mation of the essentials of Hill's (7) conception of active muscle as a two-component system made up of contractile and series elastic components; (ii) derivation of equations that quite accurately predict the mechanics of the contraction period of an isometric tetanus; (iii) a simple method for determining the stress-strain curve of the series elastic component (though this needs confirmation by direct methods); (iv) a determination of the theoretical and experimental means for studying a newly observed feature of early contraction related to the abruptly rising phase of the active state; and (v) the general mathematical basis for study of active state mechanisms in tetanus relaxation and for the entire course of the twitch. In future research it is planned to complete the analyses regarding systems including active state relaxation, extend the theory to other types of contractions, and apply it, in general, to investigations of muscular responses under a variety of experimental conditions.

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References and Notes

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8. I am thankful to Dr. Manfred Brust for performing the experimental part of this investigation.

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The Two Hemoglobin Components of the Chicken

Recently Saha *et al.* (*1*) reported the presence of two electrophoretically distinct hemoglobin components in the chicken, one of which showed the same mobility as the abnormal human hemoglobin E. In the course of our investigations of animal hemoglobins, we also studied the hemoglobin of the adult chicken, using different techniques. The results of this study will be reported here, for they offer some additional information.

Blood samples of over 50 different chickens (stock for slaughter) were examined first by paper electrophoresis with barbital buffer of *p*H 8.8 and of ionic strength 0.06. These analyses showed the presence of one main component (component I) with a low relative mobility and a second one (component II) with a much higher mobility. Component II, present for about 15 percent of the total amount of hemoglobin, was found in all examined animals. Its relative mobility is about the same as that of the abnormal human hemoglobin E. Our paper electrophoretic investigations confirmed therefore the results reported by Saha *et al.* (*1*).

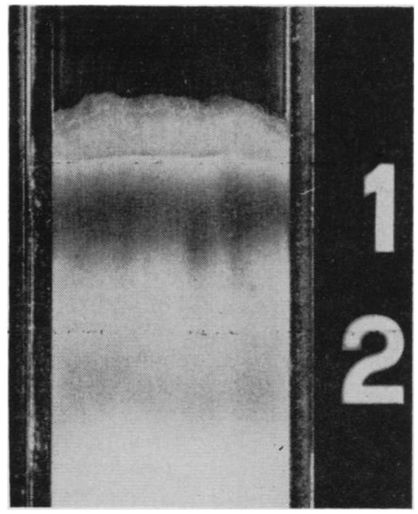

Fig. 1. Separation of two hemoglobin fractions of the chicken on Amberlite IRC-50.

The two hemoglobin components can be separated completely by chromatography on Amberlite IRC-50 with a citrate buffer solution of *p*H 6.0 and a sodium ion concentration of 0.15 (*2*). Figure 1 represents the relative positions of the two fractions. This technique offers therefore a possibility to obtain both components separately and to compare the amino acid compositions of the two hemoglobins. For this purpose about 50 mg of each protein was hydrolyzed with 500 ml of 6*N* hydrochloric acid by boiling under reflux for 48 hours. The amino acid analyses of these hydrolyzates were achieved by the column chromatographic method of Spackman, Moore, and Stein (*3*) with the Amberlite IR 120. The results of duplicate experiments are given in Table 1. Component II contains much more of the acid amino acids (aspartic acid and glutamic acid) and much less of the basic amino acids (lysine, histidine, and arginine). The large difference in the amounts of acid and basic amino acids may explain the great difference in the electrophoretic and chromatographic behavior of the two hemoglobin fractions. Moreover, other marked differences were found. The amounts of serine, valine, and leucine are higher in component II than in the other fraction, and the amounts of alanine, isoleucine, and tyrosine are lower. The results of these amino acid analyses are therefore strongly indicative of the existence of two widely different hemoglobin types in the chicken.

Table 1. Amino acid composition of the 48-hour hydrolyzates of two hemoglobin components of the chicken. The values are given in grams per 100 g of protein.

Amino acid	Component I (g/100 g)	Component II (g/100 g)
Aspartic acid	8.8	11.25
Threonine	4.5	4.1
Serine	3.15	5.15
Glutamic acid	6.8	11.5
Proline	3.2	3.0
Glycine	3.05	2.95
Alanine	8.95	7.55
Valine	8.0	9.45
Methionine	0	0
Isoleucine	5.0	3.75
Leucine	13.2	15.0
Tyrosine	3.1	1.15
Phenylalanine	6.5	6.8
Lysine	14.55	11.8
Histidine	11.8	7.7
Arginine	7.55	4.95
Totals	108.15	106.1

It is remarkable that these two different hemoglobin types were present in all the chickens studied. This situation is different from that found in some other animals—for instance, sheep (*4*) and cattle (*5*), in which the occurrence of two different hemoglobin types seems to be controlled by a pair of allelomorphic genes, both being readily recognizable in heterozygosity. It is obvious from the amino acid analyses that both components are completely different from any human hemoglobin (*6*). Any speculation based on the occurrence of human hemoglobin E (*1*) in birds is therefore without foundation (*7*).

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