

## Appendix A

### Supplementary Files

#### 1. Supplementary Tables

**Table S1.** CDSs of the plasmid pSheA.

| ORF      | Coding sequence position |            | Protein size (aa) | Possible function                                 | ORF      | Coding sequence position |            | Protein size (aa) | Possible function                                   |
|----------|--------------------------|------------|-------------------|---|----------|--------------------------|------------|-------------------|---|
|          | start codon              | stop codon |                   |   |          | start codon              | stop codon |                   |   |
| pSheA 01 | 1                        | 942        | 313               | RepA family replication initiator protein         | pSheA 80 | 51259                    | 51909      | 216               | hypothetical protein                                |
| pSheA 02 | 1643                     | 2713       | 356               | hypothetical protein                              | pSheA 81 | 51921                    | 52343      | 140               | hypothetical protein                                |
| pSheA 03 | 3453                     | 4502       | 349               | RepB family plasmid replication initiator protein | pSheA 82 | 52370                    | 53590      | 406               | hypothetical protein                                |
| pSheA 04 | 4733                     | 4530       | 67                | hypothetical protein                              | pSheA 83 | 53622                    | 53804      | 60                | hypothetical protein                                |
| pSheA 05 | 4828                     | 5370       | 180               | hypothetical protein                              | pSheA 84 | 53801                    | 54073      | 90                | hypothetical protein                                |
| pSheA 06 | 6452                     | 5358       | 364               | hypothetical protein                              | pSheA 85 | 54345                    | 54554      | 69                | hypothetical protein                                |
| pSheA 07 | 6781                     | 6449       | 110               | hypothetical protein                              | pSheA 86 | 54682                    | 54861      | 59                | hypothetical protein                                |
| pSheA 08 | 7085                     | 7393       | 102               | hypothetical protein                              | pSheA 87 | 54899                    | 55186      | 95                | hypothetical protein                                |
| pSheA 09 | 7493                     | 7849       | 118               | hypothetical protein                              | pSheA 88 | 55334                    | 56476      | 380               | GIY-YIG nuclease family protein                     |
| pSheA 10 | 7846                     | 9516       | 556               | DEAD/DEAH box helicase                            | pSheA 89 | 56633                    | 58051      | 472               | DNA cytosine methyltransferase                      |
| pSheA 11 | 9829                     | 10419      | 196               | hypothetical protein                              | pSheA 90 | 58350                    | 59543      | 397               | plasmid partition protein A                         |
| pSheA 12 | 10482                    | 10979      | 165               | hypothetical protein                              | pSheA 91 | 59543                    | 60451      | 302               | plasmid partition protein B                         |
| pSheA 13 | 11163                    | 11552      | 129               | hypothetical protein                              | pSheA 92 | 60521                    | 60655      | 44                | hypothetical protein                                |
| pSheA 14 | 13100                    | 11622      | 492               | hypothetical protein                              | pSheA 93 | 60856                    | 62172      | 438               | hypothetical protein                                |
| pSheA 15 | 13355                    | 14038      | 227               | hypothetical protein                              | pSheA 94 | 63081                    | 62341      | 246               | hypothetical protein                                |
| pSheA 16 | 14106                    | 14855      | 249               | hypothetical protein                              | pSheA 95 | 63559                    | 63098      | 153               | hypothetical protein                                |
| pSheA 17 | 14855                    | 16405      | 516               | hypothetical protein                              | pSheA 96 | 63711                    | 64991      | 426               | dbifunctional diguanylate cyclase/phosphodiesterase |

|             |       |       |     |  |              |       |       |     |                                      |
|-------------|-------|-------|-----|--|--------------|-------|-------|-----|--------------------------------------|
| pSheA<br>18 | 16418 | 17641 | 407 | hypothetical protein   | pSheA<br>97  | 66245 | 65058 | 395 | hypothetical protein                 |
| pSheA<br>19 | 17657 | 18409 | 250 | hypothetical protein   | pSheA<br>98  | 66258 | 66419 | 53  | hypothetical protein                 |
| pSheA<br>20 | 18418 | 20043 | 541 | PuIE   | pSheA<br>99  | 66443 | 67357 | 304 | ParA family protein                  |
| pSheA<br>21 | 20060 | 21178 | 372 | hypothetical protein   | pSheA<br>100 | 67376 | 68635 | 419 | ParB-like partition<br>protein       |
| pSheA<br>22 | 21322 | 21744 | 140 | prepilin-type N-terminal<br>cleavage/methylation<br>domain-containing<br>protein, PulG | pSheA<br>101 | 68635 | 69069 | 144 | hypothetical protein                 |
| pSheA<br>23 | 21834 | 22391 | 185 | hypothetical protein   | pSheA<br>102 | 69047 | 70516 | 489 | hypothetical protein                 |
| pSheA<br>24 | 22504 | 25287 | 927 | hypothetical protein   | pSheA<br>103 | 70656 | 71948 | 430 | hypothetical protein                 |
| pSheA<br>25 | 25344 | 26534 | 396 | GlyGly-CTERM sorting<br>domain-containing protein                                      | pSheA<br>104 | 71950 | 72270 | 106 | restriction<br>endonuclease          |
| pSheA<br>26 | 27128 | 28591 | 487 | PcfJ-like protein  | pSheA<br>105 | 72353 | 74167 | 604 | DNA topoisomerase<br>III             |
| pSheA<br>27 | 28607 | 29197 | 196 | hypothetical protein   | pSheA<br>106 | 74179 | 74577 | 132 | hypothetical protein                 |
| pSheA<br>28 | 29396 | 29719 | 107 | hypothetical protein   | pSheA<br>107 | 74683 | 75495 | 270 | conjugative transfer<br>protein TraP |
| pSheA<br>29 | 29890 | 30027 | 45  | hypothetical protein   | pSheA<br>108 | 75476 | 75802 | 108 | hypothetical protein                 |
| pSheA<br>30 | 30152 | 29985 | 55  | hypothetical protein   | pSheA<br>109 | 75814 | 76530 | 238 | hypothetical protein                 |
| pSheA<br>31 | 30790 | 30179 | 203 | bacteriophage CI repressor   | pSheA<br>110 | 76530 | 77072 | 180 | lytic transglycosylase<br>TraG       |
| pSheA<br>32 | 31093 | 31350 | 85  | hypothetical protein   | pSheA<br>111 | 77036 | 77593 | 185 | hypothetical protein                 |
| pSheA<br>33 | 31384 | 31956 | 190 | hypothetical protein   | pSheA<br>112 | 77593 | 79746 | 717 | conjugative coupling<br>factor TraD  |
| pSheA<br>34 | 31969 | 32265 | 98  | hypothetical protein   | pSheA<br>113 | 79746 | 80444 | 232 | hypothetical protein                 |
| pSheA<br>35 | 32267 | 32467 | 66  | hypothetical protein   | pSheA<br>114 | 80529 | 80867 | 112 | hypothetical protein                 |
| pSheA<br>36 | 32603 | 32926 | 107 | hypothetical protein   | pSheA<br>115 | 80870 | 81154 | 94  | hypothetical protein                 |
| pSheA<br>37 | 33345 | 33139 | 68  | hypothetical protein   | pSheA<br>116 | 81198 | 81581 | 127 | hypothetical protein                 |
| pSheA<br>38 | 33596 | 33784 | 62  | hypothetical protein   | pSheA<br>117 | 81588 | 81956 | 122 | hypothetical protein                 |
| pSheA<br>39 | 33869 | 34009 | 46  | hypothetical protein   | pSheA<br>118 | 81960 | 82598 | 212 | membrane protein                     |
| pSheA<br>40 | 34077 | 34259 | 60  | hypothetical protein   | pSheA<br>119 | 82816 | 85122 | 768 | ATP-binding protein                  |
| pSheA<br>41 | 34303 | 34791 | 162 | hypothetical protein   | pSheA<br>120 | 85257 | 86024 | 255 | hypothetical protein                 |

|             |       |       |     |                                 |              |        |        |      |   |
|-------------|-------|-------|-----|---------------------------------|--------------|--------|--------|------|---|
| pSheA<br>42 | 34829 | 35020 | 63  | hypothetical protein            | pSheA<br>121 | 86024  | 87469  | 481  | integrating<br>conjugative element<br>protein |
| pSheA<br>43 | 35150 | 35455 | 101 | hypothetical protein            | pSheA<br>122 | 87466  | 87819  | 117  | hypothetical protein                          |
| pSheA<br>44 | 35442 | 35705 | 87  | hypothetical protein            | pSheA<br>123 | 87821  | 90844  | 1007 | conjugative transfer<br>ATPase                |
| pSheA<br>45 | 35717 | 36007 | 96  | hypothetical protein            | pSheA<br>124 | 91212  | 90895  | 105  | hypothetical protein                          |
| pSheA<br>46 | 36017 | 36298 | 93  | hypothetical protein            | pSheA<br>125 | 91358  | 91801  | 147  | hypothetical protein                          |
| pSheA<br>47 | 36319 | 36795 | 158 | hypothetical protein            | pSheA<br>126 | 91798  | 92904  | 368  | integrating<br>conjugative element<br>protein |
| pSheA<br>48 | 36815 | 37078 | 87  | hypothetical protein            | pSheA<br>127 | 92908  | 94245  | 445  | integrating<br>conjugative element<br>protein |
| pSheA<br>49 | 37109 | 37336 | 75  | hypothetical protein            | pSheA<br>128 | 94254  | 94592  | 112  | hypothetical protein                          |
| pSheA<br>50 | 37352 | 37888 | 178 | hypothetical protein            | pSheA<br>129 | 94623  | 96377  | 584  | hypothetical protein                          |
| pSheA<br>51 | 37875 | 38072 | 65  | hypothetical protein            | pSheA<br>130 | 96686  | 96943  | 85   | hypothetical protein                          |
| pSheA<br>52 | 38102 | 38347 | 81  | antirestriction protein<br>ArdR | pSheA<br>131 | 97494  | 97769  | 91   | hypothetical protein                          |
| pSheA<br>53 | 38359 | 38721 | 120 | hypothetical protein            | pSheA<br>132 | 97857  | 98360  | 167  | hypothetical protein                          |
| pSheA<br>54 | 38826 | 39038 | 70  | hypothetical protein            | pSheA<br>133 | 98544  | 99197  | 217  | resolvase                                     |
| pSheA<br>55 | 39032 | 39277 | 81  | hypothetical protein            | pSheA<br>134 | 99424  | 99645  | 73   | hypothetical protein                          |
| pSheA<br>56 | 39297 | 39665 | 122 | hypothetical protein            | pSheA<br>135 | 99797  | 100318 | 173  | hypothetical protein                          |
| pSheA<br>57 | 39816 | 40100 | 94  | hypothetical protein            | pSheA<br>136 | 100447 | 101832 | 461  | hypothetical protein                          |
| pSheA<br>58 | 40129 | 40668 | 179 | hypothetical protein            | pSheA<br>137 | 102035 | 102619 | 194  | methyltransferase<br>type11                   |
| pSheA<br>59 | 40693 | 40914 | 73  | hypothetical protein            | pSheA<br>138 | 102701 | 103081 | 126  | N-acetyltransferase                           |
| pSheA<br>60 | 40936 | 41151 | 71  | hypothetical protein            | pSheA<br>139 | 103174 | 103413 | 79   | hypothetical protein                          |
| pSheA<br>61 | 41179 | 41439 | 86  | antirestriction protein<br>ArdR | pSheA<br>140 | 103570 | 103824 | 84   | hypothetical protein                          |
| pSheA<br>62 | 41442 | 41789 | 115 | hypothetical protein            | pSheA<br>141 | 103943 | 104227 | 94   | hypothetical protein                          |
| pSheA<br>63 | 41805 | 42050 | 81  | hypothetical protein            | pSheA<br>142 | 104459 | 104286 | 57   | hypothetical protein                          |
| pSheA<br>64 | 42074 | 42361 | 95  | hypothetical protein            | pSheA<br>143 | 104810 | 105196 | 128  | hypothetical protein                          |
| pSheA<br>65 | 42443 | 42838 | 131 | hypothetical protein            | pSheA<br>144 | 105330 | 105548 | 72   | hypothetical protein                          |

|             |       |       |     |                                    |              |        |        |     |                              |
|-------------|-------|-------|-----|------------------------------------|--------------|--------|--------|-----|------------------------------|
| pSheA<br>66 | 42880 | 43107 | 75  | hypothetical protein               | pSheA<br>145 | 105693 | 106007 | 104 | hypothetical protein         |
| pSheA<br>67 | 43141 | 43392 | 83  | hypothetical protein               | pSheA<br>146 | 106133 | 106282 | 49  | hypothetical protein         |
| pSheA<br>68 | 43431 | 43736 | 101 | hypothetical protein               | pSheA<br>147 | 106432 | 106869 | 145 | hypothetical protein         |
| pSheA<br>69 | 43726 | 44136 | 136 | hypothetical protein               | pSheA<br>148 | 107063 | 107569 | 168 | hypothetical protein         |
| pSheA<br>70 | 44231 | 44587 | 118 | hypothetical protein               | pSheA<br>149 | 107724 | 108077 | 117 | hypothetical protein         |
| pSheA<br>71 | 44600 | 44839 | 79  | hypothetical protein               | pSheA<br>150 | 108282 | 108650 | 122 | hypothetical protein         |
| pSheA<br>72 | 44911 | 45375 | 154 | hypothetical protein               | pSheA<br>151 | 108920 | 109201 | 93  | transcriptional<br>regulator |
| pSheA<br>73 | 45599 | 46459 | 286 | hypothetical protein               | pSheA<br>152 | 109213 | 109545 | 110 | hypothetical protein         |
| pSheA<br>74 | 46645 | 48507 | 620 | hypothetical protein               | pSheA<br>153 | 109564 | 109806 | 80  | hypothetical protein         |
| pSheA<br>75 | 48550 | 48852 | 100 | hypothetical protein               | pSheA<br>154 | 109817 | 110254 | 145 | hypothetical protein         |
| pSheA<br>76 | 48958 | 49287 | 109 | hypothetical protein               | pSheA<br>155 | 110351 | 110620 | 89  | hypothetical protein         |
| pSheA<br>77 | 49586 | 49771 | 61  | hypothetical protein               | pSheA<br>156 | 110645 | 110800 | 51  | hypothetical protein         |
| pSheA<br>78 | 49853 | 50974 | 373 | DNA sulfur modification<br>protein | pSheA<br>157 | 111626 | 111336 | 96  | hypothetical protein         |
| pSheA<br>79 | 51027 | 51221 | 64  | hypothetical protein               |              |        |        |     |                              |

The ORFs forming the pSheA plasmid backbone structure modules and their putative protein products are color-coded: replication – beige, conjugal transfer – blue, partitioning system – green, multimer resolution system – grey.

**Table S2.** CDSs of the plasmid pSheB.

| ORF         | Coding sequence position |            | Protein size (aa) | Possible function             | ORF         | Coding sequence position |            | Protein size (aa) | Possible function              |
|-------------|--------------------------|------------|-------------------|-------------------------------|-------------|--------------------------|------------|-------------------|--------------------------------|
|             | start codon              | stop codon |                   |                               |             | start codon              | stop codon |                   |                                |
| pSheB<br>01 | 1                        | 435        | 144               | DNA polymerase V              | pSheB<br>47 | 40303                    | 39929      | 124               | hypothetical protein TraA      |
| pSheB<br>02 | 423                      | 1676       | 417               | DNA polymerase V subunit UmuC | pSheB<br>48 | 40555                    | 40367      | 62                | TraY domain-containing protein |
| pSheB<br>03 | 1775                     | 1990       | 71                | hypothetical protein          | pSheB<br>49 | 40914                    | 40657      | 85                | hypothetical protein           |
| pSheB<br>04 | 2096                     | 2746       | 216               | hypothetical protein          | pSheB<br>50 | 41034                    | 41216      | 60                | hypothetical protein           |
| pSheB<br>05 | 2787                     | 3005       | 72                | hypothetical protein          | pSheB<br>51 | 41227                    | 41376      | 49                | hypothetical protein           |

|             |       |       |      |   |             |       |       |      |   |
|-------------|-------|-------|------|---|-------------|-------|-------|------|---|
| pSheB<br>06 | 3025  | 3429  | 134  | hypothetical protein  | pSheB<br>52 | 41658 | 42590 | 310  | hypothetical protein  |
| pSheB<br>07 | 3426  | 4157  | 243  | endonuclease I  | pSheB<br>53 | 43512 | 43793 | 93   | toxin-antitoxin system<br>antidote Rhh family               |
| pSheB<br>08 | 4172  | 4405  | 77   | hypothetical protein  | pSheB<br>54 | 43799 | 44326 | 175  | N-acetyltransferase   |
| pSheB<br>09 | 4548  | 4402  | 48   | hypothetical protein  | pSheB<br>55 | 44914 | 44768 | 48   | hypothetical protein  |
| pSheB<br>10 | 4798  | 6672  | 624  | ParB domain protein<br>nuclease                                 | pSheB<br>56 | 45164 | 46363 | 399  | chromosome<br>partitioning protein<br>ParA                  |
| pSheB<br>11 | 6797  | 7252  | 151  | hypothetical protein  | pSheB<br>57 | 46363 | 47460 | 365  | chromosome<br>partitioning protein<br>ParB                  |
| pSheB<br>12 | 7254  | 7742  | 162  | hypothetical protein  | pSheB<br>58 | 47633 | 47755 | 40   | hypothetical protein  |
| pSheB<br>13 | 7773  | 7994  | 73   | hypothetical protein  | pSheB<br>59 | 47791 | 51651 | 1286 | hypothetical protein  |
| pSheB<br>14 | 8007  | 8120  | 37   | hypothetical protein  | pSheB<br>60 | 51741 | 52466 | 241  | hypothetical protein  |
| pSheB<br>15 | 8365  | 8237  | 42   | hypothetical protein  | pSheB<br>61 | 52599 | 52976 | 125  | hypothetical protein  |
| pSheB<br>16 | 8359  | 8703  | 114  | hypothetical protein  | pSheB<br>62 | 53014 | 53898 | 294  | hypothetical protein  |
| pSheB<br>17 | 8785  | 9291  | 168  | hypothetical protein  | pSheB<br>63 | 54008 | 54976 | 322  | hypothetical protein  |
| pSheB<br>18 | 9293  | 9694  | 133  | hypothetical protein  | pSheB<br>64 | 55266 | 55739 | 157  | hypothetical protein  |
| pSheB<br>19 | 9892  | 10137 | 81   | HicA protein  | pSheB<br>65 | 56576 | 55947 | 209  | resolvase   |
| pSheB<br>20 | 10137 | 10472 | 111  | HicB family protein   | pSheB<br>66 | 56699 | 57019 | 106  | transposase   |
| pSheB<br>21 | 10776 | 10648 | 42   | hypothetical protein  | pSheB<br>67 | 57098 | 57478 | 126  | membrane protein<br>YnfA                                    |
| pSheB<br>22 | 10770 | 11114 | 114  | hypothetical protein  | pSheB<br>68 | 57887 | 58195 | 102  | ArsR family<br>transcriptional<br>regulator                 |
| pSheB<br>23 | 11077 | 12405 | 442  | hypothetical plasmid<br>protein                                 | pSheB<br>69 | 58256 | 58498 | 80   | Redox-active disulfide<br>protein 2                         |
| pSheB<br>24 | 13003 | 13314 | 103  | hypothetical protein  | pSheB<br>70 | 58517 | 59050 | 177  | sulfite exporter<br>TauE/SafE family<br>protein             |
| pSheB<br>25 | 13439 | 13311 | 42   | hypothetical protein  | pSheB<br>71 | 59043 | 59741 | 232  | Cytochrome c<br>biogenesis protein,<br>transmembrane region |
| pSheB<br>26 | 13872 | 14231 | 119  | hypothetical protein  | pSheB<br>72 | 59786 | 60910 | 374  | efflux RND transporter<br>periplasmic adaptor<br>subunit    |
| pSheB<br>27 | 20206 | 14252 | 1984 | conjugative transfer<br>relaxase/helicase Tral                  | pSheB<br>73 | 60907 | 63981 | 1024 | efflux RND transporter<br>permease subunit                  |
| pSheB<br>28 | 20444 | 20265 | 59   | thyroid hormone<br>receptor interactor 11-<br>like protein      | pSheB<br>74 | 64533 | 64099 | 144  | arsenate reductase<br>ArsC                                  |
| pSheB<br>29 | 22584 | 20458 | 708  | type IV conjugative<br>transfer system<br>coupling protein TraD | pSheB<br>75 | 65904 | 64621 | 427  | arsenical efflux pump<br>membrane protein<br>ArsB           |

|             |       |       |     |   |             |       |       |     |  |
|-------------|-------|-------|-----|---|-------------|-------|-------|-----|--|
| pSheB<br>30 | 23219 | 22584 | 211 | hypothetical protein  | pSheB<br>76 | 67741 | 65969 | 590 | arsenical pump-driving<br>ATPase ArsA                            |
| pSheB<br>31 | 26070 | 23257 | 937 | conjugative transfer<br>protein TraG  | pSheB<br>77 | 68138 | 67776 | 120 | arsenical resistance<br>operon transcriptional<br>repressor ArsD |
| pSheB<br>32 | 27461 | 26073 | 462 | conjugative transfer<br>protein TraH  | pSheB<br>78 | 68511 | 71075 | 854 | respiratory arsenate<br>reductase ArrA                           |
| pSheB<br>33 | 27634 | 27458 | 58  | hypothetical protein  | pSheB<br>79 | 71087 | 71791 | 234 | respiratory arsenate<br>reductase ArrB                           |
| pSheB<br>34 | 28085 | 27645 | 146 | type-F conjugative<br>transfer system pilin<br>assembly thiol-disulfide<br>isomerase TrbB | pSheB<br>80 | 73292 | 71862 | 476 | glutathione synthase   |
| pSheB<br>35 | 28974 | 28099 | 291 | type-F conjugative<br>transfer system pilin<br>assembly protein TraF                      | pSheB<br>81 | 74500 | 73448 | 350 | hypothetical protein   |
| pSheB<br>36 | 30782 | 28971 | 603 | type-F conjugative<br>transfer system mating-<br>pair stabilization<br>protein TraN       | pSheB<br>82 | 74725 | 75012 | 95  | ArsR family<br>transcriptional<br>regulator                      |
| pSheB<br>37 | 31519 | 30779 | 246 | type-F conjugative<br>transfer system pilin<br>assembly protein TrbC                      | pSheB<br>83 | 75111 | 75527 | 138 | arsenate reductase<br>ArsC                                       |
| pSheB<br>38 | 32549 | 31542 | 335 | conjugative transfer<br>protein TraU  | pSheB<br>84 | 75520 | 75867 | 115 | ArsR family<br>transcriptional<br>regulator                      |
| pSheB<br>39 | 33240 | 32536 | 234 | type-F conjugative<br>transfer system protein<br>TraW                                     | pSheB<br>85 | 75946 | 76458 | 170 | arsenate reductase<br>ArsC                                       |
| pSheB<br>40 | 33608 | 33237 | 123 | conjugative transfer<br>protein TrbI  | pSheB<br>86 | 76551 | 77549 | 332 | hypothetical protein   |
| pSheB<br>41 | 36198 | 33610 | 862 | type IV secretion<br>system protein TraC  | pSheB<br>87 | 77561 | 77797 | 78  | thioredoxin family<br>protein                                    |
| pSheB<br>42 | 36657 | 36202 | 151 | type IV conjugative<br>transfer system protein<br>TraV                                    | pSheB<br>88 | 77805 | 78296 | 163 | protein phosphatase  |
| pSheB<br>43 | 38204 | 36678 | 508 | conjugative transfer<br>protein TraB  | pSheB<br>89 | 78353 | 79363 | 336 | glyceraldehyde-3-<br>phosphate<br>dehydrogenase                  |
| pSheB<br>44 | 39016 | 38201 | 271 | type-F conjugative<br>transfer system<br>secretin TraK                                    | pSheB<br>90 | 79369 | 80607 | 412 | major facilitator<br>superfamily transporter                     |
| pSheB<br>45 | 39582 | 39016 | 188 | type IV conjugative<br>transfer system protein<br>TraE                                    | pSheB<br>91 | 80738 | 81013 | 91  | hypothetical protein   |
| pSheB<br>46 | 39925 | 39623 | 100 | type IV conjugative<br>transfer system protein<br>TraL                                    |             |       |       |     |  |

The ORFs forming the pSheB plasmid backbone structure modules and their putative protein products are color-coded: replication – beige, conjugal transfer – blue, partitioning system – green, multimer resolution system – grey, addiction module – red. The *ars* and *arr* modules components are colored in yellow. The putative ParB protein, which may also play a role in plasmid replication is colored in gold.

**Table S3.** ORFs located within phage MuSsp\_O23S

| ORF | Coding sequence<br>position |            | Protein size (aa) | Possible function |
|-----|-----------------------------|------------|-------------------|-------------------|
|     | start codon                 | stop codon |                   |                   |

|               |       |       |     |  |
|---------------|-------|-------|-----|--|
| MuSsp_O23S 1  | 905   | 183   | 240 | Bifunctional HTH-domain containing protein/aminotransferase with peptidase S24-like domain; transcriptional regulator protein (CI repressor) |
| MuSsp_O23S 2  | 1071  | 1319  | 82  | HTH-XRE regulatory protein; (Mu-like phage Ner protein)  |
| MuSsp_O23S 3  | 1312  | 3471  | 719 | Mu-like phage transposase A  |
| MuSsp_O23S 4  | 3542  | 4261  | 239 | Mu-like phage transposase B  |
| MuSsp_O23S 5  | 4317  | 4883  | 188 | Hypothetical protein   |
| MuSsp_O23S 6  | 4870  | 5364  | 164 | XRE family transcriptional regulator   |
| MuSsp_O23S 7  | 5364  | 5582  | 72  | Mu Kil-like protein  |
| MuSsp_O23S 8  | 5584  | 6219  | 211 | Hypothetical protein, DUF3164; sulfate transporter   |
| MuSsp_O23S 9  | 6221  | 6547  | 108 | Hypothetical protein   |
| MuSsp_O23S 10 | 6639  | 6860  | 73  | Hypothetical protein   |
| MuSsp_O23S 11 | 6854  | 7474  | 206 | Mu GemA-like; host gene modulation protein, DUF1018  |
| MuSsp_O23S 12 | 7461  | 7922  | 153 | Mor transcription activator domain protein (Mu-like phage late transcription activator C)  |
| MuSsp_O23S 13 | 8429  | 9337  | 302 | Clp protease   |
| MuSsp_O23S 14 | 9381  | 9938  | 185 | Hypothetical protein   |
| MuSsp_O23S 15 | 9967  | 10401 | 144 | Hypothetical protein   |
| MuSsp_O23S 16 | 10408 | 10433 | 102 | E18 Hypothetical protein   |
| MuSsp_O23S 17 | 10784 | 11344 | 186 | Mu-like phage lysozyme (endolysin)   |
| MuSsp_O23S 18 | 11341 | 11910 | 189 | Mu-like phage LysB, phage lysis regulatory protein   |
| MuSsp_O23S 19 | 11995 | 12219 | 74  | C4 DksA/TraR-type zinc finger protein  |
| MuSsp_O23S 20 | 12216 | 12554 | 112 | Hypothetical protein containing a coiled-coil domain   |
| MuSsp_O23S 21 | 12554 | 12850 | 98  | Mu Gp 26-like protein; Ribonuclease R winged-helix domain protein  |
| MuSsp_O23S 22 | 12853 | 13125 | 90  | Hypothetical protein   |
| MuSsp_O23S 23 | 13115 | 13684 | 189 | Mu Gp27 (GpD)-like protein; small terminase subunit  |
| MuSsp_O23S 24 | 13684 | 15324 | 546 | Mu Gp28 (GpE)-like protein; large terminase subunit  |
| MuSsp_O23S 25 | 15324 | 16925 | 533 | Mu-like phage portal protein   |
| MuSsp_O23S 26 | 16918 | 18243 | 441 | Mu Gp30 (GpF)-like protein; head assembly protein  |
| MuSsp_O23S 27 | 18253 | 18714 | 153 | Mu Gp31 (GpG)-like protein, capsid morphogenesis protein   |
| MuSsp_O23S 28 | 19551 | 18697 | 284 | HrpJ-like domain containing protein  |
| MuSsp_O23S 29 | 20281 | 20529 | 103 | XRE family transcriptional regulator   |
| MuSsp_O23S 30 | 20567 | 21523 | 318 | Reverse transcriptase (RNA-dependent DNA polymerase)   |

|               |       |       |      |   |
|---------------|-------|-------|------|---|
| MuSsp_O23S 31 | 21644 | 21970 | 110  | Hypothetical protein  |
| MuSsp_O23S 32 | 22050 | 23207 | 385  | Mu-like phage protease I  |
| MuSsp_O23S 33 | 23207 | 24127 | 306  | Major head subunit (GpT-like)                                   |
| MuSsp_O23S 34 | 24210 | 24722 | 170  | Mu Gp35-like protein; Rho termination factor, N-terminal domain |
| MuSsp_O23S 35 | 24725 | 25165 | 146  | Mu Gp36 (Gp J)-like protein                                     |
| MuSsp_O23S 36 | 25165 | 25608 | 147  | Virion structural protein                                       |
| MuSsp_O23S 37 | 25637 | 26383 | 248  | Hypothetical protein  |
| MuSsp_O23S 38 | 26503 | 30429 | 1308 | Tail length tape measure protein                                |
| MuSsp_O23S 39 | 30426 | 30791 | 121  | Hypothetical protein  |
| MuSsp_O23S 40 | 30804 | 33278 | 824  | Hypothetical protein  |
| MuSsp_O23S 41 | 33290 | 34249 | 319  | Hypothetical protein  |
| MuSsp_O23S 42 | 34242 | 34544 | 100  | Hypothetical protein  |
| MuSsp_O23S 43 | 34541 | 36328 | 595  | Hypothetical protein  |
| MuSsp_O23S 44 | 36325 | 36546 | 73   | Hypothetical protein  |
| MuSsp_O23S 45 | 36692 | 37453 | 253  | DNA adenine methyltransferase                                   |

**Table S4.** ORFs located within pSheC.

| ORF                 | Coding sequence position |            | Protein size (aa) | Possible function                               | % identity with proteins encoded in pSheD and pSheE | Homologues                               |
|---------------------|--------------------------|------------|-------------------|---|---|--|
|                     | start codon              | stop codon |                   |   |   |  |
| pSheC <sub>01</sub> | 66                       | 320        | 84                | Hypothetical protein                            | pSheE 14 100%                                       |  |
| pSheC <sub>02</sub> | 501                      | 283        | 72                | Transcriptional regulator                       | pSheE 15 100%                                       |  |
| pSheC <sub>03</sub> | 729                      | 505        | 74                | Hypothetical protein                            | pSheE 16 100%                                       |  |
| pSheC <sub>04</sub> | 1318                     | 1115       | 67                | Hypothetical protein                            | pSheE 17 100%                                       |  |
| pSheC <sub>05</sub> | 1454                     | 3598       | 714               | RstA, replication-associated protein            | pSheE 18 100%                                       | YP_004286230 Vibrio phage CTXphi (50.4%) |
| pSheC <sub>06</sub> | 3658                     | 3972       | 104               | RstB, integration (lysogeny)-associated protein | pSheE 19 100%                                       | YP_004286231 Vibrio phage CTXphi (49.5%) |
| pSheC <sub>07</sub> | 3985                     | 4191       | 68                | Minor virion protein, pVII                      | pSheD 07 42%,<br>pSheE 20 100%                      | Vibrio virus Vf33                        |
| pSheC <sub>08</sub> | 4201                     | 4410       | 69                | Major virion protein, pVIII                     | pSheD 09 50%,<br>pSheE 21 100%                      | NP_932299 Ralstonia phage p12J 39%       |



|             |      |      |     |  |                                |   |
|-------------|------|------|-----|--|--------------------------------|---|
| pSheC<br>09 | 4485 | 5942 | 485 | Attachment protein, Receptor-binding protein, pIII | pSheD 09 78%,<br>pSheE 22 100% | NP_047369 Vibrio phage fs2,<br>21%      |
| pSheC<br>10 | 5951 | 6298 | 115 | Minor virion protein, pVI                          | pSheD 10 78%,<br>pSheE 24 100% | NP_932301 Ralstonia phage<br>p12J 27%   |
| pSheC<br>11 | 6298 | 7605 | 435 | Assembly protein, Zonular occludens<br>toxin, pI   | pSheD 11 58%,<br>pSheE 25 100% | NP_932302 Ralstonia phage<br>p12J 37.3% |
| pSheC<br>12 | 7618 | 7875 | 85  | Hypothetical protein                               | pSheE 26 100%                  |   |

**Table S5.** ORFs located within pSheD.

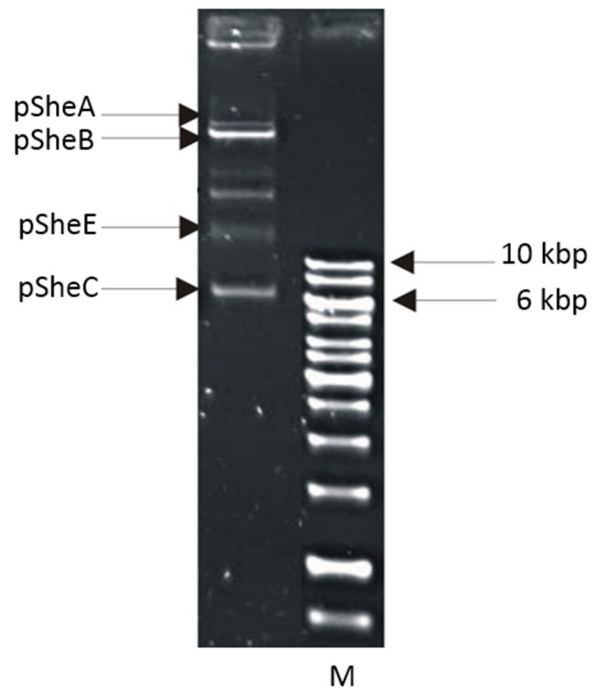
| ORF      | Coding sequence position |            | Protein size (aa) | Possible function                             | % identity with proteins encoded in pSheC and pSheE | Homologues   |
|----------|--------------------------|------------|-------------------|---|---|--|
|          | start codon              | stop codon |                   |   |   |  |
| pSheD 01 | 245                      | 505        | 86                | Hypothetical protein                          | pSheE 01 100%                                       |  |
| pSheD 02 | 495                      | 686        | 142               | Hypothetical protein                          | pSheE 02 100%                                       |  |
| pSheD 03 | 1138                     | 902        | 78                | Mobilization protein BmgB                     | pSheE 04 100%                                       |  |
| pSheD 04 | 1168                     | 2328       | 386               | Replication protein (endonuclease), pII       | pSheE 05 100%                                       | NP_047361 of Enterobacteria phage IfI 64.1%, IKE, fl |
| pSheD 05 | 2029                     | 2328       | 99                | Replication-associated protein, pX            | pSheE 06 100%                                       |  |
| pSheD 06 | 2342                     | 2665       | 107               | ssDNA binding protein (replication), pV       | pSheE 07 100%                                       | IKE, fl  |
| pSheD 07 | 2678                     | 2881       | 67                | Minor virion protein, pVII                    | pSheC 07 42%,<br>pSheE 08 100%                      |  |
| pSheD 08 | 2899                     | 3117       | 72                | Major virion protein, pVIII                   | pSheC 08 50%,<br>pSheE 09 100%                      |  |
| pSheD 09 | 3187                     | 4668       | 493               | Receptor binding protein, pIII                | pSheC 09 78%,<br>pSheE 10 100%                      |  |
| pSheD 10 | 4676                     | 5023       | 115               | Minor virion protein, pVI                     | pSheC 10 78%,<br>pSheE 12 100%                      |  |
| pSheD 11 | 5023                     | 6333       | 436               | Assembly protein, Zonular occludens toxin, pI | pSheC 11 58%,<br>pSheE 13 100%                      |  |

a -the nomenclature of Ff (M13, fl and fd) phage proteins is used

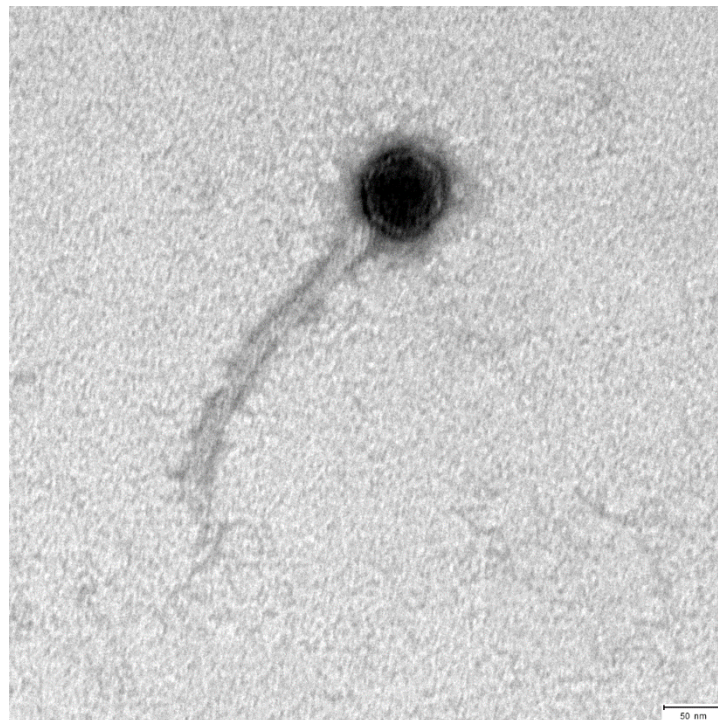
**Table S6.** Biofilm production indicator (OD<sub>570</sub>/OD<sub>600</sub> ratio) values in LB medium and LB supplemented with 5 mM of As(III) or As(V).

| Medium     | Time [hours] |       |       |
|------------|--------------|-------|-------|
|            | 24           | 48    | 72    |
| LB         | 0.769        | 0.597 | 0.293 |
| LB+As(III) | 1.284        | 0.381 | 0.306 |
| LB+As(V)   | 1.516        | 0.344 | 0.218 |

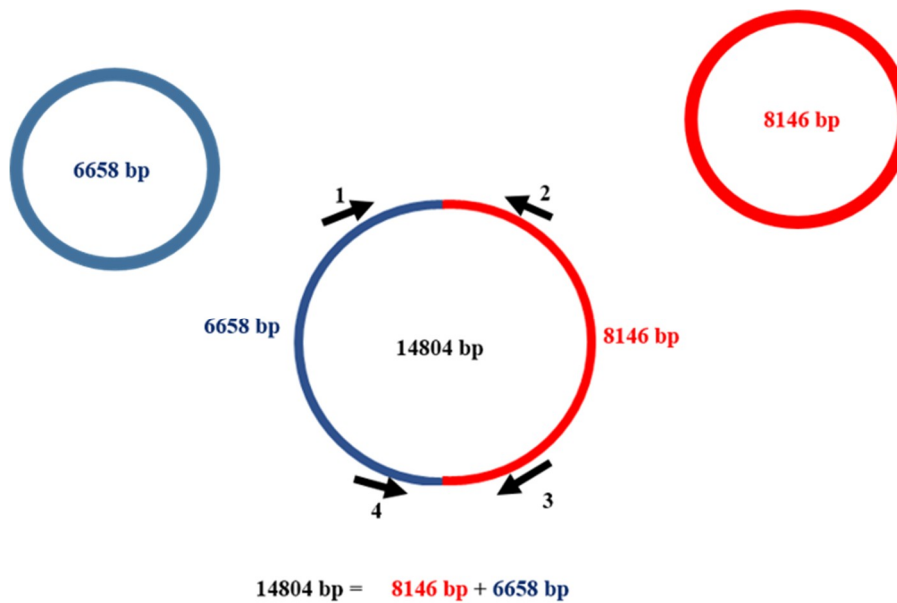
## 2. Supplementary Figures



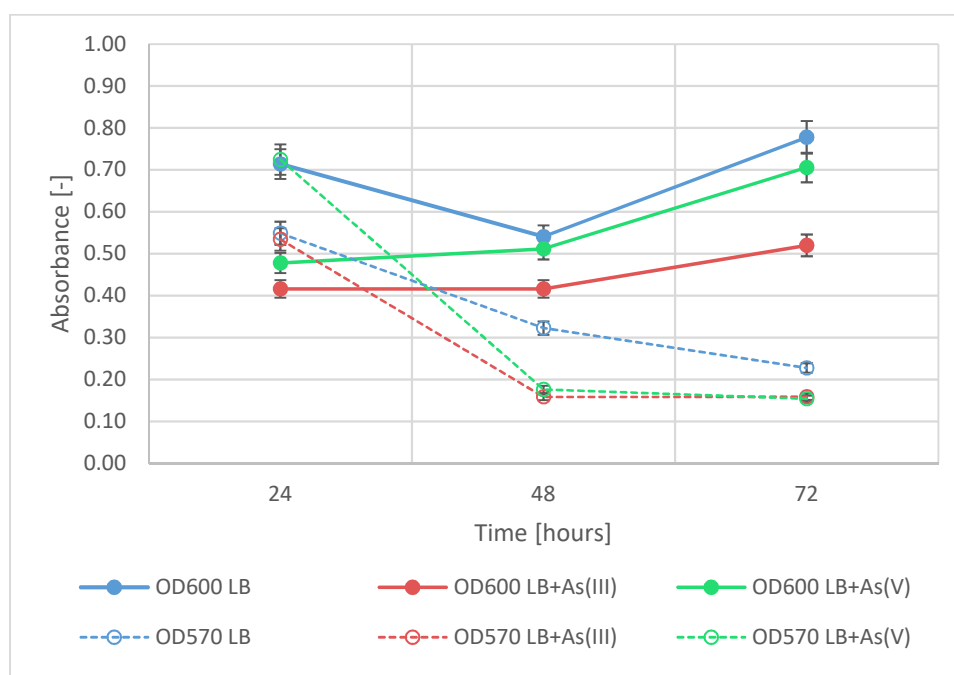
**Figure S1.** Agarose gel electrophoresis of the DNA of extrachromosomal replicons of *Shewanella* sp. O23S. Plasmid pSheD is not visible. Multimer forms of the plasmids pSheC-D can be seen



**Figure S2.** Transmission electron microscopy image of the phage MuSsp1\_O23S of *Shewanella* sp. O23S.



**Figure S3.** Plasmid-like phage pSheE (cointegrate of pSheC and pSheD) identification strategy. Arrows with numbers indicate primers, used in pairs: 1-2, 3-4, 1-4 and 2-3.



**Figure S4.** Changes in optical density of the O23S culture ( $OD_{600 \text{ nm}}$ ) in LB medium (with or without arsenic) and in the number of adherent cells stained with crystal violet ( $OD_{570 \text{ nm}}$ ).

|                        |                                      |                              |                        |                   |  |                                   |                                  |                                      |                     |                   |                 |
|------------------------|--------------------------------------|------------------------------|------------------------|-------------------|--|-----------------------------------|----------------------------------|--------------------------------------|---------------------|-------------------|-----------------|
| Negative Control       | L-Arabinose                          | N-Acetyl-D-Glucosamine       | D-Saccharic Acid       | Succinic Acid     | Succinic Acid                                      | L-Aspartic Acid                   | L-Proline                        | D-Alanine                            | D-Trehalose         | D-Mannose         | Dulcitol        |
| D-Serine               | D-Sorbitol                           | Glycerol                     | L-Fucose               | D-Glucuronic Acid | D-Gluconic Acid                                    | D,L- $\alpha$ -Glycerol-Phosphate | D-Xylose                         | L-Lactic Acid                        | Formic Acid         | D-Mannitol        | L-Glutamic Acid |
| D-Glucose-6-Phosphate  | D-Galactonic Acid- $\gamma$ -Lactone | D,L-Malic Acid               | D-Ribose               | Tween 20          | L-Rhamnose   | D-Fructose                        | Acetic Acid                      | $\alpha$ -D-Glucose                  | Maltose             | D-Melibiose       | Thymidine       |
| L-Asparagine           | D-Aspartic Acid                      | D-Glucosaminic Acid          | 1,2-Propanediol        | Tween 40          | $\alpha$ -Keto-Glutaric Acid                       | $\alpha$ -Keto-Butyric Acid       | $\alpha$ -Methyl-D-Galactoside   | $\alpha$ -D-Lactose                  | Lactulose           | Sucrose           | Uridine         |
| L-Glutamine            | m-Tartaric Acid                      | D-Glucose-1-Phosphate        | D-Fructose-6-Phosphate | Tween 80          | $\alpha$ -Hydroxy Glutaric Acid- $\gamma$ -Lactone | $\alpha$ -Hydroxy Butyric Acid    | $\beta$ -Methyl-D-Glucoside      | Adonitol                             | Maltotriose         | 2-Deoxy Adenosine | Adenosine       |
| Glycyl-L-Aspartic Acid | Citric Acid                          | m-Inositol                   | D-Threonine            | Fumaric Acid      | Bromo Succinic Acid                                | Propionic Acid                    | Mucic Acid                       | Glycolic Acid                        | Glyoxylic Acid      | D-Cellobiose      | Inosine         |
| Glycyl-L-Glutamic Acid | Tricarballic Acid                    | L-Serine                     | L-Threonine            | L-Alanine         | L-Alanyl-Glycine                                   | Acetoacetic Acid                  | N-Acetyl- $\beta$ -D-Mannosamine | Mono Methyl Succinate                | Methyl Pyruvate     | D-Malic Acid      | L-Malic Acid    |
| Glycyl-L-Proline       | p-Hydroxy Phenyl Acetic Acid         | m-Hydroxy Phenyl Acetic Acid | Tyramine               | D-Psicose         | L-Lyxose   | Glucuronamide                     | Pyruvic Acid                     | L-Galactonic Acid- $\gamma$ -Lactone | D-Galacturonic Acid | Phenylethylamine  | 2-Aminoethanol  |

**Figure S5.** Biolog™ PM1 MicroPlate carbon sources analysis for *Shewanella* sp. O23S. Color intensity indicates substrate preference.

|                            |                          |                          |                       |                        |                              |                               |                               |                                   |                              |                              |  |
|----------------------------|--------------------------|--------------------------|-----------------------|------------------------|------------------------------|-------------------------------|-------------------------------|-----------------------------------|------------------------------|------------------------------|--|
| Negative Control           | Chondroitin Sulfate C    | $\alpha$ -Cyclodextrin   | $\beta$ -Cyclodextrin | $\gamma$ -Cyclodextrin | Dextrin                      | Gelatin                       | Glycogen                      | Inulin                            | Laminarin                    | Mannan                       | Pectin                                       |
| N-Acetyl-D-Galactosamine   | N-Acetyl-Neuraminic Acid | $\beta$ -D-Allose        | Amygdalin             | D-Arabinose            | D-Arabitol                   | L-Arabitol                    | Arbutin                       | 2-Deoxy-D-Ribose                  | i-Erythritol                 | D-Fucose                     | 3-O- $\beta$ -D-Galactopyranosyl-D-Arabinose |
| Gentiobiose                | L-Glucose                | Lactitol                 | D-Melezitose          | Maltitol               | $\alpha$ -Methyl-D-Glucoside | $\beta$ -Methyl-D-Galactoside | 3-Methyl Glucose              | $\beta$ -Methyl-D-Glucuronic Acid | $\alpha$ -Methyl-D-Mannoside | $\beta$ -Methyl-D-Xyloside   | Palatinose                                   |
| Raffinose                  | Salicin                  | Sedoheptulosan           | L-Sorbose             | Stachyose              | D-Tagatose                   | Turanose                      | Xylitol                       | N-Acetyl-D-Glucosaminol           | $\gamma$ -Amino Butyric Acid | $\delta$ -Amino Valeric Acid | Butyric Acid                                 |
| Capric Acid                | Caproic Acid             | Citraconic Acid          | Citramalic Acid       | D-Glucosamine          | 2-Hydroxy Benzoic Acid       | 4-Hydroxy Benzoic Acid        | $\beta$ -Hydroxy Butyric Acid | $\gamma$ -Hydroxy Butyric Acid    | $\alpha$ -Keto-Valeric Acid  | Itaconic Acid                | 5-Keto-D-Gluconic Acid                       |
| D-Lactic Acid Methyl Ester | Malonic Acid             | Melibionc Acid           | Oxalic Acid           | Oxalomalic Acid        | Quinic Acid                  | D-Ribono-1,4-Lactone          | Sebacic Acid                  | Sorbic Acid                       | Succinamic Acid              | D-Tartaric Acid              | L-Tartaric Acid                              |
| Acetamide                  | L-Alaninamide            | N-Acetyl-L-Glutamic Acid | L-Arginine            | Glycine                | L-Histidine                  | L-Homoserine                  | Hydroxy-L-Proline             | L-Isoleucine                      | L-Leucine                    | L-Lysine                     | L-Methionine                                 |
| L-Ornithine                | L-Phenylalanine          | L-Pyroglutamic Acid      | L-Valine              | D,L-Carnitine          | Sec-Butylamine               | D,L-Octopamine                | Putrescine                    | Dihydroxy Acetone                 | 2,3-Butanediol               | 2,3-Butanone                 | 3-Hydroxy 2-Butanone                         |

**Figure S6.** Biolog™ PM2A MicroPlate carbon sources analysis for *Shewanella* sp. O23S. Color intensity indicates substrate preference.

|                          |                             |                     |               |                 |                 |                                     |                                |                                |                                    |                                |                                |
|--------------------------|-----------------------------|---------------------|---------------|-----------------|-----------------|-------------------------------------|--------------------------------|--------------------------------|------------------------------------|--------------------------------|--------------------------------|
| Negative Control         | Ammonia                     | Nitrite             | Nitrate       | Urea            | Biuret          | L-Alanine                           | L-Arginine                     | L-Asparagine                   | L-Aspartic Acid                    | L-Cysteine                     | L-Glutamic Acid                |
| L-Glutamine              | Glycine                     | L-Histidine         | L-Isoleucine  | L-Leucine       | L-Lysine        | L-Methionine                        | L-Phenylalanine                | L-Proline                      | L-Serine                           | L-Threonine                    | L-Tryptophan                   |
| L-Tyrosine               | L-Valine                    | D-Alanine           | D-Asparagine  | D-Aspartic Acid | D-Glutamic Acid | D-Lysine                            | D-Serine                       | D-Valine                       | L-Citrulline                       | L-Homoserine                   | L-Ornithine                    |
| N-Acetyl-L-Glutamic Acid | N-Phthaloyl-L-Glutamic Acid | L-Pyroglutamic Acid | Hydroxylamine | Methylamine     | N-Amylamine     | N-Butylamine                        | Ethylamine                     | Ethanolamine                   | Ethylenediamine                    | Putrescine                     | Agmatine                       |
| Histamine                | $\beta$ -Phenylethylamine   | Tyramine            | Acetamide     | Formamide       | Glucuronamide   | D,L-Lactamide                       | D-Glucosamine                  | D-Galactosamine                | D-Mannosamine                      | N-Acetyl-D-Glucosamine         | N-Acetyl-D-Galactosamine       |
| N-Acetyl-D-Mannosamine   | Adenine                     | Adenosine           | Cytidine      | Cytosine        | Guanine         | Guanosine                           | Thymine                        | Thymidine                      | Uracil                             | Uridine                        | Inosine                        |
| Xanthine                 | Xanthosine                  | Uric Acid           | Alloxan       | Allantoin       | Parabanic Acid  | D,L- $\alpha$ -Amino-N-Butyric Acid | $\gamma$ -Amino-N-Butyric Acid | $\delta$ -Amino-N-Caproic Acid | D,L- $\alpha$ -Amino-Caprylic Acid | $\delta$ -Amino-N-Valeric Acid | $\alpha$ -Amino-N-Valeric Acid |
| Ala-Asp                  | Ala-Gln                     | Ala-Glu             | Ala-Gly       | Ala-His         | Ala-Leu         | Ala-Thr                             | Gly-Asn                        | Gly-Gln                        | Gly-Glu                            | Gly-Met                        | Met-Ala                        |

**Figure S7.** Biolog™ PM3B Microplate nitrogen sources analysis for *Shewanella* sp. O23S. Color intensity indicates substrate preference.

|                       |                       |                                   |                             |                               |                           |                              |                               |                            |                               |                                      |                                      |
|-----------------------|-----------------------|-----------------------------------|-----------------------------|-------------------------------|---------------------------|------------------------------|-------------------------------|----------------------------|-------------------------------|--------------------------------------|--------------------------------------|
| Negative Control      | Phosphate             | Pyrophosphate                     | Trimetaphosphate            | Tripolyphosphate              | Triethyl Phosphate        | Hypophosphite                | Adenosine-2'-monophosphate    | Adenosine-3'-monophosphate | Adenosine-5'-monophosphate    | Adenosine-2',3'-cyclic monophosphate | Adenosine-3',5'-cyclic monophosphate |
| Thiophosphate         | Dithiophosphate       | D,L- $\alpha$ -Glycerol Phosphate | $\beta$ -Glycerol Phosphate | Carbamyl Phosphate            | D-2-Phospho-Glyceric Acid | D-3-Phospho-Glyceric Acid    | Guanosine-2'-monophosphate    | Guanosine-3'-monophosphate | Guanosine-5'-monophosphate    | Guanosine-2',3'-cyclic monophosphate | Guanosine-3',5'-cyclic monophosphate |
| Phosphoenol Pyruvate  | Phospho-Glycolic Acid | D-Glucose-1-Phosphate             | D-Glucose-6-Phosphate       | 2-Deoxy-D-Glucose-6-Phosphate | D-Glucosamine-6-Phosphate | 6-Phospho-Gluconic Acid      | Cytidine-2'-monophosphate     | Cytidine-3'-monophosphate  | Cytidine-5'-monophosphate     | Cytidine-2',3'-cyclic monophosphate  | Cytidine-3',5'-cyclic monophosphate  |
| D-Mannose-1-Phosphate | D-Mannose-6-Phosphate | Cysteamine-S-Phosphate            | Phospho-L-Arginine          | O-Phospho-D-Serine            | O-Phospho-L-Serine        | O-Phospho-L-Threonine        | Uridine-2'-monophosphate      | Uridine-3'-monophosphate   | Uridine-5'-monophosphate      | Uridine-2',3'-cyclic monophosphate   | Uridine-3',5'-cyclic monophosphate   |
| O-Phospho-D-Tyrosine  | O-Phospho-L-Tyrosine  | Phosphocreatine                   | Phosphoryl Choline          | O-Phosphoryl-Ethanolamine     | Phosphonoacetic Acid      | 2-Aminoethyl Phosphonic Acid | Methylene Diphosphonic Acid   | Thymidine-3'-monophosphate | Thymidine-5'-monophosphate    | Inositol Hexaphosphate               | Thymidine 3',5'-cyclic monophosphate |
| Negative Control      | Sulfate               | Thiosulfate                       | Tetrathionate               | Thiophosphate                 | Dithiophosphate           | L-Cysteine                   | D-Cysteine                    | L-Cysteinyl-Glycine        | L-Cysteic Acid                | Cysteamine                           | L-Cysteine Sulfinic Acid             |
| N-Acetyl-L-Cysteine   | S-Methyl-L-Cysteine   | Cystathionine                     | Lanthionine                 | Glutathione                   | D,L-Ethionine             | L-Methionine                 | D-Methionine                  | Glycyl-L-Methionine        | N-Acetyl-D,L-Methionine       | L-Methionine Sulfoxide               | L-Methionine Sulfone                 |
| L-Djenkolic Acid      | Thiourea              | 1-Thio- $\beta$ -D-Glucose        | D,L-Lipoamide               | Taurocholic Acid              | Taurine                   | Hypotaurine                  | p-Amino Benzene Sulfonic Acid | Butane Sulfonic Acid       | 2-Hydroxyethane Sulfonic Acid | Methane Sulfonic Acid                | Tetramethylene Sulfone               |

**Figure S8.** Biolog™ PM4A MicroPlate phosphorus (green) and sulfur (orange) sources analysis for *Shewanella* sp. O23S.