longer seems likely, however, for several reasons: (i) Prawitz's calculated yield is too high by a factor of about 10; (ii) the presence of Cs^{134} in regions remote from Lapland and the constancy of the proportion of Cs^{134} relative to Cs^{137} seem very hard to explain in terms of a particular accident; and (iii) the presence of Cs^{134} in current fallout in about the proportion in which it must have occurred in earlier fallout indicates that it is still being formed. We feel that the source of the Cs^{134} is yet to be identified. The yield of Cs^{134} from fissionable isotopes other than U^{235} has not been reported, and this yield may be high enough to account for the observed abundance. Unless there is a rather high yield from one of these fissionable materials, it would appear that the Cs^{134} must be produced from inert Cs^{133} (*8*).

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8. This work was performed under a contract [AT(45-1)-1350] between the Atomic Energy Commission and the General Electric Company.

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Blood Groups in Anthropoid Apes and Baboons

Abstract. *Tests on chimpanzees, orangutans, gibbons, baboons, and a gorilla, with blood grouping reagents prepared for human red cells, have disclosed patterns of reactions characteristic of each primate species. Determinations have been made of A-B-O groups and subgroups, M-N types, Rh-Hr types, secretor status, and Lewis types. Immunization experiments with ape and monkey blood are in progress.*

Biochemical evolution implies that closely related species will possess similar serological properties. In fact, it has been found that reagents prepared for blood grouping in man can be used for studies on apes and monkeys, and, conversely, reagents prepared with blood from rhesus monkeys led to the discovery of the Rh-Hr blood group system of man (*1*). Analogous cross-reacting isoantigenic systems have been revealed by recent studies in serum of primates, including man (*2*).

Recent increased interest in nonhuman primates as experimental animals has led to the creation of a number of primate research centers throughout the country, and one of the prime base-line investigations concerns studies on the blood groups of these animals. Such investigations dovetail with our own long-term interest in individual differences in human blood cells and serum, in particular, those revealed by immunological cross-reactions among primate species, including man. The present report summarizes observations on a series of chimpanzees, orangutans, gibbons, and baboons, as well as one gorilla, made with a battery of reagents prepared for grouping human blood.

Because of the presence of nonspecific heteroagglutinins in anti-**A** and anti-**B** reagents (*3*) intended for grouping human blood, such reagents had to be first absorbed with group-O chimpanzee red cells, before they could be used for testing nonhuman primate blood. With this technique, there was no difficulty in testing the blood cells from chimpanzees, orangutans, and gibbons. The results were then confirmed by reverse grouping of the ape sera against human red cells of group O, A_1, A_2, and B. In the case of the baboons, the red cells were not agglutinated by the reagents used, so the blood groups were inferred from the results of inhibition tests on the saliva as well as tests on the sera for agglutinins (*4*). Table 1 summarizes the findings of the present study, and compares them with those reported in the literature.

As can be seen from Table 1, only the blood groups A and O occur among chimpanzees. Among the combined total of 183 chimpanzees, there are 11.48 percent of group O and 88.52 percent of group A, yielding the gene frequencies, I^O = 33.9 percent and I^A = 66.1 percent. Among orangutans and gibbons, groups A, B, and AB, but not group O, have been encountered. The gorilla blood gave atypical reactions in that the cells were only weakly agglutinated by anti-**B** reagents and not affected by anti-**A** reagents. Since the serum contained only anti-A, the gorilla is classified as group B-like. Similar findings had been obtained on another gorilla by Wiener *et al.* (*5*). A gorilla studied in 1928 by Landsteiner (*6*) could not be classified, but study of the protocols indicates that this gorilla was also B-like. Table 1 does not include the findings on seven gorillas by Candela *et al.* (*7*), which were based only on tests on the urine by the inhibition technique. Interestingly, five lowland gorillas (*Gorilla gorilla*) tested in this way proved to be group B, while two mountain gorillas (*Gorilla berengei*) were group A. The baboons exhibited groups A, B, and AB; none were group O. As has been pointed out, the classification of baboons was based primarily on tests on the saliva rather than blood.

Thus, as far as the A-B-O blood groups are concerned, among the apes, gorillas are the most different from man, and most similar to monkeys, since the A-B-O groups of gorillas are more readily determined from their secretions than from their blood.

Tests for the subgroups of A were done with anti-$\mathbf{A}_1$ reagents of human origin, as well as reagents prepared from seeds of *Dolichos biflorus*. Depending on the strength of the reagent, chimpanzee group-A cells uniformly gave negative or weak reactions, indicating a closer relationship to human subgroup A_2 than to A_1; thus, chimpanzees are best classified as low grade $A_{1,2}$. On the other hand, gibbon blood of group A was strongly agglutinated by anti-$\mathbf{A}_1$ reagents; group AB gibbon blood was less strongly clumped. This indicates that such gibbons belong to subgroups A_1 and A_1B, respectively.

Table 1. A-B-O groups of apes and baboons.

Species	Investigators (*11*)	Blood groups O	A	B	AB	Totals
	Chimpanzees					
Pan satyrus	Present series	4	40	0	0	44
	Wiener *et al.* (*5, 8*)	6	41	0	0	47
	Subtotals	(10)	(81)	(0)	(0)	(91)
	Other authors (quoted in *8, 12*)	11	81	0	0	92
	Totals	21	162	0	0	183
	Orangutans					
Pongo pygmaeus	Present series	0	9	0	1	10
	Landsteiner (*6, 13*)	0	3	3	1	7
	Totals	0	12	3	2	17
	Gibbons					
Hylobates lar	Present series	0	2	3	3	8
Hylobates lar pileatus	Present series	0	0	1	0	1
Hylobates lar	Landsteiner (*6*)	0	1	0	1	2
Hylobates leuciscus	Landsteiner (*6*)	0	0	3	0	3
	Siamangs					
Symphalangus syndactylus	Landsteiner (*6*)	0	0	2	0	2
	Gorillas					
Gorilla gorilla	Present series	0	0	1*	0	1
	Wiener *et al.* (*5*)	0	0	1*	0	1
	Landsteiner (*6*)	0	0	1*	0	1
	Baboons (*14*)					
Papio cynocephalus langheldi	Present series	0	3	1	1	5
Papio anubis ibeanus	Present series	0	30	13	28	71
Papio (inbred hybrids)†	Present series	0	0	35	2	37
Papio (inbred hybrids)† backcross to *P. anubis ibeanus*	Present series	0	0	4	7	11

* B-like, see text. † Probably hybrids of *Papio anubis* and *P. cynocephalus* 30 to 40 years ago, and now maintained in the inbred colony of Southwest Foundation, Southwest Research Center, San Antonio, Texas.

Orangutan blood gave reactions of intermediate intensity, so that blood of group A showed moderately strong clumping with anti-$\mathbf{A}_1$ reagent, while blood of group AB was only feebly agglutinated. Thus, tests with anti-$\mathbf{A}_1$ reagents exhibit a characteristic pattern with gibbon A very similar to human A_1, chimpanzee A similar to human A_2 or $A_{1,2}$, while orangutan A has an intermediate position between gibbon and chimpanzee A.

Saliva tests showed all the chimpanzees to be secretors; a total of 74 chimpanzees have been tested to date, including the 44 of the present series. All nine gibbons were also secretors, but one of the ten orangutans tested proved to be a nonsecretor. In the case of the gorilla, the saliva gave weak inhibition reactions for B corresponding to the weak reaction of the red cells. Inhibition tests on the saliva with an anti-**Lewis** reagent exhibited a characteristic pattern among the various apes. Chimpanzee saliva almost uniformly gave only weak inhibition, gibbon saliva gave no inhibition, while orangutan saliva gave strong inhibition.

The M-N tests on the chimpanzee blood confirmed and extended the previous findings. The anti-**M** tests were carried out with reagents prepared from sera of rabbits immunized with human M blood. The blood cells from all 44 chimpanzees reacted with all these reagents, confirming previous observations that all chimpanzees have M-like factors. The fact that some anti-**M** reagents have been shown not to react with chimpanzee cells (*8*) merely means that chimpanzee cells do not have *all* the **M** factors that human M cells have. The tests for **N** factors were carried out with reagents prepared from sera of rabbits immunized with human type N cells as well as with reagents prepared from seeds of *Vicia graminea.* One particular reagent prepared from rabbit antisera proved to give reactions paralleling those of the seed extracts. This is the first anti-human rabbit antiserum we have encountered of this specificity, which may be designated anti-$\mathbf{N}^V$ to indicate its relationship to *Vicia graminea* seeds. With all the anti-**N** reagents which were available to us, except anti-$\mathbf{N}^V$, the chimpanzee blood cells gave negative or doubtful reactions; with anti-$\mathbf{N}^V$ reagents of seed or rabbit origin two types of chimpanzee blood can be distinguished: positive, or type $(MN_1)^{Ch}$, and negative, or type $(MN_2)^{Ch}$. Among 40 chimpanzees tested for $\mathbf{N}^V$ in the present series there were 16 type $(MN_1)^{Ch}$ and 24 type $(MN_2)^{Ch}$. Combining results with those previously obtained (*9*), the totals to date are 31 $(MN_1)^{Ch}$ and 38 $(MN_2)^{Ch}$. The main significance of these results is that the reagent anti-$\mathbf{N}^V$ which gives parallel reactions with other anti-**N** reagents in tests on human blood, distinguishes individual differences in chimpanzee blood not demonstrable with the other anti-**N** reagents.

In gibbons (*Hylobates lar*), suitably absorbed anti-**M** reagents gave negative or doubtful reactions with all but one ape; this particular ape proved to be the single one classified as *Hylobates lar* subspecies *pileatus.* Conversely, the blood from this gibbon was the only one that failed to react with anti-$\mathbf{N}^V$ reagents. Thus, with the single exception noted, the gibbons all reacted as type N.

The blood of all ten orangutans appeared to have both **M**-like and **N**-like factors. These studies are still in progress.

With regard to the Rh-Hr types, all 44 chimpanzees had both the $\mathbf{Rh}_0$ and **hr′** factors, reacting with two reagents each of these specificities to about the same titers as human red cells having these factors. The other "standard" Rh-Hr factors were not demonstrable, so that all 44 chimpanzees could be classified as type $\overline{\mathrm{R}}\mathrm{h}_0^{Ch}$, as in the previous studies on chimpanzees (*9*). On the other hand, the blood of all nine gibbons reacted strongly with only anti-**hr′** reagents, and did not react with anti-$\mathbf{Rh}_0$ or reagents of other Rh-Hr specificities. Thus, all nine gibbons could be classified as type $\overline{\mathrm{r}}\mathrm{h}^{Gi}$. Blood cells from the ten orangutans and from the gorilla gave reaction of intermediate intensity with both anti-$\mathbf{Rh}_0$ and anti-**hr′** reagents.

This investigation of primate blood grouping must be extended with the aid of antisera prepared by immunizing rabbits with ape and monkey blood, and by iso-immunizing as well as cross-immunizing primates of different species. Such experiments are now in progress (*10*).

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3. To avoid ambiguity, symbols for blood factors and their corresponding antibodies are printed in boldface type, symbols for genes and genotypes are printed in italics, and symbols for agglutinogens, phenotypes, and blood group systems are printed in regular type.
4. J. Buettner-Janusch [*Ann. N.Y. Acad. Sci.* **97**, 9, (1962)] has also observed that baboon red cells do not agglutinate in anti-**A** or anti-**B** sera, but he made no attempt to A-B-O group his baboons by testing their saliva and serum.
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11. A more complete listing of published data can be found in the review by P. Kramp, in *Primatologia, Handbook of Primatology*, H. Hofer, A. H. Schultz, D. Stark, Eds. (Karger, Basel, 1960), vol. 3, No. 2, pp. 88–162.
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13. The paper of Landsteiner (*6*) quotes two orangutans of group O, but comparison with his previous paper [K. Landsteiner and C. P. Miller, Jr., *J. Exptl. Med.* **43**, 853 (1925)] indicates that this is a typographical error and that the orangutans were really group A. Therefore, they are entered in Table 1 as group A.
14. There is a considerable confusion in the baboon taxonomy; the animals described here have been classified for this study by Dr. W. T. Roth, General Curator, Smithsonian Institution, National Zoological Park.

18 July 1963

Visual Responses in the Eye of the Dragon Fly

Abstract. *Responses to illumination recorded from cells in the eye of the dragonfly are similar to responses of cells in the eye of* Limulus *and are affected in the same manner by currents through the cell membrane. It appears probable that visual responses are brought about by the same processes in the two species.*

The compound eye of the dragonfly consists essentially of a few thousand ommatidia, each of which possesses its own dioptric system in the form of a cone-shaped lens. The ommatidia are thin, elongated structures packed in a regular array along the radii of the eye. Each ommatidium contains four transparent cells which join, along one of their long edges, to form a complex structure called a rhabdome. As in other compound eyes, the rhabdome is thought to contain the photosensitive pigment and, therefore, to be responsible for the initiation of responses to light.

When the eye is sectioned along an appropriate plane, a layer of ommatidia is exposed, and individual ommatidia (but not individual cells) can be clearly seen under a dissecting microscope. It is then possible to introduce a microelectrode into an ommatidium, under visual control.

Some features of the responses recorded from visual cells of dragonflies by means of intracellular electrodes have been described by Naka (*1*). He found that ommatidial cells are electrically polarized (with the negative pole inside) and that steps of light evoke depolarization in two phases—a high, transient and a lower, steady-state phase.

Work on the visual cells of dragonflies (suborder Anisoptera) was extended, in the experiments reported here, to include studies on the relationship between the intensity of the stimulating light and the size of the response, and also the effects of electric currents on the responses to light.

In confirmation of Naka's (*1*) re-

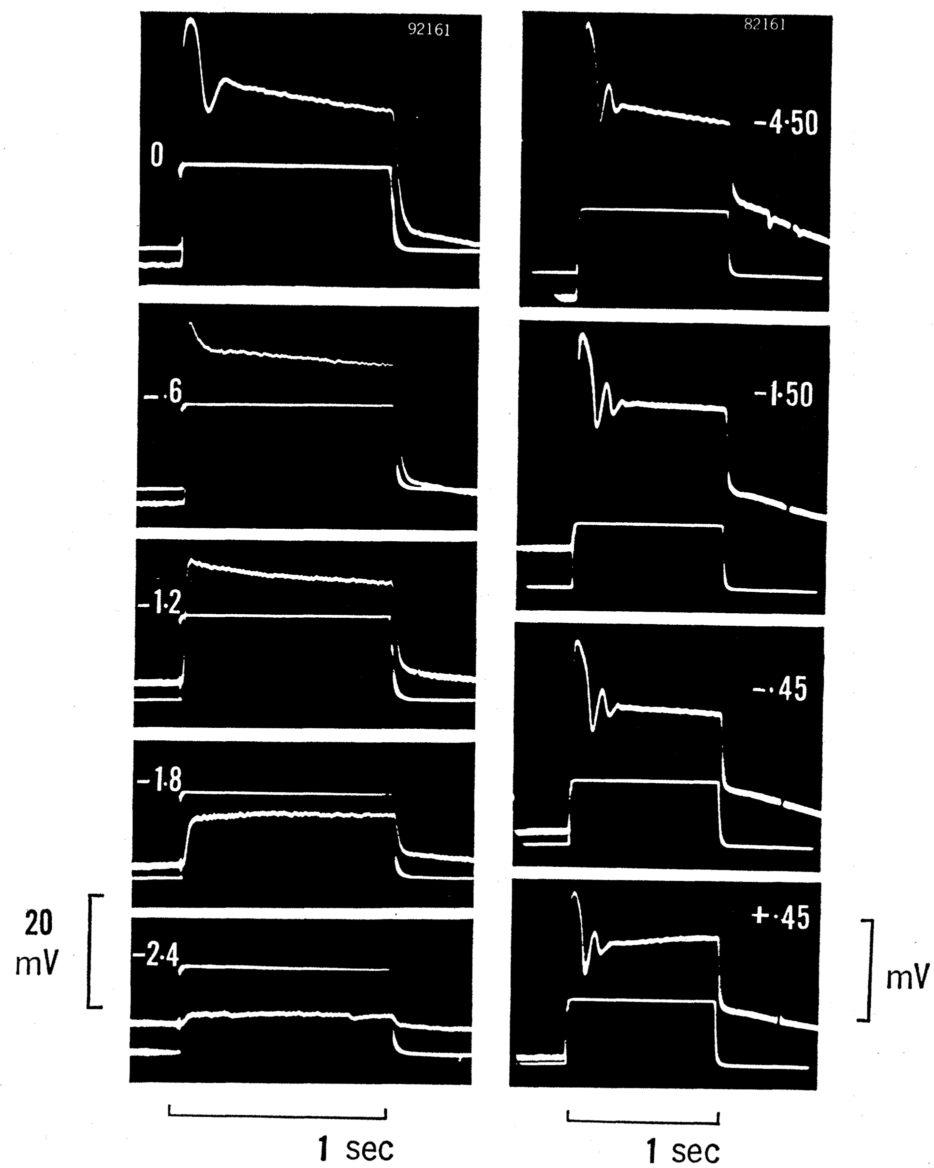

Fig. 1. Responses to illumination with steps of light of 1-second duration. (Left) Figures at left are the logarithm of relative light intensity. One beam measures duration (but not intensity) of the step of light and the other beam measures the intracellular potential change evoked by light. Temperature, 20°C. (Right) Recordings from a different preparation. Figures at right indicate the intensity, in nanoamperes (1 na $= 10^{-9}$ amp), of a steady current passed through the intracellular microelectrode and thus through the cell membrane. The steps of light are all of the same intensity. It may be seen that the change in potential is increased by hyperpolarizing ($-$) currents and decreased by depolarizing ($+$) currents. Temperature, 20°C.