and multiplying with the average residue weight of the peptide. Such calculations[3] are based on the assumption that the contributions of a D-residue and of an L-residue are numerically the same but opposite in sign.

From the specific rotations of some peptides (Table I) the residue rotations (Table II) were calculated.

TABLE I

SPECIFIC ROTATIONS[a] OF ALANINE[b] AND LYSINE PEPTIDES[c]

(1)	H·Ala-Gly·OH(L);	$[\alpha]^{24}$ + 13.8°
(2)	H·Gly-Ala·OH(L);	$[\alpha]^{24}$ −52.9°
(3)	H·Ala-Ala·OH(L-L);	$[\alpha]^{26}$ −38.3°
(4)	H·Ala-Ala·OH(L-D);	$[\alpha]^{24}$ +67.2°
(5)	H·Gly-Ala-Ala·OH(L-L);	$[\alpha]^{23}$ −87.9°
(6)	H·Gly-Ala-Ala·OH(L-D);	$[\alpha]^{23}$ −14.0°
(7)	H·Lys-Gly·OH(L);	$[\alpha]^{24}$ +31.1°
(8)	H·Gly-Lys·OH(L);	$[\alpha]^{25}$ −9.0°
(9)	H·Ala-Lys·OH(L-L);	$[\alpha]^{25}$ −7.2°
(10)	H·Ala-Lys·OH(D-L);	$[\alpha]^{25}$ −27.9°
(11)	H·Lys-Ala·OH(L-L);	$[\alpha]^{25}$ −1.9°
(12)	H·Lys-Ala·OH(L-D);	$[\alpha]^{26}$ +70.9°
(13)	H·Lys-Lys·OH(L-L);	$[\alpha]^{25}$ +5.6°
(14)	H·Lys-Lys·OH(L-D);	$[\alpha]^{23}$ +39.6°

[a] To ensure the state NH_3^+,COOH for ionizable groups, all rotations (λ = D; t = 23-26°; c = 2) were determined within five minutes after dissolving in 6 N hydrochloric acid. Rotations were constant for half an hour. [b] In part gift from Dr. Jesse P. Greenstein. [c] Peptides (1) to (4) and (7) are known (*cf.* J. S. Fruton, *Adv. Prot. Chem.*, 5, 1 (1949)); the others were synthesized by the carbobenzoxy-azide method (the satisfactory analytical data are omitted).

TABLE II

RESIDUE ROTATIONS OF L-ALANINE AND L-LYSINE RESIDUES

H...[Ala]...Gly·OH	+18°	H·Gly...[Ala]...OH	−68°
H...[Ala]...Ala·OH	+21°	H·Ala...[Ala]...OH	−75°
		H·Gly·Ala...[Ala]...OH	−74°
H...[Ala]...Lys·OH	+21°	H·Lys...[Ala]...OH	−73°
		H·Gly...[Ala]...Ala·OH	−102°
H...[Lys]...Gly·OH	+58°	H·Gly...[Lys]...OH	−17°
H...[Lys]...Ala·OH	+69°	H·Ala...[Lys]...OH	−35°
H...[Lys]...Lys·OH	+58°	H·Lys...[Lys]...OH	−44°

Apparently L-alanine and L-lysine residues are dextrorotatory in "amide" substitution (amino end), levorotatory in "acyl" substitution (carboxyl end) and as "acyl amide" (endo position).[4]

Detailed interpretation of the relatively uniform values for alanine and of the drift in the lysine values must await the investigation of additional peptides. This should also lead to a clearer understanding of the optical rotation of peptides and may prove valuable in the determination of amino acid sequences.

This work is carried out under contract between Columbia University and the Office of Naval Research.

DEPARTMENT OF BIOCHEMISTRY
COLLEGE OF PHYSICIANS AND SURGEONS
COLUMBIA UNIVERSITY ERWIN BRAND
NEW YORK, N. Y. BERNARD F. ERLANGER

RECEIVED MAY 11, 1950

(3) *Cf.* C. S. Hudson, THIS JOURNAL, **39**, 66 (1909). While this work was in progress, M. A. Nyman and R. M. Herbst, *J. Org. Chem.*, **15**, 108 (1950), have published the calculation of the contributions of the asymmetric carbon atoms of leucine dipeptides.

(4) For poly L-lysine, H·Lys-(Lys-)$_{28}$-Lys·OH, we find $[\alpha]^{23}$ −79.3°.

THE EXCHANGE REACTION BETWEEN FERROUS AND FERRIC IONS IN PERCHLORIC ACID SOLUTIONS[1]

Sir:

It has been variously reported that the electron transfer exchange reaction between ferrous and ferric ions, is fast,[2] very slow[3] or complete within one to two hours.[4] Some of the discrepancies in past work have been attributed to catalysis of the exchange reaction during the chemical separation employed to separate the exchanging species. However, Linnenbom and Wahl[4] were unable to confirm the result of Van Alten and Rice[3] that separation by a diffusion method permitted observation of a very slow exchange.

In an attempt to resolve these discrepancies a quantitative chemical separation has been devised which leads to only a small amount of induced exchange. The results to date indicate that the reaction is indeed a rapid one but that its rate can be measured. The separation is based on formation of the very stable complex between α,α'-dipyridyl and ferrous ion. Solutions of the reactants are mixed with rapid and continued stirring, and at the desired time the reaction is quenched by adding in rapid succession an excess of a dilute solution of dipyridyl followed by sufficient sodium acetate solution to bring the pH to about 5. Subsequently, the ferric iron is precipitated by addition of ammonium hydroxide. The iron in either or both fractions is finally converted to ferric 8-hydroxyquinolate and counted as such. The tracer used in the experiments here reported was Fe^{55}, obtained from Oak Ridge and was initially in the ferric species.

Figure 1 shows the data for one of the runs. The reaction appears well behaved and exhibits the usual exponential time dependence. A sum-

TABLE I

HALF-TIME OF THE FERROUS-FERRIC EXCHANGE REACTION UNDER VARIOUS CONDITIONS

$HClO_4$ formal	Formal Fe^{+++}	$\times 10^{-3}$ Fe^{++}	Chloride formal	Half-time, sec.
0.4	0.83	1.06	Trace, *ca.* 10^{-5}	23 ± 2
.4	1.00	1.10	Undetect. 10^{-6} or less	20 ± 2
.4	1.00	1.10	Undetect. 10^{-6} or less	18 ± 3
.4	1.00	1.10	0.8×10^{-3} added	21 ± 2
.4	0.50	0.55	Undetect.	44 ± 4
3.0	1.00	1.10	Undetect.	15 ± 4

(1) Research carried out at Brookhaven National Laboratory under the auspices of the Atomic Energy Commission.

(2) P. Nahinsky, Ph.D. Thesis, Univ. of Calif., 1942.

(3) L. Van Alten and C. N. Rice, THIS JOURNAL, **70**, 883 (1948).

(4) V. J. Linnenbom and A. C. Wahl, *ibid.*, **71**, 2589 (1939).

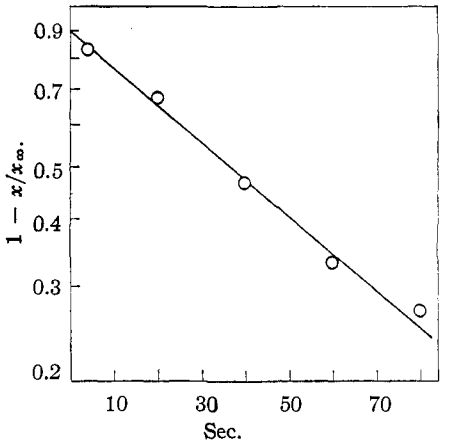

Fig. 1.—Ferrous-ferric exchange: x, radioactivity of ferrous fraction; x_∞, equilibrium value; $T_{1/2} = 44 \pm 4$ sec.

mary of the data obtained is given in Table I. All runs were made at room temperature 23 ± 2°. The results indicate that catalysis by traces of chloride was not an important factor in determining the rate; possible effects of other undetected impurities are, of course, not eliminated. The change of half-time with iron concentration shows the reaction to be second order, presumably first order in ferric and in ferrous iron, in which case the rate constant in 0.4 f perchloric acid is 16 mole^{-1}-l.-sec.$^{-1}$ at 23°.

Experiments on the various factors which affect the rate are being continued.

CHEMISTRY DEPARTMENT
BROOKHAVEN NATIONAL LABORATORY
UPTON, N. Y. RICHARD W. DODSON

RECEIVED MAY 19, 1950

THE *IN VIVO* SYNTHESIS OF LABILE METHYL GROUPS

Sir:

In the course of an investigation into the metabolism of amino acids, evidence has been obtained which can best be explained on the assumption of an *in vivo* synthesis of labile methyl groups in the rat. These methyl groups may be derived from the α-carbon of glycine, directly, or indirectly through the β-carbon atom of serine, or both, and therefore from serine itself. This is contrary to the belief that labile methyl groups cannot be synthesized in the animal organism but must be provided in the diet.[1,2]

Serine labeled in the β-position with C^{14} was synthesized according to the method of King.[3] A total of 20.1 mg. of DL-serine-β-C^{14} in 10 ml. of water was given intraperitoneally to a 150-g. male rat in divided doses twice daily over a period of five days. The rat was kept on the ordinary stock diet. The serine contained a total radioactivity of 2.8 microcuries. The rat was sacrificed and the choline in the liver isolated as the reineckate, then purified through the chloroplatinate, degraded to trimethylamine, which was precipitated as the chloroplatinate and recrystallized, all according to the method of du Vigneaud, *et al.*[1] Radioactivity was found in the methyl groups from the choline.

SPECIFIC ACTIVITY PER MILLIMOLE IN COUNTS PER MIN.

		—Platinum, %— Calcd.	Found
DL-Serine	2.2×10^7		
Choline chloroplatinate	2.3×10^4	31.7	31.5
Trimethylamine chloroplatinate	1.3×10^4	37.0	37.0

Confirmation of these findings was obtained with another animal.

That all of the choline radioactivity is not in the trimethylamine fraction indicates that serine, at least in part, has been converted to ethanolamine; this is additional support for the findings of Stetten.[4]

There is reason to believe that pteroylglutamic acid and possibly vitamin B_{12} may be involved in these transformations.

The finding of radioactivity in the choline methyl group demonstrates the *in vivo* synthesis of labile methyl groups from the β-carbon of serine and hence[5] from the α-carbon of glycine.

The authors wish to thank Dr. Louis De-Spain Smith for his valuable advice.

After this work had been completed we became aware of a report by Sakami[6] and Welch and Sakami[7] on the incorporation of the methyl group of acetone and of formate into methionine and choline methyl groups. We have obtained similar results with radioactive formaldehyde.

(1) du Vigneaud, Cohn, Chandler, Schenck and Simmonds, *J. Biol. Chem.*, **140**, 625 (1941).

(2) du Vigneaud, THIS JOURNAL, **72**, 1049 (1950), did demonstrate the incorporation of methyl groups from methanol into choline; methanol, however, is not a normal dietary constituent.

(3) King, *ibid.*, **69**, 2738 (1947).

(4) Stetten, *J. Biol. Chem.*, **144**, 501 (1942).

(5) Sakami, *ibid.*, **178**, 519 (1949).

(6) Sakami, *Federation Proc.*, **9**, 222 (1950), abstract.

(7) Welch and Sakami, *ibid.*, **9**, 245 (1950), abstract.

BIOCHEMICAL RESEARCH FOUNDATION
SIGURDUR JONSSON
NEWARK, DELAWARE WILLIAM A. MOSHER

RECEIVED MAY 15, 1950

THE SYNTHESIS OF THE METHYL GROUPS AND ETHANOLAMINE MOIETY OF CHOLINE FROM SERINE AND GLYCINE IN THE RAT[1]

Sir:

In an investigation of the mechanism of formation of the phospholipid bases it was found that L-serine is a source not only of the ethanolamine portion of choline, but also of its methyl carbon atoms. When L-serine labeled with N^{15} in the amino group and C^{14} in the β-carbon atom was

(1) This work was supported by a grant from the American Cancer Society, recommended by the Committee on Growth of The National Research Council.