
Compilation of tRNA sequences

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INTRODUCTION

This compilation presents in a small space the tRNA sequences so far published covering the literature to about the end of 1983. The numbering derived from tRNA^{Phe} from yeast as adopted in the Cold Spring Harbor Symposium on tRNA, 1979, is used (1, Fig. 1). Different from the originally adopted nomenclature (1) in 17:1, 20:1, 47:1, etc. the numbers after the colon are replaced by capital letters in alphabetical order for technical reasons. The secondary structure of tRNA is indicated by specific underlining. For the nomenclature of rare nucleosides see Table 1 and references 2 and 3; for that of species see the Nucleotide Sequence Data Library of EMBL, Heidelberg. Together with the running number and the species the anticodon sequence (in unmodified state) is given for further identification of the sequences. Footnotes are numbered according to the coordinates of the corresponding nucleoside and are indicated in the sequence by an asterisk. In the case of tRNAs where an alignment is not possible, this fact is indicated in a footnote.

The references are restricted to the citation of the latest publication in those cases, where several papers deal with one sequence. tRNA mutants are not compiled comprehensively (see another compilation within these compilations). The compilation is deposited with the Nucleotide Sequence Data Library of EMBL and available there on magnetic tape upon request. The compilers would welcome any information regarding missing material or erroneous presentation.

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Table 1: Abbreviations for modified nucleosides

A1 = M1A	= 1-METHYLADENOSINE
A2 = M2A	= 2-METHYLADENOSINE
A4 = I6A	= N6-ISOPENTENYLADENOSINE
A5 = MS2I6A	= 2-METHYLTHIO-N6-ISOPENTENYLADENOSINE
A6 = M6A	= N6-METHYLADENOSINE
A7 = T6A	= N-((9-BETA-D-RIBOFURANOSYLPURINE-6-YL) CARBAMOYL) THREONINE
A8 = MT6A	= N-((9-BETA-D-RIBOFURANOSYLPURINE-6-YL)N-METHYL-CARBAMOYL) THREONIN
A9 = MS2T6A	= N-((9-BETA-D-RIBOFURANOSYL-2-METHYLTHIOPURIN-6-YL) CARBAMOYL THREONINE
C2 = S2C	= 2-THIOCYTIDINE
C3 = CM	= 2'-O-METHYLCYTIDINE
C4 = AC4C	= 4-ACETYLCYTIDINE
C5 = M5C	= 5-METHYLCYTIDINE
C6 = M3C	= 3-METHYLCYTIDINE
D = D	= DIHYDROURIDINE
F = F	= PSEUDOURIDINE
F1 = M1F	= 1-METHYLPSEUDOURIDINE
F3 = FM	= 2'-O-METHYLPSEUDOURIDINE
G1 = M1G	= 1-METHYLGUANOSINE
G2 = M2G	= 2-METHYLGUANOSINE
G3 = GM	= 2'-O-METHYLGUANOSINE
G4 = M22G	= 2,2-DIMETHYLGUANOSINE
G7 = M7G	= 7-METHYLGUANOSINE
G5 = M22G	= 2,2,3'-TRIMETHYLGUANOSINE
I = I	= INOSINE
I1 = M1I	= 1-METHYLINOSINE
Q = Q	= QUENOSINE
Q1 = MAN_Q	= BETA, D-MANNOSYLQUENOSINE
Q2 = GAL_Q	= BETA, D-GALACTOSYLQUENOSINE
T1 = T	= 5-METHYLURIDINE
T2 = S2T	= 5-METHYL-2-THIOURIDINE
T3 = TM	= 2'-O-METHYL-5-METHYLURIDINE
U1 = MAM5U	= 5-METHYLAMINOMETHYLURIDINE
U2 = S2U	= 2-THIOURIDINE
U3 = UM	= 2'-O-METHYLURIDINE
U4 = S4U	= 4-THIOURIDINE
U7 = MCM5U	= 5-METHOXYCARBONYLMETHYLURIDINE
U8 = MAM5S2U	= 5-METHYLAMINOMETHYL-2-THIOURIDINE
U9 = MCM5S2U	= 5-METHOXYCARBONYLMETHYL-2-THIOURIDINE
V1 = O5U	= URIDINE-5-OXYACETIC ACID, (V)
V2 = MO5U	= 5-METHOXYURIDINE
V3 = MV	= URIDINE-5-OXOACETIC ACID-METHYLESTER
V4 = CMNM5U	= 5-CARBOXYMETHYLAMINOMETHYLURIDINE
V5 = CMNM5S2U	= 5-CARBOXYMETHYLAMINOMETHYL-2-THIOURIDINE
V6 = CHM5U	= 5-(CARBOXYHYDROXYLMETHYL)URIDINE
X = X	= 3-(3-AMINO-3-CARBOXYPROPYL)URIDINE, (ACP3)U
Y1 = YW	= WYBUTOSINE
Y2 = O2YW	= WYBUTOXOSINE

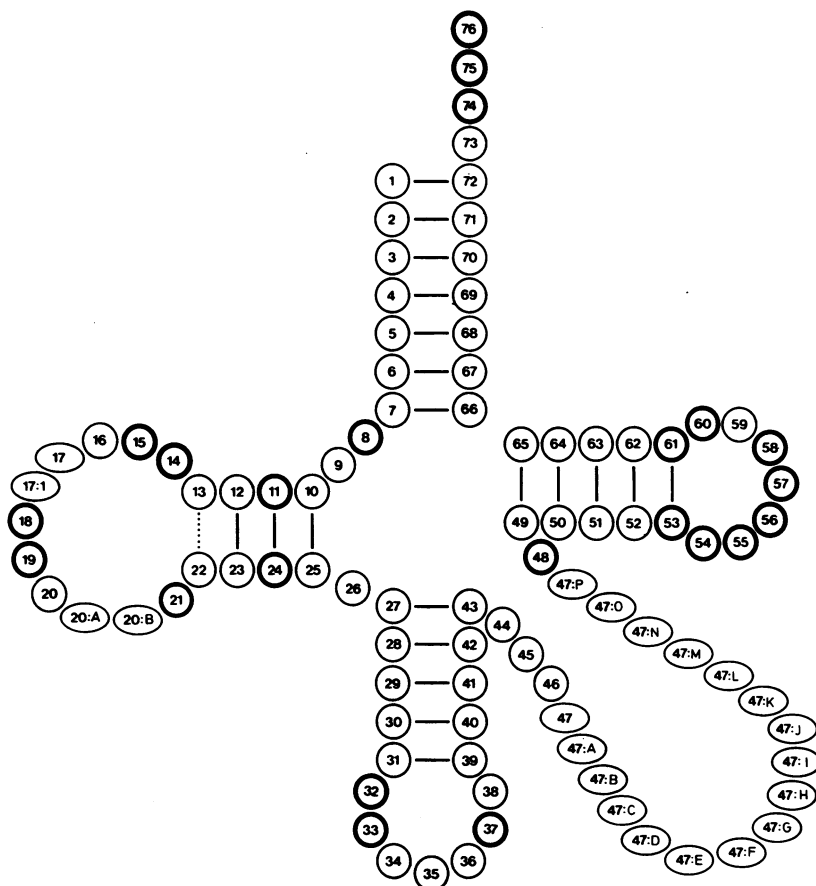


Figure 1: Numbering system of nucleotides in tRNAs according to the numbering of phenylalanine tRNA from yeast. Circles represent nucleotides which are always present; among these, the thick-edged circles denote invariant or semi-invariant nucleotides. Ovals represent nucleotides which are not present in each sequence: these are the nucleotides before the two constant GMP residues (18,19) in the D loop, the nucleotides after these GMP residues, and the nucleotides in the variable loop which may be up to 17 nucleotides.

A nucleotide to be added at a given site is indicated by the number of the preceding nucleotide followed by a colon and a capital letter in alphabetical order. Thus, e.g. 20:A and 20:B mean the first and the second nucleotide after position 20. The absence of a nucleotide is indicated by the absence of a number, e.g. if no residue is found in position 17, the sequence then reads C16-C18. The numbering for the D loop, when one, two or three nucleotides are present each between 15 and 18 or between 19 and 21, is then 16 and 16, 17 and 16, 17, 17:A or 20 and 20, 20:A and 20, 20:A, 20:B, respectively. When the variable loop is five-membered, the numbering is as in yeast phenylalanine tRNA 44, 45, 46, 47, 48. 47 is eliminated when the variable loop is four-membered. For large variable loops, numbers are added onto 47, e.g. for thirteen nucleotides 44, 45, 46, 47, 47:A, 47:B, 48:C, 47:D, 47:E, 47:F, 47:G, 47:H, 47:I.

	AMINOACYL STEM	D STEM	D LOOP	ID STEM	ANTIC. STEM	ANTIC. LOOP	ANTIC. STEM
	1 2 3 4 5 6 7	8 9 10 11 12 13	14 15 16 17 18 19 20	21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42			
A L A N I N E							
0010	UGC E. COLI	G G G G C A U A	G C U C A G C D	A G A G C G	C C U G C C	U U V16 C A C	G C R A G G
0011	UGC E. COLI	*****	G G G	A G A G C G	C C U G C C	U U V16 C A C	G C R A G G
0013	CGC HALOBACTERIUM CUT.	G G G C U C A U	A G C U C A G C D	A G A G C G	C C U G C C	U U V16 C A C	G C R A G G
0015	UGC BACILLUS SUBTILIS	*****	G G G	A G A U C G C	U U C C C	U U C G C A R A	G G R A G
0020	ACC TORULOPSIS UTILIS	*****	G G G	A G A G C C U	C U G C C	U U V25 C A B C	G C A G G
0025	UGC NEUROSPORA CRASSA MITO	*****	G G D	A G C G C G U	A G C G C G	U U I G C I1F	G C G R A
0030	ACC YERST*	*****	G G D	A G U A C A U	A G C A R U	C U U G C U C	A N U G C
0040	ACC BOMBYX MORI	*****	G G U	A G C G C G U	A G C G C G	U U I G C I1F	G G G R A G
0041	ACC BOMBYX MORI	*****	G G U	A G C G C G U	A G C G C G	U3U I G C I1F	G3F G R A G
A R G I N I N E							
0110	ACC E. COLI	G C A U C C G U A R	G C U C A G C D	A G A G U A	C U C G G C	C2U I C G A2A	C C G R A G
0111	ACC E. COLI B	*****	G C D	A G A G U A	C U C G G C	C U I C G A2A	C C G R A G

0010 R. J. WILLIAMS, W. NAGEL, B. ROE, B. DUDOCK (1974)
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 BIOCHEM. BIOPHYS. RES. COMMUN. 47, 1332-1337

0111 K. CHAKRABURTY (1980) NUCL. ACIDS RES. 8, 4459-4472

EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOCYL STEM
45	B D F H J L N P	49 51 53	55 57 59	61 63 65	67 69 71
44	A C E G I K M O	54 56 58	60 62 64	66 68 70	72 74 76

A R G I N I N E					
0010	A G 67U	C U G C G G T	F C G A U C	C C G C G C	G C C U C C C A C C C A
0011	A G 67U	C U G C G G T	F C G A U C	C C G C A U A G C U C C A C C C A	**** *****
0013	A G 6 C	C S U G G G F I F	C 3 I 1 A U	C C C A G C	C G A G U C C A C C C A
0015	A G 67U	C A G C G G T	F C G A U C	C C G C U A G C C U C C C A C C C A	*****
0020	A G 6 D	C U C C G G T	F C G A 1 C U	C C G G A C U C G U C C C A C C C A	*****
0025	U U 6	U C S A A G G T	F C A R A U	C C U U G U A U C U C C A C C C A	*****
0030	A G 6 D*	C U C C G G T	F C G A U U	C C G G A C U C G U C C C A C C C A	*****
0040	A G 67U	A C S C G G G A	F C G A 1 U A	C C C G C C C C U C C A C C C A	*****
0041	A G 67U	A C S C G G G A	F C G A 1 U A	C C C G C C C C U C C A C C C A	*****

A R G I N I N E					
0110	C G 67X	C G A G G T	F C G A R A U	C C U C C C G G A U G C A C C C A	*****
0111	C G 67X	C G A G G T	F C G A R A U	C C U C C C G G A U G C A C C C A	*****

0010/8 PARTIALLY MODIFIED
 0025/40 N IS A MODIFIED URIDINE
 0025/49 PARTIALLY MODIFIED
 0030/0 COMPARE R.W.HOLLEY ET AL. (1965) SCIENCE 147, 1462-1465
 0030/47 PARTIALLY MODIFIED
 0040/40 PARTIALLY PSEUDOURIDINE
 0110/20 PARTIALLY MODIFIED
 0111/20 A PARTIALLY MODIFIED

	AMINOACYL STEM	D STEM	D LOOP	D STEM	D LOOP	D STEM	D STEM	D LOOP	D STEM	D STEM	ANTIC. STEM	ANTIC. LOOP	ANTIC. STEM
	1 2 3 4 5 6 7	8 9 10 12 14 16 A 19 A 21 23 25	15 17 18 20 B 22 24 26	27 29 31	32 34 36 38	39 41 43							
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
0115	GC6 HALOBACTERIUM VOL.	G U C C U G A U A G A G G F A G U	G G R C U R A U C C U U C U G G C	U C C U C U G G C	U U G C G G T A G C C R G								
0120	NCU PHAGE T4	G U C C C G C U G G U G U A U	G S R A D A G C A U A C G A U C	A C G A U C G A U C	C U N C U R A G F U U G								
0125	AC6 BRACILLUS SUBTILIS	G C G C C C G U A G C U C A R U	G G R D A G A G C G U U U G R A	A G A G C G U U U G R A	C U I C G G T A U C R A R								
0130	AC6 YEAST	F U C C U C G U G U G C C C A R D	G G D C A C G G C G A	A C G G C G A	C U I C G R A C C R G R								
0140	UCU YEAST	G C U C G C G U G U G C C U A R D	G G C A R C G C G A	A C G C G A	C U U 7 C U A 7 A F C R G R								
0141	UCU YEAST	G C U U G C G U G U G C C U A R D	G G C A R C G C G A	A C G C G A	C U U 7 C U A 7 A F C R G R								
0150	UCG RAT MORRIS HEPATOMA MITO	U G G U A R U U A G U U U A R A U A		A R A U U A R A U G A	F U U C G R C F C R U U								
0151	UCG BOVINE LIVER MITO	U G U A C U U A U U U A R A U A		A R A U A R A U G A	U U U C G R C F C R U U								
0152	CCG BOVINE LIVER	G A C C C A G U G U G C C U A R D	G S R A D A R A G C C A	A G G C A F C R G C	C 3 U C C G G T A G C C U G G								
0155	NCU YEAST MITO	G C U C C U A G C C U U A R D	G G D U A R A G C A	F A R A U A	C U N C U A 7 A F R U U A								
0156	AC6 YEAST MITO	A R A U C U U A R A U U U A R D	G G D A R A A U A	F U A G A	A U A R C G R A F C U A R								
0157	UCG MOSQUITO MITO	A R A U A G A A U U U A R D	G G D A R A A U A	F U A G A	F U U C G R C C U A R U								

ARGININE cont.

0115 R. GUPTA (1981) PH.D. THESIS, UNIVERSITY OF ILLINOIS, URBANA
 0120 G.P. MAZZARA, J.G. SEIDMAN, M.H. MCCLAIN, H. YESTIAN, J. ABELSON, C. GUTHRIE (1977)
 0125 J.B. LACHER, 252, 8245-8253
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 0156 G. DIRHEIMER (1981) PERSONAL COMMUNICATION
 0157 C.C. HSUCHEN, G.R. CLEAVES, D.T. DUBIN (1983) PLASMID 10, 55-65

EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOCYL STEM																																	
45	47	B	D	F	H	J	K	L	M	N	P	49	51	53	55	57	59	61	63	65	67	69	71	73	75													
44	46	A	C	E	G	I	K	L	M	O	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76													
ARGININE cont.																																						
0115	G	G	A	C	S	G	A	G	F	1	F	C	3	2	A	R	U	C	U	C	C	G	U	C	A	G	A	C	G	C	C	A						
0120	C	G	G	U	C	C	U	G	G	T	F	C	G	A	U	C	C	A	G	G	G	S	C	G	G	A	U	A	C	C	A							
0125	A	G	G	G	U	A	G	G	G	T	F	C	G	A	U	C	C	U	C	G	G	C	G	C	G	C	C	A										
0130	A	G	A	D	U	C	S	A	G	G	T	F	C	A	A	1	6	U	C	U	G	C	G	G	A	A	G	C	C	A								
0140	A	G	A	D	U	A	U	G	G	G	T	F	C	G	A	1	C	C	C	A	U	C	G	U	G	A	G	U	G	C	C	A						
0141	A	G	A	D	U	A	U	G	G	G	T	F	C	G	A	1	C	C	C	A	U	C	G	U	G	A	G	U	G	C	C	A						
0150	A	G	A	U	U	A	U	G	A	U	A	U	A	U	A	A	U	C	A	U	A	U	U	A	U	A	U	A	C	C	A							
0151	A	G	A	U	U	A	U	A	U	A	U	U	A	A	U	A	U	C	A	U	A	U	A	U	A	U	A	C	C	A								
0152	G	G	A	D	U	G	F	G	G	G	T	F	C	G	A	1	6	U	C	C	C	A	U	C	U	G	G	U	C	G	C	C	A					
0155	A	U	A	U	U	C	C	A	U	G	T	F	C	A	A	A	U	C	A	U	G	G	A	G	A	G	U	A	C	C	A							
0156	U	U	A	U	U	A	U	A	G	G	T	F	C	A	A	A	U	C	C	A	U	A	A	G	A	U	A	U	C	C	A							
0157	C	U	U	A	A	G	G	U	G	A	A	U	A	C	C	A	U	U	C	A	C	C	A	F	A	U	U	U	C	C	A							

0120/34 N IS A NOT IDENTIFIED DERIVATIVE OF URIDINE
 0150/0 ALIGNMENT IS ARBITRARY
 0150/49 PARTIALLY G
 0151/0 ALIGNMENT IS ARBITRARY
 0155/34 MODIFIED URIDINE
 0157/0 ALIGNMENT IS ARBITRARY

		AMINOACYL STEM													D STEM				D LOOP				D STEM				ANTIC. STEM				ANTIC. LOOP				ANTIC. STEM																									
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42																	
ARGININE cont.																																																												
0171	RCG MOUSE LEUKEMIA	G	G	G	C	C	A	R	G	U	G	G	G	C	C	R	A	D	G	G	A	D	A	R	C	G	C	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A			
0172	RCG MOUSE LEUKEMIA	**	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	G	G	A	D	A	R	C	G	C	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A			
0173	UCG HAMSTER MITO*	**	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	U	G	U	G	A	U	A	R	C	U	A																															
ASPARAGINE																																																												
0210	GUJ E. COLI	U	C	C	U	C	U	G	U	A	R	G	U	C	A	R	G	D	G	G	D	A	G	A	R	C	G	A	C	U	U	A	R	G	D	A	G	A	R	C	G	A	C	U	U	A	R	G	D											
0220	GUJ PHAGE T5	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	U	A	R	U	A	G	A	R	C	G	A	C	U	U	A	R	G	D	A	G	A	R	C	G	A	C	U	U	A	R	G	D										
0260	GUJ MAMMALIAN*	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	U	A	R	U	A	G	A	R	C	G	A	C	U	U	A	R	G	D	A	G	A	R	C	G	A	C	U	U	A	R	G	D										
ASPARTIC ACID																																																												
0310	GUC E. COLI	G	G	A	G	C	C	G	U	A	R	G	U	C	A	R	G	D	G	G	D	A	G	A	R	C	G	A	C	U	U	A	R	G	D	A	G	A	R	C	G	A	C	U	U	A	R	G	D											
0315	GUC HALOBACTERIUM VOL.	G	C	C	C	G	G	U	G	G	A	U	G	G	A	U	G	U	G	A	R	G	D	A	G	A	R	C	G	A	C	U	U	A	R	G	D	A	G	A	R	C	G	A	C	U	U	A	R	G	D									
0320	GUC YEAST	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	U	C	C	G	U	A	R	G	U	C	A	R	G	D	A	G	A	R	C	G	A	C	U	U	A	R	G	D														
0171	F. HARADA, S. NISHIMURA (1980) BIOCHEMISTRY INTERNATIONAL 1, 539-546																																																											
0172	F. HARADA, S. NISHIMURA (1980) BIOCHEMISTRY INTERNATIONAL 1, 539-546																																																											
0173	C. C. HSU-CHEN, G. A. CLEAVES, D. T. DUBIN (1983) PLASMID 10, 55-65																																																											
0210	K. OHASHI, F. HARADA, Z. OHASHI, S. NISHIMURA, T. S. STEWART, G. VOGELI, T. MC CUTCHAN, D. BELL (1976) NUCLEIC ACIDS RES. 3, 3369-3376																																																											
0220	V. M. ARYUKOV, A. G. SCHLYAPNIKOV, S. I. KAZANTSEV, A. V. KALITMAN, V. N. KSENZENKO, A. A. BAYEV, ENDO-FEBS MEETING, STRASBOURG, JULY 1980																																																											
0260	E. Y. CHEN, B. A. ROE (1978) BIOCHIM. BIOPHYS. RES. COMMUN. 82, 235-246																																																											
(1980) BIOCHIM. BIOPHYS. ACTA 610, 272-284																																																												
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0310	T. SEKIYA, M. MORI, N. TAKAHASHI, S. NISHIMURA (1980) NUCL. ACIDS RES. 8, 3809-3827																																																											
0315	R. GUPTA (1981) PH.D. THESIS, UNIVERSITY OF ILLINOIS, URBANA																																																											
0320	J. GANGLOFF, G. KEITH, J. P. EBEL, G. DIRHEIMER (1972) BIOCHIM. BIOPHYS. ACTA 259, 210-222																																																											

	EXTRA ARM						TF STEM			TF LOOP			TF STEM			AMINOACYL STEM												
	45	47	B	D	F	H	J	K	L	M	N	O	48	49	51	53	55	57	59	61	63	65	67	69	71	73	75	
	44	A	C	E	G	I	K	O	48	S	O	52	54	56	58	60	62	64	66	68	70	72	74	76				
0171	ARG	D						U	CS	AG	GG	F	FC	GA	UC	CC	UG	GC	UC	UG	GC	UC	UG	GC	UC	UG	GC	UC
0172	ARG	D						U	CS	AG	GG	F	FC	GA	UC	CC	UG	GC	UC	UG	GC	UC	UG	GC	UC	UG	GC	UC
0173	ARG	A						U	UA	UG	A	CA	UA	UC	U	CA	UA	UC	CA	CA	CA	CA	CA	CA	CA	CA	CA	CA
0210	ASP	ARG	INE					C	AC	UG	GT	FC	GA	GU	CC	AG	UC	AG	AG	GG	GA	GC	CC	CA	GC	CC	CA	
0220	GG	GU						U	GC	UG	GT	FC	GA	U	CC	AG	UC	AG	AG	GG	GA	GC	CC	CA	GC	CC	CA	
0260	GG	GU						U	GG	UG	GN	FC	GA	UC	CC	AC	CC	CA	GG	GA	GC	CC	CA	GC	CC	CA		
0310	GG	GU						C	GC	GG	GT	FC	GA	GU	CC	CG	FC	CG	UUC	CC	CG	FC	CG	UUC	CC	CG	FC	
0315	UG	A						C	GC	GG	GT	FC	GA	U	CC	CG	FC	CG	UUC	CC	CG	FC	CG	UUC	CC	CG	FC	
0320	AG	A						U	CG	GG	GT	FC	GA	U	CC	CG	FC	CG	UUC	CC	CG	FC	CG	UUC	CC	CG	FC	

ARGININE cont.

ASPARAGINE

ASPARTIC ACID

0173/0 ALIGNMENT IS ARBITRARY
 0220/37 DERIVATIVE OF ADENOSINE
 0260/0 ISOLATED FROM RAT LIVER, HUMAN LIVER, HUMAN PLACENTA, AND SARCOMA
 0260/34 IN SARCOMA TRNA G INSTEAD OF Q
 0315/54 PARTIALLY F

	AMINOACYL STEM	D STEM	D LOOP	D STEM	D LOOP	D STEM	ANTIC. STEM	ANTIC. LOOP	ANTIC. STEM	
	1 2 3 4 5 6 7	8 9 10 11 12 13	14 15 16 17 18	19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42						
ASPARTIC ACID cont.										
0330	GUC PHAGE T5	G G R A C C G G G C U G G C U U G G U A A U G G U U C U C C C C U G U C A C G G G R G								
0340	GUC EUGLENA GRACILIS	***** U C U U C G G U A G U A F A G D G S G D A A G U A U N F C C G C C U G U C A N G C G G R A								
0358	GUC MOSQUITO MITO	***** A R A R A U U A G U U U A R U C A R A A R C C F F A G U A U G U C A 7 A A C U A R								
0360	GUC RAT MORRIS HEPATOMA MITO	***** G A G A U A U A G U A R A R A U A U A R C A F A R C C U U G U C C A R A G U U A								
0361	GUC BOVINE LIVER	***** G G U G C C G U A G Z C G F A G D G S G C A N C G A C U C U C 3 U Q 1 U C A R A R A G A G U								
0362	GUC RABBIT LIVER	***** U C C C G U C U A G U A F A G U G G D G A G U A U A U C C G C C U Q 1 U C A C G C G G G								
0363	GUC RAT LIVER	***** U C C U C G U U A G U A F A G U G G D G A G U A U C C C G C C U C Q 1 U C A C S G C G G G								
0364	GUC RAT HEPATOMA	***** U C C U C G U U A G U A F A G U G G D G A G U A U C C C G C C U C G U C A C S G C G G G								
0365	GUC HAMSTER MITO	***** A R G A U A U U A G U A R A R A U C A U A C A R A C U U G U C A G A G U U A								
C Y S T E I N E										
0410	GCA E. COLI	G G C G C G U U A R A C R A R A G C G G D D A U G U A R G C G G R A F U G C R A S A F C C G U								
0440	GCA YERST	***** G C U C G U A U G C C C A G D G G D A G C G C A R G C R A G A F U G C R A A R F C U G U								

0330 V. R. KRUKOV, N. G. SCHLYAPNIKOV, S. I. KAZANTSEV, A. V. KALIRAN, V. N. KSENZENKO, 1072-1081
 A. A. BAYEV, ENDO-FEBS MEETING, STRASSBOURG, JULY 1980
 0340 M. G. FARRETT, S. H. CHANG, W. E. BARNETT (1980) FED. PROC. 39, 2022
 0358 C. C. HSUCHEN, G. R. CLEAVES, D. T. DUBIN (1983) PLASMID 10, 55-65
 0360 H. P. ADRAVAL, K. RANDEKATH, E. RANDEKATH (1981) NUCLEIC ACIDS RES. 9, 2535-2541
 0361 U. N. VAKHARIA (1981) FED. PROC. 40, 1753 ABSTR. 1234
 0362 V. N. VAKHARIA, R. P. SINGHAL (1982) BIOCHEM. BIOPHYS. RES. COMMUN. 105, 1072-1081
 0363 Y. KUCHINO, N. SHINDO-OKADA, N. ANDO, S. WATANABE, S. NISHIMURA (1981) J. BIOL. CHEM. 256, 9059-9062
 0364 Y. KUCHINO, N. SHINDO-OKADA, N. ANDO, S. WATANABE, S. NISHIMURA (1981) J. BIOL. CHEM. 256, 9059-9062
 0365 C. C. HSUCHEN, G. R. CLEAVES, D. T. DUBIN (1983) PLASMID 10, 55-65
 0410 G. P. MAZZARA, M. H. MCCLAIN (1977) J. MOL. BIOL. 117, 1061-1079
 0440 N. J. HOLNESS, G. ATFIELD (1976) BIOCHEM. J. 153, 447-454

EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOCYL STEM
45	47 B D F H J L N P	49 51 53	55 57 59	61 63 65	67 69 71 73 75
44	46 A C E G I K M O	50 52 54	56 58 60	62 64 66	68 70 72 74 76
ASPARTIC ACID cont.					
0330	A G A R	U G U G G G	T F C A R A U	C C C R U	C G G U C G C G C C R
0340	A G A	N C G G G	T F C A N U U	C C C G G	C C G G A G A G C C R
0358	A A R	A U U R G A	A U C R A U	C U R A U A	F F U U U A C C R
0360	A G U	U A U A G A	C U U A R A	U C U A U A	U R U C U U A C C R
0361	G G G 7A	C S N U G A G	T F C G A U A	C U C A R C	G G C A C C G C C R
0362	A G G A	C S E S G G G	T F C G A U A	C C C C G	G A C G G A G C C R
0363	A G A	C S E S G G G	T F C G A U U	C C C C G A	C G G G G A G C C R
0364	A G A	C S E S G G G	T F C G A U U	C C C C G A	C G G G G A G C C R
0365	A R U	U A U A G A	C U A R A U C	U C U A U A	U A U C U U A C C R
C Y S T E I N E					
0410	C U R	G U C C G G	T F C G R C U	C C G G A	R C G C G C C U C C R
0440	U G G 7D	C S E U U A G	T F C G A U C	C U G A G	U G C G A G C U C C R

0330/65 30% PSEUDOURIDINE
 0330/55 20% URIDINE
 0340/26 MODIFIED GUANOSINE
 0340/38 MODIFIED CYTIDINE
 0340/48 MODIFIED CYTIDINE
 0340/49 MODIFIED CYTIDINE
 0340/58 MODIFIED ADENOSINE
 0358/0 ALIGNMENT IS ARBITRARY
 0360/0 MAMMALIAN MITO TRNA CANNOT BE FITTED TO THE GENERALISED CLOVERLEAF ARRANGEMENT
 0362/58 PARTIALLY MODIFIED
 0365/0 ALIGNMENT IS ARBITRARY

	AMINOACYL STEM	D STEM	D LOOP	D STEM	D LOOP	D STEM	D STEM	ANTIC.STEM	ANTIC.LOOP	ANTIC.STEM
	1 2 3 4 5 6 7	8 9 10 11 12 13	14 15 16 17 18 19 20 21	22 23 24 25 26 27 28 29 30 31	32 33 34 35 36 37 38 39 40 41 42					
G L U T A M I N E										
0510	NU6 E. COLI K12	U G G G U A U A C *****	G C C C A A G C G36 D	A G G C C A C C G G U A G G C C A C C G G U	A G G C C A C C G G U U3U N U G A2F	A C C G G				
0520	CU6 E. COLI K12	U G G G U A U A C *****	A G C C C A A G C G36 D	A G G C C A C C G G U U3U C U G A2F	A C C G G A C C G G A F C C G G					
0525	NU6 HALOBACTERIUM VOL.	A G U C C C A U G *****	G46 G F A G U G G C C A A U C C U G	A G G C C A U C C U G U U N U G 616	A G G C C A U C C U G F G C C A R					
0530	NU6 PHAGE T4	U G G G A U U A R *****	G C C A A G D D G G D G G D	A G G C C A A G G C C A C U N U G A2C	A G G C C A C U N U G 6 F G C C U A					
0533	UU6 PHAGE T5	U G G G A U U A R *****	G C C U U A G C U U G C C U C A A G C U U G A A 5 F C G A	A G G C C A A G C U U C G G C C U U U G A A 5 F C G A	A G G C C A C U N U G A2C F G C C U A					
0540	NU6 PHAGE T4 (FROM PRECURSOR)	U G G G A R U U A R *****	A G D D G G D D A G G D D	A G G C C A A G C C A C C U C G G A C3U C U G A R F C C A G	A G G C C A C U N U G A2C F G C C U A					
0550	CU6 RAT LIVER	G G U C C A U G *****	G U G F A R D G36 D D	A G G C C A U C G G A C3U C U G A R F C C A G	A G G C C A C U N U G A2C F G C C U A					
0551	UUC RAT LIVER	U C C A C A U G *****	G U C F A G C G G D D G D D	A G G A U C C U G G F U U9U C A C C C A G G	A G G A U C C U G G F U U9U C A C C C A G G					
G L U T A M I C A C I D										
0610	UUC E. COLI B	G U C C C C U U C *****	G U C F A G A G G C C C A G A C R	A G G C C A G A C R C C G C C C	A G G C C A G A C R C C G C C C					
0620	UUC E. COLI	G U C C C U U C *****	G U C F A G A G G C C C A G A C R	A G G C C A G A C R C C G C C C	A G G C C A G A C R C C G C C C					
0625	NUC HALOBACTERIUM VOL.	G C U C U G U G *****	G4U G F A G U C C G C C A R A U C A R A	A G G C C G C C A R A U C A C C C	A G G C C G C C A R A C U N U C A C G G U G A					

0510 R. YANIV, W. R. FOLK (1975) J. BIOL. CHEM. 250, 3243-3253
 0520 R. YANIV, W. R. FOLK (1975) J. BIOL. CHEM. 250, 3243-3253
 0525 R. GUPTA (1981) PH.D. THESIS, UNIVERSITY OF ILLINOIS, URBANA
 0530 J. B. BEIDMAN, M. R. COMER, W. H. MCCLAIN (1974) J. MOL. BIOL. 90, 677-689
 0533 V. M. KRUYKOV, M. G. SCHLYAPNIKOV, S. I. KAZANTSEV, A. V. KALININ, V. N. KSENZENKO, A. A. BAYEV, EMBO-FEBS MEETING, STRASBOURG, JULY 1980
 0540 C. GUTHRIE (1975) J. MOL. BIOL. 95, 529-548
 0550 J. A. YANG, L. W. TAI, P. F. AGRIS, C. W. GEMRKE, T. W. WONG (1983) NUCL. ACIDS RES. 11, 1991-1996
 0551 J. C. CHAN, J. A. YANG, M. J. DUNN, P. F. AGRIS, T. W. WONG (1982) NUCL. ACIDS RES. 10, 3755-3758
 0610 M. UZIEL, A. J. WEINBERG (1975) NUCLEIC ACIDS RES. 2, 469-476
 0620 Z. OHASHI, F. HARADA, S. NISHIMURA (1972) FEBS LETTERS 20, 239-241
 0625 R. GUPTA (1981), PH.D. THESIS, UNIVERSITY OF ILLINOIS, URBANA

EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOCYL STEM
45	47 B D F H J L N P	49 51 53	55 57 59	61 63 65	67 69 71 73 75
44	46 A C E G I K M O	48 50 52	54 56 58 60	62 64	66 68 70 72 74 76

G L U T A M I N E					
0510	C R U U	C C U G G	T F C G A R U	C C A G G	U A C C C C C A G C C A
0520	C R U U	C G A G G	T F C G A R U	C C U C G	U A C C C C C A G C C A
0525	C G A	C C A G G	F C 36 A R U	C C U G G	U G G A C C U A C C A
0530	G A U G	C A A G G	T F C G A G U	C C U U A	U U C C C A G C C A
0533	G R U	C A U U G	T F C A A R U	C C A R U	A U C C C U G C C A
0540	G A U G	C A R G G	T F C G A G U	C C U U A	U U C C C A G C C A
0550	C G A	U C C 55 A G	F C A R 1A U	C U C G G	U G G A C C C U C C A
0551	C G G	C C C 56 G G	T 3F C G A C U	C C C G G	U G U G G A R C C A

G L U T A M I C A C I D					
0610	U R A	C A G G G	T F C G A R U	C C C C U G	G G G A C C G C C A
0620	U R A	C A G G G	T F C G A R U	C C C C U A	G G G A C C G C C A
0625	U G A	C S A G G G	F 1F C 36 A R U	C C C U G	A C G G A C C A

0510/34 N IS A DERIVATIVE OF 2-THIOURIDINE
 0525/34 PARTIALLY MODIFIED TO A DERIVATIVE OF CYTIDINE
 0530/34 N IS AN UNKNOWN DERIVATIVE OF URIDINE..
 0533/54 30X URIDINE
 0533/55 30X URIDINE

0540/34 N IS AN UNKNOWN DERIVATIVE OF URIDINE
 0550/16 PARTIALLY MODIFIED
 0550/50 PARTIALLY MODIFIED
 0625/34 PARTIALLY MODIFIED

	AMINOACYL STEM	D STEM	D LOOP	ID STEM	ANTIC. STEM	ANTIC. LOOP	ANTIC. STEM
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42						
	-----	-----	-----	-----	-----	-----	-----
GLUTAMIC ACID cont.							
0630	UUC YERST U C C G R U A U R G U G F A R C *****	U C C G R U A U R G U G F A R C *****	G G C D	A U C A C A F C A C G C *****	F C A C G C	C U U S U C A C C C G U G U G	
0635	UUC SACCHAROMYCES POMBE U C C G U U G U G U C C A R C *****	U C C G U U G U G U C C A R C *****	G G C D	A G A U U F G U C G C *****	F G U C G C	C U U S U C A C C C G A C C G	
0670	UUC DROSOPHILA MELANO. U C C A U A U G U C F A G D *****	U C C A U A U G U C F A G D *****	G G C D	A G A U A U C U G G C *****	U C U G G C	C U U S U C A C C C A G A	
0671	UUC BOVINE LIVER G U U C U U G U R G U U G A R U G A *****	G U U C U U G U R G U U G A R U G A *****		C A R C G A F G G U U *****	F G G U U U	U U U N C A U A F C A U	
0680	UUC RAT LIVER U C C A C A U G U C F A G C *****	U C C A C A U G U C F A G C *****	G G D D	A G A U U C C U G G C *****	F G G U U C	F U U S U C A C C C A G G	
G L Y C I N E							
0710	CCC E. COLI G C G G C G U A R G U U C A R U *****	G C G G C G U A R G U U C A R U *****	G G D	A G A R C G A G A G C C *****	A G A G C C	U U C C C A R A G C U C U	
0712	CCC SALMONELLA TYPHIMUR. G C G G C G U A G U U C A R U *****	G C G G C G U A G U U C A R U *****	G G D	A G A R C G A G A G C C *****	A G A G C C	U U C C C A R A G C U C U	
0720	NCC E. COLI G C G G C A U C G U A U A R U *****	G C G G C A U C G U A U A R U *****	G G C U	A U U A C C U C A G C C *****	U C A G C C	C U N C C A R A G C U G A	
0730	GCC E. COLI G C G G R A U A G C U C A G D D *****	G C G G R A U A G C U C A G D D *****	G G D	A G A G C A C G A C C C *****	A C G A C C	U U G C C A R A G U C G C	
0740	UCC STAPHYLOCOCCUS EPID. G C G G R G U A R U U U C A R C U *****	G C G G R G U A R U U U C A R C U *****	U U D	A G A R A C G U U C C *****	A C G U U C	C U U C C C G A R C G	
0750	UCC STAPHYLOCOCCUS EPID. G C G G R G U A R G U U C A R U *****	G C G G R G U A R G U U C A R U *****	U U D	A G A R C A C R U U C C *****	A R U U C C	C U U C C C G A R A U G	
0630	T. KOHAYASHI, T. IRIE, M. YOSHIDA, K. TAKEISHI, T. UKITA (1974) BIOCHIM. BIOPHYS. ACTA 366, 168-181						
0635	T.-T. WONG, T. MCCUTCCHAN, J. KOHLI, D. SOELL (1979) NUCLEIC ACIDS RES. 6, 2057-2068						
0670	R. ALTMEG, E. KUBLI (1980) NUCLEIC ACIDS RES. 8, 215-223						
0671	B. A. ROE, J. F. H. WONG, E. Y. CHEN (1982) PERSONAL COMMUNICATION						
0680	J. C. CHAN, J. A. YANG, M. J. DUNN, P. F. AGRIS, T. M. WONG (1982) NUCL. ACIDS RES. 10, 4605-4608						
0710	C. W. HILL, G. COMBRATO, M. STEINHART, D. L. RIDOLE, J. CARBON (1973) J. BIOL. CHEM. 248, 4252-4262						
0712	C. W. HILL, G. COMBRATO, M. STEINHART, D. L. RIDOLE, J. CARBON (1973) J. BIOL. CHEM. 248, 4252-4262						
0720	J. M. ROBERTS, J. CARBON (1975) J. BIOL. CHEM. 250, 5530-5541						
0730	C. SOUJRES, J. CARBON (1971) NATURE NEW BIOLOGY 233, 274-277						
0740	R. J. ROBERTS (1974) J. BIOL. CHEM. 249, 4787-4796						
0750	R. J. ROBERTS (1974) J. BIOL. CHEM. 249, 4784-4796						

	EXTRA ARM					TF STEM	TF LOOP	TF STEM	AMINOACYL STEM																						
	45	47	B	D	F	H	J	L	N	P	49	51	53	55	57	59	61	63	65	67	69	71	73	75							
	44	46	A	C	E	G	I	K	M	O	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76						

	GLUTAMIC ACID cont.																														
0630	A	G	A	C	S	G	G	G	T	F	C	G	A	C	U	C	C	C	G	U	A	U	C	G	G	A	G	C	C	A	
0635	G	G	A	G	S	G	G	G	T	F	C	G	A	C	U	C	C	C	G	U	A	U	C	G	G	A	G	C	C	A	
0670	A	G	G	C	C	G	G	G	T	F	C	G	A	U	C	C	C	G	U	A	U	C	G	G	A	G	A	C	C	A	
0671	U	A	G	U	C	S	A	U	G	U	F	A	G	A	U	C	C	A	U	G	U	A	A	G	A	A	U	A	C	C	A
0680	C	G	G	C	C	S	G	G	T	F	C	G	A	C	U	C	C	C	G	U	A	U	C	G	G	A	G	A	C	C	A

	GLY C I N E																														
0710	A	U	A	C	G	A	G	G	T	F	C	G	A	U	C	C	C	U	C	U	C	G	C	C	G	C	U	C	C	A	
0712	A	U	A	C	G	A	G	G	T	F	C	G	A	U	C	C	C	U	C	U	C	G	C	C	G	C	U	C	C	A	
0720	U	G	A	U	G	C	G	G	T	F	C	G	A	U	C	C	C	G	U	A	U	C	G	C	C	G	U	C	C	A	
0730	G	G	G	U	C	G	C	G	A	G	T	F	C	G	A	U	C	C	G	U	A	U	C	C	C	G	U	C	C	A	
0740	A	G	A	U	A	U	A	G	G	U	G	C	A	A	A	U	C	C	A	U	C	C	G	C	U	C	C	A	C	C	A
0750	A	G	G	U	A	U	A	G	G	U	G	C	A	A	A	U	C	C	A	U	C	C	G	C	U	C	C	A	C	C	A

0670/32 PARTIALLY MODIFIED
 0670/49 AND OR 50: IN POSITION 49 AND OR 50 MSC IS PRESENT
 0671/0 ALIGNMENT IS ARBITRARY
 0671/34 N IS A MODIFIED URIDINE

0712/18 PARTIALLY MODIFIED
 0720/34 N IS AN UNIDENTIFIED DERIVATIVE OF URIDINE, AND PARTIAL MODIFICATION
 0730/34 MUTATION E.COLI INS HAS G-34 = U-34

	AMINOACYL STEM	D STEM	D LOOP	D STEM	D STEM	ANTIC.STEM	ANTIC.LOOP	ANTIC.STEM
	1 2 3 4 5 6 7	8 9 10 12 14 16 A 19 A 21	15 17 18 20 B	22 24 26 28 30 32 34 36 38	39 41 43			
	*****	*****	*****	*****	*****	*****	*****	*****
0755	UCC BACILLUS SUBTILIS	G C G G U G U A R G U U U A G U	G G D	A R A R C C U C R A G C C U V4C C R A G C U G A				
0757	UCC MYCOPLASMA MYCOIDES SUBSP. CAPRI	G C A G G U G U A R G U U U A R U	G G C	A G A C C U U C A G C C U U C C A B A G C U G A				
0760	NCC PHAGE T4	G C G G A U A U C G U A U A R U	G G D	A U A C C U C R A G A C U N C C A F C U G A				
0770	GCC YEAST	G C G C3A A G U G U U F A G D	G G D	A R A U C C A R C G F U G C C A F C G U U G				
0775	UCC YEAST MITO	A U G A U A U A G U U A R U D	G G D	A R C U G A G A U G F C U U C C A R A C A U U				
0780	GCC WHEAT GERM	G C A C3C A G U G U U C F A G D	G G U	A G A U A G U A R C C C U G C C A C55 G U A C				
0790	GCC BOMBYX MORI	G C A U3C G G U G U U C A G U	G G D	A G A U G C U C G C C U G C C A C55 C G G G				
0791	NCC BOMBYX MORI	G C G U3U G G U G U G F A A D	G G D C	A G C A U A G F U G C C U N C C A R A G C A U				
0792	GCC HUMAN PLACENTA	G C A U3U G25 U G U U C A G U	G G D	A G A U U C U C G C C U G C C A C55 C G G G				
0793	CCC HUMAN PLACENTA	G C G C3C G2C U G U G F A G U	G G D	A U C A U G C A R G A U3U C C C A U F3C U U G				
0794	UCC BOVINE LIVER MITO*	A U C C U U U A T152U A U A R C U A		G U A C C A G C U G A C U U C C A R A F C A G C				

GLYCINE cont.

0755 H. ISHIKURA, K. MURAO, Y. YAMADA, EMBO FEBS MEETING, STRASBOURG, JULY 1980 0790 J. P. GAREL, G. KEITH (1977) NATURE 269, 350-352
 0757 A. W. KILPATRICK, R. T. WALKER (1980) NUCLEIC ACIDS RES. 8, 2783-2786
 0760 S. STAHL, G. V. PADDOCK, J. ABELSON (1974) NUCLEIC ACIDS RES. 1, 1287-1304 0791 M. KAWAKAMI, K. NISHIO, S. TAKEKURA (1978) FEBS LETTERS 87, 288-290
 0770 M. G. BARELL, A. R. COULSON, M. H. MCCLAIN (1973) FEBS LETTERS 37, 64-69 0792 R. C. GUPTA, B. A. ROE, K. RANDEKATH (1979) NUCLEIC ACIDS RES. 7, 959-970
 0775 G. D. IRHEIMER (1981) PERSONAL COMMUNICATION 0793 R. C. GUPTA, B. A. ROE, K. RANDEKATH (1980) BIOCHEM. 19, 1699-1705
 0780 K. B. MARCU, E. R. HIGNERT, B. S. DUDOCK (1977) BIOCHEMISTRY 16, 797-806 0794 R. A. ROE, J. F. H. WONG, E. Y. CHEN, P. A. ARMSTRONG (1981) PROC. THIRD CLEVELAND SYM. A. G. WALTON (ED) ELSEVIER AMSTERDAM

EXTRA ARM												TF STEM												TF LOOP												TF STEM												AMINOCYL STEM											
45	47	B	D	F	H	J	L	N	P	49	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81	83	85	87	89	91	93	95	97	99	101	103	105																					
44	46	A	C	E	G	I	K	M	O	50	52	54	56	58	60	62	64	66	68	70	72	74	76	78	80	82	84	86	88	90	92	94	96	98	100	102	104	106																					
GLYCINE cont.																																																											
0755	U	G	U													C	G	U	G	A	G	T	F	C	G	A	U	U	C	U	C	A	U	C	A	C	C	C	G	C	U	C	C	A															
0757	U	U	G													U	G	A	G	G	U	F	C	G	A	U	U	C	C	U	U	C	A	C	C	U	U	C	C	U	G	C	U	C	C	A													
0760	U	G	A													U	G	U	G	A	G	T	F	C	G	A	U	U	C	U	C	A	U	U	C	C	G	C	U	C	C	A	U	C	C	A													
0770	G	G													C	S	C	C	G	T	F	C	G	A	U	U	C	C	G	G	C	U	U	C	C	G	C	A	U	C	C	A	U	C	C	A													
0775	G	R	A													U	G	C	G	A	G	T	F	C	G	A	U	U	C	U	C	A	U	U	C	U	C	A	U	U	C	U	C	A	U	U	C	C	A										
0780	A	G	A													C	S	C	S	G	G	U	F	C	G	A	U	U	C	C	G	C	U	U	C	C	G	C	G	C	A	U	C	C	A	U	U	C	C	A									
0790	C	G	G													C	S	C	S	G	G	T	F	C	G	A	U	U	C	C	G	C	U	U	C	C	G	C	G	A	U	C	C	A	U	U	C	C	A										
0791	U	G	A													U	C	S	C	S	G	G	T	F	C	G	A	U	U	C	C	G	C	U	U	C	C	G	C	A	U	C	C	A	U	U	C	C	A										
0792	A	G	G													C	S	C	S	G	G	T	F	C	G	A	U	U	C	C	G	C	U	U	C	C	G	C	A	U	U	C	C	A	U	U	C	C	A										
0793	C	G	A													C	S	C	S	G	G	T	F	C	G	A	U	U	C	C	G	C	U	U	C	C	G	C	G	C	A	U	C	C	A	U	U	C	C	A									
0794	U	R	G													U	U	C	G	G	U	C	U	C	A	U	U	C	C	G	C	A	U	U	C	C	A	U	U	C	C	A	U	U	C	C	A	U	U	C	C	A							

0760/34 PROBABLY RELATED TO MARSS2U
 0775/37 IS 14A OR MS216A
 0791/9 PARTIALLY MODIFIED
 0791/34 N IS CHR5U AND AN ESTER THEREOF; N.KAWAKAMI, K.NISHIO, S.TAKEMURA,
 T.KONDO, T.GOTO (1979) NUCLEIC ACIDS RES. SYMP. SERIES NO. 6, S.53
 0792/4 PARTIALLY MODIFIED
 0792/6 PARTIALLY MODIFIED
 0793/4 PARTIALLY MODIFIED
 0793/6 PARTIALLY MODIFIED
 0793/32 PARTIALLY MODIFIED
 0793/56 PARTIALLY MODIFIED
 0794/0 ALIGNMENT IS ARBITRARY

	AMINOACYL STEM	D STEM	D LOOP	ID STEM	ANTIC.STEM	ANTIC.LOOP	ANTIC.STEM
	1 2 3 4 5 6 7 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43						
H I S T I D I N E							
0810	GUG G C U A U A R *****	G C U C A G D D	G G D	A G A G C C	C U G G A U U O U G A Z F	U U O U G A Z F	F C C A G
0820	GUG G C U A U A R *****	U C A U A U U	G G U U	A U U G G	J C C U G A U U G U G A R	U U G U G A R	F C A G G
0840	GUG G A R U A U A R *****	A U U C A R D	G G D	A G A R A F	A C G C C F U G U G G T F	F U G U G G T F	G C G U U
0870	GUG D R O S O P H I L A M E L A N D *****	G C C G U G A U C G U C F A G D	G G D D	A G G A C C C C A C G	F U G U G G T C	F U G U G G T C	C G U G G
0871	GUG S H E E P L I V E R *****	G C C G U G 2 A U C G U A F A G D	G G D D	A G U A C U C U G C G	F U O U G G T C	F U O U G G T C	C G C A G
0898	GUG M A M M A L I A N *****	N G C C G U G A U C G U A F A G D	G G D D	A G U A C U C U G C G	F U G U G G T C	F U G U G G T C	C G C A G
I S O L E U C I N E							
0910	GAU E . C O L I *****	A G C C U U G U A G C U C A G G D	G G D D	A G A G C C	G C A C C C C U G A U A 7 A	C U G A U A 7 A	G G G U G
0911	NAU E . C O L I *****	G C C C U J A R G C U C A G U	G G D D	A G A C C A	A G C C G A C U N A U A 7 A	C U N A U A 7 A	F C G C U
0913	GAU H A L O B A C T E R I U M V O L . *****	G G C C A R A U A G C U C A G U C A G G U	G G U	U G A G C G A C	F C G G C U G A U N A C C S G G G	C U G A U N A C C S G G G	G G G
0915	NAU P H A G E T 4 *****	G C C C U G U A G C U C A R A U	G G D D	A G C A G C A G	A G U C C C C U N A U N A	C U N A U N A	G G G A R
0920	AAU T O R U L O P S I S U T I L I S *****	G G U C C C U J G G Z C C C A G D D	G G D D	A R G G C C	G G G U G C U I A U A 7 A	C U I A U A 7 A	C G C C A

0810 C.E.SINGER, G.R.SMITH (1972). J.BIOL.CHEM. 247, 2989-3000
 0820 V.M.KRYUKOV, A.G.SCHLYAPNIKOV, S.I.KAZANTSEV, A.V.KALITAN, V.N.KSENZENKO, A.A.BAYEV, ERBO-FEBS MEETING, STRASBOURG, JULY 1980
 0840 A.P.SIBLER, R.P.MARTIN, G.DIRNHEIMER (1979) FEBS LETTERS 107, 182-186
 0870 M.ALTWEGG, E.KUBLI (1980) NUCLEIC ACIDS RES. 8, 3259-3262
 0871 M.ROISNARD, G.PETRISSANT (1981) FEBS LETTERS 129, 180-184
 0898 M.D.ROSA, J.P.HERDRICK, JR., M.R.LERMER, J.A.STEITZ (1983) NUCL. ACIDS RES. 11, 853-870
 0910 M.YARIUS, B.G.BARELLI (1971) BIOCHEM.BIOPHYS.RES.COMMUN. 43, 729-734
 0911 Y.KUCHINO, S.WATANABE, F.HARADA, S.RISHIMURA (1980) BIOCHEM. 19, 2085-2089
 0913 R.GUPTA (1981) PH.D. THESIS, UNIVERSITY OF ILLINOIS, URBANA
 0915 C.GUTHRIE, W.H.ACLLAIM (1979) BIOCHEM. 18, 3786-3795
 0920 S.TAKEMURA, M.MURAKAMI, M.MIYAZAKI (1969) J.BIOCHEM. 65, 553-566

EXTRA ARM	TF STEM	TF LOOP	TF STEM	AMINOACYL STEM
45 47 B D F H J L N P 44 46 A C E G I K M O	48 51 53 50 52 54	55 57 59 56 58 60	61 63 65 62 64 66	67 69 71 73 75 68 70 72 74 76
H I S T I D I N E				
0810 U U G U	C G U G G G T	F C G A R U	C C C R U	U A G C C A C C C C A *****
0820 C C U A	U G U G G A T	F C G A R U	U C U A C	U A G C C A C C A C C A *****
0840 A A R A	U C U G A G T	F C G A U U	C U C A G	U A U C A C C C C A *****
0870 U A R A	C C S A G G U	F C G A T A U	C C U G G	U C A C G C S A C C A *****
0871 C A R A	C S U C G G U	F C G A T A U	C C G A G	U C A C G C S A C C A *****
0898 C A R A	C S U C G G U	F C G A T A U	C C G A G	U C A C G C C A C C A *****
I S O L E U C I N E				
0910 A G G 7X ^a	C G U G G T	F C A R G U	C C A C F	C A G G C C U A C C A *****
0911 U G G 7X	C G C U G G T	F C A R A G U	C C A G C	A G G G C C A C C A *****
0913 A G G C	C S G C G G F1F	C 362A A U	C C G C G	U G G C C C A C C A *****
0915 A G G 7U	U A C C A G T	F C A R A U	C U G G U	F U G G U C A C C A *****
0920 A G A D	C S A G C A G T	F C G A T U C	C U G C U	A G G A C C C A C C A *****

0810/0 IDENTICAL WITH SALMONELLA TYPHIMURIUM
 0810/38 + 0810/39 HIS T MUTATION F-38 = U-38, F-39 = U-39. C.E. SINGER,
 G.R. SMITH, R.CORTESE, B.N. AMES (1972) NATURE NEW BIOLOGY 238, 72-74
 0820/39 PARTIALLY MODIFIED
 0871/16 PARTIALLY MODIFIED
 0898/0 ISOLATED FROM HcL₃ CELLS; ANTI-Jo-1 ANTIGEN
 0898/0 5' TERMINAL NUCLEOTIDE IS A METHYLATED GUANYLIC ACID RESIDUE
 0898/58 N IS A MODIFIED NUCLEOTIDE
 0910/17 PARTIALLY MODIFIED
 0910/47 PROBABLY X
 0911/0 DESIGNATED AS TRNA-ISOLEUCINE-PINOR
 0911/17 PARTIALLY MODIFIED
 0915/37 N IS A DERIVATIVE OF ADENOSINE
 0915/0 MUTANTS: HA1, C-4 = U-4; HA101, C-4 = U-4, U-71 = C-71; HA103, C-4 = U-4, G-69 = A-69

	AMINOACYL STEM			D STEM			D LOOP			D STEM			ANTIC. STEM			ANTIC. LOOP			ANTIC. STEM																																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44								
ISOLEUCINE cont.																																																				
0950	GAU	YERST	G	R	A	R	C	U	A	U	A	R	U	C	A	R	A	D	D	G	G	D	A	G	R	A	U	A	G	U	A	U	F	U	G	A	U	A	U	G	A	U	A	U	C	A	R	C	A			
0951	GAU	SPINACH	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****			
0952	GAU	BOVINE LIVER	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****			
0953	GAU	ZER MAYS	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****			
0954	XAU	SPINACIA OLERACER	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****			
0957	GAU	MOSQUITO	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****			
0980	IAU	MOUSE	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****				
L E U C I N E																																																				
1010	CAG	E. COLI	G	C	G	A	G	G	U	G	C	G	G	A	R	D	D	G	G	D	A	G	A	C	G	C	G	C	U	A	R	G	C	U	U	C	A	G	C	U	U	C	A	G	N	F	G	F	U	A	R	G
1011	GAG	E. COLI	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	
1012	NAA	E. COLI	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****		
1013	CAR	RHODOSPIRILLUM R.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****		

0950 G. DIRIETNER (1981) PERSONAL COMMUNICATION
 0951 P. GUILLEHAUT, J.H. NEILL (1982) NUCL. ACIDS RES. 10, 1653-1659
 8-A. ROE, J.F.H. WONG, E.Y. CHEN, P.A. ARNSTROM (1981) PROC. THIRO
 CLEVELAND SYM. A.G. WALTON (ED) ELSEVIER AMSTERDAM
 0953 P. GUILLEHAUT, J.H. NEILL (1982) NUCL. ACIDS RES. 10, 1653-1659
 0954 R.A. FRANCIS, B.S. DUDOCK (1982) J. BIOL. CHEM. 257, 11195-11198
 0957 C.C. HSUEH, G.R. CLEAVES, D.T. DUBIN (1983) PLASRID 10, 55-65
 0980 N. SHINRIKI, K. ISHIZAKI, K. Ikehata, K. MURA, T. UEDA, N. KATO, F. HARRADA (1981)
 NUCL. ACIDS RES. SYM. SER. 10, 211-214
 1010 H.U. BLANK, D. SOELL (1971) BIOCHEM. BIOPHYS. RES. COMMUN. 43, 1192-1197
 S.-K. DUBE, K.-A. MARCKER, A. YUDELEVICH (1970) FEBS LETTERS 9, 168-170
 1011 H.U. BLANK, D. SOELL (1971) BIOCHEM. BIOPHYS. RES. COMMUN. 43, 1192-1197
 Z. YAMAIZUMI, Y. KUCHINO, F. HARADA, S. NISHIMURA, J.-A. MCCLOSKEY
 (1980) J. BIOL. CHEM. 255, 2220-2225
 1013 N. MEHHOUSE, K. MITOGHOSIAN, R.J. CEDERBERG (1981) CAN. J. BIOCHEM. 59, 921-932

EXTRA ARM			TF STEM	TF LOOP	TF STEM	AMINOCYL STEM											
45	47	B D F H J L N, P	49	51	53	55	57	59	61	63	65	67	69	71	73	75	
44	46	A C E G I K M O	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76
<hr/>																	
ISOLEUCINE cont.																	
0950	A R R U U R G G T F C R A U C C C U G U J A G U U U C R C C R																
0951	A G 67X C U C U G G T F C R A G U C C A G G R U G C C C A C C R																
0952	A U R A U A G A G G U C R A R C C C U U J A U U C U A C C R																
0953	A G 67X C U C U G G T F C R A G U C C A G G R U G C C C R C C R																
0954	A R U U C U A G G T F C R A U C C U A C U G G A U G C R C C R																
0957	A U U A U A R A G A U U A R U A C U U F A F U C A U U A C C R																
0980	A G 67D C S C G G G T F C G A U C C C C G U A C G G C C R C C R																
<hr/>																	
L E U C I N E																	
1010	U G U C C U U A C G G A C G U G G G G T F C R A G U C C C C C C C U C G C A C C R																
1011	U G C C C R A U A G G C C U U A C G G G T F C R A G U C C C G U C C U G G U A C C R																
1012	C G C G U C G C G C U G U S C G G G T F C R A G U C C C G C U C C G G U A C C R																
1013	U U G G U A A C C C A G G U G U A G T F C G A C U C U C C C A A R G C A C C R																

1010/38 HIS T MUTANT OF SALMONELLA TYPHIMURIUM TRNA LEU 1 HAS F38 = U38 AND F-40 = U-40, H.S.-ALLAUDEEN, S.K.-YANG, D.-SOELL (1972) FEBS LETTERS 28, 205-208

1011/0 FOR NUMBERING OF E. COLI LEUCINE TRNAS SEE R. E.-HURD, G. T.-ROBILLARD, B.-A.-REID (1977) BIOCHEMISTRY 16, 2095-2100

1011/37 N IS AN UNKNOWN DERIVATIVE OF GUANOSINE

1012/34 N IS A DERIVATIVE OF ADENOSINE

1013/37 UNKNOWN DERIVATIVE OF ADENOSINE

0951/0 IDENTICAL WITH MAIZE CHLORO TRNA ILE 2

0952/0 ALIGNMENT IS ARBITRARY

0953/46 PARTIALLY MODIFIED

0954/0 ALIGNMENT IS ARBITRARY

0957/0 ALIGNMENT IS ARBITRARY

1010/0 FOR NUMBERING OF E.-COLI LEUCINE TRNAS SEE R. E.-HURD, G. T.-ROBILLARD, B.-A.-REID (1977) BIOCHEMISTRY 16, 2095-2100

1010/0 IDENTICAL WITH SALMONELLA TYPHIMURIUM LT2 TRNA LEU 1

1010/37 N IS AN UNKNOWN DERIVATIVE OF GUANOSINE

	AMINOACYL STEM							D STEM							D LOOP							ID STEM							ANTIC. STEM							ANTIC.. LOOP							ANTIC..STEM						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42							
LEUCINE cont.																																																	
1015	GAG	HALOBACTERIUM VOL.	G	G	U	G	G	G	U	A	G	C	C	A	R	N	C	C	A	G	G	C	C	A	R	C	G	G	C	A	G	C	G	U	U	G	A	G	G	G	G	C	U	G					
1030	NRA	PHAGE T4	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****					
1031	UAG	PHAGE T5	G	G	G	C	U	A	U	G	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G	A	C	U	G				
1040	CAA	YEAST	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****				
1050	UAG	YEAST	G	G	A	G	U	U	G	G	2C	C	4G	A	G	C	G	C	4G	A	G	D	G	C	C	4G	A	G	C	G	C	4G	A	G	D	G	C	C	4G	A	G	D	G	C	C	4G			
1055	NRA	NEUROSPORA CRASSA MITO	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****				
1056	UAG	NEUROSPORA CRASSA MITO	A	U	C	G	A	G	U	G	A	U	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D				
1057	CAA	ANACYSTIS NIDUL.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****				
1058	CAG	ANACYSTIS NIDUL.	G	C	G	A	C	U	G	A	C	U	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D	G	A	D				
1060	CAA	TORULOPSIS UTILIS	G	G	A	U	C	U	U	G	G	2C	C	4A	A	G	C	G	C	4A	A	G	C	G	C	4A	A	G	C	G	C	4A	A	G	C	G	C	4A	A	G	C	G	C	4A	A	G			
1073	IRG	CRENDRABDITIS ELEG.	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****				

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	EXTRA ARM	TF STEM	TF LOOP	TF STEM	RMINDRACYL STEM
	45 47 B D F H J L N P	49 51 53	55 57 59	61 63 65	67 69 71 73 75
	44 46 A C E G I K M O	48 50 52	54 56 58 60	62 64 66 68 70 72	74 76

	LEUCINE cont.				
1015	U C C U G U A G A G G U C	C S C C G G F 1 F	C 362A R A U	C C G G U	C C C A C G C C A C C A
	:::::	:::::	:::::	:::::	*****
1030	C G A A U G A U U C C U	U G U G G G	T F C G A G U	C C C A C	U U C U C G C A C C A
	:::::	:::::	:::::	:::::	*****
1031	A G C U A A A U G C G	U G G G A G	T F C G A G U	C U C C U	A G C C C A C C A
	:::::	:::::	:::::	:::::	*****
1040	U A U C G U A R A G A U G	C S A R G A G	T F C G A R U	C U C U A R G	A G C A R C C A C C A
	:::::	:::::	:::::	:::::	*****
1050	U A U C U U C G A U G	C S A R G G G	T F C G A R A U	C C C U A R G	C U C U C A C C A
	:::::	:::::	:::::	:::::	*****
1055	G G C U U C A R A G C U G	U G A R G G	T F C A R A G U	C C U U C U	U C G G A U A C C A
	:::::	:::::	:::::	:::::	*****
1058	U G G U U A A R A C U G	U A C A R G	T F C A R A G U	C U U G U C A U	C U A U A C C A
	:::::	:::::	:::::	:::::	*****
1057	C G C U A G C G A U G U G	U G U G G G	T F C G A G U	C C C A C C U	G C C C A C C A
	:::::	:::::	:::::	:::::	*****
1058	U G G U U C A C G A C U G	U C C G G G	T F C A R A G U	C C C G G U	C C C G C A C C A
	:::::	:::::	:::::	:::::	*****
1060	U A U C G U A R A G A U G	C S A U G A G	T F C G A R A U	C U C A U R G	A G C A U C C A C C A
	:::::	:::::	:::::	:::::	*****
1073	U C C C U U C G G G G G	C G U G G G	T U C G A R U	C C C A C C U	C U C U C A C C A
	:::::	:::::	:::::	:::::	*****

1030/34 N IS A DERIVATIVE OF URIDINE
 1055/34 N IS A MODIFIED URIDINE
 1057/37 IS A MODIFIED ADENOSINE
 1073/0 THE RNA TRANSCRIPT WAS PROCESSED IN XENOPUS OOCYTES

	EXTRA PRIM	TF STEM	TF LOOP	TF STEM	AMINOCYL STEM
	45 47 B D F H J L N P	48 50 52 54 55 57 59	61 63 65	67 69 71 73 75	
	44 46 A C E G I K M O	49 51 53 56 58 60	62 64 66 68 70 72 74 76		
1074	U A C U U A R C A G U A	U G A R G G T F C A R G U	C C U U U A R A U A G C A C C A		
	
1075	C G A C U U A R A R U C A	U G A G G G T F C A R G U	C C C U C U A U C C C C A C C A		
	
1076	U G C U A R A G A G C G	U G A G G G T F C G A G U	C C C U U C A R G U C A C C A		
	
1077	U G C U A G A G C A	U C U C G G T F C G A G U	C C G A G U A G C G C A C C A		
	
1078	U G C G A G A G C A	U C U C G G T F C G A G U	C C G A G U A G C G C A C C A		
	
1080	U C F C F U C G G G G	C S G U G G G T F C G A T A U	C C C A C C G C U G C C A C C A		
	
1081	N F C C G U A U G G A G	C S G U G G G T F C G A T A U	C C C A C U C U G A C A C C A		
	
1082	U G C F C C U G G A G G	C S G U G G G T F C G A T A U	C C C A C U C U G A C A C C A		
	
1083	A R A	C S U U G G U G C A R C U	C C A R A U A R A G U A C C A		
	
1084	U R U C	C S A G G G A U U C A R T A U	C C U C U C C U U A R C A C C A		
	
1085	A R	A R U U G G U G C A R C U	C C A R A U A R A G U A C C A		
	

LEUCINE cont.

1074/17 PARTIALLY MODIFIED
 1074/34 MODIFIED URIDINE
 1075/34 N IS AN UNKNOWN URIDINE DERIVATIVE
 1076/37 IS EITHER 16A OR ZEATIN
 1076/37 IS AN UNIDENTIFIED DERIVATIVE OF ADENOSINE
 1081/10 PARTIALLY MODIFIED
 1081/12 PARTIALLY MODIFIED
 1081/34 N IS A DERIVATIVE OF CYTIDINE
 1081/37 N IS A DERIVATIVE OF GUANOSINE
 1081/44 N IS A DERIVATIVE OF URIDINE
 1081/45 PARTIALLY MODIFIED
 1081/47 B IS ACCEPTOR HAS ADENOSINE AT THIS POSITION
 1083/5 PARTIALLY GUANOSINE
 1084/0 ALIGNMENT IS ARBITRARY
 1084/34 N IS A MODIFIED URIDINE
 1085/0 ALIGNMENT IS ARBITRARY

EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOCYL STEM
45	47 B D F H J L N P	49 51 53	55 57 59 61 63 65	67 69 71	73 75
44	46 A C E G I K M O	48 50 52 54 56 58 60	62 64 66 68 70 72	74 76	

L Y S I N E					
1110	U G G U	C G C G G T F C G A R U C C U G C A C G A C C C A C C A			
1115	C G G U	C S G C G F G F I F C 362A R U C G C G U C C G C C C A C C A			
1120	G G G U	C G A R G G T F C G A G U C C U U C A U G G C U C A C C A			
1130	A G G U	U A G G G G T F C G A G C C C C U A C G G C C U C C A			
1140	A U G U*	C S G G G G T F C G A G C C C C U A F G A G A G C C A			
1150	C C A	U G C U G G T F C A C C U C C A G C J A U U C U C A C C A			
1159	A R U A	U A G U A R A U U A G C A U U A C F C U A R U G A C C A			
1170	G G G U	C G U G G N ¹ C G A G C C C A C G U G G C G C C A			
1171	G G G U	C S C A G G G T 3F C A A G U C C C U G U C G G C G C C A			
1181	G G G U	C S G U G G G T 3F C G A G C C C C A C G U G G C G C C A			
1182	G G G U	C S G U G G G T 3F C G A G C C C C A C G U G G C G C C A			

1115/34 PARTIALLY MODIFIED TO UNIDENTIFIED DERIVATIVE OF CYTIDINE
 1115/52 PARTIALLY MODIFIED
 1120/32 ONE ISOACCEPTOR (1) HAS AN UNMODIFIED CYTIDINE, THE OTHER ONE (3) A MODIFIED CYTIDINE
 1120/34 Y. YAMADA, K. NURA, H. ISHIKURA (1981) NUCLEIC ACIDS RES. 9, 1735-1737
 1120/37 Y. YAMADA, H. ISHIKURA (1981) J. BIOCHEM. 89, 1589-1591; PARTIALLY MODIFIED
 1130/9 PARTIALLY MODIFIED

1130/58 PARTIALLY MODIFIED
 1140/0 IS IDENTICAL WITH SACCHAROMYCES CEREVISIAE HAPLOID 2:C.J. SMITH, H.-S. TEN, A. K. LEY, P. D'OBRENAN (1973) J. BIOL. CHEM. 248, 4475-4485
 1140/47 PARTIALLY MODIFIED
 1150/34 IS A DERIVATIVE OF URIDINE
 1159/0 ALIGNMENT IS ARBITRARY
 1170/54 N IS VERY LIKELY TN
 1170/55 U IS PROBABLY PARTLY MODIFIED TO F
 1171/34 N IS PROBABLY ADMSS2U

Table with columns: AMINOCYL STEM (1-7), D STEM (8-13), D LOOP (14-19), ID STEM (20-25), AN TIC .STEM (26-31), AN TIC . LOOP (32-36), AN TIC . STEM (37-41), AN TIC . STEM (42-48). Rows include LYSINE cont., M E T H I O N I N E, and specific organism/strain identifiers like 1183 UUU RABBIT LIVER, 1184 CUU MOUSE FIBROBLAST*, 1210 CRAU E. COLI CA 26S, etc.

- 1183 M. RABA-K., LINBURG, M., BURGHAGEN, J., R. KATZE, M., SIMSEK, J., E. HECKMAN, ...
1184 U.L. RAJBHANDARY, H., J. GROSS (1979) EUR. J. BIOTECHEM. 97, 305-318
1185 U.L. RAJBHANDARY, H., J. GROSS (1979) EUR. J. BIOTECHEM. 97, 305-318
1186 E. RANDERATH, H.P., AGRANAL, K., R. RANDEARTH (1981) BIOTECHEM. BIOPHYS. RES. COMMUN. 103, 739-744
1245 C.-C. HSUCHEN, G. R. CLEAVES, D. T. DUBIN (1983) NUCL. ACIDS RES. 11, ...

	EXTRA ARM						TF STEM	TF LOOP	TF STEM	AMINOCYL STEM																		
	45	47	B	D	F	H	J	L	N	P	49	51	53	55	57	59	61	63	65	67	69	71	73	75				
	44	46	A	C	E	G	I	K	M	O	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76			

1183	LYSINE cont.																											
	G	G	G	T	C	C	C	A	R	A	G	U	C	C	U	G	U	C	G	G	C	G	C	C	A			
1184	G	G	G	U	F	C	G	A	G	C	C	C	A	C	G	U	G	G	C	G	C	G	C	C	A			
1185	A	G	A	C	C	A	R	A	U	A	C	C	U	C	C	U	G	G	U	G	U	G	A	C	C	A		
1186	A	G	U	A	A	C	A	A	A	A	U	C	C	A	A	A	U	C	C	A	A	A	A	C	C	A		
1187	A	A	U	A	A	C	U	C	U	A	G	U	C	C	A	G	U	C	C	A	G	U	G	A	C	C	A	

1210	METHIONINE																											
	G	G	G	T	F	C	G	A	R	U	C	C	G	U	C	G	U	C	G	U	R	G	C	C	C	C	A	
1230	A	G	G	T	F	C	G	A	U	C	C	C	U	C	C	G	C	G	U	A	C	C	A	C	C	A		
1235	A	A	G	T	F	C	G	A	U	A	C	C	U	C	C	U	A	G	A	G	C	A	G	C	C	C	A	
1240	A	G	G	T	F	C	G	A	A	C	C	U	C	C	U	C	U	C	U	G	A	G	C	C	C	C	A	
1245	G	A	G	T	F	C	A	R	A	U	C	C	A	R	U	C	C	A	R	U	G	A	G	U	A	C	C	A

1184/27 PARTIALLY MODIFIED
 1184/37 N IS PROBABLY A PRECURSOR OF T6A
 1184/54 CONTAINS U, T, TA AND F
 1185/0 ALIGNMENT IS ARBITRARY
 1185/34 N IS A MODIFIED URIDINE
 1185/37 N IS A MODIFIED ADENOSINE
 1186/0 ALIGNMENT IS ARBITRARY
 1186/34 N IS A DERIVATIVE OF URIDINE
 1187/33 HYPERMODIFIED DERIVATIVE OF URIDINE
 1210/16 PARTIALLY MODIFIED
 1210/18 PARTIALLY MODIFIED
 1230/46 PARTIALLY MODIFIED
 1230/47 PARTIALLY MODIFIED
 1235/27 N IS A MODIFIED URIDINE.
 1240/26 PARTIALLY MODIFIED
 1240/27 PARTIALLY MODIFIED
 1240/47 PARTIALLY MODIFIED

	AMINOACYL STEM							D STEM				D LOOP				D STEM			ANTIC. STEM			ANTIC. LOOP			ANTIC. STEM																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42
METHIONINE cont.																																										
1250	CAU MAMMALIAN*	G C C U C G Z U J A R G Z C G C C A G D A G G D A G G C G C G C A G G F C U C A U A 7 A F C U G A							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A										
1255	CAU THERMOPLASMA ACIDO.	G C C G G G G U A G G C U C A N C U G G A G A G C N C C G G A C 3 U C A U A 7 A U C C G G							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A										
1257	CAU MOSQUITO MITO*	A A A A G A U A R A G C U A A U A A A R A C A U U G F C U C A U A 7 A F C U G A							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A										
1265	CAU YEAST MITO	G C C G G G G U A G G C U C A N C U G G A G A G C N C C G G A C 3 U C A U A 7 A U C C G G							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A										
1266	CAU BOVINE LIVER MITO*	A A A A G A U A R A G C U A A U A A A R A C A U U G F C U C A U A 7 A F C U G A							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A													
1267	CAU LUPIN	G C C G G G G U A G G C U C A N C U G G A G A G C N C C G G A C 3 U C A U A 7 A U C C G G							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A													
1268	CAU WHEAT GERM	G G G G U G G U G 1 G 2 C G C A G D D G G C X A G C G C G A F C U C A U A 7 A F C U G A							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A													
METHIONINE - INITIATOR																																										
1310	CAU E. COLI CA 26S	C G C G G G G U A G G C U C A N C U G G A G A G C N C C G G A C 3 U C A U A 7 A U C C G G							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A													
1313	CAU STREPTOMYCES GRIS.	C G C G G G G U A G G C U C A N C U G G A G A G C N C C G G A C 3 U C A U A 7 A U C C G G							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A													
1314	CAU EUPHAUSIA SPERBA	A G C G G G G U A G G C U C A N C U G G A G A G C N C C G G A C 3 U C A U A 7 A U C C G G							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A													
1315	CAU HALOBACTERIJUM VOL.	A G C G G G G U A G G C U C A N C U G G A G A G C N C C G G A C 3 U C A U A 7 A U C C G G							A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A				A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A			A G C G C G A F C A G F C U C A U A 7 A F C U G A													

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EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOACYL STEM
45	B	49	55	61	67
47	D	51	57	63	69
48	F	53	59	65	71
49	H	55	61	67	73
50	J	57	63	69	75
51	L	59	65	71	77
52	N	61	67	73	79
53	P	63	69	75	81
54	R	65	71	77	83
55	T	67	73	79	85
56	V	69	75	81	87
57	W	71	77	83	89
58	X	73	79	85	91
59	Y	75	81	87	93
60	Z	77	83	89	95
61		79	85	91	97
62		81	87	93	99
63		83	89	95	101
64		85	91	97	103
65		87	93	99	105
66		89	95	101	107
67		91	97	103	109
68		93	99	105	111
69		95	101	107	113
70		97	103	109	115
71		99	105	111	117
72		101	107	113	119
73		103	109	115	121
74		105	111	117	123
75		107	113	119	125
76		109	115	121	127

METHIONINE cont.	
1250	AGG7D
1255	AGGU
1257	UUA
1265	UAA
1266	AAA
1267	AGG7D
1268	AGG7D

METHIONINE - INITIATOR	
1310	AGG7U
1313	AGGU
1314	AGG7U
1315	AGRU

1266/0 MOUSE MYELOMA AND RABBIT LIVER
 1250/34 PARTIALLY MODIFIED
 1255/26 IS A DERIVATIVE OF GUANOSINE
 1257/0 THIS SPECIES MAY ALSO FUNCTION AS INITIATOR TRNA; ALIGNMENT IS ARBITRARY

1266/0 ALIGNMENT IS ARBITRARY
 1310/46 #7946 = A46 IN THE MINOR SPECIES OF TRNA F-TET FROM E. COLI. S. K. DUBE, K. A. MARCKER, B. F. C. CLARK, S. CORY (1968) NATURE 218, 231-233;
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	AMINOACYL STEM	D STEM	D LOOP	D STEM	D LOOP	D STEM	ANTIC. STEM	ANTIC. LOOP	ANTIC. STEM
	1 2 3 4 5 6 7	8 9 10 11 12 13	14 15 16 17 18 19 20	21 22 23 24 25 26	27 28 29 30 31 32	33 34 35 36 37 38 39 40 41 42			
METHIONINE-INITIATOR cont.									
1316	CAU THERMOPLASMA ACIDO. *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C G U							
1317	CAU HALOCOCCUS MORRHUAE *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C G C							
1318	CAU SŪLOLOBUS ACIDOCAL. *****	U N G G G A C U G G G A U C C N C A G G C C U C A U A C C C U G							
1320	CAU THERMOPLASMA THERMO. *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C G A							
1321	CAU THERMOPLASMA THERMO. *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C G A							
1330	CAU BACILLUS SUBTILIS *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C G A							
1340	CAU ANACYSTIS NIDULANS *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C G A							
1350	CAU MYCOPLASMA *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C G G							
1354	CAU SCENEDESMUS OBLIO. *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C A							
1355	CAU SCENEDESMUS OBLIO. *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C A							
1360	CAU NEUROSPORA CRASSA MITO *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C A							
1370	CAU NEUROSPORA CRASSA *****	U G G G F A G U C C G A R A U C C G A U G G C C U C A U A C C C G G							

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	EXTRA ARM						TF STEM	TF LOOP	TF STEM	AMINOCYL STEM
1316	A G R U	45 47 B D F H J L N P	49 51 53	55 57 59	61 63 65	67 69 71	73 75			
1317	A G R U	44 46 A C E G I K M O	50 52	54 56 58 60	62 64	66 68 70 72	74 76			
METHIONINE-INITIATOR cont.										
1318	A G G U		C G A U G G F C3N ⁺ A1A U	C C A U C C C C G C U A C C A						
1320	A G G U		C A G U G N ⁺ F C3N ⁺ A R U	C U A R C U U C C C G C U A C C A						
1321	A G G U		C S C U G G U3U C3N ⁺ A1A U	C C A G G C G C C G C U A C C A						
1330	A G G U		C G C C G G T2F C A R1A U	C C G G C C C C G C A C C A						
1340	A G G U		C G C C G G T2F C A R1A U	C C G G C C C G C A C C A						
1350	A G G C		C G C A G G T F C R A R U	C C U G C C C C G C A C C A						
1354	A U G7D		C A G A G G T F C R A R U	C C U G C C C C G C A C C A						
1355	A G G7D		C G C A G G U F C G A G U	C C U G C C C C G C A C C A						
1360	U G A		C G C A G G T F C R A R U	C C U G C C C C G C A C C A						
1370	A G G7D*		C S A C A G G A U C G A1A A	C C U N U C C A G C U A C C A						
			C A U A G G U G C A R A U	C C U G A U C C G C A U C C A						
			C A C U C G A U C G A1A A	C G A N U G C A G C U A C C A						

1316/32 PARTIALLY MODIFIED
 1316/57 N IS PRESUMABLY INOSINE
 1317/54 N IS PRESUMABLY 1-METHYLPSEUDOURIDINE
 1317/57 N IS PRESUMABLY 1-METHYLINOSINE
 1318/9 N IS A MODIFIED NUCLEOTIDE
 1318/26 N IS A DERIVATIVE OF GUANOSINE, PRESUMABLY 2,2,2'-TRIMETHYL-GUANOSINE, M22GN
 1318/57 N IS PRESUMABLY 1-METHYLINOSINE
 1340/47 PARTIALLY MODIFIED
 1350/17 PARTIALLY MODIFIED
 1355/64 POSITION 64 IS PROBABLY OCCUPIED BY GN
 1360/38 N IS MOST PROBABLY PSEUDOURIDINE
 1370/28 N IS A DERIVATIVE OF PYRIDINE
 1370/47 PARTIALLY MODIFIED TO U
 1370/44 N IS A DERIVATIVE OF GUANOSINE

1375	CAU WHEAT GERM	AMINOACYL STEM										D LOOP										D STEM					ANTIC. STEM					ANTIC. LOOP					ANTIC. STEM															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45						
	METHIONINE-INITIATOR																																																			
1375	CAU WHEAT GERM	A U C A G A G U G 162C G C A G C	G G A	A G C G U G 25 F G G G C	C C C A U A 7A	C C C A C																																														
1376	CAU BEAN	*****	A U C A G A G U G 162C G C A G C	G G A	A G C G U G 25 U G G G C	C C C A U A 7A	C C C A C																																													
1377	CAU BEAN CHLORO	*****	C G C G A G U A G A G C A C U U G 36 D		A G C U C G C A G G G	C U C A U A	C C U U G																																													
1378	CAU SPINACH CHLORO	*****	C G C G G G U A G A G C A G U U G 36 D		A G C U C G C A G G G	C U C A U A	C C U U G																																													
1380	CAU YEAST	*****	A G C G C C G U G 162C G C A G D	G G A	A G C G C G 4 C A G G G	C U C A U A 7A	C C C U G																																													
1381	CAU YEAST MITO	*****	U G C A R U A U G A U G U A R D U	G G D U	A R C A U U U A G G G	G U C A U G 1A	C C U A R																																													
1382	CAU TORULOPSIS UTILIS	*****	A G C G U C U U G 162C G C A G D	G G A	A G C G C G 4 C A G G G	C U C A U A 7A	C C C U G																																													
1383	CAU TETRAPHYENA THERMO.	*****	A G C A G G G U G 16 G C G A R A D	G 36 A	A U C G C G U F G G G	C U C A U A 7A	C F C A R																																													
1384	CAU LUPIN	*****	A U C A G A G U G 162C G C A G C	G G A	A G C G C G 45 F G G G C	C C C A U A 7A	C C C A C																																													
1385	CAU DROSOPHILA MELAND.	*****	A G C A G A G U G 162C G C A G U	G G A	A G C G U G 2 C U G G G C	C C C A U A 7A	C C C A G																																													
1386	CAU STARFISH	*****	A G C A G A G U G 162C G C A G U	G G A	A G C G U G C U G G G	C C C A U A 7A	C C C A G																																													
1387	CAU XENOPUS LAEVIS	*****	A G C A G A G U G 162C G C A G C	G G A	A G C G U G 2 C U G G G	C C C A U A 7A	C C C A G																																													

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EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOACYL STEM
45	47 B D F H J L N P	49 51 53	55 57 59	61 63 65	67 69 71 73 75
44	46 A C E G I K M O	48 50 52	54 56 58 60	62 64 66	68 70 72 74 76

METHIONINE-INITIATOR cont.					
1375	A G 67D	CSC A G G A F C G A1A A	C C U G ^A G C U C U G A U A C C A	*****	
1376	A G 67D	CSC C R G G A F C G A1A A	C C U G3G C U C U G A U A C C A	*****	
1377	A A 67X	U A C G G G T F C A R A U	C C C G U C U C C G C A R C C A	*****	
1378	A G 67U	C A C G G G T F C A R A U	C C U G U C U C C G C A R C C A	*****	
1380	A U 67D	CSESU C G G A U C G A1A A	C C G N ^A C G G C G C U A C C A	*****	
1381	U U A	U A U A C G T F C A R A U	C G U U U A U U G C F A C C A	*****	
1382	A U 67D	CSC U G G A U C G A1A A	C C A N ^A G A G A C C U A C C A	*****	
1383	A A 67U	C5A G A G G A F C G A1A A	C C U C U C U C G U A C C A	*****	
1384	A G 67D	C5N ^A C R G G A F C G A1A A	C C U N G C U C U G A U A C C A	*****	
1385	A G 67D	CSC G A G G A U C G A1A A	C C U U G C U C U G C U A C C A	*****	
1386	A G 67D	CSC G A G G A F C G A1A A	C C U C G C U C U G C U A C C A	*****	
1387	A G 67D	C5G A U G G A U C G A1A A	C C A U C C U C U G C U A C C A	*****	

1375/64 IS AN UNKNOWN GUANOSINE DERIVATIVE
 1380/64 N IS A DERIVATIVE OF ADENOSINE
 1380/65 N IS A DERIVATIVE OF GUANOSINE
 1381/72 PARTIALLY MODIFIED
 1382/64 N IS A DERIVATIVE OF GUANOSINE
 1384/28 PARTIALLY MODIFIED
 1384/49 DERIVATIVE OF CYTIDINE

	AMINOACYL STEM	D STEM	D LOOP	ID STEM	ANTIC. STEM	ANTIC. LOOP	ANTIC. STEM
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44						
1390	CAU MAMMALIAN* METHIONINE-INITIATOR cont. A G C A G A G G U G G C C G C A G C *****	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44	G G R	A G C G U G C U G G G C C C A U A 7 A	U G G G C C C A U A 7 A	C C C A U A 7 A	C C C A G
1410	P H E N Y L A L A N I N E GAR E. COLI G C C C G G A U A R G C U C A G D C G G D *****	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44	G G D	A G A G C C A G G G G A F U G A A A S A	U G G G A F U G A A A S A	F U G A A A S A	F C C C C
1415	GAR RHODOSPIRILLUM R. G C C C G G G U A G C U C A G C D G G D *****	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44	G G D	A G A G C C A G G G A C U G A A A S A	U G G G A C U G A A A S A	F U G A A A S A	F C A C G
1420	GAR BACILLUS STEREO. G C U C G G U A R G C U C A G U C G G D *****	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44	G G D	A G A G C C A G G G A C U G A A A S A	U G G G A C U G A A A S A	F U G A A A S A	F C C U U
1430	GAR BACILLUS SUBTILIS G C U C G G U A G C U C A G U D G G D *****	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44	G G D	A G A G C C A G G G A C U G A A A S A	U G G G A C U G A A A S A	F U G A A A S A	F C C G U
1440	GAR MYCOPLASMA SP. G G U C G U G U A G C U C A G U C G G D *****	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44	G G D	A G A G C C A G G G A C U G A A A S A	U G G G A C U G A A A S A	F U G A A A S A	F C U G C
1445	GAR YEAST MITO G C U U U A U A G C U U A G D G G D ****	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44	G G D	A A G C G A U A R A F U G A A G 1 A	U A R A F U G A A G 1 A	F U U A U	F U U A U
1450	GAR BEAN CHLORO G U C G G G U A G C U C A G U D G 36 D ** **	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44	G 36 D	A G A G C C A G G G A C U G A A A S A	U G G G A C U G A A A S A	F U G A A A S A	F C C U C
1451	GAR SPINACH CHLORO G U C G G G U A G C U C A G C U G 36 D ** **	11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44	G 36 D	A G A G C C A G G G A C U G A A A S A	U G G G A C U G A A A S A	F U G A A A S A	U C C U C

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	EXTRA ARM	TF STEM	TF LOOP	TF STEM	AMINOACYL STEM	
	45 47 B D F H J L N P 44 46 A C E G I K M O	49 51 53 50 52 54	55 57 59 56 58 60	61 63 65 62 64 66	67 69 71 68 70 72	73 75 74 76
1390	METHIONINE-INITIATOR cont. R G 67D	C S G A U G G R A U C G A R A C C R A U C C U C U G C U A C C A				
1410	P H E N Y L A L A N I N E G U 67X	C C U U G G T F C G R A U U C C G A G U C C G G C C A C C A				
1415	G U 67U	C G U G G T F C G A C U C C G C C C C G G C C A C C A				
1420	G U 67U	C G C G G T F C G A U U C C G U C C G A G C C A C C A				
1430	G U 67U	C G C G G T F C G A U U C C G U C C G A G C C A C C A				
1440	G U 67U	C G C G G U F C A R A U C C G U C C A C G A C C A C C A				
1445	U U A	C A U G U A G U F C G A U U C U C A U A R G G C C A C C A				
1450	G U 67X	C A C C A G T F C A R A U C U G G U C C U G G C A C C A				
1451	G U 67X	C A C C A G T F C A R A U C U G G U C C U G G C A C C A				

1390/0 RABBIT LIVER, SHEEP BANTARY BLANDS, SALMON TESTES, SALMON LIVER, HUMAN
PLACENTA, MOUSE MYELOMA CELLS, ODCYTES AND SOMATIC CELLS OF XENOPUS
1445/48 FOR ALTERNATIVE ALIGNMENT SEE NUCLEIC ACIDS RES. 5, P. 4587
LAEUIS

	AMINOACYL STEM								D STEM								D LOOP								ID STEM								ANTIC. STEM								ANTIC. LOOP								ANTIC. STEM							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50						
PHENYLALANINE cont.																																																								
1452	GAA	AGMENELLUM	QUADR.	G	C	C	A	G	G	A	U	A	G	C	N ⁺	C	A	G	U	D	G	S	S	D	A	G	A	G	C	A	G	A	G	G	A	C	U	G	A	A	A	S	A	F	C	C	U	C								
1460	GAA	EUGLENA GRACILIS	CHILDRO	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****								
1461	GAA	EUGLENA GRACILIS		G	C	C	A	G	C	U	A	G	C	U	C	A	G	U	A	G	C	U	A	G	S	S	D	A	G	A	G	C	A	G	A	G	G	A	C	U	G	A	A	Y	A	F	C	U	A	A						
1462	GAA	CYANOBACTERIUM SP.		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****								
1465	GAA	NEUROSPORA CRASSA		G	C	G	G	U	U	A	G	C	U	C	N ⁺	G	D	D	G	G	G	S	S	D	A	G	A	G	C	A	G	A	G	C	A	G	A	C	U	G	A	A	N ⁺	A	F	C	S	U	G	A						
1470	GAA	YEAST		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****							
1471	GAA	SACCHAROMYCES POMBE		G	U	C	G	C	A	A	U	N ⁺	G	U	G	F	A	G	D	G	G	G	S	S	D	A	G	C	A	F	G	A	C	A	G	A	C	U	G	A	A	Y	A	F	C	S	U	G	U							
1479	GAA	LUPIN		G	C	G	G	G	A	U	A	G	C	U	C	A	G	D	G	G	G	S	S	D	A	G	A	G	C	A	G	A	G	C	A	G	A	C	U	G	A	A	Y	A	F	C	U	G	A							
1480	GAA	WHEAT, PEA, BARLEY		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****							
1484	GAA	BOMBYX MORI		*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****							

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EXTRA ARM		TF STEM	TF LOOP	TF STEM	TF STEM	AMINOCYL STEM
45	47 B D F H J L N P	49 51 53	55 57 59	61 63 65	67 69 71	73 75
44	46 A C E G I K M O	48 50 52	54 56 58 60	62 64	66 68 70 72	74 76

PHENYLALANINE cont.						
1452	G U G7U	C G C G G T	F C A R A U U	C C G C C U	C C C G G C A C C A	
1460	G U G7X	C A C C A G T	F C A R A U	C U G G U	C C C U A G C A C C A	
1461	A G G7U	C C U G G T	F C G A U C	C C G G A G F C G C A C C A	*****	
1462	G U G7U	C S G C G G T	F C A R A U	C C G C C U	C C C G G C A C C A	
1465	A G G7D	C S G U G U G T	F C G A U C	C A C A C A	C C C G C A C C A	
1470	A G G7U	C C S U G U G T	F C G A U C	C A C A G A	A U U C G C A C C A	
1471	U G G7N*	C A U C G G T	F C G A U C	C C G G U	U G U G A C A C C A	
1479	A G G7D	C A C G U G T	F C G A U C	C A C G U	C A C C G C A C C A	
1480	A G G7D	C G C G U G T	F C G A U C	C A C G C U	C A C C G C A C C A	
1484	A G G7D*	C S C U G G T	F C G A U C	C C G G G U	U U C G G C A C C A	
		-----	-----	-----	-----	-----

1452/12 N IS A DERIVATIVE OF URIDINE
 1460/20 PARTIALLY MODIFIED TO D
 1461/49 PROBABLY A DERIVATIVE OF CYTIDINE
 1462/39 N IS PROBABLY A DERIVATIVE OF URIDINE
 1465/14 N IS A DERIVATIVE OF ADENOSINE
 1465/37 N IS A DERIVATIVE OF Y
 1471/9 N IS A DERIVATIVE OF GUANOSINE
 1471/10 IS PROBABLY N2B
 1471/26 IS PROBABLY N2B
 1471/47 N IS PROBABLY A DERIVATIVE OF URIDINE
 1484/32 PARTIALLY MODIFIED
 1484/47 PARTIALLY MODIFIED
 1484/48 MODIFICATION EITHER IN POSITION 48 OR 49
 1484/57 MINOR SPECIES HAS A57

	AMINOACYL STEM	D STEM	D LOOP	D STEM	D STEM	D LOOP	D STEM	D STEM	ANTIC. STEM	ANTIC. LOOP	ANTIC. STEM	
	1 2 3 4 5 6 7 8 9 10 12 14 16 A 19 A 21 23 25 27 29 31	11 13 15 17 18 20 B 22 24 26 28 30 32 34 36 38 40 42										
PHENYLALANINE cont.												
1485	GAA DROSOPHILA MELANO. G C C G R A R A U A G2C U C A G D D G G G A G A G C G A F A G A C3U G3R A G1A F C U A R	*****										
1486	GAA XENOPUS LAEVIS G C C G R A R A U A G2C U C A1G D D G G G A G A G C G A F A G A C3U G3R A Y1A F C U A R	*****										
1490	GAA MAMMALIAN* G C C G R A R A U A G2C U C A1G D D G G G A G A G C G A F A G A C3U G3R A Y2A F C U A R	*****										
1491	GAA BOVINE LENS G C C G R A R A U A G2C U C A1G D D G G G A G A G C G A F A G A C3U G3R A Y2A F C U A R	*****										
1492	GAA BOVINE LENS G C C G R A R A U A G2C U C A1G D D G G G A G A G C G A F A G A C3U G3R A Y2A F C U A R	*****										
1493	GAA MOUSE LIVER G C C G R A R A U A G2C U C A1G D D G G G A G A G C G A F A G A C3U G3R A Y1A F C U A R	*****										
P R O L I N E												
1510	N65 PHAGE T4 C U C C G U G U A A G C U C A G U U G G D A G A G C C C U G A U3U N6 G G G1A F C A G G	*****										
1511	U66 PHAGE T5 C U C C G A U A G C U C A R A U G C C D A G A G U A C C C G U U G G G1G C G G U G	*****										
1515	N66 HALOBACTERIUM VOL. G G C C G G U G G4G G F A N C U U G G U A U C C U C G G C C U U N6 G G G1F G C C G	*****										
1516	C66 SALMONELLA TYPHIMUR. C G G U G R U U4G G C G C A G C C U G G D A G C G C A C U U C G U3U C G G G1A C G A G	*****										

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EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOCYL STEM
45	47 B D F H J L N P	49 51 53	55 57 59 61	63 65	67 69 71 73 75
44	46 A C E G I K M O	48 50 52	54 56 58 60	62 64	66 68 70 72 74 76

PHENYLALANINE cont.					
1485	A G 670 [†]	C C C G G	T F C A A1U C	C C G G G	J U U C G G C A C C A
1486	A G 670	C C C U G G	T F C G A1U C	C C G G G	J U U C G G C A C C A
1490	A G 670*	C C C U G G	T F C G A1U C	C C G G G	J U U C G G C A C C A
1491	A G 670	C C C U G G	T F C G A1U C	C C G G G	J U U C G G C A C C A
1492	A G 670	C C C U G G	T F C G A1U C	C C G G G	J U U C G G C A C C A
1493	A G 670	C C C U G G	T F C G A1U C	C C G G G	J U U C G G C A C C A

P R O L I N E					
1510	A G 670	C C A R G G	T F C A R A R U	C C U U G	J A U G G A G A C C A
1511	G G 670	U G A R G G	T F C G A G U	C C U U C	A U U G G A G A C C A
1515	U A R	C C S U C A G	T F C36 A R U	C U G A G	C C G C C C A C C A
1516	G G 670	C C G G G	T F C G A R U	C C U C U	A U C A C G A C C A

1485/32 PARTIALLY MODIFIED
 1485/47 PARTIALLY MODIFIED
 1490/0 RABBIT LIVER-CALF LIVER-BOVINE LIVER AND HUMAN PLACENTA
 1490/47 PARTIALLY MODIFIED
 1490/54 CONTENT OF T IS DIFFERENT FOR DIFFERENT SPECIES. PARTIALLY U
 1510/8 PARTIALLY MODIFIED
 1510/34 N IS A DERIVATIVE OF URIDINE
 1515/34 PARTIALLY MODIFIED TO UNIDENTIFIED DERIVATIVE OF CYTIDINE
 1515/38 PARTIALLY MODIFIED
 1515/48 PARTIALLY MODIFIED
 1515/55 PARTIALLY MODIFIED
 1516/52 PARTIALLY MODIFIED

EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOACYL STEM
45	B	49	55	61	67
46	C	50	56	62	68
47	D	51	57	63	69
48	E	52	58	64	70
49	F	53	59	65	71
50	G	54	60	66	72
51	H				73
52	I				74
53	J				75
54	K				
55	L				
56	M				
57	N				
58	O				
59	P				
60					
61					
62					
63					
64					
65					
66					
67					
68					
69					
70					
71					
72					
73					
74					
75					

PROLINE cont.
1517 G G 67U C G G A G G T F C A R A U C C U C U C U G C C G A C C A
1518 G G 67U C G G A G G T F C G A U C C U C F U C G C C G A C C A
1520 U G 67D C S C S A G G G T F C A R U U C C C U G C U C G C C C C A
1550 A C C U A G U A G T F C G A U C C U A U C C U A U C G A C C A
1580 A U 67U C A C G G T F C A R A U C C U G U E A U C C C U A C C A
1580 A G 67D C S C S C G G G F F C A R A U C C C G A C G A G C C C C A
1581 A G 67D C S C S C G G G F F C A R A U C C C G A C G A G C C C C A

SERINE
1610 C G A C C C G A R A G G G U U C A G A G T F C G A U C U C U C C G C C A
1611 A G U A G G G G C A C U C U A C C G G G T F C A R A U C C C C U C U C C C C C A
1620 U A U G C G G U C A R A G C U G C A U C C G G G T F C G A U C C C C G C C U C A C C G C C A

1518/32 PARTIALLY MODIFIED
 1518/65 PARTIALLY MODIFIED
 1520/34 N IS A DERIVATIVE OF URIDINE
 1580/10 N IS A DERIVATIVE OF GUANOSINE
 1560/32 PARTIALLY MODIFIED
 1560/34 N IS A DERIVATIVE OF URIDINE
 1560/37 N IS A DERIVATIVE OF ADENOSINE
 1581/34 N IS MOST LIKELY A U DERIVATIVE
 1620/32 IN THE POSITION 32 IS MOST PROBABLY 2-THIOCYTIDINE

	AMINOACYL STEM	D STEM	D LOOP	D STEM	D STEM	D LOOP	D STEM	ANTIC. STEM	ANTIC. LOOP	ANTIC. STEM
	1 2 3 4 5 6 7	8 9 10 11 12 13	14 15 16 17 18 19 20 21	22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44						
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1653	CCR BOVINE LIVER*	U G A U C C U C A G U G G U C C G G G U	U C A G U G G U C C G G G U	U G A U C C U C A G U G G U C C G G G U	U C A G U G G U C C G G G U	U C A G U G G U C C G G G U	U G A U C C U C A G U G G U C C G G G U	G D A G G C U C 3 C A A 4 A	C C U G U	
1654	NCR BOVINE LIVER*	U G A U C C U C A G U G G U C C G G G U	U C A G U G G U C C G G G U	U G A U C C U C A G U G G U C C G G G U	U C A G U G G U C C G G G U	U C A G U G G U C C G G G U	U G A U C C U C A G U G G U C C G G G U	G C A G G C U N C A A 4 A	C C U G U	
1660	AGA RAT HEPATOMA	U G C C 4 G A G D	G 3 5 D D	U G C C 4 G A G D	G 3 5 D D	U G C C 4 G A G D	U G C C 4 G A G D	F G G A C 8 U I G A A 4 A	F 3 C C A U	
1670	GCU RAT LIVER	U G C C 4 G A G D	G 3 5 D D	U G C C 4 G A G D	G 3 5 D D	U G C C 4 G A G D	U G C C 4 G A G D	F G G A C 8 U G C U A 8 A	F C C A U	
1671	CCR BOVINE LIVER SUP	U G A U C C U C A G U G G U C C G G G U	U C A G U G G U C C G G G U	U G A U C C U C A G U G G U C C G G G U	U C A G U G G U C C G G G U	U C A G U G G U C C G G G U	U G A U C C U C A G U G G U C C G G G U	G D A G G C U C 3 C A A 4 A	C C U G U	
1675	GCU YEAST MITO	U A C U A D A	G G D	U A C U A D A	G G D	U A C U A D A	U A C U A D A	G G A U U A F	F U G C U A A	G U A U U
1676	UGA YEAST MITO	U G A C U G A G D	G G D U U A	U G A C U G A G D	G G D U U A	U G A C U G A G D	U G A C U G A G D	F G A U A	F U U G A G 1 C	F A U C A
1677	UGA YEAST MITO	U G A C U G A G D	G G D U U A	U G A C U G A G D	G G D U U A	U G A C U G A G D	U G A C U G A G D	F G A U A	F U U G A G 1 C	F A U C A
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
	GCU E. COLI	U A G C U C A G D D	G G D	U A G C U C A G D D	G G D	U A G C U C A G D D	U A G C U C A G D D	C A C C C	U U G G U A 8 A	G G G U G
1720	UGU BACILLUS SUBTILIS	U A G C U C A R A U D	G G D*	U A G C U C A R A U D	G G D*	U A G C U C A R A U D	U A G C U C A R A U D	C U G A	C U V 2 G U A 7 A	F C A G U
	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****

SERINE cont.

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EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOACYL STEM
45	A 47 B D F H J L N P	49 51 53	55 57 59	61 63 65	67 69 71 73 75
44	A 46 A C E G I K M O	50 52 54	56 58 60	62 64 66	68 70 72 74 76

SERINE cont.					
1653	A G C U G U C U A G C G A C A	G A G U G G	U F C A A U U	C C A C C U U	U C G G C C G C C A
	:::~::~:	:::~::~:			:::~::~:
1654	A G C U G U C U A G C G A C A	G A G U G G	U F C A A U U	C C A C C U U	U C G G C C G C C A
	:::~::~:	:::~::~:			:::~::~:
1660	U 96 G G G U C B U C C C C G	C 96 C A G G T	F C G A A U	C C U G C C G	A C U A C C G C C A
	:::~::~:	:::~::~:			:::~::~:
1670	U 96 F G C U C B U G C A C G	C 96 U G G G T	F C G A A U	C C C A U C C	U C G U C C G C C A
	:::~::~:	:::~::~:			:::~::~:
1671	A G C U G U C U A G C G A C A	G A G U G G	U F C A A U U	C C A C C U U	U C G G C C G C C A
	:::~::~:	:::~::~:			:::~::~:
1675	U G A R U U G U A R A U U C U	U A U G A G T	F C G A A U	C U C A U A U	U U U C C G C C A
	:::~::~:	:::~::~:			:::~::~:
1676	U U A G U C U U A R U U G G C U A	C G U A G G T	F C A R A U	C C U A C A U	C A U C C G C C A
	:::~::~:	:::~::~:			:::~::~:
1677	U U A G U C U U A R U U G G C U A	C G U A G G T	F C A R A U	C C U A C A U	C A U C C G C C A
	:::~::~:	:::~::~:			:::~::~:
T H R E O N I N E					
1710	A G 67U	C G G C A G T	F C G A R U	C U G G C C U	A U C A G C C A C C A
1720	A G 67U	U G G G G T	F C A R A G U	C C U C U U	G C C G C C A C C A
		:::~::~:			:::~::~:

1676/27 PARTIALLY MODIFIED
 1677/27 PARTIALLY MODIFIED
 1720/20 PARTIALLY MODIFIED

1653/0 CAN BE PHOSPHORYLATED TO PHOSPHOSERYL-TRNA; UGA SUPPRESSOR
 1654/0 CAN BE PHOSPHORYLATED TO PHOSPHOSERYL TRNA; UGA-SUPPRESSOR
 1660/18 HEPATOMA LACKS MODIFICATION

	AMINOACYL STEM								D STEM				D LOOP				ID STEM				ANTIC.STEM				ANTIC.LOOP				ANTIC.STEM															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42		
THREONINE cont.																																												
1730	NGU PHAGE T4																																											
1740	UGU NEUROSPORA CRASSA																																											
1760	MITO																																											
1765	Yeast																																											
1770	GGU SPINACH																																											
1771	UGU BOVINE LIVER																																											

T R Y P T O P H A N																																												
1810	CCA E. COLI CR 244																																											
1840	CCA Yeast																																											
1841	NCA Yeast																																											
1845	UCA NEUROSPORA CRASSA																																											
1846	CCA SPINACH																																											

1730	C. GUTHRIE, C. A. SCHOLLA, H. YESIAN, J. ABELSON (1978) NUCLEIC ACIDS RES. 5, 1833-1844																																											
1740	J. E. HECKMAN, J. SARNOFF, B. ALZNER-DE WEERD, S. YIN, U. L. RAJBHANDARY (1980) PROC. NATL. ACAD. SCI. USA 77, 3159-3163																																											
1760	J. WEISBERG, I. KIRALY, G. DIRHEIMER (1977) BIOCHIMIE 59, 381-391																																											
1765	A. P. SIBLER, G. DIRHEIMER, R. P. MARTIN (1981) FEBS LETTERS 132, 344-348																																											
1770	M. A. KASHAN, R. M. PIRTLE, I. L. PIRTLE, J. L. CALAGAN, H. J. VREMAN, B. S. DUDOCK (1980) J. BIOL. CHEM. 255, 8831-8835																																											
1771	B. A. ROE, J. F. H. WONG, E. Y. CHEN (1982) PERSONAL COMMUNICATION																																											
1810	D. HIRSH (1971) J. MOL. BIOL. 58, 439-458																																											
1840	G. KEITH, A. ROY, J. P. EBEL, G. DIRHEIMER (1972) BIOCHIMIE 54, 1405-1426																																											
1841	A. P. SIBLER, R. BORDONNE, G. DIRHEIMER, R. MARTIN (1980) COMP. REND. ACAD. SCI. D. 290, 495-498																																											
1845	J. E. HECKMAN, J. SARNOFF, B. ALZNER-DE WEERD, S. YIN, U. L. RAJBHANDARY (1980) PROC. NATL. ACAD. SCI. USA 77, 3159-3163																																											
1846	J. CANADAY, P. GUILLEHAUT, R. GLOCKLER, J. H. WEIL (1981) NUCLEIC ACIDS RES 9, 47-53																																											

EXTRA ARM		TF STEM	TF LOOP	TF STEM	AMINOCYL STEM
45	B D F H J L N P	49 51 53	55 57 59	61 63 65	67 69 71
44	A C E G I K M O	48 50 52	54 56 58 60	62 64 66	68 70 72 74 76

THREONINE cont.					
1730	AUGU	C G C G G T	F C G A U U	C G U C A R A U	C A G C A C C A
1740	AG A	-----	-----	-----	*****
1760	AG A D	A G C A G T	G C G A U A	C U U G C A C U	G G C U C C A
1765	U A R	C S T U C G G T	F C A A 1 A U	C C G A U U G G	A R G C C A C C A
1770	A A G 7 D	U C U A G T	F C A R A U	C U U A G U A U	U A C C A C C A
1771	A G A	C A U C G G T	F C A R A U	C C G A U A G G	G C U C C A
		A G G A R A	C A R C U A C	C C C C F A R G	A C U C C A
		-----	-----	-----	*****
T R Y P T O P H A N					
1810	G U G 7 U	U G G A G T	F C G A G U	C U C U C G C C	C C U G C C A
1840	G G G 7 D	U G C A G G T	F C A A 1 U U	C C U G F C C G	U U C A C C A
1841	C A U	-----	-----	-----	*****
1845	A R U	U A G G A G T	F C G A R U	C U C U U A U C	C U U G C C A
1846	A U G N	U C U A G T	F C G A G U	C U A R G U A C	U C U U G C C A
		C G A R G G T	F C A R A G U	C C U A C A G A	G G C G U C C A
		-----	-----	-----	*****

1730/34 N IS A DERIVATIVE OF URIDINE
 1730/37 N IS A DERIVATIVE OF ADENOSINE
 1760/49 IN OTHER ISOACCEPTOR G
 1760/65 IN OTHER ISOACCEPTOR C
 1771/0 ALIGNMENT IS ARBITRARY

1841/34 MODIFIED URIDINE
 1841/37 I6A OR MS216A
 1845/34 MODIFIED DERIVATIVE OF URIDINE
 1845/37 MODIFIED DERIVATIVE OF ADENOSINE
 1846/37 I6A OR MS216A

	AMINOACYL STEM	D STEM	D LOOP	ID STEM	ANTIC.STEM	ANTIC.LOOP	ANTIC.STEM
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42						
TRYPTOPHAN cont.							
1850	G R C C U C G U G 152C G C A R C		G3G D	A G C G C G C F C U G A	C3U C3C A G1A	F3C A G A	
1860	***** G A C C U C G U G 152C G C A R C		G3G D	A G C G C G C F C U G A	C3U C3C A G1A	F3C A G A	
1861	***** A G G A U U U A 152B U U A R A C A			G A C C A R A G A G C C U N C A A S A		G C C C U	
1890	***** G A C C U C G U G 152C G C A R C		G3G D	A G C G C G C F C U G A	C3U C3C A G1A	F3C A G A	
T Y R O S I N E							
1910	G G U G G G G U4U4C C C G A G C		G3G C C R A G G G A	A G G G A G C A G A	C U O U A A S A	F C U G C	
1915	***** C C G C U C U J A G C U C A N C C U G G C			A G A G C A G C C G A C3U G U A G1A		F C G G C	
1918	***** G G A G G G U4A G C G A R A G U		G3G C U R A	A1C G C G C G A C U O U A A4A		F C C G C	
1920	***** G G A G G G U4A G C G A R A G U		G3G C U R A	A1C G C G C G A C U O U A A S A		F C C G C	
1925	***** A G G A G G G U C C G U U U G U G G D R A G A C G G G F U R A G C			C U G U A N A C U G U A N A		C U U R A	
1930	***** C U C U C G U A 52C C A R A G D D		G3G D D D A	A G G C A R A G C C A R A G A	C U G F A A4A	F C U U G	

1850 F. HARADA, R. C. SAWYER, J. E. DAHLBERG (1975) J. BIOL. CHEM. 250, 3487-3497
 1860 R. FOURNIER, J. LABUESSSE, G. DIRHEIMER, C. FIX, G. KEITH (1978) BIOCHIM. BIOPHYS. ACTA 521, 198-208
 1861 B. G. ROE, J. F. H. VONG, E. Y. CHEN, P. A. ARMSIRONG (1981) PROC. THIRD CLEVELAND SYM. A. G. HALTON (ED) ELSEVIER AMSTERDAM
 1890 J. L. HU, J. E. DAHLBERG (1983) NUCL. ACIDS RES. 11, 4823-4833
 1910 H. N. GOODMAN, J. ABELSON, A. LANDY, S. BRENNER, J. D. SMITH (1968), NATURE 217, 1019-1024
 1915 R. GUPTA (1981), PH. D. THESIS, UNIVERSITY OF ILLINOIS, URBANA
 1918 B. MENCHI, H. H. ARNOLD, T. HEYMAN, G. DIRHEIMER, G. KEITH (1980) BIOCHIM. BIOPHYS. RES. COMMUN. 95, 461-467
 1920 R. S. BROWN, J. R. RUBIN, D. RHODES, H. GUILLEY, A. STONGSITS, G. G. BROWNLEE (1978) NUCLEIC ACIDS RES. 5, 23-36
 1925 J. E. HECKMAN, B. ALZNER-DE WEERD, U. L. RAJBHANDARY (1979) PROC. NATL. ACAD. SCI. USA 76, 717-721
 1930 J. T. MADISON, H. K. KUNG (1967) J. BIOL. CHEM. 242, 1324-1330

	EXTRA ARM										TF STEM	TF LOOP	TF STEM	AMINOCYL STEM																																		
	45	47	B	D	F	H	J	L	N	P	49	51	53	55	57	59	61	63	65	67	69	71	73	75																								
	44	46	A	C	E	G	I	K	M	O	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76																							
TRYPTOPHAN cont.																																																
1850	A	G	G	T	C	G	G	G	F	F	U	G	C	G	U	G	F	C	G	A	1A	U	C	A	C	G	U	C	G	G	G	U	C	C	A	C	C	A										
1860	A	G	G	T	C	G	G	G	F	F	U	G	C	G	U	G	F	F	C	G	A	1A	U	C	A	C	G	U	C	G	G	U	C	C	A	C	C	A										
1861	A	A	G								C	A	G	U	A	C	A	R	A	U	U			U	A	C	U	U	A	R	U	C	C	U	G	C	C	A										
1890	A	G	G								C	G	C	G	G	F	F	C	G	A	1A	U	C	A	C	G	U	C	G	G	U	C	C	A	C	C	A											
T Y R O S I N E																																																
1910	C	G	U	C	A	U	C	G	A	C	U	C	G	A	G	G	T	F	C	G	A	U	C	C	U	C	C	C	C	C	C	C	C	C	C	C	C	A	C	C	A							
1915	U	U	G	U							C	S	C	C	G	F	1F	C	362A	A	U	C	G	G	G	A	G	A	G	C	G	A	C	C	A													
1918	U	C	C	C	U	C	A	G	G	G	U	C	G	C	A	G	T	F	C	G	A	U	C	U	G	C	C	C	C	C	C	C	C	C	C	C	A	C	C	A								
1920	U	C	C	C	U	U	G	G	G	U	C	G	C	G	G	T	F	C	G	A	U	C	C	G	U	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	A					
1925	U	G	A	C	A	R	A	U	A	G	U	C	G	U	C	G	A	G	G	T	F	C	A	R	U	C	C	U	U	C	C	U	U	C	C	U	C	C	C	C	C	C	C	C	C	C	C	A
1930	A	G	A	D							C	S	G	C	G	T	F	C	G	A	1C	U	C	G	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	A				

1850/0 THE SEQUENCE WAS DETERMINED ON PRIMER RNA FOR INITIATION OF IN VITRO ROUS-SARCOMA VIRUS DNA SYNTHESIS. TRNA-TRP FROM CHICKEN CELLS HAS AN IDENTICAL COMPOSITION. L.C. WATERS, H.-K. YANG (1975) J. BIOL. CHEM. 250, 6427-6429; COMPARE ALSO B. CORDELL ET AL. (1980) J. BIOL. CHEM. 255, 9358-9368

1860/7 PARTIALLY MODIFIED
 1860/16 PARTIALLY C
 1860/34 PARTIALLY MODIFIED
 1860/46 PARTIALLY MODIFIED
 1860/47 PARTIALLY C
 1860/57 PARTIALLY A

1861/0 ALIGNMENT IS ARBITRARY
 1861/34 N IS A MODIFIED URIDINE
 1910/9 U IS PROBABLY MODIFIED TO SAU
 1910/47 B PARTIALLY A
 1910/47 C PARTIALLY A
 1915/32 PARTIALLY MODIFIED
 1918/0 SEE FOOTNOTE 37
 1918/37 IN THE SPECIES 2 MS2IGA AT THIS POSITION
 1925/37 N IS PROBABLY ISOPENTENYL ADENOSINE
 1925/47 I OR 48: ONE OF CYTIDINES IS MODIFIED TO NSC

	AMINOCYL STEM	D STEM	D LOOP	ID STEM	ANTIC. STEM	ANTIC. LOOP	ANTIC. STEM
	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42						
TYROSINE cont.							
1940	GUA TORULOPSIS UTILIS C U C U C G G U G 162 C A R A G D D G 36 D D D A R A G G C G A C A G A C U G F A R A R F C U G A						
1941	GUA SACCCHAROMYCES POMBE C U C C U G A U G 16 U G F A G D D G D D A U C A C A C C C G G C U G F A R A R C C G G U						
1980	GUA YEAST G G A G G A U U U C A R A U G U D G G D R A G U U G G A G F U G A G C U G U A A C U C C R A						
1980	GUA XENOPUS LAEVIS C C U U C G A U A 62 C U C A G C D G G X ³ A G A G A C G A G G A C U G F A G 1 A F C C U U						
V A L I N E							
2010	UAC E. COLI K12/B G G U G U G A U U 4 R G C U C A G C D G G G A G A G C A C C U C C C U V 1 R C R A G G A G G						
2020	GAC E. COLI G C G U C C G U 4 R G C U C A G D D G D D A G A G C A C C A C C U U G A C A U G G U G G						
2021	GAC E. COLI G C G U C C A U 4 R G C U C A G D D G D D A G A G C A C C A C C U U G A C A U G G U G G						
2022	GAC HALOBACTERIUM CUT. G G U G U G U G U G U C F A G U C A G G C U A U G A C A C C U C C U U G A C A U G G A G G						
2023	GAC HALOBACTERIUM VOL. G G G U U G G U G U C F A G U C U G G U U A U G A C A C C U C C U U G A C A U G G A G G						
2024	CAC HALOBACTERIUM CUT. G G G U U G G U N G U C F A G U C A G G C U A U G A C A C C U C C U U C A C A U G G A G G						

1940 S. HASHIMOTO, S. TAKENURA, M. MIYAZAKI (1972) J. BIOCHEM. 72, 123-134
 1941 G. VOLEGEL (1979), NUCLEIC ACIDS RES. 7, 1059-1065
 1950 A. P. SILBER, G. DIAMETRE, R. P. MARTIN (1983) FEBS LETTERS 152, 153-156
 1980 W. FILIPOWICZ, A. J. SHATKIN (1983) CELL 32, 547-557
 F. A. LASKI, A. Z. FIRE, J. L. RAJHANDARY, P. A. SHARP (1983) J. BIOL. CHEM. 258 11974-11980
 F. RUELLER, S. B. CLARKSON (1980) CELL 19, 345-348
 2010 M. YANIV, B. G. BARRELL (1969) NATURE 222, 278-279
 F. KITURA, F. HARADA, S. HISHIMURA (1971) BIOCHEMISTRY 10, 3277-3283
 2020 M. YANIV, B. G. BARRELL (1971) NATURE NEW BIOL. 233, 113-114
 2021 M. YANIV, B. G. BARRELL (1971) NATURE NEW BIOL. 233, 113-114
 2022 X.-R. GU, K. NICOGHOSIAN, R. J. CEDERGREN, J. TZE-FEI WONG (1983) NUCL. ACIDS RES. 11, 5433-5442
 2023 R. GUPTA (1981) PH.D. THESIS, UNIVERSITY OF ILLINOIS, URBANA
 2024 X.-R. GU, K. NICOGHOSIAN, R. J. CEDERGREN, J. TZE-FEI WONG (1983) NUCL. ACIDS RES. 11, 5433-5442

	EXTRA ARM					TF STEM	TF LOOP	TF STEM	AMINOCYL STEM																										
	45	47	B	D	F	H	J	L	N	P	49	51	53		61	63	65	67	69	71	73	75													
	44	46	A	C	E	G	I	K	M	O	48	50	52		54	56	58	60	62	64	66	68	70	72	74	76									

	TYROSINE cont.																																		
1940	A	C	A	D	C	S	G	G	C	G	T	F	C	G	A	1	A	U	C	G	C	C	C	C	C	C	G	A	G	A	C	C	A		
1941	U	G	6	7	U	C	S	G	C	U	A	G	T	F	C	G	A	1	U	C	U	G	G	C	U	C	A	G	A	G	A	C	C	A	
1950	U	G	A	C	U	A	G	G	U	C	U	U	C	A	U	A	G	T	F	C	A	U	U	C	C	U	U	C	A	C	C	A			
1960	A	G	6	7	U	C	S	G	C	U	G	T	F	C	G	A	1	U	C	C	G	G	C	U	C	G	A	G	A	C	C	A		

	V A L I N E																																		
2010	G	G	6	7	U	C	G	C	G	G	T	F	C	G	A	U	C	C	G	U	C	C	C	G	A	U	C	A	C	C	C	A	C	C	A
2020	G	G	6	7	X	C	G	U	G	G	T	F	C	G	A	G	U	C	C	A	C	U	C	G	A	C	G	A	C	G	C	A	C	C	A
2021	G	G	6	7	X	C	G	U	G	G	T	F	C	G	A	G	U	C	C	A	U	C	C	A	U	G	A	C	G	C	A	C	C	A	
2022	A	G	6	U	C	S	G	C	G	G	F	1	F	C	3	N	A	A	U	C	C	G	C	C	C	A	A	C	C	C	A	C	C	A	
2023	A	G	6	C	C	S	G	C	A	G	F	1	F	C	3	6	2	A	A	U	C	U	G	C	C	C	A	A	C	C	C	A	C	C	A
2024	A	G	6	U	C	G	C	S	G	G	F	1	F	C	3	1	A	A	U	C	C	G	C	C	C	A	A	C	C	C	A	C	C	A	

1980/46 PARTIALLY MODIFIED
 1980/48 PARTIALLY MODIFIED
 2023/35 PARTIALLY MODIFIED
 2024/9 probably nlg

1941/27 F IN 20% OF THE TRNA
 1950/37 ADENOSINE IS MODIFIED TO I6A OR MS216A
 1980/20 PARTIALLY MODIFIED
 1980/24 PARTIALLY MODIFIED
 1980/26 PARTIALLY MODIFIED

	AMINOCYL STEM	D STEM	D LOOP	ID STEM	ANTIC.STEM	ANTIC.LOOP	ANTIC.STEM
	1 2 3 4 5 6 7 8 9	11 12 13 14 15 16 17 18 19 20 21	22 23 24 25 26 27 28 29 30 31	32 33 34 35 36 37 38 39 40 41 42 43			
	-----	-----	-----	-----	-----	-----	-----
	*****	*****	*****	*****	*****	*****	*****
2025	UAC BACILLUS SUBTILIS	G G A G G A U U A G C U C A G C D	G G G	A G A G C C A U C U G C C	C U V 2 A C A 6 A	G C A G A	
2026	GAC HALOBACTERIUM CUT.	G G G U U G G U G G U C F A G U C A G G C U		A U G A C C C U C C C	U U G A C A U G	G A G G	
2028	NAC SPINACH CHLORO	A G G C C U A U A G C C U C A G U U A G 35 D		A G A G C C A C C U C G U U N A C A C	C C G A G A		
2030	GAC BACILLUS STEARO.	G A U C C G U A G C U C A G C D	G G G	A G A G C C G C C A C C	U U G A C A 6 5	G U G G	
2040	PAC YEAST	G G U U C G U G U G U C F A G D C	G G D D	A U G G C A F C U G C	F U I A C A C	G C A G A	
2050	NAC YEAST	G G U C C A A U G G 2 U C C A G D	G G D D C A	A G A C G 4 F C G C C	F U N A C A C	G C G A	
2051	CAC YEAST	G U C C A A U A G 2 U G F A G C	G G C D	A U C A C G 2 F F G C C	F U C A C A C	G G C A R	
2055	UAC NEUROSPORA CRASSA MITO	G A G A G A U U A G C U C A G U U	G G D	A G A G C A A C C G U	U U U A C A C	A C G A	
2060	PAC TORULOPSIS UTILIS	G G U U C G U G U U C F A G D D	G G D C	A U G G C A F C U G C	F U I A C A C	G C A G A	
2065	PAC DROSOPHILA MELANO.	G U U 3 C C G U G U G F A G C	G G D X	A U C A C A F C U G C	C 3 U I A C A	C 5 5 C G A	
2070	PAC MAMMALIAN*	G U U C C G U A G U G F A G D	G G D D	A U C A C G 2 F U C G C	C 3 U I A C A	C 5 5 C G A	

VALINE cont.

2025 K. MURAO, T. HASEGAWA, H. ISHIKURA (1982) NUCL. ACIDS RES. 10, 715-718
 2026 X.-R. GU, K. NICOBOSSIAN, R. J. CEDERBERN, J. TZE-FEI WONG (1983) NUCL. ACIDS RES. 11, 5433-5442
 2028 H. A. SPROUSE, M. KASHWAN, L. OTIS, B. DUDDOCK (1981) NUCLEIC ACIDS RES. 9, 2543-2547
 2030 C. TAKADA-GUERRIER, H. GROSJEAN, G. DIRHETMER, G. KEITH (1976) FEBS LETTERS 42, 1-3
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	AMINOACYL STEM	D STEM	D LOOP	D STEM	ANTIC.STEM	ANTIC.LOOP	ANTIC.STEM
	1 2 3 4 5 6 7	8 9 10 11 12 13	14 15 16 17 18 19 20	21 22 23 24 25	26 27 28 29 30	31 32 33 34 35 36	37 38 39 40 41 42
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	G U U C C G	A G U G F A	G D	A U C A C	G C U C G C	C U C A C A C	G C G A A
	*****					
	G U U C C G	A G U G F A	G D	A U C A C	G C U C G C	C U N A C A C	C S C G A A
	*****					
	G U U C C G	A G U G F A	G D	A U C A C	G C U C G C	C U I A C A C	C S C G A A
	*****					
	C A G A U A	A G C U A R A C A		A A G C A	F C C A G	U U A C C A C	C U A G A
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VALINE cont.
 2071 CRC HUMAN PLACENTA
 2075 NRC RAT LIVER
 2076 PRC RAT HEPATOMA
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	EXTRA ARM					TF STEM	TF LOOP	TF STEM	AMINOCYCL STEM																													
	45	47	B	D	F	H	J	L	N	P	49	51	53	55	57	59	61	63	65	67	69	71	73	75														
	44	46	A	C	E	G	I	K	M	O	48	50	52	54	56	58	60	62	64	66	68	70	72	74	76													

	VRLINE cont.																																					
2071	R	G	G	D							C	S	C	C	G	G	U	F	C	G	A	A	C	C	G	G	C	G	A	C	A	C	C	A				
2075	R	G	G	D							C	S	C	C	G	G	U	F	C	G	A	A	C	C	G	G	C	G	A	C	A	C	C	A				
2076	R	G	G	D							C	S	C	C	G	G	U	F	C	G	A	A	C	C	G	G	C	G	A	C	A	C	C	A				
2077	R	G	A								C	U	C	A	U	U	C	A	U	U																		

2077/0 ALIGNMENT IS ARBITRARY