APPLIED BIOCHEMISTRY AND BIOTECHNOLOGY 9, 187–206 (1984)

Molar Absorptivity and $A_{1\,cm}^{1\%}$ Values for Proteins at Selected Wavelengths of the Visible and Ultraviolet Regions. XXIII

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Received August 10, 1982; Accepted March 10, 1983

ABSTRACT

The molar absorptivity and $A_{1cm}^{1\%}$ values for 150 proteins are reported. The conditions under which these values were obtained and citations to the sources of the data are also provided.

Index Entries Proteins, molar absorptivity of; $A_{1cm}^{1\%}$ values, of proteins; molar absorptivity, of proteins; ultraviolet absorption, of proteins.

INTRODUCTION

The molar absorptivity and $A_{1cm}^{1\%}$ values for 150 proteins are given in Table 1. The sources of these proteins, the conditions under which the numerical data were obtained, the molecular weights for many proteins, and citations to the primary references are also given. The footnotes to Table 1 contain additional information. The method used to compile these data has been described (*1*).

This paper is part of a continuing compilation of absorption characteristics of proteins in the ultraviolet and visible regions (2).

REFERENCES

1. Kirschenbaum, D. M. (1980), *J. Chem. Info. Comput. Sci.* **20,** 152.
2. Kirschenbaum, D. M. (1982), *Applied Biochem. Biotechnol.* **7,** 475.

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0273–2289/84/0400–0187$4.00

Table 1
Protein Index

Protein	$\epsilon_M^a \times 10^{-4}$	$A_{1\,cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
Acetylcholinesterase					
Electric eel		17.6	280	*1*	N
Cobra [*Naja naja oxiana*] venom		16.2	280	*2*	
Torpedo californica		17.5	280	*3*	Lowry × 1.079
β-*N*-Acetylhexosaminidase					
Tobacco hornworm [*Manduca sexta L.*]					
EI	18.7	30.7	280	*4*	Lowry, AA; mw = 61,000
EII	18.4	30.2	280	*4*	Lowry, AA; mw = 61,000
Pycnoporus cinnabarinus	20.2	16.8	280	*5*	mw = 120,000
Actin					
Beef skeletal muscle		6.6	290	*6*	
Chick embryo brain		11.1	280	*7*	Dry wt
Rabbit muscle	2.7	6.3	280	*8*	mw = 43,000 LS
Actin-like protein					
Yeast [*Saccharomyces cerevisiae*]		11.0	280	*9*	
Acyl carrier protein					
Escherichia coli	1.8		280	*10*	
Acyl-CoA oxidase					
Candida tropicalis		15.6	280	*11*	pH 7.4, 0.02*M*, KPh; dry wt
Rat liver					
Oxidized form		1.19	450	*12*	Data from Fig. 8; 50 m*M* KPh, pH 7.4
		0.99	378	*12*	From absorption ratio (*12*)
		12.85	278	*12*	From absorption ratio (*12*)
Adenosine cyclic 3′,5′-phosphate receptor protein					
Escherichia coli		8.8	277.5	*13*	
Chymotryptic core		14.2	277.5	*13*	
SAP core[e]		9.9	277.5	*13*	
13K Fragment		2.8	275	*13*	
9K Fragment		17.9	279	*13*	
Adenosine diphosphate glucose synthetase					
Rhodospirillum tenue	6.4	12.5	280	*14*	mw = 51,000; *N*

(*continued*)

Table 1 (*continued*)

Protein	$\epsilon_M^a \times 10^{-4}$	$A_{1\,cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
Adenosine 5′-triphosphatase					
Escherichia coli		4.0	280	*15*	
β Subunit		3.8	280	*15*	
γ Subunit		5.1	280	*15*	
ε Subunit	0.64	4.0	276	*16*	mw, 15.900
Micrococcus lysodeikticus		6.8	276	*17*	50 m*M* Tris-6 *M*; GHCl-1 m*M* DTT, pH 7.5; LS
α Subunit		3.7	276	*17*	50 m*M* Tris-6 *M*, GHCl-1 m*M* DTT, pH 7.5; LS
β Subunit		5.2	276	*17*	50 m*M* Tris-6 *M*, GHCl-1 m*M* DTT, pH 7.5; LS
Micrococcus lysodeikticus		8.5	276	*17*	50 m*M* Tris-HCl *mM* 1 m*M* DTT, pH 7.5; LS
		4.5	276	*17*	50 m*M* Tris-HCl *mM* 1 m*M* DTT, pH 7.5; LS
		5.3	276	*17*	50 m*M* Tris-HCl *mM* 1 m*M* DTT, pH 7.5; LS
Pig kidney medulla					
α Subunit		12.0	nc	*18*	
β Subunit		14.4[f]	nc	*18*	
		11.3[g]	nc	*18*	
Rabbit kidney outer medulla					
α Subunit	14.3		280	*19*	
β Subunit	7.8		280	*19*	
Squalus acanthias rectal gland		10.96	280	*20*	Lowry; SDS or OEGD
Thermophilic bacterium PS3		5.0	278	*21*	In urea, GHCl, Tris, EDTA or SDS; dry wt
α Subunit		5.0	278	*21*	In urea, GHCl, Tris, EDTA or SDS; dry wt
Rhodospirillum rubrum		15.6	280	*22*	
Adenosine triphosphate citrate lyase [pro-3S]					
Rat mammary gland	57.7	12.2	280	*23*	mw = 473,000; refr

(*continued*)

Table 1 (*continued*)

Protein	$\epsilon_M^a \times 10^{-4}$	$A_{1\,\mathrm{cm}}^{1\%b}$	nm[c]	Ref.	Comments[d]
Adenylate deaminase					
Duck heart		9.3	278	*24*	0.03*M* Ph cont. 0.1*M* NaCl and 0.005% ME, pH 6.5
Adrenodoxin					
Beef	0.98		414	*25*	0.1*M* Ph, pH 7.4
Apo-	0.3		276	*25*	0.1*M* Ph, pH 7.4
Alanine aminotransferase					
Pig heart	0.9060	0.9	427	*26*	mw = 98,000; pH 5.5
	7.4	7.5	279	*26*	mw = 98,000; pH 5.5
Alanine dehydrogenase					
Thermus thermophilus	2.4	5.0	280	*27*	mw = 48,000
Albumin					
Beef serum		30.7	235	*28*	
		7.01	280	*28*	
	0.5130		335	*29*	Deaerated, 0.2*M* NaOH
		6.47	280	*30*	
Adelie penguin [*Pygoscelis adeleae*]					
Blood		6.84	280	*31*	
Carp [*Cyprinus carpio*]					
S2D1	9.1	6.29	280	*32*	mw = 145,000
S2D2	9.5	6.55	280	*32*	mw = 145,000
S3E1	3.5	6.01	280	*32*	mw = 58,000
S3E2	7.8	11.0	280	*32*	mw = 71,000
S3E3	8.9	12.5	280	*32*	mw = 71,000
Rabbit	4.7	6.76	280	*32*	mw = 69,000
Human serum		5.35	279	*33*	
Human plasma		5.1	280	*34*	Dimer
		11.1	280	*34*	Polymer
Wheat	4.9	19	280	*35*	mw = 26,000
		13.1	278	*36*	Dilute acid
Alcohol dehydrogenase [EC 1.1.1.1]					
Horse liver					
$Co[c]_{1.6}$					
$Zn[n]^{h}_{1.7}$-	0.7		350	*37*	
	0.0250		520	*37*	
	0.1200		650	*37*	

(*continued*)

Table 1 (*continued*)

Protein	ϵ^a_M × 10^{-4}	$A^{1\%b}_{1\,cm}$	nm[c]	Ref.	Comments[d]
$ZN[c]_{1.7}$					
$Co[n]^h_{1.6}$-	0.6500		342	*37*	
	0.1000		656	*37*	
$Zn[c]_{2.0}$					
$Co[n]^h_{2.0}$-	0.8000		340	*37*	
	0.1050		655	*37*	
	0.0750		740	*37*	
$Co_{2.5}Zn_{0.2}$-	0.9700		342	*37*	
	0.0250		520	*37*	
	0.1950		650	*37*	
	0.0750		740	*37*	
$Co_{3.1}Zn_0$-	1.3300		342	*37*	
	0.0250		520	*37*	
	0.2000		650	*37*	
	0.0750		740	*37*	
$Co_{3.9}$					
$Zn_{<0.2}$-	1.5500		340	*37*	
	0.2050		655	*37*	
	0.0750		740	*37*	
Simian [*Saimiri sciureus*]					
Liver-pyrazol insensitive	5.16	6.6	280	*38*	mw = 78,000; Refr.
pyrazol-sensitive	4.84	6.2	280	*38*	mw = 78,000; Refr.
Rhodopseudomonas acidophilia	11.4	9.8	280	*39*	mw = 116,000
	1.69	1.46	340	*39*	Data from Fig. 2; mw = 116,000
Alcohol oxidase					
Candida 25-A		21	280	*40*	Dry wt
Aldehyde dehydrogenase					
Sheep liver cytoplasm		11.3	280	*41*	Dry wt
Gluconobacter melanogenus	7.5	5.1	280	*42*	mw = 148,000; dry wt
Gluconobacter suboxydans [Red. form][i]		12	418	*43*	Dithionite red
[Oxid. form][i]		8.3	410	*43*	
Methylosinus trichosporium		7.0	280	*44*	50 m*M* Ph, pH 7.0
Dithionite reduced		3.4	412	*44*	50 m*M* Ph, pH 7.0
Oxidized		3.3	410	*44*	50 m*M* Ph, pH 7.0

(*continued*)

Table 1 (*continued*)

Protein	ϵ_M^a $\times 10^{-4}$	$A_{1\,cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
Aldehyde reductase					
Pig kidney					
cortex	4.8	11	280	*45*	Dry wt
Pig liver	4.3	12.6	nc	*46*	mw = 34,000; dry wt
Aldolase					
Rainbow trout [*Salmo gairdnerii irideus*]		9	280	*47*	pH 7.5, Ph
Allergen					
Russian thistle [*Salsola pestifer*]					
RT1	4.1	10.5	277	*48*	mw = 39,000
RT2	4.3	10.2	277	*48*	mw = 42,000
Allinase					
Garlic bulbs [*Alliium sativum L.*]	1.49	2.3	430	*49*	mw = 65,000
	10.5	16.2	280	*49*	w = 65,000
Allophycocyanin II					
Blue-greeen alga [*Mastigocladus laminosus*]		10	280	*50*	Data from Fig. 1; 0.02*N* KPh, pH 8.0
α Subunit		10	280	*50*	Data from Fig. 1; 0.02*N* KPh, pH 8.0
β Subunit		20.9	280	*50*	Data from Fig. 1; 0.02*N* KPh, pH 8.0
Amine oxidase					
Beef serum	33.1	17.4	280	*51*	mw = 190,000
Beef plasma		20.8	280	*52*	Dry wt
α-Amino acid ester hydrolase					
Xanthomonas citri	11.8	16.4	280	*53*	0.05*M* KPh, pH 7.0; mw = 72,000
L-Amino acid oxidase [EC 1.4.3.2]					
Anacystis nidulans	14.5	14.81	275	*54*	0.01*M* KPh, pH 7.0 mw = 98,000
	1.32	1.35	462	*54*	0.01*M* KPh, pH 7.0. mw = 98,000
Aminoacylase [EC 3.5.1.14]					
Aspergillus oryzae		14.2	280	*55*	0.05*M* Ph, pH 7.3; AA

(*continued*)

Table 1 (*continued*)

Protein	$\epsilon_M^a \times 10^{-4}$	$A_{1\ cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
δ-Aminolevulinate dehydrase [EC 1.2.1.24]					
Human erythrocytes	8.68	28	280	*56*	mw = 31,000
	1.02	3.3	325	*56*	mw = 31,000
	0.434	1.4	410	*56*	mw = 31,000
5-Aminolevulinic acid dehydratase [Porphobilinogen synthase]					
Beef liver	27.2		280	*57*	Octomer
Aminopeptidase					
Rat brain		8.3	280	*58*	Dry wt
Agave americana	8.36	9.7	280	*59*	mw = 86,000
α-Amylase, acid stable					
Aspergillus niger		17.7	280	*60*	
		17.8	280	*61*	
Acid unstable		20.0	280	*61*	
Bacillus subtilis		48.3	235	*28*	
		24.2	280	*28*	
Yellow mealworm [*Tenebrio molitor* *L.*] larva		8.1	280	*62*	
Short-necked clam style		5.97	280	*63*	
α-Amylase inhibitor					
Cladosporium herbarum F828	1.37	7.07	280	*64*	mw = 19,400
Amyloid					
Human spleen		25	280	*65*	Data from Fig. 3
Anthranilate synthase					
Serratia marcescens					
Component I	44.5		280	*66*	Data from Fig. 5; 50 m*M* KPh, 1 m*M*, EDTA, pH 6.5
Antithrombin					
Chicken blood	7.14	11.9	280	*67*	mw = 60,000; AA
Antithrombin III					
Rat plasma	3.79	5.92	280	*68*	50 m*M* Tris-HCl, 0.15*M* NaCl, pH 7.5; mw = 64,000
Human plasma	4.09	6.10	280	*69*	0.1*M* Tris-HCl, pH 7.4; mw = 67,000
		10.5	280	*70*	

(*continued*)

Table 1 (*continued*)

Protein	$\epsilon_M^a \times 10^{-4}$	$A_{1\,cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
Antigen, Australia		37.26	280	*71*	*N*
Hepatitis B 880		32.50	280	*72*	mw = 2,720,000
Arginine deiminase					
Mycoplasma arthritidis	9.5	10.9	278	*73*	mw = 87,300
Arginine esterase					
Gaboon adder [*Bitis gabonica*] venom					
E-I	4.38	13.7	280	*74*	mw = 32,000
E-II	4.38	13.7	280	*74*	mw = 32,000
E-III	3.84	12.0	280	*74*	mw = 32,000
Arylsulfatase A					
Rabbit liver		10.9	280	*75*	0.1*M* Tris-HC1, pH 7.5; AA
		10.0	280	*75*	0.1*N* NaOAc, pH 4.5; AA; mw = 100,000
Rabbit testicular	68	68	280	*76*	
Aryl sulfotransferase IV					
Rat liver	9.5	15.6	280	*77*	mw = 61,000
Ascorbate oxidase					
Cucurbita pepo medullosa	0.9700		610	*78*	0.1*M* Ph, pH 7.0
	0.3050		330	*78*	0.1*M* Ph, pH 7.0
	24.2		280	*78*	0.1*M* Ph, pH 7.0
	0.1386		500	*78*	0.1*M* Ph, pH 7.0
Aspartate aminotransferase					
Beef mitochondria	6.9	14.9	280	*79*	mw = 46,500
Pig heart					
Mitochondria	6.4	14	280	*80*	mw = 46,000
Cytoplasma	6.4	14	280	*80*	mw = 46,000
Escherichia coli B	7.48		280	*81*	pH 8.5
	1.35		360	*81*	pH 8.5
	1.29		440	*81*	pH 5.5
Aspartate-β-semialdehyde dehydrogenase					
Escherichia coli	3.8	10	280	*82*	mw = 38,000
Aspartate transcarbamoylase					
Escherichia coli [mutant]		5.9	280	*83*	Interf.
Catalytic polypeptide		7.2	280	*83*	Interf.
Regulatory polypeptide		3.1	280	*83*	Interf.
Azurin					
Paracoccus denitrificans	0.351	2.54	277	*84*	mw = 13,790
	0.99	7.18	448	*84*	mw = 13,790
	0.153	1.11	595	*84*	mw = 13,790

(*continued*)

Table 1 (*continued*)

Protein	ϵ_M^a $\times 10^{-4}$	$A_{1\,cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
Bacteriocin					
Erwinia carotovora		9.9	280	*85*	Data from Fig. 6. 0.05*M* Ph, pH 7.2.
Bacteriophage lambda particles					
Unprocessed prehead		16.0	280	*86*	10 m*M* Tris HC1, 1 m*M* $MgSO_4$, 10 m*M* NaN_3, pH 8; AA
Processed prehead		16.0	280	*86*	10 m*M* Tris HC1, 1 m*M* $MgSo_4$, 10 m*M* NaN_3, pH 8; AA
Empty head		15.4	280	*86*	10 m*M* Tris HC1, 1 m*M* $MgSO_4$, 10 m*M* NaN_3, pH 8; AA
Band 3					
Beef erythrocytes		10.3	280	*87*	Above 6.5*N* GHC1
Large fragment[j]		12.1	280	*87*	Above 6.5*N* GHC1
Small fragment[j]		9.1	280	*87*	Above 6.5*N* GHC1
α-*N*-Benzoylarginine β-naphthylamide hydrolase					
Beef lymph nodes	4.31	14.0	280	*88*	1*M* acetate, pH 2–5 or 0.8*M* NaBic, pH 8.0, dry wt
Biliprotein					
Turban shell [*Turbo cornutus*]					
Ovary		12.15	278	*89*	
		4.48	374	*89*	
		1.86	535–540	*89*	
		2.18	600–605	*89*	
Blood					
Human					
Fresh		47.5	406	*90*	0.1*M* NaPh, pH 7.5
Dried [8 yr]		27.1	406	*90*	0.1*M* NaPh, pH 7.5; dry wt
Bromoperoxidase					
Penicillus capitus	21.2		413	*91*	
	24.6		495	*91*	
	20.4		545	*91*	
	10.4		635	*91*	

(*continued*)

Table 1 (*continued*)

Protein	$\epsilon_M^a \times 10^{-4}$	$A_{1\,cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
Ferrous enzyme	17.8		447	*91*	
	4.52		563	*91*	
	2.32		597	*91*	
Fe·CO complex	28.26		426	*91*	
	2.82		565	*91*	
	2.14		595	*91*	
CN^-·Enzyme complex	21.6		431	*91*	
	3.80		555	*91*	
	2.72		600	*91*	
N_3^-·Enzyme complex	19.54		417	*91*	
	2.04		540	*91*	
	1.78		500	*91*	
	0.88		640	*91*	
α-Bungarotoxin					
Bungarus multicinctus Venom		1.20	280	*92*	Dry wt
Butyrylcholinesterase [EC 3.1.1.8]					
Rabbit liver					
I		11.6	280	*93*	Dry wt
		8.9	280	*93*	Lowry
II		11.0	280	*93*	Dry wt
		10.7	280	*93*	Lowry
Calcium-binding protein					
Amphioxus	4.4	20	280	*94*	mw = 22,000; AA
Sandworm [*Nereis diversicolor*]	1.91	9.70	280	*95*	50 m*M* Tris HCl, pH 8.0; mw = 19,700
Morris hepatoma	0.51	4.63	268	*96*	10 m*M* NaCac, 1 μ*M* $CaCl_2$,pH 7.0; mw = 11,000
Calcium-modulated protein					
Chicken fibroblasts					
Transformed	0.3169		276	*97*	0.10*M* Im HCl, 0.001*M* EDTA, pH 7.0
Calmodulin					
Dictyostelium discoideum	0.7172	4.3	280	*98*	mw = 16,680
	0.62	4.3	280	*99*	mw = 14,500
Human brain		20	276	*100*	20 m*M* Hepes, 100 m*M* KCl, 1 m*M* $CaCl_2$, pH 7.4. Data from Fig. 3

(*continued*)

Table 1 (*continued*)

Protein	ϵ_M^a $\times 10^{-4}$	$A_{1\ cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
Human erythrocytes		2.3	280	*101*	
Neurospora crassa	0.32	2	280	*102*	mw = 16,000
Octopus	0.24		278	*103*	
Ram testes	0.33		277	*104*	
Scallop					
[*Patenopecten sp.*]					
muscle	0.97		;278	*105*	
Anemone					
[*Metridium*]	0.93		278	*105*	
Xenopus laevis					
Oocyte	0.34		277	*106*	65 m*M* AmBic, 20 μ*M* $CaCl_2$, pH 8, Data from Fig. 2
Calotropin					
Calotropis gigantea					
DI	4.7	19.8	280	*107*	Dry wt; mw = 23,800
DII	4.8	19.8	280	*107*	Dry wt, mw = 24,200
Concanavalin					
Jack bean		6.8[k]	275	*108*	30 m*M* Tris HC1, pH 7
Carbonic anhydrase					
Beef erythrocyte					
Cu[II] enzyme complex with					
H_2O	0.0130		770	*109*	
I^-	0.0400		790	*109*	
	0.2800		445	*109*	
	0.3200		355	*109*	
Br^-	0.0300		790	*109*	
Cl^-	0.0130		790	*109*	
CN^-	0.0190		690	*109*	
N_3^-	0.0330		735	*109*	
	0.2700		400	*109*	
CNS^-	0.0150		735	*109*	
	0.0900		360	*109*	
CNO^-	0.0140		735	*109*	
HCO_3^-	0.0140		735	*109*	
Hagfish [*Myxine glutinosa*]					
Erythrocytes	4.6	15.9	280	*110*	mw = 29,200
Toad [*Bufo marinus*]	4.9	17	280	*111*	mw = 29,000
Carbon monoxide: methylene blue oxidoreductase					
Pseudomonas carboxydovorans		39.55	275	*112*	
		4.39	405	*112*	

(*continued*)

Table 1 (*continued*)

Protein	$\epsilon_M^a \times 10^{-4}$	$A_{1\,cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
Carboxylesterase [EC 3.1.1.1]					
Rabbit liver					
Monomeric		11.6	280	*113*	Dry wt
		11.2	280	*113*	Lowry
Oligomeric		—[l]	280	*113*	Dry wt
		13.6	280	*113*	Lowry
Carboxypeptidase					
Streptomyces griseus		16.3	280	*114*	
	7.04	17.1	280	*115*	mw = 41,200
Carboxypeptidase inhibitor					
Potato		30	280	*116*	
Cardiotoxin					
Naja melanoleuca $V^{II}1$		7.0	280	*117*	
Casein					
Beef milk					
α_{2S}-Casein		14.05	290	*118*	pH 12
α_S-Casein[m]		10.0	278	*119*	
β-Casein		4.7	278	*119*	
γ-Caseins[m]		8.3	278	*119*	
κ-Casein		9.6	278	*119*	
Rat milk		6.8	280	*120*	10 m*M* Im, 70 m*M* KCl, pH 7.1
Catalase					
Beef liver					
Catalase CN^-	7.65		423	*121*	
		1.14	554	*121*	
Desulfovibrio vulgaris	20.5	8.8	405	*122*	mw = 232,000
	24.4	10.5	278	*122*	mw = 232,000
Human erythrocytes	2.8		624	*123*	Ph, pH 7.0
	3.52		540	*123*	Ph, pH 7.0
	4.05		505	*123*	Ph, pH 7.0
	39.7		405	*123*	Ph, pH 7.0
	4.49		555	*123*	0.1 m*M* Cy, pH 7.0
	32.5		424	*123*	0.1 m*M* Cy, pH 7.0
	11.9		360	*123*	0.1 m*M* Cy, pH 7.0
	3.61		620	*123*	0.1*M* N_3^-, pH 7.0
	3.12		540	*123*	0.1*M* N_3^-, pH 7.0
	4.05		505	*123*	0.1*M* N_3^-, pH 7.0
	41.1		413	*123*	0.1*M* N_3^-, pH 7.0
	4.38		600	*123*	0.1*M* F^-, pH 7.0
	3.91		530	*123*	0.1*M* F^-, pH 7.0
	4.74		485	*123*	0.1*M* F^-, pH 7.0
	36.5		405	*123*	0.1*M* F^-, pH 7.0

(*continued*)

Table 1 (*continued*)

Protein	$\epsilon_M^a \times 10^{-4}$	$A_{1\,cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
	2.80		624	*123*	Ph, pH 5.0
	3.52		540	*123*	Ph, pH 5.0
	4.05		505	*123*	Ph, pH 5.0
	39.7		405	*123*	Ph, pH 5.0
Neurospora crassa		11.6	280	*124*	0.001*M* NaCl; dry wt
		8.86	400	*124*	0.001*M* NaCl; dry wt
Cathepsin B					
Beef lymph nodes	4.87	18.5	280	*88*	1*M* Acetate, pH 2–5 or 0.8*M* NaBic, pH 8.0; mw = 26,300; dry wt
Cathepsin D					
Rabbit muscle	16.4	280		*125*	
Cathepsin G					
Human neutrophil leukocytes		6.64	280	*126*	
		6.67	280	*127*	
Cathepsin H					
Human liver		12.2	280	*128*	Lowry
Rat liver		12.2	280	*129*	
Cerato-Ulmin [wilting toxin]					
Fungus [*Cerato ulmi*]	0.26	2.0	280	*130*	60% EtOH/8*M* U; mw = 13,000
Ceruloplasmin					
Human	21.74	16.1	280	*131*	mw = 135,000
	1.0	0.741	610	*131*	mw = 135,000
Beef plasma	18.3	15.4	280	*132*	mw = 119,000
	0.84	0.67	610	*132*	mw = 119,000
Rat	0.85	0.688	610	*133*	mw = 124,000
Chloroperoxidase A					
Caldariomyces fumago	7.63		398	*134*	Water
	1.35		513	*134*	Water
	1.23		543	*134*	Water
	0.59		648	*134*	Water
	10.15		280	*134*	Water
Cholesterol oxidase					
Schizophyllum commune	14.6		275	*135*	0.1*M* KPh, pH 7.5, data from Fig. 2.
Oxidized form	1.06		370	*135*	0.1*M* KPh, pH 7.5, data from Fig. 2.
	1.17		454	*135*	0.1*M* KPh, pH 7.5, data from Fig. 2.

(*continued*)

Table 1 (*continued*)

Protein	$\epsilon_M^a \times 10^{-4}$	$A_{1\,cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
Choline oxidase					
Cylindrocarpon didymum M-1		14.4	280	*136*	0.05*M* Tris HC1, cont. 1 m*M* EDTA, and 0.1 m*M* DTT, pH 8.5
		1.41	454	*136*	0.05*M* Tris HC1, cont. 1 m*M* EDTA, and 0.1 m*M* DTT, pH 8.5
Alcaligenes sp.					
Oxidized		30	277[n]	137	Water, data from Fig. 1
		15.3	345[n]	137	Water, data from Fig. 1
		16.7	440[n]	137	Water, data from Fig. 1
	9.7		278	*135*	0.1*M* KPh, pH 7.5, data from Fig. 1
	0.77		368[o]	135	0.1*M* KPh, pH 7.5, data from Fig. 1
	0.80		462[o]	135	0.1*M* KPh, pH 7.5, data from Fig. 1
Reduced with choline		30	276	*137*	Water, data from Fig. 1
	9.8		277	*135*	0.1*M* KPh, pH 7.5, data from Fig. 1
	0.41		354	*135*	0.1*M* KPh, pH 7.5, data from Fig. 1
Cholinesterase					
Human serum	50.46	14.5	280	*138*	mw = 348,000
α-Chymotrypsin					
Commercial		19.88[p]	280	*139*	8*M* U; dry wt
Beef	0.9690		190	*140*	
α-Chymotrypsin A					
Beef	0.0905		335	*29*	Deaerated 0.2*N* NaOH
Chymotrypsinogen A					
Commercial		18.97	280	*139*	8*M* U; dry wt
Beef		20.2	280	*28*	
Citrate synthase					
Acinetobacter anitratum	5.11	10.87	280	*141*	mw = 47,000

(*continued*)

Table 1 (*continued*)

Protein	$\epsilon_M^a \times 10^{-4}$	$A_{1\,cm}^{1\%b}$	nm[c]	Ref.	Comments[d]
Clathrin					
Brain					
Human		10.9	280	*142*	Far UV assay
		10.5	280	*142*	Interf.
Bovine		10.9	280	*142*	Far UV assay
		10.5	280	*142*	Interf.
Coagulogen					
Tachypleus		8.52	280	*143*	pH 6.5
		9.80	280	*143*	0.2*N* NaOH–8*M* U
Cobra venom factor					
Naja naja siamensis		10.7	278	*144*	0.1*M* AmAc
Coglucosidase					
Beef spleen	0.3000	6.12	274	*145*	mw = 4900
Colipase					
Horse pancreas	0.82	8.0	280	*146*	mw = 10,200
	0.9	9.0	nc	*147*	mw = 10,000
Pig pancreas	0.4	4.0	nc	*147*	mw = 10,000
	0.37	3.6	280	*148*	mw = 10,314
Collagenase [Clostridopeptidase EC 3.4.24.3]					
Clostridium histolyticum	8.75	12.5	280	*149*	mw = 70,000
Collagenase					
Insect [*Hypoderma lineatum*]	4.5	18.8	280	*150*	mw = 24,000; AA

[a]ϵ_M is the molar absorptivity with units of $M^{-1}cm^{-1}$ and is either the value reported in the reference cited or calculated from the $A_{1cm}^{1\%}$ value and the molecular weight.

[b]$A_{1cm}^{1\%}$ is the absorption for a 1% solution in a 1 cm cuvet and is either the value reported in the reference cited or calculated from the ϵ_M and the molecular weight. The relationship between ϵ_M, $A_{1cm}^{1\%}$, and molecular weight, mw, is $10\epsilon_M = (A_{1cm}^{1\%})$ (mw).

[c]Refers to the wavelength cited and may not be the peak of the absorption band.

[d]*Abbreviations used*: KPh, potassium phosphate; Tris, tris-[hydroxymethyl]aminomethane; GHCl, guanidine hydrochloride; DTT, dithiothreitol; SDS, sodium dodecylsulfate; OEGD, octaethylene-glycoldodecyl ether; EDTA, ethylenediaminetetraacetic acid; ME, mercaptoethanol; Ph, phosphate; NaOAc, sodium acetate, NaBic, sodium bicarbonate; Im, imidazole; NaCac, sodium cacodylate; Hepes, *N*-2-hydroxyethylpiperazine-*N'* -2-ethanesulfonic acid; AmBic, ammonium bicarbonate; Cy, cyanide; U, urea; AmAc, ammonium acetate. *Methods of protein determination*: Lowry, colorimetric method; AA, amino acid analysis; LS, light scattering corrected; N, nitrogen determination; dry wt, dry weight; mw, molecular weight; refr, refractometry; interf, interferometry.

[e]*Staph aureus* V8 protease core.

[f]Protein part.

[g]Protein plus sugar.

[h][c] denotes catalytic site substitution and [n] denotes noncatalytic site substitution.

(*continued*)

Table 1 (*continued*)

[i]Buffer, 0.075*M*, containing 0.5% Triton X-100, 25 m*M* benzaldehyde, and 10% sucrose.
[j]Chymotrypsin hydrolysis product.
[k]ϵ_m not calculated. The following molecular weights given in ref. *108*: 20,700 by amino acid analysis, 22,700 by SDS gal filtration method, and 91,000 by sedimentation.
[l]15.6 or 13.9 given in ref. *113*.
[m]More than one casein present.
[n]The absorption maxima given in ref. *137* are *277* nm, 358 nm, and 435 nm. Measurements made from Fig. 1 result in the wavelengths used.
[o]The absorption maxima given in ref. *135* are 368 and 455 nm. Measurements made from Fig. 1 result in the wavelengths used.
[p]$A_{1cm}^{1\%}$ = 19.64 at 280 nm using a direct measure of protein.

ACKNOWLEDGMENTS

The Library of the Downstate Medical Center College of Medicine has been the major source of all publications examined. What was not available in the library was obtained for me from other libraries by its excellent interlibrary loan service. I should like to thank all the librarians for their most useful and continuing assistance. During the summers of 1971–75, and 1977–82 I was a Library Reader at the Library of the Marine Biological Laboratory, Woods Hole, Massachusetts. From February, 1976 to July, 1976 I used the Library of the University of Sussex, Falmer, Brighton, England. I thank the Librarians of each of these libraries for their kind assistance. I thank Mrs. Marvo Lowe for typing the reference list.

This compilation project was supported in part by Grant No. 1 RO1 LM 03591-03 awarded by the National Library of Medicine, DHEW.

REFERENCES

1. Dudai, Y., Silman, I., Kaldeson, N., and Blumberg, S. (1972), *Biochim. Biophys. Acta* **268,** 138.
2. Raba, R., Aaviksaar, A., Raba, M., and Siigur, J. (1979), *Eur. J. Biochem.* **96,** 151.
3. Taylor, P., Jones, J. W., and Jacobs, N. M. (1974), *Mol. Pharm.* **10,** 78.
4. Dziadik-Turner, C., Koga, D., Mai, M. S., and Kramer, K. J. (1981), *Arch. Biochem. Biophys.* **212,** 546.
5. Ohtakara, A., Yoshida, M., Murakami, M. and Izumi, T. (1981), *Agric. Biol. Chem.* **45,** 239.
6. Mannherz, H. G., Goody, R. S., Konrad, M., and Nowak, E. (1980), *Eur. J. Biochem.* **104,** 367.
7. Pardee, J., and Bamburg, J. R. (1979), *Biochemistry* **18,** 2245.
8. Muhlrad, A., and Hozumi, T. (1982), *Proc. Nat. Acad. Sci. USA* **79,** 958.
9. Koteliansky, V. E., Glukhova, M. A., Bejenian, M. V., Surguchov, A. P., and Smirnov, V. N. (1979), *FEBS Lett.* **102,** 55.
10. Rock, C. O., and Cronan, Jr., J. E. (1980), *Anal. Biochem.* **102,** 362.
11. Shimizu, S., Yasui, K., Tani, Y., and Yamada, H. (1979), *Biochem. Biophys. Res. Comm.* **91,** 108.

12. Osumi, T., Hashimoto, T., and Ui, N. (1980), *J. Biochem., Tokyo* **87,** 1735.
13. Aiba, H., and Krakow, J. S. (1981), *Biochemistry* **20,** 4774.
14. Yung, S-G., and Preiss, J. (1981), *J. Bacteriol.* **147,** 101.
15. Paradies, H. H. (1981), *FEBS Lett.* **133,** 17.
16. Sternweis, P. C., and Smith, J. B. (1980), *Biochemistry* **19,** 259.
17. Andreu, J. M., and Munoz, E. (1979), *Biochemistry* **18,** 1836.
18. Freytag, J. W., and Reynolds, J. A. (1981), *Biochemistry* **20,** 7211.
19. Peters, W. H. M., Depont, J. J. H. H. M., Koppers, A., and Bonting, S. L. (1981), *Biochim. Biophys. Acta* **641,** 55.
20. Esman, M., Skou, J. C., and Christiansen, C. (1979), *Biochim. Biophys. Acta* **567,** 410.
21. Yoshida, M., Sone, N., Hirata, H., Kagawa, Y., and Ui, N. (1979), *J. Biol. Chem.* **254,** 9525.
22. Muller, H. W., Schwulera, U., Salzer, M., and Dose, K. (1979), *Z. Naturforsch.* **34C,** 38.
23. Guy, P. S., Cohen, P., and Hardie, D. G. (1981), *Eur. J. Biochem.* **114,** 399.
24. Pekkle, V. A., and Kirkel, A. Z. (1979), *Biochemistry* (*Biokhimiya*) **44,** 1311.
25. Lim. B. T., and Kimura, T. (1980), *J. Biol. Chem.* **255,** 2440.
26. Tanase, S., Kojima, H., and Morino, Y. (1979), *Biochemistry* **18,** 3002.
27. Vali, Z., Kilar, F., Lakatos, S., Venyaminov, S. A., and Zavodszky, P. (1980), *Biochim. Biophys. Acta* **615,** 34.
28. Whitaker, J. R., and Granum, P. E. (1980), *Anal. Biochem.* **109,** 156.
29. Florence, T. M. (1980), *Biochem. J.* **189,** 507.
30. Hemmings, B. A., Yellowlees, D., Kernohan, J. C., and Cohen, P. (1981), *Eur. J. Biochem.* **119,** 443.
31. Feeney, R. E. (1982), *Int. J. Peptide Prot. Res.* **19,** 215.
32. Yanagisawa, T., Hashimoto, K., and Matsuura, F. (1979), *Bull. Jap. Soc. Sci. Fish.* **43,** 1219.
33. Pavlic, A., and Lapanie, S. (1981), *Biochim. Biophys. Acta* **669,** 60.
34. Tankersley, D. L., and Finlayson, J. S. (1981), *Dev. Biol. Stand.* **48,** 113.
35. Ewart, J. A. D. (1969), *J. Sci. Food Agric.* **20,** 730.
36. Fish, W. W., and Abbott, D. C. (1969), *J. Sci. Food Agric.* **20,** 723.
37. Maret, W., Andersson, I., Dietrich, H., Schneider-Bernlohr, H., Einarsson, R., and Zeppezauer, M. (1979), *Eur. J. Biochem.* **98,** 501.
38. Dafeldecker, W. P., Pares, X., Vallee, B. L., Bosron, W. F., and Li, T. K. (1981), *Biochemistry* **20,** 856.
39. Bamforth, C. W., and Quayle, J. R. (1979), *Biochem. J.* **181,** 517.
40. Yamada, H., Shin, K. G., Kato, N., Shimizu, S., and Tani, Y. (1979), *Agric. Biol. Chem.* **43,** 877.
41. Dickinson, F. M., Hart, G. J., and Kitson, T. M. (1981), *Biochem. J.* **199,** 573.
42. Adachi, O., Matsushita, K., Shinagawa, E., and Ameyama, M. (1980), *Agric. Biol. Chem.* **44,** 155.
43. Adachi, O., Tayama, K., Shinagawa, E., Matsushita, K., and Ameyama, M. (1980), *Agric. Biol. Chem.* **44,** 503.
44. Patel, R. N., Hou, C. T., Derelanda, P., and Felix, A. (1980), *Arch. Biochem. Biophys.* **203,** 654.
45. Morpith, F. F., and Dickinson, F. M. (1980), *Biochem. J.* **191,** 619.
46. Branlant, G., and Bellman, J. F. (1980), *Eur. J. Biochem.* **105,** 611.
47. Nagahisa, E., and Tsuchiya, Y. (1971), *Tohoku J. Agric. Res.* **22,** 46.
48. Shafiee, A., Yunginger, J. W., and Gleich, G. J. (1981), *J. Allergy Clin. Immunol.* **67,** 472.
49. Kazaryan, R. A., and Goryachenkova, E. J. (1978), *Biochemistry* (*Biokhimiya*) **43,** 1502.

50. Gysi, J. R., and Zuber, H. (1979), *Biochem. J.* **181,** 577.
51. Suzuki, S., Sakurai, T., Nakahara, A., Oda, O., Manabe, T., and Okuyama, R. (1980), *FEBS Lett.* **116,** 17.
52. Ishizaki, H., and Yasunobu, K. T. (1980), *Biochim. Biophys. Acta* **611,** 27.
53. Kato, K., Kawahara, K., Takashahi, T., and Kakinuma, A. (1980), *Agric. Biol. Chem.* **44,** 1069.
54. Pistorius, E. K., and Voss, H. (1980), *Biochim. Biophys. Acta* **611,** 227.
55. Gentzen, I., Loffler, H. G., Schneider, F. (1980), *Z. Naturforsch.* **35C,** 544.
56. Anderson, P. M., and Desnick, R. J. (1979), *J. Biol. Chem.* **254,** 6924.
57. Seehra, J. S., and Jordan, P. M. (1980), *Eur. J. Biochem.* **113,** 435.
58. Schnebli, H. P., Phillipps, M. A., and Barclay, R. K. (1979), *Biochim. Biophys. Acta* **569,** 89.
59. Du Toit, P. J., Schabort, J. C., Kempff, P. G., and Laubscher, D. S. A. (1978), *Phytochemistry* **17,** 365.
60. Minoda, Y., Koyano, T., Arai, M., and Yamada, K. (1968), *Agric. Biol. Chem.* **32,** 104.
61. Minoda, Y., Arai, M., and Yamada, K. (1969), *Agric. Biol. Chem.* **33,** 572.
62. Buonocore, V., Gramenzi, F., Pace, W., Petrucci, T., Poerio, E., and Silano, V. (1980), *Biochem. J.* **187,** 637.
63. Hara, K., Ishihara, T., and Yasuda, M. (1979), *Bull. Jap. Soc. Sci. Fish.* **45,** 1005.
64. Saito, N. (1982), *J. Biol. Chem.* **257,** 3120.
65. Pras, M., Schubert, M., Zucker-Franklin, D., Rimon, A., and Franklin, E. C. (1968), *J. Clin. Invest.* **47,** 924.
66. Tso, J. Y., and Zalkin, H. (1981), *J. Biol. Chem.* **256,** 9901.
67. Koide, T., Ohta, Y., Odani, S., and Ono, T. (1982), *J. Biochem., Tokyo* **91,** 1223.
68. Takahara, H., and Sinohara, H. (1980), *Biochim. Biophys. Acta* **612,** 185.
69. Miller-Anderson, M., Borg, H., and Andersson, L. O. (1974), *Thromb. Res.* **5,** 439.
70. Rosenberg, R. D., and Damus, P. S. (1973), *J. Biol. Chem.* **248,** 6490.
71. Vyas, N. G., Williams, E. W., Klaus, G. G. B., and Bond, H. E. (1972), *J. Immunol.* **108,** 1114.
72. Wong, B. L., and Charm, S. E. (1977), in *Biomedical Applications of Immobilized Enzymes and Proteins,* Chang, T. M. S., ed., Plenum, New York, pp. 131–146.
73. Weickmann, J. L., Himmel, M. E., Squire, P. G., and Fahrney, D. E. (1978), *J. Biol. Chem.* **253,** 6010.
74. Viljoen, C. C., Meecham, C. M., and Bates, D. P. (1979), *Toxicon* **17,** 145.
75. Waheed, A., and Vanette, R. L. (1980), *Arch. Biochem. Biophys.* **203,** 11.
76. Faooqui, A. A., and Srivasta, P. N. (1979), *Biochem. J.* **181,** 331.
77. Sekura, R. D., and Jakoby, W. B. (1981), *Arch. Biochem. Biophys.* **211,** 352.
78. Marchesini, A., and Kroneck, P. M. H. (1979), *Eur. J. Biochem.* **101,** 65.
79. Capasso, S., Garzillo, A. M., Marino, G., Mazzarella, L., Pucci, P., and Sannia, G. (1979), *FEBS Lett.* **101,** 351.
80. Riva, F., Carotti, D., Barra, D., Giartosio, A., and Turano, C. (1980), *J. Biol. Chem.* **255,** 9230.
81. Yagi, T., Kagamiyama, H., Motosugi, K., Nozaki, M., and Soda, K. (1979), *FEBS Lett.* **100,** 81.
82. Biellmann, J. F., Eid, P., Hirth, C., and Jornvall, H. (1980), *Eur. J. Biochem.* **104,** 53.

83. Wall, K. A., Fiaiguard, J. E., Gibbons, I., and Schachman, H. K. (1979), *J. Biol. Chem.* **254,** 11910.
84. Martinkus, K., Kennelly, P. J., Rea, T., and Timkovich, R. (1980), *Arch. Biochem. Biophys.* **199,** 465.
85. Itoh, T., Izaki, K., and Takahashi, H. (1978), *J. Gen. Appl. Microbiol.* **24,** 27.
86. Kunzler, P., and Hohn, T. (1978), *J. Mol. Biol.* **122,** 191.
87. Makino, S., Nakashima, H., and Shibagaki, K. (1981), *J. Biochem., Tokyo* **89,** 651.
88. Zvonar-Popovic, T., Lah, T., Kregar, I., and Turk, V. (1980), *Croat. Chem. Acta* **53,** 509.
89. Yamaguchi, K., and Ogata, T. (1978), *Bull. Jap. Soc. Sci. Fish.* **44,** 631.
90. Sensabaugh, Jr., G. F., Wilson, C. A., and Kirk, P. L. (1971), *Int. J. Biochem.* **2,** 545.
91. Manthey, J. A., and Hager, L. P. (1981), *J. Biol. Chem.* **256,** 11232.
92. Chen, Y. H., Tai, J-C., Huang, W-J., Lai, M-Z., Hung, M-C., Lai, M-D., and Yang, J. T. (1982), *Biochemistry* **21,** 2592.
93. Rush, R. S., Main, A. R., Meller, S. K., and Kilpatrick, B. F. (1980), *J. Biol. Chem.* **255,** 7155.
94. Kohler, L., Cox, J. A., and Stein, E. A. (1978), *Mol. Cell. Biochem.* **20,** 85.
95. Cox, J. A., and Stein, E. A. (1981), *Biochemistry* **20,** 5340.
96. MacManus, J. P. (1980), *Biochim. Biophys. Acta* **621,** 296.
97. Van Elkik, L. J., and Watterson, D. M. (1970), *J. Biol. Chem.* **254,** 10250.
98. Bazari, W. L., and Clarke, M. (1981), *J. Biol. Chem.* **256,** 3598.
99. Bazari, W., and Clarke, M. (1980), *Ann. NY Acad. Sci.* **356,** 358.
100. Schreiber, W. E., Sasagawa, T., Titani, K., Wade, R. D., Malencik, D., and Fischer, E. H. (1981), *Biochemistry* **20,** 5239.
101. Jarret, H. W., and Kyte, J. (1979), *J. Biol. Chem.* **254,** 8237.
102. Perez, R. O., Von Tuinen, D., Marme, D., Cox, J. A., and Turian, G. (1981), *FEBS Lett.* **133,** 205.
103. Kilhoffer, M. C., Gerard, D., and Demaille, J. (1980), *FEBS Lett.* **120,** 99.
104. Autric, F., Ferraz, C., Kilhoffer, M. C., Cavadore, J. C., and Demaille, J. G. (1980), *Biochim. Biophys. Acta* **631,** 139.
105. Yazawa, M., Sakuma, M., and Yagi, K. (1980), *J. Biochem., Tokyo* **87,** 1313.
106. Haiech, J., and Demaille, J. G. (1980), *J. Biol. Chem.* **255,** 9404.
107. Pal. G., and Sinha, N. K. (1980), *Arch. Biochem. Biophys.* **202,** 321.
108. Margalit, R., and Daniel, E. (1978), *Phytochemistry* **17,** 1015.
109. Morpurgo, L., Rotillo, G., Finazzi Agro, A., and Mondovi, B. (1975), *Arch. Biochem. Biophys.* **170,** 360.
110. Carlsson, U., Kjellstrom, B., and Antonsson, B. (1980), *Biochim. Biophys. Acta* **612,** 160.
111. Scott, W. N., and Skipski, I. (1979), *Comp. Biochem. Physiol.* **63B,** 429.
112. Meyer, O., Schlegel, H. G. (1980), *J. Bacteriol.* **141,** 74.
113. Miller, S. K., Main, A. K., and Rush, R. S. (1980), *J. Biol. Chem.* **255,** 7161.
114. Narahashi, Y., and Yoda, K. (1979), *J. Biochem., Tokyo* **86,** 683.
115. Breddam, K., Bazzone, T. J., Holmquist, B., and Vallee, B. L. (1979), *Biochemistry* **18,** 1563.
116. Hass, G. M., and Ryan, C. A. (1981), *Meth. Enzymol.* **80C,** 778.
117. Louw, A. I., and Carlsson, F. H. H. (1979), *Toxicon* **17,** 193.
118. Snoeren, T. H. M., Van Markwijk, B., and Van Montfort, R. (1980), *Biochim. Biophys. Acta* **622,** 268.
119. Barry, J. G., and Donnelly, W. J. (1979), *Biochem. Soc. Trans.* **7,** 529.

120. Hirose, M., Kato, T., Omori, K., Maki, M., Yoshikowa, M., Sasaki, R., and Chiba, H. (1981), *Biochim. Biophys. Acta* **667**, 309.
121. Browett, W. R., and Stillman (1979), *Biochim. Biophys. Acta* **577**, 291.
122. Hatchikian, C. E., and LeGall, J. (1977), in *Superoxide and Superoxide Dismutases*, Michelson, A. M., McCord, J. M., and Fridovich, I., eds., Academic Press, New York, pp. 159–172.
123. Palcic, M., and Dunford, H. B. (1979), *Can. J. Biochem.* **57**, 321.
124. Jacob, A. S., and Orme-Johnson, W. H. (1979), *Biochemistry* **18**, 2967.
125. Suzuki, A., Okitani, A., and Fujimaki, M. (1969), *Agric. Biol. Chem.* **33**, 579.
126. Barrett, A. J., and McDonald, J. K. (1980), *Mammalian Proteases A Glossary and Bibliography*, Vol. I., Academic Press, New York, pp. 182–187.
127. Saklatvala, J., and Barrett, A. J. (1980), *Biochim. Biophys. Acta* **615**, 167.
128. Schwartz, W. N., and Barrett, A. J. (1980), *Biochem. J.* **191**, 487.
129. Kirschke, H., Langner, J., Wiederanders, B., Ansorge, S., Bohley, P., and Hanson, H. (1977), *Acta Biol. Med. Ger.* **36**, 185. [Cited in Barrett, A. J., and Kirschke, H. (1981), *Methods in Enzymol.* **80C**, 535.]
130. Stevenson, K. J., Slater, J. A., and Takai, S. (1979), *Phytochemistry* **18**, 235.
131. Noyer, M., Dwulet, F. E., Hao, Y. L., and Putnam, F. W. (1980), *Anal. Biochem.* **102**, 450.
132. Calabrese, L., Malatesta, F., and Barra, D. (1981), *Biochem. J.* **199**, 667.
133. Manolis, H., and Cox, D. W. (1980), *Prep. Biochem.* **10**, 121.
134. Sae, A. S. W., and Cunningham, B. A. (1979), *Phytochemistry* **18**, 1785.
135. Ohta-Fukuyama, M., Miyake, Y., Shiga, K., Nishina, Y., Watari, H., and Yamano, T. (1980), *J. Biochem., Tokyo* **88**, 205.
136. Tani, Y., Mori, N., Ogata, K., and Yamada, H. (1979), *Agric. Biol. Chem.* **43**, 815.
137. Ohta-Fukuyama, M., Miyake, Y., Emi, S., and Yamano, T. (1980), *J. Biochem., Tokyo* **88**, 192.
138. Haupt, H., Heide, K., Zwisler, O., and Schwick, H. G. (1966), *Blut* **14**, 65.
139. Prakash, V., Loucheux, C., Scheufele, S., Gorbunoff, M. J., and Timasheff, S. N. (1981), *Arch. Biochem. Biophys.* **210**, 455.
140. Hennessey, Jr., J. P., and Johnson, Jr., W. C. (1981), *Biochemistry* **20**, 1085.
141. Morse, D., and Duckworth, H. W. (1980), *Can. J. Biochem.* **58**, 696.
142. Nandi, P. K., Pretorius, H. T., Lippoldt, R. E., and Johnson, M. L., and Edelhoch, H. (1980), *Biochemistry* **19**, 5917.
143. Nakamura, S., Shishikura, F., Iwanaga, J., Takagi, T., Takahashi, K., Niwa, M., and Sekiguchi, K. (1980), in *Frontiers in Protein Chemistry*, Liu, T. Y., Mamiya, G., and Yasunobu, K. T., eds., Elsevier-North Holland, New York, pp. 495–514.
144. Eggertsen, G., Lind, P., and Sjoquist, J. (1981), *Mol. Immunol.* **18**, 125.
145. Berent, S. L., and Radin, N. S. (1981), *Arch. Biochem. Biophys.* **208**, 248.
146. Chapus, C., Desnuelle, P., and Foglizzo, E. (1981), *Eur. J. Biochem.* **115**, 99.
147. Pierrot, M., Astier, J. P., Astier, M., Charles, M., and Drenth, J. (1982), *Eur. J. Biochem.* **123**, 347.
148. Canioni, P., Cozzone, P. J., and Sarda, L. (1980), *Biochim. Biophys. Acta* **621**, 29.
149. Emod, L., Tong, N. T., and Keil, B. (1981), *Biochim. Biophys. Acta* **659**, 283.
150. Lecroisey, A., Boulard, C., and Keil, B. (1979), *Eur. J. Biochem.* **101**, 385.