Journal of Chromatography, 220 (1981) 115–194
Chromatographic Reviews
Elsevier Scientific Publishing Company, Amsterdam — Printed in The Netherlands

CHREV. 149

ISOELECTRIC POINTS AND MOLECULAR WEIGHTS OF PROTEINS

A NEW TABLE

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(Received May 25th, 1981)

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1. COMPILATION OF THE TABLE

After the great interest in our first table on isoelectric points (p*I*) and molecular weights (MW) of proteins[946] (more than 2000 reprint requests were received), we have undertaken the task of updating this collection (Table 1).

The present table starts from where we finished the previous collection[946], and covers a 4-year period, from 1976 to 1979. We were aided in this extensive survey by a literature reference list, *Acta Ampholinae*, published by LKB Produkter (Bromma, Sweden). In that list, we started from No. 1800 and screened all the articles up to No. 4000 (end of 1979). We have thus gone through about 2200 publications and selected 945 articles containing the information we were looking for. It might be of interest to the reader to know some statistics on this article. Even though our list of references quotes 120 different journals, 60% of the total citations are contained in a small core of only five journals. The most often cited is *J. Biol. Chem.*, which produced 20% of the total entries, closely followed by *Biochim. Biophys. Acta* (16%), then *Eur. J. Biochem.* (10%) and finally *Biochemistry* (8%). The Japanese journal *J. Biochem.* scores a good 5%. Considering that mostly Japanese scientists publish in *J. Biochem.*, this is not a small achievement for a regional journal.

These data fully support what E. Garfield (the Editor of *Current Contents*) has been propounding for many years, that there is only a small core of scientific journals that carry most (and the most qualified) of the scientific information[947]. We should also like to add some more comments, stemming from the knowledge we have accumulated during this extensive screening. From a point of view of "readability", nothing beats an abstract in *J. Biol. Chem.* It seems as if the authors who publish in this journal have been specially trained to squeeze all the relevant information into their abstracts. *J. Biol. Chem.*, *Biochim. Biophys. Acta* and *Eur. J. Biochem.* also share

0378-4355/81/0000–0000/$16.00

TABLE I

pI AND MW VALUES OF PROTEINS

pI = isoelectric point; MW = molecular weight; IEF = isoelectric focusing; n.g. = not given; r.t. = room temperature; s.p.c. = single peptide chain. When a pI value is followed by the symbol $^+$, it represents a major isozyme band. When individual pI values are not reported, but a pI range is given in parentheses, it means either that there were too many isoproteins separated (usually > 10) or that it was difficult to establish the actual pI values from the original graphs reported in the articles. In these instances, we have at least tried to report the pI(s) of the major band(s).

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
N-Acetylaspartate amidohydrolase[1]	Rat	Brain				5.1	1	r.t.
Acetylcholine receptor protein (AChR)[2]	*Torpedo marmorata*	Electric organ membrane fragments		1 1 1	40,000 50,000 60,000	~5.4	1	n.g.
Acetylcholine receptor[3]	Mammalian	Skeletal muscle				5.3	1	n.g.
Acetylcholine receptors:[4]	Rat							
Functional receptor		Diaphragm muscle				5.09	1	n.g.
Extrajunctional receptor		Denervated diaphragm muscle				5.32	1	n.g.
Acetylcholinesterase (AChE)[5,6]	Human	Erythrocyte			80,000	4.55, 4.68$^+$, 4.81$^+$, 4.98, 5.18	5	n.g.
Acetylcholinesterase[7]	Cobra (*Naja naja atra*)	Venom	144,000	2	~69,000	6.25–6.4	>10	n.g.
Acetylcholinesterase[8]	Cobra (*Naja naja oxiana*)	Venom	67,000		s.p.c.	5.2–6.2	14–16	n.g.
Acetylcholinesterase[8,9]	Cobra	Venom						
	(*Naja melanoleuca*)					4.2–5.2	7	n.g.
	(*Bungarus fasciatus*)		126,000[8]	2	63,000	4.3–5.3	10	
Acetylcholinesterase (11S)[10]	*Electrophorus electricus*	Electric eel tissue	~280,000	4	70,000	5.5–6.0	5 major, 3 minor	n.g.
Acetyl-CoA acetyltransferase (I, A, B)[11]	Bovine	Liver mitochondria	152,000	4	~38,000	6.9, 7.5, 8.8	3	4
Acetyl-CoA: choline O-acetyltransferase[12,13]	Squid	Head ganglia	93,000[13]	1 1	37,000 56,000	(5.0–6.2) 5.2$^+$, 5.7$^+$, 6.2$^+$	6	n.g.
α-N-Acetylgalactosaminidase[14]	Limpet (*Patella vulgata*)		200,000	4	50,000	5.5	1	n.g.

α-N-Acetylglucosaminidase (I, II)[15]	Bovine	Spleen	127,000(I) 64,500(II)			4.8 for both forms	1	n.g.
α-N-Acetylglucosaminidase[16,17]	Human	Urine	307,000[16]			(3.3–6.0), 4.8[117]	4 major 2 minor	n.g.
β-N-Acetylglucosaminidase (A and B)[18,19]	Bull	Sperm	190,000[18]			7.96[18]	1	
			200,000(A)		53,000 13,400	5.31(A)	1	n.g.
			190,000(B)		53,000 13,000	6.78(B)	1	
β-N-Acetylglucosaminidase[20]	Human	Serum, liver				4.5	1	n.g.
N-Acetyl-β-D-hexosaminidase[21]	Human	Leucocytes,				5.2^+, 7.2	2	
		amniotic fluid,				4.3, 5.2, 7.2^+	3	4
		fibroblasts				5.0^+, 7.2	2	
N-Acetyl-β-D-hexosaminidase (A, B)[22]	Human	Liver				4.9–5.5 (A) 7.0–7.3 (B)	4	0
N-Acetyl-β-D-hexosaminidase (A, B)[23]	Human	Colonic carcinoma				5.2 (A) 7.7 (B)	2	n.g.
N-Acetyl-β-D-hexosaminidase[24]	Human	Fibroblast cultures				5.0, 7.8	2	
		Sandhoff disease:						
		Infantile				4.4^+	2	
		Juvenile				5.0^+	2	n.g.
N-Acetyl-β-D-hexosaminidase (A, B)[25]	Human	Brain (variant AB of infantile G_{M2} gangliosidosis)				5.0^+ (A) 7.2 (B)	2	n.g.
N-Acetyl-β-D-hexosaminidase[26]	Human	Pregnancy serum and Tay-Sachs disease				5.0^+, 5.4, 5.7, 6.1^+, 6.3, 6.7, 7.0	7	n.g.
N-Acetyl-β-D-hexosaminidase, P[27]	Human	Pregnancy serum	150,000			6.3^+, 6.7^+	2	n.g.
N-Acetyl-β-D-hexosaminidase, S-like (1), A-like (2)[28]	Human	Urine, deficiency disease				4.1 (1) 4.7 (2)	2	n.g.
N-Acetyl-β-D-hexosaminidase (A, B)[29]	Human	Placenta				5.4 (A) 7.9 (B)	1	n.g.
N-Acetyl-β-D-hexosaminidase (surface-bound)[30]	*Bacillus cereus* T	Spores	40,000			9.7	1	n.g.
N-Acetyl-β-D-hexosaminidase (I, II, III, IV)[31]	*Trigonella foenum graecum*	Seeds	84,000(I) 72,000(II) 180,000(III) 150,000(IV)	3 3 6 6	28,000 24,000 30,500 30,000	6.78 (I) 6.30 (II) 4.90 (III) 4.65 (IV)	1	4

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TABLE I (*continued*)

Protein	Source	Organ and/or subcellular location	MW	Subunit No.	Subunit MW	pI	No. of iso-enzymes	Temperature (°C)
Acid deoxyribonuclease[32]	Human	Gastric mucosa, cervix uteri	38,000			6.86, 7.02$^+$	2	n.g.
Acid DNase inhibitor[33]	Chicken	Brain				4.2	1	n.g.
Acid phosphatase[34]	Human	Erythrocyte				5.45, 5.66, 6.43, 6.57, 7.11	5	15
Acid phosphatase[21]	Human	Fibroblasts, leucocytes, amniotic fluid				4.8$^+$, 6.3$^+$, 7.5, 5.1$^+$, 6.0$^+$, 7.5, 3.5, 5.1, 6.0$^+$	3	n.g.
Acid phosphatase (type A, B and C)[35]	Human	Red blood cell				5.36, 5.77, 6.47, 6.66, 7.16, 7.31, 7.58 (A)	7	
						5.34, 5.67, 6.26, 6.50 (B)	4	n.g.
						5.37, 5.79, 6.36, 6.62 (C)	4	
Acid phosphatase[36–39]	Human	Prostate gland	104,000	2	52,000	(4.1–5.5) 4.9$^+$	> 8	n.g.
Acid phosphatase[40]	Rat	Liver lysosomes				4.47$^+$, 5.62, 6.02, 6.78, 7.12, 7.83$^+$	6	4
Acid phosphatase[41]	Tasmanian devil	Plasma				5.5–6.5	4 major 4 minor	
		Liver				5.2–7.9	5 major 10 minor	
		Intestine				5.2–7.9	7 major 6 minor	n.g.
		Kidney				4.9–5.9	7 major 2 minor	
Acid phosphatase isozymes (1′, 2′, 3′a, 3′b, 4′a, 4′b)[42]	Rice	Cell wall	94,000 96,000 (1′) 100,000 (2′) 65,000 (3′ a) 155,000 (4′ a) 96,000 (4′ b)			8 (1′), 7.5 (2′), 7.2 (3′ a), 7.1 (3′ b) 6.8 (4′ a), 6.7 (4′ b)	6	n.g.
Acid phosphomonoesterase[43]	Human	Seminal plasma				4.6–5.25	16–20	n.g.

Acid protease (A_1, A_2)[43]	*Aspergillus oryzae*		63,000 (A_1)			3.15(A_{1a}), 3.50(A_{1b})	2	n.g.
			32,000 (A_2)			3.9(A_2)	1	
Acid protease[44]	*Penicillium duponti*					3.81	1	n.g.
Aconitase (mitochondrial; $ACON_M$ and soluble: $ACON_S$)[45]	Human	Kidney, liver, placenta				5.1 ($ACON_S$)	1	n.g.
						6.9 ($ACON_M$)	1	
Actin (β and γ)[46]	Human	Platelets				5.63(β), 5.65(γ)	1	n.g.
Actin (α, β, γ)[47–50]	Mammals, bird, fish, slime mould	Skeletal muscle and heart muscle (α) Non-muscle tissue (β, γ)	~ 45,500[50]			5.47(α), 5.53(γ), 5.50(β)	1	n.g.
Acyl-CoA hydrolase[51]	Rat	Liver mitochondria	19,000		s.p.c.	6.0	1	4
Adenosine deaminase[52] (Adase A, B, C)	Human	Colon tumours	>100,000 (A)			4.8^+, 4.7 (rat)	2	n.g.
	Rat		72,000 (B)					
			35,000 (C)					
Adenosine deaminase[53]	Rabbit	Kidney	~215,000	2	110,000	4.15, 4.50, 5.05, 5.65	4	n.g.
Adenosylhomocysteinase[54]	*Lupinus lutens*	Seeds	110,000	2	55,000	4.9	1	r.t.
Adenosylhomocysteinase[55]	Calf	Liver	237,500	4	~60,000	5.8, 6.0	2	n.g.
Adenylate cyclase[56]	Mouse	Parotid				5.9	1	n.g.
Adenylate kinase[57]	Human	Muscle	~ 31,000			6.3, 8.6, 10.5	3	
		Heart				6.4, 7.2, 8.6, 9.5	4	
		Kidney				5.9, 7.2, 8.2	3	
		Liver				4.7, 5.8, 8.8	3	
		Bladder				4.8, 9.2	2	
		Erythrocytes				9.5		
	Dog	Heart and liver	~ 31,000			6.5	1	
		Kidney				4.9	1	
		Intestine				5.8	1	
	Cow	Heart				8.5	1	
		Liver				5.3, 6.8, 7.4, 8.2	4	

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TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Adenylate kinase[58]	Rat	Muscle, brain, heart, lungs, uterus, cytoplasm				7.4		
		Liver, kidney, mitochondria				8.2		
		Hepatomas, foetal tissues, cytoplasm				9.3		n.g.
Adenylosuccinate synthetase[59]	*Leishmania donovani*	Promastigotes	>250,000			8.7	1	n.g.
Agarose-degrading enzymes (I, IIb)[60]	*Pseudomonas*-like bacteria		210,000 (I)	2				
			63,000 (IIb)			5.1(IIb)	1	r.t.
Agglutinin[61]	*Limulus Polyphemus*	Haemolymph	22,000			4.83	1	4
Agglutinin wheat germ (WGA I, IIa, IIb, III)[62]	Plant	Wheat germ	36,000	2	18,000	8.7(I, IIa, III) 7.7(IIb)	1	n.g.
Agglutinin wheat germ (succinylated)[63]	Plant	Wheat germ	36,000	2	18,000	4.0	1	n.g.
D-Alanyl-*meso*-A_2pm endopeptidase[64]	*Streptomyces*					7.9	1	1
Albumin[65]	Human	Plasma				4.8^+, 5.6^+	2 major	4
Albumin[66]	Human	Bisalbuminaemia serum				5.65, 5.84	2	n.g.
Albumin:[67]	Wheat							
Mb 0,19						7.3		
Specific albumin						4.7	1	n.g.
Alcohol dehydrogenase (ADH)[68]	Human	Liver				9.0, 9.8, 9.9, 10.15^+	4	4
Alcohol dehydrogenase[69]	*Rhodopseudomonas acidophila*		~120,000	2	63,000	9.3	1	n.g.
Alcohol dehydrogenase[70]	Wheat					6.18, 6.28, 6.38, 6.58, 6.73, 6.80	6	n.g.
Aldehyde dehydrogenase[71]	Bovine	Liver	220,000	4	55,000	5.4	1	n.g.

Aldehyde dehydrogenase[72]	Sheep	Liver						
		Cytoplasmic	212,000	4	53,000	5.25	1	n.g.
		Mitochondrial	205,000					
Aldehyde dehydrogenase (I, II, III, IV)[73–75]	Rat	Liver						
		Normal liver, hepatomas[73]				5.4(I), 6.9(II, III, IV)	4	
		Cytoplasmic[74]				8.5(I), 5.8(II)	2	
		Mitochondrial[75]	320,000 (I)			6.06(I)	1	
			67,000 (II)			6.64(II)	1	
		Microsomal[74]				4.0	1	4[74]
(Aromatic) aldehyde-ketone[76] reductases (AR1, AR2)	Guinea pig	Liver				8.1(AR2)	1	4
						9.0(AR1)	1	
Aldehyde reductase[77]	Human	Liver	36,200		s.p.c.	5.3	1	n.g.
Aldolase A[78]	Human	Erythrocytes	158,000	4	39,500	8.9	1	4
Aldolase B[79]	Human	Liver				$6.3(\beta'^4)$, $6.5(\beta\beta'^3)$, $6.8(\beta^2\beta'^2)$, $7.0(\beta^3\beta')$ $7.3(\beta^4)$	5	n.g.
Aldolase C[80]	Rat	Brain	148,000	4	37,000	4.28	1	n.g.
Aldolase[81]	Rabbit	Muscle				8.40, 8.65, 8.90, 9.0, 9.15	5	n.g.
Aldolase[81]	Nematode (*Turbatrix aceti*)					7.10	1	n.g.
Aldose reductase (AR I, AR II)[82]	Calf	Brain	29,000 (AR I)			4.88(AR II)		
			30,000 (AR II)			6.18(AR I)	1	n.g.
Aldose reductase[83]	Bovine	Eye lens	37,000		s.p.c.	4.85	1	n.g.
Alkaline phosphatase[84]	Rabbit	Lung	210,000(1) 185,000(2) 185,000(3)			5.0(1), 5.5(2), 5.8(3)	3	n.g.
Alkaline phosphatase[85]	Rat	Kidney			48,000	~5.15(A)		
					100,000	~5.95(B)	2	n.g.

(Continued on p. 122)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Alkaline phosphatase[86–88]	Human	Liver	136,000[86–88]	4	34,000	4.2[86] 4.7[87]		
		Intestinal[87]				4.5	1	r.t.[87]
Alkaline phosphatase (I variant)[89]	Human	Placenta	120,000	2	60,000	3.4, 4.3, 4.6⁺, 5.4, 6.0⁺	6	n.g.
Alkaline phosphatase HeLa 65[90]	Human	HeLa cells	120,000			4.3	1	n.g.
Alkaline phosphatase KB cell[91]	Human	Nasopharyngeal tumour	136,000	1	64,000	4.3	1	n.g.
				1	72,000			
Alkaline phosphatase[92]	*Thermus aquaticus*					8.4	1	n.g.
Alkaline ribonuclease[93]	Bullfrog (*Rana catesbeiana*)	Hepatic cytosol	12,000		s.p.c.	9.4	1	n.g.
Allergen: Asc-1, A[1][94]	*Ascaris suum*	Perienteric fluid	14,000A[1] 18,000Asc-1			6⁺	3	n.g.
Allergen Ra 5[95]	Ragweed	Pollen	5,000			9.5	1	n.g.
Alloantigens HLA-linked B lymphocyte[96]	Human		64,000	1	29,000	6.1		
				1	34,000	5.2	2	n.g.
Allophycocyanin II (A II) and its α- and β-subunits[97]	Blue-green alga		102,500 (A II)		16,000 (α) 31,000 (β)	4.64(α), 4.65(A II) 4.82(β)	3	n.g.
Alveolysin[98]	*Bacillus alvei*		60,000			5.1, 7.0	2	n.g.
α-Aminoadipate aminotransferase[99]	Rat	Kidney	85,000	2	~45,000	6.56	1	4
Aminoazo dye-binding protein A[100]	Rat	Liver	14,000			5.0, 5.9, 7.6	3	n.g.
4-Aminobutyrate transaminase (I, II)[101]	Pig	Liver	110,000	2	55,000	6.10, 6.30(I), 5.90, 6.34(II)	4	n.g.
δ-Aminolaevulinic acid synthetase[102]	Rat	Liver mitochondria	120,000	2	58,000	4.5	1	n.g.
δ-Aminolaevulinate dehydrase[103]	Human	Erythrocytes	252,000	8	31,000	4.9	1	4
5-Aminolaevulinate synthetase[104]	*Rhodopseudomonas spheroides*		65,000		s.p.c.	5.2, 5.35, 5.45, 5.55	4	n.g.
Aminopeptidase[105]	*Physarum polycephalum*					(5–6.5), 5.6⁺	4	n.g.

Aminopeptidase B-like enzyme[106]	Rat	Leukocytes				5.0	1	n.g.
5′-AMP aminohydrolase[107]	Human	Erythrocyte	285,000	4	70,000	5.5	1	n.g.
α-Amylases (1A, 1B, 2A, 2B)[108]	Human	Submandibular saliva	~220,000	2	57,000 (1A, 1B)	5.9 (1A, 2A)	4	n.g.
				2	54,000 (2A, 2B)	6.4 (1B, 2B)		
α-Amylase[109–113]	Human	Serum				5.88, 6.4^+, 6.88	3	
		Urine				5.93, 6.48^+, 6.98	3	
		Saliva	125,000[110]	1	61,000 (A)	5.9, 6.4^+ (A)	2	
				1	64,000 (B)	5.9^+, 6.4(B)[110]	2	
		Pancreas	60,000[110]			6.0, 6.5, 6.88^+	3	20[112]
α-Amylase[114]	Rabbit	Pancreas	56,500			6.8, 8.5	2	n.g.
Angiotensinogen[115]	Rat	Plasma			56,400	4.85	1	n.g.
Angiotensinogen[116,117]	Human	Plasma	66,000[117]			4.3, 4.5, 4.6^+, 4.7^+, 4.8^+, 4.9^+, 5.0^+	7	r.t.[117]
Angiotensinogen[117] (II)	Hog	Plasma	48,000			4.09, 5.05^+, 5.2^+, 5.35^+	4	
	Rabbit		56,000			5.0, 5.1^+, 5.35^+, 5.5^+	4	r.t.
Antigen alkali-soluble, water-soluble (B-ASWS)[118]	*Blastomyces dermatitidis*	Cells walls				4.01^+, 4.69^+	2	n.g.
I-Antigen 51 A[119]	*Paramecium tetraurelia*		300,000			4.1^+, 4.3^+, 4.4	3	n.g.
Antigen K 99[120]	*E. coli*					4.2	1	n.g.
Antigen carcinoembryonic (CEA)[121]	Human	Colon carcinomas				(2.5–4.5) 3.45^+		n.g.
Antigen, histocompatibility-2 (H-2)[122]	Mouse	Liver			40,000 12,000	4.9^+	> 1	n.g.
Antigen hepatitis B core and surface (HB_cAg, HB_sAg)[123,124]	Human	Sera				$4.4(HB_cAg)$[123]	1	
						3.7^+, 4.0^+, 4.4^+, 4.9, 5.1, $5.3(HB_sAg)$[124]	6	n.g.
Antigens HLA-A9 and HLA-B12[125]	Human	Urine	32,000			5.1(HLA-A9), 4.7(HLA-B12)	1	n.g.
Antigen Rh (D)[126]	Human	Erythrocyte membrane	10,000–20,000			2.8, 3.8, 5.2, 7.3^+	4	n.g.

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TABLE I *(continued)*

Protein	Source	Organ and/or subcellular location	MW	Subunit No.	Subunit MW	pI	No. of iso-enzymes	Temperature (°C)
Antigen-tumour[127]	Human	Epidermoid carcinomas	25,000–50,000			8.36–8.40		n.g.
F antigen[128]	Human	Liver	40,000–80,000			6.6	1	0
Antithrombin III[129]	Guinea pig	Plasma				5.15	1	n.g.
Antithrombin III[130]	Human	Plasma	58,000	2	29,000	4.9, 5.1^{+}, 5.3	3	4
Antithrombin III[130]	Bovine	Plasma	56,000	2	28,000	4.5, 4.6^{+}, 4.7^{+}, 4.8^{+}, 4.9^{+}, 5.0	6	4
α-1 Antitrypsin[131]	Dog	Plasma	58,000			4.40, 4.52	2	4
α-1 Antitrypsin (F, M, S, Z)[132]	Human	Plasma				4.54(F), 4.59(M), 4.66(S), 4.74(Z)	1	n.g.
Apolipoprotein[133]:	Rat	Serum apoHDL, apoVLDL						
C-I					7,000	>6.0		
A-I					27,000	5.55, 5.65, 5.75, 5.82	4	
ARP and A-IV					35,000 (ARP)	5.31, 5.36, 5.39, 5.41	4	
					46,000 (A-IV)			r.t.[133]
A-II			8000			4.83	1	
C-II			8000			4.74	1	
C-III (0, 1, 2, 3, 4)			10,000 (CIII0)			4.57, 4.61, 4.67	3	
			11,000 (CIII3)			4.43, 4.50	2	
Apolipoprotein[135]:	Vervet apoHDL	Plasma						
A-I			27,800			5.9–6.3		
DI-1			13,900			6.94	1	
DI-2			9900			5.17	1	n.g.
DII-1			11,500			6.44	1	
DII-2			8000			5.20	1	
DIII			9500			5.05		

Apolipoproteins, AI, A2 (threonine-poor)[136]	Human	Plasma	10,000 (AI)			6.0(AI)		
		apo-HDL	40,000 (AII)	2	20,000	6.5(AII)*		
Apolipoprotein A-IV[137]	Human	Mesenteric lymph chylomicrons	46,000			5.15	1	n.g.
Apoliproteins C-I, C-II, C-III, CIV, CV, E[138–140]	Human	Plasma apo-VLDL				CI: 6.5	1	
						CII: 4.78	1	
						CIII: 4.54, 4.72, 4.93	3	n.g.
						CIV[138]: 4.61		
						CV[139]: 4.44		
						E: 5.7, 5.8, 5.9, 6.0, 6.2[139]	5	
Apolipoprotein D peak II protein[141]	Human	Plasma apoVLDL			33,000	9.5	1	n.g.
Apolipoprotein F[142]	Human	Plasma HDL	26,000–32,000			3.7	1	n.g.
α-L-Arabinofuranosidase[143]	*Scopolia japonica*	Calluses				5.7, 6.0, 8.0*	3	n.g.
AraC protein[144]	*E. coli*		56,000	2	28,000	7.1	1	n.g.
Arylamidase[145,146]	Human	Cancerous lung[145]	240,000[146]			4.2	1	
		Ascites				3.7, 3.9*, 4.2*	3	4[146]
Arylsulphatase A (AS-A)[147]	Human	Urine (u)				4.7, 4.8, 4.9 (u)	3	
		Liver (l)				4.4, 4.5, 4.6*, 4.7*, 4.8*, 4.9 (l)	6	n.g.
Arylsulphatase B (AS-B)[148]	Human	Placenta (p)				8.2 (p)	1	
		Brain (b)				6.8, 7.0, 7.2 (b)	3	n.g.
Arylsulphatases A and B (AS-A, AS-B)[149]	Human	Leucocytes				5.2 (AS-A)		
						8.2, 9.4 (AS-B)	2	n.g.
Arylsulphatases A and B (AS-A, AS-B)[150]	Rat	Basophil leukaemia tumour	116,000 (AS-A)			4.2 (AS-A)	1	
			50,000 (AS-B)			6.4 (AS-B)	1	n.g.
Aspartate aminotransferase[151–153]:	Pig	Heart	82,000	2	41,000	5.68(1)		
Pyridoxal homomer (1)						5.79(2)	1	
Apo/pyridoxal hybrid (2)						5.92(3)		
Apo homomer (3)								r.t.[153]
Aspartate aminotransferase[154]	Sheep	Liver	87,000			9.14	1	n.g.

(Continued on p. 126)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit* *No.*	*Subunit* *MW*	*pI*	*No. of iso-enzymes*	*Temper-ature (°C)*
Ca^{2+}-ATPase and Mg^{2+}-ATPase[155]	Bovine	Brain (microsomes)	105,000			4.8, 6.3	2	n.g.
ATPase (single-stranded DNA-dependent)[156]	Mouse	Myeloma				6.5	1	n.g.
Ca^{2+}-ATPase[157]	Rabbit	Sarcoplasmic reticulum	115,000			5.0, 5.1, 5.2^+ 5.4, 5.5	5	n.g.
ATPase inhibitor (F_1)[158]	*Saccharomyces cerevisiae*		7000			9.05	1	n.g.
Bacitracin A[159]	*Bacillus licheniformis* *B. subtilis*					6.0^+, 6.5, 6.8, 7.1^+	4	n.g.
Bacteriorhodopsin[160]	*Halobacterium halobium*					3.98^+, 4.98, 5.45	3	n.g.
α-N-Benzoylarginine-2-naphthyl-amide hydrolase (I and II)[161]	Rat	Skin	27,000			6.2(II), 7.5(I)	2	n.g.
Betaine aldehyde dehydrogenase[162]	*Pseudomonas aeruginosa* A-16		145,000			5.1	1	n.g.
Bilirubin glucuronoside glucuro-nosyltransferase[163]	Rat	Liver	160,000	6	28,000	7.9	1	n.g.
Biotin-binding protein[164]	Chicken	Egg (yolk)	74,300	4	18,575	4.6	1	n.g.
2,3-Bisphosphoglycerate phos-phatase and bisphosphoglycero-mutase (peak III)[165]	Human	Erythrocytes	63,000	2	29,000	5.1	1	25
2,3-Bisphosphoglycerate synthase[166]	Human	Erythrocytes				4.6, 4.9, 5.0^+	3	20
α-Bungarotoxin-binding protein[167]	*Drosophila melanogaster*	Heads				6.6	1	n.g.
α-Bungarotoxin-binding protein[168]	Mouse	Brain	700,000			5.6	1	n.g.
γ-Butyrobetaine hydroxylase[169]	*Pseudomonas* sp. AK 1		90,000	1 1	39,000 37,000	5.1	1	n.g.
Butyrylcholine-hydrolysine enzyme[170]	*Pseudomonas polycolor*		59,000			5.1	1	4
Cadmium-binding protein[171]	Rat	Liver				4.2^+, 4.7	2	n.g.
Cadmium-binding protein[172]	Rat	Liver				5.3, 5.7^+, 6.2	3	n.g.

Calcium-binding protein[173]	Chick	Chorioallantoic membrane	100,000	4	25,000	8.06	1	n.g.
Calcium-binding protein[174]	Soy					5.1+, 5.2+, 5.8+	3	
	Leaf					3.7+, 3.9, 5.2	3	
	Wheat					6.5, 6.6+, 7.7, 8.0+	4	n.g.
Calcium-modulated protein (calmodulin)[175]	Chicken embryo	Fibroblasts				3.8, 4.1+	2	n.g.
Carbonic anhydrase III[176]	Rabbit	Skeletal muscle	58,000	2	29,000	8.41 (monomer), 9.34 (dimer)	1	n.g.
Carbonic anhydrase: C_1, C_2, C_3 isozymes[177]	Equine	Erythrocyte				8.52(C_3), 9.0(C_2), 9.63(C_1)	3	n.g.
Carbonic anhydrase[178]	Rat	Kidney	25,700			7.2, 6.9	2	
		Erythrocyte RBC-C	26,000			7.2, 6.9	2	n.g.
		Erythrocyte RBC-B	24,000			7.2+, 7.0	2	
Carbonic anhydrase[179]	Male rat	Liver	29,000			5.97, 6.28+, 6.60+, 7.25	4	n.g.
Carboxylesterase[180]	Human	Brain	340,000			3.9+, 4.0, 4.1, 4.2 4.5, 4.7	6	25
Carboxylesterase[181]	Human	Pancreas	54,000			4.65	1	n.g.
Carboxylesterase[182]	Rat	Serum	84,000			4.4	1	n.g.
Carboxypeptidase N[183]	Human	Serum				3.8+, 4.3+	2	r.t.
Carboxypeptidase[184]	*Streptomyces griseus* K-1		34,000			5.2	1	20
Cardiotoxin (Mojave toxin)[185]	*Crotalus scutulatus*	Venom	22,000	2	12,000	4.7	1	n.g.
Carnitine acetyltransferase[186]	Ox	Heart				5.2, 8.1	2	
		Liver				4.9, 7.6	2	
	Sheep	Liver				5.0, 7.9	2	n.g.
	Pigeon	Breast muscle: Crude				5.0, 8.1	2	
		Purified				8.0	1	
Carnosinase[187]	Hog	Kidney	84,000			5.8	1	n.g.
Catalase[188]	*Neurospora crassa*		320,000	4	80,000	5.0	1	n.g.
Catalase[189]	Human	Granulocyte from myeloid leukaemia	263,000	4	65,500	6.7	1	n.g.

(Continued on p. 128)

TABLE I (*continued*)

Protein	Source	Organ and/or subcellular location	MW	Subunit No.	Subunit MW	pI	No. of iso-enzymes	Temperature (°C)
Catalase[190]	Mouse	Liver				6.25, 6.35⁺, 6.40⁺ 6.50⁺, 6.65, 6.80, 6.90, 7.15, 7.45	9	n.g.
Catalase[191]	Rat	Liver				6.49, 6.64, 6.74	3	0
Catechol O-methyltransferase:[192]	Rat	Liver						
COMT I			24,000			4.9		
COMT-II			47,500			4.8	2	n.g.
Cathepsin B[193]	Squid (*Dorytheuthis bleekri*)	Liver	13,600			6.8	1	n.g.
Cathepsin B1 (F-4.5)[194]		Liver	50,000	2	25,000	4.5	1	n.g.
Cathepsin B1[195]	Squid (*Ommatostrephes sloani pacificus*)	Liver	18,000			5.7	1	n.g.
Cathepsin B1[196]	Human	Foetal membranes of placenta				5.1⁺, 5.4, 5.5	3	n.g.
Cathepsin B[197]	Human	Placenta	24,500			5.4	1	
Cathepsin collagenolytic[197]	Human	Placenta	34,600			5.1	1	n.g.
Cathepsin B forms I, II, III[198]	Pig	Liver	29,000 (I, II)	1 1	25,000 4,000	5.2(I), 5.4(II)		
			29,000 (III)		s.p.c.	5.8(III)	1	n.g.
Cathepsin B[199]	Rat	Liver	22,500			4.9, 5.0⁺, 5.1, 5.3	4	n.g.
Cathepsin D I and D II[200]	Rat	Spleen	44,000		s.p.c.	4.2, 4.9, 6.1, 6.5 (DI)	4	
						4.6, 5.6, 5.8(DII)	3	n.g.
Cathepsin L[201]	Rat	Liver lysosomes			23,500	5.8–6.1	4	n.g.
Cellobiose oxidase[202]	*Sporotrichum pulverulentum*		93,000			4.5	1	20
Cellobiose: quinone oxido-reductase[203]	*Sporotrichum pulverulentum*		58,000			4.0, 5.7, 6.4	3	4
Cellulase[204]:								
Endoglucanase (1)	*Chaetomium thermophile*		41,000(1)			~4.55	1	n.g.

Exoglucanase(2)			67,000(2)			~4.55	1	
Cellulase: β-glucosidase (GB-2 component)[205]	*Pyricularia oryzae*		240,000	2	120,000	4.05	1	n.g.
Cellulase: C_1 component[206]	*Fusarium solani*					4.75^+, 4.82, 4.90^+, 4.95	4	n.g.
Chitinase[207]	Goat	Serum	60,000			4.85	1	4
Chitinase[208]	Calf	Serum	47,000			5.3	1	n.g.
Chitin synthetase-activating factor inhibitor[209]	*Saccharomyces cerevisiae*		8,500			7.1	1	n.g.
Cholesterol-binding protein[210]	Rat	Liver, cytosol			26,500	5.75, 5.80	2	n.g.
Cholesterol esterase[211]	Rat	Adipose tissue				5.1^+, 4.7	2	n.g.
Cholesterol ester exchange factor[212]	Rabbit	Plasma				5.2	1	n.g.
Choline oxidase[213]	*Arthrobacter globiformis*		83,000		s.p.c.	4.5	1	5
Cholinesterase (ChE)[214]	Earthworm (*Eisenia foetida*)		108,000			(4.9–5.5) 5.1^+, 5.2^+, 5.3^+	8	0.5–1.0
Cholinesterase[215]	Frog	Brain (b)	394,000(b_1) 550,000(b_2) 550,000(b_3)			5.9, 6.0, 6.1 (b)	3	
		Retina (r)	292,000(r_1) 470,000(r_2)			6.0, 6.1 (r)	2	n.g.
Chymotrypsin[216]	Mouse (strains NZB and A/Sn)	Pancreas				7.4(A/Sn I) 4.9(A/Sn II)	2	
						6.5(NZB I) 4.5(NZB II)	2	n.g.
Chymotrypsin-like esterase[217]	Beef	Lung	>104,000	>2	~52,000	6.20, 6.33, 6.42, 6.54	4	n.g.
Coagulogen[218]	Japanese horseshoe crab	Amoebocyte lysate	15,300		s.p.c.	10.0	1	n.g.
Cobalophilin (R-protein)[219]	Pig	Ileal and pyloric mucosa	120,000			4.1	1	r.t.
Cobra venom factor (CVF)[220]	Cobra (*Naja naja*)	Venom				5.0, 5.2, 5.3, 5.5, 6.4^+	5	n.g.
Colicin E4[221]	Citrobacter		56,000			8.2, 9.4	2	n.g.
Colicin O 111[222]	*E. coli* O 111: B4:H2		69,000			9.50	1	25

(*Continued on p. 130*)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Collagenase precursor[223]	Human	Skin fibroblast	50,000		s.p.c.	6.7	1	n.g.
Colony stimulating factors (CSF)[224]	Mouse	L cells	70,000	2	35,000	4.0^{+}, 4.2^{+}, 4.8, 5.1	4	n.g.
Colony stimulating factors (CSF)[225]	Human	Cultured pancreatic carcinoma cells	50,000			3.7–4.6		n.g.
Complement, C1$\bar{r}$ subcomponent[226]	Human	Serum	110,000	1	68,000	4.9	1	0
				1	41,000			
Conalbumin[227]	Chicken	Egg						
Native						6.0, 6.3, 6.6^{+}	3	n.g.
γ-Irradiated						7.1^{+}, 7.4^{+}, 7.8	3	
β-Conglycinin, α,α′,β[228]	Soybean		57,000			4.90(α)	1	
			(α,α′)			5.18(α′)	1	20
			42,000(β)			5.66–6.00(β)	4	
Corticosteroid-binding protein[229]	Rat	Brain				4.3, 5.8, 6.75^{+}	3	n.g.
		Pituitary cytosol				4.2^{+}, 6.5^{+}, 8.2	3	
C-reactive protein (CRP)[230]	Mouse	Liver, serum				4.8, 5.62	2	n.g.
Creatine kinase[231]	Rabbit	Skeletal muscle				6.1, 6.3^{+}, 6.4^{+}, 6.5^{+}	4	n.g.
Creatine kinase (CK): MM isozymes[232]	Human	Serum				6.24(MM_1), 6.45(MM_2), 6.86(MM_3)	3	n.g.
Creatine phosphokinase (CPK)[233]	Human	Heart				6.9(CPK-2)		
		Skeletal muscle				7.2(CPK-1)	2	4–8
Creatinine amidohydrolase (creatininase)[234]	*Pseudomonas putida*, strain C-83		175,000	8	22,000	4.7	1	n.g.
δ-Crystallin[235–237]	Avian, reptilian	Lens	200,000	4	50,000	5–7		
	embryonic mallard	Lens	200,000	4	50,000	(5.0–5.8)	5 major 9 minor	
	Embryonic chick	Lens	200,000	4	50,000	5.1–5.4	7	r.t.[237]
Cyclic AMP-adenosine binding protein[238]	Mouse	Liver	180,000	4	45,000	5.7	1	n.g.
Cyclic nucleotide phosphodiesterase[239]	Rat	Brain				5.2, 6.5	2	n.g.

Cyclic AMP phosphodiesterase 1 and 2[240]	*Dictyostelium purpureum*		60,000(1) 50,000(2a) 48,000(2b)			8.5(1) 7,5(2a, 2b)	1 1	n.g.
Cyclic AMP phosphodiesterase[241]	*Dictyostelium discoideum*					4.6, 6.5, 8.3	3	n.g.
Cyclic AMP phosphodiesterase F1, F2-I, F2-II forms[242]	Rat	Pancreatic cytosol	500,000(F1) 70,000 (F2-I, F2-II)			3.9(F2-II)	1	n.g.
Cyclic nucleotide phosphodiesterases[243,244]	Rat	Cerebellum[243]				4.4, 4.8$^+$, 5.0$^+$, 6.1$^+$, 8.3, 9.0	6	
	Rat	Cerebrum[244]				5.1, 5.6$^+$, 6.1$^+$, 6.6$^+$, 8.0, 9.0	6	n.g.
Cyclic nucleotide phosphodiesterase[245]	Rat	Neostriatum				4.30$^+$, 4.45$^+$, 4.70, 4.85$^+$, 5.50	5	n.g.
		Cerebellum				4.1, 4.35$^+$, 4.5$^+$, 4.7, 4.9$^+$, 5.5	6	
Cyclic nucleotide phosphodiesterase activator[246]	Bovine	Brain	15,000		s.p.c.	4.3	1	n.g.
Cyclooxygenase, prostaglandin-forming[247]	Sheep	Vesicular glands				6.3$^+$, 6.5, 6.7	3	n.g.
Cystathionine β-synthase:								
Normal (1)	Human	Skin fibroblasts	123,000	1	53,000	5.7 (1)	1	
Deficient homocystinuria (2)[248]				1	70,000	4.9 (2)	1	n.g.
Cystic fibrosis protein: CF ACTOR[249–255]	Human	Sera from cystic fibrosis	3,500–10,000			8.46	1	4[249,250] 5[254]
Cytochrome b_5-like haemoprotein[256]	Rat	Liver-mitochondrial outer membranes	60,000	4	16,000	3.6	1	5
Cytochrome b_{556}[257]	*E. coli* K 12				17,500	8.5	1	n.g.
Cytochrome c[258]	*Tetrahymena pyriformis*		11,300		s.p.c.	6.5	1	n.g.
Cytochrome c[259]	*Dyctyostelium discoideum*					10.2	1	n.g.
Cytochrome c peroxidase[260]	*Pseudomonas denitrificans*		63,000			5.6	1	n.g.

(Continued on p. 132)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Cytochrome[261]:								
$c_{550(a)}$ Oxidized form	*Pseudomonas*					5.6(d), 5.7(c),		12(b)
$c_{551(b)}$	*aeruginosa* and					6.5(a), 7.3(b)	1	14(a,c)
$c_{555(c)}$	*fluorescens*							18(d)
Azurin (d)								
Cytochrome *f*[262]	*Sinapis arvensis* L.	Leaves	27,000		s.p.c.	5.50	1	n.g.
Cytochrome *P*-450[263]	*Bacillus megaterium* ATCC 13368				52,000	4.9	1	n.g.
Cytochrome *P*-450: I, II[264-266]	Bovine	Adrenocortical mitochondria	850,000[266]	16	53,000	4.0(I), 7.0(II)[264,265]	2	n.g.
Cytochrome *P*-450[267]	Rat	Liver, microsomal				4.8^+, 5.4^+, 5.6^+	3	4
Cytochrome oxidase[268]	*Pseudomonas*		120,000	2	60,000	6.9	1	n.g.
Cytosol receptors for testosterone[269]	Rat	Kidney, submaxilari gland(1), prostate(2)				4.6, 5.1(1)	2	
						5.8(2)	1	n.g.
Cytosol thyronine-binding protein[270]	Dog	Kidney, cytosol	70,000			3.0^+, 3.8^+, 4.4		
						4.7, 5.3, 5.7	6	n.g.
Dehydrogenase (apo-NADH)[271]	*Peptostreptococcus elsdenii*		75,000	1	41,000	4.9, 5.4	2	n.g.
				1	33,000			
3′-Deocymononucleotide-producing nuclease[272]	*Verongia aerophoba*		62,000			6.1	1	n.g.
Desulphoviridin[273]	*Desulfovibrio vulgaris*					4.4^+, 4.55	2	n.g.
Detoxifying enzymes[274]:	*E. coli*							
Mercuric reductase			180,000	3	60,000	5.3	1	
Organomercurial hydrolase			43,000			5.5	1	r.t.
Diglyceride kinase[275]	*E. coli*	Membrane	15,400		s.p.c.	4.0	1	n.g.
Dihydrofolate reductase[276]	Beef	Liver	22,500		s.p.c.	5.70, 6.80^+	2	n.g.
Dihydrofolate reductase[277]	Chicken	Liver	22,474		s.p.c.	6.3, 6.8, 7.4, 8.4^+	4	n.g.
Dihydrofolate reductase (1, 2)[278]	*E. coli* B (RT-500)		18,500			4.6(1), 4.7(2)	2	n.g.
Dihydropteridine reductase[279]	Rat	Liver	51,000	2	25,000	6.35	1	n.g.
Dihydropteridine reductase[279]	Sheep	Liver	52,000	2	25,000	5.4	1	n.g.
Diisopropyl fluorophosphatase (DFPase)[280]	*E. coli*					5.3^+, 5.7, 6.1^+, 7.8	4	n.g.

Dipeptidyl carboxypeptidase[281]	Human	Seminal plasma	330,000			4.6, 5.0	1	n.g.
o-Diphenol-oxygen-oxidoreductase[282]	*Agaricus bisporus*	Fruiting bodies	118,700			5.12, 5.41, 6.25	3	n.g.
DNase[283]	*Aspergillus oryzae*		48,000		s.p.c.	9.2	1	n.g.
DNase[284]	*Chlamydomonas reinhardii*		35,000		s.p.c.	9.5	1	n.g.
DNase V[285]	Calf	Thymus	53,000	4	13,000	10.3 ± 0.2	1	n.g.
DNase B[286]	Streptococci							
	Group A					4.4, 5.8, 7.9$^+$, 9.0$^+$	4	4
	Group C					4.4, 5.8	2	
DNAase[287]	Human	Urine	38,000			3.9	1	n.g.
DNAase[288]	Human	Pancreatic secretion				4.58, 4.68, 4.79$^+$, 4.86$^+$, 5.00, 5.08	6	23
DNA-binding protein (DNA-110 protein)[289]	Rat	Brain, cytosol	68,000			5.9	1	n.g.
DNA-binding proteins (1 and 2)[290]	Human	Serum			126,000 (1)	7.01(1)	1	
					86,000 (2)	5.97, 6.03, 6.09(2)	3	r.t.
DNA ligase[291]	*E. coli* B/6, T-4-amber-N82 mutant		60,000			6.0	1	n.g.
DNA polymerase[292]	Calf	Thymus (cyto)	160,000	1	90,000	5.3$^+$, 5.8, 6.3$^+$	3	n.g.
				1	60,000			
DNA polymerase (I and II)[293]	Yeast		>100,000			5.1	1	n.g.
DNA polymerase III[294]	Mouse	Myeloma	270,000			5.8	1	n.g.
DNA polymerases (A, B, and C)[295]	Wheat	Embryos				5.2(B), 7.0(A,C)	3	n.g.
DNA polymerase-α[296]	Human	KB cells	140,000	1	76,000	5.1	1	n.g.
				1	66,000			
DNA polymerase-β[297]	Rat	Cortex neuronal nuclei	51,000			8.3	1	n.g.
DNA polymerase-β[298]	Human	Novikoff hepatoma cells				7.5(7.35-S form) 8.5(4.15-S form)	2	n.g.
DNA polymerase-γ[299]	Rat	Brain nuclei	180,000			5.4	1	n.g.
DNA polymerase inhibitor[300]	*Physarum polycephalum*	Slime mould	16,000			10.1	1	n.g.
Elastase[301]	Human	Granulocyte lysosomal				8.2, 9.0	2	n.g.

(Continued on p. 134)

TABLE I *(continued)*

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit*		*pI*	*No. of iso-enzymes*	*Temperature (°C)*
				No.	*MW*			
Elastase II[302]	Porcine	Pancreas	26,500			8.5	1	n.g.
Elongation factor 2 (EF-2)[303]	Hen	Oviduct	93,000		s.p.c.	6.75	1	n.g.
Elongation factor 1-βγ[304] (EF-1-βγ)	Pig	Liver	90,000	1 1	30,000 55,000	5.0(EF-1-β) 7.0(EF-1γ)	2	n.g.
Elongation factor cEF-Ts[305]	Mouse	Krebs II-ascites tumour cells	52,000	2	26,000	4.7	1	n.g.
Endochitinase[306]	Wheat germ		30,000		s.p.c.	7.5–9.2		n.g.
Endo-α-N-acetyl-D-Galactos-aminidase[307]	*Diplococcus pneumoniae*		160,000			8.5	1	r.t.
Endopolygalacturonase[308]	*Rhizoctonia fragariae*		36,000		s.p.c.	6.76, 7.08	2	n.g.
Endoribonuclease[309]	Bovine	Adrenal cortex cytosol				8.3	1	n.g.
Enolase[310]	*Turbatrix aceti*					5.6	1	4
Enolase[311]	Rabbit	Muscle Liver	85,000	2	42,500	7.7, 8.4, 8.8^{+}, 6.3, 6.7^{+}	3 2	n.g. n.g.
Enolase A[312]	Yeast					6.1^{+}, 6.3, 7.0	3	22–25
Enterotoxin A[313]	*Staphylococcus aureus*					6.5, 7.0, 8.0	3	n.g.
Enterotoxin A[314]	*Staphylococcus aureus*					6.8, 7.2, 7.6, 8.1^{+} 8.6^{+}	5	25
Epidermal growth factor (EGF)-binding protein[315]	Mice	Submaxillary glands	29,300			5.6	1	n.g.
Epidermal growth factor (EGF)[316]	Mice	Submaxillary glands	74,000 (complex)	2 2	6,045 29,300 (binding protein)	4.60	1	n.g.
Erythrocruorin[317]	Leech *(Dina dusia)*			1 1 1 1 1	13,000 21,000 23,000 25,000 31,000	5.87	1	n.g.

Erythrocruorin[318]	Leech (*Haemopis grandis*)			1 1 1 1	13,500 21,000 23,000 27,000	6.0	1	n.g.
Esterase (I and II)[319]	Rat	Liver	70,000(I) 160,000(II)			5.82(I), 6.32(II)	1	0
Esterase, non-specific (NSE)[320]	*Fasciola hepatica*					5.10^+, 5.15^+, 5.25^+, 5.40, 5.55, 5.65, 5.75	7	20
Esterase B_4[321]	Human	Liver	20,000		s.p.c.	8.7	1	8
Esterase[286]	*Streptococci* (group C)					5.8	1	4
Estrogen binding protein[321]	Calf	Uterus	115,000			4.9	1	4
Estrogen receptor[322]	Lamb	Uterus	35,300			5.5^+, 5.8^+, 6.2	3	n.g.
	Rat	Uterus	49,600			6.4	1	
Exonuclease[323]	Beef	Spleen				6.67	1	n.g.
Factor IX pools: I, II, III[324]	Human	Plasma				3.98^+, 4.16^+, 4.50(I)	3	
						3.85^+, 4.12, 4.42^+, 5.35, 5.80, 6.04(II)	6	n.g.
						3.85, 4.10, $4.36^{\prime}$, 4.83^+(III)	4	
Factor D[325]	Human	Serum	24,000		s.p.c.	7.4	1	4
Fatty acid synthetase[326]	*Mycobacterium smegmatis*				290,000	4.8	1	n.g.
Fatty acid-binding protein[327]	Rat	Heart	12,000		s.p.c.	5.0	1	n.g.
Feline sarcoma virus-coded precursor polyprotein[328]	Feline sarcoma virus		130,000			3.9	1	n.g.
Ferredoxin[329]	*Clostridium pasteurianum*					2.75	1	10
Ferredoxin-NADP$^+$ reductase[330]	Spinach	Leaves			34,000 (b) 37,000 (c, d)	4.8(e), 5.0(d), 5.2(c), 5.5(b), 6.0(a)	5	2
Ferritin[331]	Rat	Heart	530,000–626,000			4.6, 4.8	2	r.t.
Ferritin[332,333]	Human (1) Rat (2) Horse (3)	Liver and heart	450,000–620,000	24	H:21,000 L:19,000	4.8–5.8(1) 5.1–5.9(2) 4.1–5.1(3)	~ 6–10 ~15–18 15–18	2

(Continued on p. 136)

TABLE 1 *(continued)*

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Ferritin[334]	Human	Placenta				4.7–5.0	~ 6–7	n.g.
Ferritin[335]	Human	Tumour and normal sera				4.90–5.10 (tumour), 5.25–5.65 (normal)	Several	n.g.
α-Fetoprotein[336]	Mouse	Foetal plasma, amniotic fluid			70,000	4.4–5.4	5–8	r.t.
α-Fetoprotein[337]	Mouse	Hepatoma BW7756	72,000		s.p.c.	(4.3–5.2), 4.6†	4–6	n.g.
α-Fetoprotein[338]	Human	Cord serum	71,000		s.p.c.	4.85	1	n.g.
α-Fetoprotein[339]	Human	Hepatoma serum and ascitic fluid	67,500		s.p.c.	4.57†, 5.2	2	n.g.
α-Fetoprotein[340]	Human	Foetal tissue				4.7†, 5.3	2	n.g.
Fetuin-like antigen[341]	Human	Nephro blastoma (Wilm's tumour)				3.8†, 4.2	2	n.g.
F_0F_1 ATPase complex[342]	*Rhodospirillum rubrum*	Chromatophores	480,000 ± 30,000			5.4	1	n.g.
ex-Flagellin[343]	*Rhizobium lupini* (1113-3)	Flagella			43,000	4.5, 4.65†, 4.8†	3	10
Flavivirus structural proteins:[344]	Virus		7,000			3.8		
Envelope glycoprotein			53,000			7.8	3	n.g.
Nucleocapsid protein			14,000			10.3		
Flavocytochrome C[345]	*Chromatium vinosum*			1	21,000	5.0, 5.2†, 5.6†	3	n.g.
				1	46,000			
Flavodoxin[329]	*Clostridium pasteurianum*					3.1	1	10
Folate-binding protein[346]	Goat	Milk	37,000		s.p.c.	6.6, 7.3, 8.4	3	n.g.
Formaldehyde dehydrogenase[347]	Human	Liver	81,400	2	40,000	6.35	1	n.g.
F. pili[348]	*E. coli*	Filamentous organs			11,800	3.6	1	4
Fructokinase[349]	Bovine	Liver	56,000	2	28,000	5.7	1	n.g.
Fructose 1,6-bisphosphatase[350]	Mouse	Liver	143,000	4	37,500	6.1	1	n.g.
L-Fucose dehydrogenase (NAD-dependent)[351]	Sheep	Liver	123,000	4	30,000	5.8	1	n.g.
α-Fucosidase[352–354]	Human	Fucosidosis sera				4.35–4.95	6	n.g.
α-Fucosidase[21]	Human	Leucocytes				5.6	1	
		Fibroblasts				5.7†, 7.0, 7.6	3	4
		Amniotic fluid				5.6	1	

α-L-Fucosidase[20,355,356]	Human	Liver	200,000	4	50,000	5.2, 5.4, 5.6^{+}, 5.9^{+}, 6.2^{+}, 6.4	6	n.g.
α-L-Fucosidase[357]	Human	Foetal liver				5.0, 5.2, 5.5, 5.7, 6.0^{+}, 6.4^{+}, 6.7	7	n.g.
α-L-Fucosidase[358]	Human	Serum	296,000		56,500	5.0^{+}, 5.4		
					54,000	5.7, 5.9, 6.2, 6.4, 6.8	7	n.g.
α-L-Fucosidase[359]	Human	Brain			51,000	4.7, 5.2, 5.4, 5.75^{+}, 6.0^{+}, 6.3^{+}, 6.65	7	0–2
α-L-Fucosidase[360]	Human	Skin fibroblasts, amniotic fluid cells				4.9, 5.2, 5.4, 5.8, 6.1, 6.5, 7.1	7	n.g.
Fucosyl transferase[361]	Human	Plasma				4.7^{+}, 5.1, 5.5	3	n.g.
D-Galactonate dehydrase[362]	*Pseudomonas*		240,000	4	57,000	4.5	1	4
Galactose-1-phosphate uridylyl transferase[363]	Human	Erythrocyte				5.7^{+}, 6.2	2	n.g.
Galactose-1-phosphate urydylyl transferase[364,365]	Human	Liver				5.30–5.80		
		Red cell				5.0–5.45	5	n.g.
		Erythroblast				5.55–5.90		
		Reticulocytes				5.30–5.50		
α-Galactosidase[20]	Human	Liver, serum				5.0	1	n.g.
α-Galactosidase A[366]	Human	Liver				4.7	1	n.g.
α-Galactosidase (I, II, IV forms)[367]	Human	Leukocytes				5.0(I), 4.5(II), 3.95(IV)	3	n.g.
α-Galactosidase[368]	*E. coli* K 12		329,000	4	82,000	5.1	1	n.g.
β-Galactosidase[22]	Human	Liver				4.4–4.7	4–5	0
β-Galactosidase[369]	Human	Leukocyte				3.9, 4.5^{+}	2	n.g.
β-Galactosidase[370]	Human	KB cells				4.3^{+}, 4.8	2	20
β-Galactosidase (peaks I and II)[371]	Human	Placenta	420,000		77,000			
			480,000(I)		31,000			
					22,000	3.6, 4.7(I)	2	n.g.
			220,000(II)		77,000	4.64(II)	1	
β-Galactosidase[372]	Rabbit	Brain				6.3	1	3–4
β-Galactosidase[373]	*Aspergillus niger*		124,000(1)					
			150,000(2)			~4.6	1	n.g.
			173,000(3)					
β-Galactosidase[374]	*Aspergillus oryzae* RT 102					4.2	1	0
β-Galactosidase[375]	*Curvularia inaequalis*		120,000			4.4	1	n.g.

(Continued on p. 138)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
γ-Globin (G_γ, A_γ)[376]	Human	Foetal hemoglobin				6.85(A_γ), 6.95(G_γ)	2	r.t.
Globulin (Narbonin)[377]	*Vicia narbonensis* L.	Seeds	33,500		s.p.c.	5.17	1	n.g.
Glucacone-like polypeptides (I, II, III, IV fractions)[378]	Porcine	Colon			12,000 (I)	4.5, 4.9, 5.2, 6.1 6.8(I)	5	
					8000 (II)	6.2(II)	1	
					5000 (III)	4.8, 5.6, 10(III)	3	4
					3000 (IV)	10(IV)	1	
1,3-β-Glucanase[379]	*Bacillus* No. 221				36,000	4.1	1	n.g.
1,4-β-Glucan glucanohydrolase (I, II)[380]	*Trichoderma viride*		12,500(I) 50,000(II)		s.p.c.	4.60(I) 3.39(II)	2	10
1,4-β-Glucan glucanohydrolase[381]	*Trichoderma viride* QM 9414		20,000			7.52	1	20
1,4-α-Glucan phosphorylase[382]	*Klebsiella pneumoniae*		180,000	2	90,000	5.3	1	n.g.
Glucoamylase ($Gluc_1$, $Gluc_2$, $Gluc_3$)[383]	*Rhizopus*		74,000 ($Gluc_1$) 58,600 ($Gluc_2$) 61,400 ($Gluc_3$)			8.7($Gluc_1$, $Gluc_2$) 8.8($Gluc_3$)	2	n.g.
Glucoamylase[384]	*Endomycopsis* sp. 20-9		53,000			3.81	1	n.g.
Glucocorticoid receptor[385,386]	Rat	Liver and hippocampus			89,000	5.8	1	2-4
Glucosaminephosphate isomerase[387]	Rat	Hepatoma(1), liver (2)				4.1, 4.5^+ (1) 5.0^+ (2)	2 1	12

α-Glucosidase[388]	*Saccharomyces carlsbergensis*		63,000		s.p.c.	7.0	1	n.g.
α,β-Glucosidase[20]	Human	Liver, serum				5.0	1	n.g.
β-D-Glucosidase[389]	Almond		135,180	2	65,150	7.3	1	n.g.
β-D-Glucosidase[390]	*Stachybotrys atra*		67,000			4.8	1	n.g.
1,4-β-Glucosidase[391]	*Sporotrichum pulverulentum*				165,000–182,000	4.52–5.15	5	n.g.
β-Glucosidase (I and II)[392]	*Picea Abies*	Seeds	58,570(I)		s.p.c.	10.0(I), 10.3(II)	2	n.g.
β-Glucosidase[393]	*Cicer arietinum* L.		110,000	1	63,000	9.0, 9.3	3	n.g.
				1	43,000	10.0		
β-Glucuronidase[394]	Human	Fibroblast				6.0–6.5	4	n.g.
		Platelet				6.0–6.5	6	
		Liver				6.5–7.5	3	
		Placenta				7.0–7.5	4	
β-Glucuronidase[395]	Mouse	Urine	280,000	4	70,000	5.5–6.0		n.g.
β-Glucuronidase[396]	Rat	Liver lysosomes				5.58, 5.78⁺, 5.95⁺ 6.02	4	n.g.
β-Glucuronidase[397]	Rat (female)	Preputial gland	283,000	4	72,000	6.15	1	n.g.
β-Glucuronidase[398]	Rat	Liver:						
		Golgi				(5.7–6.6), 6.0⁺, 6.3⁺, 6.4⁺	6	
		Lysosomal				(5.8–6.8), 6.0⁺, 6.3⁺, 6.4⁺, 6.7⁺	13	n.g.
		Microsomal				(6.9–7.6), 7.0⁺, 7.4⁺	5	
β-Glucuronidase[399]	*Littorina littorea* L.	Liver	250,000			4.2, 5.5	2	2
L-Glutamate decarboxylase[400]	Human	Brain	~140,000	2	67,000	5.0⁺, 5.1⁺, 5.2, 5.4	4	n.g.
L-Glutamate dehydrogenase[401]	Human	Liver	330,000			4.83	1	n.g.
Glutamate dehydrogenase[402]	Rat	Liver				4.88, 4.96, 5.12	3	4
Glutamate dehydrogenase[403]	*Bacillus subtilis* PCI 219		250,000		57,000	3.7	1	n.g.
Glutamate dehydrogenase[404]	Oat	Leaves	230,000			6.5, 6.8	2	n.g.
L-Glutaminase (I, II, III)[405]	*Pseudomonas* ATCC 21025		146,000	4	36,400	7.8(III), 8.05(II), 8.35⁺(I)	3	n.g.
Glutamine synthetase[406]	*Azotobacter vinelandii*		640,000	12	53,000	4.6	1	n.g.
Glutamine synthetase[407]	*Rhizobium japonicum* 61A76					5.4, 6.1	2	n.g.

(Continued on p. 140)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temper-ature (°C)*
γ-Glutamyl cyclotransferase[408]	Rat	Kidney				4.6, 5.1	2	n.g.
γ-Glutamyl transferase[409]	Beef	Colostrum	80,000	1	25,000	3.85	1	n.g.
				1	55,000			
γ-Glutamyl transpeptidase[410]	Rat	Kidney	68,000	1	46,000	5.40, 5.50, 5.65, 5.85^{+}		
				1	22,000	6.12^{+}, 6.32^{+}, 6.51^{+}, 6.71^{+}, 7.0^{+}, 7.27, 7.68, 9.20	12	n.g.
Glutathione peroxidase[411]	Human	Placenta	85,000	4	22,000	4.8	1	n.g.
Glutathione reductase[412]	Mouse	Liver	105,000			6.46	1	n.g.
Glutathione reductase[413]	Baker's yeast		120,000			4.9^{+}, 5.9	2	4
Glutathione-S-arene oxidase transferase[414]	Sheep	Liver	40,000			6.3, 6.9^{+}, 7.1, 7.3, 7.5^{+}	5	4
Glutathione S-transferase[415]	Rat	Liver	45,000	2	25,000	8.9, 9.8	2	n.g.
Glutathione synthetase[416]	Bovine	Eye lens	180,000			4.75, 4.80	2	n.g.
Glutathionethiol esterase[417]	Human	Red blood cells				7.0–8.4	9	4
Glutathione transferase[418]	Human	Erythrocytes	47,500	2	23,750	4.5	1	n.g.
Glyceraldehyde 3-phosphate dehydrogenase[419]	Fish	Muscle	160,000	4	39,000	7.9, 8.25^{+}, 8.42^{+}	3	4
		Liver				6.3, 6.5, 6.6, 6.8, 7.1	5	
Glycerol 3-phosphate dehydrogenase[420]	Rabbit	Liver				6.3, 6.58^{+}	2	
		Heart				6.1^{+}, 6.58	2	n.g.
sn-Glycerol 3-phosphate dehydrogenase[421]	*E. coli*		51,000	2	25,500	6.0	1	n.g.
α-Glycerol phosphate dehydrogenase[422]	*Drosophila melanogaster*					5.4	1	n.g.
α-Glycerol phosphate dehydrogenase[423]	*Colias* butterflies					5.8, 6.1, 6.2, 6.4	4	r.t.
Glycogen phosphorylase[424]	Rat	Muscle (1)	185,000(1,2)			5.60(3), 5.90(2),	3	n.g.
		Liver (2)	200,000(3)			6.15(1)		
		Novikoff hepatoma (3)						
Glycogen phosphorylase b[425]	Human (A)	Brain (1)				5.6(A,B,1)		
		Liver (2)				6.1–6.3(A,2)		

	Rabbit (B)	Muscle (3)				6.3(A,B,3) 6.1(B,2)		n.g.
Glycogen synthase[426]	Swine	Adipose tissue			90,000	4.8	1	n.g.
Glycoprotein[427]	Human	Blood platelets	450,000	3	150,000	4.7	1	n.g.
α-2-Glycoprotein[428]	Human	Pregnancy sera	490,000		90,000	4.8	1	n.g.
Glycoprotein[429]	Mouse	Submandibular glands			28,000	4.85	1	n.g.
Glycoprotein (secretory, AM_2 protein)[430]	Mouse	Submandibular glands			80,000 40,000	4.7	1	n.g.
Glycoprotein[431]	Chicken	Egg white	27,800			4.8	1	n.g.
Glycoproteins (envelope E_1, E_2)[432]	Sindbis virus					6.0(E_1), 9.0(E_2)	2	4
Glycoprotein[433]	*Cercopithecus aethiops*	Submandibular gland secretion				10.0, 11.0	2	4
Glycosulphatases (I, II)[434]	Marine gastropod (*Charonia lampas*)	Liver	112,000(I) 79,000(II)			6.3(II)	1	n.g.
Glyoxalase (I)[435]	*Saccharomyces cerevisiae*		32,000		s.p.c.	7.0	1	
	Human, pig	Erythrocytes	46,000	2	23,000	4.8	1	4
Gonadotropin[436]	Fish	Pituitary gland	40,000	2	18,000	4.38, 4.57, 4.67^{+}, 4.78^{+}, 4.80^{+}, 5.05	6	n.g.
Gonadotropin[437]	Rat	Hypophysis				2.8(FSH), 4.4(LTH), 4.8(GH), 9.0(LH)		n.g.
Gonadotropin, chorionic (hCG) isohormones[438,439]	Human		65,000			4.4, 4.5, 4.6, 4.8, 5.05, 5.3, 5.65, 5.95, 6.3	9	n.g.
Green-fluorescent protein (GFP)[440]	*Renilla reniformis*		54,000	2	27,000	5.34	1	n.g.
Green haemoprotein[441]	Bovine	Erythrocytes	27,000		s.p.c.	5.74, 5.83^{+}, 5.95^{+}	3	2
Group-specific component (Gc-globulin) (vitamin D-binding protein)[442–444]	Human	Serum				4.95(Gc-1 Fast) 5.03(Gc-1 Slow)	2	
						5.10(Gc-2)	1	4
						4.95, 5.03, 5.10(Gcl-2)	3	
Growth hormone[445]	Monkey	Pituitary				5.03, 5.23, 5.44^{+}, 5.78	4	
	Human	Pituitary				4.58, 4.80^{+}, 5.05, 5.40	4	n.g.
Growth hormone receptor[446]	Rabbit	Liver, membranes	300,000	4	75,000	4.6	1	n.g.

(Continued on p. 142)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Guanine aminohydrolase[447]	Rabbit	Liver	112,000	2	53,000	4.78	1	n.g.
Haemagglutinin[448]	*Maclura pomifera*	Seeds	40,000	2 2	12,000 10,000	4.75	1	n.g.
Haemagglutinin[449]	*Wistaria floribunda*	Seeds			28,000	5.4	1	n.g.
Haemocyanins[450]	Spiders: *Dugesiella californica* (1) *Cupiennius* (2)	Haemolymph	71,000(1) 72,000(2)			5.2(2) 5.5(1)	1	n.g.
Haemoglobin[451]	*Dicrocoelium dendriticum*		22,000		15,000	4.51, 4.53	2	12–14
Haemoglobin[452]	Annelid (*Eunice aphroditois*)		$3.49 \cdot 10^6$			7.7^+	> 3	n.g.
Haemoglobin[453]	Bloodworm (*Glycera gigantea*)	Coelomic cells	55,000	4	13,000	5.60, 5.90^+, 6.12^+, 6.2, 6.32^+, 6.63^+, 6.78^+, 6.92, 7.08, 7.36	>10	10
Haemoglobin[454]	Bloodworm (*Glycera rouxii*)	Coelomic cells	34,500	2	17,000	6.72^+, 7.26, 7.67	3	15
Haemoglobin[455]	Bloodworms (*Glycera dibranchiata*)	Coelomic cells	 125,000	 4	15,600 31,000	5.4, 6.0, 6.4, 6.5, 7.05^+, 7.4, 8.1 (4.9–5.9) 4.9^+, 5.2^+, 5.5^+, 5.9^+	7 > 4	25
Haemoglobin (I, II, III, IV)[456]	Killifish (*Fundulus heteroclitus*)	Red cells	64,000	4	16,000	8.20 (I) 7.52 (II) 6.48 (III) 5.82 (IV)	1 1 1 1	n.g.
Haemoglobin III (liganded states):	*Chironomus thummi thummi*							
O_2-haemoglobin (II)						5.87	1	25
CO-haemoglobin (II)						5.92	1	
Deoxyhaemoglobin (II)[457]						5.93	1	
Haemoglobin	Hamster	Peripheral blood				6.80, 7.18^+, 7.30, 7.41, 7.50	5	r.t.

Haemoglobin[459]	Hamster	Peripheral blood				6.67, 7.18$^+$, 7.38, 7.58, 7.81	5	n.g.
Haemoglobin[460]	Dog	Red blood cells				6.91$^+$	> 2	6
Haemoglobin Alberta[461] ($\alpha_2\beta_2{}^{101\ Glu \to Gly}$)	Human	Red blood cells				7.05	1	n.g.
Haemoglobin J. Cairo[462]	Human	Red blood cells				6.75	1	n.g.
Haemorrhagic component (HR1)[463]	*Trimeresurus flavoviridis*	Venom			60,000	4.4	1	n.g.
Haptoglobins[464]	Human	Ascitic fluids				4.03–4.24		
	Porcine	Plasma				4.0–4.30		n.g.
	Equine	Serum				3.80–4.15		
Haptoglobin (type 1-1)[465]	Human	Serum	98,200	2	9,100	4.25	1	n.g.
				2	40,000			
Haptoglobin–apohemoglobin complex (Hp-apoHb)[466]	Human	Serum				5.10	1	n.g.
Herbage protein[467]:	*Medicago sativa*							
Fraction I						5.5$^+$	2	
Fraction II						4.4$^+$, 4.8$^+$, 5.0$^+$, 5.1$^+$	15	n.g.
Hexokinase (P-I, P-II)[468]	Yeast		104,000	2	52,000	5.0(P-II), 5.3(P-I)	2	n.g.
Hexokinase[469]	*Ascaris suum*	Muscle			100,000	5.9	1	4
Hexokinase:								
Young cells (1)[470]	Human	Erythrocyte	120,000(1)			5.75 (1)		
Total cells (2)			115,000(2)			5.75 (2)	1	n.g.
Old cells (3)			111,500(3)			5.60 (3)		
Hibernation-inducing triggers[471]	Woodchucks	Plasma				4.5, 5.2	2	4
High-density lipoproteins: HDL_2[472]	Human	Plasma				4.03, 4.32, 4.54$^+$, 4.89, 5.02, 5.22$^+$, 5.41, 5.52$^+$, 5.67, 6.67	10	n.g.
Histidine decarboxylase[473]	Rat	Gastric mucosa	94,000		s.p.c.	5.4, 5.75, 6.0	3	n.g.
Histidyl-t-RNA synthetase[474]	Rabbit	Reticulocytes	122,000	2	64,000	5.0	1	n.g.
Histoplasmin: HPD αII[475]	*Histoplasma capsulatum*		12,000		s.p.c.	5.68	1	n.g.
Homoserine dehydrogenase[476]	*Rhodospirillum rubrum*		110,000	2	55,000	5.0, 5.3, 5.7, 6.1$^+$	4	n.g.
Hormone (growth)[477]	Human	Pituitary				4.95, 5.1$^+$, 5.2$^+$	3	4

(Continued on p. 144)

TABLE 1 (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Hormone (growth; variant)[478]	Human	Pituitary extracts	22,000			5.85	1	r.t.
Hormone (luteinizing)[479]	Human	Urine				6.71^{+}, 7.26^{+}, 7.72^{+}, 8.14^{+}	> 4	n.g.
Hormone (luteinizing) (IR-LH)[480]	Rat	Anterior pituitary				7.9, 8.5^{+}, 8.8^{+}, 9.1^{+}, 9.35^{+}, 9.6, 9.8	7	n.g.
Horseradish peroxidase C[481]	Horseradish	Root	34,000		s.p.c.	9	1	n.g.
Hyaluronate lyase[286]	Streptococci:							
	Group A					4.4	1	4
	Group C					4.3		
Hyaluronidase[482]	Human	Placenta	70,000			5.2	1	4
Hydrogenase[483]	*Desulfovibrio vulgaris*		89,000	1 1	59,000 28,000	6.2^{+}, 5.8	2	n.g.
Hydrogenase[484]	*Chromatium*		100,000	2	50,000	4.2, 4.4	2	n.g.
Hydrogenase[485]	*E. coli*	Membrane-bound	113,000	2	56,000	4.2	1	n.g.
Hydrogenase[487]	*Alcaligenes eutrophus* H 16	Soluble form	205,000			4.85	1	6
Hydrolases: cathepsin B1 (1) and BANA (2)[488]	Rabbit	Lung, lysosomes	26,000 29,000			5.0–5.5 (1) 5.8–6.5 (2)	4 6	n.g.
3-Hydroxy-3-methylglutaryl-CoA reductase[489]	Chicken	Liver, microsomes				6.7	1	n.g.
β-Hydroxy-β-methylglutaryl-CoA reductase[490]	Rat	Liver, microsomes	200,000	4	51,000	6.2	1	n.g.
4-Hydroxyphenylpyruvate dioxygenase[491,492]	Human	Liver	87,000	2	43,000	7.1 (ref. 491) 6.5–7.5 (ref. 492)	1 3	n.g. r.t.
4-Hydroxyphenylpyruvate dioxygenase[493]	*Pseudomonas* sp. P.J. 874		150,000	4	36,000	4.8	1	n.g.
17α-Hydroxysteroid dehydrogenase[494]	Rabbit	Liver				4.7^{+}, 4.85^{+}, 5.0^{+}, 6.1^{+}	> 4	n.g.
3(17)β-Hydroxysteroid dehydrogenase[495]	*Pseudomonas testosteroni*		98,500	4	23,500	7.0^{+}, 7.5^{+} (of subunits)	6	n.g.

Hypoxanthine-guanine phosphoribosyl transferase (HGPRT)[496]	Human	Skin fibroblasts				6.25	1	n.g.
	Mouse	L cells				6.6		
Hypoxanthine guanine phosphoribosyl transferase (HGPRT)[497]	Chinese hamster	Liver, V 79 tissue, culture cells	78,000	3	25,000	6.2^{+}, 6.3^{+}, 6.6^{+}	6	n.g.
Hypoxanthine-guanine phosphoribosyl transferase (HGPRT)[498]	*Saccharomyces cerevisiae*		51,000		s.p.c.	5.1	1	n.g.
Hypoxanthine phosphoribosyl transferase[499]	Human	HeLa cells			26,000	6.0	1	n.g.
Hypoxanthine phosphoribosyl transferase[500]	Human	Erythrocytes	81,000	3	26,000	5.6, 5.7^{+}, 5.9^{+}	3	n.g.
Immunoglobulin G: Fc, Fab fragments[501]	Human	Serum	50,000 (Fab) 340,000 (Fc)			7.0(Fc), 8.2^{+} 9.0^{+}, 9.5^{+} (Fab)	> 4	5
Immunoglobulin G (monoclonal)[486]	Human	Myeloma serum				7.5, 7.6, 7.7, 7.8, 7.86	5	n.g.
Immunoglobulin M (antilactose antibody)[502,503]:	Equine	Serum						
H chains						5.4–6.2	10	r.t.
J chains						4.8, 4.9, 5.0	3	r.t.
Immunoreactive glucagon fractions (IRGs)[504]	Dog	Pancreas (1) gastric fundus (2)	3500(1a) 9000(1b) 3500(2a) 9000(2b) 65,000(2c)			6.25(1a) 4.65(1b) 6.15(2a) 4.50(2b) 6.40(2c)		n.g.
Immunoreactive insuline[505]	Dog	Pancreatic juice				4.8^{+}, 5.7^{+}	> 2	25
Immunoreactive somatostatin[505]	Dog	Pancreatic juice				9.7^{+}, 10.2^{+}	> 2	25
Inhibitory factor[506]	Human	Granulocytes	102,000–128,000			6.3	1	n.g.
myo-Inositol 3-methyltransferase[507]	*Pisum sativum*		42,000		s.p.c.	6.95	1	n.g.
myo-Inositol 1-methyltransferase[507]	*Vinca minor*		27,000		s.p.c.	7.10	1	n.g.
Interferon[508]	Rainbow trout	Serum	26,000			(4.5–6.2) 5.3^{+}		n.g.

(Continued on p. 146)

TABLE I *(continued)*

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of Iso-enzymes*	*Temperature (°C)*
Interferon[509]	Mouse	Ehrlich ascites tumour cells	25,000–35,000			9.8^+		n.g.
Interferon[510,511]	Human	Leukocyte	17,500–23,000		s.p.c.	5.5^+, 6.2^+, 6.6^+ 7.0	4	
		Fibroblasts				(6.8–7.8)	Several	4
Interferon[512]	Human	Lymphoblastoid cells	18,000–22,000			5.7^+, 6.0^+, 6.3^+	8	n.g.
Invertase:								
FH4C external (1)	Yeast, FH4C strain (1,2)					2.7, 3.32, 3.65 (1)	3	
FH4C internal (2)						4.5 (2)	1	n.g.
External (3)[513]	*S. cerevisiae* (3)					3.9–4.5 (3)	4	
Iron-binding protein[514]	Guinea pig	Intestinal mucosa	80,000	2	40,000	6.16, 6.23	2	n.g.
Iron–sulphur protein (high potential type) (HiPIP)[515]	Beef	Heart mitochondria	89,000			8.55	1	n.g.
(Iso)ferritins[516]	Human							
		Normal liver				5.35, 5.54, 5.56	3	
		Normal kidney				5.12, 5.22^+, 5.25^+	3	
		Normal pancreas				5.19, 5.25^+, 5.30^+ 5.34^+, 5.55	5	
		Normal serum				5.04, 5.16, 5.28, 5.35, 5.45, 5.56^+, 5.62^+	7	n.g.
		Normal colon				5.20, 5.35^+, 5.45, 5.55	4	
		Renal carcinoma				5.25, 5.35, 5.54^+	3	
		Pancreatic carcinoma				5.19, 5.25, 5.30, 5.35^+, 5.54^+	5	n.g.
		Colonic carcinoma				5.25, 5.36^+, 5.45, 5.54^+	4	
(Iso)ferritins[517]	Human	Normal liver, Normal spleen (1)				5.25, 5.33, 5.47 5.65 (1,3)	4	
		Foetal liver,				4.9, 5.1, 5.25, 5.33,		

		hepatoma (2)				5.47, 5.65 (2)	6	
		Leukaemia serum, Liver, spleen (3)						
(Iso)ferritins[518]	Horse	Spleen	450,000			4.10, 4.25, 4.35, 4.40, 4.45, 4.60	6	20
Isoleucine aminopeptidase[519]	*Ulex minor*	Root				4.28, 4.51, 4.78	3	4
Isomerase (acylthioester)[520]	Hog	Liver	90,000	2	45,000	6.57, 6.83, 7.01, 7.21	4	4
Isorenin (acid proteinase)[521]	Rat	Brain			45,000	5.45, 5.87, 6.16, 7.05	4	2
Kallikrein[522]	Rat	Urine	33,100			4.18^+	1	n.g.
Kallikrein[523]	Rat	Pancreas	27,000			4.05, 4.15	2	
	Dog	Pancreas	30,000			4.1, 4.2, 4.4^+	3	10
Kallikrein[524]	Cat	Submaxillary gland	50,000		s.p.c.	4.2–5.1	6–7	n.g.
Kallikrein (d_1,d_2 forms)[525]	Porcine	Pancreas	34,500(d_1) 31,000(d_2)			3.75, 3.82, 3.92^+ 3.97^+, 4.11^+(d_1)	5	25
						3.93, 4.01^+, 4.11^+(d_2)	3	
Kallikrein[526]	Human	Urine	43,600			3.80^+, 3.95^+, 4.06	3	n.g.
Kallikrein[527,528]	Human	Urine	27,000 (HUK-1; HUK-2)			3.9(HUK-1) 4.0(HUK-2)	3	n.g.
			29,000 (HUK-3)			4.2(HUK-3)		
Kallikrein[529]	Human	Urine	64,000	1	29,000	3.8, 3.9, 4.05	3	n.g.
				1	45,000			
Kallikrein inhibitor[530]	Rat	Plasma	73,000			4.4	1	4
Kanamycin acetyltransferase II[531]	*Moraxella*					7.6	1	n.g.
Δ^5-3-Ketosteroid isomerase[532]	*Pseudomonas testosteroni*					4.75^+	3	n.g.
Kininogen[533]	Human	Plasma	50,000			4.4, 4.9^+	> 2	n.g.
Kininogen[534]	Human	Plasma	120,000			4.7	1	r.t.
Kynurenine pyruvate aminotransferase[535]	Rat	Kidney	76,000			5.2	1	4
β-Lactamase[536]	*E. coli* RTEM					5.4	1	n.g.
β-Lactamase[537–539]	*E. coli* P111 (TEM1)					5.4		
	E. coli RP 4 (TEM2)					5.6		
	Ps. aeruginosa RL 113					5.7		

(Continued on p. 148)

TABLE I *(continued)*

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of isoenzymes*	*Temperature (°C)*
	E. coli P 453 (type 2)					7.7	1	n.g.
	P. morganii NCTC 235					8.3		
	Ps. aeruginosa NCTC 8203					8.7		
	Ps. aeruginosa NCTC 10701					9.4		
	Ps. aeruginosa HL					5.3		
Lactase[540]	Rat	Enterocytes (brush border)				4.8	1	n.g.
Lactate dehydrogenase (LDH-1)[541]	Human	Heart muscle				4.6	1	n.g.
Lactate dehydrogenase[542]	Cestoda *(Hymenolepis diminuta)*					7.0	1	n.g.
Lactate dehydrogenase[543]	*Lactobacillus*		140,000	4	36,000			
	L. plantarum					4.4	1	n.g.
	L. curvatus					4.9		
	L. acidophilus					5.1		
	L. casei					5.3		
Lactate dehydrogenase[544]	*Ambystoma mexicanum*					5.24 (LDH-1)	1	n.g.
						5.58, 5.62 (LDH-2)	2	
						5.74, 5.80 (LDH-3)	2	
						6.07, 6.14 (LDH-4)	2	
						6.52, 6.60 (LDH-5)	2	
L-Lactate dehydrogenase, membrane bound[545]	*E. coli*	Membranes	480,000	12	43,000	8.3	1	n.g.
Lactogen[546]	Ovine	Placenta			22,500	6.8 (monomer) 7.7 (aggregate)	1	10
Lactogen[547]	Human	Placenta				5.0, 5.5, 5.8 6.0, 6.1, 6.2	6	n.g.

Lactoperoxidases[548]	Monkey:	Parotid saliva	79,000			6.1, 7.3, 8.4(1)	3	
	M. mulatta (1),					7.9(2)	1	n.g.
	M. fascicularis (2)							
Lectin[549,550]	*Ricinus communis*	Seeds	130,000	2	33,500	7.1 (ricin)		
	Abrus precatorius			2	32,000	7.5 (ricin A chain)		
						4.8 (ricin B chain)		
						6.1 (abrin)	1	n.g.
						4.6 (abrin A chain)		
						7.2 (abrin B chain)		
						5.0 (abrus)		
Lectin[551]	*Eunonymus europeus*	Seeds	166,000		35,000	$4.4^{\dagger}$, $4.7^{\dagger}$,	6	n.g.
					17,000	4.9^{+}		
Lectin[552]	*Pisum sativum*	Seeds	49,000	2	7,000 (α)	$4.1^{\dagger}$, 5.1, 5.8	4	n.g.
				2	17,000 (β)	$6.5^{\dagger}$		
Lectin[553]	*Vicia cracca*	Seeds	125,000	4	32,000	5.2–5.6		n.g.
Lectin[554]	*Anguilla anguilla*	Serum	50,000	2	23,000	5.6–6.0		
	Clitocybe nebularis	Fruiting bodies	70,000		19,000	4.3, 4.5	2	
					14,500			
	Fomes fomentarius	Fruiting bodies	60,000	1	35,000	5.8, 6.3, 6.5	3	
				1	21,000			
				1	10,000			n.g.
	Maclura pomifera	Seeds	60,000	5	12,000	5.3–5.8		
	Marasmius oreades	Fruiting bodies	50,000	1	33,000	5.2–5.4		
				1	23,000			
	Ononis spinosa	Root	110,000	4	30,000	4.0–4.4		
	Sarothamnus scoparius	Seeds	120,000	4	28,000	6.3	1	
Lectin[555]	Embryonic chick	Pectoral muscle	30,000	2	15,000	4.0	1	n.g.
Lectin[556]	Barley	Seeds	31,000			4.95	1	n.g.
Lectin[557]	*Phaseolus vulgaris*	Seeds	119,000			4.6–5.2	5	r.t.
Lectin, α-D-galactosyl-binding[558]	*Bandeiraea simplicifolia*	Seeds	114,000	4	28,500	4.9–5.1	4	n.g.
Leghaemoglobin: Lba, Lbc[559]	Soybean	Root nodules				4.88 (Lba, high spin)		
						4.99 (Lba, low spin)	4	2
						4.50 (Lbc, high spin)		
						4.64 (Lbc, low spin)		

(Continued on p. 150)

TABLE I *(continued)*

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Leghaemoglobin [iron(III) form][560]	Soybean	Nodules				4.90 (a) 4.73 (b) 4.62 (C_1) 4.59 (C_2) 4.56 (C_3) 4.50 (d_1) 4.47 (d_2) 4.44 (d_3)	8	2
Leghaemoglobin[561]	*Phaseolus vulgaris*	Root nodules	16,900 (Lba)			4.70 (Lba) 4.55 (Lbb)	2	2
Leucine aminopeptidase[540]	Rat	Enterocytes (brush border)				4.78	1	n.g.
Leucyl-tRNA synthetase[562]	*Tetrahymena pyriformis*	Mitochondria Cytoplasm	100,000		s.p.c.	6.5 8.8	1 1	n.g.
Ligandin[563–565]	Rat	Liver cytosol	46,000	1 1	22,000 25,000	7.3, 8.0, 8.4, 9.5[†], 9.7[†] 10.3[*]	6	n.g.
Light-harvesting pigment protein complex[566]	*Rhodopseudomonas sphaeroides* strain 2.4.1					7.2 ± 0.25 7.8 ± 0.2	2	n.g.
Lectin, sialic acid-binding (limulin)[567]	Crab (*Limulus polyphemus*)	Haemolymph	335,000		19,000	5.0–5.1	3	n.g.
Lipase[568]	Human	Serum (pancreatic disease)	46,000			6.4, 6.8, 7.4	3	n.g.
Lipase (A, B)[569]	Pig	Adipose tissue	60,000			5.2 (A) 5.5 (B)	1	n.g.
Lipase, hormone-sensitive[570]	Rat	Adipose tissue				6.7	1	4
Lipid-exchange protein[571]	Rat	Hepatoma	11,200		s.p.c.	5.2	1	n.g.
Lipoprotein lipase[572]	Pig	Adipose tissue	61,000			4.0	1	n.g.
Lipoprotein lipase[573]	Human	Post-heparin plasma	67,000			4.5	1	n.g.

Lipoproteins: LDL, VLDL (fractions I and II)[574]	Human	Serum				LDL-I: 4.1		
						4.5	3	
						4.6		
						LDL-II: 4.9		
						5.2		
						5.3		
						5.35	6	
						5.45		
						6.1		r.t.
						VLDL-I: 4.2		
						4.4	3	
						4.5		
						VLDL-II: 4.9		
						5.0		
						5.1	6	
						5.4		
						5.45		
						6.1		
Lipoproteins, VLDL[575]	Human	Double pre-β-lipoproteinaemia, primary dys-β-lipoproteinaemia				5.57–6.03	3–4	n.g.
Lipoprotein (apo-CIII, CII)[576]	Human	Blood plasma				4.69 (C III) 4.86 (C II)	2	n.g.
Lipoprotein–proteoglycan complex[577]	Human	Serum				5.4–6.4	7	n.g.
Lipoxygenase[578]	Rabbit	Reticulocytes	78,000			5.5	1	n.g.
Luciferin-binding protein[579]	*Renilla reniformis*		18,500		s.p.c.	4.3	1	n.g.
Luteinizing hormone[580]	Human	Pituitary gland, plasma				6.75, 7.33, 7.80, 8.23, 8.81, 9.17, 9.55	7	4
Lutropin[581]	Bovine	Anterior pituitary gland				8.3[i]	> 1	n.g.
Lymphocyte activating factor[582]	Mouse	Tumour cells	100,000			4.9	1	n.g.
	Human	Leukocytes	13,000			6.85	1	
Lysine decarboxylase, inducible[583]	*E. coli*		780,000	10	78,000	4.5	1	n.g.
Lysophospholipases: I, II[584]	Beef	Liver	25,000(I) 60,000(II)			5.2(I) 4.5(II)	1	n.g.

(Continued on p. 152)

TABLE 1 *(continued)*

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temper-ature (°C)*
Lysozyme[585]	*Ceratitis capitata*	Eggs	23,200		s.p.c.	> 11	1	n.g.
α_2-Macroglobulin[586]	Human	Plasma				5.3	1	5
α_2-Macroglobulin[587]	Human	Serum				4.1–4.9	7	10
Macromomycin[588–590]	*Streptomyces macromomy-ceticus*		12,500 or 16,000		s.p.c.	5.4	1	n.g.
Malate dehydrogenase[591]	*Saccharomyces cerevisiae*	Mitochondrial	68,000	2	34,000	6.8	1	
		Cytoplasmic	75,000	2	37,500	6.75–7.1	> 1	4
Malate dehydrogenase[422]	*Drosophila*	Cytoplasmic				5.7	1	n.g.
Malate dehydrogenase	Cestoda *(Hymenolepis diminuta)*					7.45	1	n.g.
Malate dehydrogenase[592]	Rat	Liver				6.3	1	r.t.
Malate dehydrogenase (MOR-2-AB)[593]	Bovine	Mitochondrial	70,000	2	35,000	8.0–8.5	2	n.g.
Malic enzyme[594]	Cherry	Fruits	180,000			4.6	1	10
Malonyl-CoA decarboxylase[595]	*Mycobacterium tuberculosis*		44,000			6.7	1	n.g.
Mammary stimulating factor (MSF)[596]	Mouse	Serum	10,200			5.7	> 1	n.g.
α-Mannosidase[21]	Human	Leukocytes				5.4^{+}, 6.7	2	
		Fibroblasts				6.3	1	4
		Amniotic fluid				4.1, 5.25^{+}, 6.25^{+}	3	
α-Mannosidase[20]	Human	Liver				4.5	1	n.g.
α-Mannosidase[597]	Calf	Plasma from mannosidosis				5.0, 5.9^{+}, 7.0^{+}, 7.9	4	n.g.
α-D-Mannosidase[598]	Rat	Liver, Golgi membranes	300,000		75,000		1	n.g.
					145,000	5.8		
α-Mannosidase I, II[599]	*Phaseolus vulgaris*		220,000	2	110,000	5.1(I)	1	n.g.
						6.1(II)		
β-D-Mannosidase[600]	*Aspergillus niger*		130,000			4.7	1	n.g.

Melanocyte-stimulating hormone (MSH) release-inhibiting factor[601]	Bovine	Kidney	300,000	5	56,000	4.1	1	n.g.
Mercaptoethanol-releasing factor[602]	Human	Serum				4.65, 4.85†	2	25
Metalloproteins: Zn/Cd and Zn/Hg[603]	Rainbow trout	Liver, kidney, gills, gut				4.8$^+$, 5.3$^+$, 5.6† 6.3	4	n.g.
Metalloprotein[604]	Tea	Leaves				9.6†, 8.7, 8.4	3	4
Metallothionein[605]	Mouse	Liver				4.0†, 6.0$^+$	2	n.g.
Methionyl-tRNA$_f^{MET}$ deacylase[606]	Human	HeLa cells	80,000	2	40,000	9.0	1	n.g.
Methylase EcoRI[607]	*E. coli*		39,000		s.p.c.	8.7$^+$	> 1	n.g.
Methyltransferase, cytochrome c-specific protein–lysine[608]	*Neurospora crassa*		120,000			4.8	1	n.g.
Metridiolysin[609]	Sea anemone (*Metridium senile*)		80,000			5.0	1	n.g.
α_1-Microglobulin[610]	Guinea pig, human	Urine, sera	25,500		s.p.c.	4.3–4.8		n.g.
β_2-Microglobulin[611]	Guinea pig	Urine	11,500			6.6	1	n.g.
β_2-Microglobulin[612]	Human	Urine from normal and renal trans-plantation subjects	12,000			5.3, 5.7†	2	n.g.
β_2-Microglobulin[613]	Human	Urine				5.75†, 6.0	2	n.g.
β_2-Microglobulin-like protein[614]	Chicken	Sera			11,400	5.0$^+$, 6.0	2	n.g.
α_1-Microglycoprotein[615]	Human	Urine from leukaemia			27,000	4.45$^+$, 4.7$^+$, 4.85†, 6.0	4	n.g.
Migration inhibition factor[616]	Mice	Lymph node lymphocytes	50,000–100,000			6.45	1	n.g.
Migration inhibitory factor:	Guinea pig	Lymph node cells						
3 MIF			65,000			3.0–4.5	4–5	
5 MIF			25,000–43,000			5.0–5.5	2	
Mitogenetic factor (MF)[618]	Human	Lymphocytes	25,000			4.8†, 5.8$^+$, 8.0$^+$, 8.3	4	n.g.
Myelin basic protein[619]	Dog	Spinal cord	18,000			9.5	1	n.g.
Myoglobin[620]	Yellowfin tuna (*Thunnus albacares*)		16,200			8.6	1	n.g.
Myoglobin[621]	Chicken	Muscle				7.70$^+$	3	n.g.
Myoglobin[622]	Penguin	Breast muscle				8.5$^+$(I), 8.0(II) 7.7(III)	3	15

(*Continued on p. 154*)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Myokinase (MK)[233]	Human	Skeletal muscle, heart				8.9 (MK-2) 9.8 (MK-1)	2	4–8
Myosin, subfragment-1[623]	Pig	Cardiac muscle	119,000			6.45, 6.70	2	4
Myotoxin[624]	Prairie rattlesnake		4,100			9.6	1	n.g.
Myrosinase[625]	*Sinapis alba*		120,000			4.9^{+}, 6.2	2	6
NADase (NAD glycohydrolase)[286]	Streptococci:							
	Group A					8.4, 8.9	2	
	Group C					8.6, 9.3	2	4
NADH-cytochrome *c* Reductase[626]	*Pseudomonas arvilla* C-1		38,000		s.p.c.	4.2	1	n.g.
NADPH-adrenodoxin reductase[627]	Bovine	Adrenocortical mitochondria	51,000			5.4	1	n.g.
NADPH-flavin reductase[628]	Human	Erythrocytes	22,000		s.p.c.	8.1	1	n.g.
Neocarzinostatin[629–631]	*Streptomyces carzinostaticus*		10,700		s.p.c.	3.3	1	n.g.
Neocarzinostatin[632]	*Streptomyces carzinostaticus*					3.13, 3.28	2	
Nerve growth factor[633]	*Bungarus multicinctus*	Venom	21,000	2	10,500	*ca.* 10	1	n.g.
Nerve growth factor[634]	Cobra (*Naja naja atra*)	Venom	22,000	2	11,000	7.02	1	n.g.
Nerve growth factor[635]	Human	Placental tissue	150,000			9.5	1	n.g.
Neuraminidase[636,637]	*Arthrobacter*		88,000		s.p.c.	5.35^{+}, 5.25–5.70	7	n.g.
	Clostridium perfringens					5.1^{+}	3	
Neurocuprein[638]	Bovine	White and grey matter	9,500			3.5	1	n.g.
Neurophysin precursor[639]	Rat	Brain	~ 18,500			5.1^{+}, 5.4^{+}, 5.6^{+}, 6.1^{+}, 6.9	5	n.g.
Neurotoxin:[640]	*Bungarus multicinctus*	Venom						
α-Type synaptic neurotoxins			8000			9.0–9.2	1	
β-Type synaptic neurotoxins			21000			8.8–9.7	> 1	n.g.

Neurotoxin (major toxin)[641]	*Pelamis platurus*	Venom	6600			9.69	1	n.g.
(anti-)Neurotoxin factor[642]	*Vipera palaestinae*	Serum	56,000			4.0	1	4
Nicotinic acetylcholine receptor[643]	Gold fish	Brain	340,000			5.0	1	n.g.
Nitrate reductase[644]	*Clostridium perfringens*		90,000		s.p.c.	5.5	1	n.g.
Nitrate reductase (ferredoxin)[645]	*Clostridium perfringens*		6000			3.0	1	n.g.
Nitrogenase:[646]	*Azotobacter vinelandii*							
Mo–Fe protein			216,000	4	56,000	5.2		
Fe protein			66,000	2	33,000	4.7	1	n.g.
Nitrogenase (Mo–Fe protein)[647]	*Anabaena cylindrica*		220,000			4.8	1	n.g.
Norephinephrine N-methyl transferase[648]	Rabbit:	Adrenal gland	35,000–40,000		s.p.c.			
	Adult					4.7^{+}, 5.0^{+}, 5.25^{+}, 5.65	4	n.g.
	Young					5.05, 5.45	2	
Nuclease S_1[649]	*Aspergillus oryzae*	Mycelia	25,000–41,000			4.35	1	n.g.
Nuclease inhibitor[650]	*Aspergillus oryzae*		22,000			4.09	1	4
Nucleosidases:[651]	*Leishmania donovani*							
Pyrimidine ribonucleosidase			180,000			6.3	1	
Purine ribonucleosidase			205,000			4.4	1	n.g.
Purine 2′-deoxyribonucleosidase			33,000			4.3	1	
Nucleoside diphosphatase[652]	Rat	Liver cytosol	120,000	4	30,000	4.7, 5.0	2	n.g.
Nucleoside phosphorylase[653]	Human	Placental	93,000	3	31,000	5.64, 5.74, 5.86	3	n.g.
		erythrocyte				5.24, 5.34, 5.44, 5.64, 5.74, 5.86	6	n.g.
Nucleoside phosphotransferase[654]:	Chick	Embryo cells						
C[a]		Cytosol, mitochondria, nucleus				5.0		
D		Cytosol				4.1	1	n.g.

(Continued on p. 156)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
5′-Nucleotidase[655]	Rat	Brain, microsomes				6.4	1	n.g.
5′-Nucleotidase[656]	Human	Placental, microsomes				5.4, 5.62, 5.91, 6.26, 6.48	5	4
Octopine dehydrogenase[657] isoenzyme 2	Squid (*Loligo vulgaris* Lam)					8.3, 8.7	2	n.g.
[^{3}H]Oestradiol receptor complex[658]	Guinea pig	Foetal, uterus, cytosol fraction				6.15	1	n.g.
[^{3}H]Oestradiol-17β receptor[659]	Rat	Uterus, cytosols: Mature				6.3, 7.7, 8.0	3	4
		Immature				5.5, 5.8$^+$, 6.0$^+$, 6.4, 7.5$^+$	5	
Ornithine transcarbamylase[660]	Rat	Liver	112,000	3	39,000	7.2	1	n.g.
Ornithine transcarbamylase[661]	Human	Liver	114,000	3	38,000	6.8	1	n.g.
Ornithine transcarbamylase[662]	Human	Normal liver	110,000	3	36,500	7.95	1	4
		Reye's syndrome liver				8.05	1	
Ovomucoid[663]	Chicken					3.52, 3.82$^+$, 4.0, 4.15$^+$, 4.35$^+$, 4.50	6	n.g.
Oxaloacetate decarboxylase[664]	Fish	Muscle			63,000	6.59	1	n.g.
Pallidin (carbohydrate-binding protein)[665]	*Polysphondylium pallidum*		250,000		24,800	7.0	1	n.g.
Palmityl-CoA-ACP-transacylase[666]	*Mycobacterium smegmatis*					4.7	1	n.g.
Pantothenase[667]	*Pseudomonas fluorescens*		100,000	2	50,000	4.7	1	10
Parathyroid hormone (BPTH)[668]	Bovine					8.73	1	n.g.
Parvalbumin[669]		Skeletal muscle						
	Turtle		12,000			4.4		
	Chicken		12,000			4.9	1	n.g.
	Rabbit		12,000			4.9		
Parvalbumin (IVa, IVb)[670]	Frog (*Rana temporaria*)	Skeletal muscle				4.97(IVa) 4.75(IVb)	2	n.g.

Parvalbumins[671]	Fish:	White muscle						
	Haddock III		11,348			4.20		
	Whiting III_b		11,340			4.44		
	Cod III		11,211			4.1		
	Haddock II		11,904			4.35	1	n.g.
	Cod II		11,513			4.4		
Pectinase[672]	Fungi (*Aspergillus niger*)		33,000			4.5–7	15	n.g.
Pectolytic enzyme-stimulating factor[673]	*Aspergillus japonicus*					3.2, 3.7, 4.1^+	3	n.g.
P-enolpyruvate carboxykinase ferroactivator[674]	Rat	Liver (cytosol)	82,000		23,600	7.5^+, 7.7^+, 7.9^+, 8.4	4	5
Pepsin[675]	Bovine					2.80^+, 2.90^+, 2.99^+, 3.09	4	20
	Pig					3.02^+, 3.2	2	
	Chicken					4.03^+	> 1	
Peptidase[676]	Human	Liver	130,000			5.6	1	n.g.
Peroxidase[677]:	Melon:							
S_1	Infected					3.9^+, 4.9, 8.1, 10.9^+	4	
	Not infected					10.0	1	n.g.
S_3	Infected					3.6, 9.2^+, 9.9^+, 11.0^+	4	
	Not infected					9.2	1	
Peroxidase[678]	*Phellinus igniarus*		39,000			2.85^+	2	n.g.
Peroxidase[679]	Soybean					3.2^+, 4.2^+, 4.5^+, 5.0^+, 7.1^+	12	n.g.
Peroxidase[680]	Horseradish					6.5, 7.1	2	n.g.
Phenol sulphotransferase I[681]	Rat	Liver	65,000	2	32,500	8.05	1	n.g.
Phenylalanine hydroxylase[682]	*Chromobacterium violaceum*		32,000		s.p.c.	4.5	1	n.g.
Phenylalanine hydroxylase[683]	Rat	Hepatoma				5.2	1	
		Liver				5.2^+, 5.3^+, 5.6	3	r.t.
		Kidney				5.35	1	
Phenylalanine ammonia-lyase[684]	Mustard	Cotyledons				5.5^+	> 1	n.g.
Phenylalanine(histidine): pyruvate aminotransferase[685]	Mouse	Liver, mitochondria	80,000	2	40,000	5.6, 6.0^+, 6.2^+, 6.5^+, 6.7	5	n.g.
Phenylalanine racemase[686]	*Bacillus brevis*					4.6	1	4

(Continued on p. 158)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Phosphatidase C[687]	*Erwinia carotovora*					7.5	1	n.g.
Phosphatidylcholine exchange protein[688]	Bovine	Brain, liver, heart				5.3, 5.6†	2	n.g.
Phosphatidylinositol exchange protein[688]	Bovine	Brain, liver, heart				5.2†, 5.5	2	n.g.
Phosphodiesterase[689]	Tobacco	Cell culture			72,000	8.8	1	n.g.
Phosphodiesterase[56]	Mouse	Parotid				5.0†, 5.25†, 5.4, 5.65†	7	n.g.
Phosphodiesterase II[690]	Rat	Intestine	160,000			3.4, 4.2· 4.5, 7.2		n.g.
Phosphodiesterase-phosphomonoesterase[691,692]	*Fusarium moniliforme*		106,000			5.9, 6.2†, 6.3†, 6.6†	4	n.g.
Phosphofructokinase[693]	*Lactobacillus acidophilus*, *L. plantarum*		154,000	4	38,500	4.9 5.1		n.g.
Phosphoglucomutase[34]	Human	Erythrocytes				5.05, 5.19, 5.45, 5.56, 5.69, 5.73, 5.96	7	15
Phosphoglucose isomerase[694]	Schistosoma					6.5†, 6.8†, 7.0†, 7.4†	>15	n.g.
Phosphoglucose isomerase[695]	Human	Erythrocytes	131,000	2	65,500			
Wild type						9.25	1	
Singh variant						9.25, 9.40†, 9.57	3	n.g.
Phosphoglucose isomerase[422]	*Drosophila*					6.3	1	n.g.
D-3-Phosphoglycerate dehydrogenase[696,697]	Chicken	Liver	165,000	4	41,000	8.95	1	n.g.
3-Phosphoglycerate kinase[698]	Yeast		47,000			7.01	1	n.g.
Phosphoglycerate kinase[699]	Yeast					6.94	1	4
Phosphoglycerate kinase[700]	Human	Erythrocytes				8.75	1	n.g.
Phosphoglycerate mutase[701]	Human	Erythrocytes						
Monophosphoglycerate			57,000			6.2	1	4
Biphosphoglycerate			54,000			4.9	1	
Phosphoglycerate mutase[166]	Human	Red cells				5.6, 5.9, 6.2†	3	20
Phosphoglycerate mutase[702]	*Bacillus subtilis*		75,000			5.6	1	n.g.
Phosphoglyceromutase[165]	Human	Erythrocytes				5.1	1	25
Phosphoglycolate phosphatase[703]	Tobacco	Leaves	86,300	4	20,500	3.85	1	n.g.
O-Phosphohydroxylysine phospholyase[704]	Rat	Liver	140,000			5.5	1	0

Phospholipase A_2[705]	Horse	Pancreas, pancreatic juice				5.5	1	n.g.
Phospholipase A_2[706]	*Vipera berus*	Venom	13,400		s.p.c.	9.2	1	5
Phospholipase A (detergent-resistant)[707]	*E. coli* K 12				21,000	5.0	1	n.g.
Phospholipase D[708]	*Bacillus subtilis* G-72		21,500		s.p.c.	4.2	1	n.g.
Phospholipase D[709]	*Streptomyces chromofuscus*		50,000		s.p.c.	5.1	1	n.g.
Phospholipase D[710]	Peanut	Seeds	200,000		48,500	4.65	1	n.g.
Phospholipid exchange protein[711]	Rat	Liver, cytosol			18,700	4.2–5.6, 8.3–9.0	> 6	n.g.
Phospholipid exchange protein[712]	Bovine	Heart				3.9, 4.2, 4.55$^+$, 5.0$^+$	4	n.g.
Phospholipid exchange protein[713]	Bovine	Heart	23,500			5.3, 5.6	2	n.g.
Phospholipid transfer protein (I, II)[714]	Bovine	Brain cortex	29,900(I) 30,000(II)			5.2 (I) 5.5 (II)	1	n.g.
Phospholipid transfer protein[715]	Rat	Liver	13,000		s.p.c.	8.8	1	n.g.
Phosphoprotein[716]	Rat	Incisor dentin				1.1	1	4
Phosphorylase[717]	Swine	Adipose tissue			90,000	6.3	1	n.g.
Phosphorylase phosphatase[718]	Rabbit	Muscle			33,000	5.0	1	n.g.
Phosphorylated (1) and dephosphorylated (2) cAMP-binding proteins[719]	Bovine	Cardiac muscle	56,000(1) 54,000(2)			5.35(1) 5.40(2)	1 1	n.g.
Phosphotransferase (GTP-AMP)[720]	Beef	Heart, mitochondria	26,000			9.8	1	n.g.
R-Phycocyanin[721]	Red alga (*Porphyridium cruentum*)		103,000		18,200 (α) 20,500 (β)	5.2 (α) (blue) 5.3 (β) (purple)	2	n.g.
Phycoerythrin-545[722]	*Cryptomonas maculata*		44,500	2 2	9,900 (α) 15,700 (β)	4.84, 5.05$^+$, 7.83	3	n.g.
B Phycoerythrin[723]	*Porphyridium cruentum*					4.3$^+$, 4.6$^+$, 5.3$^+$	> 6	n.g.
Phytohaemagglutinin[724]	Sunn hemp (*Crotalaria juncea*)	Seed	120,000			8.8	1	n.g.
Phytohaemagglutinin[725]	Pea (*Pisum sativum*)					5.90$^+$, 6.35, 7.00$^+$	3	n.g.

(Continued on p. 160)

TABLE I *(continued)*

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit* No.	*Subunit* MW	*pI*	*No. of iso-enzymes*	*Temper-ature (°C)*
Pilin[726]	*Bacteroides nodosus*		19,000			4.5	1	4
Plasminogen (F-1, F-2)[727]	Rabbit	Plasma				8.51, 8.91⁺, 9.14⁺ (F-1)	3	
						8.64, 8.97⁺, 9.19⁺ (F-2)	3	22
Plasminogen[728]	Human	Plasma				6.40⁺, 6.55⁺, 6.70⁺	6	n.g.
Plasminogen activator[729]	Human	Psoriatic scale extract				6.5–6.6		
						5.4–6.2		
						4.9	> 3	2
Plasminogen activator[730]	Human	Vascular vessel	70,000		s.p.c.	8.2⁺	> 1	n.g.
Plasminogen activator[731]	Human	Pancreatic carcinoma cells	55,000			8.7	1	n.g.
Plasminostreptin, proteinase inhibitor[732]	*Streptomyces antifibrinolyticus*		25,000	2	12,500	6.3	1	5
Platelet adhesiveness inhibitor[733]	Human	Plasma	150,000		31,000 24,000	5.1	1	n.g.
Platelet factor 4 (low affinity)[734]	Human	Platelets			9000	8.0	1	n.g.
Poliovirus polypeptides[735]	Poliovirus	Capsid				8.1(VP_1), 6.4 (VP_2), 6.0(VP_3), 7.3(VP_4)	4	n.g.
Polyamine oxidase[736]	Rat	Liver	60,000		s.p.c.	4.9	1	4
endo-Polygalacturonate trans-eliminase[687]	*Erwinia carotovora*					9.5	1	
Poly(A)polymerase[737]	Hamster	Fibroblasts	145,000 (IIA) 155,000 (IIB)			~6	2	n.g.
Poly(ADP-ribose)polymerase[738]	Human	Ehrlich ascites tumour cells			130,000	9.40	1	n.g.
Poly(ADP-ribose)polymerase[739]	Pig	Thymus nuclei	60,000		s.p.c.	8.4	1	4
Polynucleotide phosphorylase[740]	*Thermus thermophilus*		190,000	1 1 1	92,000 73,000 35,000	4.3⁺, 4.7	2	n.g.

Polypeptide, organic solvent								
soluble[741]	*Rhodospirillum rubrum*	Photoreceptor complexes, chromatophores			12,000	7.10	1	n.g.
Polypeptide p30[742]	Mouse	C-type endogenous viruses:						
		Class I				6.1⁺, 5.6, 6.6	3	
		Class II				5.7	1	
		Class III:						
		NIH Swiss				5.5	1	
		ATS				5.5	1	
		NZB[124]				5.5⁺, 6.1	2	n.g.
Polyphenoloxidase[743]	Mushroom					4.4, 4.5, 4.55 (high)		
						4.3, 4.65, 4.7, 4.75,		
						4.9 (medium) 5.05,		
						5.9 (low)	10	
	Potato					4.95, 5.05, 5.15 (high)		4
						4.9, 5.4, 5.7 (medium)		
						5.9, 6.0, 6.2, 6.8 (low)	10	
Polyprotein precursor to cytochrome c oxidase ($P_{r\ IV-VII}$)[744]	*Saccharomyces cerevisiae*	Postmitochondrial supernatant			55,000	6.2	1	n.g.
Poly(vinyl alcohol)-degrading enzyme[745]	*Pseudomonas*		30,000			10.3	1	n.g.
Porins[746]	*Salmonella typhymurium:*	Membrane						
	SH 5551		39,800			4.78		
	SH 6377		39,300			4.77	1	n.g.
	SH 6017		38,000			4.85		
Postproline-cleaving enzyme[747]	Lamb	Kidney			58,000	4.8	1	n.g.
Postproline dipeptidyl aminopeptidase(dipeptidyl aminopeptidase IV)[748]	Lamb	Kidney	230,000	2	115,000	4.9	1	n.g.
Prenyltransferase[749]	Chicken	Liver	86,000	2	43,000	5.72	1	n.g.
Progesterone-binding protein[750]	Human	Mammary cytosol				5.0⁺, 6.5	2	n.g.
Progesterone receptor[751,752]	Chick	Oviduct (cytosol)				6.0(A), 7.0(B)	2	n.g.
Progestin receptor[753]	Human	Endometrial carcinoma				5.0⁺, 6.3	2	20

(Continued on p. 162)

TABLE 1 (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit* No.	*Subunit* MW	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Prolactin[754,755]	Human	Amniotic fluid	27,000(c) 36,000 (A, B, D)			5.3, 5.7, 6.2	3	n.g.
Prolactin[445]	Monkey	Pituitary				5.78, 6.0^{+}, 6.78	3	n.g.
	Human	Pituitary				5.45, 5.82, 5.93^{+}	3	
Prolyl dipeptidase[756]	Bovine	Kidney	100,000			4.25	1	n.g.
Prolyl hydroxylase[757]	Chick	Embryos	248,000	2	64,000 (α)	4.7, 5.5(subunits pI)	2	n.g.
				2	60,000 (β)			
Prostaglandin synthetase (aspirin-acetylated)[758]	Sheep	Vesicular gland	85,000			6.6–7.2		n.g.
Prostatic-binding protein[759]	Rat	Ventral prostate	51,000	1	19,000 (F)	4.6(F)		
				1	20,000 (S)	4.9(S)	2	n.g.
Protease[687]	*Erwinia carotovora*					8.3	1	n.g.
Protease[760]	*Staphylococcus aureus*				29,000	4.6	1	n.g.
Protease[761]	*A. oryzae*				22,000	5.7^{+}	15	n.g.
	B. subtilis				16,000	(7.0–10.0), 8.2^{+}	10	
Protease[762]	*Lupinus angustifolius*	Seeds	27,500		s.p.c.	9.0	1	n.g.
Protease[763]	*Agave americana variegata*	Leaves	57,000			5.25	1	5
Protease inhibitor: I_1, I_2[764]	Rat	Skin	74,000(I_1) 13,400(I_2)			4.6(I_1) 4.9(I_2)	2	n.g.
Protease inhibitor, I–V[765]	Soybean	Seeds	7000–8000			4.2–6.2	5	n.g.
Protease trypsin-like[766]	*Streptomyces griseus*					6.5, 7.5, 9.2^{+}	3	n.g.
Protein (basic)[767]	Rat	Stratum corneum, epidermis			50,000	9.38, 9.60, 10.5^{+}	3	n.g.
Protein (gene 32)[768]	Bacteriophage T4				35,000	5.0^{+}, 4.95	2	n.g.

Protein (nuclear)[769]	*Physarum polycephalum*	Nuclei			34,000	8.35	1	n.g.
Proteins:	*Spinacia oleracea*	Leaves, chloroplast membrane						
Photosystem I					68,000 } 60,000 }	5.6		
					33,000– } 44,000 }	5.9–6.8		22
Photosystem II[770]					33,000 } 23,000 }	5.3, 6.3		
Protein A[771]	*Staphylococcus aureus*, A676		41,000			5.1	1	n.g.
Protein–arginine methyltransferase[772]	Calf	Brain				5.1	1	n.g.
Proteinase A inhibitors (I_2^A,I_3^A)[773]	Yeast		23,000	4	6000	5.7$^+$, 6.0, 6.5 (I_2^A) 5.6, 5.99, 6.3$^+$(I_3^A)	3 3	n.g.
Proteinase inhibitors[774]	*Stephanurus dentatus*	Excretory gland cells			9500	6.45(I) 6.20(II) 5.34(III)	3	n.g.
Proteinase inhibitor[775]	Horse	Leukocyte, cytosol			35,200	5.38	1	n.g.
Proteinase (metallo, extracellular, I-IV)[776]	*Chromobacterium lividum* (NCIB 10926)		75,000(I) 72,000(II) 67,000(III)			8.05(I) 7.15(II) 6.15(III) 4.35(IV)	4	4
Protein, bactericidal and membrane-active[777]	Human	Granules of polymorphonuclear leukocytes	59,000		s.p.c.	9.8	1	n.g.
Protein, fraction I:	Tobacco							
Large subunits (L 1, 2, 3)			56,000 (L1, L2, L3)			6.36(L1), 6.30(L2) 6.23(L3)		
Small subunits (S 1, 2)[778]			12,500 (S1, S2)			5.50(S1), 5.44(S2)	5	n.g.

(Continued on p. 164)

TABLE I (*continued*)

Protein	Source	Organ and/or subcellular location	MW	Subunit No.	Subunit MW	pI	No. of iso-enzymes	Temperature (°C)
Protein kinase[779]	Rat	Liver:						
		microsomes				No cAMP:		
		MI				8.05	1	
		MII				5.50	1	
		MIII				4.80	1	
						+ cAMP:		
		MI				8.05	1	
		MII				5.50	1	
		MIII				8.10, 7.35	2	
		Cytosol:				No cAMP:		
		CIa				8.10	1	0
		CIIa				5.10	1	
		CIIb				5.45	1	
		CIII				4.90	1	
						+ cAMP:		
		CIa				8.15	1	
		CIIa				8.15, 7.35	2	
		CIIb				5.45	1	
		CIII				8.15, 7.35	2	
Protein kinase, cAMP-dependent[780]	Bovine	Heart	39,000			7.01^{+}, 7.48^{+}, 7.78^{+}	> 3	n.g.
Protein kinase, cAMP-dependent:[781]	Bovine	Cerebral cortex						
Holoenzyme			87,000			5.5		
cAMP-independent catalytic subunit					40,000	7.0	1	n.g.
cAMP-binding regulatory subunit					52,000	4.8		
Protein kinase, cAMP dependent	Calf	Ovarian cytosols				5.0(I) 4.9–5.0(II) 5.3(V)		n.g.
Protein kinase, cAMP dependent[783]	Rabbit	Skletal muscle	11,300			4.24	1	n.g.
Protein kinase, cAMP dependent[784]	Rabbit	Skeletal muscle	226,000		180,000 48,000 42,000	5.27	1	r.t.

Protein kinase, cAMP dependent[785]	Yeast					7.7	1	n.g.
Protein kinase, cGMP-dependent[786]	Bovine	Lung	150,000	2	74,000	5.4	1	n.g.
Protein kinase cAMP dependent[56]	Mouse	Parotid				5.00, 5.15, 5.32	3	n.g.
Protein kinase (cGMP-dependent) stimulatory modulator[787]	Dog	Heart	69,000	2	34,000	4.0	1	n.g.
Protein kinase, nucleoside-dependent[788]	*Trypanosoma gambiense*		90,000			4.85	1	2
Protein, low-sulphur[789]	Sheep	Wool				5.35(5), 5.05(7a), 5.05(7b), 4.9(7c), 5.0(8a), 4.8(8b) 4.7(8c-1), 4.7(8c-2)	8	20
Protein M[790]	*Streptococci* (group A)		70,000	2	36,000	4.5^+, 4.7		
						5.2–5.9	> 3	n.g.
Protein, mRNP-48[791]	Rabbit	Reticulocytes			48,000	5.0	1	n.g.
Protein S (vitamin K-dependent)[792]	Bovine	Plasma	64,000		s.p.c.	5.4–5.9		
	Human	Plasma	69,000		s.p.c.	5.0–5.5		n.g.
Protein, stimulating aerobic plasmalogen biosynthesis[793]	Pig	Kidney	27,000			5.1(I), 4.9(II)	2	n.g.
Protein, structural (major component)[794]	Giant land snail (*Strophocheilus oblongus*)	Calcified eggs			53,000	6.9	1	n.g.
Proteins, structural:[795]	Western equine encephalitis virus							
E$_1$ protein						6.5	1	
Nucleocapsid protein						4.0	1	n.g.
Protein, TCDD receptor[796]	Rat	Liver, cytosol				5.15–5.25	1	0–2
		Serum				5.7–5.8	1	
Proteolipid apoprotein[797,798]	Bovine	Brain, white matter				8.9–9.2	1	25
Pseudocholinesterase[799]	Human	Sera				3.95	1	n.g.
		Genetic variant				4.4-4.9	6	
Pteroyl-γ-oligoglutamyl endo-peptidase[800]	Chicken	Intestine	80,000			4.8	1	n.g.
Purine nucleoside phosphorylase[801]	Human	Erythrocytes	90,000	3	30,000	5.85^+, 5.92^+, 6.02^+, 6.08^+, 6.14, 6.25	6	
	Rat	Erythrocytes				5.6, 5.7	2	
	Bovine	Spleen	90,000	3	30,000	5.4	1	n.g.

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TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Purine nucleoside phosphorylase[802,803]	Human	Erythrocytes	93,000	3	30,000	6.20⁺, 6.29⁺, 6.41⁺, 6.63⁺, 6.83, 6.95 (subunit p*I*s)	6	n.g.
Purine phosphoribosyltransferase[804]	Human: Gilles de la Tourette syndrome	Erythrocytes				5.6, 5.8⁺, 6.0⁺, 6.1⁺, 6.2	5	n.g.
Pyrophosphatase (inorganic)[805]	*Thiobacillus thiooxidans*		88,000	4	22,000	5.05	1	n.g.
Pyrophosphatase (inorganic)[806]	Brewer's yeast	Hyaloplasm			60,000	5.0	3	n.g.
Pyrrolidonecarboxylate peptidase[807]	*Klebsiella cloacae*		74,000			4.7	1	2.5
Pyruvate kinase[808]	*Neurospora crassa*					6.40(free) 5.50(FDP complex)	1	n.g.
Pyruvate kinase[809]	Yeast		220,000	4	57,000	6.6	1	n.g.
Pyruvate kinase[810]	Chicken	Skeletal muscle	212,000	4	53,000	8.45, 8.77⁺	2	n.g.
Pyruvate kinase[811]	Turtle	Heart				6.05	1	n.g.
Pyruvate kinase[812]	Rat	Liver				5.2, 5.3, 5.9⁺	3	n.g.
Pyruvate kinase[813]	Rat	Liver				6.3, 6.6⁺ (subunit p*I*s)	2	n.g.
Pyruvate kinase[814]	Rat	Muscle: foetal				5.2⁺, 6.0, 6.8, 7.3	4	
		adult				7.3⁺	1	
Pyruvate kinase (type A)[815]	Pig	Kidney	249,000	4	60,000	5.6	1	n.g.
Pyruvate kinase (type L)[816]	Human	Liver	240,000	4	60,000	5.85⁺, 6.28	2	0
Pyruvate oxidase[817]	*E. coli*		240,000	4	60,000	5.6	1	n.g.
PZ-peptidase[818]	Chick	Embryos	77,000			5.0	1	n.g.
Quinate (shikimate)dehydrogenase[819]	*Neurospora crassa*		41,000		s.p.c.	4.79⁺, 4.88⁺, 5.09⁺	5	n.g.
Quinolinic acid phosphoribosyltransferase[820]	Castor bean	Endosperm	70,000	2	35,000	5.9	1	r.t.
Receptor, cholinergic[821]	Housefly	Heads, central nervous system	350,000		82,000 90,000	4.8⁺, 6.8, 9.4	3	n.g.

Reductase, -azo and -nitro[822]	*Ascaris lumbricoides var. suum*					4.75	1	
	Moniezia expansa					4.50	1	n.g.
Renin[823]	Human	Juxtaglomerular cell tumour	40,000	1	20,000	4.95, 5.10, 5.35, 5.55, 5.70	5	n.g.
				1	25,000			
Renin[824]	Human	Plasma				4.79, 4.88, 4.94, 5.02	4	n.g.
Renin[825]	Hog	Kidney	40,000			4.70, 4.95*	2	n.g.
Renin[826,827]	Hog	Kidney	36,400			5.2	1	4
Renin[828]	Rabbit	Kidney	37,000			5.1, 5.3*, 5.42*, 5.5*	4	r.t.
Rennetts[829,830]	Calf	Stomach				4.70*	>1	
	Endothia parasitica					4.89*	>1	r.t.
	Mucor miehei					4.20*	>1	
	Mucor pusillus Lindt					3.95*	>1	
Retinol binding protein[831]	Rat	Testis, cytosol	14,600			4.8, 4.9	2	n.g.
Rh-antigen[832]:	Human	Erythrocyte membrane						
E			50,000–100,000			7.7		
C			50,000–100,000			7.6		
e			20,000–30,000			7.5	1	n.g.
c			20,000–30,000			7.5		
D			10,000–30,000			7.3		
Rh(c) antigen[833]	Human	Erythrocyte membrane	20,000–30,000			5.3, 6.4, 7.2*, 7.5*, 8.2	5	n.g.
Rhodopsin[834,835]	Bovine	Retina				5.07*, 5.36*, 5.95	3	n.g.
Rhodpsin[836]	Bovine	Retina				4.5, 4.7, 4.9, 5.2, 6.0*	5	n.g.
Riboadenylate transferase[837]	Calf	Thymus	62,000		s.p.c	7.4	1	n.g.
Ribonuclease[838,839]	Human	Urine	21,500			4.1	1	n.g.
Ribonuclease[840]:	*Vicia faba*	Root cells						
A_1, A_2, A_3						~4*	3	n.g.
C_1, C_2						~8*	2	

(Continued on p. 168)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temper-ature (°C)*
Ribonuclease[841]	Plant (*Ipomoea tricolor*)	Petals				4.95^{+}, 5.2, 5.39^{+}	3	n.g.
Ribonuclease (I, II)[842]	*Physarum polycephalum*	Exoplasmodial	25,000			4.3(I), 3.8(II)	1	n.g.
Ribonuclease inhibitor[843]	Human	Placenta	50,000			4.8	1	0–4
Ribulose 1,5-diphosphate carboxylase[844]	*Nicotiana tabacum*	Leaves				6.0, 6.5^{+} (subunit p*I*s)	2	n.g.
mRNA-binding protein[845]	Rabbit	Reticulocyte poly-ribosomes			39,000 51,000	6.35	1	n.g.
mRNA-binding protein[846]	Rabbit	Reticulocyte poly-ribosomes	120,000	1 1	66,000 56,000	5.35	1	n.g.
tRNA ligase: A, B[847]	Wheat germ		105,000(A) 70,000(B)		s.p.c. s.p.c.	6.0(A) 5.85(B)	1 1	n.g.
tRNA nucleotidyltransferase[848]	*E. coli*				52,000	5.85	1	n.g.
RNA polymerases (A,B)[849]	Yeast			1 1 1	27,000 23,000 14,500	9.2 4.5 4.6 (subunit p*I*s)	3	n.g.
Rubredoxin[850]	*Pseudomonas oleovorans*		19,000			4.2	1	n.g.
Saccharopine dehydrogenase[851]	Baker's yeast		39,000		s.p.c.	10.1	1	0
Secretory component (FSC)[852]	Chicken	Intestine				4.5	1	n.g.
Serine protease[853]	Human	Hepatoma 8999 (mitochondrial fraction)	24,000			10.6	1	n.g.
Serine proteinase[854]	*Phycomyces blakesleeanus*		18,000 22,000 60,000			7.6 5.1 4.4	3	n.g.
Serine proteinase inhibitor[854]	*Phycomyces blakesleeanus*		10,000(I) 10,000(II)			4.50 4.95	2	n.g.
Serine–pyruvate aminotransferase[855]	Mouse	Liver	80,000	2	40,000	6.1, 6.3, 6.6^{+}, 6.9^{+}	4	0–4
	Dog	Liver	80,000	2	40,000	6.6, 6.9^{+}	2	
	Cat	Liver	80,000	2	40,000	6.6, 6.9^{+}	2	

Sialyltransferase[856]	Human	Liver				5.0–8.6	8	0–2
Skeletin[857,858]	Cow	Heart purkinje fibres	55,000			6.35	1	n.g.
Somatic extracts of adult worms (SEAW)[859]	*Dipetalonema vitae*					3.3^+, 4.0^+, 4.3^+, 4.4^+, 5.2^+	9	n.g.
Somatic extracts microfilariae (SEM)[859]						3.2^+, 4.4^+	9	5
Somatomedin[860]	Rat	Plasma	160,000		9000	9.0^+ (subunit p*I*)	> 1	n.g.
Spectrin: I, II[861,862]	Human	Erythrocyte	237,500(I) 238,600(II)		s.p.c. s.p.c.	5.6	1	n.g.
Sperm-activating substance (SAS)[863]	*Pseudo-centrotus*	Eggs	630			5.3	1	n.g.
Sphingomyelinase[864]	*Bacillus cereus*		24,000			5.6	1	r.t.
Sphingomyelinase[865]	Human	Skin fibroblasts				4.85, 6.15^+, 6.80, 7.25, 7.75, 8.25, 8.50	7	n.g.
Sphingomyelinase[866]	Human	Liver				4.6^+, 5.2^+	> 2	2
Spinin[867]	Marine bacterium D 71		19,000		s.p.c.	3.45	1	4
S-Succinylglutathione hydrolase[868]	Human	Liver	17,000		s.p.c.	8.7	1	n.g.
Staphylocoagulase[869]	*Staphylococcus aureus*		61,000			4.53	1	n.g.
17β-Hydroxy-C_{19}-steroid dehydrogenase[870]	Guinea pig	Liver	32,000 (Pre-1, Pre-2, EI-1, EII-1) 35,000 (EI-2, EII-2, EIII)	 1 1	s.p.c. 24,000 11,000	8.3(Pre-1) 6.6(EI-1) 6.8(EI-2) 5.9(EII-1) 6.3(EII-2)		n.g.
Steroid–receptor complex[871]	Rat	Prostate gland cytoplasm				5.81	1	n.g.
Stimulatory factor for RNA polymerase II[872]	Lamb	Thymus	24,000			8.0	1	n.g.
Streptokinase[286]:	Streptococci							
Group A						5.8	1	
Group C						5.4	1	4
Streptolysin O[286]	Streptococci					6.0^+, 7.5	2	4
Strictosidine synthetase[873]	*Catharanthus roseus*		38,000			4.6	1	n.g.

(Continued on p. 170)

TABLE I (*continued*)

Protein	Source	Organ and/or subcellular location	MW	Subunit No.	Subunit MW	pI	No. of iso-enzymes	Temperature (°C)
Subtilisins[874]:	*Bacillus* species							
Carlsberg						6.7	1	
Novo						8.1	1	n.g.
Sucrase[875]	Honey bee (*Apis mellifera*)	Head, abdomen	51,000–82,000			6.5	1	n.g.
Sulphating enzyme of bile salts[876]	Rat	Liver, cytosol	130,000			5.3	1	0
Sulphogalactosylsphingosine sulphatase[877]	Human	Skin fibroblasts				4.8	1	n.g.
Supernatant protein factor (SPF)[878]	Rat	Liver	47,000		s.p.c.	6.74	1	n.g.
Superoxide dismutases[879]	Fruit fly (*Ceratitis capitata* L.)		35,000			5.4, 5.9$^{\prime}$	2	n.g.
Superoxide dismutase[880]	Red alga (*Porphyridium cruentum*)		40,000	2	20,000	4.2	1	n.g.
Superoxide dismutase[881]	Blue-green alga (spirulina)				32,000	4.35, 4.60	2	n.g.
Superoxide dismutase[882]	Rat	Liver				4.65, 4.75 4.85$^{\prime}$, 5.15$^{\prime}$	4	n.g.
Taurocyamine kinase[883]	Lugworm (*Arenicola marina*)	Body-wall musculature	60,000		22,000 14,000 11,000	(6.1–7.8) 7.3^{+}	8	n.g.
T cell-replacing factor (TRF-II)[884]	Mice	Spleen	45,000 35,000 25,000			4.4, 5.1$^{\prime}$, 6.3, 6.9^{+}	4	4
Tetrahydrofolate[885]: Dehydrogenase Cyclohydrolase Synthetase	Porcine	Liver	150,000		s.p.c.	6.6	1	n.g.
Tetrahydrofolate reductase[886]	Pig	Liver	180,000			4.8	1	n.g.
Testosterone–estradiol-binding globulin (TeBG)[887]	Human	Plasma	94,000			5.51	1	n.g.

Thiamine-binding protein[888]	*E. coli*					6.0	1	n.g.
Thioredoxin reductase[889]	Rat	Novikoff tumour	116,000	2	58,000	5.1	1	n.g.
Thrombin[890]	Bovine	Plasma				7.05	1	8
α-Thrombin[891]	Human	Plasma	36,600	1 1	32,000 4600	6.35, 6.55, 7.0^{+}, 7.3^{+}, 7.6^{+}	5	n.g.
Thymidylate kinase[892]	Mouse	LMTK mouse cells	71,000			7.7, 8.2^{+}	2	n.g.
Thymidylate synthetase[893]	*E. coli*		64,000	2	32,000	4.7	1	n.g.
Thymidine kinase: F, A[654]	Chick	Embryo cells				9.7(F) 6.5(A)	1	n.g.
Thymine dimer excising nuclease[894]	Human	KB cells				6.0(A,C), 9.0(B)	3	n.g.
Thyrotropin[896]	Calf	Thymus	3,350			4.2	1	n.g.
Thyrotropin[896]	Human					7.25^{+}(I), 6.62^{+}(II) 6.08^{+}(III), 5.93(IIIa), 5.45(IV), 5.18(V^{b})	6	n.g.
Thyrotropin-releasing hormone deamidase[897]	Rat	Brain	73,500		s.p.c.	4.5	1	n.g.
Toxin[898]	*Pseudomonas aeruginosa*					5.8	1	n.g.
α-Toxin[899]	*Clostridium perfringens*	Venom				$4.8(\alpha_0)$, $4.81^{+}(\alpha_1)$, $4.82^{+}(\alpha_2)$, $4.83(\alpha_3)$	4	r.t.
α-Toxin[900]	*Staphylococcal*		36,000			7.98	1	10
Toxin[901]	Scorpion (*Palamineus gravivamus*)	Venom	7000			10.6	1	n.g.
Toxin, delta[902]	*Clostridium perfringens*				42,000	8.8, 9.4	2	n.g.
Toxin, epidermolytic[903]	*Staphylococcus aureus*		25,000			6.0, 7.0^{+}	2	n.g.
Toxin, haemolytic[904]	Sea anemone (*Stoichactis helianthus*)		16,000			9.8	1	n.g.
Toxin, haemorragic[905]	*Crotalus atrox*	Venom	25,700		s.p.c.	5.6	1	n.g.
Toxin, paralysing[906]	Wasp (*Microbracon hebetor*)	Venom	61,000			6.8	1	n.g.

(*Continued on p. 172*)

TABLE I (*continued*)

Protein	*Source*	*Organ and/or subcellular location*	*MW*	*Subunit No.*	*Subunit MW*	*pI*	*No. of iso-enzymes*	*Temperature (°C)*
Toxin (pyrogenic exatoxin type C)[907]	*Streptococcal* Group A		13,200		s.p.c.	6.7	1	n.g.
Transaldolase, type III[908]	*Candida utilis*		63,600			3.95	1	n.g.
Transcobalamin I and II[909]	Porcine	Serum	135,000(I)			3.23, 3.42, 3.69(I)	3	
			38,000(II)			3.47(II)	1	4
Transcobalamin II-cyanocobalamin[910]	Human	Plasma			37,000 29,000	(6.2–6.8), 6.30^{+}, 6.45^{+}	4	n.g.
Transferrin Tl[C3 911,912]	Human	Serum				5.2, 5.6, 5.9, 6.0, 6.1, 6.2	6	n.g.
Transferrin[913]	Rat	Serum				5.8, 6.0	2	n.g.
Transglutaminase[914]	Rabbit	Liver	80,000		s.p.c.	5.35	1	n.g.
Triglyceride lipase[572]	Human	Post-heparin plasma	69,000			4.95, 5.3, 7.6	3	n.g.
Trehalase[540]	Rat	Enterocytes (brush border)				4.99	1	n.g.
Triacylglycerol acylhydrolase[915]	*Pseudomonas fluorescens*		33,000		s.p.c.	4.46	1	4
Triacylglycerol lipase[916]	Rat	Liver, cytosol	42,000			7.2	1	n.g.
Triacylglycerol lipase[917]	*Mycobacterium phlei*		40,000			3.8	1	n.g.
Triosephosphate isomerase[918]	Human	Erythrocytes				6.0^{+}, 5.6	1	n.g.
Tropomyosin[919]	Canine	Cardiac	70,000	2	35,000	5.4, 5.6	2	n.g.
Trypsin inhibitor[920]	Eggplant	Exocarps	5,000-10,000			4.2, 4.7^{+}, 6.0	3	n.g.
Tryptophan aminotransferase[921]	Rat	Brain	55,000			6.2	1	0
Tubulin[922]	Bovine	Brain			56,000	5.2, 5.4 (subunit pIs)	2	n.g.
Tyrosinase[923]	*Porcellio laevis*	Cuticle	122,000	4	31,000	6.1^{+}, 7.1	2	4
Tyrosine[924]	Frog	Epidermis	200,000	4	50,000	9.25	1	n.g.
L (−)-Tyrosine decarboxylase[925]	*Streptococcus faecalis*					4.5, 3.2	2	1
Tyrosine hydroxylase[926]	Beef	Adrenal gland			60,000	6.6	1	n.g.
UDP-glucose-4-epimerase[927]	*Physarum policephalum*					6.0, 6.7^{+}, 7.6	3	0

UDP-glucuronosyltransferase[928]	Rat	Liver, microsomes	59,000		s.p.c.	6.31, 6.56, 6.68	3	n.g.
UMP:pyrophosphate phosphoribosyltransferase[929]	Yeast		80,000	1	58,000	5.27^+, 5.35	2	n.g.
				1	25,000			
Uricase[930]	Mackerel	Liver, peroxisomes	127,000			7.8	1	n.g.
Uridine nucleosidase[931]	Yeast		44,000		s.p.c.	4.03	1	n.g.
Urokinase[932]	Human	Urine	47,000	1	33,000	8.60^+, 8.90	2	
				1	18,000			
			33,400		s.p.c.	8.05, 8.35^+, 8.60^+, 8.70^+	4	25
Valyl-tRNA synthetase[933]	*E. coli*		112,000		s.p.c.	4.8	1	n.g.
Vicilin peptidohydrolase[934]	Mung-bean	Cotyledons	23,000			3.75	1	n.g.
Vitamin B_{12}-binding protein[935,936]	Human	Gastric mucosa	63,000			4.84, 4.94^+, 5.06^+, 5.10, 5.18, 5.44, 5.64	7	n.g.
Vitamin B_{12}-binding protein[937]	Human	Plasma	120,000 (TCI)			3.0, 3.3^+, 3.6	3	n.g.
			35,000 (TCII)			3.3, 3.6^+, 3.9, 4.2	4	n.g.
Vitamin D-binding protein[938]	Rat	Serum	52,000		s.p.c.	5.2	1	4
Vitellin[939]	*Locusta migratoria*	Oocyte	530,000	1	110,000	6.9	1	n.g.
				1	130,000			
				1	120,000			
				1	55,000			
				1	65,000			
Xanthine dehydrogenase[940]	*Streptomyces cyanogenus*		125,000	2	67,000	4.4	1	n.g.
endo-1,4-β-Xylanase[941]	*Aspergillus niger* Str. 14		27,000		s.p.c.	4.2	1	n.g.
β-Xylosidase[942]	*Penicillium wortmanni*		100,000			5.0	1	n.g.
Zeins[943-945]	Maize	Endosperm, protein bodies			9600	6-9	15	r.t.
					13,500			
					$21,000^+$			
					$22,000^+$			

a useful feature for the reader: all the relevant information about the article (volume, year, first and last page, etc.) is neatly printed in the upper left (or right) corner of the first page, thus greatly facilitating its quotation. The prize for "unreadability", unfortunately, goes to *Biochemistry*, whose abstracts are far from being fully informative, and whose ideas for classifying an article are unfortunate: the same vital information (volume, year, first and last page, etc.) is scattered throughout the pages of the article, rendering its collection more difficult. Perhaps the Editors of the journal still live with the presumption that a reader of a given article will go through its whole length, whereas it is common knowledge today that even Nobel Laureates barely manage to carry their readership to the end of the summary in their articles.

A few words should be said about pH (and thus p*I*) measurements in isoelectric focusing (IEF). We have already dealt with it extensively in our first paper[946], to which the reader is referred. It is frustrating that most scientists still do not report the temperature of pH measurement after IEF (albeit in most instances it could be presumed to be room temperature, *i.e.*, 20–25°C outside the tropics). Fredriksson[948] has published tables which allow a pH course mapped at room temperature to be converted into the one existing during the focusing experiment (usually at 4°C) and *vice versa*. The p*I* values of proteins should be expected to decrease with increasing temperature. The magnitude of the temperature coefficient dpI/dT depends on the protolytic composition of the protein and, to a lesser extent, on the temperature. For a strongly acidic protein, dpI/dT should be *ca.* −0.005 pH unit per degree at about 4°C, whereas for a strongly basic protein it should be *ca.* −0.03 pH unit per degree. When performing IEF in presence of additives (glycerol, sucrose, ethylene glycol, urea, etc.), the pH readings should be corrected for the variation of the dielectric constant of water, as this in turn influences the p*K* of ionizable groups. Gelsema's group has published a series of papers on this topic[949,950]. The interference of carbon dioxide absorption on p*I* values determined at alkaline pH in thin-layer gel IEF has been measured by Delincée and Radola[951].

2. ACKNOWLEDGEMENTS

This project would have been impossible without generous help from LKB Produkter (Bromma, Sweden), who put at our disposal a collection of more than 4000 articles on IEF, and two copying machines. Another lucky event was a 2-month visiting professorship for P.G.R. at the Department of Biochemistry, University of Uppsala, Sweden, which allowed week-end trips to Stockholm to "digest" the literature in the field, together with K.E. P.G.R. is supported by grants from the Consiglio Nazionale delle Ricerche (CNR) and Ministero della Pubblica Istruzione (MPI, Rome).

3. SUMMARY

Proteins with known isoelectric points (p*I*), as determined by isoelectric focusing, are tabulated. When available, the native molecular weight and the subunit molecular weight and stoichiometry are reported. For each entry, the source and, when applicable, the organ of origin and/or subcellular location are given. A previous table [P. G. Righetti and T. Caravaggio, *J. Chromatogr.*, 127 (1976) 1–28] covered the years from 1966 (the introduction of isoelectric focusing) to 1975. The present compilation spans the years 1976–1979 and contains approximately three times as many references and entries (>900).

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