

Compilation of 5S rRNA and 5S rRNA gene sequences

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ABSTRACT

The BERLIN RNA DATABANK as of Dezember 31, 1989, contains a total of 667 sequences of 5S rRNAs or their genes, which is an increase of 114 new sequence entries over the last compilation (1). It covers sequences from 44 archaeobacteria, 267 eubacteria, 20 plastids, 6 mitochondria, 319 eukaryotes and 11 eukaryotic pseudogenes. The hardcopy shows only the list (Table 1) of those organisms whose sequences have been determined. The BERLIN RNA DATABANK uses the format of the EMBL Nucleotide Sequence Data Library complemented by a Sequence Alignment (SA) field including secondary structure information.

QUALITY OF THE SEQUENCE DATA

Although the methods of RNA sequencing have been improved, the RNA sequence data still lies below that of DNA. Mainly at 5' and 3' end deviations are found. Detailed phylogenetic analyses still lead to sequencing errors. For detailed information see (1).

THE ALIGNMENT

The SA fields of the database present a universal alignment of all organisms. The alignment has been obtained by using the program ALIGNSTAT (technoma GmbH, Heidelberg) designed for the IBM XT/AT/PS2 and compatibles which performs multisequence alignment of up to 180 5S rRNA sequences in one step by the method of Krüger and Osterburg (2). It was manually adjusted to account for common secondary structure elements (Fig. 1).

Alignment positions occurring only in a single species should always be treated with caution especially if they are not present in close relatives and not confirmed by a DNA sequence. For further information see (1).

THE SECONDARY STRUCTURE

The common secondary structure of all 5S rRNAs is composed of five helices, A to E, connected by loops a to e. The basic features of this structure were proposed by Hishikawa and Takemura (3) for eukaryotes, and by Fox and Woese (4) for eubacteria. For the eukaryotic helix E the conformation proposed by Andersen and Delihans (5–7) has been preferred resulting in a GA (in some groups AG or GG) odd base-pair at position 84:96. The two positions both exhibit the same variability, whereas that of position 84.1 is extremely low. The base-pairing scheme is

then identical to that of most archaeobacterial groups with an unpaired U residue at position 84.1.

The presence of a fifth helix even in eubacteria of at least 2 bp was detected by MacDonell and Colwell (8) and in our laboratory (9). This Helix D is best suited to distinguish between five different structural groups (Fig. 2):

The first group consists of division I of archaeobacteria comprising Thermococcales, Thermoplasmatales, Methanobacteria and Halobacteria, the second is represented by division II of archaeobacteria (Eocytes), the third by the single organism, Octopus Spring species 1, the fourth by eubacteria including plastids and mitochondria, and the fifth by eukaryotes.

The 5S rRNA molecule is the only molecule so far showing a clear-cut difference between the two archaeobacterial divisions. This distinction is in accordance with the finding of George Fox (10).

The structure of the first group displayed in Figure 2 represents the Ur-5S rRNA (11), since the Thermococcales appear to be closest to the overall root according to Woese (12). If one assumes the most thermophilic organisms to be most primitive the Eocyte structure might represent the Ur-5S rRNA.

Minor structural deviations (Insertions, Deletions and Odd base-pairs) from the displayed structures are listed in Table 2.

ACKNOWLEDGEMENTS

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2216 *Nucleic Acids Research, Vol. 18, Supplement*

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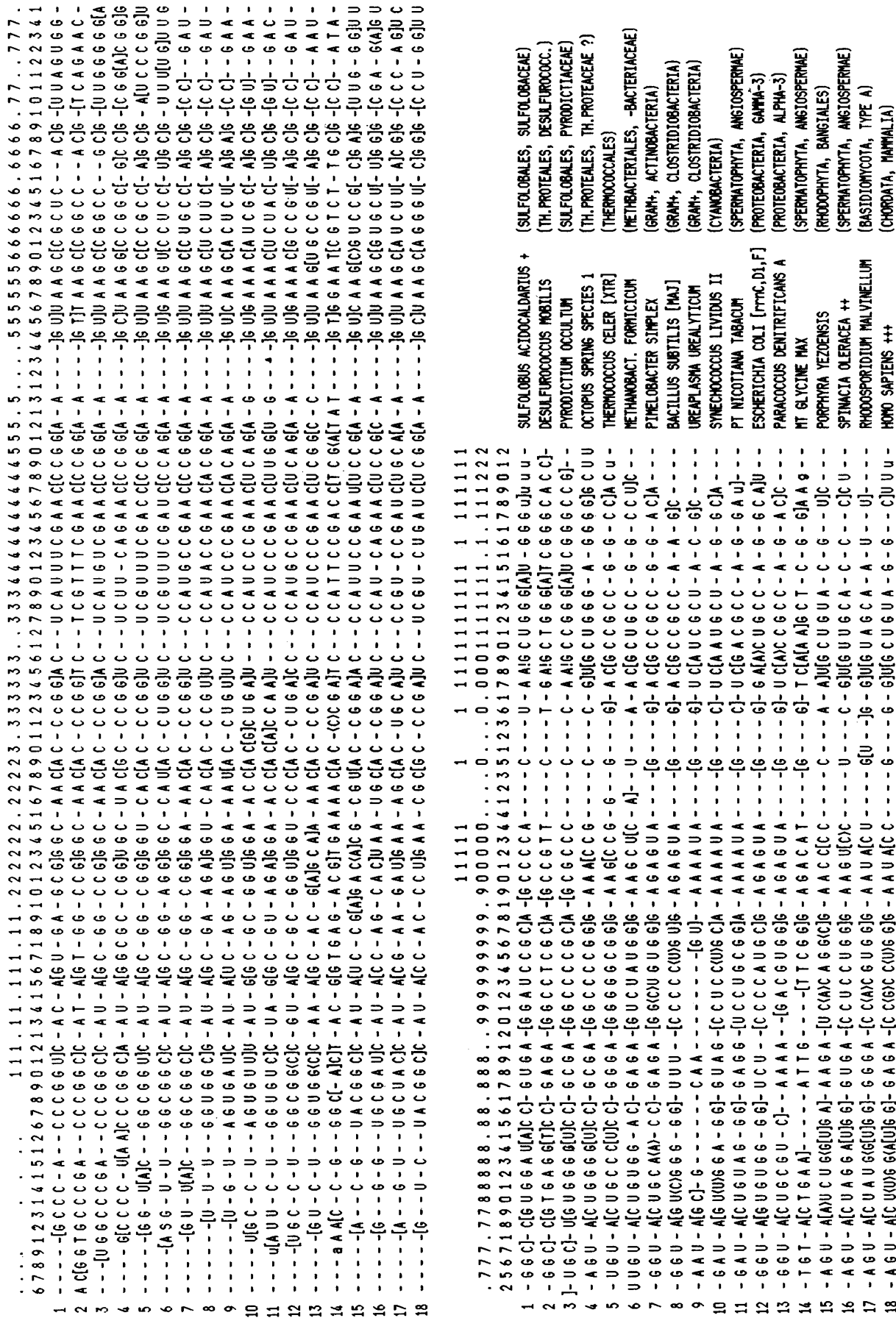


Figure 1. Alignment of 5S rRNAs. Alignment gaps are indicated by hyphen: -. Sequence heterogeneity deduced from the autoradiogram without sequencing distinct bands separately is indicated as recommended by the IUB-IUPAC joint commission on biochemical nomenclature (14): R=AG, Y=CU, K=GU, M=AC, S=GC, W=AU, B=notA, D=notC, H=notG, V=notU, incomplete sequence analysis by X. DNA sequences are indicated by T instead of U, pseudouridine by F, length heterogeneity by lower case letters. The numeration is according to the E. coli sequence (1,13). Helix boundaries of the secondary structure and bulge boundaries within helices are indicated by square brackets: [], helix end and start of a new helix at the same position by acclamation mark: !. Odd base-pairs are parenthesized by less/greater symbols: < >.

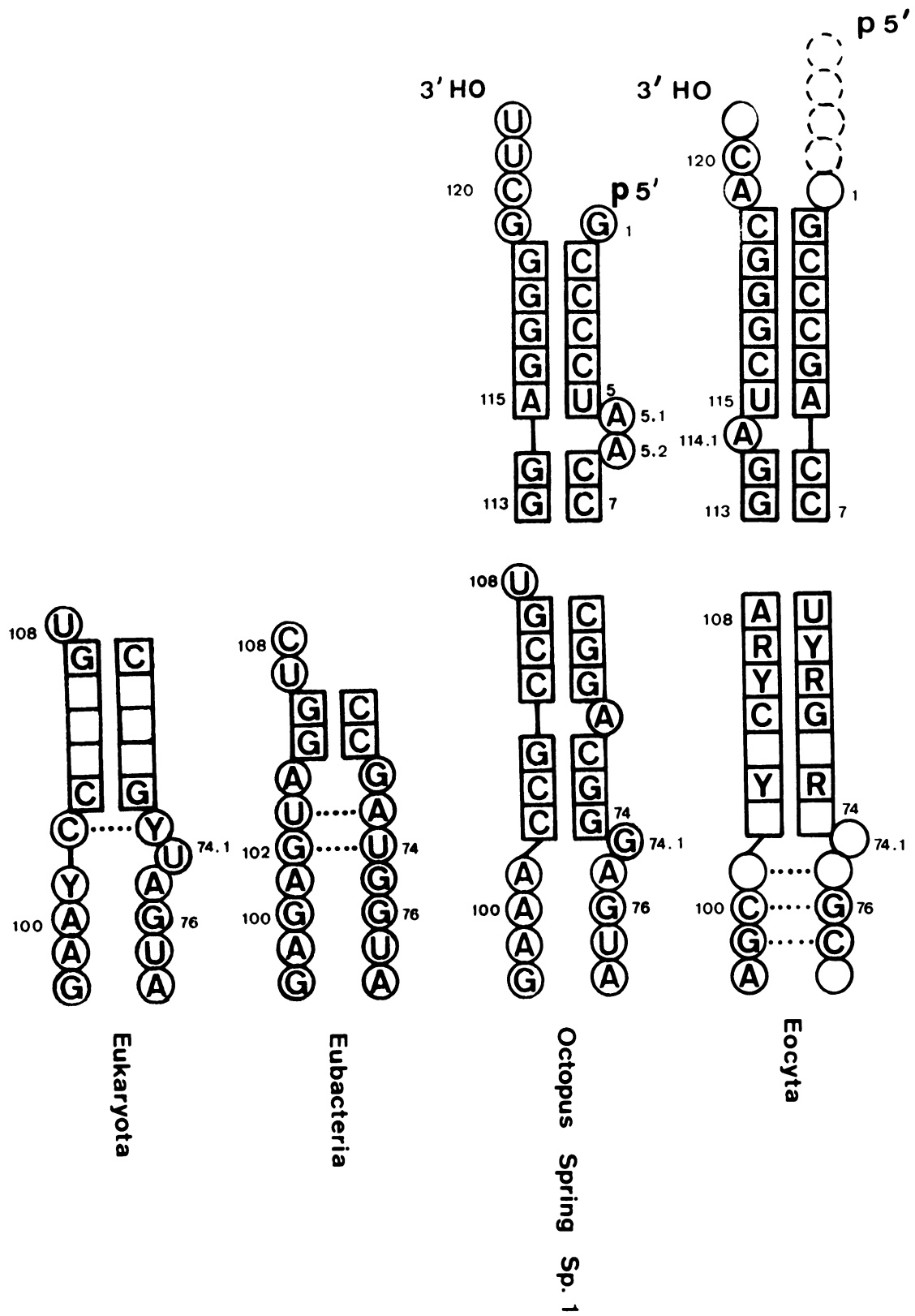
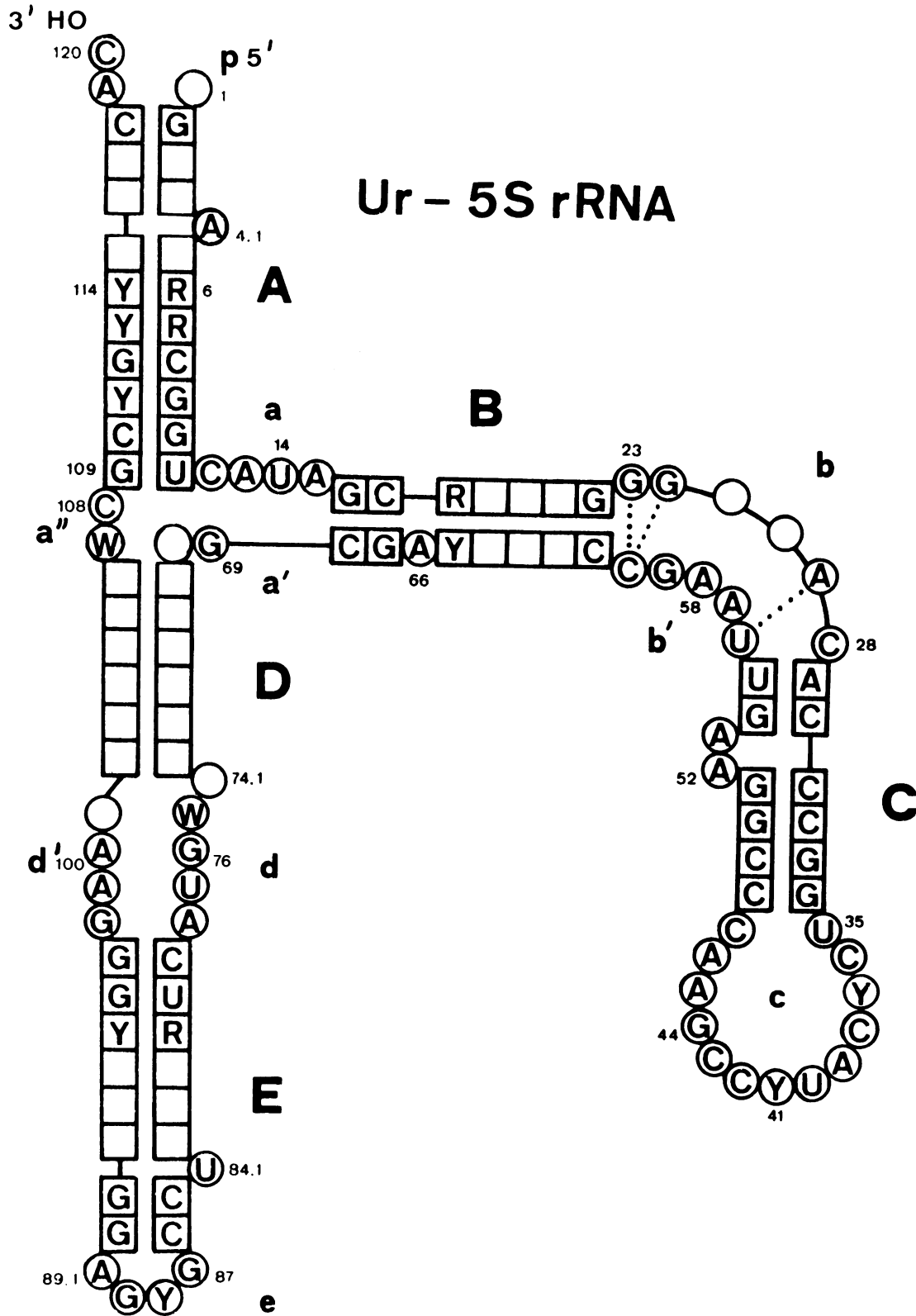


Figure 2. Minimal model of 5S rRNA secondary structure. Squares indicate conserved base-pairing, circles unpaired nucleotides, dotted lines possible helix extensions. Bases indicated in the minimal model are supposedly plesiomorphic (ancestral) to the respective group, hypervariable positions remain blank. The numeration of



bases is according to the E. coli sequence (1,13). Differences between the five structural groups are show for helix/loop D/d and helix A.

TABLE 1

Listing of species entries:

The species names are listed in phylogenetic groups. For the indented species the sequence is identical to the one above. Strains are also listed, if known.

STRUCTURAL TYPE: Archaeobacteria division II (Eocyta)

SULFOLOBALES/THERMOPROTEALES

SULFOLOBUS ACIDOCALDARIUS
SULFOLOBUS SOLFATARICUS #STRAIN MT4
SULFOLOBUS SPEC. #STRAIN B12
SULFUROCOCCUS MIRABILIS #STRAIN INMI AT-59
DESULFUROCOCCUS MOBILIS
PYRODICTIONUM OCCULTUM #STRAIN PL-19 [=DSM 2709]

STRUCTURAL TYPE: Archaeobacterium (single organism)

OCTOPUS SPRING SPECIES 1 #LOCUS YELLOWSTONE NATIONAL PARK, WY, USA

STRUCTURAL TYPE: Archaeobacteria division I

THERMOCOCCALES

THERMOCOCCUS CELER #STRAIN VU [=DSM 2476] [XTR]
PYROCOCCUS WOESSEI #STRAIN DSM 3773

THERMOPLASMATALES

THERMOPLASMA ACIDOPHILUM #STRAIN 122-1B2, 122-1B3

METHANOBACTERIALES

METHANOTHERMUS FERVIDUS #CLONE PET5307
METHANOBACTERIUM FORMICICUM #STRAIN Z-281
METHANOBREVIBACTER RUMINANTIUM #STRAIN M-1
METHANOBACTERIUM THERMOAUTOTROPHICUM #STRAIN DELTA-H A1
METHANOBACTERIUM THERMOAUTOTROPHICUM #STRAIN DELTA-H A2
METHANOBACTERIUM THERMOAUTOTROPHICUM #STRAIN DELTA-H B
METHANOBACTERIUM THERMOFORMICICUM #STRAIN Z-245

METHANOCOCCALES

METHANOCOCCUS THERMOLITHOTROPHICUS #STRAIN DSM 2095
METHANOCOCCUS VANNIELII #STRAIN 5B [LNK]
METHANOCOCCUS VOLTAE #STRAIN PS [=DSM 1537] [LNK]
METHANOCOCCUS VANNIELII #STRAIN 5B [XTR]
METHANOCOCCUS VOLTAE #STRAIN PS [=DSM 1537] [XTR]

METHANOMICROBIALES

METHANOSPIRILLUM HUNGATII
METHANOLOBUS TINDARIUS #STRAIN DSM 2278 A
METHANOLOBUS TINDARIUS #STRAIN DSM 2278 B
METHANOSARCINA VACUOLATA #STRAIN Z-761
METHANOSARCINA BARKERI #STRAIN DSM 800
METHANOSARCINA ACETIVORANS #STRAIN DSM 2834
METHANOCOCCOIDES METHYLUTENS #STRAIN DSM 2657
'METHANOCOCCUS' HALOPHILUS #STRAIN Z-7982
METHANOHALOBIUM EVESTIGATUS #STRAIN Z-7303

HALOBACTERIALES

HALOBACTERIUM DISTRIBUTUS #STRAIN BKM 4
HALOBACTERIUM DISTRIBUTUS #STRAIN BKM 13 [U]
HALOBACTERIUM DISTRIBUTUS #STRAIN BKM 13 [M]
HALOFERAX VOLCANII [=HALOBACTERIUM V.] #STRAIN DS2 [=NCMB 2012, =ATCC 29605]
HALOFERAX MEDITERRANEI #STRAIN DSM 1411;
HALOCOCCUS TURKMENICUS
HALOCOCCUS MORRHUAE #STRAIN ATCC 17082
HALOARCULA MARIS-MORTUI [=HALOBACTERIUM M.]
HALOBACTERIUM SALINARIUM SSP.CUTIRUBRUM #STRAIN NRC 34001
HALOBACTERIUM SALINARIUM SSP.HALOBIUM #STRAIN RI
NATRONOCOCCUS OCCULTUS #STRAIN BKM 3
NATRONOBACTERIUM PHARAONIS #STRAIN BKM 6
NATRONOBACTERIUM PHARAONIS #STRAIN BKM 12

STRUCTURAL TYPE: Eubacteria

GRAMPOSITIVES

Actinobacteria subdivision (Actinomycetes and relatives)

PIMELOBACTER SIMPLEX #STRAIN CNF 035 [=ATCC 6946]
ARTHROBACTER GLOBIFORMIS #STRAIN CNF 022 [=ATCC 8010]
ARTHROBACTER GLOBIFORMIS #STRAIN IFO 12137
ARTHROBACTER LUTEUS #STRAIN ATCC 21606
ARTHROBACTER OXYDAN #STRAIN JCM 2521
ARTHROBACTER POLYCHROMOGENES #STRAIN JCM 2523
RHODOCOCCUS ERYTHROPOLIS #STRAIN TYPE STRAIN
RHODOCOCCUS FASCIANS #STRAIN DSM 20131 [=ATCC 12975]
CELLULOMONAS BIAZOTEA #STRAIN CNF 024 [=ATCC 486]

MICROCOCCUS LYSODEIKTICUS [=M. LUTEUS] # STRAIN NCTC 2665 [=ATCC 4698] B
 MICROCOCCUS LYSODEIKTICUS [=M. LUTEUS] # STRAIN ATCC 4698 A
 MICROCOCCUS LUTEUS [=SARCINA LUTEA] # STRAIN ATCC 9341
 MYCOBACTERIUM NONCHROMOGENICUM # STRAIN ATCC 19530
 MYCOBACTERIUM BOVIS # STRAIN BCG
 MYCOBACTERIUM BOVIS # STRAIN ATCC 35737
 MYCOBACTERIUM FLAVESCENS # STRAIN ATCC 14474
 MYCOBACTERIUM PHLEI # STRAIN ATCC 35737
 MYCOBACTERIUM SMEGMATIS # STRAIN SN2, RABINOWITSCH
 FRANKIA # STRAIN EUII
 CURTOBACTERIUM CITREUM # STRAIN CNF 026 [=ATCC 15828]
 STREPTOMYCES GRISEUS # STRAIN 45-H
 'CORYNEBACTERIUM' AQUATICUM # STRAIN CNF 038 [=ATCC 14665]
 AUREOBACTERIUM TESTACEUM # STRAIN CNF 032 [=ATCC 15829]
 CORYNEBACTERIUM XEROSIS # STRAIN CNF 010 [=ATCC 7711], JCM 1971 [=ATCC 373]
 CORYNEBACTERIUM GLUTAMICUM # STRAIN CNF 016 [=ATCC 13032]
 CORYNEBACTERIUM VARIABILIS [=CASEOBACTER POLYMORPHUS] # STRAIN CNF 057 [=ATCC 33010]
 BREVIBACTERIUM LINENS # STRAIN CNF 019 [=ATCC 9172]
 BREVIBACTERIUM HELVOLUM # STRAIN IFO 12073

Clostridiobacteria subdivision (Clostridia and relatives)

CLOSTRIDIUM PASTEURIANUM # STRAIN ATCC 6013, NCIB 9486
 CLOSTRIDIUM CARNIS # STRAIN JCM 1393 [ATCC 25777]
 CLOSTRIDIUM BUTYRICUM # STRAIN NCIB 7423 1
 CLOSTRIDIUM BUTYRICUM # STRAIN NCIB 7423 2
 BACILLUS ACIDOCALDARIUS
 BACILLUS BREVIS # STRAIN ATCC 8185
 BACILLUS PASTEURII # STRAIN ATCC 11859
 BACILLUS STEAROTHERMOPHILUS # STRAIN 1430R, 1430FV [1430R] [MAJ]
 BACILLUS STEAROTHERMOPHILUS # STRAIN 799 [MIN]
 CLOSTRIDIUM TYROBUTYRICUM # STRAIN NCIB 10635 1
 CLOSTRIDIUM TYROBUTYRICUM # STRAIN NCIB 10635 2
 CLOSTRIDIUM TYROBUTYRICUM # STRAIN NCIB 10635 3
 CLOSTRIDIUM TYROBUTYRICUM # STRAIN NCIB 10635 4
 AMPHIBACILLUS XYLANUS # STRAIN JCM 7361
 BACILLUS MEGATERIUM # STRAIN KM
 BACILLUS FIRMUS # STRAIN ATCC 14575
 BACILLUS GLOBIGII # STRAIN RUB 561
 BACILLUS SUBTILIS # STRAIN BD170 trpC2 thr-5, 168 [MAJ]
 BACILLUS SPEC. # STRAIN Q [MAJ]
 BACILLUS LICHENIFORMIS # STRAIN S244 [MAJ]
 BACILLUS SUBTILIS # STRAIN 168 [MIN]
 BACILLUS SPEC. # STRAIN Q [MIN]
 BACILLUS LICHENIFORMIS # STRAIN S244 [MIN]
 PLANOCOCCUS CITREUS # STRAIN CCM 316 [=ATCC 14404]
 PLANOCOCCUS KOCURII # STRAIN CCM 1849
 SPOROSARCINA UREA # STRAIN CCM 684 [=ATCC 6473]
 ENTEROCOCCUS FAECALIS [=STREPTOCOCCUS F.]
 LACTOBACILLUS BREVIS # STRAIN X-2
 LACTOBACILLUS VIRIDESCENS # STRAIN ATCC 12706 [MAJ]
 LACTOBACILLUS VIRIDESCENS # STRAIN ATCC 12706 [MIN]
 LACTOBACILLUS BULGARICUS # STRAIN ATCC 11842
 SPOROLACTOBACILLUS INULINUS # STRAIN NRIC 1133 [=ATCC 15538, =JCM2257]
 SPOROLACTOBACILLUS LAEVUS # STRAIN JCM 3514
 LACTOBACILLUS PLANTARUM # STRAIN NRIC 1067 [=ATCC 14917 =JCM 1149]
 LACTOCOCCUS LACTIS [=STREPTOCOCCUS L.] # SUBSP CREMORIS # STRAIN ATCC 11603
 CLOSTRIDIUM BIFERMENTANS # STRAIN LMG 3029
 STAPHYLOCOCCUS AUREUS # STRAIN SMITH
 STAPHYLOCOCCUS EPIDERMIDIS # STRAIN ATCC 14990
 CLOSTRIDIUM INNOCUUM
 ANAEROPLASMA BACTOCLASTICUM # STRAIN 5LA
 ANAEROPLASMA ABACTOCLASTICUM # STRAIN 6-1
 ACHOLEPLASMA LAIDLAWII # STRAIN K2
 ACHOLEPLASMA MODICUM # STRAIN SQUIRE [=NCTC 10134]
 MYCOPLASMA SPEC. # STRAIN PG50 [rrnA]
 MYCOPLASMA MYCOIDES # SUBSP MYCOIDES
 MYCOPLASMA MYCOIDES # SUBSP CAPRI # STRAIN PG3
 MYCOPLASMA CAPRICOLUM # STRAIN ATCC 27343
 MYCOPLASMA HYOPNEUMONIAE # STRAIN ATCC 27719
 MYCOPLASMA PNEUMONIAE # STRAIN FH [=NCTC 10119]
 MYCOPLASMA GALLISEPTICUM # STRAIN A5969
 SPIROPLASMA MELLIFERUM # STRAIN BC3
 UREAPLASMA UREALYTICUM # STRAIN 960-CX8 [=NCTC 10177]

BACTEROIDES-FLAVOBACTERIA GROUP

THERMOBACTEROIDES ACETOLYTICUS
 BACTEROIDES FRAGILIS # STRAIN ATCC 25285
 BACTEROIDES THETAIOAOMICRON # STRAIN ATCC 29148

BACTEROIDES CAPILLOSUS #STRAIN ATCC 29799
BACTEROIDES VERORALIS #STRAIN ATCC 33779
ANAERORHABDUS FURCOSUS #STRAIN ATCC 25662
PORPHYROMONAS GINGIVALIS #STRAIN ATCC 33277
FUSOBACTERIUM VARIUM #STRAIN VPI 0499A
FUSOBACTERIUM MORTIFERUM #STRAIN ATCC 25537
FUSOBACTERIUM MORTIFERUM #STRAIN VPI 4249
FUSOBACTERIUM NUCLEATUM #STRAIN 85-56A

PLANCTOMYCES GROUP

GEMMATA OBSCURIGLOBUS #STRAIN UQM 2246
ISOSPHAERA PALLIDA #STRAIN IS 1B
PIRELLULA MARINA #STRAIN IFAM 1313
PIRELLULA SPEC. #STRAIN IFAM 1441
PIRELLULA SPEC. #STRAIN IFAM 1310
PLANCTOMYCES LIMNOPHILUS #STRAIN IFAM 1008
PLANCTOMYCES BRASILIENSIS #STRAIN IFAM 1448

UNCERTAIN AFFILIATION

VERRUCOMICROBIUM SPINOSUM #STRAIN DSM 4436

DEINOCOCCUS-THERMUS GROUP

OCTOPUS SPRING SPECIES 2 #LOCUS YELLOWSTONE NATIONAL PARK
OCTOPUS SPRING SPECIES 3 #LOCUS YELLOWSTONE NATIONAL PARK
THERMUS THERMOPHILUS #STRAIN HB8
THERMUS AQUATICUS #STRAIN ATCC 25104
DEINOCOCCUS RADIODURANS

CHLOROFLEXUS GROUP

HERPETOSIPHON SPEC. #STRAIN SENGHAS WIE2

CHLOROBIIUM GROUP

CHLOROBIIUM LIMICOLA
SPIROSOMA SPEC. #STRAIN 1
FLECTOBACILLUS MAJOR [=MICROCYCLIS M.]

CYANOBACTERIA

PROCHLORON DIDEMNI #STRAIN LP
ANACYSTIS NIDULANS #STRAIN 1405/1
SYNECHOCOCCUS LIVIDUS #STRAIN ATCC 27149 MUTANT III
SYNECHOCOCCUS LIVIDUS II #STRAIN Y-150-S

PLASTIDS

PT PORPHYRA UMBILICALIS
PT CYANOPHORA PARADOXA
PT EUGLENA GRACILIS #STRAIN Z [rrmA?B]
PT EUGLENA GRACILIS #STRAIN Z [rrmC]
PT EUGLENA GRACILIS #SUBSP BACILLARIS [B] [rrmB]
PT CHLAMYDOMONAS REINHARDII
PT CHLORELLA ELLIPSOIDEA #STRAIN IAM C87
PT JUNGERMANNIA SUBULATA
PT MARCHANTIA POLYMORPHA
PT DRYOPTERIS ACUMINATA
PT CYCAS REVOLUTA
PT JUNIPERUS MEDIA
PT NICOTIANA TABACUM #VAR TURKISH SAMSUM, BRIGHT YELLOW 4
PT SPINACIA OLERACEA
PT GLYCINE MAX #VAR PI437833
PT VICIA FABA #VAR THE SUTTON
PT PELARGONIUM ZONALE #VAR HORT. ROSEUM
PT LEMNA MINOR
PT SPIRODELA OLIGORHIZA
PT ZEA MAYS

PROTEOBACTERIA

Epsilon subdivision ?

THIOVULUM SPEC. [=T. MINUS?]
CAMPYLOBACTER JEJUNI #STRAIN HC
CAMPYLOBACTER COLI #STRAIN WR

Delta subdivision

DESULFOVIBRIO VULGARIS #STRAIN MK

Gamma subdivision

ECTOTHIORHODOSPIRA HALOPHILA #STRAIN BN 9624
ECTOTHIORHODOSPIRA VACUOLATA #STRAIN ATCC 43036
ECTOTHIORHODOSPIRA MOBILIS
ECTOTHIORHODOSPIRA SHAPOSHNIKOVI
CHROMATIUM MINUTISSIMUM
THIOBACILLUS #STRAIN M1 [=THIOBACILLUS 'FERROOXIDANS']
RIFTIA SYMBIONT
BEGGIATO A ALBA #STRAIN B18LD
VITREOSCILLA BEGGIATOIDES #STRAIN B23SS
METHYLOMONAS ALBUS
LEGIONELLA PNEUMOPHILA #STRAIN CDSC 62212
LEGIONELLA PNEUMOPHILA [=FLOURIBACTER P.] #STRAIN PHILADELPHIA-1

LEGIONELLA PNEUMOPHILA [=FLOURIBACTER P.] #STRAIN BLOOMINGTON
 LEGIONELLA LONGBEACHAE
 LEGIONELLA BOZEMANII
 LEGIONELLA DUMOFFII
 THIOBACILLUS NEAPOLITANUS #STRAIN X
 THIOMICROSPIRA PELOPHILA #STRAIN ATCC 27801
 THIOMICROSPIRA #STRAIN L12 #LOCUS GALAPAGOS SUBMARINE HYDROTHERMAL VENT
 ACINETOBACTER CALCOACETICUS #STRAIN ITG 59
 THIOTRIX NIVEA #STRAIN JP2
 THIOTRIX #STRAIN 30
 SOLEMYA SYMBIONT
 PSEUDOMONAS FLUORESCENS #STRAIN ATCC 13430, ATCC 13525
 PSEUDOMONAS AERUGINOSA #STRAIN CCEB 481 [=ATCC 10145]
 PSEUDOMONAS AERUGINOSA #STRAIN K [ATCC 25102] [DNA]
 AZOTOBACTER VINELANDII #STRAIN NCIB 8789
 PSEUDOMONAS DENITRIFICANS
 'ALCALIGENES FAECALIS' #STRAIN IAM 1015
 VIBRIO MARINUS #STRAIN MP-1 [=ATCC 15381]
 SHEWANELLA PUTREFACIENS [=ALTEROMONAS P., =PSEUDOMONAS P.] #STRAIN ATCC 8071
 SHEWANELLA BENTHICA #STRAIN UM40, W145
 SHEWANELLA HANEDAI [=ALTEROMONAS H.] #STRAIN ATCC 33224
 SHEWANELLA COLWELLIANA [=ALTEROMONAS C.] #STRAIN ATCC 39565
 CALYPTOGENA SYMBIONT
 ODONTELLA SYMBIONT
 LISTONELLA ANGUILLARA [=VIBRIO ANGUILLARUM] #STRAIN ATCC 19264
 LISTONELLA PELAGIA [=VIBRIO PELAGIUS] #STRAIN ATCC 25916
 LISTONELLA AESTUARIANUS [=VIBRIO AE.] #STRAIN ATCC 35048
 LISTONELLA DAMSELA [=VIBRIO D.] #STRAIN ATCC 33539
 LISTONELLA ORDALII [=VIBRIO O.] #STRAIN ATCC 33509
 LISTONELLA TUBIASHII [=VIBRIO T.] #STRAIN ATCC 19105
 PHOTOBACTERIUM FISCHERI [=VIBRIO F.] #STRAIN ATCC 7744
 PHOTOBACTERIUM LOGEI [=VIBRIO L.] #STRAIN ATCC 15382
 PHOTOBACTERIUM LEIOGNATHI #STRAIN ATCC 25521
 PHOTOBACTERIUM ANGUSTUM #STRAIN ATCC 25915
 PHOTOBACTERIUM PHOSPHOREUM #STRAIN 8265
 VIBRIO GAZOGENES #STRAIN ATCC 29988
 VIBRIO DIAZOTROPHICUS #STRAIN ATCC 33466
 VIBRIO PROTEOLYTICUS #STRAIN ATCC 15338
 VIBRIO CARCHARIAE #STRAIN ATCC 35084
 VIBRIO CINCINNATIENSIS #STRAIN ATCC 35912
 VIBRIO METSCHNIKOVII #STRAIN ATCC 7708
 VIBRIO FLUVIALIS #STRAIN NCTC 11328 [=ATCC 33812]
 VIBRIO MIMICUS #STRAIN ATCC 33655
 VIBRIO CHOLERAЕ #STRAIN ATCC 14033, E8498
 VIBRIO VULNIFICUS #STRAIN ATCC 27562
 VIBRIO PARAHAEMOLYTICUS #STRAIN ATCC 17082
 VIBRIO ALGINOLYTICUS #STRAIN ATCC 17749 A
 VIBRIO ALGINOLYTICUS #STRAIN TOKUDA 138-2 B
 VIBRIO NEREIS #STRAIN ATCC 25917
 VIBRIO NATRIEGENS #STRAIN ATCC 14048
 VIBRIO HARVEYI [=BENECKEA H., =LUCIBACTERIUM H.] #STRAIN 392
 VIBRIO MEDITERRANEI #STRAIN ATCC 43341
 AEROMONAS HYDROPHILA #STRAIN ATCC 9071
 AEROMONAS MEDIA #STRAIN ATCC 33097
 AEROMONAS SALMONICIDA #STRAIN ATCC 27013
 COLWELLIA PSYCHROERYTHRUS [=VIBRIO P.] #STRAIN ATCC 27364
 COLWELLIA HADALIENSIS [=VIBRIO SPEC.] #STRAIN BNL-1
 HAEMOPHILUS AEGYPTICUS #STRAIN ATCC 11116
 PROTEUS SHIGELLOIDES [=PLESIOMONAS SH.] #STRAIN ATCC 14029
 PROTEUS VULGARIS
 ESCHERICHIA COLI #STRAIN NF955[RRNC], C600[RRND1,RRNF]
 A19[SPECIES A], JA200[MAJ], CA265[MAJ], MRE600[MAJ]
 ESCHERICHIA COLI #STRAIN K12[RRNB], CGSC 4401, 4474 [RRNE]
 A19[SPECIES B], CA265[MIN], MRE600[MIN]
 ESCHERICHIA COLI #STRAIN K12[MIN], JA200[MIN], A19[SPECIES C] [rrmA]
 ESCHERICHIA COLI #STRAIN MRE600[RRNB,C,D] [MIN]
 ESCHERICHIA COLI #STRAIN C600[RRND2]

Beta subdivision

THIOBACILLUS FERROOXIDANS #STRAIN ATCC 19859
 CHINO ISOLATE 1 #LOCUS COPPER LEACHING POND AT CHINO MINE, HURLEY, NM, USA
 THIOBACILLUS THIOOXIDANS #STRAIN ATCC 8085
 SULFUR SPRING ISOLATE #LOCUS YELLOWSTONE NATIONAL PARK, WY, USA
 RHODOCYCLUS GELATINOSUS [=RHODOPSEUDOMONAS GELATINOSA]
 THIOBACILLUS THIOPARUS #STRAIN ATCC 8158
 CHINO ISOLATE 2 #LOCUS COPPER LEACHING POND AT CHINO MINE, HURLEY, NM, USA
 VITREOSCILLA STERCORARIA #STRAIN VT1

VITREOSCILLA FILIFORMIS # STRAIN ATCC 15551, L1401-7
 METHYLOMONAS CLARA # STRAIN ATCC 31226
 METHANOLOMONAS GLUCOSEOXIDANS # STRAIN DSM 3031
 METHANOMONAS METHYLOVORA # STRAIN ATCC 21369
 THIOBACILLUS INTERMEDIUS # STRAIN ATCC 15466
 THIOBACILLUS PEROMETABOLIS # STRAIN ATCC 23370
 LEPTOTRHX DISCOPHORA # STRAIN STOKES
 PSEUDOMONAS CEPACIA # STRAIN ATCC 17616 A
 PSEUDOMONAS CEPACIA # STRAIN ATCC 17616 B
 AQUASPIRILLUM SERPENS # STRAIN ATCC 11335
 ALCALIGENES FAECALIS # STRAIN NCIB 8156
 ALCALIGENES DENITRIFICANS # SUBSP XYLOSOXYDANS [=ACHROMOBACTER X.]
 # STRAIN ATCC 27061 [=GIFU 543], ATCC 212 [=GIFU 1051]
 ALCALIGENES SPEC. # STRAIN NCIB 11015

Alpha subdivision

ERYTHROBACTER LONGUS # STRAIN IFO 14126
 RHODOSPIRILLUM RUBRUM # STRAIN S1
 RICKETTSIA MOOZERI
 RICKETTSIA PROWAZEKII
 AGROBACTERIUM TUMEFACIENS # STRAIN ICPB TT2
 'ACHROMOBACTER' CYCLOCLASTES # STRAIN ATCC 21921 [=IAM 1013]
 BLASTOBACTER VISCOSUS
 RENOBACTER VACUOLATA
 TUBEROIDOBACTER MUTANS
 ANCYLOBACTER AQUATICUS [=MICROCYCLUS A.]
 SELIBERIA STELLATA
 METHYLOBACTERIUM ORGANOPHILUM
 PSEUDOMONAS STUTZERI
 PSEUDOMONAS # STRAIN AM1, M27
 HYPHOMICROBIUM VULGARE
 HYPHOMICROBIUM SPEC. # STRAIN IFAM 1761
 HYPHOMICROBIUM # STRAIN H1
 HYPHOMICROBIUM # STRAIN 440
 HYPHOMICROBIUM # STRAIN G10
 HYPHOMICROBIUM # STRAIN SP12
 HYPHOMICROBIUM # STRAIN NP160
 HYPHOMICROBIUM # STRAIN ZV
 PROSTHECOMICROBIUM ENHYDRUM
 STELLA HUMOSA # STRAIN IFAM 1203
 THIOBACILLUS ACIDOPHILUS # STRAIN DSM 700 [=ATCC 27807]
 ACIDIPHILIUM CRYPTUM # STRAIN LHET2 [=ATCC 33463]
 THIOBACILLUS NOVELLUS # STRAIN ATCC 8093
 RHODOPSEUDOMONAS PALUSTRIS # STRAIN ATCC 17001
 NITROBACTER WINOGRADSKYI # STRAIN ENGEL
 METHYLOBACTERIUM EXTORQUENS [=PROTOMONAS E.] # STRAIN TK 0001
 CAULOBACTER CRESCENTUS # STRAIN CB13
 CAULOBACTER # STRAIN C12
 CAULOBACTER # STRAIN C90
 CAULOBACTER # STRAIN BC101
 CAULOBACTER # STRAIN C107
 CAULOBACTER # STRAIN C6
 CAULOBACTER # STRAIN BC22
 CAULOBACTER # STRAIN P105
 HYPHOMONAS POLYMORPHA
 HYPHOMONAS OLIGOTROPHA
 RHODOBACTER SPHAEROIDES [=RHODOPSEUDOMONAS S.] # SUBSP DENITRIFICANS
 RHODOBACTER SPHAEROIDES [=RHODOPSEUDOMONAS S.] A
 RHODOBACTER SPHAEROIDES [=RHODOPSEUDOMONAS S.] B
 ACETOBACTER # STRAIN MB 58/4
 RHODOBACTER CAPSULATUS # STRAIN NCIB 8254
 RHODOBACTER CAPSULATUS # STRAIN ATCC 23782
 RHODOBACTER CAPSULATUS [=RHODOPSEUDOMONAS CAPSULATA] C
 THIOBACILLUS VERSUTUS # STRAIN ATCC 25364
 THIOBACILLUS # STRAIN A2
 PARACOCCUS DENITRIFICANS # STRAIN ATCC 13543 A
 PARACOCCUS DENITRIFICANS # STRAIN GOETTINGEN B

Mitochondria

MT GLYCINE MAX # VAR MANDARIN
 MT OENOTHERA BERTERIANA [=OE. VILLARICAE]
 MT TRITICUM AESTIVUM # VAR THATCHER
 MT TRITICUM VULGARE
 MT ZEA MAYS
 MT ZEA DIPLOPERENNIS

STRUCTURAL TYPE: Eukaryota

RHODOPHYTA

PORPHYRA YEZOENSIS
PORPHYRA TENERA
PORPHYRA UMBILICALIS
PALMARIA PALMATA
GELIDIUM AMANSII WITH GELIDIOCOLAX SPEC. AS EPIPHYTE ? [L]
GELIDIUM AMANSII WITH GELIDIOCOLAX SPEC. AS EPIPHYTE ? [S]
GRACILARIA COMPRESSA
BATRACHOSPERMUM ECTOCARPUM
CARPOPELTIS CRISPATA
GLOIOPELTIS COMPLANATA

CHLOROBIONTA

Volvocophyta

CHLAMYDOMONAS REINHARDII # STRAIN CW15 CELL WALL DEFICIENT MUTANT 1
CHLAMYDOMONAS REINHARDII # STRAIN CW15 CELL WALL DEFICIENT MUTANT 2
CHLAMYDOMONAS SPEC.

Zygnematophyta

SPIROGYRA SPEC.

Chlorophyta s.s.

CHLORELLA PYRENOIDOSA # STRAIN SAG 211/8B
CHLORELLA SPEC. # STRAIN ATCC 11469
SCENEDESMUS QUADRICAUDA # STRAIN ATCC 11460
SCENEDESMUS OBLIQUUS
ULVA PERTUSA

Charophyta

NITELLA FLEXILIS

Bryophyta

ANTHOCEROS PUNCTATUS
MARCHANTIA POLYMORPHA
LOPHOCOLEA HETEROPHYLLA
PLAGIOMNIUM TRICHOMANES

Pteridophyta

PSILOTUM NUDUM
LYCOPODIUM CLAVATUM
EQUISETUM ARVENSE
DRYOPTERIS ACUMINATA

Spermatophyta

CYCAS REVOLUTA
GNETUM GNEMON
EPHEDRA KOKANICA
GINGKO BILOBA
METASEQUOIA GLYPTOSTROBOIDES
SPINACIA OLERACEA # VAR 424
BETA VULGARIS SACCHARIFERA
BRASSICA NAPUS
MATTHIOLA INCANA
VICIA FABA
PISUM SATIVUM
PHASEOLUS VULGARIS # VAR LIMBURG
VIGNA RADIATA
MEDICAGO SATIVA
LUPINUS LUTEUS # VAR BASS AND TOPAZ
LINUM USITATISSIMUM
GOSSYPIUM HIRSUTUM
LYCOPERSICUM ESCULENTUM # VAR MARMANDE
NICOTIANA TABACUM
PETUNIA HYBRIDA 1
PETUNIA HYBRIDA 2
PETUNIA HYBRIDA 3
HELLANTHUS ANNUUS # VAR GIGANTEUS
SECALE CEREALE # VAR LOVASZPATONAI, SOMRO
TRITICUM AESTIVUM # VAR THATCHER
ZEA MAYS
ORYZA SATIVA # VAR IR-20 [ALL]
ORYZA SATIVA # VAR IR-20 [OOC]
LEMNA MINOR

CRYPTOPHYTA

CHILOMONAS PARAMECIUM [PLASTID LESS SPECIES]

DINOPHYTA

CRYPTHOCODINIUM COHNII [PLASTID LESS SPECIES]

CILIOPHORA

EUPLOTES WOODRUFFI

EUPLOTES EURYSTOMUS
BRESSLAUA VORAX
BLEPHARISMA JAPONICUM # STRAIN R13
PARAMECIUM TETRAURELIA # STRAIN MATING TYPE VIII
GLAUCOMA CHATTONI
TETRAHYMENA PATULA # STRAIN L-FF, NEI
COLPIDIUM CAMPYLUM
COLPIDIUM COLPODA
TETRAHYMENA PARAVORAX # STRAIN RP
TETRAHYMENA THERMOPHILA # STRAIN B, MATING TYPE IV, B-1868-VII 1
TETRAHYMENA PYRIFORMIS # STRAIN GL, W
TETRAHYMENA VORAX # STRAIN V2S
TETRAHYMENA LEUCOPHRYS # STRAIN TUR
TETRAHYMENA THERMOPHILA # STRAIN B VII, B IV, CU357 2

CHROMOPHYTA

Chrysophyceae

HYDRURUS FOETIDUS

Thraustochytriaceae

THRAUSTOCHYTRIUM VISURGENSE # STRAIN ATCC 28208
SCHIZOCHYTRIUM AGGREGATUM # STRAIN ATCC 28209

Bacillariophyceae

DIATOMA TENUIS

Phaeophyceae

ACINETOSPORA CRINITA
EISENIA BICYCLIS
SARGASSUM FULVELLUM
CHORDARIA FLAGELLIFORMIS
AKKESIPHICUS LUBRICUM

Oomycetes

SAPROLEGNIA FERAX # STRAIN ATCC 26116
PYTHIUM HYDNOSPORUM # STRAIN ATCC 26929

RHIZOPODA

Amoebina

ACANTHAMOEBA CASTELLANII # STRAIN ATCC 30010
MASTIGAMOEBA INVERTANS

Dictyostellia

DICTYOSTELIUM DISCOIDEUM # STRAIN NC-4

Myxogastria

PHYSARUM POLYCEPHALUM

Amoebidiales

AMOEBIDIUM PARASITICUM

UNCERTAIN AFFILIATION

PNEUMOCYSTIS CARINII # STRAIN IMS-PCR84;

APICOMPLEXA

PLASMODIUM BERGHEI
PLASMODIUM FALCIPARUM

EUGLENOZOA

uncertain subgroup

CYANOPHORA PARADOXA

Euglenida

EUGLENA GRACILIS # STRAIN Z HETEROTROPH A
EUGLENA GRACILIS # STRAIN Z PLASTID-LESS MUTANT CM500 B

Kinetoplastida

CRITHIDIA FASCICULATA
TRYPANOSOMA BRUCEI # SUBSP BRUCEI # STRAIN IATAT 1.2, MITAR I
SUBSP RHODESIENSE # STRAIN WRATAT 1.1

EUMYCOTA

Chytridiomycota

BLASTOCLADIELLA SIMPLEX # STRAIN ATCC 24579
PHLYCTOCHYTRIUM IRREGULARE # STRAIN ATCC 32066

Zygomycota

COEMANSIA MOJAVENSIS
DIPSACOMYCES ACUMINOSPORUS # STRAIN ATCC 14302
LINDERINA MACROSPORA
CUNNINGHAMELLA ELEGANS # STRAIN ATCC 9245
BLAKESLEA TRISPOA # STRAIN ATCC 14271
MORTIERELLA FORMOSENSIS # STRAIN ATCC 24542
PHYCOMYCES BLAKESLEEANUS # STRAIN NRRL 1555
BASIDILOBOLUS MAGNUS # STRAIN ATCC 15379
SMITTIUM CULISETAE # STRAIN ATCC 16244
GENISTELLOIDES HIBERNUS
CAPNIOMYCES STELLATUS

Ascomycota

PROTOMYCES INUNDATUS # STRAIN ATCC 28130
TAPHRINA DEFORMANS # STRAIN PB 3713
SCHIZOSACCHAROMYCES POMBE # STRAIN IFO 0345, ADE6 SUP3-704

LIPOMYCES LIPOFERUS #STRAIN ATCC 32031
 YARROWIA LIPOLYTICA #STRAIN ATCC 8661
 NADSONIA FULVESCENS #STRAIN ATCC 24236
 CANDIDA ALBICANS #STRAIN MCRI C001
 HANSENULA JADINII [=CANDIDA UTILIS, =TORULOPSIS UTILIS]
 SACCHAROMYCES CARLBERGENSIS
 SACCHAROMYCES CEREVISIAE 1
 KLUYVEROMYCES LACTIS
 SACCHAROMYCES CEREVISIAE #STRAIN X2180-1B 2
 SACCHAROMYCES CEREVISIAE #STRAIN X2180-1B 3
 PICHIA MEMBRANAEFACIENS
 TRICHOPHAEA ABUNDANS #STRAIN ATCC 26431
 AUREOBASIDIUM PULLULANS #STRAIN ATCC 28998
 KABATIELLA MICROSTRICTA #STRAIN CBS 342.66
 MONILINIA FRUCTICOLA #STRAIN ATCC 9684
 THERMOMYCES LANUGINOSUS #STRAIN ATCC 16455 1
 THERMOMYCES LANUGINOSUS #STRAIN ATCC 16455 2
 ASPERGILLUS NIDULANS #STRAIN MCRI A007 1
 ASPERGILLUS NIDULANS #STRAIN PABA A1, BI A1, MCRI A007 2 [MAJ]
 ASPERGILLUS NIDULANS #STRAIN MCRI A007 3
 ASPERGILLUS NIDULANS 4
 ASPERGILLUS NIDULANS 5
 ASPERGILLUS NIDULANS 6
 ASPERGILLUS NIDULANS 7
 ASPERGILLUS NIDULANS 8
 ASPERGILLUS FLAVUS #STRAIN MCRI A003
 ASPERGILLUS NIGER #STRAIN BEECHAM PHARMACEUTICALS M8115
 PENICILLUM CHRYSOGENUM #STRAIN ATCC 10002
 PENICILLUM PATULUM #STRAIN MCRI P031
 NEUROSPORA CRASSA #STRAIN EM5256 [=ATCC 10815] [ALPHA]
 NEUROSPORA CRASSA #STRAIN OAK RIDGE 74-OR23-1A [=FGSC 986],
 BEADLE AND TATUM 25A [=FGSC 353] [ALPHA] 2
 NEUROSPORA CRASSA #STRAIN BEADLE AND TATUM 25A [=FGSC 353] [ALPHA] 3
 NEUROSPORA CRASSA #STRAIN OAK RIDGE 74-OR8-1A [=FGSC 988] [ALPHA] 4
 NEUROSPORA CRASSA #STRAIN OAK RIDGE 74-OR8-1A [=FGSC 988] [ALPHA] 5
 NEUROSPORA CRASSA [BETA]
 ACREMONIUM PERSICINUM [=PAECILOMYCES PERSICINUS] #STRAIN CBS 169.65 1
 ACREMONIUM PERSICINUM [=PAECILOMYCES PERSICINUS] #STRAIN CBS 169.65 2
 ACREMONIUM PERSICINUM [=PAECILOMYCES PERSICINUS] #STRAIN CBS 169.65 3
 ACREMONIUM CHRYSOGENUM [=CEPHALOSPORIUM ACREMONIUM] #STRAIN ATCC 14553

Basidiomycota

AGARICOSTILBUM PULCHERRIMUM [=A. PALMICOLUM] A
 AGARICOSTILBUM PULCHERRIMUM #STRAIN RJB 6859-1 B
 RHODOSPORIDIUM MALVINELLUM #STRAIN CBS 6082
 ATRACTIELLA SOLANI #STRAIN CBS 277-32
 PHLEOGENA FAGINEA #STRAIN FO 24396
 RHODOSPORIDIUM TORULOIDES
 SPOROBOLOMYCES SALMONICOLOR [=AESSOSPORON S.]
 PACHNOCYBE FERRUGINEA
 RHIZOCTONIA CROCORUM [=HELICOBASIDIUM PURPUREUM] #STRAIN ATCC 11070
 RHIZOCTONIA HIEMALIS [=TRICHOPHAEA BULLATA?] #STRAIN ATCC 14016
 SEPTOBASIDIUM CARESTIANUM #STRAIN FO 25109
 USTILENTYLOMA FLUITANS #STRAIN RB 900
 PLATYGLOEA PENIOPHORAE #STRAIN FO 22315
 MICROBOTRYUM VIOLACEUM [=USTILAGO VIOLACEA]
 SPHACELOTHECA POLYGONI-PERSICARIAE #STRAIN GD 1127
 USTILAGO SCABIOSAE #STRAIN GD 1425
 PUCCINIA SUAVEOLENS #STRAIN BM 51
 GYMNOSPORANGIUM SABINAE #STRAIN BM 76
 FARYSIA THUEMENII #STRAIN GD 1309
 TULASNELLA VIOLEA #STRAIN FO 29326
 STILBUM VULGARE #STRAIN RJB 6851B-3
 TILLETIARIA ANOMALA #STRAIN ATCC 24038
 MONILIELLA ACETABUTANS #STRAIN ATCC 18455
 TRICHOSPORONOIDES OEDOCEPHALIS #STRAIN ATCC 16988
 USTILAGO MAYDIS #STRAIN GD 1042
 USTILAGO HORDEI #STRAIN GD 935
 TRICHOSPORON ORYZAE #STRAIN ATCC 28323
 USTILAGO LONGISSIMA #STRAIN GD 666
 GINANNIELLA PRIMULICOLA #STRAIN GD 1394
 TILLETIA CONTROVERSA
 EXOBASIDIUM VACCINII #VAR JAPONICUM #STRAIN ATCC 24312
 GRAPHIOLA PHOENICIS #STRAIN PB4349
 MICROSTROMA JUGLANDIS #STRAIN PB4142
 CHIONOSPHAERA APOBASIDIALIS
 STERIGMATOMYCES PENICILLATUS #STRAIN ATCC 32127

TREMELLA MESENERICA A
TREMELLA MESENERICA #STRAIN WZ 173 B
TREMELLA ENCEPHALA #STRAIN WZ 185B
BULLERA ALBA #STRAIN ATCC 18568
AGARICUS EDULIS
CRYPTOCOCCUS ALBIDUS [=FILOBASIDIUM SPEC.?] #STRAIN ATCC 10666
CRYPTOCOCCUS LAURENTII #STRAIN CBS 139 [T]
FILOBASIDIUM FLORIFORME #STRAIN GD 776, GD 855, GD 830
FILOBASIDIUM FLORIFORME #STRAIN WILLIAM WALKER
#STRAIN GD 778
FILOBASIDIUM CAPSULIGENUM
CHRISTIANSANIA PALLIDA #STRAIN FO 31621
ITERSONILIA PERPLEXANS #STRAIN ATCC 15495
EXIDIA GLANDULOSA #STRAIN FO 25056
EFIBULOBASIDIUM ALBESCENS #STRAIN FO 34705
RHIZOCTONIA GLOBULARIS [=SEBACINA SPEC.?] #STRAIN ATCC 14015
PHAFFIA RHODOZYMA #STRAIN ATCC 24202
DACRYMYCES STILLATUS [=D. DELIQUESCENS] #STRAIN ATCC 13292
HIRNEOLA AURICULA [=AURICULARIA A.]
CERATOBASIDIUM CORNIGERUM #STRAIN FO 29225
UTHATOBASIDIUM FUSISPORUM #STRAIN FO 25106
BJERKANDERA ADUSTA
COPRINUS RADIATUS #STRAIN ATCC 28538
LYCOPERDON PYRIFORME #STRAIN FO 23332
PLEUROTUS OSTREATUS
RUSSULA CYANOXANTHA
SCHIZOPHYLLUM COMMUNE
COPRINUS CINEREUS

METAZOA

Porifera

HALICLONA OCULATA
HYMENIACIDON SANGUINEA
HALICHONDRIA JAPONICA
HALICHONDRIA PANICEA

Cnidaria

SPIROCODON SALTATRIX
NEMOPSIS DOFLEINI
CHRYSAORA QUINQUECIRRHA
AURELIA AURITA A
AURELIA AURITA B
ANTHOPLEURA JAPONICA
ACTINIA EQUINA

Nemathelminthes

BRACHIONUS PLICATILIS
CAENORHABDITIS ELEGANS #STRAIN BRISTOL N2
CAENORHABDITIS BRIGGSÆ
RHABDITIS TOKAI
BRUGIA MALAYI

Tentaculata

LINGULA ANATINA
BUGULA NERITINA

Pogonophora

RIFTIA PACHYPTILA

Sipunculida

PHASCOLOPSIS GOULDII

Echiurida

URECHIS UNICINCTUS

Plathelminthes

PLANOCERA RETICULATA
DUGESIA JAPONICA A
DUGESIA JAPONICA B

Mesozoa

DICYEMA MISAKIENSE

Nemertini

LINEUS GENICULATUS
EMPLECTONEMA GRACILE 1
EMPLECTONEMA GRACILE 2

Mollusca

APLYSIA KURODAI
HELIX POMATIA
ARION RUFUS
MYTILUS EDULIS
CALYPTOGENA MAGNIFICA
SOLEMYA VELUM
ILLEX ILLECEBROSUS

SEPIA OFFICINALIS
 OCTOPUS VULGARIS

Annelida
 SABELLASTARTE JAPONICA
 PERINEREIS BREVICIRRIS
 ENCHYTRAEUS ALBIDUS

Arthropoda
 LIMULUS POLYPHEMUS
 EURYPELMA CALIFORNICA
 ARENEUS DIADEMATUS
 CALANUS FINMARCHICUS
 ARTEMIA SALINA
 DAPHNIA MAGNA
 LIGIA OCEANICA
 HOMARUS GAMMARUS
 CANCER PAGURUS
 SPIROBOLUS SPEC.
 LOCUSTA MIGRATORIA
 ACHAETA DOMESTICA
 ACYRTHOSIPHON MAGNOLIAE
 DROSOPHILA MELANOGASTER
 DROSOPHILA SIMULANS #STRAIN 206-1
 DROSOPHILA TEISSIERI #STRAIN 201-5
 CALLIPHORA ERYTHROCEPHALA
 PHILOSAMIA CYNTHIA-RICINI
 BOMBYX MORI
 BOMBYX MORI #VAR 757
 PHILOSAMIA CYNTHIA-RICINI×BOMBYX MORI HYBRID
 ANTHERAEA PERNYI
 TENEBRIO MOLITOR

Echinodermata
 LYTECHINUS VARIEGATUS
 HEMICENTROTUS PULCHERRIMUS
 PSEUDOCENTROTUS DEPRESSUS
 ASTERIAS VULGARIS
 ASTERINA PECTINIFERA
 STICHOPUS OSHIMAE

Hemichordata
 SACCOGLOSSUS KOWALEVSKII 1
 SACCOGLOSSUS KOWALEVSKII 2

Chordata
 HALOCYNTHIA RORETZI
 BRANCHIOSTOMA BELCHERI
 ENTOSPHENUS JAPONICUS [ALL]
 LAMPETRA REISSNERI
 ENTOSPHENUS JAPONICUS [OOC]
 SCYLIORHINUS CANICULUS
 TINCA TINCA [ALL]
 MISGURNUS FOSSILIS [ALL]
 TINCA TINCA [OOC]
 MISGURNUS FOSSILIS [OOC]
 SALMO GAIRDNERI
 XENOPUS TROPICALIS [ALL]
 XENOPUS LAEVIS [ALL]
 XENOPUS BOREALIS [=MULLERI] [ALL]
 XENOPUS TROPICALIS [OOC]
 XENOPUS LAEVIS [OOC] 1
 XENOPUS LAEVIS [OOC] 2
 XENOPUS BOREALIS [OOC] 1
 NOTOPHTHALMUS VIRIDESCENS [OOC?]
 PLEURODELES WALTL [ALL]
 PLEURODELES WALTL [OOC] 1
 PLEURODELES WALTL [OOC] 2
 TERRAPENE CAROLINA
 IGUANA IGUANA
 GALLUS GALLUS 1
 GALLUS GALLUS 2
 HOMO SAPIENS
 MUS MUSCULUS
 RATTUS RATTUS
 MESOCRICETUS AURATUS

PSEUDOGENES
 LUPINUS LUTEUS #VAR BASS DNA1
 LUPINUS LUTEUS #VAR BASS DNA2
 TRITICUM AESTIVUM #VAR CHINESE SPRING 1

TRITICUM AESTIVUM #VAR CHINESE SPRING 2
 TRITICUM AESTIVUM #VAR CHINESE SPRING 3
 XENOPUS LAEVIS [OOC] 3
 XENOPUS LAEVIS [OOC] 4
 XENOPUS BOREALIS [OOC] 2
 XENOPUS BOREALIS [OOC] 3
 DROSOPHILA MELANOGASTER 2
 DROSOPHILA MELANOGASTER 3

TABLE 2Significant alterations of the displayed secondary structural model for phylogenetic groups:
(A) Insertions/Deletions (INS/DEL) (B) Odd base-pairs**(A) INSERTIONS/DELETIONS IN THE STRUCTURAL TYPES DISPLAYED**

Pos.	Group
1-2	absent Clostridiobacteria
1-2	absent Verrucomicrobium
4.1:115.1	DEL Sulfolobales
4.1	DEL eubacteria except Actinobacteria
9	DEL plant mitochondria
17.1	INS Octopus Spring Species 1
17.1	INS plant mitochondria
19.1	INS Rhodophyta
25.1	INS plant mitochondria
30.1	INS Cyanobacteria/plastids exc. pt Euglena
36	DEL Synechococcus/plastids exc. pt Porphyra
41	DEL Octopus Spring Species 1
41	DEL Eukaryota exc. Rhodophyta
52.1	INS plant mitochondria
52.1	INS Ascomycota exc. Protomycetales
66	DEL Eocyta
66	DEL Thermoplasma
74.1	DEL Sulfolobaceae/Desulfurococcaceae
74.2	INS Methanobacteriaceae
74.2	INS Saccharomycetales
84.1	DEL Methanobacteriales
84.1	DEL Eubacteria
84-92	DEL Methanococcales
81-95	successive DEL various Eubacteria
105.1	INS Basidiomycota type A

(B) ODD BASE-PAIRS

Pos.	Group
2-4:116-118	unpaired Halobacteriales
3:117	UU most Basidiomycota
11:109	CA some Actinobacteria
11:109	CA some Proteobacteria
17:67	CA some Methanomicrobiales
17:67	CA some Clostridiobacteria
17:67	CA some Bacteroides-Flavobacteria
17:67	CA some β Proteobacteria
31:50	CA some Proteobacteria
81:95	YY some Clostridiobacteria
81:95	UU Flavobacteria
81:95	YY Cyanobacteria/plastids
81:95	AC some Basidiomycota type B
81:95	UU Metazoa
84:92	GA Eukaryota exc. Chlorobionta