# DATA for BIOCHEMICAL RESEARCH

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*Third Edition*

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# Preface

In this third edition, we again aim to supply information needed by biochemists in a form sufficiently concise to be kept in the laboratory. No attempt is made to be comprehensive. Material has been selected under the guiding principle that it should be of potential use to a reasonably large number of readers. We try, in fact, to occupy the central ground of possible interest to all biochemists. This excludes much material of use only to specialists in individual areas, but they will have more comprehensive sources of information in their own fields. Between the extremes of obvious material for inclusion, such as buffers, and for exclusion, such as rarely encountered metabolites, there is a large grey area in which subjective decisions have had to be made. Such decisions cannot suit everyone or every situation, but we have been encouraged by the sustained interest in, and demand for, the previous edition to believe that this policy is supplying a real need in the laboratory.

Much has been deleted from earlier editions to be replaced by new material of current importance to biochemistry and molecular biology. With the increase in commercial availability of biochemicals, references to preparations have been omitted as a routine; with the development of sophisticated separative technologies there is less need for references to estimations of many compounds. References are now included in the general remarks only where they appear to be of use. Alphabetical listing has been retained but functional groupings of compounds has been emphasized so that a reader can see what is available as well as find individual compounds.

Much of the revision has been done by the authors with help from people too numerous to mention individually. Some sections however have been largely revised by specialists and these are listed overleaf. It is emphasized that the final selection and presentation of material has always been made by the authors who must therefore bear the responsibility for omissions and deficiencies. Names no longer appear at the head of sections because with revisions and reorganizations it is difficult to associate any one name with a section. Acknowledgement must be made to contributors to earlier editions on whose work the current volume is based.

*Babraham, Adelaide, Bedford Park, and Leicester* R.M.C.D. W.H.E.
July 1984 D.C.E. K.M.J.

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17 Stability constants for metal complexes: Dr D. Perrin, John Curtin School of Medical Research, Australian National University, Canberra.

19 Gel electrophoresis: Dr R. Symons, Department of Biochemistry, University of Adelaide.

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# Notes on the use of this book

## I. Tables of biochemical compounds and comprehensive index of compounds

1. The tables of biochemical compounds are arranged in sections according to the type of compound. In some instances ambiguity existed as to the correct section for a particular compound and here arbitrary decisions have been made. Few cross-references between sections or to synonyms have been included, but **there is a comprehensive index of all compounds and of their commonly used synonyms (p. 561). It is strongly advised that this index be used to determine whether a compound is included in the tables and to ascertain its location.**

2. *Melting-points and boiling-points*

The value given is that at a pressure of 760 mm of mercury, unless otherwise stated.

3. *Optical rotations*

The optical activity quoted is the specific rotation, generally for the sodium D line, with the temperature of the measurement indicated by a superscript. Where other wavelengths have been employed, the wavelength is given in Å as a subscript. Where given, the concentration of the substance is in g/100 ml.

4. *Solubility*

Solubilities are given as grams of solute dissolving in 100 ml of solvent. The temperatures at which solubility data were determined are given as superscripts. Where there is no temperature indicated, the data are for room temperature, that is in the range 15–25 °C.

## II. References

In general, references are intended to enable readers to find the relevant literature on methods and not necessarily to give credit to the main workers in the field. References are usually not given to methods of preparation of compounds which can be readily obtained commercially at a reasonable price. An abbreviated system of references has been used throughout the volume. Authors of individual papers have been omitted and for those journals and books which are mentioned most frequently the titles have been specially abbreviated as follows:

| | |
|---|---|
| *ABB* | *Archives of Biochemistry and Biophysics.* |
| *Ann.* | *Liebig's Annalen der Chemie.* |
| *ARB* | *Annual Review of Biochemistry.* |
| *BBA* | *Biochimica et Biophysica Acta.* |
| *BBRC* | *Biochemical and Biophysical Research Communications.* |
| *Ber.* | *Chemische Berichte* (prior to 1947 *Berichte der deutschen chemischen Gesellschaft*). |
| *Biochem. Preps.* | *Biochemical Preparations* (Wiley & Sons Inc., New York). |
| *BJ* | *Biochemical Journal.* |
| *BZ* | *Biochemische Zeitschrift.* |
| *EJB* | *European Journal of Biochemistry.* |
| *JACS* | *Journal of the American Chemical Society.* |
| *JBC* | *Journal of Biological Chemistry.* |

| | |
|---|---|
| *JCS* | *Journal of the Chemical Society.* |
| *JMB* | *Journal of Molecular Biology.* |
| *Meth. Biochem. Anal.* | *Methods of Biochemical Analysis*, ed. D. Glick (Wiley-Interscience Inc., N.Y.). |
| *Meth. Enzymol.* | *Methods in Enzymology*, ed. S.P. Colowick and N.O. Kaplan (Academic Press). |
| *PNARMB* | *Progress in Nucleic Acid Research and Molecular Biology.* |
| *PNAS* | *Proceedings of The National Academy of Sciences.* |
| *PSEBM* | *Proceedings of the Society for Experimental Biology and Medicine.* |
| *TIBS* | *Trends in Biochemical Sciences.* |
| *ZPC* | *Hoppe-Seyler's Zeitschrift für physiologische Chemie.* |

For other journals the conventional system of abbreviation has been adopted. In certain sections, works of reference which have been quoted extensively in that section only have been abbreviated and a note to this effect is included in the preamble to the section.

# Abbreviations

| | |
|---|---|
| $[\alpha]_D^t$ | specific optical rotation for sodium D line at temperature *t* |
| abs. | absolute, absorbance |
| acet. | acetone |
| alk. | alkaline |
| amorph. | amorphous |
| anhyd. | anhydrous |
| approx. | approximately |
| aq. | aqueous |
| benz. | benzene |
| B.p. | boiling-point |
| c | concentration (g/100 ml) |
| *ca.* | circa = approximately |
| cf. | compare |
| ch. | chapter |
| c.n.s. | central nervous system |
| col. | colourless |
| comp. | competitive(ly) |
| compd. | compound |
| conc. | concentrated, concentration |
| cryst. | crystals, crystalline, crystallization |
| d. | with decomposition (after M.p. or B.p.), density |
| decomp. | decomposition point, decomposes |
| deliq. | deliquescent |
| deriv. | derivative |
| diam. | diameter |
| dil. | dilute |
| dimorph. | dimorphic |
| DMF | dimethylformamide |
| DMSO | dimethylsulphoxide |
| ed. | editor, edition |
| efflor. | efflorescent |
| equiv. | equivalent |
| esp. | especially |
| EST. | estimation, estimated |
| eth. | diethyl ether |
| evap. | evaporates, evaporation |
| exptl. | experimental |
| extr. | extracted |
| F.p. | freezing-point |
| fluor. | fluorescence |
| A | excitation maximum |
| F | fluorescence maximum |
| g.i.t. | gastro-intestinal tract |
| gl. acetic | glacial acetic acid |
| GLC | gas-liquid chromatography |
| gp. | group |
| hex. | hexagonal, hexane |
| hygr. | hygroscopic |
| i. | insoluble |
| IDENT. | identification |
| i.m. | intramuscular |
| incl. | including |
| inorg. | inorganic |
| insol. | insoluble |
| i.p. | intraperitoneal |
| i.r. | infra-red |
| ISOL. | isolation, isolated |
| i.v. | intravenous |
| liq. | liquid |
| lt. | light |
| max. | maximum |
| min. | minimum, minute |
| misc. | miscible |
| monocl. | monoclinic |
| M.p. | melting-point |
| M.wt. | molecular weight |
| no. | number |
| opt. | optimum |
| org. | organic |
| orthorh. | orthorhombic |
| p., pp. | page, pages |
| path. | pathological |
| pet. eth. | petroleum ether |
| ppt. | precipitate |
| pptd. | precipitated |
| pract. | practically |
| prep. | prepared, preparation |
| PREP. | preparation |
| prism. | prismatic |
| pt. | point |
| PURIF. | purification |
| pyr. | pyridine |
| q.v. | quod vide = which see (in cross references) |
| recryst. | recrystallize |
| rect. | rectangular |
| ref. | reference |
| rel. | relative(ly) |
| resp. | respectively |
| rh. | rhombic |
| R.T. | room temperature |
| s. | soluble |
| sat., satd. | saturated |
| s.c. | subcutaneous |
| sens. | sensitivity |

| | |
|---|---|
| s.g. | specific gravity |
| sh | shoulder |
| sl. | slight, slightly |
| sl. s. | slightly soluble |
| sol. | soluble, solubility |
| soln. | solution |
| solv. | solvent(s) |
| sp. | sparingly, species |
| sp. gr. | specific gravity |
| sp. s. | sparingly soluble |
| suppl. | supplement |
| SYN. | synthesis |
| temp. | temperature |
| TLC | thin-layer chromatography |
| tol. | toluene |
| tr. | trace |
| tricl. | triclinic |
| u.v. | ultra-violet |
| v. | very |
| veg. | vegetable |
| visc. | viscous |
| vol. | volume |
| v.s. | very soluble |
| v. sl. s. | very slightly soluble |
| v/v | volume for volume |
| wh. | white |
| w/v | weight for volume |
| w/w | weight for weight |
| yel. | yellow |
| ∞ | completely miscible |

# Contents

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# 1 Amino acids, amines, amides, peptides, and their derivatives

### Optically active compounds

For compounds exhibiting optical isomerism, information about the optical isomers (enantiomers) and the racemic (DL-) mixture, and, where they exist, about allo- and *meso*-isomers, has been included in a single entry. In most such cases, the properties of only one optical isomer, usually the one which is most abundant in natural sources, have been given in detail. The properties of the other isomer are the same *except* that the sign of optical rotation is reversed.

### Peptides

A few peptides possessing physiological activity are included in this section. Peptides used as substrates for peptidase assay are included in the Section on Artificial and natural substrates (p. 360).

### General references

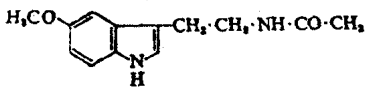
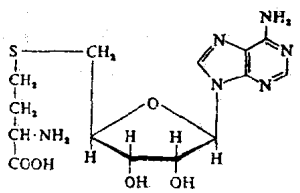
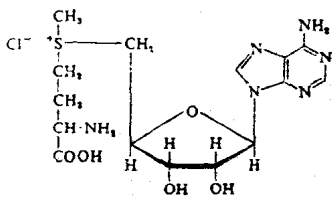
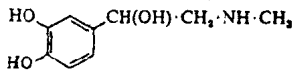
J. P. Greenstein and M. Winitz, *Chemistry of the amino acids*, 3 volumes, Wiley (1961).
A. Meister, *Biochemistry of the amino acids*, 2 volumes, Academic Press (1965).

### Nomenclature

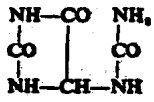
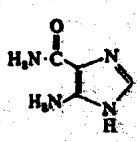
Rules of nomenclature for α-amino acids are given in *BJ* **149**, 1 (1975) and *Biochem.* **14**, 449 (1975).
Symbols for amino acid derivatives and peptides: *BJ* **126**, 773 (1972); *EJB* **27**, 201 (1972); *JBC* **247**, 977 (1972).

### $pK_a$ values

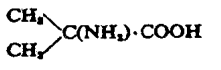
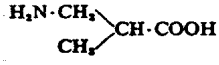
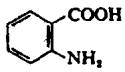
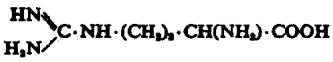
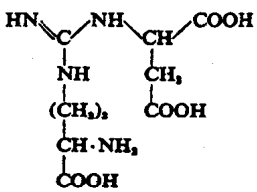
Most of the values quoted are from D. D. Perrin, *Dissociation constants of organic bases in aqueous solution*, Butterworth (1965) and D. D. Perrin, *Dissociation constants of organic bases in aqueous solution: Supplement 1972*, Butterworth (1972).

| *Name* | *Synonyms* | *Formula* | *M. wt.* | *Physical properties* |
|---|---|---|---|---|
| Acetamide | Ethanamide | $CH_3 \cdot CO \cdot NH_2$ | 59.1 | col. deliq. cryst.; M.p. 81–3, B.p. 222 |
| Acetylcholine | ACh; 2-Acetyloxy-*N*,*N*,*N*-trimethyl-ethanaminium salt | $(CH_3)_3\overset{+}{N} \cdot CH_2 \cdot CH_2 \cdot O \cdot CO \cdot CH_3$ $X^-$ | Free base as hydroxide, 163.2; Chloride, 181.7; Bromide, 226.1; Iodide, 273.1 | Chloride: v. hygr. needles or prisms; M.p. 149–52; faint amine-like odour, sharply saline taste. Bromide: hygr. prisms; M.p. 143. Iodide: non-hygr. cryst.; M.p. 161. |
| *N*-Acetyl-glutamic acid | | $HOOC \cdot CH_2 \cdot CH_2 \cdot CH(NH \cdot CO \cdot CH_3) \cdot COOH$ | 189.2 | L-: cryst; M.p. 199 |
| *N*-Acetyl-5-methoxytrypt-amine | Melatonin; *N*-[2-(5-Methoxy-1*H*-indol-3-yl)-ethyl] acetamide |  | 232.3 | pale yellow leaflets; M.p. 116–18; sublimes |
| Acetyl-β-methylcholine chloride | Methacholine chloride; Mecholyl chloride; 2-(Acetyloxy)-*N*,*N*,*N*-trimethylpropanaminium chloride | $(CH_3)_3\overset{+}{N} \cdot CH_2 \cdot CH(CH_3) \cdot O \cdot CO \cdot CH_3$ $Cl^-$ | Chloride, 195.7; Bromide, 240.2; Iodide, 287.1 | Chloride: v. deliq. needles; M.p. 172–3. Bromide: hygr. cryst., M.p. 147–9. Iodide: non-hygr. cryst.; M.p. 138–9.5 |
| *S*-Adenosyl-homocysteine | 5′-*S*-(3-Amino-3-carboxypropyl)-5′-thio-adenosine; *S*-(5′-Deoxy-adenosine-5′)homocysteine |  | 384.4 | DL-: small prisms. L-: col. tufts of needles; M.p. 210 |
| *S*-Adenosyl-methionine | Active methionine; SAM; 5′-[(3-Amino-3-carboxy-propyl) methylsulphonio-5′-deoxyadenosine; *S*-(5′-Deoxyadenosine-5′)-methionine |  | Free cation, 399.4; Chloride, 434.9; Bromide, 479.3; Iodide, 526.4; Hydrogen sulphate, 496.5 | Salts: cryst. solids. Chloride and bromide, hygr.; iodide, v. sl. hygr. L- chloride: M.p. 118–22d. |
| D-Adrenaline | 4-[1-Hydroxy-2-(methyl-amino)ethyl]-1,2-benzenediol; 1-(3,4-Dihydroxy-phenyl)-2-methylamino-ethanol; Epinephrine; Suprarenine |  | 183.2 | wh. cryst. solid; M.p. 211–15d. |

| $[\alpha]_D^t$ | $pK_a$ at 25°C | *Solubility* | *General remarks* |
|---|---|---|---|
| | | $97.5^{20}$, $178^{60}$ $H_2O$; $25.0^{20}$, $257.1^{60}$ EtOH; v.s. glycerol; s. $CHCl_3$; sl. s. eth. | Odourless if pure, but frequently has a mousy odour. Solution neutral. Can be absorbed by cation exchange resins, *Naturwissenschaften* **42**, 580 (1955). |
| | | Chloride, bromide, iodide: v.s. $H_2O$, EtOH; s. $CHCl_3$; i. eth., benz. | Neurotransmitter substance at synapses and neuroeffector junctions, parasympathomimetic agent. Acts as transmitter of cholinergic nerve fibres. Action short-lived due to rapid breakdown of ACh by cholinesterases; action of ACh prolonged by cholinesterase inhibitors. 'Nicotinic' actions blocked by nicotine, hexamethonium, or *d*-tubocurarine (at autonomic ganglia), and by decamethonium or *d*-tubocurarine (skeletal muscle). 'Muscarinic' actions (on smooth and cardiac muscle, exocrine glands) blocked by atropine. Aq. soln. slightly acid (pH ~ 5). Aq. soln. most stable at pH 4; decomposed at alkaline pH or by heating at neutral pH. Reacts with hydroxylamine to form acethydroxamic acid. |
| L-, $-16.6^{25}$ (c = 2 in $H_2O$) + $3.9^{25}$ (c = 2 in M-NaOH) | | s. $H_2O$, alkalis, hot EtOH | |
| | | s. EtOH; sl. s. $H_2O$, benz.; v. sl. s. pet. eth. | Occurs in mammalian pineal gland. Lightens skin colour by reversing effect of MSH. $\lambda_{max}$ (in 95% EtOH) 223 nm $\epsilon$ 27 500 and 278 nm $\epsilon$ 6300. |
| L-, $+27.0^{22.5}$ (c = 2 iodide in 90% EtOH) | | v.s. $H_2O$, EtOH; s. $CHCl_3$; i. eth. | Parasympathomimetic agent: muscarinic actions, esp. on cardiovascular system, predominate, nicotinic actions negligible. Actions more prolonged than acetylcholine since less sensitive to cholinesterases. Biologically active compd. is L- isomer. Rapid decomp. by alkalis. Aq. soln. slightly acid (pH ~ 5), slowly decomp. on standing, should not be kept longer than 2 weeks at 0–4°C. Store solid airtight and protected from light. Iodide turns yellow in air and light. |
| L-, $37^{25}$ (c = 1.3 in 0.05M-$H_2SO_4$) + $44.5^{23}$ (c = 1 in 0.05 M-HCl) | | s. hot $H_2O$; sl. s. cold $H_2O$, EtOH; v. sl. s. eth. | Slowly oxidized to sulphoxide as solid and in soln., protected from oxidation by thiodiglycol. Store solid in inert atmosphere at low temp. Hydrolysed in acid soln., e.g. 0.1M-HCl, 100°C, 90 min., forming *S*-ribosylhomocysteine. Not hydrolysed in neutral or alkaline soln., e.g. stable in 0.1M-NaOH, R.T., 10 min., but oxidation more rapid in alkaline soln. Neutral solns. containing thiodiglycol stable for long periods at R.T. Spectrum, $\lambda_{max}$ 260 nm $\epsilon$ 16 000 at pH 7. PREP. and PURIF. *Anal. Biochem.* **15**, 323 (1966), **35**, 505 (1970); *Biochem. Preps.* **8**, 8 (1961); *J. Org. Chem.* **43**, 998 (1978). |
| L-, $+48.5^{24}$ (c = 1.8 chloride in 5M-HCl) + $16.8^{24}$ (c = 1 bromide in $H_2O$) | | L- chloride: v.s. MeOH at pH 2; s. $H_2O$; sl. s. MeOH at pH 6. Hydrogen sulphate: v.s. $H_2O$. | Compd. unstable under many conditions, presence of impurities should be expected unless special precautions have been taken. Solid halide salts unstable, iodide 12% decomp. in 1 week at 3°C, 30% at 24°C, stabilized by mixture with Li halides (10–20%). Stable solid forms include hydrogen sulphate (< 3% decomp. at 4°C in 6 months) and disulphate di-*p*-toluenesulphonate. Relatively stable in acid soln., v. unstable in alkali. At pH 2.8 after 1 week, 14% decomp. a 3°C, *more* stable in strong acid, e.g. 1M-HCl or 6M-$H_2SO_4$. Complete decomp. in 0.1M-NaOH at R.T. in 10 min. Slow decomp. at neutral pH, e.g. in 24 hr at 30°C, 10% decomp. at pH 6.6, 32% at pH 7.8, 70% at pH 8.8. Store solns. at −20°C or below at pH 2.5–4, do not store for longer than 1 month. Do not warm up solutions until immediately before use; do not mix with neutral solutions until last possible moment; in assays preferably initiate reactions by adding *S*-adenosylmethionine. Spectrum, $\lambda_{max}$ 260 nm $\epsilon$ 15 400 at pH 7, $\lambda_{max}$ 256 nm $\epsilon$ 15 200 at pH 1. Compd. has 4 stereoisomers; natural compd. is L- at $\alpha$-carbon, (−)- at sulphonium centre; see *JACS* **81**, 3975 (1959). PREP. and PURIF. *JBC* **244**, 682 (1969); *Meth. Enzymol.* **17B**, 393 (1971); *Anal. Biochem.* **15**, 323 (1966). |
| $-53.2^{22-25}$ (c = 1.2 in 0.5M-HCl) $-50.6^{17}$ (c = 7.5 in 0.37M-HCl) | 8.66 (NH) 9.95 (OH) | s. gl. acetic, mineral acids, alkalis; sl. s. $H_2O$, EtOH; i. eth., acet., $CHCl_3$ | Sympathomimetic agent, acting esp. on heart and on vascular and other smooth muscle. Predominant hormone of adrenal medulla, affecting esp. glucose and fatty acid metabolism. Configuration of natural adrenaline is D- by relation to D-mandelic acid, *JCS* **1958**, 2069. Unstable in aq. soln. at alkaline pH and when heated. Relatively stable at pH 5 in cold. Aq. soln. slightly alkaline. Solid slowly browns on exposure to air and light. |

| *Name* | *Synonyms* | *Formula* | *M. wt.* | *Physical properties* |
|---|---|---|---|---|
| Alanine | 2-Aminopropanoic acid; Ala | $CH_3 \cdot CH(NH_2) \cdot COOH$ | 89.1 | needles or prisms; sublimes >200 |
| β-Alanine | 3-Aminopropanoic acid | $H_2N \cdot CH_2 \cdot CH_2 \cdot COOH$ | 89.1 | col. prisms; M.p. 207d. (199d.); sublimes |
| Allantoin | 5-Ureidohydantoin; (2,5-Dioxo-4-imidazolidinyl)-urea |  | 158.1 | wh. prisms or plates; M.p. 238 |
| Amino acyl-transfer RNA | Amino acyl-tRNA | Transfer RNA (tRNA) with an aminoacyl group esterified with the 2′- or 3′-hydroxyl group of the terminal adenosine residue. The amino acyl group migrates rapidly between the 2′- and 3′-positions, each isomer having a half-life of 1 ms or less. The equilibrium mixture contains 2′- and 3′-isomers in a ratio of about 1:2. | | wh. amorph. powder; hygr. |
| 2-Amino-adipic acid | 2-Aminohexanedioic acid; α-Aminoadipic acid | $HOOC \cdot (CH_2)_3 \cdot CH(NH_2) \cdot COOH$ | 161.2 | cryst. solid; M.p. DL-, very variable, range 165–202d., L-, 206d. |
| 2-Amino-butyric acid | α-Aminobutyric acid; 2-Aminobutanoic acid; Butyrine | $CH_3 \cdot CH_2 \cdot CH(NH_2) \cdot COOH$ | 103.1 | leaflets; sublimes > 300 |
| 4-Amino-butyric acid | γ-Aminobutyric acid; Piperidic acid; 4-Amino-butanoic acid; GABA | $H_2N \cdot CH_2 \cdot CH_2 \cdot CH_2 \cdot COOH$ | 103.1 | monocl. tablets, plates or needles; M.p. 203d. |
| 5-Amino-imidazole-4-carboxamide | AICA; 5-Amino-1*H*-imidazole-4-carbox-amide |  | 126.1; Hydrochloride, 162.6 | wh. needles; M.p. 170–1. Hydrochloride: wh. needles; M.p. 255–6d. |

| $[\alpha]_D^t$ | $pK_a$ at 25°C | *Solubility* | *General remarks* |
|---|---|---|---|
| L-, + 14.6[25] (c = 2.0 in 5M-HCl) + 1.8[25] (c = 2.0 in $H_2O$) | 2.35<br>9.87 | DL-: 16.6[25], 32.2[75] $H_2O$; 0.084[25] 90% EtOH; 0.0087[25] EtOH; i. eth.<br>L-: 16.65[25], 28.5[75] $H_2O$; v. sl. s. EtOH; i.eth., acet. | L-Hydrochloride, prisms, decomp. 204, $[\alpha]_D^{26}$ + 8.5 (c = 9.3 in $H_2O$). |
| | 3.55<br>10.24 | 54.5[25] $H_2O$; 0.017[25] EtOH; i. eth., acet., $CHCl_3$ | Decomposes in alkali at 37°C yielding ammonia and acrylic acid. β-Alanine monohydrochloride, M.p. 122.5, s. $H_2O$, sl. s. EtOH. |
| | 8.96 | 0.76[22], 3.3 hot $H_2O$; 0.2 EtOH; i. eth. | Hydrolysed to allantoic acid by alkali. Allantoic acid is unaffected by dil. alkali, but hydrolysed to glyoxylic acid and urea by 0.05M-HCl at 100°C in 2 min. Satd. aq. soln. pH 5.5. |
| | | s. $H_2O$, M-NaCl; i. EtOH | *Amino acyl-tRNA compds. are obtained by the reaction between amino acids,* ATP, and tRNA, catalysed by amino acyl-tRNA synthetases (amino-acid-activating enzymes). Methods for the preparation of mixed and single species of tRNAs, synthetases, and amino acyl-tRNAs are given in *Meth. Enzymol.* vols. 6, 12A, 12B, 20, 29, 30, 59 and 60. Amino acyl-tRNAs are rapidly hydrolysed to the amino acid and tRNA above pH 6; half-lives in 0.1M-Tris buffer pH 8.6 at 37°C, 2–65 min., depending on nature of the amino acid moiety. Rate of hydrolysis is increased by alkaline pH, Tris, increase in temp. or ionic strength, decreased by acylation of amino group of amino acid. For details, see *BBA*, 281 228 (1971); *Biochimie* 56, 383 (1974). Amino acyl groups are completely removed from tRNA (stripping) by 1–2M-Tris, pH 9–9.5, in 30–120 min. at 37°C. Store amino acyl-tRNAs in soln. or lyophilized at −20°C or below and pH 5. Spectrum as RNA, $A_{260}$ 22–24 for 1 mg/ml soln. |
| L-, + 3.2[25] (c = 2 in $H_2O$) + 25.0[25] (c = 2 in 5M-HCl) | 2.14<br>4.21<br>9.77 | 0.22[40] $H_2O$; sl. s. EtOH, eth. | Free acid cyclizes in boiling water to piperidonecarboxylic acid; DL-, M.p. 177–8; D-, $[\alpha]_D^{25}$ − 16.5 (c = 2 in $H_2O$) −41.5 (c = 2 in 6M-HCl). SYN. DL-, D- and L-, *Anal. Biochem.* 43, 282 (1971); 55, 411 (1973). |
| L-, + 20.6[25] (c = 1–2 in 5M-HCl) + 9.3[25] (c = 1–2 in $H_2O$) | 2.29<br>9.83 | DL-: 28 $H_2O$; 0.18[78] EtOH; i. eth.<br>L-: s. $H_2O$, gl. acetic; sl. s. EtOH, eth. | L- Hydrochloride, needles, $[\alpha]_D^{19}$ + 12.9 (c = 3.64 in $H_2O$), s. $H_2O$. |
| | 4.03<br>10.56 | v.s. $H_2O$; sl. s. EtOH; i. eth., benz. | Inhibitory neurotransmitter in mammalian CNS and at crustacean neuromuscular junctions. Action blocked by picrotoxin. Monohydrochloride, M.p. 135–6, v.s. $H_2O$. |
| | | s. $H_2O$ | Spectrum, $\lambda_{max}$ (ε), 240 nm (9050) and 267 nm (11 200) at pH 1; 266 nm (12 700) at pH 7; 277 nm (12 500) at pH 13. Bratton-Marshall chromophore, $\lambda_{max}$ 540 nm ε 26 400. Riboside, 5-amino-1-(β-D-ribofuranosyl)imidazole-4-carboxamide, wh. needles, M.p. 215–6, $[\alpha]_D^{26}$ −63.0 (c = 1 in $H_2O$), spectrum $\lambda_{max}$ 267 nm, ε 11 000 (pH 2), 12 200 (pH 7), 12 600 (pH 10.5). |

| *Name* | *Synonyms* | *Formula* | *M. wt.* | *Physical properties* |
|---|---|---|---|---|
| 2-Aminoisobutyric acid | α-Aminoisobutyric acid; α-Methylalanine; 2-Amino-2-methylpropanoic acid |  | 103.1 | col. plates or prisms; sublimes 280; M.p. 335 (sealed tube) |
| 3-Aminoisobutyric acid | α-Methyl-β-alanine; β-Aminoisobutyric acid; 3-Amino-2-methylpropanoic acid |  | 103.1 | (±)-: col. prisms; M.p. 177–9. (−)-: cryst. plates; M.p. 194–6. |
| 5-Aminolaevulinic acid | 5-Amino-4-oxopentanoic acid; δ-Aminolaevulinic acid | $HOOC \cdot CH_2 \cdot CH_2 \cdot CO \cdot CH_2 \cdot NH_2$ | 131.1; Hydrochloride, 167.6 | cryst.; M.p. 118–9. Hydrochloride: M.p. 144–51. |
| Angiotensin | Hypertensin; Angiotonin | Asp-Arg-Val-Tyr-Ile-His-Pro-Phe<br>Angiotensin II<br>Asp-Arg-Val-Tyr-Ile-His-Pro-Phe-His-Leu<br>Angiotensin I<br>The structures refer to angiotensins of man, pig, and horse; in ox, $Ile^5$ is replaced by Val. | II: 1046<br><br>I: 1297 | |
| Anthranilic acid | *o*-Aminobenzoic acid |  | 137.1 | wh. to pale yellow cryst. leaflets; M.p. 146–9 |
| Arginine | 2-Amino-5-guanidinopentanoic acid; *N*-5-Amidinoornithine; Arg |  | 174.2; Hydrate, 210.2 | DL-: M.p. 238d. L-: prisms + $2H_2O$ from $H_2O$; anhyd. plates from EtOH, decomp. 244 |
| L-Argininosuccinic acid | *N*-[[(4-Amino-4-carboxybutyl)amino] iminomethyl]-L-aspartic acid |  | 290.3 | v.hygr. powder. Ba salt: amorphous powder |
| Asparagine | 2-Aminosuccinamic acid; Aspartic acid β-monoamide; Asn | $H_2N \cdot CO \cdot CH_2 \cdot CH(NH_2) \cdot COOH$ | 132.1; Hydrate, 150.1 | DL-: col. cryst. + $1H_2O$. L-: col. cryst. + $1H_2O$; M.p. 236d. |



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