**Figure 2-source data 1. Occurrence of *hdr-*like, *lbpA* and *lbpA* maturation genes in genome-sequenced prokaryotes** Typical hdr-like gene clusters in established chemo- and photolithoautotrophic sulfur oxidizers have an *hdrC1B1A-hyp-hdrC2B2* arrangement. Genes that are immediately linked are highlighted in yellow. radSAM1 radical SAM domain-containing protein 1, lplA, lipoate:protein ligase, GGred, FAD-NAD-binding protein with some similarity to geranylgeranyl reductases. Genes that appear to be located in the same operon are highlighted in yellow. Genes that are located close to each other but not in the same transcriptional unit are marked in a lighter yellow. RISC, reduced inorganic sulfur compounds.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Organism/group** | ***hdr*-like genes** | ***lbpA* genes** | | ***radSAM1-lplA-GGred-radSAM2*** | | | **2. lplA gene** | | | **Canonical pathway (*lipAB, lipL, lipM*)** | | **Comments/ references** |
| **BACTERIA** |  |  | |  | | |  | | |  | |  |
| **PROTEOBACTERIA** |  |  | |  | | |  | | |  | |  |
| **α-PROTEOBACTERIA** |  |  | |  | | |  | | |  | |  |
| ***Rhodobacterales*** |  |  | |  | | |  | | |  | |  |
| ***Rhodobacteraceae*** |  |  | |  | | |  | | |  | |  |
| *Defluviimonas* *indica* DSM 24802T | SAMN05444006\_102161-166 | SAMN05444006\_102168 | | SAMN05444006\_102157-154 | | | no | | | SAMN05444006\_10595, SAMN05444006\_1105 | | RISC oxidation (*Jiang et al., 2014*) |
| *Rhodobacter aestuarii* JA296T (JCM 144887T) | BW967\_RS14395-420 | BW967\_RS14430 | | BW967\_RS14355-370 | | | no | | | SAMN05421580\_101623, SAMN05421580\_103182 | | RISC oxidation negative(*Venkata Ramana et al., 2009*), isolated from estuarine microbial mat |
| *Rhodobacter* *sp*. SW2 | RSW2DRAFT\_RS16425-16450 | RSW2DRAFT\_RS16455 | | RSW2DRAFT\_RS09280, 290-300 | | | RSW2DRAFT\_RS16410 | | | RSW2DRAFT\_RS05200, RSW2DRAFT\_RS07695 | | Oxidizes FeS to sulfate (*Ehrenreich and Widdel, 1994*) |
| ***Rhizobales*** |  |  | |  | | |  | | |  | |  |
| ***Phyllobacteriaceae*** |  |  | |  | | |  | | |  | |  |
| *Hoeflea* sp. BRH\_c9 | VR78\_06515-06490 | VR78\_06480 | | no | | | VR78\_06530 | | | VR78\_02800, no *lipB* | | Sulfur compound oxidation not reported, isolated from deep subsurface clay rock formation (*Bagnoud et al., 2016*) |
| ***Hyphomicrobiaceae*** |  |  | |  | | |  | | |  | |  |
| *Hyphomicrobium denitrificans* ATCC 51888T | Hden\_0689-0694 | Hden\_0696 | | Hden\_0683-0686 | | | no | | | Hden\_2670, Hden\_2234 | | Oxidizes dimethyl sulfide to sulfate (*Koch and Dahl, 2018*) |
| *Hyphomicrobium sp.* GJ21 | HYPGJ\_30416-410 | HYPGJ\_30408 | | HYPGJ\_30421-418 | | | no | | | HYPGJ\_31698, HYPGJ\_40109 | | Sulfur compound oxidation not reported, isolated from activated sludge wastewater treatment plant (*Bringel et al., 2017*) |
| ***Sphingomonadales*** |  |  | |  | | |  | | |  | |  |
| ***Erythrobacteraceae*** |  |  | |  | | |  | | |  | |  |
| Altererythrobacter epoxidivorans CGMCC 1.7731T | AMC99\_00780-775 | AMC99\_00773 | | AMC99\_00785, no *GGred*, AMC99\_00784-783 | | | no | | | AMC99\_01196, AMC99\_02058 | | Sulfur compound oxidation not reported, isolated from marine cold-seep sediment (*Kwon et al., 2007; Li et al., 2016*) |
| **β-PROTEOBACTERIA** |  |  | |  | | |  | | |  | |  |
| ***Sulfuricellales*** |  |  | |  | | |  | | |  | |  |
| ***Sulfuricellaceae*** |  |  | |  | | |  | | |  | |  |
| *Sulfuricella denitrificans* skB26T (DSM 22764T) | SCD\_RS09320-305†† | SCD\_RS03980 | | SCD\_RS03985-4000 | | | no | | | SCD\_RS00530, SCD\_RS00525 | | RISC oxidation (*Watanabe et al., 2012*) |
| **γ-PROTEOBACTERIA** |  |  | |  | | |  | | |  | |  |
| ***Acidithiobacillales*** |  |  | |  | | |  | | |  | |  |
| ***Acidithiobacillaceae*** |  |  | |  | | |  | | |  | |  |
| *Acidithiobacillus caldus* SM-1 (CGMCC 1.7296) | Atc\_2352-2347 | Atc\_2344, Atc\_2346 | | Atc\_2343-2340 | | | Atc\_2337 | | | Atc\_2379, Atc\_2378 | | RISC oxidation (*You et al., 2011a*) |
| *Acidithiobacillus ferrivorans* SS3 (DSM 17398) | Acife\_2476-2471 | Acife\_2468, Acife\_2470 | | Acife\_2464-2467 | | | Acife\_2461 | | | Acife\_2503, Aceife\_2502 | | RISC oxidation (*Hallberg et al., 2010*) |
| *Acidithiobacillus ferrooxidans* ATCC 23270T | AFE\_2555-2550 | AFE\_2547, AFE\_2549 | | AFE2543-2546 | | | AFE\_2540 | | | Afe\_2570, Afe\_2569 | | RISC oxidation (*Kelly and Wood, 2000*) |
| *Acidithiobacillus ferrooxidans* ATCC 53993 | Lferr\_2185-2178 » | Lferr\_2175, Lferr\_2177 | | Lferr2171-2174 | | | Lferr\_2168 | | | Lferr\_2200, Lferr\_2199 | | RISC oxidation (*Kelly and Wood, 2000*) |
| *Acidithiobacillus thiooxidans* ATCC 19377T | ATHIO\_RS0101720-0101745 | ATHIO\_RS0101750, RS0101760 | | ATHIO\_RS0101765-775 | | | no | | | ATHIO\_RS0101590, ATHIO\_RS0101595 | | RISC oxidation (*Kelly and Wood, 2000*) |
| ***Thermithiobacillaceae*** |  |  | |  | | |  | | |  | |  |
| *Thermithiobacillus tepidarius* DSM 3134T | G579\_RS0105310-0105285 | G579\_RS0105270, RS0105280 | | G579\_RS0105265-5250 | | | G579\_RS0105230 | | | G579\_RS0102775 (*lipA*) G579\_RS0109695 (*lipA*) G579\_RS15480 (*lipB*) | | RISC oxidation (*Kelly and Wood, 2000*) |
| ***Chromatiales*** |  |  | |  | | |  | | |  | |  |
| ***Ectothiorhodospiraceae*** |  |  | |  | | |  | | |  | |  |
| *Ectothiorhodospira* sp. PHS-1 | ECTPHS\_RS10575 -10600 | ECTPHS\_RS10605, RS10615 | | ECTPHS\_RS10620-10635 | | | no | | | ECTPHS\_RS09075, ECTPHS\_RS02465 | | RISC oxidation (*Kulp et al., 2008; Zargar et al., 2012*) |
| *Ectothiorhodospira marina* DSM 241T | SAMN05444515\_102233-2238 | SAMN05444515\_102239, 102241 | | SAMN05444515\_102242-102245 | | | SAMN05444515\_10991 (weak) | | | SAMN05444515\_1188, SAMN05444515\_11261 | | RISC oxidation (*Imhoff, 2005*) |
| *Ectothiorhodospira haloalkaliphila* ATCC 51935T | ECTHA\_RS0104485-0104460 | ECTHA\_RS0104445, RS0104455 | | ECTHA\_RS0104440-0104425 | | | no | | | ECTHA\_RS0115590, ECTHA\_RS0109110 | | RISC oxidation (*Imhoff, 2005*) |
| *Ectothiorhodospira mobilis* DSM 4180 | SAMN05421721\_10344-10349 | SAMN05421721\_10350, 10352 | | SAMN05421721\_10353-10356 | | | SAMN05421721\_11133 (weak) | | | SAMN05421721\_11419, SAMN05421721\_12217 | | RISC oxidation (*Imhoff, 2005*) |
| *Ectothiorhodosinus mongolicus* M9T (DSM 15479T) | B0B04\_RS03070-03045 | B0B04\_RS03040, RS03030 | | no | | | no | | | B0B04\_RS04725, B0B04\_RS07340 | | RISC oxidation (*Gorlenko et al., 2004*) |
| *Halorhodospira halochloris* str. A (DSM 1059T) | M911\_11240-11215 | M911\_11200, M911\_11210 | | M911\_11195-11180 | | | no | | | M911\_01920, M911\_03385 | | Sulfide oxidation (*Imhoff, 2005*) |
| *Acidihalobacter prosperus* V6 (DSM 14174) | BJI67\_RS04060-85 | BJI67\_RS04090, BJI67\_RS04100 | | BJI67\_RS04105-04120 | | | BJI67\_RS04910 | | | BJI67\_RS04410, BJI67\_RS04405 | | RISC oxidation (*Khaleque et al., 2017*) |
| *Thioalkalivibrio nitratireducens* DSM 14787T | TVNIR\_3249-3244 | TVNIR\_3241, TVNIR\_3243 | | no | | | TVNIR\_3231 (not the same operon) | | | TVNIR\_2196, TVNIR\_2197 | | RISC oxidation (*Sorokin et al., 2003*) |
| *Thioalkalivibrio* sp. K90mix | TK90\_0632-0637 | TK90\_0638, TK90\_0640 | | TK90\_0641-0644 | | | TK90\_0648 | | | TK90\_1966, TK90\_1967 | | RISC oxidation (*Muyzer et al., 2011a*) |
| *Thioalkalivibrio sulfidophilus* HL-EbGr7 | Tgr7\_2216-2211 | Tgr7\_2208, Tgr7\_2210 | | Tgr7\_2207-2204 | | | Tgr7\_2168 | | | Tgr7\_2696, Tgr7\_2704 | | RISC oxidation (*Muyzer et al., 2011a*) |
| *Thioalkalivibrio sp.* ALJ3 | C935\_RS0110745-720 | C935\_RS0110705, R0110715 | | C935\_RS0110700-0110685 | | | no | | | C935\_RS0107845, C935\_RS0107850 | | RISC oxidation (*Muyzer et al., 2011b*) |
| *Thioalkalivibrio sp.* AKL11 | D574\_RS0112030-005 | D574\_RS0111990, 0112000 | | D574\_RS0111985-0111970 | | | D574\_RS0111950 | | | D574\_RS0111650, D574\_RS0111645 | | RISC oxidation (*Muyzer et al., 2011b*) |
| *Thioalkalivibrio sp.* ALMg13-2 | F618\_RS0106210-185 | F618\_RS0106170, 0106180 | | F618\_RS0106165-0106150 | | | F618\_RS0112570 | | | F618\_RS0103420, F618\_RS0103425 | | RISC oxidation (*Muyzer et al., 2011b*) |
| *Thiorhodospira sibirica* ATCC 700588T | ThisiDRAFT\_1539-34 | ThisiDRAFT\_1533, 2312 | | ThisiDRAFT\_0082, 0513, 1283, 1859 | | | no | | | ThisiDRAFT\_0545, ThisiDRAFT\_2181 | | Sulfide oxidation (*Bryantseva et al., 1999; Imhoff, 2005*) |
| *Thioalkalivibrio versutus* D301 | TVD\_10650-10625 | TVD\_10610, TVD\_10620 | | TVD\_10605-10590 | | | TVD\_10570 | | | TVD\_11020, TVD\_11025 | | RISC oxidation (*Imhoff, 2005; Mu et al., 2016*) |
| *Thiohalospira halophila* DSM 15071T | SAMN05660831\_02553-557 | SAMN05660831\_02558, 02560 | | SAMN05660831\_02561-02564 | | | SAMN05660831\_02568 | | | SAMN05660831\_01616, SAMN05660831\_01951 | | RISC oxidation (*Sorokin et al., 2008b*) |
| *Thiohalorhabdus denitrificans* HL 19 (DSM 15699T) | BLP36\_RS08655-630 | BLP36\_RS08615, RS08625 | | BLP36\_RS08610-8595 | | | BLP36\_RS08575 | | | BLP36\_RS10220, BLP36\_RS10225 | | RISC oxidation (*Sorokin et al., 2008a*) |
| **ACTINOBACTERIA** |  |  | |  | | |  | | |  | |  |
| **ACTINOBACTERIA** |  |  | |  | | |  | | |  | |  |
| ***Pseudonocardiales*** |  |  | |  | | |  | | |  | |  |
| ***Pseudonocardiaceae*** |  |  | |  | | |  | | |  | |  |
| *Saccharomonospora marina* XMU15 (DSM 45390T) | SACMADRAFT\_RS09370-385\* | | SACMADRAFT\_RS09400, RS09445, RS09450 | | SACMADRAFT\_RS09405-09415 no *GGred* | | | SACMADRAFT\_RS28470 | | SACMADRAFT\_RS07040, SACMADRAFT\_RS07065, no *lipM,* no *lipL* | | Sulfur compound oxidation not reported, isolated from ocean sediment (*Klenk et al., 2012; Liu et al., 2010*)  linkage of *hdrBCA* with genes for CCG domain proteins and *etfBA* and Lbp biosynthesis genes |
| ***Corynebacteriales*** |  |  | |  | | |  | | |  | |  |
| ***Gordoniaceae*** |  |  | |  | | |  | | |  | |  |
| *Gordonia rhizosphera* NBRC 16068T | GORHZ\_RS13510-13495\* | GORHZ\_RS13480, GORHZ\_RS18175, 18180 | | GORHZ\_RS13475, RS13470, no *GGred*, GORHZ\_RS05265 | | | no | | | GORHZ\_RS00170, GORHZ\_RS00165, no *lipM*, no *lipL* | | Sulfur oxidation not reported, isolated from Mangrove rhizosphere (*Takeuchi and Hatano, 1998*), genes on different contigs |
| **ACIDIMICROBIA** |  |  | | | |  | | |  | |  | |
| ***Acidimicrobiales*** |  |  | |  | | |  | | |  | |  |
| ***Acidimicrobiaceae*** |  |  | |  | | |  | | |  | | Oxidation of FeS2, reduced sulfur compounds not oxidized (*Johnson et al., 2009*) |
| *Ferrithrix thermotolerans* DSM 19514T | SAMN02745225\_01749-01751\* | SAMN02745225\_01759, 01758 | | no | | | no | | | SAMN02745225\_01216, (*lipAB* fusion), no *lipM*, no *lipL* | | Linkage of *hdrBCA* with genes for CCG domain proteins and *etfBA* |
| *Acidimicrobium ferrooxidans* DSM 10331T | Afer\_0964-67\* | Afer\_0973, Afer\_0974, Afer\_1055 | | Afer\_1054-1052, no *GGred*, | | | no | | | Afer\_0719 (*lipAB* fusion), no *lipM*, no *lipL* | | Oxidation of FeS2 (*Clark and Norris, 1996; Clum et al., 2009*), Linkage of *hdrBCA* with genes for CCG domain proteins and *etfBA* |
| **FIRMICUTES** |  |  | |  | | |  | | |  | |  |
| **CLOSTRIDIA** |  |  | |  | | |  | | |  | |  |
| ***Clostridiales*** |  |  | |  | | |  | | |  | |  |
| **Family XVII. *Incertae Sedis*** |  |  | |  | | |  | | |  | |  |
| *Sulfobacillus acidophilus* DSM 10332T | Sulac\_1384-87\* | Sulac\_1389, Sulac\_1390, Sulac\_2875 | | Sulac\_2874 (*lplA*), 2876 (*lplA*), 2877 (*radSAM*), 2878 (*radSAM*), no *GGred* | | | Sulac\_1391 | | | Sulac\_3479, Sulac\_3478, no *lipM*,, no *lipL* | | Oxidation of mineral sulfides, RISC oxidation (*Watling et al., 2008*), linkage of *hdrBCA* with genes for CCG domain proteins, *etfBA* and one *lplA*-like gene |
| *Sulfobacillus acidophilus* TPY | TPY\_3531-28\* | TPY\_3526, TPY\_3525, TPY\_0765 | | TPY\_0766 (*lplA*), 0764 (*lplA*), 0763 (*radSAM*), 0762 (*radSAM*), no *GGred* | | | TPY\_3524 | | | TPY\_3785, TPY\_3784, no *lipM*, *no lipL* | | Oxidation of mineral sulfides, RISC oxidation (*Guo et al., 2016*), linkage of *hdrBCA* with genes for CCG domain proteins, *etfBA* and one *lplA*-like gene |
| *Sulfobacillus thermosulfidooxidans* DX | BFX05\_RS00130-145\* | BFX05\_RS00170, RS00175, BFX05\_RS14350 | | BFX05\_RS14345 (*lplA*), RS14355 (*lplA*) BFX05\_RS14360 (*radSAM*), BFX05\_RS14365 (*radSAM*) | | | BFX05\_RS00180 | | | BFX05\_RS03940, BFX05\_RS03935, no *lipM*  no *lipL* | | Oxidation of mineral sulfides, RISC oxidation (*Zhang et al., 2017*), linkage of *hdrBCA* with genes for CCG domain proteins, *etfBA* and one *lplA*-like gene |
| **BACILLI** |  |  | |  | | |  | | |  | |  |
| ***Bacilliales*** |  |  | |  | | |  | | |  | |  |
| ***Alicyclobacillaceae*** |  |  | |  | | |  | | |  | |  |
| *Kyrpidia tusciae* DSM 2912T | Btus\_2498-95\* | Btus\_2489, Btus\_2490, Btus\_2481 | | Btus\_2482 (*lplA*), Btus\_2480 (*lplA*), Btus\_2479 (*radSAM*), Btus\_2478 *(radSAM*) | | | Btus \_2488 (ligase) | | | Btus\_1312, no *lipB* Btus\_1766 (*lipM* ), no *lipL* | | Sulfur oxidation not reported, isolated from solfatara (*Bonjour and Aragno, 1984; Klenk et al., 2011*), Two clusters of the Sulfobacilli are linked |
| **CHLOROBI** |  |  | |  | | |  | | |  | |  |
| **CHLOROBIA** |  |  | |  | | |  | | |  | |  |
| ***Chlorobiales*** |  |  | |  | | |  | | |  | |  |
| ***Chlorobiaceae*** |  |  | |  | | |  | | |  | |  |
| *Chloroherpeton thalassium* ATCC 35110T | Ctha\_0138-0136 # | Ctha\_0140, Ctha\_0129 | | Ctha\_0128 (*lplA*), Ctha 127 (*radSAM*), Ctha\_0126 (*radSAM)*, Ctha\_125 (*lplA*), Ctha\_124 (*radSAM*), no *GGred* | | | no | | | Ctha\_2201, Ctha\_0430 | | Oxidation of sulfide (*Bonjour and Aragno, 1984*), possible operon is broken by Ctha\_0135, linkage of *hdrBCA* with genes for CCG domain proteins and *etfBA* |
| **CHLOROFLEXI** |  |  | |  | | |  | | |  | |  |
| **THERMOMICROBIA** |  |  | |  | | |  | | |  | |  |
| ***Thermomicrobiales*** |  |  | |  | | |  | | |  | |  |
| ***Thermomicrobiaceae*** |  |  | |  | | |  | | |  | |  |
| *Thermomicrobium roseum* DSM 5159T | trd\_0155-52\* | trd\_0144, trd\_143, trd\_0157 | | no | | | Trd\_0142 (*lplA*) | | | trd\_0168, trd\_0170 | | Sulfur oxidation not reported, isolated from Yellowstone hot spring (*Wu et al., 2009*), linkage of *hdrBCA* with genes for CCG domain proteins, *etfBA* and one *lplA*-like gene |
| **AQUIFICAE** |  |  | |  | | |  | | |  | |  |
| **AQUIFICAE** |  |  | |  | | |  | | |  | |  |
| ***Aquificales*** |  |  | |  | | |  | | |  | |  |
| ***Aquificaceae*** |  |  | |  | | |  | | |  | |  |
| *Aquifex aeolicus* VF5 | aq\_391-400 | aq\_402 | | aq\_403, aq\_1638, aq\_121, aq\_1958 | | | no | | | aq\_1355, no *lipB* | | RISC oxidation (*Gupta and Lali, 2013*) |
| *Hydrogenivirga* sp. 128-5-R1-1 | HG1285\_RS14290-14265 | HG1285\_RS14255 | | HG1285\_RS14250, HG1285\_06515, 15109, 16345 | | | no | | | HG1285\_06045, HG1285\_04243 (both *lipA*), no *lipB* | | RISC oxidation (*Gupta and Lali, 2013*) |
| *Hydrogenobacter thermophilus* TK-6T (DSM 6534T) | HTH\_1882-HTH\_1878 | HTH\_1874, HTH\_1877 | | HTH\_1873, HTH\_1603, 1747 HTH\_1871 | | | no | | | HTH\_0701, HTH\_0579 (both *lipA*), no *lipB* | | RISC oxidation (*Gupta and Lali, 2013*) |
| *Hydrogenobaculum* sp. HO | HydHO\_1077-1072 | HydHO\_1068, HydHO\_1071 | | HydHO\_1066, HydHO\_0926, HydHO\_0802, HydHO\_0584 | | | no | | | no *lipA*, no *lipB* | | RISC oxidation (*Gupta and Lali, 2013; Romano et al., 2013*) |
| *Hydrogenobaculum* sp. Y04AAS1 | HY04AAS1\_RS05470-05445 | HY04AAS1\_RS05425, HY04AAS1\_RS05440 | | HY04AAS1\_RS05415, RS04710, RS04065, RS02975 | | | no | | | no *lipA*, no *lipB* | | RISC oxidation (*Gupta and Lali, 2013; Romano et al., 2013*) |
| *Thermocrinis albus* DSM 14484T | THAL\_RS06855-06830 | THAL\_RS06810, THAL\_RS06825 | | THAL\_RS06805, RS01130, RS04395, RS01575 | | | no | | | THAL\_RS05455, no *lipB* | | RISC oxidation (*Gupta and Lali, 2013*) |
| *Thermocrinis jamiesonii* GBST (DSM 27162T) | K217\_RS0105820-0105845 | K217\_RS0105850, RS0105865 | | K217\_RS0105870, RS0101120 RS0100395, RS0104270 | | | no | | | K217\_RS0107180, no *lipB* | | RISC oxidation (*Ganji et al., 2016; Gupta and Lali, 2013*) |
| *Thermocrinis minervae* DSM 19557T | SAMN05444391\_ 1193-1188 | SAMN05444391\_1184, SAMN05444391\_1187 | | SAMN05444391\_1183, \_1443, \_1281, \_0147 | | | no | | | SAMN05444391\_1343, SAMN05444391\_0326 (both *lipA*), no *lipB* | | RISC oxidation (*Caldwell et al., 2010; Gupta and Lali, 2013*) |
| **ARCHAEA** |  |  | |  | | |  | | |  | |  |
| **CRENARCHAEOTA** |  |  | |  | | |  | | |  | |  |
| ***Sulfolobales*** |  |  | |  | | |  | | |  | |  |
| ***Sulfolobaceae*** |  |  | |  | | |  | | |  | |  |
| *Acidianus hospitalis* W1 | Ahos\_1696-1691 | Ahos\_1686, Ahos\_1684 | | Ahos\_1681, Ahos\_1682, no *GGred,* Ahos\_1680 | | | Ahos\_1685 | | | no *lipA*, no *lipB*,  archaeal LplA-LplB system:  Ahos\_0168, Ahos\_0169 | | Oxidation of sulfur (*You et al., 2011b*), *lbp* gene(s) in vicinity but not in same operon as *hdr* genes and biosynthetic genes |
| *Metallosphaera cuprina* Ar-4T (JCM 15769T) | Mcup\_0684-0689 | Mcup\_0662 | | Mcup\_0672, Mcup\_0671, no *GGred,* Mcup\_0729 | | | Mcup\_0767 | | | no *lipA,* no *lipB,* archaeal LplA-LplB system: no, Mcup\_0731 lipoate:protein ligase, Mcup\_0730 radSAM, Mcup\_0729 radSAM, | | Oxidation of tetrathionate, FeS and FeS2 (*Liu et al., 2011*) *lbp* gene(s) in vicinity but not in same operon as *hdr* genes and biosynthetic genes |
| *Metallosphaera sedula* DSM 5348T | Msed\_1547-1542 | Msed\_1570 | | Msed\_1559, Msed\_1560, no *GGred,* Msed\_1558 | | | Msed\_1480 | | | no *lipA,* no *lipB,* archaeal LplA-LplB system: no Msed\_1506 lipoate:protein ligase, Msed\_1507 radSAM, Msed\_1508 radSAM | | Oxidation of sulfur and metal sulfides (*Auernik et al., 2008*) *lbp* gene(s) in vicinity but not in same operon as *hdr* genes and biosynthetic genes |
| *Sulfolobus acidocaldarius* DSM 639T | Saci\_0334/0329-0325 | Saci\_0349, Saci\_0350 | | Saci\_0344, Saci\_0345, no *GGred,* Saci\_0343 | | | Saci\_0351 | | | Saci\_0309 (lipoyl synthase) no *lipB*  Archaeal LplA-LplB system: Saci\_0307, Saci\_0310, no *lplB* | | Sulfur oxidation of lab strain unclea (*Brock et al., 1972; Chen et al., 2005; Zillig et al., 1994*) *lbp* gene(s) in vicinity but not in same operon as *hdr* genes and biosynthetic genes |
| *Sulfolobus “islandicus”* M.14.25 | M1425\_1101-1096 | M1425\_1122 | | M1425\_1113, M1425\_1114, no *GGred,* M1425\_1112 | | | M1425\_1159 | | | M1425\_2212, no *lipB* Archaeal LplA-LplB system: M1425\_2214, no *lplB*, archaeal LipA: M1425\_2212, M1425\_2211, M1425\_0822. | | Sulfur oxidation of lab strain unclear (*Reno et al., 2009; Zillig et al., 1994*) *lbp* gene(s) in vicinity but not in same operon as *hdr* genes and biosynthetic genes |
| *Sulfolobus solfataricus* P2 (DSM 1617) | SSO1127-1135 | SSO1105 | | SSO1114, SSO1112, no *GGred,* SSO1115 | | | SSO1060 | | | SSO3158, no *lipB,* Archaeal LplA-LplB system: SSO3157, no *lplB,* archaeal *lipA* SSO3158  SSO3157 (*lplA-1*), SSO3158 (LipA), SSO3159 (*lplA-2*) | | Sulfur oxidation of lab strain unclear (*Zillig et al., 1994; Zillig et al., 1980*) *lbp* gene(s) in vicinity but not in same operon as *hdr* genes and biosynthetic genes |
| *Sulfolobus tokodaii* str. 7 (DSM 16993T) | STK\_18750-18700 | STK\_18940, STK\_18950 | | STK\_18870, STK\_18880, no *GGred,* STK\_18860 | | | STK\_18960 | | | No lipoate:protein ligases or lipoyl synthases | | Slow oxidation of sulfur (*Suzuki et al., 2002*), *lbp* gene(s) in vicinity but not in same operon as *hdr* genes and biosynthetic genes |

aGenomes were analysed by BLAST searches using the resources provided by Integrated Microbial Genomes (DOE Joint genomes Institute, <http://img.jgi.doe.gov>) and GenBank (<http://www.ncbi.nml.nih.gov>. Baits: Hdr-like proteins from *Acidithiobacillus caldus* SM1: HdrC1, Atc\_2352; HdrB1, Atc\_2351; HdrA, Atc\_2350; Hyp, Atc\_2349;, HdrC2, Atc\_2348; HdrB2, Atc\_2347; lipoate-binding proteins and their biosynthesis from *A. caldus*, LbpA1, Atc\_2346; LbpA2, Atc\_2344; radical SAM protein 1, Atc\_2343; single domain LplA (Atc\_2342), geranylgeranyl reductase like FAD-NAD-binding protein, Atc\_2341; radical SAM protein 2, Atc\_2340; second LplA-like protein, Atc\_2337; LipA (AAA66345) and LipB (AAA66342) from *E. coli* str. K-12 substr. W3110. Actinobacteria and Firmicutes were also searched for LipM (BSU24530) and LipL (BSU37640) from *Bacillus subtilis* subsp. s*ubtilis* str. 168. Archaea were checked for occurrence of archaeal LplAB from *Thermoplasma acidophilum* (*Christensen and Cronan, 2009*).

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