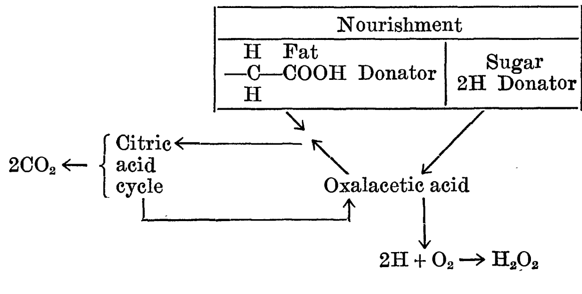
to iodacetic acid. The quantity of citric acid formed is about I–6 mg per gram wet tissue per hour at 38° C.

Oxalacetic acid is therefore the meeting point in sugar and fat metabolism. Sugar (as 2 H donator) and fat (as $-\overset{H}{\underset{H}{C}}-COOH$ donator) are in competition to metabolize oxaloacetic acid. Sugar-H is metabolized preferentially, as already small traces of sugar hydrogen reduce immediately and quantitatively small amounts of oxalacetic acid to 1-malic acid, while the condensation of β-keto acids with oxalacetic acid needs a surplus of oxalacetic acid, but only small amounts of β-keto acid.

Fat is only metabolized by oxalacetic acid, if small amounts of sugar are available; if no sugar at all is available, no pyruvic acid as precursor of oxalacetic acid (perhaps formed from pyruvic acid and carbon-dioxid after Evans and Slotin) is formed. Under such conditions β-keto acids are not metabolizable and we find the normal excretion of ketoacids in urine, as happens if much fat and little sugar are given with the food. We can formulate as follows:



F. L. Breusch

Second Chemical Institute,
University of Istanbul, Turkey

A MAP OF THE NATURAL AMINO ACIDS

Chart 1 has been designed as a visual aid for those whose work or interest is concerned with the protein-building α-amino acids. One may distinguish in each amino acid the $^{+}H_3N-\overset{|}{C}H-COO^{-}$ grouping which, as the carrier of the peptide-forming and acid-base functions common to all, may be termed the "body," and the remainder of the molecule, which, because it imparts to each compound its individuality and modifies the function of the "body," can be conceived of as the "head." Crude as this distinction is—as, for instance, it takes no account of the acid or basic functions of the dicarboxylic and diamino acid—it is useful as a basis for the systematic arrangement shown. In the chart each amino acid (to the extent permitted by current knowledge) has been characterized by a few data which may be considered as of fundamental chemical and biological significance. The first column of figures in the upper left corner of each space gives, in downward order, approximate figures for the optical rotation, on a molar basis, [M], in acid, neutral (isoelectric) or basic solution. The next column gives data on the dissociation constants of the acid and basic groups, expressed in pK values of acid (—COOH, —OH, —SH, $=NH_2^+$, $-NH_3^+$) groups. In those cases where groups other than carboxyl and amino are involved their identity is indicated by a symbol wherever possible. A figure separated by a blank space at the lower end of the pK column refers to the isoelectric point (pI). A figure in the upper right-hand corner shows the solubility at room temperature, in moles per liter. The figure to the left of the name is the molecular weight. A line under the name signifies that the amino acid is one of those found nutritionally indispensable (in rat and dog) for normal growth by Rose.[1] The dashed line (arginine) indicates that this amino acid can be synthesized by the animal organism but that the rate of bio-synthesis in the rat is not adequate for the requirements of normal growth. A dotted line under the name classifies the amino acid as one of those found necessary in the diet for the maintenance metabolism of adult rats.[2]

Those familiar with the chemistry of amino acids need not be reminded that of necessity the selection of the amino acids included in the chart is to some extent an arbitrary one, and that the same holds true for the numerical data given, where the dependence of optical rotations or dissociation constants on temperature or concentration, and other variables had to be ignored in favor of approximation values. The handbook of Schmidt[3] has been the source of most of the data shown. Blank spaces in the chart suggest possible undiscovered protein components. They do, however, neither exhaust the possibilities, nor has each space a hypothetical occupant. Spaces which for obvious reasons have no structural meaning have been marked by a black dot.

The chart is presented[4] in the hope that it may be of some use to the student, investigator and practitioner in fields ranging from physical chemistry to practical nutrition.

G. Toennies

The Lankenau Hospital
Research Institute,
Philadelphia, Pa.

[1] Science, 86: 298, 1937.

[2] Burroughs, Burroughs and Mitchell, *Jour. Nutrition,* 19: 363, 1940.

[3] "The Chemistry of the Amino Acids and Proteins," Springfield, 1938.

[4] A limited number of reprints is available. A magnifying glass will aid in reading the small print.

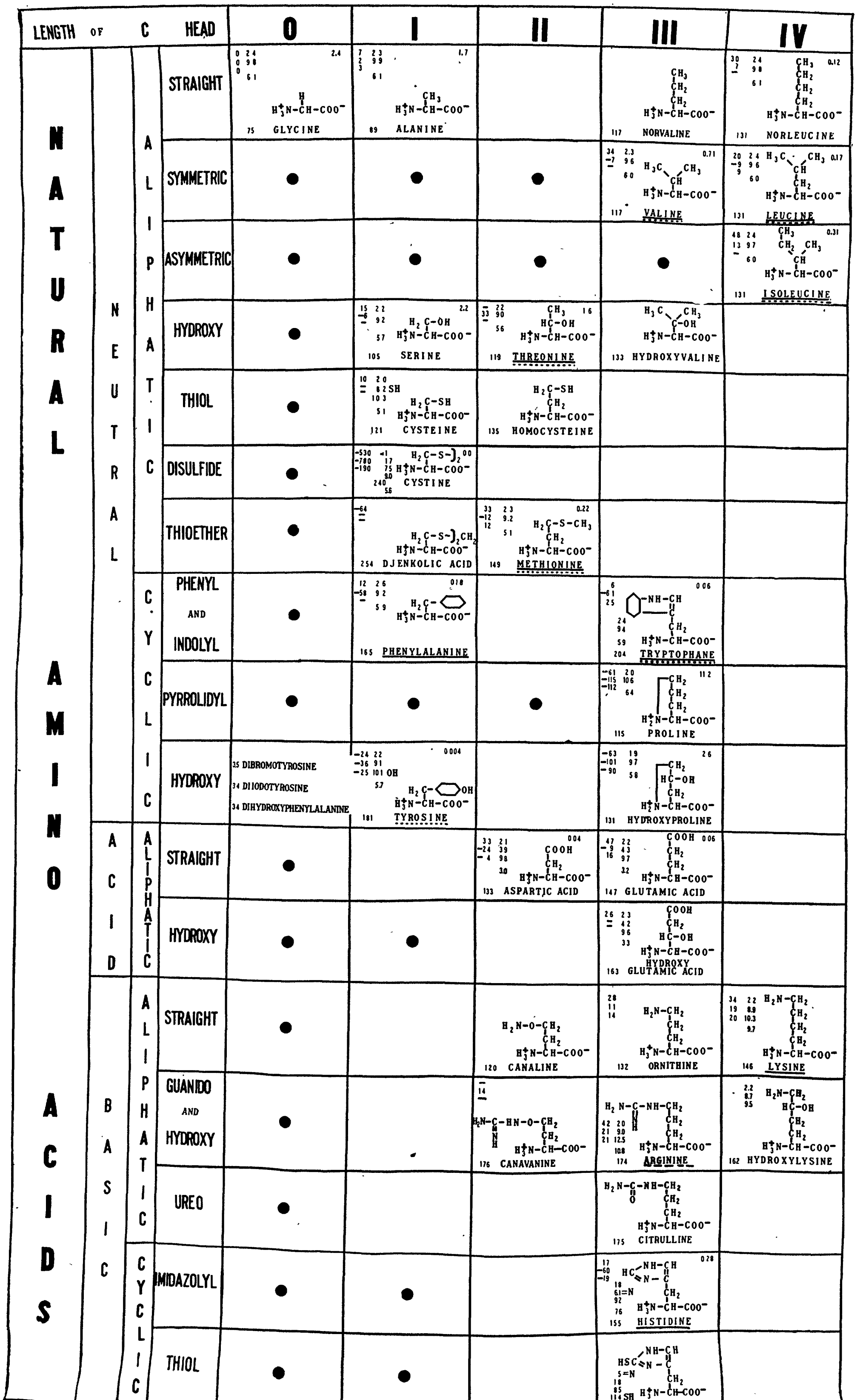

LENGTH OF C HEAD
0
I
II
III
IV
NATURAL AMINO ACIDS
NEUTRAL
ACID
BASIC
ALIPHATIC
CYCLIC
STRAIGHT
SYMMETRIC
ASYMMETRIC
HYDROXY
THIOL
DISULFIDE
THIOETHER
PHENYL AND INDOLYL
PYRROLIDYL
GUANIDO AND HYDROXY
UREO
IMIDAZOLYL
GLYCINE
ALANINE
NORVALINE
NORLEUCINE
VALINE
LEUCINE
ISOLEUCINE
SERINE
THREONINE
HYDROXYVALINE
CYSTEINE
HOMOCYSTEINE
CYSTINE
DJENKOLIC ACID
METHIONINE
PHENYLALANINE
TRYPTOPHANE
PROLINE
DIBROMOTYROSINE
DIIODOTYROSINE
DIHYDROXYPHENYLALANINE
TYROSINE
HYDROXYPROLINE
ASPARTIC ACID
GLUTAMIC ACID
HYDROXY GLUTAMIC ACID
CANALINE
ORNITHINE
LYSINE
CANAVANINE
ARGININE
HYDROXYLYSINE
CITRULLINE
HISTIDINE
THIOHISTIDINE

Chart 1